

**RE-EVALUATING THE ECONOMIC  
COSTS OF CONFLICTS**

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# Re-evaluating the economic costs of conflicts

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## Abstract

This paper studies the economic costs of conflicts at the country and ethnic group settlement level with light output data as measured by orbital satellites and conflict data spatially mapped to latitude and longitude coordinates. Using a worldwide dataset of 7,704 individual ethnic group settlements of 862 ethnic groups in 177 countries, we find that conflicts strongly reduce light output in settlements directly affected by fighting over the period 1992-2008. In addition, conflicts have large negative spillovers both across and within countries: light output in settlements not directly exposed to fighting declines significantly once a conflict begins; neighboring countries also experience large negative effects. The negative effects of conflicts are particularly pronounced in Eastern Europe, but also observable in sub-Saharan Africa, Latin America, and South and South-East Asia. In contrast, conflicts have, on average, no negative effects on light output in the Middle East and in the West. We contrast these results with cross-country regressions with GDP data, which suggest much smaller negative effects of conflicts.

**Keywords:** Violent conflicts, economic conditions, light output

**JEL codes:** O10, O40, R10

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# 1 Introduction

Many authors argue that violent conflicts have large economic costs (Collier, 1999; Rodrik, 1999).<sup>1</sup> This argument is supported by considerable empirical evidence obtained with both regional (Gaibulloev and Sandler, 2009) and global samples (Blomberg et al., 2004; Cerra and Saxena, 2008). For example, focusing on African and Latin American countries, Stewart et al. (1997) show that the growth rate of GDP is severely affected by conflicts. Gupta et al. (2004), too, find for a sample of low- and middle-income countries several adverse consequences of conflicts, including lower economic growth. In addition, case studies on specific conflicts also suggest substantially adverse economic effects (Arunatilake et al., 2001; Abadie and Gardeazabal, 2003; Ganegodage and Rambaldi, 2014).<sup>2</sup>

However, existing estimates of conflict costs are potentially inaccurate as quantification is hampered by three main difficulties. First, most studies use administrative GDP data as the main indicator for economic conditions. Yet, GDP data are often unreliable, particularly in countries most likely to be afflicted by conflicts (Heston, 1994; Jerven, 2013). Second, it is unclear what the appropriate geographical unit of analysis should be: should conflict costs be evaluated at the country level or at a more disaggregated, i. e. subnational, level? While most existing studies are conducted at the country level, this high level of aggregation may be uninformative and lead to distorted findings. Third, identifying a valid counterfactual against which economic development in conflict regions or countries can be evaluated is difficult. In most existing studies, the composition of the control group is

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<sup>1</sup>For a discussion of the reasons why conflicts may have either positive or negative effects on economic growth, see Van Raemdonck and Diehl (1989).

<sup>2</sup>The consequences of conflicts on other economic indicators have also been analyzed. Blomberg and Hess (2006) show that conflicts lead to less trade. Gupta et al. (2004) show that conflicts are related to higher inflation, lower tax revenues, and lower investments. Addison et al. (2002) show that conflicts have a significant impact on a country's financial development. Justino and Verwimp (2013) document that in the aftermath of the genocide in Rwanda, 20% of the population fell below the poverty line.

often not explicitly discussed, and possibly includes countries or regions indirectly affected by conflicts.<sup>3</sup>

Having in mind these considerations, we revisit the question of how conflicts affect economic development and make three methodological contributions to the literature. Our first contribution is to use a proxy for economic conditions that is more accurate than administrative GDP data: night light output as measured by orbital satellites. Night light output is a more accurate indicator of economic development than official GDP figures especially in developing countries with low statistical capacity since it is not subject to human misreporting and inaccuracies (Henderson et al., 2012). Second, we study the costs of conflicts not only at the country but also at the subnational level, specifically at the level of individual ethnic group settlements. Third, we account for economic spillovers to neighboring geographical units, notably to neighboring ethnic settlements and countries not directly affected by conflicts.

Relying on a dataset consisting of 7,704 individual settlements of 862 ethnic groups in 177 countries over the period 1992-2008 we show, first, that using GDP leads to an underestimation of the costs of conflicts. This results from the focus on countries rather than subnational units. Overall, while previous studies estimate that conflicts reduce GDP by 1.3 to 6 percent (Blomberg et al., 2004; Cerra and Saxena, 2008), we find that they reduce light output by up to 33 percent. Extrapolating from estimates of 0.3 for the elasticity of GDP growth with respect to night lights growth (Henderson et al., 2012), this drop in night lights implies a decline of GDP by about 10 percent. Second, we find that not only those settlements directly affected by conflicts, but also other settlements in the conflict country and neighboring countries where no fatalities were recorded are harmed. Thus, the most natural counterfactual, neighboring settlements or countries,

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<sup>3</sup>Murdoch and Sandler (2002b, 2004) show that civil wars have significantly negative effects on contemporaneous growth. The negative effects are felt beyond a country's borders, suggesting that neighboring countries are not appropriate counterfactuals.

are contaminated by spillover effects, leading to a violation of the stable unit treatment value assumption (SUTVA) condition. Third, our results indicate that countries almost immediately recover economically after a conflict ends. Overall, these results are important as they allow for a more comprehensive assessment of the costs of conflicts than the previous literature.

Our identification strategy is a difference-in-difference (DiD) design. In this context, one major concern is that conflicts are not random. In fact, many studies point to an increased likelihood of insurgency steaming from slow economic growth and poverty (Collier and Hoeffler, 2002, 2004; Fearon and Laitin, 2003).<sup>4</sup> Given the nature of our sample, which is global, a quasi-experimental design is infeasible. It is unlikely that any variables exist that would systematically induce quasi-random variation in the onset of conflicts across the globe. Thus, we trace night light output in the three years before and after the outbreak of the conflict. This approach provides an implicit placebo test. Overall, we find that conflicts reduce light output substantially only when a country or region is currently affected by a conflict, but not in pre-conflict years. The drop during conflict years is of such magnitude relative to pre-conflict years that it is plausible to rule out reverse causality or unobserved omitted variables.

This paper contributes to the empirical literature on the economic costs of conflicts. As mentioned previously, this literature is large, but exhibits some problematic features such as the use of administrative GDP data as proxy for economic conditions or an exclusive focus on country-level outcomes, thereby ignoring potential regional or between-country spillovers. In general, light output has only rarely been used to evaluate the costs of conflicts. Li et al. (2013) document cross-country correlations between night lights and conflicts. However, besides documenting only correlations, this study focuses exclusively on the country-level. There are also some studies that link conflicts to night light output

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<sup>4</sup>Similarly, studies find that periods of poor economic performance and commodity price downturns predict the outbreak of conflict (Blomberg and Hess, 2002; Brückner and Ciccone, 2010).

within individual countries. Agnew et al. (2008) use night light output data to study whether the increase in military presence in Baghdad in 2007 reduced political and social instability. Witmer and O’Loughlin (2011) study the effects of war in the Caucasus region by focusing on trends in night light output. Rohner et al. (2013) analyze post-conflict economic recovery in Uganda with night lights data. Shortland et al. (2013) analyze the economic impact of conflict on local light output in Somalia.<sup>5</sup>

The remainder of the paper is structured as follows. The next section discusses several channels through which conflicts may affect economic variables. Sections 3 and 4 describe the data and the empirical model, respectively. The results are collected in Section 5. Section 6 explores effects across regional subsamples. Finally, Section 7 concludes.

