Revolt of the Paupers or the Aspiring? Geographic Wealth Dispersion and Conflict[•]

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Abstract

Although income can vary considerably within countries and conflicts zones are rarely typical or representative for states at large, most existing research on development and conflict has neglected spatial differences in the distribution of wealth and only examined national averages. We argue that areas with low absolute income are likely to be more prone to conflict, even if a country's GDP per capita may not be low, and that areas with large income deviations from national averages are more likely to see violence. We test these hypotheses empirically using spatially disaggregated data on income and conflict locations. Our results show that absolute poverty increases the risk that specific areas will see conflict and that relative wealth increases the risk of conflict in poor states. We also scale within-country variation in income up to country profiles, and show that local information on income can improve on conventional country average measures in accounting for conflict.

Introduction

Civil war is by far the most common form of conflict in the contemporary global system. Although civil wars tend to be less intense and claim fewer direct casualties than interstate wars, such conflicts are often very persistent and have proven more difficult to settle. Beyond the direct casualties from conflict, efforts to evaluate the indirect consequences of civil war furthermore find that the negative human and social impacts of civil war are so severe as to constitute “development in reverse” (Collier et al. 2003). Hence, understanding the causes of civil war and what may be done to contain conflict is both valuable in its own right and important for understanding key obstacles to economic development and political reform.

The existing literature on civil war has highlighted as one of its main empirical results how poorer countries are more likely to experience conflict. Prominent examples include Collier and Hoeffler (2004) and Fearon and Laitin (2003), see Miguel and Blattman (forthcoming) for a comprehensive review. This finding has been replicated by many studies, although there is no consensus on the underlying mechanisms that may account for the observed relationship. However, most existing work relating civil war to social and economic conditions thus far have looked at the characteristics of countries at large, even though it is clear that features such as poverty and income tend to vary considerably within country. Moreover, it is easy to show that the areas of a state that see conflict rarely are typical or representative for countries at large (Buhaug and Lujala 2005).

In this paper, we argue that geographical variation in income and wealth within countries is likely to be very influential in shaping the risk of violence and can provide incentives for separatist conflict as well as opportunities for mobilization. We hypothesize that conflict is more likely in areas that have low income, even if a state in general may not be particularly poor, and that countries with large deviations in income are more likely to be prone to conflict, in particular in areas that see large divergences from country averages.

To our knowledge, this article provides the first comprehensive study using geographically disaggregated data on local income and conflict onset location to evaluate hypotheses about geographical dispersion and conflict with a global coverage. Although there exist some previous studies that have attempted to disaggregate the relationship between development and civil war, these studies use either indirect measures of development and/or cover only variation in income and conflict within a restricted set of countries.[1] In contrast, we here assess the risk of conflict onset based on local characteristics, using Geographic Information System (GIS) software and data to convert the earth into grid cells of approximately 50 km x 50 km with local estimates of income and data conflict on conflict onset locations.

Our results show that geographical variation in income indeed is related to the location of conflict onsets. We find that absolute local income levels is associated with a higher risk of conflict onset, and that pockets of wealth in very poor states are more likely to see. We also show that local characteristics are better predictors of conflict than traditional country average or aggregate measures, and that that measures of within country income variation can provide additional information and help better discriminate between the countries that see conflict and those that do not.

The paper is structured as follows. We first provide a brief review of the neglect of geographical variation in existing work on income, inequality, and conflict, and why spatial dispersion in income is plausibly related to conflict. We proceed to demonstrate geographical

[1] Buhaug and Rød's (2006) study of civil war in Africa, considering geographic cells, use road networks as a proxy for development. Østby, Nordås and Rød (2009) construct measures for poverty at the regional level from survey data, but their sample is restricted to 22 African countries. Hegre, Østby and Raleigh (forthcoming) look at local variation in poverty and conflict events in Liberia only.

variation in income empirically. We then turn to develop more fully our theoretical propositions on the specific distributions likely to be related to conflict. Our empirical analysis considers the specific spatial locations where conflicts occur and the relationship to the local distribution of income across smaller geographic cells, and we also as compare profiles reflecting geographical dispersion within countries and conflict to conventional country average and aggregate measures.

Income, poverty, and conflict: The need for spatial disaggregation

We start by a brief overview of existing research on income, poverty, and conflict to motivate our study and justify our claim that geographical variation has been neglected. Many recent studies emphasize the role of economic factors in civil war. Collier et al. (2003), for example, stress the role of opportunities in explaining resort to violence and highlight how wealth and economic factors shape these. From their perspective, civil wars become less likely with higher income and a more developed economy, since the costs for potential insurgents from participating in rebellion will be high in terms of the foregone income, or what they can earn in regular economic activities. Conversely, the risk of civil war will be high when potential insurgents have little to lose from taking up arms and rebellion can be sustained by looting or appropriation during conflict. Collier et al. (2003) consider the negative relationship between a country's per capita income and conflict to provide support for these arguments.

The negative relationship between GDP per capita income and conflict has been replicated in many other comparative studies, although the interpretations of the mechanisms producing the finding often differs. Fearon and Laitin (2003) see GDP per capita as a measure of state strength, and argue that wealthier states see less conflict because they are better able to deter rebellion or conduct efficient counterinsurgency. Another interpretation is that poverty in and of itself may motivate resort to violence (see, e.g., Rice, Graff, and Lewis 2006). Dissatisfaction with current material conditions may lead to increased support for efforts to replace an existing government or for efforts to seek secession, if a sufficient number of actors or groups believe that an area could do better under a different government or by severing its ties to the larger state. Older contributions to the literature on revolutionary violence and secessionist conflict often highlight the role of social and economic grievances and relative deprivation (see, e.g. Gurr, 1970; Hechter 1975). The role of poverty is often dismissed outright in contemporary research on civil war on the basis that grievances are ubiquitous and hence do not allow accounting for why some grievances result in conflict while others do not. This is not necessarily a particularly convincing argument for the irrelevance of poverty or grievances, since the fact that not all low income societies actually see civil war would apply equally to any argument or mechanisms for which GDP per capita is suggested as a proxy.

In our view, studies relating conflict to country-level characteristics suffer from a general conceptual problem, since they aggregate or average features that may vary considerably within countries. Conflict is almost invariably a localized phenomenon that does not engulf entire countries, but normally takes place in particular regions in the periphery of a country that may be quite atypical and often very different from the rest of the country (Buhaug and Lujala 2005). Averaging or aggregating features at the country-level in cross-national studies risks a number of aggregation fallacies in making inferences about factors affecting the likelihood of conflict. This is likely to be highly problematic in studies that examine social and economic factors.

The conflict in Chechnya illustrates the problem of relying on country level measures alone to understand civil war. Fighting in the conflict is mainly confined to the province of Chechnya and neighboring areas in the Caucasus. Yet, by construction, country comparative studies treat all of Russia as "at war" and examine to what extent the presence of conflict in the state can be explained by characteristics of the country at large or national averages. Since Chechnya is a small federal subject and its populace comprises a negligible part of Russia, the area and its inhabitants will have little influence on national income statistics. We lack reliable data on income for Chechnya prior to the conflict, but existing research suggests very large geographical differences in income within the Soviet Union (see Fuchs and Demko 1979; Schroeder 1972). However, national level figures tell us little about the situation in province of Chechnya itself, and are thus unlikely to reflect any economic conditions favoring insurgencies or grievances that may have combined with demands for national autonomy in the onset of the conflict.

The current lack of attention to geographical variation is particularly notable since an earlier tradition of research on secessionism very much emphasized geographical differences in income and wealth.[2] Hecther's (1975) influential book on internal colonialism argued that the economic peripheral status of the Celtic Fringe in Great Britain, rather than primordial nationalist sentiment, was the key driving force towards separatist political activity. Whereas traditional "diffusion" models lead us to expect national assimilation of minorities, peripheral economic status may fuel further ethnic polarization and segmentation that can give rise to nationalism. Hecther argued that industrialization had generally generated assimilation in the English core, but economic development failed to overcome established regional inequalities separating the Celtic periphery and alter the "cultural division of labor".

Other work on ethnicity and nationalism has emphasized the importance of social and economic factors in shaping nationalist sentiment, even if not necessarily going as far as claiming that imperialism drives nationalism, or highlighting nationalism among the aspiring rather than the oppressed. Gourevitch (1979), for example, noted that nationalism had emerged in many affluent or economically dynamic areas that felt undermined by political dominance of economically more backward areas. The modern rise of the Scottish National Party is often similarly attributed the

[2] An important exception is the still unpublished paper by Sambanis and Milanovic (2004) on inter-regional variation in income and separatism.

discovery of oil in the North Sea, which led many to believe that an independent Scotland could do better outside the United Kingdom (Esman 1975).

Although these arguments are set forward to account for nationalism rather than the use of violence, similar arguments have been used to explain the violent breakup of the former Yugoslav republic, explicitly postulated as a critique of the conventional wisdom that these conflicts were caused by ancient hatreds between ethnic groups (e.g., Woodward 1994, 1995). Both relatively wealthier areas such as Slovenia and Croatia as well as poorer areas such as Kosovo saw the development of separatist movements that were prepared to use violence to advance their aims if the center was not willing to grant independence or make concessions to their demands.

The possibility for such regional inequalities to create motives for resort to violence seem very relevant in developing countries. Regional inequalities are often large in developing societies (Kanbur and Venables 2005; Williamson 1965), and since peripheral regions tend to be scarcely populated, they will often exert little influence on national level income statistics. Since most insurgencies take place in the periphery and often mobilize from local networks, concentrated regional inequalities should be more likely to give way to violent conflict than diffuse social inequalities. Many case studies of individual conflicts have found a great deal support for both rich and poor regions mobilizing against the state in developing countries. For example, Humphreys and Mohamed (2005) claim that the severe poverty in the Casamance region in Senegal has been very important for generating the conflict. Furthermore, regional inequality may be relevant even in the absence of sharply drawn pre-existing ethnic differences or traditions. Tadjoeddin (2003), for example, concludes that conflict in Indonesia often involves richer provinces, where inhabitants resist efforts by the center to redistribute the region's wealth to poorer regions. Whether perceived distinctions become considered as "ethnic" may in part depend on conflict and lack of integration (Barth 1969). Accordingly, social and economic differences can be a confounding factor challenging the role often attributed to ethnic exclusion in some recent studies of civil war, focusing on groups and local characteristics (e.g., Buhaug, Cederman, and Rød 2008, Toft 2003). This is especially relevant as these studies to date have not explicitly examined disaggregated social and economic characteristics within countries.

