The War Disease: A Spatial-Temporal Analysis of Political Violence*

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Abstract

Social phenomena rarely occurs in isolation and civil wars are no exception. War has usually been viewed as a one dimensional phenomena and the spillover of war studied across international boundaries only. This paper is a first step towards building a conceptual framework to analyze violence upsurges in a more dynamic and disaggregated setting. Using data on the Maoist insurgency in Nepal, I propose a model that conceptualizes violence as a spatial-temporal process and then estimate the parameters of interest via the Maximum Likelihood technique. Like the spread of a disease, the spread of war can be broken down into two stages. First is the infection stage when initial areas become involved in war. The second stage occurs when the extent of violence in the affected areas increases. In the model the two stages are correlated, which allows for unobserved heterogeneity in an area's war receptivity to jointly influence the likelihood of war, and the intensity of violence upon war starting in the area. The main conclusion is that the key determinant of whether or not an area is drawn into a civil war is its proximity to areas that are already engaged in the civil war. Moreover, contrary to previous studies, socioeconomic conditions related to greed, grievance, and opportunity become insignificant once the proximity to conflict is accounted for.

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1 Introduction

Civil wars [1] can be frequent, persistent, and costly. Since World War II there have been on average 2.3 new civil wars around the world per year (Fearon and Laitin, 2003), lasting an average of seven years- almost six times longer than the average international war (Collier, Hoeffler, and Soderbom, 2004). These wars have taken 20 million lives and caused 67 million people to become refugees (Doyle and Sambanis, 2003). It is estimated that by the end of a conflict, a country's GDP will be 15 percent lower than when it began. It will take an average of 21 years for the country to reach the level of GDP that would have been attained had it not experienced the conflict (Collier and Hoeffler, 2004).

There are two primary views of civil wars. The first, and the traditional view, is that wars have deep roots in socioeconomic conditions. As such, this view seeks to identify the characteristics of a country that make it more likely to breed insurgents. These characteristics are broadly classified as greed, grievance, and opportunity. The provision of natural resources, such as diamonds, causes greed among the population and provides financial means for their armed struggle. While high levels of destitution faced by the denizens leads to grievance, which make them more likely to wage war against the government, armed uprisings can also emerge simply because there are opportunities that allow such activities to take place (Collier and Hoeffler, 2000; Fearon and Laitin, 2003; Collier, Hoeffler, and Soderbom, 2004). Some examples of the socioeconomic conditions that result in grievance are poverty, unstable governments, and religious and ethnic cleavages. Similarly, the presence of a rugged terrain, a large population, and dense forests, are thought to provide suitable environments and opportunities for an armed uprising to emerge and to persist.

Taking a behavioral approach, some studies model these determinants in a game-theoretical context (Hirshleifer, 1991, 1994, 2001). Most of the studies, however, focus on empirically identifying the relationship between the key characteristics of countries and conflict outbreak. Nevertheless, there is little agreement as to what socioeconomic conditions are favorable to insurgents and how they relate to the prevalence of armed struggle. For example, Collier and Hoeffler (2004), Stewart (2001), and Elbadawi and Sambanis (2002) establish

[1] I use civil war, conflict, rebellion, and insurgency interchangeably. Authors like Elbadawi and Sambanis (2002) argue that since civil war and rebellion include collective action and violence against an established authority, the overall meaning remains the same.

the importance of ethnic inequality in causing a conflict, whereas Fearon and Laitin (2003) and Sambanis (2001) refute this argument. Similarly, the importance of other local drivers of conflict, such as a rugged terrain or measures of deprivation, are also contested in the empirical analysis. Generally, these studies highlight some measure of greed, grievance, and opportunity as fuel for a conflict. It is not clear, however, why poverty, ethnic divisions, and the like are pervasive in many areas that are not engaged in a civil war.

The second view of civil war is that the increase in war is a spatial process. That is, war clusters in a certain space and exerts negative externalities on the nearby areas around it. This view of civil war abstracts away from associating the local conditions with conflict outbreak, and analyzes war as a more dynamic spatial phenomenon that has a significant contagion effect once it has emerged. In this regard, the emergence of war is thought to be a direct result of either a gain in knowledge in war-related tactics (which is a diffusion process), or a physical movement of rebellious activities from other war affected areas (which is a contagion process)[2]. This is the more relevant approach, because there are considerable variations in rebel motivation and historical background across countries and regions that render identifying the root causes of war an extremely difficult task. For instance, Fearon (2004) finds that once the heterogeneity in the motivation to rebel is accounted for, none of the "usual suspects" explain why some wars last longer than others.

War spills over national borders as rebels seek refuge, they use the resources of nearby areas, and they aim to spread their presence and influence into these neighboring areas. This knowledge-sharing and expansionary view of war has been formalized since the 1970s. The idea that once an area is at war, the malaise will spread to contingent areas was proposed by Alcock (1972) and further extended by Most and Starr (1980), Hill and Rothchild (1986), and Rosh (1988) to name a few.

More recently, the contagion effect of war is confirmed in empirical analysis as well. Sambanis (2001) finds that having a neighboring country at war significantly increases the probability of ethnic conflict in an adjoining country. Similarly, Ward and Gleditsch (2002) model the likelihood of a country engaging

[2]Diffusion and contagion are different mechanisms by which a war spreads. Since it is a matter of argument as to which of these mechanisms are at play, I do not distinguish between the two mechanisms.

in war conditional on war in proximate states. Although their data covers only a cross-section (1988) of countries at war, it is able to predict roughly half of the international and civil wars from 1989 to 1998. Murdoch and Sandler (2002) analyze the spillover effect of war in a neighboring country on domestic human capital accumulation. To estimate this neighborhood effect, the authors use a weighted average of civil war measures in the neighboring countries, where the weights are proportional to the length of common borders. Buhaug and Gleditsch (2008) study whether the contagion effect of war remains once the spatial clustering of a country's characteristics are accounted for, and find that the contagion effect does remain.

Although most studies focus on the contagion of war across countries, distance from capital city to conflict area is commonly used to study the consolidation of insurgent activities within a country. That is, depending on the rebel motivation, war clusters more nearer or more farther away from the capital city of a country (Buhaug and Gates, 2002). Moreover, the spatial nature of war, or the extent of geographical spread, is also viewed as an outcome of war itself . Regardless of the way proximity is viewed (capital-conflict distance, length of common border, or outcome of a war), the conclusion of these spatial studies is that a region's proximity to an emerging civil war is a major predictor of whether that region will itself become engulfed in the civil war.

The importance of geographical proximity in transmitting externalities goes beyond the study of war. The concept of war being spatially clustered and having spillover effects to nearby areas resonates with the idea that many social phenomena have ripple effects across borders to neighboring countries. Intangible assets, like the knowledge of the workforce, or the political institutions within a country, are traditionally thought to have spillover effects on neighboring countries. That is why there is international support to facilitate the transmission of positive spillover effects and to form coalitions to abate the spread of the negative ones. For instance, democracy (Leeson and Dean, 2009), economic freedom (Sobel and Leeson, 2007), and media freedom (Sobel, Dutta, and Roy, 2001) are also contagious. A general consensus is that approximately 25 percent of a country's economic and political institutions are a direct result of the economic and political institutions of the neighboring countries. The spillover effects of civil war are not understood as clearly as the aforementioned contagion effect of political and/or social institutions. This paper aims to en-

hance our understanding of this key area.