## 2 Conflicts, costs, and spillovers

Collier (1999) lists four major negative economic effects of internal conflict. First, the overall destruction of resources or factors of production. Second, the diversion of public expenditure from productive investment to war related uses. Third, the disruption of previously well-established economic flows. Fourth, a dissaving process caused not only by the depletion of the capital stock but also through the crowding out of foreign investment.

In general, existing empirical evidence links civil wars especially to human suffering, notably to diseases and short- and long-term health (Ghobarah et al., 2003).<sup>6</sup> The impact of intrastate violence on the composition of public expenditure is also well-established. Relying on a sample of 22 conflict episodes, Gupta et al. (2004) provide significant evidence of an increase in the share of defense spending in total government expenditure. Addison

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<sup>5</sup>This paper is also related to the literature that uses night lights as a proxy for economic development at large. For example, Michalopoulos and Papaioannou (2014) study the importance of institutions for economic development in border regions in Africa. Also, Maystadt et al. (2015) and Esteban et al. (2014) use night lights to control for changes in economic activity.

<sup>6</sup>See e. g. Gustafson et al. (2001) and Akresh et al. (2012).

et al. (2002) show that conflicts prompt the diversion of funds from productive to unproductive uses. A case study on the civil war in Sri Lanka shows defense spending increased from 4.4% to 21.6% of total government spending between 1983 and 1996 (Arunatilake et al., 2001).

On trade flows, Blomberg and Hess (2006) compare conflicts to distorting taxes or tariffs causing a significant decline in bilateral trade. In fact, the effect of peace on trade is argued to be stronger than that of generalized systems of preference. Furthermore, cross-country analysis in general show that political instability has a negative impact on investment (Alesina and Perotti, 1996; Gaibulloev and Sandler, 2009), savings (Venieris and Gupta, 1986) and economic growth (Alesina et al., 1996; Barro, 1991).

With respect to neighboring countries, internal conflicts appear to be contagious (Blattman and Miguel, 2010). War in a neighboring country significantly predicts the outbreak of civil conflicts in a given country (Hegre and Sambanis, 2006). Conflict risk is further aggravated by the existence of trans-boundary ethnic groups, yet proximity to strong democracies and intense inter-regional trade diminish this risk (Gleditsch, 2007). Still, the increase in the likelihood of a civil war outbreak is not the only impact felt in neighboring countries. For a global sample, Murdoch and Sandler (2004) find that the spatial dispersion of the negative spillovers of civil conflicts on growth can be identified up to 950km away from the country experiencing a war. Neighboring countries are ultimately also liable to suffer in terms of trade flows and reduced foreign investment due to the risks and uncertainty that come with the proximity to a conflict zone.

Moreover, the vast displacement of civil population, i. e. refugees, is in itself a negative externality of war, creating further repercussions at multiple levels (Salehyan and Gleditsch, 2006). As Toole and Waldman (1993, p.605) describe it, “refugee camps are the emergency department of international public health.” where “death rates ... have remained unacceptably high, and the most common causes of death remain largely pre-

ventable.” The widespread exposure to epidemic diseases can lead to serious public health crisis affecting not only refugees and internally displaced persons, but the population at large. In summary, while light output clearly does not capture all costs of conflicts, it provides for a broad assessment, ranging from displacement, lower public good provisions, and less economic activity in general.

## 3 Data

### 3.1 Light output data

The seminal papers by Chen and Nordhaus (2011) and Henderson et al. (2012) led to an increasing number of studies relying on night light output to measure the economic environment. Data are collected by the Defense and Meteorological Satellite Program (DMSP) satellites which are equipped with an Operational Linescan System (OLS) initially designed to record daily information on worldwide cloud coverage. The program typically provides for two satellites simultaneously orbiting the Earth, in a sun-synchronous, low altitude polar orbit. The OLS in turn, consists of two telescopes and a photo multiplier tube, collecting visible and infrared imagery. The Earth Observation Group from the National Geophysical Data Center (NGDC) of the National Oceanic and Atmospheric Administration treats the collected data and produces a reliable time series of annual cloud-free composites of DMSP nighttime lights from 1992 to 2012. For the years two satellites were collecting data, two composites were produced.<sup>7</sup>

We use one of the final products, with 30 arc second grids spanning -180 to 180 degrees longitude and -65 to 75 degrees latitude, called “Average Visible, Stable Lights, & Cloud

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<sup>7</sup>For a more thorough description on the data collection and treatment refer to the Earth Observation Group from the National Geophysical Data Center of the National Oceanic and Atmospheric Administration website (<http://ngdc.noaa.gov/eog/>) or see e. g. Chen and Nordhaus (2011) or Henderson et al. (2012).

Free Coverages” retrievable from the NGDC website. In this product each pixel quantifies the one-year average of stable lights, with values ranging from 0 to 63. Whilst fires and other sporadic lights are thereby removed, gas flares may still contaminate the data. Following the literature, we correct for the presence of gas flares relying on satellite sensor observations (Elvidge et al., 2009).

### **3.2 Ethnic data**

We obtain the information on the location of ethnic group settlements from the “Geo-Referencing of Ethnic Groups” (GREG) dataset (Weidmann et al., 2010). This dataset disaggregates ethnic groups spatially by representing their territories as polygon shapefile. This representation is based on the Soviet Atlas Narodov Mira that catalogs ethnic groups across the globe. Using the GREG dataset, we construct in ArcGIS our main outcome variable by matching night light output with the GREG dataset. That is, we construct the sum of digital values associated with the pixels in DMSP-OLS that are located within the boundaries of a given ethnic group settlement.<sup>8</sup>

### **3.3 Conflict data**

Data on conflict events comes from the Peace Research Institute Oslo (PRIO). Conflict is defined as “a contested incompatibility that concerns government and/or territory where the use of armed force between two parties, of which at least one is the government of a state, results in at least 25 battle-related deaths” (Harbom et al., 2008). Conflicts according to this definition encompass inter- as well as intrastate armed conflicts.