Similar problems of aggregation and lack of regard for the role of geography and spatial variation arise in the study of inequality and conflict. Some studies have dismissed that inequality may influence the prospects for conflict, since there is little evidence that countries with higher income inequality are more prone to conflict (for example, Collier et al. 2003; Fearon and Laitin 2003).[3] Whether this finding is correct or not, however, does not alter the basic fact that these studies all have considered measures of income inequality across individuals such as GINI coefficients or the share of income held by the upper/lower quintiles (see Deininger and Squire 1996). Others argue that whether inequality may give rise to conflict depends crucially on the specific distribution of inequality, or whether inequality overlaps with other relevant political cleavages. Researchers that have examined other horizontal inequalities, or inequalities that coincide with ethnic or regional cleavages, find much stronger evidence for a positive relationship to conflict (see Stewart 2002; Østby 2008; Østby, Nordås, and Rød 2009). However, to our knowledge, no studies have looked systematically at spatial inequalities and conflict on a global basis. Newly developed disaggregated data on both conflict and income, which are described in more detail below, allows us to consider this issue explicitly here.

Figure 1 demonstrates our point about geographical variation in the distribution of income more systematically for the case of Russia and India, using data on per capita income by geographical cells (of appr. 50 X 50 km) based on Nordhaus (2005) that will be explained in more detail later. A Lorenz curve plots the cumulative distribution of income over some unit of

[3] Earlier studies looking at other measures of political violence such as Mueller and Seligson (1988), however, find stronger evidence that more unequal countries are more prone to violence.

observation, in this case geographical cells. A perfectly equal distribution would follow a 45 degree line. By contrast, an unequal distribution of income over units will lead to an observed cumulate distribution that rises much more slowly. The GINI coefficient, a common measure of inequality, is given by the area between the 45 degree line and the cumulative distribution. The spatial Lorenz curves for both Russia and India shown in Figure 1 suggest considerable geographical income dispersion. For example, Figure 1 reveals that the poorest 20% of the geographical cells in Russia hold only about 7.5% of the cumulative share of per capita income, and that a very small number of cells in India lead to a sharp increase in the cumulative in the distribution at the upper end of the income distribution.

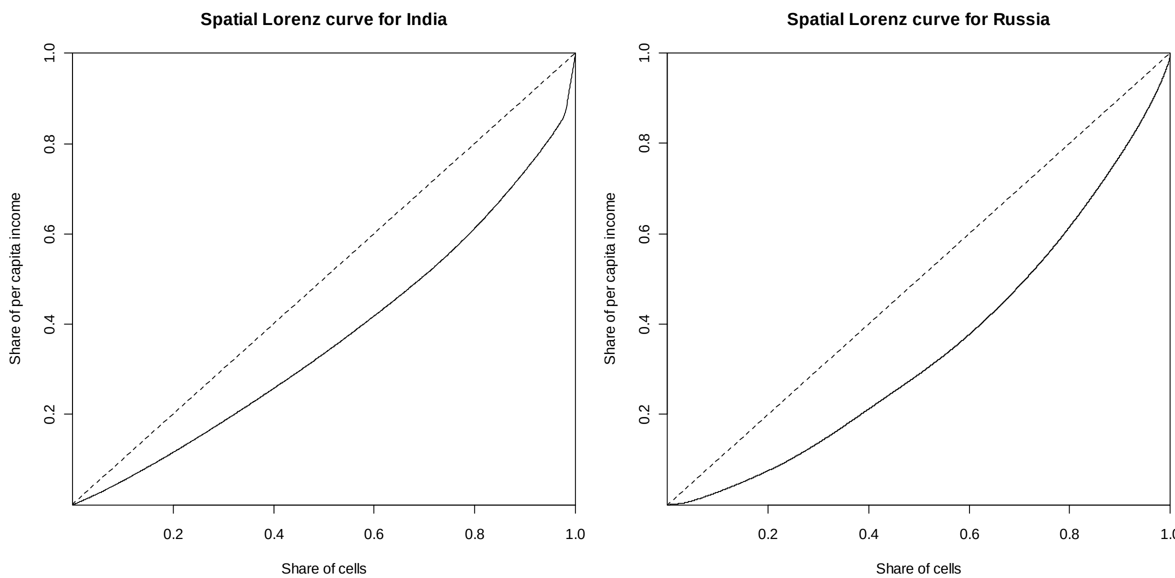

Figure 1: Spatial Lorenz curves for India and Russia 1990, based on Nordhaus (2005)

Figure 2 displays a map of the distribution of per capita income by geographical cells in India, by quartiles of the distribution, using data from Nordhaus (2005). As can be seen, we see much lower income per capita values in the cells in the North Eastern part of the country, where most of the civil wars in India take place. Figure 3 provides an alternative measure of development, i.e., a Human Development Index, plotted for different Indian regions, using data from the 2002

Indian *National Human Development Report*. As can be seen, the overall distribution of the values in Figure 3 displays considerable correspondence with the income distribution in Figure 2 from Nordhaus (2005), although the units for which the HDI measure are available for here pertain to much larger geographical areas, and have missing data for many areas, including the North East, where many of the conflicts have taken place. Likewise, many of the areas such that have recently seen conflict in Russia, such as Chechnya and Dagestan, have per capita incomes far below the national average.

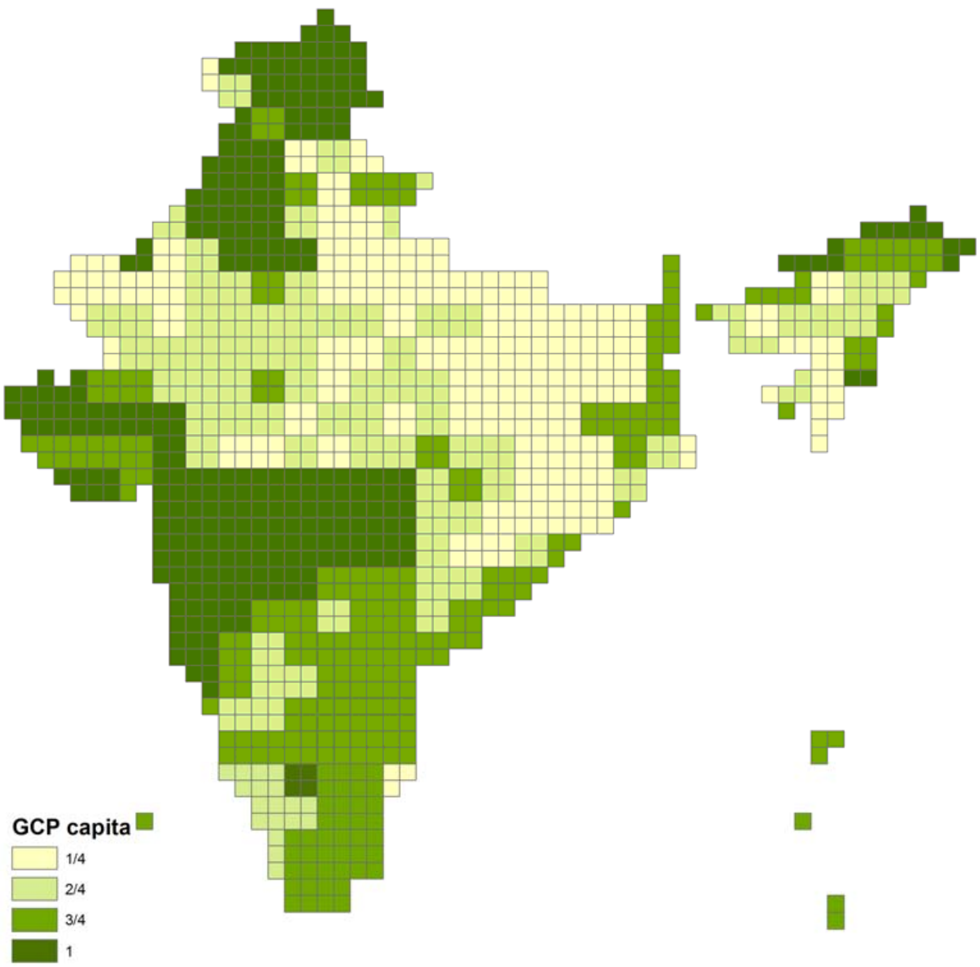

Figure 2: GCP per capita for India by quartiles, 1990, based on Nordhaus (2005)