In summary, while the traditional view of war focuses on identifying the correlates of war, studies have not been able to fully explain the differences between the attributes of countries and how they relate to the characteristics of war. More importantly, based on their analysis, one cannot predict where conflict outbreak will happen, since the studies cannot explain why many local driving forces which are thought to fuel an insurgency (like poverty, or an unstable government) are pervasive in many areaa, while civil wars are not. There exists an abundance of would-be counter examples in this regard. The second or the dynamic view of war, although new in empirical analysis, is more able to predict the locations of war emergence (Ward and Gleditsch, 2002). This is primarily because war is thought to be a dynamic phenomenon instead of an on-off process. Even though this view takes a dynamic approach to understanding a conflict, one drawback is that war is thought to be only a one-dimensional process. The other dimension, the temporal aspect of war, is not studied in conjunction with the spatial dimension.

Starr (2003) argues that *"time and space are two primary ways in which we contextualize social behavior and interaction ... the notion of movement through space is voluntary and through time is involuntary. Just because it [the movement through space] is voluntary, the spatial context should be even more important to many aspects of our research."* Although the importance of space in the study of war is clear, there is no study that views war as a spatial process and accounts for the temporal dimension as well. That is, the study of war as a spatial-temporal process has not been undertaken, which means the relationship between the spread of violence (the contagion effect) and the escalation of violence (the temporal aspect) remains unexplained.

This leads to a few important questions. Firstly, how can we conceptualize the spread of a war? Since the study of war as a spatial-temporal process has not been undertaken, how can we integrate the space and time dimensions of war to study the characteristics of war? Can we explain war as a dynamic phenomenon rather than being "static" with only local drivers behind its upsurge? If violence is a spatial-temporal process, is the spread completely spatial like the spread of a disease? Or does violence spread systematically according to the characteristics of an area? Additionally, does violence escalate suddenly, like an earthquake, or does it escalate slowly over time like a volcano eruption (Sambanis, 2009)?

And perhaps most importantly, once an area is engulfed by war, how does the violence evolve?

These questions remain unanswered, since studies have focused on the spillover of war across international boundaries only. By focusing on the cross-border spillover of war, one cannot explain the heterogeneity in violence within a country. To conceptualize war as a spatial-temporal process, data at a sub-national level is required. There needs to be considerable variation in the geographical spread of war and the socio-economic conditions within a country, in addition to information on the temporal intensity of violence. As such, the data on the Maoist insurgency in Nepal is quite suitable. This insurgency, which started as low-scale political violence, has grown to a level of war,[3] and has spread through the entire country within seven years of initiation. Most importantly, data gathering remained functional over the duration of the war, and is systematically available for all the administrative units of the country.

There are three main studies that use the Nepali Maoist uprising as their area of interest. Murshed and Gates (2005) and Do and Iyer (forthcoming) analyze the determinants of the insurgency, while Bohara et al (2006) study the pattern of violence exchanged between the government and the Maoist insurgents, and analyze how the pattern varies according to the characteristics of districts (administrative units). A major drawback of these studies is that the spatial nature of war is not accounted for and the analysis of the temporal aspect is not fully exploited.

By recognizing this shortcoming, this study proposes a way to conceptualize violence as a spatial-temporal process. Like the spread of a disease, the spread of war can be broken down into two stages; an infection stage and an escalation stage. First, there is an infection stage when an area becomes engaged in a civil war. In the second stage, there may be an escalation as the surrounding areas engage in violence. The two stages are allowed to be correlated, which allows for unobserved heterogeneity in an area's war receptivity to jointly influence the likelihood of war and the intensity of violence upon war starting in an area. The results of this study suggest that geographical proximity determines how quickly an area gets drawn into violence, and that escalation of violence is due to early exposure to violence. If the spread was systematically related to the

[3]By the standard definition of war categories, if the fighting results in greater than 1000 deaths in a given year, it is categorized as a war (Gleditsch et al, 2002).

attributes of an area, we would expect such factors as poverty rate, literacy rate, forest density, etc, to explain conflict emergence. I show that if the spatial nature of war is ignored, the results are similar to the view of war as having local root causes. Once the spatial nature of conflict is accounted for, however, the aforementioned local conditions do not influence the manner in which violence unfolds.

This paper is organized as follows. Section 2 presents the data, followed by a brief discussion on the history of the Maoist insurgency in Section 3. War-as-a-Process based view is conceptualized in 4. The results are presented in Section 5 and I conclude in Section 6.

2 Data

Since the traditional studies of war argue that local conditions- broadly categorized as greed, grievance, and opportunity- influence violence upsurge, I use various indicators of these conditions in the analysis. Poverty and literacy rates are used as measures of local grievance. The poverty rate is the percentage of population below the national poverty line. It is calculated from household level data from the Nepal Living Standard Survey (1995-1996) jointly by the Central Bureau of Statistics (Nepal) and the World Bank. It is plausible that poverty rate is measured inaccurately or is endogenous. Miguel et al (2004) show that if the economy is dependent on agriculture, variation in annual rainfall provides an exogenous source of variation in income. They argue that volatility in weather (rainfall) significantly affects agricultural yield in an area, thereby affecting the income of the people of the area. Rainfall data is preferred to poverty, because unlike poverty, rainfall (precipitation level) is measured more accurately and varies over time. Since agriculture is the largest sector of the economy of Nepal, it is reasonable to use rainfall as an alternative indicator of income. Hence, I alternatively use annual levels of rainfall to check the sensitivity of the results.

The lack of natural resources to finance rebel activities in Nepal (like diamonds, oil, timber, or coca) refutes greed as a motivation for the insurgency. Opportunities provided by the geography should still exist, since the country is very mountainous (8 out of 10 highest peaks of the world are located in Nepal), and there is an abundance of densely forested areas. Several authors use percentage of district area covered by forest (forest density), length of road per

district area (road density), elevation, population density, etc, as measures of opportunities for rebellious activities (Fearon and Laitin, 2003; Bohara et al, 2006; Do and Iyer, *forthcoming*). Elevation and road density are highly correlated, so I use only road density in the main analysis. Road density data is preferred to elevation because it measures accessibility and it is an indicator of demand for public services that is affected by elevation and population. I alternatively use elevation instead of road density and find that the results are not sensitive to using either of these measures. All of these local drivers of conflict are measured at the district level in the pre-conflict period (before 1996).

The dynamic view of war, on the other hand, finds that the relative location of an area determines the likelihood of a war in that area. The measures of relative location that make countries vulnerable to war are length of common border with a country at war and distance from a war affected country. Many authors use distance from capital city to analyze the consolidation of rebellion activities within a country. I argue that distance from capital city is not very relevant for the study of spread of war. Firstly, the capital city is the decision making center of the government. If the interest lies in understanding the spread of war, the decision making center of the insurgents (the conflict location) should be the area of reference. After all, the conflict location is the source of war emergence. Secondly, the distance from a capital city is only meaningful if the interest lies in investigating whether rebellion activities consolidate nearer or farther away from a capital city. This is simply a function of rebel motivation. For example, if the motivation for the uprising is to overthrow the government, the uprising is likely to be in or around the capital city. Although I use distance from capital city to test the sensitivity my results, the primary measure of proximity is the minimum distance from the initial conflict affected areas.