We rely on the latest version of the Conflict Site Dataset, which extends the UCDP/PRIO Armed Conflict Dataset by providing coordinates for the conflict zones

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<sup>8</sup>To check the accuracy of our aggregation, we further aggregate the settlement-level values to the country-level and compare the values with the country-level values provided by Henderson et al. (2012). Results between both datasets are very similar.

(Gleditsch et al., 2002). Figure 1 maps the conflict location across the globe. We code the whole settlement in which a conflict takes place as the relevant conflict area.<sup>9</sup> Specifically, we project the latitude and longitude coordinates of conflict events in each year on the GREG map of ethnic group settlements. For the country-level analysis, we aggregate all ethnic group settlements in a country and classify any country in which at least one settlement was affected by a conflict as a conflict country.

### 3.4 A case study

Before conducting the global level analysis, we provide some anecdotal evidence on the impact of conflict events on night lights by focusing on a specific case. Figure 2 depicts conflicts in Uganda for the period 1992 to 2008. We focus on a particular conflict event taking place in the ethnic Banyoro region in 1999, a clash between an armed opposition group, the Allied Democratic Forces, and the Uganda People’s Defense Force. Figure 3 provides plots depicting night light output in the region for three consecutive years, from 1998 to 2000, in order to trace its development from pre- to post-conflict period.

As can be observed, the intensity of night light output decreases considerably in the conflict period, i. e. subfigure (b), not only in the Banyoro settlement in which the event took place but also in the surrounding Bakomo, Baganda and Banyaruanda ethnic settlements within Uganda. In fact, spillovers may be observed as far as the Barega ethnic settlement in the Democratic Republic of the Congo and the cross-border Banyoro settlement in Tanzania. Night light output appears to rebound for all observed regions in the post-conflict year, even if not entirely in the conflict settlement itself.<sup>10</sup>

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<sup>9</sup>The UCDP/PRIO dataset provides a radius for each conflict, thus delineating conflict zones. However, the coding of the radius involves certain trade-offs and is deemed problematic (Hallberg, 2011).

<sup>10</sup>We acknowledge, however, that this evidence is only suggestive as over-time comparisons in light output are difficult due the use of different satellites in DMSP-OLS and deterioration of sensor quality from year to year. In the regressions, we account for this issue with year dummies (Henderson et al., 2012).

This short case study suggests that conflicts have negative effects on light output. Second, it also indicates that conflicts can have large spillovers, even across countries. Thus, we explore in the following whether we can uncover these results in a more general sample.

## 4 Empirical model

We identify the impact of conflicts on economic conditions relying on variants of the following specification:

$$y_{i,t} = \alpha_{i,t} + \sum_h \gamma_{h,t} + \sum_{n=-3}^3 \beta_{1,n} \text{Conflict country}_{i,t+n} + \sum_{n=-3}^3 \beta_{2,n} \text{Neighbor country}_{i,t+n} + \epsilon_{i,t}, \quad (1)$$

where the dependent variable  $y_{i,t}$  reflects economic conditions and is measured by two different variables. First, and as a point of reference, economic conditions are proxied by the log of GDP. Second, we rely on the log of the deflated sum of night light output, which as argued above is a potentially more accurate indicator of economic conditions than administrative GDP data in conflict countries. We focus on levels instead of growth rates in order to capture any, possibly permanent, destruction of physical capital and population outflows. To capture the effects of population movements, we refrain from scaling the dependent variable by population (i. e. we use levels rather than per-capita figures).

We track economic conditions in conflict countries for a six years window, three years prior and three years after the conflict episode. Thus, we include the dummy variables  $\text{Conflict}_{i,t+n}$  and  $\text{Neighbor Conflict}_{i,t+n}$ . These were constructed as follows. First, the  $\text{Conflict}_{i,t+n}$  dummy is 1 for each year in which fighting is recorded, implying that for conflicts lasting several consecutive years it is consecutively equal to 1. Second, many countries experience several intermittent conflicts during the sample period. In cases where a conflict has ceased in year  $t + 1$  but another conflicts starts within the next two years

(i. e. during our post-conflict event window) in the same country, all post-conflict dummies are set to 0 from the year of the new conflict onward.<sup>11</sup>

Correspondingly,  $Neighbor\ Conflict_{i,t+n}$  is 1 for all countries not recording a conflict that share a contiguous border with a country that is experiencing a conflict in year  $t$ . The pre- and post-conflict dummies for the neighbor country are constructed in the same manner as for the conflict country.

We begin by exploring the impact of conflicts at the country level with  $i$  indexing countries,  $t$  years, and  $h$  the world region (i. e. Sub-Saharan Africa, South and South East Asia, Latin America, Eastern Europe and former USSR, the West, and the Middle East and North Africa) where the country is located. Thus,  $\alpha_{i,t}$  indicates country fixed effects and  $\gamma_{h,t}$  region-specific year fixed effects. The year fixed effects control for region specific shocks unrelated to conflicts. They also account for yearly variation in light output simply due to the use of different satellites and sensor deterioration from year to year.

We also relate conflicts to light output at the settlement level. Using individual settlements as unit of analysis allows us to explore within-country spillovers in conflict costs. For this purpose, we estimate the following model:

$$\begin{aligned}
 y_{i,t} = & \alpha_{i,t} + \sum_h \gamma_{h,t} + \sum_{n=-3}^3 \beta_{1,n} \text{Conflict settlement}_{i,t+n} \\
 & + \sum_{n=-3}^3 \beta_{2,n} \text{Unaffected settlement}_{i,t+n} + \sum_{n=-3}^3 \beta_{3,n} \text{Neighbor Conflict}_{i,t+n} + \epsilon_{i,t},
 \end{aligned} \tag{2}$$

where most variables are constructed as previously described, but in this context  $i$  indicates an individual settlement and  $\alpha_{i,t}$  settlement fixed effects. Correspondingly,  $\text{Conflict settlement}_{i,t+n}$  are settlement-level conflict dummies. The additional dummy vari-

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<sup>11</sup>For example, if a conflict has ceased in year  $t + 1$  and breaks out again in year  $t + 2$ ,  $\text{Conflict}_{i,t+2}$  and  $\text{Conflict}_{i,t+3}$  are 0 while  $\text{Conflict}_{i,t+1}$  is 1.

able  $Unaffected\ settlement_{i,t+n}$  corresponds to settlements within the conflict country not directly affected by fighting.

## 5 Results

### 5.1 Results for real GDP

The results for a model relating GDP to conflicts at the country-level are collected in Figure 4. Subfigure (a) presents the estimated coefficients of the conflict dummies in Equation 1. The results suggest that in the three years preceding a conflict, GDP is not systematically different in prospective conflict countries than in other countries. The estimated coefficients for the three pre-conflict years are statistically insignificant and, more importantly, economically small. In the conflict year, there is a visible drop in GDP. From being at a similar level as in non-conflict countries, the series drops to being 5 percent lower when a conflict breaks out. Standard errors are higher in conflict years than in the pre-conflict years, presumably because the response in GDP to conflicts varies strongly between countries: some see a substantial decline while others do not. One year after the conflict has ended, GDP rebounds.