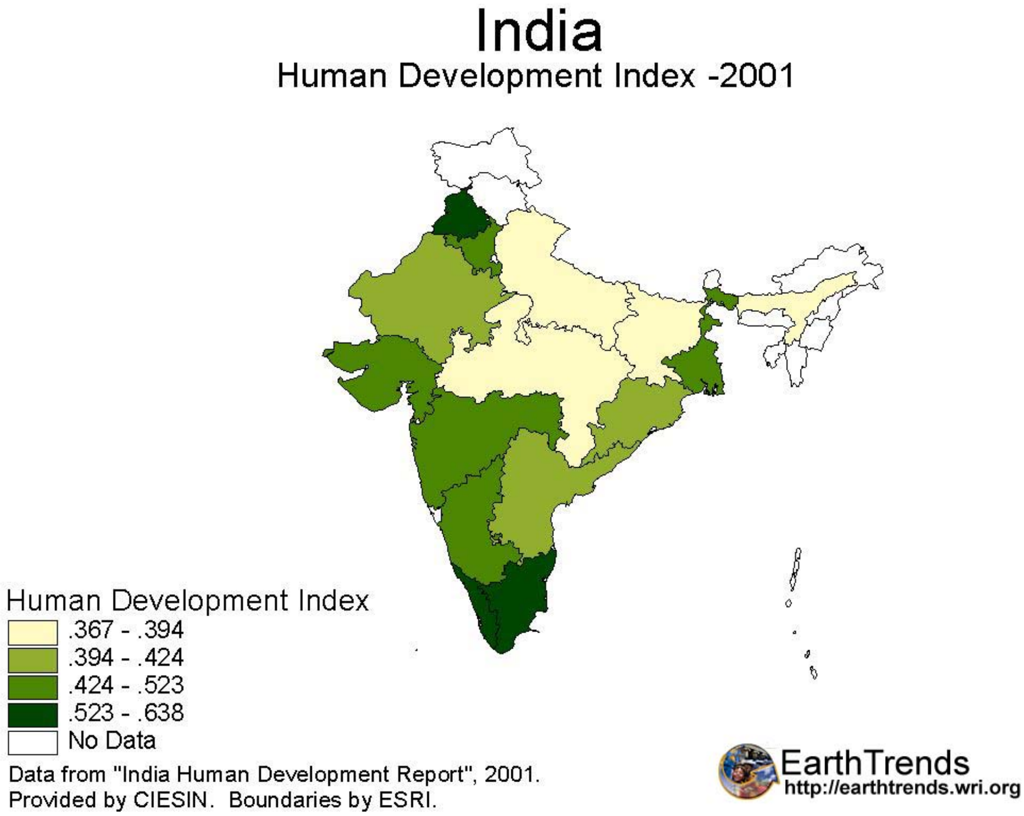

Figure 3: Human Development Index for India, 2001

We conclude that understanding the potential role of income and wealth for the prospects for violent conflict requires us to also consider local variation within countries that may not be discernable in per capita income at the national level. In this paper we examine how both absolute and relative variation in income influence the risk of violent armed conflict. We focus in this article only on the purely geographic income differences in this article, given the turn to completely new subnational income data, and defer to future research the task of examining its relationship to ethnic groups or other social cleavages, as well as variation in state infrastructure or the initial economic resource endowment.

Geographical variation in income, poverty, and conflict

We see several reasons for why spatial variation in absolute and relative income should influence the risk of conflict. First, we may see more violence in areas with lower levels of absolute income, even in countries where average per capita income is not particularly low. There are several possible linkages that could give rise to such a relationship. Low income can generate grievances and separatist incentives, as suggested by Hechter (1975), that in turn may motivate violence. Furthermore, Collier et al.'s (2003) argument that lower economic opportunities increase prospects for mobilization seems much more applicable to local conditions than country averages. Indeed, if the local economic opportunities are the most relevant, then prospects for violent conflict should depend on the weakest link (see Hirshleifer 1983), or the least affluent are of a country, rather than national average income or population weighted GDP per capita. Since national income statistics will be heavily weighted by more populated areas, these can mask considerably internal variation and pockets of poverty with relatively low population density. It is also possible that a relationship between local poverty and conflict could reflect weaker state infrastructure and deterrent capacity in such areas (see Fearon and Laitin 2003), although more capable states least in principle should be able to reallocate resources from elsewhere. Based on the above, we state the following two hypotheses on the local and national level respectively:

H1a: Areas with low per capita income are more likely to see armed civil conflict.

H1b: The risk of armed civil conflict increases with the lowest income area of a country

Hypothesis H1a makes predictions about the specific areas where we are likely to see conflict. Hypothesis H1b makes predictions about conflict risk given country profiles based on disaggregated information. This in turn can be compared to conventional country measures and evaluated relative to the null hypothesis that national level factors better reflect the risk of conflict than local characteristics.

Second, conflict may increase with larger relative differences between different areas of a country. Theories of relative deprivation argue that relative comparisons with others who are better off may inspire radical action and violent political mobilization (Gurr 1970). This suggests that regional variation matters for the risk of conflict not just in terms of the local conditions, but that the relative size of differences may also have an influence. Regional inequality – both positive and negative deviations - can exacerbate regional competition in ways that may lead to armed conflict. First, large inter-regional differences may fuel dissatisfaction and grievance among the poorer regions, which might provide incentives for violent mobilization. Second, inter-regional inequality is often associated with inter-regional transfers from richer to poorer regions. If richer regions view these transfers as too large, they can chose to secede or they can push poorer regions to exit by insisting on a lower transfer rate (Sambanis and Milanovic 2004, 24). Even if grievances are not the primary basis of a conflict, spatial inequalities can still be exploited by conflict entrepreneurs (Stewart 2002). Based on the above, we state the following hypotheses:

H2a: Areas with larger income deviations from the national average have higher risks of armed civil conflict

H2b: Countries with larger spatial income deviations have higher risks of armed civil conflict

Finally, particular forms of spatial inequalities such as pockets of wealth within poor societies can be particularly conflict prone. Although local wealth can generate contention in all states over local versus central control, the effects may be particularly pronounced in poor countries. Collier et al. (2003) stress the role of rent-seeking activities in violent conflict such as crime and looting, as well as the distorting effects that national resource wealth can have in low income countries, often labeled the so-called resource curse (see also Ross 2004). de Soysa (2002) argues that pockets of relative wealth can have a "honey pot" effect, and become particularly attractive targets in conflict. A number of studies have used various measures of valuable commodities or raw materials as proxies for pockets of wealth. With the exception of a quantitative case study of Liberia (Hegre, Østby, and Raleigh forthcoming), we are not aware of any empirical studies that have explicitly considered subnational geographical variation of wealth. The above suggests the following hypotheses:

> *H3a: Pockets of wealth in poor countries are more likely to experience armed civil conflict.*
>
> *H3b: Low income countries with pockets of wealth have a higher risk of armed civil conflict.*

Data and research design

Geographical grid cells and PRIO-GRID

We test our hypotheses using spatially disaggregated data that capture subnational variation in our key variables conflict and economic activity. The main units of analysis that we consider in this paper are geographical grid cells (see also Buhaug and Rød 2006; Nordhaus and Chen 2009). Geographical cells enable researchers to look below the country at large, through scaling information to a common unit of observation, consistently defined. Analysts can then examine whether cells with certain characteristics (or cells proximate to particular characteristics) are more likely to experience violent conflict. We use a new dataset entitled PRIO-GRID that provides a global grid of cells with a resolution of 0.5 decimal degrees (roughly 50 × 50 km at the equator), and partitions the earth's landmass into 62,000 cells in a single cross section. The grid is based on a pseudo-cylindrical projection (Eckert VI), which gives a less distorted two-dimensional representation of the world than e.g. an equal area projection (although cells along the equator will cover a larger area than cells near the poles). PRIO-GRID is stored in a geographic information system (GIS) format, with one shapefile per calendar year (1946–2007).

We would ideally like to have disaggregated economic income data with both a broad temporal and geographic coverage. However, the only feasible alternative existing collection of global economic data is the G-Econ dataset (Nordhaus 2005), which measures the amount of economic output per 1 degree grid cell with global coverage. The global scope of this dataset is quite unique and impressive, and it has gathered a large collection of the best available specific sources on local economic data and converted these to a format allowing meaningful comparisons across countries. However, since these data only exist for one year, 1990, we are constrained to examine a cross-section without over time variation.

Before we proceed to our conflict data we briefly justify our choice of relying on geographical grid cells as units of analysis. Even if one accepts the case for disaggregation, it may be contended that geographical cells are artificial and have no inherent political meaning compared to other alternative disaggregated units such as politically defined regions or the settlement areas of ethnic groups (see Østby, Nordås and Rød 2009 on the former and Buhaug, Cederman and Rød 2008 on the latter). These are clearly valuable alternatives in their own right, but neither seems feasible here. These units are often so large as to mask considerable internal variation, and raise many of the same aggregation problems as country data. Moreover, the size and role of regions varies between countries, and we are not aware of any regional data collected in a manner that allows for cross-country comparisons. Furthermore, the role of regions as well as their boundaries may change over time, and the fact that provinces may emerge as a result of social conflict suggests that partitions often are structured in ways that may be related to conflict. Ethnic categories are often contested, and limiting our sample to ethnic groups would be unfortunate when looking at differences in income and wealth, since many violent conflicts where social economic factors are central in the explicit aims of movements, lack clear ethnic referents (e.g., Marxist insurgencies).

Geocoded conflict data

Our dependent variable is the outbreak of armed intrastate conflict, based on the UCDP/PRIO Armed Conflict Dataset (see Gleditsch et al. 2002, Harbom et al. 2007). Whereas most data on civil conflict contain little information on conflicts beyond stating that a civil war took place in country X in some time interval, the UCDP/PRIO data have recently been expanded by various researchers with additional information, including the location where armed conflict takes place. This information is provided both as polygons indicating the extension of conflicts (see Buhaug and Rød 2006), as well as point data on conflict onset, representing the specific location of fighting on the first day of each conflict (see Holtermann ND). The conflict onset location data were imported into the grid using point coordinates, and each conflict is assigned to the grid cell to which the point coordinates correspond only. We examine whether we see conflict in the following decade following 1990, i.e., 1991–2000.[4]

Changes in the composition of states in the system and their boundaries over the period, and the fact that these often take place in the context of violent conflict, creates some problems in treating this as a simple cross-section. In particular, the former Soviet Union and the Socialist Federal Republic of Yugoslavia split up and several new states emerge over the period. Whereas some conflict outbreaks occur prior to new states achieving independence (e.g., Slovenia and Croatia), others take place or recur after the formal independence of the new state (e.g., the conflict in Bosnia and Herzegovina and the disputed Nagorno-Karabakh region in Azerbaijan). Many conflicts in new states are clear "old" disputes over the dissolution of former states and new boundaries (e.g., the conflict in Bosnia). However, conflicts that occur longer after the dissolution

[4] 12 conflicts were excluded, as it was not possible to assign a precise single location for the onset of violence.

of the former states the such as the Islamic rebellion in Uzbekistan in the late 1990s are perhaps better seen as “new” or independent conflicts, where relative comparisons with 1990 data and capitals may be inappropriate. We have opted for emphasizing the states and boundaries in existence at 1990 and the outset of the period, but we also consider various robustness tests with regards to new nations.