Besides the local conditions and the geographic proximity to war affected areas, local politics should also matter for the emergence and prevalence of an armed uprising. McColl (1967) and Raleigh *et al.* (2009) argue that the strategic location of a place is more important than the topology of the location. One of strategic advantages of a location is its population base. Hence, it is reasonable that without the support of the local people of an area, insurgents cannot grow in sheer size and capacity.

The mid-western part of Nepal, the Maoist's stronghold, was strategically favorable for the Maoists because of the presence of communist activities in those

areas since as far back as in the 1950s. As such, the communist stronghold in a district is measured by the share of votes received by the communist party in the 1994 House of Representative election (obtained from the Election Commission). Furthermore, in the aforementioned area live Magars, an ethnic group known to be of militant in nature, as a dominant population. The Magars were the soldiers of the Gorkha expansionary army, who fought to unite the country (1765-1768). They formed a part of the ruling elite in the initial years of the new empire; nevertheless, over the years they have been marginalized and have thought of themselves as neglected by the government. It has been argued that the presence of the Magars and Rais (another ethnic group with similar history as Magars) and the history of neglect faced by this population also gave the Maoists the much needed support (Thapa and Sijapati, 2004). In order to measure the concentration of the local population base thought to support the Maoist's cause, the Census data is used to calculate the share of population that belong to ethnic groups believed to be of militant in nature [4]. For the ease of reference, the share of these ethnic groups is referred to as "ethnicity" and the share of votes received by the communist party as "communist stronghold". The ethnicity and communist stronghold capture the strategic importance of a location or are indicators of local politics[5].

Lastly, the data on the temporal levels of violence, such as the number of killings by the Maoist rebels and the government were collected from the Informal Sector Service Center (INSEC). The INSEC maintains the data on yearly human rights violations, such as killings, beatings, threats, arrests, separately by the actors (government or insurgents). Since only the killings data is available consistently throughout the years, I use the number of killings (both by the government and the Maoists) weighted by the district population (of 1990) as a measure of conflict intensity. The years following 2001 were marked by the escalation of violence due to the government engaging in arbitrary counter-insurgency tactics. Upon the change in the Commander-in-Chief of the army,

[4]These ethnic groups are Magar, Rai, Tamang, Limbu, and Gurung. They form the majority of Nepali to serve in the British Army, and to some degree in the Nepali Army.

[5]Several authors use ethnic factionalization or ethnic polarization to measure the heterogeneity of the population base. Such measures are relevant to understand if the violence is ethnic based. Since the conflict under investigation is a politically motivated one and the focus of this paper is to explain violence upsurges, it is more meaningful to analyze how local population base relate to the insurgency.

the King, army was mobilized for the first time to abate the insurgency. This further increased the ferocity of violence. Moreover, there were several rounds of futile peace talks and ceasefires after 2001. Given these reasons and that after 2001 the entire country was affected by the conflict, which reduces variation in conflict onset, I use data from 1996-2001 only.

Table (1) provides a summary statistics of the data. As the Table shows, there are significant variations in grievance, opportunity, local politics, and violence in the country. For example, the percentage of population below the national poverty line ranges from 4.4 percent to 60 percent. Similarly, literacy rate ranges between almost 20 percent to 70 percent. Furthermore, there is a considerable variation in violence overtime. The sharpest increase in violence happened in 1998, after which the intensity of violence remained high.

3 Background: The "People's War" (1996-2006)

Nepal is a landlocked country located in Southern Asia surrounded by India on the East, West, and South and China on the North. The country has a population of approximately 28.1 million and total land area of 147.2 thousand square kilometers. Agriculture is the largest sector of the economy with a GDP per capita of USD 470 (Fiscal Year 2009, World Bank: Nepal Country Overview 2010). There are 75 administrative units, called districts, which are grouped into 5 development regions. As statistics are consistently reported at the district level, these districts are the units of observation. A district is comparable to a county in the United States. (Do and Iyer, *forthcoming*).

The official birth of the Maoists in Nepal is considered to be in 1995. In 1994 the Election Commission had denied the request for recognition of a communist party, which was a breakaway faction of the Communist Party of Nepal (Unity Center). After the rejection by the Election Commission the party was renamed as the Communist Party of Nepal (Maoist) and the leaders of the party went completely underground in preparation of an armed revolt. February, 13, 1996, marked the initiation of the insurgency in the country, when a series of attacks on government offices were launched in several parts of the country. Baburam Bhattarai, the vice-chairman of the CPN (M), had approached the prime minister with a 40 point memorandum on February, 4, and warned of armed struggle should the government fail to meet those demands by February, 17. However,

the attacks were launched on February 13, the date the party had decided, instead of honoring the deadline of February 17, as given in the proposal to the government (Thapa and Sijapati, 2004).

As the monarchy ended in 2006, the political parties signed the Comprehensive Peace Agreement in which the Maoist leaders agreed to keep their arms and soldiers in UN monitored cantonments. An agreement was reached to hold a constituent assembly election, as a step towards writing a new constitution. The signing of the Comprehensive Peace Agreement marked the end of the decade long insurgency.

4 War-as-a-Process Based View

Since the focus of this paper is to conceptualize war as a spatial-temporal process, the characteristics of war are divided into two stages: the contagion stage and the stage when the extent of violence increases. A relevant approach to understanding the contagion effect of violence is to observe the start of violence in an area and time elapsed until the incidence of violence is observed in other areas. This approach relates the attributes of an area to the role those attributes play in determining how quickly the area gets drawn into violence. The time until the first change- onset of conflict- occurs can be implemented using the Poisson distribution. The dependent variable is the time elapsed between the initiation of conflict in the country and the first incidence of conflict related violence in a district. This variable is equal to zero in the districts where the conflict initiated (in 1996), one for the districts that were affected in the first year after the conflict started (1997), and so on. On the other hand, the stage when the extent of violence in affected areas increases is analyzed using ordinary least squares (OLS) technique.

I begin the analysis with the "static" view of war. That is, I test whether local conditions (grievance, opportunity, and local politics) explain the spread and intensity of violence. As can be seen in Table (2), poverty, literacy rate, forest density, and ethnicity are significantly associated with conflict onset. The negative sign on forest density and ethnicity implies that densely forested areas and areas with higher concentration of the ethnic group had violence earlier. Similarly, the positive sign on literacy indicates that higher levels of literacy rate delayed the onset of violence. The sign on poverty rate is opposite, mean-

ing that higher level of poverty is associated with conflict happening at a later stage. As mentioned earlier, rainfall is an alternative measure of poverty and elevation and road density are highly correlated. Column II in Table (2) reports a separate analysis using rainfall instead of poverty and elevation instead of road density. Neither of these alternative measures are significant, although the coefficient on forest density becomes insignificant. Similarly, Column IV-VI of Table (2) reports the results for the escalation of violence. An OLS estimation of cumulative violence shows that violence was more intense in densely forested areas (Column IV). In Column V rainfall and elevation are used instead of poverty rate and road density, respectively. Upon adding these alternative measures, literacy rate and elevation become significant and the explanatory power of forest density increases.