Subfigure (b) collects the estimates for neighboring countries. The plot shows no strong discontinuities in conflict years. The series evolves smoothly in the three year before and after a conflict breaks out in a conflict country, suggesting no spillover effects.

### 5.2 Results for light output

In this section, we replicate the model above relying on the log of the sum of deflated light output as the dependent variable. Results in Figure 5 suggest large negative effects of conflicts, both in countries directly affected by the conflict episode as well as in neighboring

countries. In conflict countries, the light output series drops to 11 percent in the conflict year (from 0.02 to -0.09). Scaled by Henderson et al's (2012) estimate of 0.3 for the elasticity of GDP growth with respect to light output growth, a drop of 11 percent in light output implies a drop in GDP by 3 to 4 percent due to conflicts, which is roughly in line with the average effect identified in the previous subsection. Second, we also find that neighboring countries face a drop in light output of similar if not slightly larger magnitude, indicating the presence of strong spillover effects. As a result, classifying neighboring countries as regular non-conflict countries might lead to biased estimates due to a violation of the SUTVA condition. Third, light output bounces back almost immediately to pre-conflict levels after a conflict ends both in conflict countries and neighboring countries.

We next complement the country-level evidence with an analysis at the level of individual settlements. This disaggregation allows us to explore not only between- but also within-country spillovers from regions directly affected by fighting to regions in conflict countries not directly affected. The coefficients are obtained based on the estimation of Equation 2 and are collected in Figure 6. Settlements directly affected by fighting experience a drop in light output in the conflict year of 30 percent (from 3 to -0.33), three times the drop assessed in the country-level analysis. This figure would suggest a drop in GDP by about 10 percent. Moreover, there are considerable within- and between-country spillovers. First, non-affected settlements face a 19 percent drop in light output. Second, neighboring countries also experience a larger drop in light output than in the country-level analysis: about 40 percent (from 6 to -34). However, the series for neighboring countries is more volatile than in the country-level analysis. On the other hand, considering the relative sizes of the drops, spillovers seem to be even larger on neighboring countries than on unaffected settlements in the conflict country. This may indicate that conflict countries are on average poorer than their neighboring non-conflict countries, so that any general uncertainty associated with conflicts may harm neighboring countries more in absolute

terms than unaffected regions in the conflict country itself. In addition, we find that as above, light output returns almost to pre-conflict levels immediately after the conflict ends.

In summary, the night light output analysis offers compelling results which provide three key insights. First, using GDP as a proxy for economic conditions results in an underestimation of the costs of conflicts. The same happens however, when using night light data and the analysis is conducted at the country-level. Observed effects are considerably larger at the settlement level, both in affected and unaffected settlements of conflict countries and in neighboring countries. This difference in results may be due to how light output is aggregated across settlements in the country-level analysis. The average drop in light output after being first aggregated to the country level appears to be smaller than the average of the individual drops in each settlement across all conflict settlements (which is the parameter our DiD setup estimates). Second, there are large spillovers from conflict settlements to non-conflict settlements and neighboring countries. Finally, we also observe a strong rebound after a conflict ends.

## 6 Regional subsamples

In order to understand the patterns in the data in more detail and explore whether any outliers drive the baseline results, it is useful to look at regional subsamples. We thus explore in the following how conflicts affect night lights in subsamples consisting only of countries from either Sub-Saharan Africa, South and South-East Asia, Latin America, Eastern Europe and former Soviet Union, the West, and Middle East and North Africa.

### 6.1 Sub-Saharan Africa

Sub-Saharan Africa is the world region with the highest number of countries experiencing at least one conflict event in the sample period. Figure 7 provides the settlement-level

results. In conflict settlements, there is a noticeable, but statistically insignificant, drop in light output by 16 percent in conflict years (subfigure (a)). With regards to spillovers, a smaller but still visible drop of 11 and 5 percent is observable in unaffected settlements and neighboring countries, respectively. The limited spillover effects are in line with previous findings suggesting that spillovers are region specific, and relatively weak in Africa (Murdoch and Sandler, 2002a).

## 6.2 South and South-East Asia

Figure 8 presents the graphs for South and South-East Asia. Subfigure (a) provides the coefficient estimates for the settlements affected by conflicts. A drop in light output is identifiable not only in the conflict years but also in the year preceding the conflicts, which may suggest that any political instability preceding the actual outbreak of a conflict may have some negative economic consequences. We also observe negative effects for unaffected settlements (subfigure b) and neighboring countries (subfigure c), but these are somewhat smaller than for the affected settlements. For all three units of analysis – conflict settlements, unaffected settlements, and neighboring countries – there is a clear rebound of light output in the periods following the conflict.

## 6.3 Latin America

Graphs for Latin America are collected in Figure 9. As in South and South-East Asia, light output in Latin American conflict settlements experiences a large drop, but the estimates are imprecise as indicated by the large confidence intervals. We also observe a drop in unaffected settlements. The drop is smaller than for affected settlements, but the estimates are also more precisely estimated. As in the full sample, light output quickly rebounds to

pre-conflict levels already one year into the post-conflict period. Finally we do not observe a large drop in neighboring countries.

## **6.4 Eastern Europe and former Soviet Union**

Figure 10 replicates the settlement-level results for Eastern Europe and the former USSR. A substantial drop in light output is visible across all three plots in the conflict years. For settlements directly affected by conflicts, the estimated drop in light output is as high as about 90 percent whilst in unaffected settlements the drop amounts to 58 percent and in neighboring countries to 85 percent. However, light output quickly returns to post-conflict periods in both affected and unaffected settlements and in neighboring countries after a conflict ends.

## **6.5 The West**

Figure 11 shows the impact of conflicts in light output in the West (US, Western-Europe, Australia etc). Only three conflict events have been recorded in the West for the time period under study. These include an ETA attack in Madrid in 1992, religiously-motivated conflicts in Ireland in 1998, and 9/11 in the US. Overall, it appears that conflicts have the lowest impact on light output in the West. In settlements directly affected the drop is about 5 percent. In unaffected settlements and neighboring countries, there is no significant effect.

## **6.6 Middle East and North Africa**

Finally, Figure 12 presents the graphs for countries in the Middle East and North Africa. In contrast to the evidence presented so far, night light output in both affected and unaffected settlements increases in the conflict years by 9 and 15 percent, respectively. In neighboring

countries in turn, light output does not change in conflict years compared to the year immediately before conflicts break out.