Geocoded income and population data

We use the G-Econ dataset developed by Nordhaus (2005) for measures of local income and variation. This measures the amount of economic output per 1 degree grid cell on a global basis, converted into common metrics using both market exchange rates and purchasing power parity (PPP) exchange rates. The G-Econ project uses different methodologies for deriving estimates for individual countries, depending upon data availability and quality.[5] The gross cell product (GCP) can be seen as the local equivalent of a country wide gross domestic product (GDP), indicating the value of production in each cell. The sum of the GCPs for all cells in a country gives the total GDP. Dividing the GCP for each cell with the estimated population for the cell provides a per capita income measure (GCP per capita). Whereas GDP per capita income provides a population averaged per capita measure for a country, variation in GCP per capita values will reflect spatial variation in income within a country. We also consider the positive and negative deviations between GCP per capita and national GDP per capita, normalized as a proportion of GDP per capita.[6]

[5] The data and methods are described in more detail at http://gecon.yale.edu/.

[6] We separate positive and negative deviations since we do not want to impose symmetry around 0, and scale by GDP per capita since the weight of an absolute difference is likely to differ by overall income. The net difference between the GCP per capita and GDP per capita is problematic, as the effects of differences are unlikely to be linear around 0.

Data on economic activity are obviously not direct measures of household income or living standards. Cells may have high income generated from mining and mineral production, where the main part of the locally generated revenue eventually is distributed elsewhere in the country. However, these issues apply in equal weight to GDP per capita and conventional income measures, and the G-Econ data provide the best available measure for examining the relationship between spatial economic variation and conflict. The only comparable alternative data source that we are aware of is the Global Poverty Data from the Center for International Earth Science Information Network (CIESIN),[7] which contain gridded information on malnutrition and infant mortality for constructed from various sources, including household surveys. However, these data are less helpful for this study, as they are available only for 2000, and we have limited data on conflict after this. Although looking at prior conflict by poverty data for 2000 is potentially problematic, as some values could reflect conflict, we will consider their data on local infant mortality rates as a robustness check.

The G-Econ database is a truly impressive collection. However, as the underlying data vary considerably in quality across space, so will the reliability of the G-Econ data. For many European countries the underlying economic data are highly disaggregated (up to the third-level administrative divisions), but for other countries the data may be given only at the first-level administrative entities, have little variance, or the data themselves may be of very poor or questionable quality. We exclude all observations that are coded as having “low quality” (i.e., quality<2), although we note that there are no armed conflict onsets among such cells. We also exclude cells with no or very low population (population<10,), and cells with a very low proportion of land mass (RIG <0.05), as these are unlikely to see conflict. We provide descriptive statistics by country in Table A1 in the Appendix.

[7] See http://sedac.ciesin.columbia.edu/povmap/methods_global.jsp for further details.

Control variables

We also consider a series of local control variables that may plausibly be associated with variation in both local economic development and conflict. Conflict is more common in the periphery (see Buhaug and Gates 2002), and areas further away from core areas of the country are also likely to be less developed and have lower degrees of penetration by the state. Moreover, conflicts are more common in border locations, which often span groups from neighboring countries and may provide particular opportunities for conflicts (see Salehyan 2009), and in many cases constitute hinterlands that are systematically discriminated by the center. Previous studies have highlighted the role of rough terrain such as mountains and dense forests for the opportunities for conflicts. However, these features may also undermine state formation and economic development (Cederman 2006; Hechter 1975; Rokkan 1999). As such, we include a number of control variables for peripheral cell position, including the (logged) distance from the capital city and borders, as well as the share of a cell area covered by mountains (data from UNEP) and forests (data from FAO). More populated areas may be more likely to experience conflict and may be associated with differences in income, and we thus control for the total population of a cell. Existing work has shown that larger countries have a greater risk of conflict, and country size may also be systematically associated with inter-country variation in income. We thus control for the number of cells in a country (multiplied by 1000 to scale the coefficients so that this can be shown adequately with three digits). Finally, the capital area may have a special political significance that makes it more likely to become target for violent dissent, irrespective of its social and economic characteristics. We introduce a dummy variable indicating whether cells are national capitals, since these may be more prone to conflict than would be expected from its income levels.

Population and case control analysis

The full population at risk of civil conflict is in principle all populated and non-negligible grid cells in all independent states post 1990 for which we have data. However, although the total N given by the number of these cells may appear very large, many of the features that we are interested in are likely to display strong spatial correlation. This implies that the cells are unlikely to be independent of another; The independent information from additional neighboring cells often is negligible. We would be likely to underestimate the standard errors, and our coefficient estimates would not be efficient in the presence of spatial correlation (see Cressie 1991). The problem of spatial correlation declining information from nearby cells is in particular applicable for the large number of non-onset cells that dominate the sample. To address these issues, we use logistic regression with a case-control design (see King and Zeng 2001), where we compare onset cells to a random sample of non-onset observations. This approach is valid since the effects on odds estimated by logit are invariant to changes in the marginal totals, in the sense that the estimated coefficients of covariates on the log odds of the event of interest are not influenced by the relative share of 1s and 0s in the sample.[8] Using a random sample of the non-onset cases ensures a sample that is representative of the population, but unlikely to include neighboring values that are very similar to one another and hence do not contribute any additional information. Designating a single cell as the onset location implies that we disregard the eventual spatial escalation of the conflict. Since it may well be that many of the areas that see conflict after onset may resemble the original conflict onset locations, it would be unfortunate to treat these as non-conflict location. We therefore draw the sample of

[8] The coefficient for the intercept, of course, will be affected, and must be adjusted for the relative share of 1s and 0s in the population for deriving predicted probabilities. More specifically, we must use an adjusted intercept estimate $\beta_o = \hat{\beta}_0 - \ln\left[\left(\frac{1-\tau}{\tau}\right)\left(\frac{\bar{y}}{1-\bar{y}}\right)\right]$, where τ is the proportion of 1s in the population and $\bar{y}$ is the proportion of 1s in the estimation sample.

comparison cases so as to exclude cells that become part of the larger spatial extent of the conflict, as given by the full conflict polygon data.

Empirical Analysis

Descriptive statistics

We start by providing some simple descriptive statistics on conflict and violence. Table 1 lists the GCP per capita for all of the onset cells in our data, labeled by geographic region, along with the respective countries' overall GDP per capita, ordered by the GCP per capita. Table 1 clearly suggests spatial patterns in conflict and spatial variation income consistent with our previous arguments. Most of the civil conflict onsets take place in low income countries. However, it is also clear that the overwhelming majority of conflict locations have a GCP per capita value that is much lower than the country's GDP per capita. Conflicts are not exclusively confined to low income countries, and the values of the observed GCP per capita of some of the conflict locations in countries that are fare more conflict prone than one would expect from their relatively higher national income countries are indeed far below national GDP per capita. For example, Russia would not seem a particularly poor country based on its overall GDP per capita, but the conflicts in the Caucasus take place in very poor regions with a per capita cell income a fraction of the country average. Moreover, we see some examples of conflicts taking place in comparatively wealthy areas in very poor states, and urban conflicts and initial attacks in cities generally also occur in locations with above average income. Although Table 1 is suggestive with regards to how income deviates from national averages in conflict locations, looking only at conflict cases is subject to the usual problems of selecting on the dependent variable, since we cannot tell what the spatial distribution of income may look like for the cells where we do not observe conflict.

Analysis of conflict onset location by cell

Table 2 provides the results for a logistic regression of cell characteristics on conflict onset, based on the randomly drawn case control sample for comparing onset cells to cells without conflict. Model 1 in Table 2 considers only the absolute cell GCP per capita value. As can be seen, consistent with H1a, we find a clear and statistically significant negative effect on the log odds of conflict with higher logged GCP per capita, indicating that cells with low absolute income have a higher risk of conflict onset.

Model 2 in Table 2 shows the results adding national level GDP per capita to the previous Model 1. As can be seen, adding national level GDP per capita to the model with specific cell GCP per capita returns an estimated coefficient that is negative, but not statistically significant. Note also that the size of the coefficient for GDP per capita is much lower than the local GCP per capita coefficient. Comparing the fit measures for the two models further indicates that adding national level GDP per capita does not improve notably on Model 1 with just the cell specific income measure. Hence, we find that spatial variation is important; Low income cells have a high risk of conflict compared to high income cells, and this holds even when we control for a country's per capita income. Local variation seems clearly relevant for the prospects for violent conflict, and predictions of conflict risks based on national averages and local conditions can reach very different conclusions.