Nevertheless, these results are in alignment with the other studies that analyze the determinants of conflict. For example, the results suggests that grievance (poverty and literacy rate), geography (forest density), and local politics (concentration of the ethnic group) determine how quickly an area gets drawn into violence and how intense the violence gets. Do and Iyer (forthcoming) find that the association between conflict and poverty is driven by poorer districts being involved in conflict at an early stage of the conflict, and the geographical conditions affect the intensity of the conflict once it started. Similarly, Bohara *et al* (2006) find that the government and the Maoists engaged in higher levels of violence in districts with rugged terrain. The results in Columns I-II and Columns IV-V of Table (2) conform the results from these studies. Furthermore, since the local drivers seem to be important in explaining the characteristics of violence in Nepal, the insurgency in Nepal is comparable to that of the other countries studied in the literature.

As mentioned in the Data section, the view of war as a spatial phenomenon highlights the importance of geographic proximity to war affected areas in determining the likelihood of a war in an area. Hence, minimum distance to initial war affected areas (districts) is used as a measure of geographic proximity. Column III of Table (2) shows the results for the same analysis as above with distance as an additional control. Once distance from the nearest conflict affected district is controlled for, the local conditions are no longer significant. A null hypothesis that all the local drivers of conflict are jointly significant cannot be rejected. Similarly, adding distance as a control in the analysis of violence

intensity removes the significance of other drivers of violence as well. Distance is both statistically significant, provides a better fit of the data, and explains about a quarter of variation in the violence intensity. I checked the sensitivity of this analysis using distance from capital city (Kathmandu) instead and find that distance from capital is not significantly associated with either the spread or the intensity of violence [6].

Overall, Table (2) highlights the importance of proximity in the spread of violence and the higher intensity of violence seems to be driven by early exposure to violence. That is, being close to a war affected area increases the likelihood of war in an area and the longer duration of violence results in higher level of casualties. Figures 1-6 show the maps of districts affected by the insurgency in various years. As can be seen, the conflict spread to nearby areas and grew ferocious over time. Additionally, Table (3) provides the summary statistics of local conditions by proximity. I divide the districts into three groups based on how close the districts are to the districts that had conflict in 1996 (which are initial conflict affected areas) . The Table shows that the areas that were close by (0-50 kilometers) have higher levels of violence compared to the areas in the middle range (50-100 kilometers) and furthest away (greater than 100 kilometers). However, aside from the intensity of violence, these districts are comparable. The districts that are close by are not systematically poorer, have low literacy rate, etc. This simple way of categorizing districts suggests that the differences in conflict spread and intensity is not due to poorer or remote areas being drawn into violence at an early stage, but because the districts happen to be closer to the conflict affected districts. As such, these observations provide motivations to conceptualize war as a spatial-temporal phenomena.

These things considered, let T be the year the conflict initiates in the country and $\overline{T}$ [7] be the end of observation. Proximity, as measured by distance (d_i) from a district (i) to another district with conflict in 1996, is among many characteristics of a district that make it prone to conflict. If there is more than one district with conflict, then the minimum distance measures the proximity. That is, the year in which the conflict starts in a district (τ_i) is a function of distance (d_i) to an initial conflict affected district and other socio-economic characteristics of the district (X_i). Furthermore, the longer the time elapsed

[6] For brevity results are not reported.

[7] Since the time period under consideration is 1996-2001, $\overline{T} = 2001$

since the conflict started in the country $(t-T)$, the more likely it is that the conflict spreads to a district. Here, t is any year under consideration and $t-T$ is the time elapsed since the conflict started, which is the same for all the districts.

Let, $y_i = \tau_i - T$. That is, y_i is the waiting time until the first change occurs in a district (i). The probability that the conflict spreads to a district i after a given interval Y is:

$$Pr[y_i = Y] = f(d_i, X_i, t-T, \epsilon_i) \tag{1}$$

$$\frac{\partial f}{\partial d_i} \succ 0,\ \frac{\partial f}{\partial t} \prec 0$$

In Equation (1) X_i is a set of explanatory variables and ϵ_i is the time-invariant unobservable characteristics of a district. Using Poisson distribution to implement the probability,

$$Pr[y_i = Y] = \frac{(exp^{-\lambda_i}) * (\lambda_i^Y)}{Y!} \text{if } \tau_i \leq \overline{T} \tag{2}$$

Where, $\lambda_i = exp(\theta X_i + \epsilon_i)$, $Y = 0, 1, 2, ...$ If there was no conflict in a district by the end of the period of observation $(\overline{T})$, then there is still a chance that the district will have violence in the years to follow. Failure to take into account the probability that there might be conflict in year greater $\overline{T}$ means that Y will be truncated at $\overline{T}$.

The probability that there will be a conflict in any given year greater than $\overline{T}$ is

$$Pr[y_i \succ (\overline{T} - T)] = 1 - \sum_{y_i=0}^{\overline{T}-T} \frac{(exp^{-\lambda_i}) * (\lambda^{y_i})}{y_i!}$$

Once the conflict infiltrated a particular location, the intensity escalates with the duration $(t-(\tau_i-1))$ of the conflict in that location. It is natural to assume that longer lasting conflicts will result in more casualties. The term $(t-(\tau_i-1))$ will be different in each t, which captures the temporal aspect of the violence. Since, τ_i is the time of start of conflict, $t-(\tau_i-1)\ \forall t \geq \tau_i$ is the duration of conflict in district i. Let, ω_i be the time invariant unobservable characteristics of district associated with the intensity of violence and $D_{it} = t-(\tau_i-1)$ be the duration of conflict in a district i in year t. The expected level of violence in a

given year t and location i is

$$E[V_{it}] = \begin{cases} g(D_{it}, X_i, \omega_i, \eta_{it}) & \text{if } t \geq \tau_i \\ 0 & otherwise \end{cases}$$

Where,

$$\tfrac{\partial g}{\partial (D_{it})} \succ 0, \, \binom{\epsilon}{\omega} \sim N(0, \Sigma)$$

and

$$\Sigma = \begin{bmatrix} \sigma_\epsilon^2 & \sigma_{\epsilon\omega} \\ \sigma_{\epsilon\omega} & \sigma_\omega^2 \end{bmatrix}$$

More specifically,

$$E[V_{it}] = \begin{cases} \beta(D_i) + \pi * X_i + \omega_i + \eta_{it} & \text{if } t \geq \tau_i \\ 0 & otherwise \end{cases} \tag{3}$$

To operationalize Σ, ω can be expressed as

$$\omega = \tilde{\sigma}_{\epsilon\omega} * \tilde{\epsilon} + \tilde{\sigma}_\omega * \tilde{\omega}.$$

where, $(\tilde{\epsilon}, \tilde{\omega})$ $N(0, 1)$.