In fact, graphical evidence for the Middle East and North Africa region appears almost reversed when compared to the other assessed regions. These results are driven by conflict-year observations in Iran and Iraq. The two countries fought each other in the first Persian Gulf War shortly before the beginning of our sample period. In addition, Iraq was invaded by an international coalition in early 1991. Any effects due to internal violence experienced by both countries during the sample period were arguably minor compared to these external conflicts. When we exclude these two countries from the analysis, light output development in conflict years follows the same pattern as in the baseline sample.<sup>12</sup>

## 7 Conclusion

This paper analyzes the impact of conflicts on growth. In contrast to previous studies with global datasets, it relies on satellite imagery data on night light output as a proxy for economic conditions to identify the costs of conflict events for the period between 1992 and 2008. With this data, we make four contributions. First, we show that using GDP as a measure for economic conditions leads to a substantial underestimation of the costs of conflict. Second, we document that choosing the appropriate level of analysis is important to accurately estimate conflict costs. Third, we identify significant between and within countries spillovers. Fourth, we find that countries rebound quickly after a conflict ends. Nevertheless, conflicts seem to have huge economic costs while they are ongoing.

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<sup>12</sup>Graphs available from the authors.

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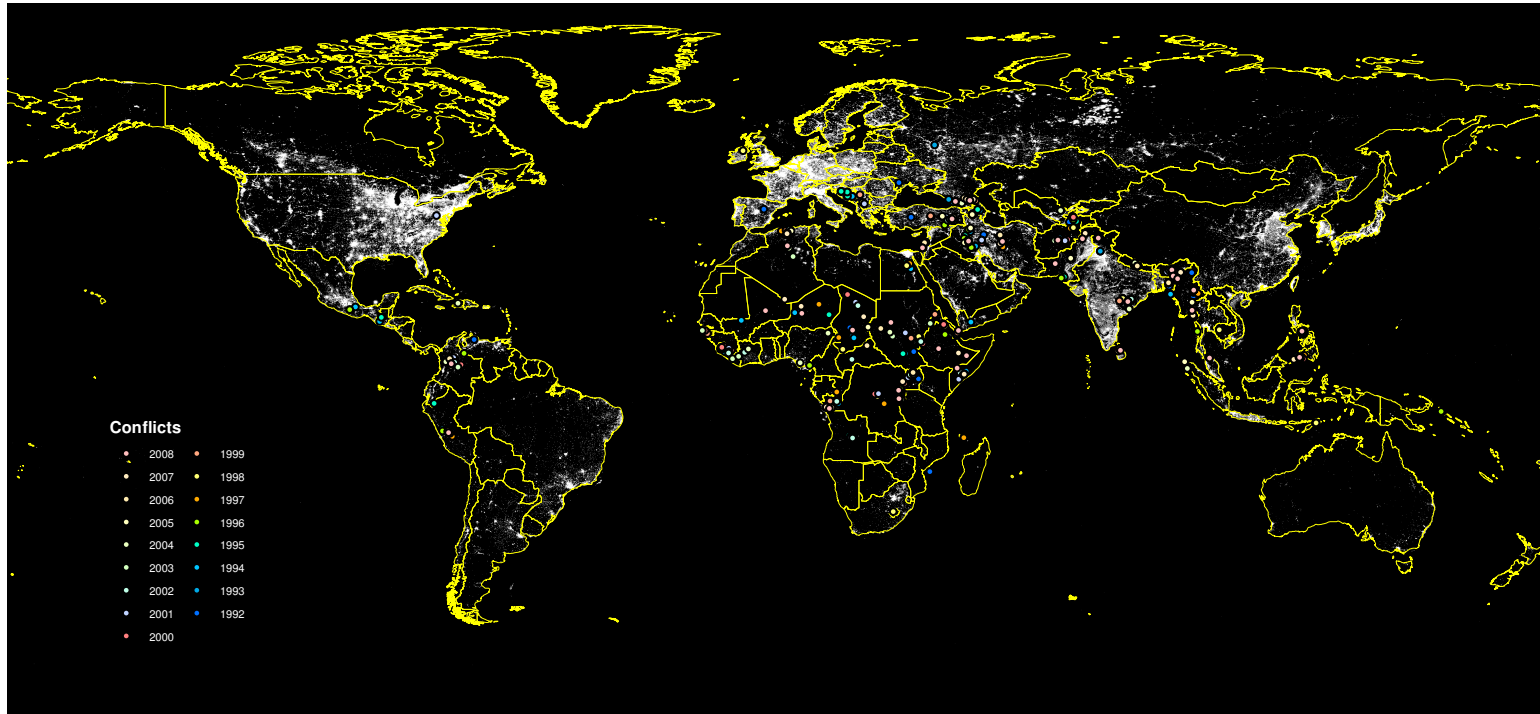
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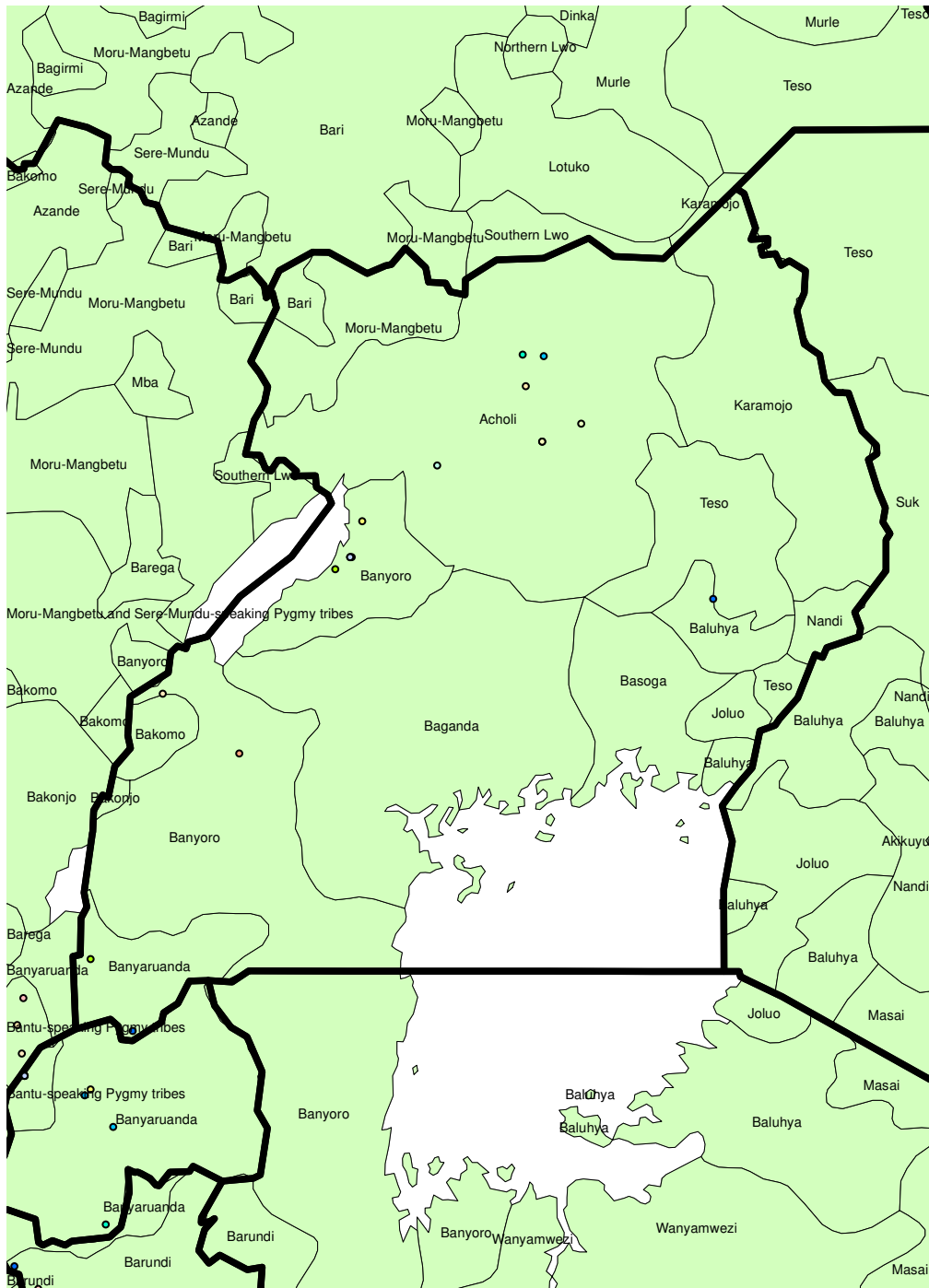
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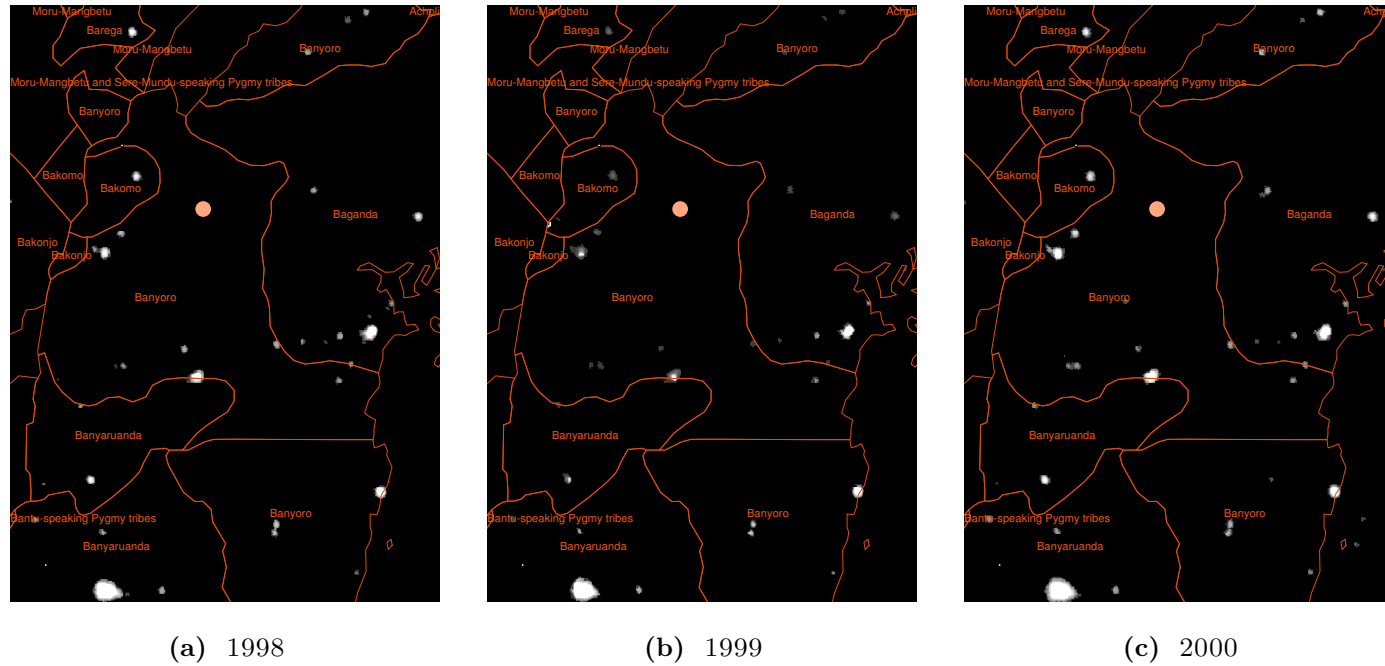
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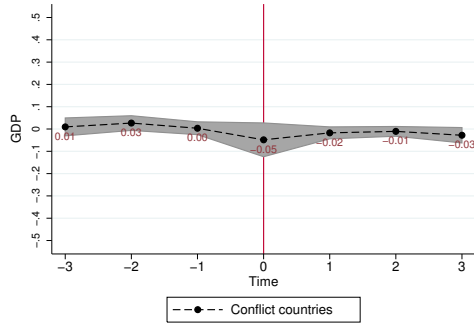
**Figure 1:** Conflicts, 1992-2008. This map shows the location of ethnic conflicts around the world during the 1992-2008 period.