Table 1: List of onset locations (1991-2000), sorted by GCP per capita (1990)

Country	Location name	GCP pc	GDP pc
Ethiopia	Borena district	262.27	432.11
Ethiopia	Ogaden (region)	375.35	432.11
Democratic Republic of Congo	Sud-Kivu	392.67	492.91
Uganda	Gulu	408.61	472.87
Burundi	Bujumbura	420.85	422.88
Ethiopia	Afar region	469.53	432.11
Guinea-Bissau	Bissau	522.86	531.98
Chad	Oumou	533.84	853.68
Sierra Leone	Kailahun district	537.47	537.42
Rwanda	Kinigi	589.82	589.84
Togo	Lome	741.33	736.08
Mali	Gao	786.36	662.81
Guinea	Macenta	796.42	796.02
India	Tripura (state)	849.14	1052.33
Niger	Aderbissinat	900.38	604.29
India	Nagaland	902.32	1052.33
United Kingdom	Omagh	908.60	20008.80
India	Assam (state)	932.28	1052.33
India	Manipur (state)	1049.78	1052.33
Niger	Air mountains	1054.34	604.29
Philippines	Mindanao	1086.67	2144.54
Comoros	Mutsamudu	1108.42	1075.01
Arab Republic of Yemen	Amran	1469.47	1580.54
Lesotho	Lesotho	1510.00	1463.56
Russia (Soviet Union)	Chechnya	1623.13	11178.25
Russia (Soviet Union)	Botlikh area	1623.13	11178.25
Angola		1792.84	2292.86
Angola	Andulo	1805.45	2292.86
Uzbekistan	Tashkent province	1842.54	1691.42
Azerbaijan	Nagorno Karabakh	2008.35	2012.40
Azerbaijan	Gandja	2089.23	2012.40
Liberia	Zorzor	2298.26	2304.00
Russia (Soviet Union)	Karamakhi	2364.59	11178.25
Congo	Brazzaville	2512.81	2506.09
Djibouti	Tadjoura	2593.45	2605.05
Djibouti	Medeho	2593.45	2605.05
Indonesia	Aceh province	2615.75	1765.29
Tajikistan	Kurgan-Tyube (area)	2709.67	2719.60
Niger	Libyan border area	3231.97	604.29
Yugoslavia (Serbia)	Likosane	3260.43	3260.36
Iran	Western Iran (near Iraq)	3325.68	5558.88
Moldova	Dubossary	3423.58	3423.85
Algeria	El Oued	4176.44	4492.33
Mexico	San Cristobal	4334.57	7870.10
Georgia	South Ossetia	4516.09	4703.17
Georgia	Tblisi	4665.75	4703.17
Georgia	Sokhumi	5058.04	4703.17
Iran	Kurdistan region	5427.39	5558.88
Pakistan	Karachi	5487.50	1552.85
Bosnia and Herzegovina	Bosnia and Hercegovina	5876.52	6545.66
Venezuela	Caracas	8008.25	8312.17
Yugoslavia	Slovenia	9368.15	12530.91
Russia (Soviet Union)	Moscow	9766.62	11178.25
Croatia	Slavonia region	14302.48	9998.75
Israel	Jerusalem	14658.92	15244.87
Bosnia and Herzegovina	Bihac	16403.68	9998.75
Spain	San Sebastian	22253.35	17281.18

Table 2: Logit regressions of conflict onset locations, case control sample

	Model 1			Model 2			Model 3		
	Coef.	SE	Z	Coef.	SE	Z	Coef.	SE	Z
Intercept	4.488	1.001	4.482	4.594	1.030	4.458	4.350	2.607	1.668
Ln GCP pc	-0.746	0.127	-5.884	-0.628	0.310	-2.025	-0.599	0.185	-3.245
Ln GDP pc				-0.130	0.311	-0.417			
Positive income deviations							0.073	0.436	0.169
Negative income deviations							0.673	0.887	0.760
Pos. inc. dev * LDC							1.440	0.618	2.328
Ln distance to border (+1)							-1.730	0.419	-4.132
Ln distance to capital (+1)							-0.769	0.241	-3.196
Capital city							-0.339	1.068	-0.317
Forrest cover (%)							0.002	0.005	0.346
Mountainous terrain (%)							0.022	0.005	4.152
Ln Population							0.327	0.097	3.368
No. of cells (*1000)							0.200	0.501	3.948
N	342			342			342		
Log likelihood	-133.4576 (df=2)			-133.3697 (df=3)			-90.51221 (df=12)		
LR Chi-Square	41.26 (df=1)			41.44 (df=2)			127.16 (df=11)		
AIC	270.92			272.74			205.02		

Model 3 introduces two measures of geographical deviations in income for cells relative to country per capita, along with a number of control variables that we have argued could be plausibly related to both income and conflict. We drop the insignificant national level GDP per capita when introducing the deviation terms, since including this would make the coefficients difficult to interpret. Finally, we include an interaction between positive relative income deviations and a dummy for least developed country, based on the suggested World Bank definition of per country capita income of less than $750. At a first glance, our results provide much less support for the claim that the relative magnitude of spatial variation matters, even if the absolute level of spatial variation in income continues to have a significant effect. The terms for positive and negative relative income deviations between cell and country per capita income both have positive estimated coefficients, but the terms are not statistically significant. Hence, there is little evidence for a consistent relationship between deviations in income from the national average and conflict, once we consider the absolute cell income, for countries that are not among the least developed.[9]

Note, however, that the estimated coefficient interactive term shows that positive deviations do have a significant positive effect on conflict in the least developed countries.[10] This is consistent with the claim that pockets of wealth in very poor countries indeed are more likely to see conflict. Indeed, considering the two estimates jointly for least developed countries, a substantially higher GCP per capita than national GDP per capita is associated with a higher rather than smaller risk of conflict, as one would expect from a higher absolute GCP per capita alone. This does not refer to an

[9] We have also considered various alternative specifications of the size of deviations, including the absolute magnitude irrespective of sign or the net difference, but these do not yield substantively different conclusions with regards to evidence for effects of relative difference.

[10] We have also considered an interactive term for negative income deviations and LDC, but this was not statistically significant.

empty or very small set; GCP per capita is higher than GDP per capita for 1268 cells in least developed countries with a national GDP per capita of less than $750. Of these cells, 7 see conflict onsets. This is over five times the rate of onset that we see in the sample at large.

Adding the control variables suggests that other cell characteristics indeed may have independent effects on the risk of conflict. But even if these may be related to geographical variation in income, including these characteristics directly in the regression does not alter our basic findings with respect to the impact of GCP per capita income. With regards to the findings for the control variables, our results suggest that size matters and that larger countries are more prone to conflict. Both the estimated coefficients for higher cell population as well as the total number of cells in the country are positive and significant. Moreover, we find a great deal of support for the idea that more peripheral areas can be more prone to conflict, since cells that are closer to international borders and cells that have a higher share of mountainous terrain are both more likely to see conflict onset. However, the coefficient for distance to the capital actually has a negative sign rather than the positive sign that we would expect if areas further from the capital become increasingly more peripheral. It is possible that although conflict may be more likely to take place and spread to areas further from the capital once started, the most remote areas are not necessarily those most at risk for the initial onset.[11] The coefficients for share of cell with forest cover and capital city locations are not significant. However, we note that there are only 7 capital city cells in our sample (of which we see conflict in 4).

[11] Adding a squared term of distance to the capital suggests that the relationship may be non-monotonic, and that conflicts are more likely to break out some distance from rather than in or very far away from national capitals. However, although both these terms are significant, the overall measures of fit do not suggest that adding a square term for distance to the capital improves notably on the model.

We have considered various robustness tests to ensure that are results cannot be considered artifacts of the specific measures used, or reflecting idiosyncrasies due to specific observations, countries, or events after the end of the Cold War. First, we have replaced some onset cells with suspicious values with averages of neighboring cells (e.g., the cell for Omagh in Table 1), but find that these do not change our results.[12] Second, to ensure that our results are not determined exclusively by observations from the former Soviet Union and the Federal Socialist Republic of Yugoslavia, we omit in Model 4 all states that see border changes over the period under analysis (i.e., USSR, Yugoslavia, as well as Ethiopia). Doing so forces us to exclude a number of onsets, and we note that the size of the USSR means that the country is also much more likely to provide non-conflict onset cells in a random sample. The results for Model 4 show that our findings are not an artifact from including these countries. If anything, the estimated coefficients or effects on the log-odds of conflict are larger when excluding these states, both for the absolute cell income per capita as well as the effect of positive relative income deviations in the least developed countries. We have also tried to exclude only cells located in successor states, and this does not change the substantive conclusions of our analysis with regards to variation in absolute local income and relative income deviations within countries. The results for other variables remain generally consistent when excluding states with major changes. The coefficient for the number of cells actually switches sign when we exclude the Soviet Union, probably reflecting the fact that other large states in terms of area such as Canada and the United States do not see conflict over this period. Moreover, the coefficient estimate for capital city cells becomes positive and statistically significant.

[12] These results are available on request.

Table 3: Additional robustness checks, conflict onset cells

	Model 4			Model 5			Model 6		
	Coef.	SE	Z	Coef.	SE	Z	Coef.	SE	Z
Intercept	0.794	3.583	0.222	-6.888	2.550	-2.701	-1.741	1.964	-0.887
Ln GCP pc	-1.218	0.283	-4.310				-0.569	0.138	-4.128
Ln infant mortality rate				0.821	0.228	3.594			
Positive income deviations	0.018	0.441	0.042	-0.160	0.519	-0.308	-0.069	0.446	-0.155
Negative income deviations	1.022	1.295	0.789	0.487	1.023	0.476	0.389	0.781	0.498
Pos. inc. dev * LDC	4.656	2.535	1.837	1.510	0.679	2.225	1.120	0.480	2.333
Ln distance to border (+1)	-2.269	0.827	-2.744	-1.854	0.451	-4.110	-1.383	0.289	-4.784
Ln distance to capital (+1)	0.477	0.364	1.311	-0.685	0.250	-2.743	-0.555	0.159	-3.488
Capital city	4.063	1.647	2.467	-0.364	1.088	-0.335	1.068	0.652	1.639
Forrest cover (%)	-0.008	0.007	-1.134	0.002	0.005	0.386	0.000	0.004	-0.030
Mountainous terrain (%)	0.021	0.007	2.882	0.022	0.005	4.027	0.016	0.003	4.811
Ln Population	0.503	0.169	2.985	0.429	0.104	4.123	0.252	0.071	3.542
No. of cells (*1000)	-1.551	0.567	-2.735	0.178	0.052	3.448	0.174	0.038	4.636
N	240			342			55,677		
Log likelihood	-51.54086 (df=12)			-84.245 (df=12)			-378.9228 (df=12)		
LR Chi-Square	113.19 (df=11)			128.88 (df=11)			140.9 (df=11)		
AIC	127.08			192.49			781.85		

In Model 5 we re-estimate the previous Model 4 using infant mortality rates rather then GCP per capita measure of income from the Nordhaus G-Econ data. In this case, we find a significant positive coefficient, which implies that areas with higher infant mortality appear to have a higher risk of conflict onset. Adjusting for the change sign, since higher infant mortality rates implies that areas are less developed, this is fully consistent with our previous findings that less developed cells are more prone to conflict. Moreover, our findings with regards to the impact of relative geographic deviations in income and pockets of wealth in developing countries do not change when using infant mortality rates rather than GCP per capita as a measure of absolute local development.[13] Even though these refer to a different time period, one would generally expect patterns of inequality to be persistent, and change only slowly over time (see Ahluwalia 1976). Finally, the results for the other control variables do not change notably in the model with infant mortality rates compared to the results with cell specific income per capita measures from the G-ECON data.