The unobservable term $\tilde{\sigma_\omega}$ accounts for the unobserved variation V_{it}, the conflict intensity, once the variation in conflict intensity due to the unobserved variation in conflict start is accounted for. Intuitively, ϵ and ω are time invariant state specific unobserved disturbance term. If $\tilde{\sigma}_{\epsilon\omega}^2 + \tilde{\sigma}_\omega^2$ is the total time-invariant unobserved variation in V_{it}, then $\tilde{\sigma}_{\epsilon\omega}$ is a portion of ω that is due to the the district being drawn into conflict at an earlier stage and $\tilde{\sigma}_\omega$ is the remaining variation of ω that is associated with violence intensity. If the covariance between the two processes is zero, the unobservable characteristics that makes districts more likely to have higher (lower) level of violence is unrelated to the unobservable characteristics of the same districts that make them have conflict early (later) on. If the covariance is positive, then the unobservable characteristics of a district that make them more likely to have conflict early on also make the district *less* likely to have higher levels of violence.

The probability of a given sequence of observation in a district (i) is

$$Pr[V_i = v] = \begin{cases} \prod_{t=\tau_i}^{\overline{T}} \phi(z_t|\epsilon_i) * Pr[y_i = Y|X_i] * f(\epsilon_i) & \text{if } \tau_i \leq \overline{T} \\ Pr[y_i \succ (\overline{T} - T)|X_i] & otherwise \end{cases}$$

Where, $\phi(.)$ is the density of a standard normal distribution and $z_t = \frac{\overline{V_t} - \beta(D_{it}) - \pi * X - \tilde{\sigma}_{\epsilon\omega} * \tilde{\epsilon}}{\tilde{\sigma}_\omega}$. The conditional density of z needs to be adjusted, since $Pr[\omega_i|\epsilon_i]$ is distributed normally with mean $\tilde{\sigma}_{\epsilon\omega} * \tilde{\epsilon}$ and variance $\tilde{\sigma}_\omega^2$

Let, $\delta_i = 1$ if $\tau_i \leq \overline{T}$. The likelihood function is

$$l_i(\theta, \beta, \sigma) = \prod_{i=1}^{N} \left[\int \left(\left\{ \prod_{t=\tau_i}^{\overline{T}} \phi(z_t|\epsilon_i) * Pr[y_i = Y] \right\}^{\delta_i} \left\{ Pr[y_i \succ (\overline{T} - T)] \right\}^{1-\delta_i} \right) * d\epsilon_i \right].$$

The log-likelihood function is

$$L(\theta, \beta, \sigma) = \sum_{i=1}^{N} \int \left[\delta_i * \left\{ \prod_{t=\tau_i}^{\overline{T}} (\phi(z_t|\epsilon_i) * Pr[y_i]) \right\} + (1 - \delta_i) * \left\{ Pr[y_i \succ (\overline{T} - T)] \right\} \right] * d\epsilon_i. \tag{4}$$

The parameters of interest are θ, β, σ, where $\sigma \in \{\sigma_\epsilon, \tilde{\sigma_{\epsilon\omega}}, \tilde{\sigma_\omega}\}$. The likelihood function is weighted by the density of ϵ. By simulating the likelihood function, the particular values of ϵ will be integrated out and only the parameters that describe the density of ϵ will contribute to the likelihood function. If there is no correlation between the two random components, then the Poisson distribution and the probability of the violence reaching a certain level are two separate processes. Two separate likelihood functions can be written and maximized individually. Although, the likelihood is a function of parameters of ϵ, an unobservable, simulation methods are used to derive the unbiased estimator of the probabilities.

5 Results

Table (4) summarizes the main results. A positive coefficient for the conflict spread means the variable causes conflict to happen in later years. Column I allows distance and duration to have non-linear effects in the Poisson analysis and conflict intensity, respectively, while controlling for all local conditions in both cases. Column II differs from Column I only in that distance is removed from analysis. This is to test whether the local conditions are jointly significant

in explaining conflict spread. Similarly, in order to test the explanatory power of distance, only distance is included in Poisson analysis (Column III) and all socio-economic conditions pertain to the conflict intensity only (Column IV).

The effect of distance is substantial in all the specifications. A coefficient of distance (3.098) in Column I of Table (4) implies that increasing the proximity from the zero (areas from where violence began) to the tenth percentile (35 kilometers) makes the districts have conflict about 3 years later. Similarly, increasing the distance from tenth percentile to twenty five percentile (from 35 kilometers to 45 kilometers) delays the conflict onset by about a year and half. Put differently, half a standard deviation increase in distance (about 25 km) from zero delays the start of conflict by 1.3 standard deviations (2 years later). This is a very large effect, which is reasonable considering that, on average, a district witnessed violence within 3.15 years of initiation (with 1.75 standard deviation). Figure 7 and Figure 8 plot the total effect and the marginal effect of distance, respectively.

None of the other social and economic condition are significant in these analysis. This result is consistent across different specifications too. A null hypothesis that the local drivers of the conflict are jointly insignificant (zero) cannot be rejected at the 95 percent confidence level. The covariance between unobserved heterogeneity across the two models is positive. A positive coefficient implies that the unobservable characteristics of districts that are positively associated with conflict onset are negatively correlated with violence intensity. This positive correlation can be interpreted as highlighting a mechanism. If districts having majority of communist supporters are the ones to revolt (conflict happens sooner), the same districts may have less violence in the following years, as their political targets might be located in other districts. It is this type of association between conflict emergence and escalation that the results suggest. The key result is that space and time is what matters the most for conflict start and escalation, respectively.

Similarly, none of the socio-economic conditions are significant in explaining the conflict escalation either. The most influential variable in explaining conflict intensity is the conflict duration. The coefficient on duration in Column I of Table (4) suggests that increasing the mean duration by half a standard deviation increases the violence intensity by 1.2 standard deviation. This translates to 30 additional deaths using the mean population of the country (25,8497) and

standard deviation of yearly conflict in 2001. Furthermore, each increment in duration by 1 year from 1996, on average, increases the number of casualties by 125 per year (using the mean population).

It is possible that the lack of significance of poverty could be because poverty is measured incorrectly or because poverty is endogenous. As mentioned in the Data section, variation in annual rainfall provides an exogenous source of variation in income for an economy that is heavily dependent on agriculture. As an alternative to poverty rate, I use annual rainfall and find that the main results are not sensitive to using either of these measures of deprivation. Furthermore, including elevation instead of road density does not alter the main results either.

It is quite surprising that none of the local socio-economic and political conditions matter for conflict spread and escalation. Although this result seems counter-intuitive at first, I draw upon recent studies of armed uprising that analyze war at disaggregated level (within-country analysis) to argue that the results of this study is not so counter-intuitive after all. In the paragraphs to follow, I revisit each of the local drivers of conflict in turn to document regional differences in the role these local conditions play in inflicting violence.