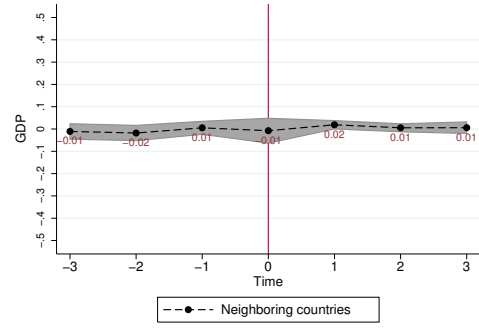
**Figure 2:** Conflicts in Uganda, 1992-2008. This map shows the location of ethnic conflicts in Uganda during 1992-2008 period.



**Figure 3:** Conflict and light output in Banyoro settlement area (South-West Uganda). These figures show light output in south-west Uganda one year prior, during, and year after a conflict in 1999.

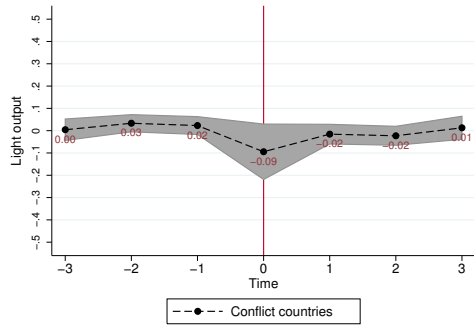


(a) CONFLICT COUNTRIES

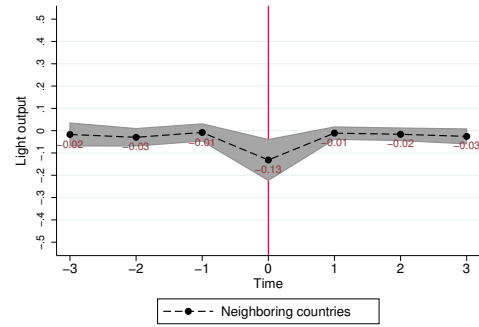


(b) NEIGHBORING COUNTRIES

**Figure 4:** Conflict and GDP at the country-level. The subfigures show the estimated marginal effects of conflicts on GDP in (a) conflict countries and (b) neighboring countries. Coefficients are based on the DiD model in Equation 1.  $N=2,755$ . 90% confidence intervals are indicated in gray.

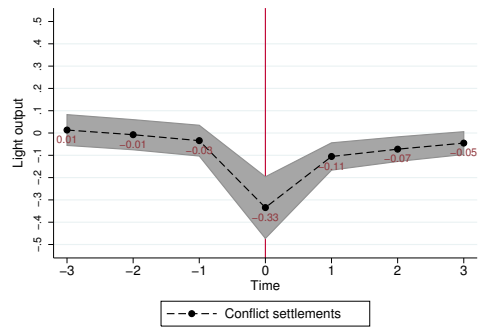


(a) CONFLICT COUNTRIES

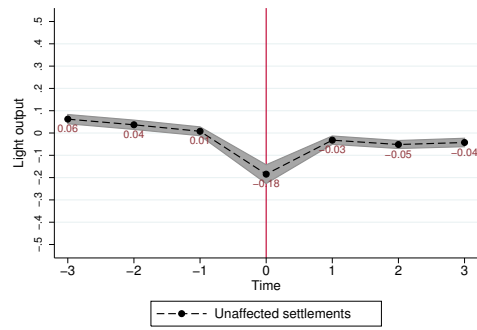


(b) NEIGHBORING COUNTRIES

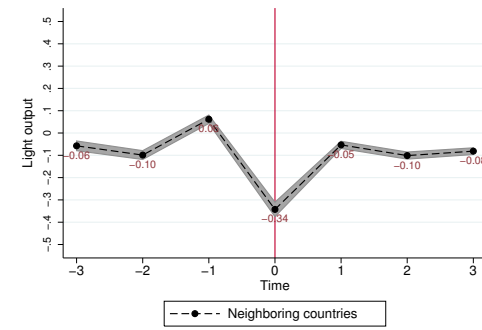
**Figure 5:** Conflict and light output at the country-level. The subfigures show the estimated marginal effects of conflicts on deflated light output in (a) conflict countries and (b) neighboring countries. Coefficients are based on the model specified in Equation 1.  $N=3,009$ . 90% confidence intervals are indicated in gray.



(a) CONFLICT SETTLEMENTS



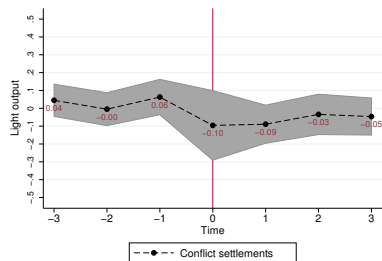
(b) UNAFFECTED SETTLEMENTS



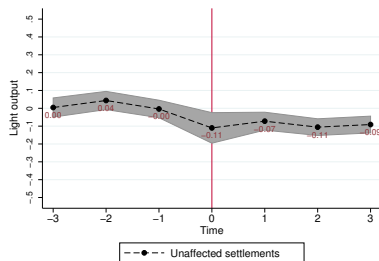
(c) NEIGHBORING COUNTRIES

**Figure 6:** Conflict and light output at the settlement-level. The subfigures show the estimated marginal effects of conflicts on deflated light output in (a) settlements affected by conflicts, (b) unaffected settlement and (c) neighboring countries. Coefficients are based on the model specified in Equation 2. N=110,402. 90% confidence intervals are indicated in gray.

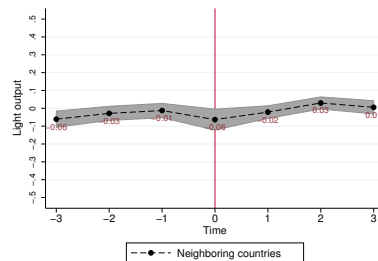
### Sub-Saharan Africa



(a) CONFLICT SETTLEMENTS



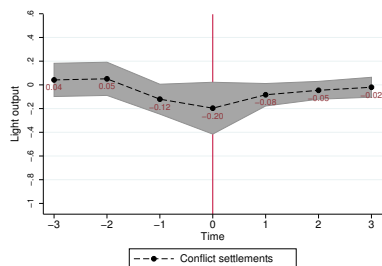
(b) UNAFFECTED SETTLEMENTS



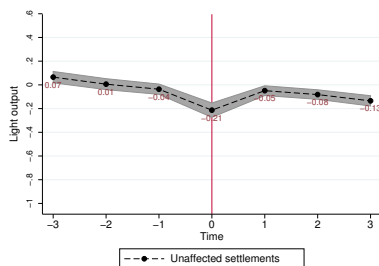
(c) NEIGHBORING COUNTRIES

**Figure 7:** Conflict and light output at the settlement-level in different regions. The subfigures show the estimated marginal effects of conflicts on deflated light output in (a) settlements affected by conflicts, (b) unaffected settlement and (c) neighboring countries. Coefficients are based on the model specified in Equation 2.  $N=10,901$ . 90% confidence intervals are indicated in gray.

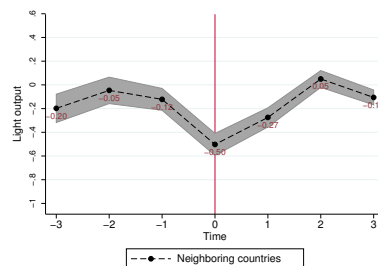
### South and South-East Asia



(a) CONFLICT SETTLEMENTS



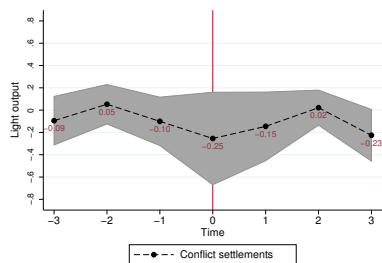
(b) UNAFFECTED SETTLEMENTS



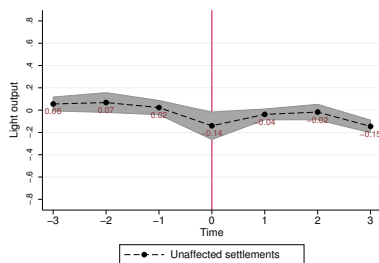
(c) NEIGHBORING COUNTRIES

**Figure 8:** Conflict and light output at the settlement-level in different regions. The subfigures show the estimated marginal effects of conflicts on deflated light output in (a) settlements affected by conflicts, (b) unaffected settlement and (c) neighboring countries. Coefficients are based on the model specified in Equation 2.  $N=15,106$ . 90% confidence intervals are indicated in gray.