It is possible that our results may stem from idiosyncrasies of our sample of control cases. Other random samples yield similar results, but given the large imbalance between the small number of conflict onset cells and the many non-conflict onset cells, it is still possible that there could exist particular extreme values in the full population that could have a large impact on the estimated results, yet be unlikely to be included in the full sample. Model 6 re-estimates our model on the full sample of cells for which we have data. Although the standard errors of these estimates are likely to be too small, reflecting that the effective N is lower than the absolute N in the presence

[13] We also considered relative deviations in infant mortality rates from the national average. These estimates suggest that areas with higher than average infant mortality are significantly more likely to see conflict. However, an interaction term between the LDC dummy and negative infant mortality rate deviations (i.e., lower rate than the national average) cannot be estimated, since NO such areas exist for any LDC in our estimation sample.

of spatial correlation among neighboring cells, these results are generally qualitatively similar to our result using the case control design. This in turn suggests that there is no reason to suspect that our reported results and analyses are particularly sensitive to sampling or the influence of particular data points.

Country level analysis

Predicting the geographic location of conflict onsets is in itself a rather different research question than previous studies that have examine whether income or development helps account for a country's risk of civil war. Moreover, the research design used here, based on geographic cells and local characteristics, is very different from previous studies of civil war that focused on accounting for which countries see war and which do not. As such, to compare the role of within country variation in income more directly with standard country-level measures, we now turn to look at whether the disaggregated information in our social and economic data can provide additional information that may help in predicting what countries are more likely to see conflict. Based on the idea of a weakest link technology governing the risk of conflict, the most direct way to consider the effect of cells with low absolute GCP per capita in a country profile is the minimum cell GCP per capita value. Similarly, the log of maximum GCP per capita value can help identify risk in terms of pockets of wealth in poor societies. Capturing cell variation for country profiles is somewhat more complicated since we need to reduce variation across many values to one. Here we consider the standard deviation as a possible measure (normalized by the number of cells, since the number of observations varies considerably for countries in the data due to size differences).

Table 4: Logit regressions of conflict onset, country level

	Model 1			Model 2			Model 3		
	Coef.	SE	Z	Coef.	SE	Z	Coef.	SE	Z
Intercept	3.482	1.239	2.809	4.592	1.731	2.653	0.519	4.711	0.11
Ln min. GCP pc	-0.708	0.183	-3.869	-0.636	0.199	-3.192	-0.857	0.289	-2.959
Ln GDP pc				-0.206	0.218	-0.948	-0.410	0.508	-0.807
LDC * ln max. GCP pc							1.662	1.304	1.275
Cell variance scaled							2.839	2.133	1.331
Ln No. of cells							-0.418	0.305	-1.371
Ln Population							0.574	0.288	1.994
Ln mountainous terrain							0.246	0.208	1.185
Non-contiguous							1.725	0.933	1.849
Oil-producing state							0.774	0.852	0.908
New state							-13.907	1455.4	-0.01
Instability							-0.197	0.846	-0.233
Polity II							0.126	0.059	2.117
Ethnic fractionalization							1.854	1.093	1.697
Religious fractionalization							0.851	1.503	0.566
N		149			149			132	
Log likelihood		-63.66 (df=2)			-63.20 (df=3)			-46.38 (df=15)	
LR Chi-Square		19.56 (df=1)			20.47 (df=2)			46.24 (df=14)	
AIC		131.31			132.40			122.76	

Model 1 in Table 4 indicates that the minimum value of GCP per capita for the cells in a country has a negative and statistically estimated coefficient on the risk of conflict. In Model 2 we expand the regression model to include country GDP per capita. Although GDP per capita also has a negative estimated coefficient on the risk of conflict, the coefficient is much smaller than that of minim GCP per capita and the coefficient estimate is not significantly different from 0. This provides support for our argument that spatial variation is very important; Conflict onsets are more strongly related to local characteristics than average or aggregate country profiles, and the characteristics of the specific locations where conflict break out may not be well approximated by conventional measures that are based on population averaged or country aggregate measures, which ignore within country variation.

Model 3 introduces the tentative measures of within country cell variation discussed previously. We also introduce a number of control variables at the country level from Fearon and Laitin's (2003) prominent study of civil war to ensure that our results do not simply reflect other country characteristics that influence civil war and may be associated with our explanatory variables. As can be seen, we continue to find a significant negative effect from the minimum GCP for a country, while national level GDP per capita – the key variable highlighted by Fearon and Laitin – is less than half the size of minimum cell GCP and far from statistical significance. The coefficient estimates for our other measures of geographical dispersion have positive signs, although they do not achieve statistical significance at conventional levels. We note, however, that the N here is very low, and that we only have a single cross section with a limited number of conflict onsets and comparison cases. Moreover, our suggested measures of within country variation in income have ratios of coefficients to their standard errors that are higher than that of national level GDP per capita, and larger than many of the features highlighted by Fearon and Laitin such as the proportion of mountainous terrain. Indeed, of their ten suggested explanatory variables, only three approach significance at the 0.05 level here. As such, it is very difficult to argue that they receive less support than other features emphasized in existing country comparative work, and it is probably not wise to conclude too much from significance tests for the relatively restricted sample. Although this analysis only covers a cross-section, we see our results as providing strongly support for that measures reflecting within country variation also can be very helpful at the country level, and can improve on our ability to predict the country profiles at greater risk of conflict.. Beyond our specific application to income, local measures can reveal important features that would not be apparent from national aggregates or averages.

Conclusion

Although most existing work on income and civil war has examined only country level features, it is clear that there is considerable geographical variation in social and economic characteristics within many countries and that conflict locations rarely are typical or representative of nations at large. We have argued that this lack of attention to spatial variation is unfortunate; Income varies considerably within countries in ways that are likely to be influential for conflict, and existing findings on income and conflict are ambiguous with regards to what areas see conflicts and whether national averages are appropriate for capturing local conditions. Using disaggregated data on income and conflict we find evidence for our claim that the absolutely poorest areas are more prone to conflict, even if national level income is not particularly low. Moreover, we also find evidence that pockets of wealth within low income countries are more likely to see conflict. Finally, we show that within country variation is helpful not only for understanding locations of conflict onset, but that this information can be scaled up to country level profiles and improve on the ability to identify where we see conflict.

There are clearly many limitations in the existing disaggregated income data that we have used here. The fact that we have income data only for a single year implies that our results could be sensitive to idiosyncrasies in this particular time period. However, many of the same data problems apply in equal measure in data for countries. We are optimistic that future developments of disaggregated economic and social data may allow expanding the domain of this study in time and space. Furthermore, it may be possible to get additional estimates for longer time series for individual countries, and possible locally varying features that can help instrument for both persistent inequalities and more short term influences on economic growth. Future research should also consider group-based analyses and explore how ethnic or other social cleavages in society might influence the relationship between spatial inequalities and conflict, or to what extent ethnic and economic differences overlap geographically. Finally, future studies should investigate the impact of state infrastructure or the initial economic resource endowment on the risk of conflict. For now, however, we conclude that location variation in income appears to be closely related to conflict, and greater use of this information is likely to be more helpful for understanding civil war than additional regressions with the same country level data.

References

Ahluwalia, Montek S. 1976. "Inequality, Poverty and Development." *Journal of Development Economics* 3 (2): 307–342

Buhaug, Halvard, and Scott Gates. 2002. "The Geography of Civil War." *Journal of Peace Research* 39 (4): 417–433.

Buhaug, Halvard, and Päivi Lujala. 2005. "Accounting for Scale: Measuring Geography in Quantitative Studies of Civil War." *Political Geography* 24 (4): 399–418.

Buhaug, Halvard, and Jan Ketil Rød. 2006. "Local Determinants of African Civil Wars, 1970–2001." *Political Geography* 25 (3): 315–335.

Buhaug, Halvard, Lars-Erik Cederman, and Jan Ketil Rød. 2008. "Disaggregating Ethno-Nationalist Civil Wars: A Dyadic Test of Exclusion Theory." *International Organization* 62 (3): 531–551.

Cederman, Lars-Erik. 2008. "Articulating the Geo-Cultural Logic of Nationalist Insurgency." In *Order, Conflict, and Violence*, ed. Stathis N. Kalyvas, Ian Shapiro, and Tarek Masoud. Cambridge: Cambridge University Press.

Collier, Paul, Lani Elliott, Håvard Hegre, Anke Hoeffler, Marta Reynal-Querol, and Nicholas Sambanis. 2003. *Breaking the Conflict Trap: Civil War and Development Policy.* Oxford University Press and Washington, DC: World Bank, online at http://econ.worldbank.org/prr/CivilWarPRR/.

Collier, Paul, and Anke Hoeffler. 2004. "Greed and Grievance in Civil War." *Oxford Economic Papers* 56 (4): 663–595.

Cressie, Noel. 1991. *Statistics for Spatial Data.* New York: Wiley.