Firstly, consider the role of poverty and literacy rate in giving rise to violence in a country. The idea that poverty and low education attainment leads to armed revolt is based on the assumption that destitution leads to higher levels of grievance and lower opportunity cost of participating in the revolt. These arguments assume that the poor voluntarily join the rebel army, however, many rebel groups grow in size by forced recruitment. A well known example is the mass abduction of children in Uganda in the 1990s by the LRA insurgents [8].

Similarly, there are many regional differences in literacy rate that refute the simplistic view that links lower levels of literacy rate with conflict outbreak. For example, Lebanon had one of the highest levels of schooling in the Arab world in the 1950-60 period, while Saudi Arabia had the schooling rate of only 4% and no war (Makdisi and Sadaka, 2002). Similarly, although African countries have low levels of schooling and higher levels of violence, countries like Cyprus, Yugoslavia, Georgia, Russia had high schooling rates at the time of war (Sambanis, 2009). Moreover, Krueger and Maleckova (2003) find that Hizbollah recruits in Lebanon were among the highly educated ones. Hence, it is not very surpris-

[8] Sambanis (2009) argues the same point. That is, he argues that there is considerable regional heterogeneity in the relationship between poverty and literacy rate and armed conflict.

ing that conflict does not spread through the areas of low literacy rate or high poverty, specially when analyzing the spread of war within a country.

The geography of Nepal would be thought to provide the rebels a safe haven from the government, since the country is very mountainous and has abundance of dense forests. However, during the initial phases of the insurgency, and during the other times the leaders were operating in secrecy, they sought refuge in India (South Asia Terrorism Portal). That is, the Maoists fleeing the government were not hiding in the jungles of Nepal, but went underground in neighboring India. The training and meetings that the Maoists held were also carried out in India. The Maoists have links with the Kamtapur Liberation Organization (KLO), which provided a support for the Maoists from Nepal to flee to certain parts of India (South Asia Terrorism Portal).

In this regard, the porous border with India might have rendered more opportunities for the Maoists to sustain and to carry out their campaign than the rugged terrain of Nepal. While rugged terrain and inaccessibility certainly contributes to the ability of the rebels to hide, it is hard to imagine that if the government considered the would-be rebels warranted a credible, a campaign to wipe them out would be so infeasible. This is certainly true given that the Maoists barely had more than two rifles when they initiated their war in 1996 and the Communist Party had merely 2000 members enlisted in 1990 (Thapa and Sijapati, 2004). From the start of insurgency to within 7-8 years the Maoists were able to gather 5,500 combatants, 8,000 militia, 4,500 cadres, 33,000 serious followers, and 200,000 sympathizers (South Asia Terrorism Portal). By 2003 their capacity surpassed that of the Nepali Police. The growth of their capability stands out as an example that such highly politically motivated campaign could not be fully sustained simply by the poor peasants joining the revolt and seeking refuge in the hinterlands.

The presence of rugged terrain and forests are thought to create a barrier for the government to access the rebel bases or headquarters. However, there are old and emerging studies that challenge this viewpoint. McColl (1967), as quoted in Raleigh, Witmer, and O'Loughlin (*working paper*), argues that, " *locations must have access to political targets... these are the treaty ports for their wealth and large administrative centers for their political and economic significance. This means that bases cannot be simply located where they would be safe due to topography or distance for the enemy.*" Raleigh and Hegre (2009) hold an

analogous view. Arguing that the strategic location of a place is more important than the topology of the location, they find that conflict in the Central African countries were not primarily located in remote hinterlands. They argue that for a battle to take place, both parties (the government and the rebel group) must be able to reach to the particular location. Additionally, the rebel groups target places that are high value to them (natural resources in case of the African countries), which are connected by roads. In this regard, the usual way in which rugged terrain is thought to influence conflict may not always hold true for two reasons. Firstly, for the rugged terrain to actually matter the rebels must be using it to their advantage. Secondly, the potential battlefields need to be accessible to both parties. This means that extreme rugged terrain is unfavorable to both parties, as it is not only difficult for the government to access those areas, but presumably, rebels will find those areas hard to access as well. Furthermore, without any strategic importance of those areas, it is unlikely that rebels would base their activities in those regions for the sole reason to take refuge in those areas.

6 Conclusion

This paper is a first step towards understanding war as a spatial-temporal process. Although the importance of proximity to a conflict affected area in increasing the likelihood of war has long been observed, spatial-temporal view of war has not been fully incorporated into empirical analysis. As such, there exists no conceptual framework to understand how contagion of war takes place. By recognizing these shortcomings, I propose a way to systematically conceptualize war as a spatial-temporal process. This approach helps us understand the mechanism that drives the spread of violence separately from the mechanism that makes violence escalate over time. As a result, heterogeneity in violence within a country can be explained. That is, using the model proposed in this study, we are able to understand why certain areas are drawn into violence or have higher levels of violence.

I show that if war is viewed as a result of a dire economic situation or local political grievance, a within-country analysis of war conforms this view. Once the spatial nature of war is accounted for, however, the local drivers commonly thought to breed insurgents are no longer significant. I test the sensitivity of

the results using alternative measures of poverty, road density, and an area's relative location. Annual rainfall is used as an exogenous source of variation in income. Similarly, elevation and distance from a capital city are alternative measures for road connectivity and relative location, respectively. The results are not sensitive to the inclusion of either measures of poverty or road density, and distance from a capital city is not significant in explaining a spread of a conflict.

The conceptual framework proposed in this study is implemented using the case study of a country. Future work will be to implement this framework using other countries to examine if the patterns observed in this study are generalizable. The results of this study aid in answering questions that abound in the study of conflict. For example, Sambanis (2009) questions whether violence escalates suddenly, like an earthquake, or whether it builds slowly over time like a volcanic eruption. The results strongly suggest that the escalation of violence is like a volcano eruption. The implications for policy intervention is that "hot spot" areas ought to be targeted at an early stage. On the spatial analysis of conflict, Raleigh, Witmer, O'Loughlin (*working paper*) question, " *once we have modeled the variation in local causes and accounted for spatial autocorrelation, is there evidence remaining that indicates that location matters?*." I show that it does matter, and interpret the results with respect to local politics as well; an approach that is missing in the literature but is increasingly recognized as being necessary for understanding in-country variation in war attributes.