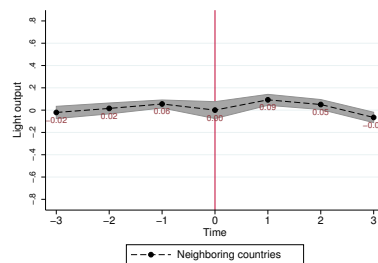
### Latin America



(a) CONFLICT SETTLEMENTS



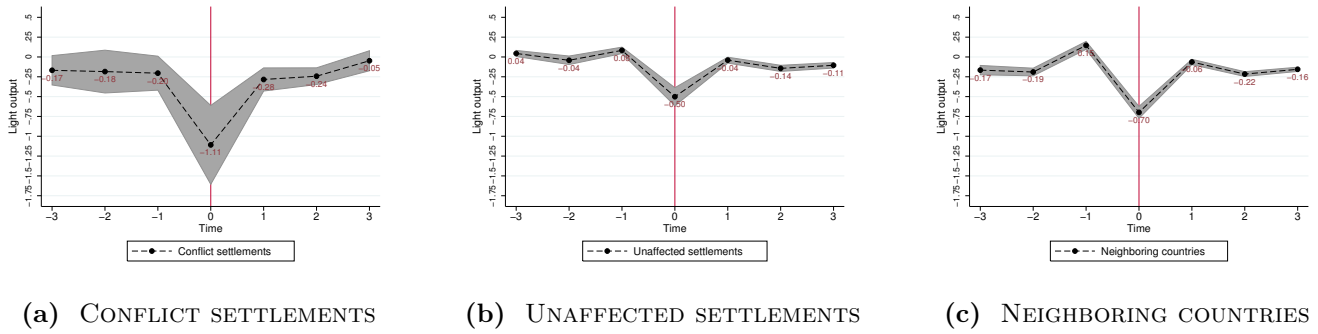
(b) UNAFFECTED SETTLEMENTS



(c) NEIGHBORING COUNTRIES

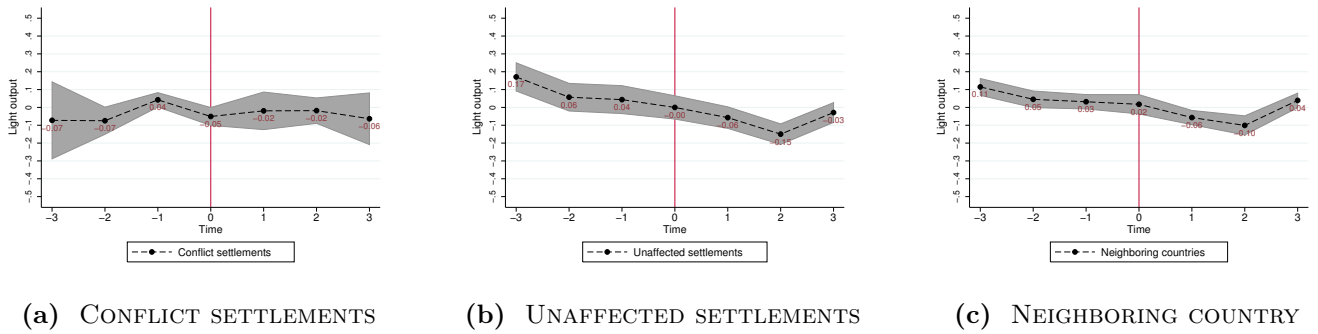
**Figure 9:** Conflict and light output at the settlement-level in different regions. The subfigures show the estimated marginal effects of conflicts on deflated light output in (a) settlements affected by conflicts, (b) unaffected settlement and (c) neighboring countries. Coefficients are based on the model specified in Equation 2.  $N=8,902$ . 90% confidence intervals are indicated in gray.

## Eastern Europe and former USSR



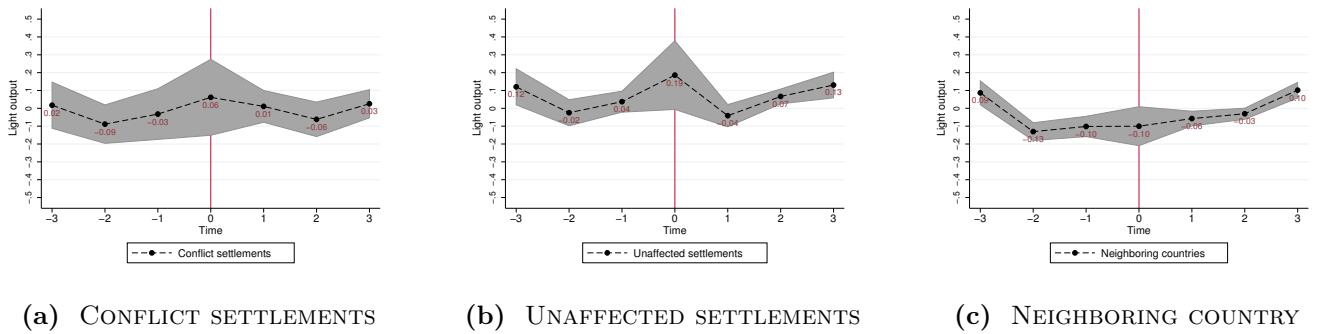
**Figure 10:** Conflict and light output at the settlement-level in different regions. The subfigures show the estimated marginal effects of conflicts on deflated light output in (a) settlements affected by conflicts, (b) unaffected settlement and (c) neighboring countries. Coefficients are based on the model specified in Equation 2.  $N=47,634$ . 90% confidence intervals are indicated in gray.

## The West



**Figure 11:** Conflict and light output at the settlement-level in different regions. The subfigures show the estimated marginal effects of conflicts on deflated light output in (a) settlements affected by conflicts, (b) unaffected settlement and (c) neighboring countries. Coefficients are based on the model specified in Equation 2.  $N=10,127$ . 90% confidence intervals are indicated in gray.

## Middle East and North Africa



**Figure 12:** Conflict and light output at the settlement-level in different regions. The subfigures show the estimated marginal effects of conflicts on deflated light output in (a) settlements affected by conflicts, (b) unaffected settlement and (c) neighboring countries. Coefficients are based on the model specified in Equation 2.  $N=7,318$ . 90% confidence intervals are indicated in gray.