Deininger, Klaus, and Lynn Squire. 1996. "A New Data Set: Measuring Income Inequality." *World Bank Economic Review* 10 (3): 565–591.

de Soysa, Indra. 2002. “Paradise is a Bazaar? Greed, Creed, and Governance in Civil War, 1989–99.” *Journal of Peace Research* 39 (4): 395–416.

Esman, Milton J. 1975. “Scottish Nationalism, North Sea Oil, and the British Response.” In *Ethnic Conflict in the Western World*, ed. Milton J. Esman. Ithaca, NY: Cornell University Press, pp. 251–286.

Fearon, James D., and David D. Laitin. 2003. “Ethnicity, Insurgency, and Civil War.” *American Political Science Review* 97 (1): 75–90.

Fuchs, Roland J., and George J. Demko. 1979. “Geographic Inequality under Socialism.” *Annals of the Association of American Geographers* 69 (2): 304–318.

Gleditsch, Nils P., Peter Wallensteen, Michael Eriksson, Margareta Sollenberg, and Håvard Strand. 2002. “Armed Conflict 1946–2001: A New Dataset.” *Journal of Peace Research* 39 (5): 615–637.

Gourevitch, Peter. 1979. “The Re-emergence of 'Peripheral Nationalism': Some Comparative Speculations on the Spatial Distribution of Political Leadership and Economic Growth.” *Comparative Studies in Society and History* 21 (2): 303–322.

Gurr, Ted Robert. 1970. *Why Men Rebel.* Princeton, NJ: Princeton University Press.

Harbom, Lotta, and Peter Wallensteen. 2007. “Armed Conflict 1989–2006.” *Journal of Peace Research* 44 (5): 623–634.

Hechter, Michael. 1975. *Internal Colonialism: The Celtic Fringe in British National Development, 1536–1966*. Berkeley, CA: University of California Press.

Hegre, Håvard; Gudrun Østby, and Clionadh Raleigh. Forthcoming. “Poverty and Civil War Events: A Disaggregated Study of Liberia.” *Journal of Conflict Resolution.*

Hirshleifer, Jack. 1983. “From Weakest-Link to Best-Shot: The Voluntary Provision of Public Goods.” *Public Choice* 41 (3): 371–386.

Holtermann, Helge. ND. “Onset Location Data.” Unpublished Data Source, Centre for the Study of Civil War, PRIO.

Humphreys, Macartan, and Habaye ag Mohamed. 2005. “Senegal and Mali: A Comparative Study of Rebellions in West Africa.” In *Understanding Civil War in Africa: Evidence and Analysis,* ed. Paul Collier, and Nicholas Sambanis.Washington, DC: World Bank, pp. 247–302.

Kanbur, Ravi, and Tony Venables. 2005. “Introduction: Spatial Inequality and Development.” *Journal of Economic Geography* 5 (1): 1–2.

King, Gary, and Langche Zeng. 2001. “Logistic Regression in Rare Events Data.” *Political Analysis* 9 (2): 137–163.

Miguel, Edward, and Christopher Blattman. Forthcoming. “Civil War.” *Journal of Economic Literature*.

National Human Development Report. 2002. Planning Commission, Government of India, New Dehli. Available online at http://planningcommission.nic.in/reports/genrep/nhdrep/nhdreportf.htm

Nordhaus, William D. 2005. “Geography and Macroeconomics: New Data and New Findings”: Typescript, Department of Economics, Yale University.

Nordhaus, William D. and Xi Chen. 2009. “Geography: Graphics and Economics.” *The B.E. Journal of Economic Analysis & Policy* 9 (2): 1–12. http://www.bepress.com/bejeap/vol9/iss2/art1

Nordhaus, William, Qazi Azam, David Corderi, Kyle Hood, Nadejda Makarova Victor, Mukhtar Mohammed, Alexandra Miltner, and Jyldyz Weiss. 2006. “The G-Econ Database on Gridded Output: Methods and Data.” Yale University, May 12, 2006. URL: gecon.yale.edu

Østby, Gudrun. 2008. “Polarization, Horizontal Inequalities and Violent Civil Conflict.” *Journal of Peace Research* 45 (2): 143–162.

Østby, Gudrun, Ragnhild Nordås, and Jan Ketil Rød. 2009. "Regional Inequalities and Civil Conflict in Sub-Saharan Africa." *International Studies Quarterly* 53 (2): 301–324.

Rice, Susan E., Corinne Graff, and Janet Lewis. 2006. "Poverty and Civil War: What Policymakers Need to Know." Brookings Institution, Global Economic Development Working Paper #02.

Rokkan, Stein. 1999. *State Formation, Nation-Building, and Mass Politics in Europe: The Theory of Stein Rokkan.* Oxford: Oxford University Press.

Ross, Michael. 2004. "What Do We Know About Natural Resources and Civil War?" *Journal of Peace Research* 41 (2): 337–356.

Salehyan, Idean. 2009. *Rebels Without Borders: State Boundaries, Transnational Opposition, and Civil Conflict.* Ithaca, NY: Cornell University Press.

Sambanis, Nicholas, and Branko Milanovic. 2004. "Explaining the Demand for Sovereignty." Typescript, Yale University and World Bank, www.yale.edu/macmillan/globalization/Sambanis-Milanovic_May2004.pdf.

Schroeder, Gertrude E. 1973. "Regional Differences in Income and Levels of Living in the USSR." In *The Soviet Economy in Regional Perspective*, ed. V.N. Bandera and Z.L. Melnyk. New York: Praeger, pp. 167–195.

Stewart, Frances. 2002. "Horizontal Inequalities: A Neglected Dimension of Development." Queen Elizabeth House Working Paper Series 81, University of Oxford. http://www.qeh.ox.ac.uk/pdf/qehwp/qehwps81.pdf.

Tadjoeddin, Mohammad Zulfan 2003. "Aspiration to Inequality: Regional Disparity and Centre-Regional Conflicts in Indonesia." Paper presented to the UNI/WIDER Project Conference on Spatial Inequality in Asia, Tokyo, March 28–29.

Toft, Monica Duffy. 2003. *The Geography of Ethnic Violence.* Princeton, NJ: Princeton University Press.

Williamson, Jeffrey G. 1965. “Regional Inequality and the Process of National Development: A Description of the Patterns.” *Economic Development and Cultural Change* 13 (4): 3–54.

Woodward, Susan. 1994. *Balkan Tragedy: Chaos and Dissolution after the Cold War.* Washington, DC: Brooking.

Woodward, Susan. 1995. *Socialist Unemployment: The Political Economy of Yugoslavia, 1945–1990.* Princeton University Press, Princeton, NJ.

Appendix

Table A1: Country descriptive statistics

Country	GWid	N. cells	min GCPpc	max GCPpc	mean GCPpc	sd GCPpc	GDPpc
United States of America	2	4607	5559.4	59534.84	30735.27	15467.99	28113.53
Canada	20	4173	1664.84	67800.31	23456.05	8524.9	22986.09
Bahamas	31	6	15399.6	15633.02	15478.02	120.07	15403.64
Cuba	40	58	4023.37	4113.67	4088.62	22.01	4079.24
Haiti	41	13	1587.8	1588.01	1587.89	0.07	1587.94
Dominican Republic	42	18	2716.08	2717.21	2716.78	0.37	2716.95
Jamaica	51	7	4826.18	4890.91	4853.92	34.6	4861.02
Trinidad and Tobago	52	1	6595	6595	6595	NA	6596.8
Mexico	70	765	1582.31	33001.28	8157.52	3854.07	7870.1
Belize	80	4	4341.98	4395.81	4373.3	22.55	4281.98
Guatemala	90	34	3148.65	3749.74	3520.79	182.94	3597.77
Honduras	91	32	735.63	2713.25	2135.51	530.52	2279.22
El Salvador	92	5	3538.6	3647.09	3596.27	54.78	3513.42
Nicaragua	93	46	1543.36	2235.69	1826.1	178.52	1853.19
Costa Rica	94	18	4868.43	5344.51	5112.95	161.72	5160.48
Panama	95	33	4458.49	5780.97	4764.61	389.72	4726.64
Colombia	100	379	1400.92	21701.32	4168.51	3276.24	4207.38

Venezuela	101	304	330.18	63451.18	8968.41	8398.4	8312.17
Guyana	110	62	1102.12	1232.53	1208.2	34.1	1226.42
Surinam	115	40	4486.51	11715.71	7887.44	2283.99	5013.09
Ecuador	130	88	1995.16	25793.59	6358.62	5878.18	4309.49
Peru	135	433	785.82	113844.63	10385.38	19695.08	3843.11
Brazil	140	2848	758.56	179477.41	7312.39	10962.35	6247.91
Bolivia	145	359	1423.17	4205.09	2653.72	696.76	2567.99
Paraguay	150	135	816.53	3719.78	3240.09	661.79	3579.02
Chile	155	398	48.87	83096.03	7593.29	11558.99	5547.89
Argentina	160	1120	922.64	15431.56	4414.98	2263.47	6335.2
Uruguay	165	67	5875.5	6247.69	5970.02	76.97	5979.33
United Kingdom	200	185	84.77	47367.22	19534.1	9171.01	20008.8
Ireland	205	49	6804.4	43923.92	12957.93	5116.95	14249.04
Netherlands	210	21	14248.94	25556.95	21862.23	3394.32	22910.25
Belgium	211	17	16230.76	26340.93	20672.27	3322.02	22201.04
France	220	268	14725.73	36661.56	19241.15	2857.32	22142.52
Switzerland	225	14	28437.53	30900.7	29714.96	921.25	30522.58
Spain	230	236	10125.6	22583.32	16619.86	3346.86	17281.18
Portugal	235	38	6207.9	15225.96	10124.17	2648.46	13467.23
German Federal Republic	260	187	12200.9	33513.16	20096.17	5141.31	22315.23
Poland	290	164	3674.23	11875.06	6769.01	1964.25	6712.53
Austria	305	35	16934.72	29987.27	21976.01	3823.86	23264.3