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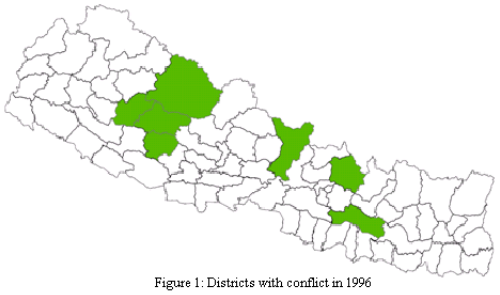


Figure 1: Districts with conflict in 1996

Figure 2: Districts with conflict in 1997

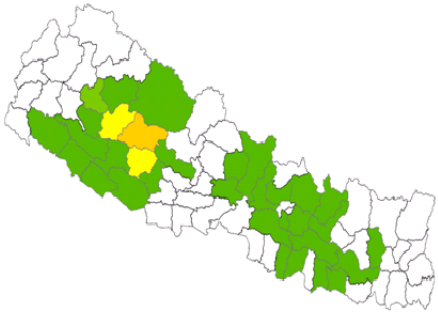


Figure 3: Districts with conflict in 1998

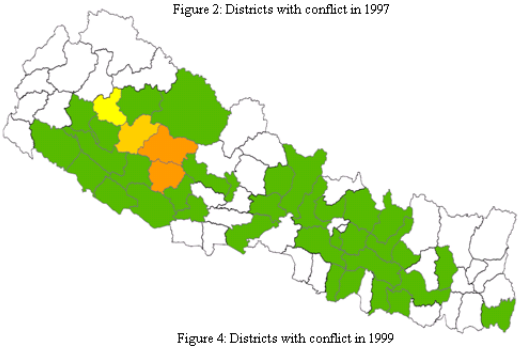


Figure 4: Districts with conflict in 1999

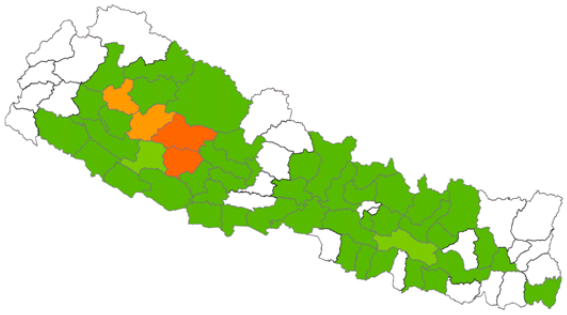


Figure 5: Districts with conflict in 2000

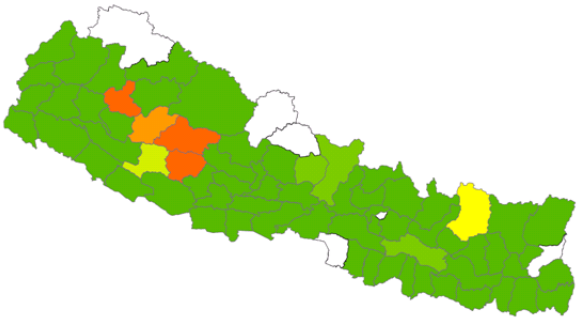


Figure 6: Districts with conflict in 2001

Table 1: Descriptive Statistics

Category	Obs.	Mean	Standard Deviation	Min	Max
Grievance					
% Poverty	75	0.382	0.125	0.044	0.603
Literacy rate	75	0.380	0.1102	0.196	0.701
Opportunity					
Population Density	75	204.6	267.2	2.388	1709.72
Forest Density	75	0.398	0.189	0.017	0.983
Road Density	75	0.113	0.210	0	1.329
Politics					
Communist Stronghold[a]	75	0.3172	0.1503	0	0.794
Ethnicity[b]	75	0.243	0.217	0.0015	0.979
Cumulative Conflict Intensity					
Cumulative deaths per 10,000 population	75	1.761	3.949	0	20.379
Yearly Conflict Intensity					
Deaths/10,000 population in 1996	75	0.0687	0.339	0	2.393
Deaths/10,000 population in 1997	75	0.037	0.160	0	1.169
Deaths/10,000 population in 1998	75	0.352	0.985	0	5.616
Deaths/10,000 population in 1999	75	0.392	1.179	0	6.680
Deaths/10,000 population in 2000	75	0.434	1.268	0	6.868
Deaths/10,000 population in 2001	75	0.478	0.931	0	6.172

a Communist stronghold is the percentage of votes received by the Communist Party in the 1994 House of Representative Election.
b Ethnicity is the share of ethnic groups that are militant in nature. They are Magar, Rai, Tamang, Limbu, and Gurung.

Table 2: Preliminary Analysis

	Onset[a]			Intensity[b]		
	I	II	III	IV	V	VI
Distance	-	-	3.034***	-	-	−13.310***
			(0.621)			(2.306)
Distance Sq	-	-	−1.014***	-	-	5.170***
			(0.260)			(1.123)
Poverty	1.249*	-	-0.859	2.827	-	4.896
	(0.647)		(0.786)	(5.744)		(4.846)
Literacy Rate	3.109***	2.879**	-0.936	-10.660	−12.365***	-0.089
	(0.732)	(0.906)	(1.099)	(6.553)	(5.752)	(6.214)
Population Density	-0.057	-0.046	0.008	-0.308	0.188	-0.455
	(0.082)	(0.036)	(0.093)	(0.516)	(0.217)	(0.437)
Forest Density	−1.043**	-0.444	-0.126	5.170*	6.440***	2.143
	(0.495)	(0.373)	(0.559)	(2.727)	(2.344)	(2.413)
Road Density	0.349	-	0.700	6.174	-	3.452
	(1.056)		(1.145)	(6.689)		(5.498)
Communist Stronghold	0.359	0.568	-0.344	-4.690	-3.791	-1.117
	(0.598)	(0.603)	(0.564)	(3.250)	(3.266)	(2.709)
Ethnicity	−0.952**	−0.743*	0.768	1.980	2.096	-2.947
	(0.437)	(0.420)	(0.539)	(2.716)	(2.432)	(2.601)
Rainfall	-	0.056	-	-	0.326	-
		(0.125)			(0.832)	
Elevation	-	0.088	-	-	1.034*	-
		(0.095)			(0.601)	
Observation	69	69	69	75	75	75
Loglikelihood (R-sq)	-128.02	-127.09	-108.27	0.227	0.248	0.504

a The dependent variable is time elapsed since the conflict started in the country and the first incidence of violence in a country. It is implemented using a Poisson distribution. The districts that did not have conflict by 2001 were dropped.

b The dependent variable is the cumulative violence intensity in 2001.

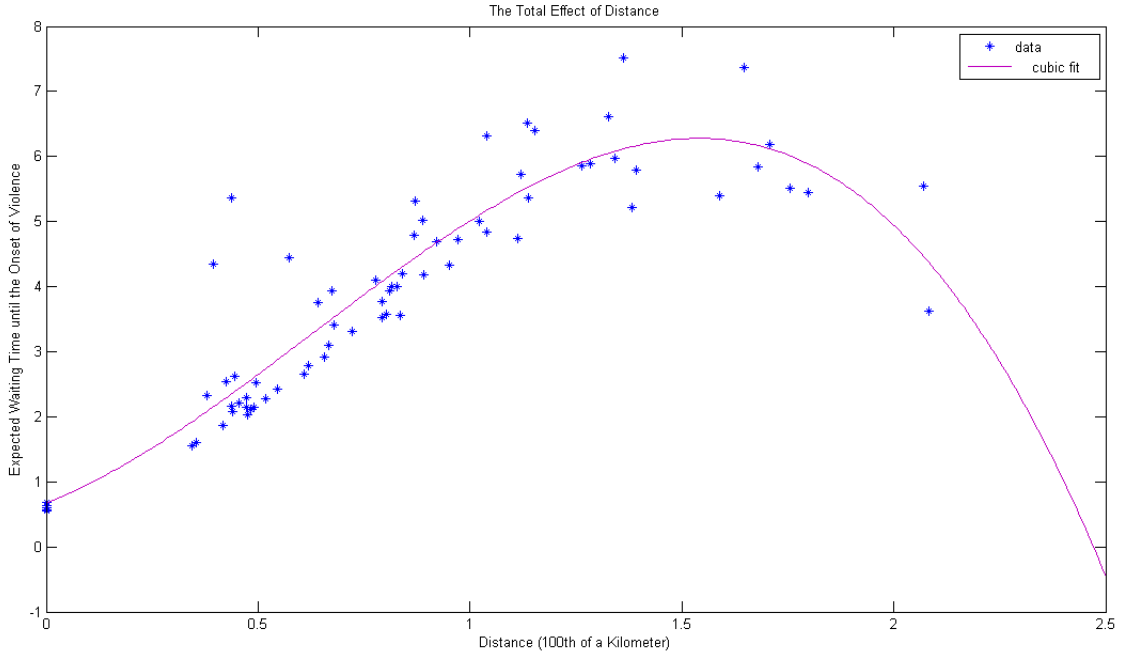
Table 3: Descriptive Statistics by Proximity

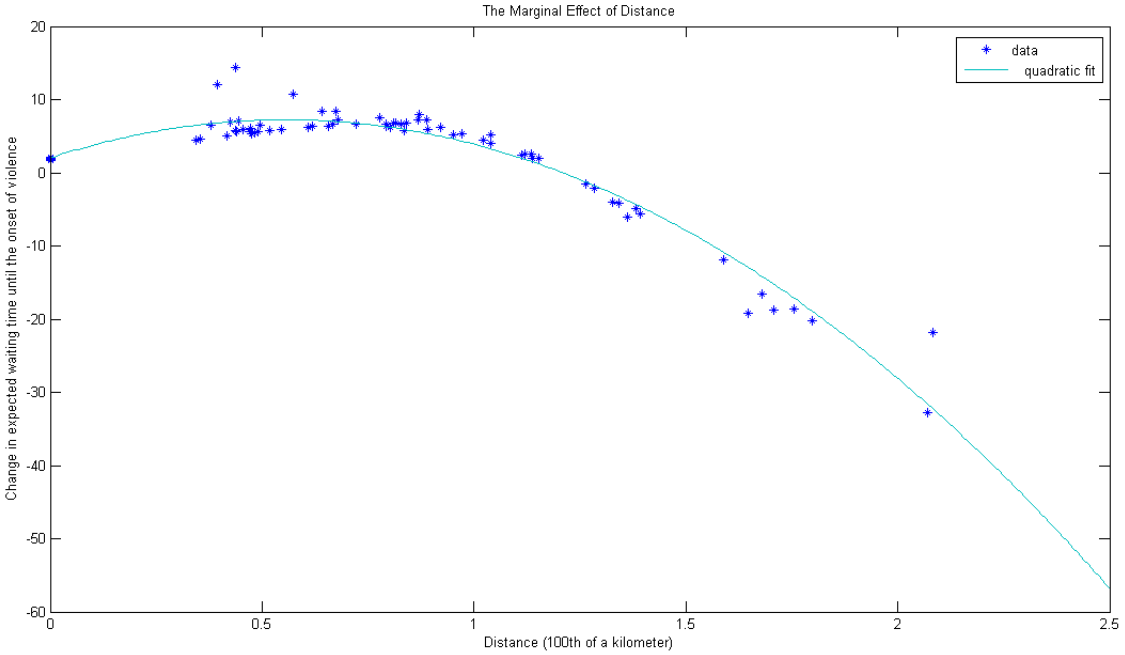
Category	0-50 km	50-100 km	$\succ$ 100km
	Mean (std)	Mean (std)	Mean (std)
Conflict Related			
Cumulative deaths per 10,000 population	3.853	1.093	0.272
	(5.714)	(2.729)	(0.436)
Year of Conflict Onset	1.84	3.24	4.478
	(1.7)	(1.268)	(1.122)
Distance	31.436	76.271	141.046
	(20.358)	(13.109)	(32.122)
Grievance			
Poverty	0.388	0.392	0.377
	(0.133)	(0.132)	(0.111)
Literacy rate	0.343	0.381	0.413
	(0.111)	(0.116)	(0.096)
Opportunity			
Population Density	2.598	1.851	1.835
	(4.173)	(1.571)	(1.235)
Forest Density	0.423	0.427	0.371
	(0.223)	(0.126)	(0.188)
Road Density	0.150	0.105	0.091
	(0.324)	(0.147)	(0.082)
Politics			
Communist Stronghold	0.257	0.362	0.355
	(0.143)	(0.147)	(0.128)
Ethnicity	0.259	0.237	0.196
	(0.175)	(0.249)	(0.198)
N	25	27	23

Table 4: Conflict Spread and Intensity

	Onset[a]			Intensity[b]		
	I	II	III	IV	V	VI
Distance	3.098***	-	2.733***	-	-	-
	(0.672)		(0.598)			
Distance sq	−1.052**	-	−0.934***	-	-	-
	(0.284)		(0.268)			
Poverty	-0.588	0.997	-	4.501	8.149	8.931
	(1.167)	(1.022)		(16.148)	(16.304)	(15.911)
Literacy Rate	-0.604	2.818*	-	-2.886	-5.240	-4.367
	(1.531)	(1.120)		(17.546)	(19.138)	(17.192)
Population Density	0.010	-0.063	-	-1.212	-1.179	-1.176
	(0.097)	(0.084)		(1.284)	(1.295)	(1.260)
Forest Density	-0.097	−1.025**	-	2.872	5.211	5.101
	(0.604)	(0.522)		(7.539)	(8.011)	(7.244)
Road Density	0.627	0.365	-	4.338	8.111	7.906
	(1.189)	(1.087)		(16.709)	(16.705)	(16.336)
Communist Stronghold	-0.315	0.460	-	-6.588	-13.006	-12.029
	(0.595)	(0.612)		(8.695)	(8.821)	(8.512)
Ethnicity	0.646	−0.928*	-	-0.781	2.001	1.370
	(0.621)	(0.486)		(7.480)	(8.011)	(7.510)
Duration				6.434***	5.629**	6.097***
				(2.131)	(2.335)	(2.128)
Duration sq				−0.734**	−0.704**	−0.713**
				(0.341)	(0.343)	(0.342)
Covariance	0.420	−0.389	0.606**			
	(0.573)	(1.095)	(0.367)			
Loglikelihood	-891.570	-908.404	-893.463			

a The dependent variable is time elapsed since the conflict started in the country and the first incidence of violence in a country. It is implemented using a Poisson distribution.
b The dependent variable is yearly violence intensity. Time fixed-effects are included in all the analysis.


The Total Effect of Distance
data
cubic fit
Expected Waiting Time until the Onset of Violence
Distance (100th of a Kilometer)
8
7
6
5
4
3
2
1
0
-1
0
0.5
1
1.5
2
2.5


The Marginal Effect of Distance
data
quadratic fit
Change in expected waiting time until the onset of violence
Distance (100th of a kilometer)
20
10
0
-10
-20
-30
-40
-50
-60
0
0.5
1
1.5
2
2.5