Hungary	310	42	4614.15	14650.29	9294.17	2538.76	10514.46
Czechoslovakia	315	56	6908.58	17096.07	11261.84	2613.86	11863.72
Italy/Sardinia	325	167	2890.24	77335.23	22520.68	14348.99	20659.1
Albania	339	15	3115.25	3115.85	3115.46	0.2	3115.59
Serbia	345	113	2730.78	24694.71	8261.97	5616.8	6852.97
Greece	350	104	6665.62	78430.88	22429.22	17571.83	18575.22
Cyprus	352	10	13593.06	66660.58	31193.39	20426.02	16400.73
Bulgaria	355	42	2600.96	10504.49	5813.9	1856.1	6220.55
Rumania	360	105	2481.02	26366.32	8014.97	4386.08	7002.2
Russia (Soviet Union)	365	14621	29.3	140860.11	14514.87	9108.49	10301.76
Finland	375	261	13075.65	35748.47	17987.18	3091.01	20042.17
Sweden	380	336	17243.79	27794.5	20825	1407.56	21685.82
Norway	385	290	13512.55	36734.85	19377.54	2973.28	27614.37
Denmark	390	38	17659.84	28847.32	20048.52	3184.32	22179.31
Iceland	395	106	6300.37	22813.75	18886.15	4642.52	22376.87
Cape Verde	402	6	1425.01	1426.18	1425.4	0.6	1425.05
Guinea-Bissau	404	13	522.86	541.94	532.05	7.95	531.98
Equatorial Guinea	411	10	1701.59	1874.84	1756.34	59.9	1784.86
Gambia	420	2	879.33	880.34	879.83	0.72	884.78
Mali	432	412	8.7	2989.75	694.96	413.94	662.81
Senegal	433	70	1106.62	1199.94	1151.98	17.94	1156.38
Benin	434	34	637.34	1070.5	753.36	131.37	893.9

Mauritania	435	387	852.41	10319.34	1763.13	1155.16	1541.38
Niger	436	398	98.56	4814.16	1513.29	1125.72	604.29
Cote D'ivoire	437	106	1344.88	1472.67	1412.9	17.64	1415.39
Guinea	438	81	770.27	830.5	797.8	10.44	796.02
Burkina Faso (Upper Volta)	439	82	554.27	1176.07	664.98	74.99	649.85
Liberia	450	34	2298.26	2305.35	2301.79	2.81	2304
Sierra Leone	451	27	536.85	537.47	537.28	0.23	537.42
Ghana	452	78	590.25	997.3	762.56	107.68	749.48
Togo	461	13	731.65	741.33	737.03	3.83	736.08
Cameroon	471	148	1178.81	3082.63	1726.16	391.17	1794
Nigeria	475	304	699.51	3771.65	923	332.32	1047.11
Gabon	481	91	9703.92	16038.67	13677.87	1067.81	12029.07
Central African Republic	482	193	328.34	1429.06	572.88	160.25	709.07
Chad	483	382	417.13	2868.26	680.82	333.02	853.68
Congo	484	106	2391.29	2513.55	2477.51	33.53	2506.09
Congo, DR (Zaire)	490	748	370.4	1397.59	440.59	79.27	492.91
Uganda	500	67	408.61	796.57	517.15	107.56	472.87
Kenya	501	177	210.63	12890.33	1355.71	1846.33	1234.82
Tanzania	510	293	306.4	1156.9	689.4	209.16	652.23
Burundi	516	10	420.85	425.84	424.21	2.14	422.88
Rwanda	517	6	589.82	589.86	589.83	0.02	589.84
Djibouti	522	8	2593.45	2607.14	2598.26	5.63	2605.05

Ethiopia	530	359	226.63	660.35	411.24	81.56	432.11
Angola	540	408	864.65	11728.22	1870.6	793.29	2292.86
Mozambique	541	275	105.93	1323.43	375.09	220.85	350.44
Zambia	551	240	583.78	1639.09	789.3	201.58	994.29
Zimbabwe	552	123	1143.56	3723.31	2566.77	419.4	2448.36
Malawi	553	28	534.49	534.8	534.67	0.09	534.73
South Africa	560	465	1415.39	220862.25	11992.38	21278.04	6649.07
Namibia	565	283	477.05	40640.24	6666.24	7522.72	3101.91
Lesotho	570	9	1475.57	1510	1488.7	16.48	1463.56
Botswana	571	192	1472.33	14329.54	3848.92	2942.36	5867.22
Swaziland	572	4	4025.9	4077.89	4045.97	25.11	4065.42
Madagascar	580	233	685.21	988.09	781.23	78.38	827.62
Comoros	581	1	1108.42	1108.42	1108.42	NA	1075.01
Mauritius	590	1	5055.53	5055.53	5055.53	NA	5049.89
Morocco	600	233	1049.72	9702.66	2618.27	1631.28	2338.08
Algeria	615	833	2831.84	664972.84	10643.81	51605.63	4492.33
Tunisia	616	59	3101.69	3904.11	3330.7	205.11	3404.39
Libya	620	591	697.79	565393.81	21058.48	59794.7	13954.68
Sudan	625	812	247.86	2690.41	704.77	349.74	823.79
Iran	630	628	820.08	135110.44	12705.31	22485.54	5558.88
Turkey	640	341	1071.98	11271.61	4276.65	2089.9	5099.74
Egypt	651	360	81.8	3062677.95	115339.06	427389.55	2865.24

Lebanon	660	5	5654.44	5655.47	5654.8	0.5	5655.27
Jordan	663	32	2720.81	2804.98	2781.99	22.9	2803.31
Israel	666	11	167.7	22811.16	13723.92	6499.6	12964.23
Saudi Arabia	670	687	446.55	1150064.78	25833.1	115282.7	17939.62
Yemen (Arab Republic of)	678	161	485.61	10447.09	1526.4	1437.11	1580.54
Kuwait	690	1	4083.56	4083.56	4083.56	NA	22159.01
Qatar	694	3	26447.99	26447.99	26447.99	0	44484.12
United Arab Emirates	696	30	33281.55	33446.81	33382.91	56.69	33421.77
Oman	698	110	3993.86	12501.26	11079.54	2053.05	12154.78
China	710	3803	487.37	3133.64	934.8	242.9	981.5
Mongolia	712	716	222.03	10569.03	2372.36	1407.72	1837.74
Taiwan	713	12	948.76	948.76	948.76	0	981.5
Japan	740	227	4008.96	137552.78	31767.5	23630.07	23066.75
India	750	1147	435.47	8448.46	1230.19	1038.14	1052.33
Bhutan	760	9	1497.34	1501.92	1500.29	2.02	1501.94
Pakistan	770	294	620.26	5487.5	1446.7	640.06	1552.85
Bangladesh	771	52	521.31	941.93	698.99	129	630.29
Sri Lanka)	780	26	1689.58	2116.85	1920.51	159.12	1725.29
Nepal	790	40	623.76	647.31	632.36	6.08	624.82
Thailand	800	175	1092.01	12333.9	2518.55	2229.61	3625.44
Cambodia	811	64	493.2	1651.66	999.82	186.85	1005.63
Laos	812	71	707.94	1078.95	845.46	58.64	897.19

Vietnam	816	118	375.98	1444.27	680.91	198.09	749.49
Malaysia	820	113	2262.53	9626.13	5478.02	1507.71	5713.16
Singapore	830	1	539.33	539.33	539.33	NA	1765.29
Brunei	835	1	40284.38	40284.38	40284.38	NA	43854.58
Philippines	840	196	891.93	4367.44	1629.83	644.64	2144.54
Indonesia	850	818	328.44	105377.88	4651.32	10628.98	1765.29
Australia	900	2923	833.22	45573.84	20355.62	4762.68	20657.61
Papua New Guinea	910	176	943.46	3618.18	1108.14	265.28	1272.19
New Zealand	920	160	12058.86	18344.76	15786.36	1596.71	16051.39
Solomon Islands	940	24	983.25	5376.63	2932.43	1654.15	1813.51
Fiji	950	15	1534.3	6396.68	3812.29	2029.23	3298.39

Table A2: Summary statistics for full sample of cells

Variable	N	Mean	St. dev.	Min	Max
Ln GCP pc	55707	8.71	1.36	2.16	14.93
Ln GPD pc	55707	8.7	1.22	5.86	10.7
Ln infant mortality rate	53164	5.42	1.01	2.94	7.9
Positive income deviations	55707	0.59	12.54	0	1067.91
Negative income deviations	55707	-0.13	0.18	-1	0
Least Developed Country	55707	0.06	0.23	0	1
Ln distance to border (+1)	55707	1.02	0.7	0	2.79
Ln distance to capital (+1)	55707	7.03	1.07	2.51	8.98
Capital city	55707	0	0.05	0	1
Forrest cover (%)	55707	40.53	42.09	0	100
Mountainous terrain (%)	55707	23.66	36.43	0	100
Ln Population	55707	9.74	2.98	2.33	17.09
No. of cells (*1000)	55707	5132.75	5747.25	1	14518

Table A3: Summary statistics for case control sample of cells

Variable	**N**	**Mean**	**St. dev.**	**Min**	**Max**
Ln GCP pc	342	8.59	1.33	5.28	11.86
Ln GPD pc	342	8.63	1.24	5.86	10.24
Ln infant mortality rate	330	5.5	1.01	2.94	7.42
Positive income deviations	342	0.25	0.83	0	11.6
Negative income deviations	342	-0.14	0.2	-0.95	0
Least Developed Country	342	0.08	0.27	0	1
Ln distance to border (+1)	342	1.02	0.72	0	2.71
Ln distance to capital (+1)	342	6.93	1.13	3.13	8.78
Capital city	342	0.02	0.14	0	1
Forrest cover (%)	342	37.53	41.92	0	100
Mountainous terrain (%)	342	23.6	36.54	0	100
Ln Population	342	10.17	2.97	2.52	15.85
No. of cells (*1000)	342	4808.02	5524.2	1	14518