Civil War, Sexual Violence and HIV Infections: Evidence from the Democratic Republic of the Congo

Isaac Kalonda-Kanyama
Department of Economics
The University of Kansas
ikanyama@ku.edu

November 25, 2010

Abstract

This paper estimates the effect of conflict and conflict-related vulnerability factors, namely sexual violence and economic vulnerability, on HIV prevalence rates. We find that HIV prevalence rates are higher in conflict-affected regions of the Democratic Republic of the Congo (DRC) than in non-conflict regions, and that sexual violence and economic vulnerability significantly affect HIV prevalence rates. Specifically we find that (i) HIV prevalence is 1.64 % higher in war-affected zones than elsewhere in the DRC; (ii) the impact of sexual violence in conflict-affected regions is 55 times greater than on average (1.10 % versus 0.02 %); (iii) Civil war and sexual violence jointly increase HIV infection rates by 1.45 %; (iv) Finally, economic conflict-related vulnerability does not explain HIV infection rates. In contrast, a one percent point decrease in the poverty incidence, that is a reduction in economic vulnerability, increases HIV prevalence rates by 0.048 % regardless of the situation of conflict.

JEL Classification Numbers: I10, O10.
Keywords: AIDS, HIV, Civil war, sexual violence, DRC, Sub-Saharan Africa.

1 Introduction

The existing literature on the impact of conflict on HIV largely focuses on the difference between the prevalence of infections among the refugees and the host communities and finds that prevalence rates are lower for these displaced conflict-affected populations than for the surrounding communities or countries (Spiegel, 2004; Spiegel et al., 2007; Becker et al., 2008). For example, Spiegel (2007) reports that refugees from DRC have lower HIV prevalence rates than their neighboring communities in Rwanda, Tanzania and Sudan. On the other hand, prevalence rates in sentinel surveillance sites of eastern DRC have lower prevalence rates than the nearest sentinel sites in neighboring countries except for Rwanda where it is much the same. HIV prevalence rates were also found to be low in countries such as Liberia, Mozambique, Rwanda and Sierra Leone, compared to surrounding countries, even though sexual violence and abuses were systematically used during armed conflicts in these countries (Elbe, 2002; Spiegel, 2004). According to these findings, the limited mobility of the refugees and the limited access to the areas where they are located explain the low HIV prevalence among them compared to the prevalence rates in surrounding communities. It is worth noticing that an important conclusion of this line of research is that the data do not support the claim according to which conflict-generated vulnerability factors (rapes, breakdown of social structure, lack of income and basic needs, and sexual violence and abuses) render the affected people more vulnerable to HIV transmission.

While comparisons between refugees living in camps and the surrounding communities provide interesting insights regarding conflict-affected displaced populations, it is necessary to consider the effect of conflict-related factors on HIV infections among the general population within conflict-affected countries. This is of uttermost importance especially in cases where different parts of a country may be differently affected by the conflict. In addition, settings where entire communities frequently switch back and forth under the control of different rebellion groups and armed groups prompt the question of the impact of conflict-related vulnerability factors such as sexual violence

and abuses in the explanation of possible differences in HIV infections between conflict-affected communities and relatively stable ones within a same country.

This paper attempts to analyze the impact of conflict, sexual violence and poverty incidence on HIV and to assess the difference between HIV prevalence in conflict-affected communities and in non-conflict affected ones in the DRC. Some evidence points to the fact that increased rapes and sexual abuses have increased HIV infection rates in the eastern DRC (Goodwin, 2003; Nolen, 2005). However, this anecdotal evidence is based only on women victims of raped who visited health facilities rather than the general population. We use survey data on the DRC to assess the difference in HIV prevalence rates between the general population in the conflict-affected eastern DRC and the general population of the remaining parts of the country. The main implication of this paper is that an alternative way of assessing the impact of conflict and conflict-related vulnerability factors on HIV transmissions is to look at differences among communities in the general population within the affected countries rather than focusing only on the differences with surrounding countries. To the best of our knowledge, this approach has not been considered yet in the literature. This paper contributes to the empirical literature on the effect of armed conflict and conflict-related vulnerability factors on HIV prevalence by filling this gap.

The remainder of this paper is organized as follows. Section 2 provides a brief overview and the conflict in DRC and its social and human costs; section 3 describes the data used in this study; section 4 presents the empirical results and section 5 concludes.

2 War and sexual violence in the DRC

2.1 A brief overview

The first DRC war started as a revolutionary conflict in 1996 with the Rwanda-Uganda backed armed coalition, the Alliance des Forces Démocratiques pour la Liberation du Congo (AFDL), led by Laurent-Desiré Kabila. Ka-

bila was successful to overthrow the then president of the Republic of Zaire, Mobutu Sese Seko and declared himself president of the renamed country, the Democratic Republic of the Congo, on May 17, 1997. To secure his power, he put the DRC's armed forces under the command of a Rwandan officer and Rwandan troops kept operating within the country's armed forces. The second DRC war started in August 1998 following the Rwandan troop mutiny throughout the DRC as a response to Kabila's decision to dismiss his Rwandan chief of army and to get rid of the presence Rwandan troops. This war often referred to as the Africa's World War, involved nine African countries. Rwanda and Uganda backed the newly born rebel group, the Rally for Congolese Democracy (RCD), in the eastern provinces of Sud-Kivu, Nord-Kivu and the northeastern Orientale province. In addition, Uganda exclusively supported on its own another rebel group in the Equateur province, the Mouvement pour la Libération du Congo (MLC). On the other hand, Angola, Chad, Libya, Namibia, Sudan and Zimbabwe allied with the government of Kabila to secure its positions and stop the advancement of rebel forces to march on the capital city, Kinshasa.

The second war theoretically ended in 2003, following the signing of an all-inclusive power sharing agreement on the seventeenth of December 2002 between all the Rwandan- and Ugandan-backed rebel groups and the government of President Joseph Kabila, the son of Laurent-Desiré Kabila who succeeded his father after he was assassinated on January 16, 2001. Followed this agreement was the official withdrawal of all the foreign troops, with the Ugandan troops being the last to officially withdraw in May 2003. However, Rwandan troops were allegedly reported to be integrated with the armed forces of the RCD in the eastern Congo. Even though the second DRC war officially ended in 2003, the eastern and northeastern part of the country did not get out of the conflict spiral because of the Kivu conflict (in Nord-Kivu and Sud-Kivu province) and the Ituri conflict (in the Oriental province). The Kivu conflict refers to the war from 2004 to March 2009, between the armed forces of the Democratic Republic of the Congo (FARDC) and the Tutsi rebel forces of the National Congress for the Defense of the People (CNDP) while the Ituri conflict that continued until 2007 in the Oriental province involved

tribal militia. This explains why the provinces of Sud-Kivu, Nord Kivu and Oriental define the variable war used in this paper.

2.2 The social costs of the war and HIV in DRC

The second DRC war and its aftermath have created an unprecedented humanitarian crisis, with an estimated 5.4 million victims as of April 2007 and 6.9 million as of February 2010 (Coghlan et al., 2007; Kristof, 2010), making it the deadliest conflict since World War Two and so far claiming more lives than the Holocaust. About 45,000 Congolese were reported to be killed every month due to the exposure of civilian population to conditions that increase the risk of disease, malnutrition and injury. In addition, the war in the eastern DRC since 1998 has been accompanied by massive displacement of populations and sexual abuses including gang-rapes and sex slavery of women and girls. Sexual violence has disastrous health, social and psychological impact on the victims, including HIV and other sexually transmittable diseases. Two of the reports by Human Rights Watch (2002, 2009) gave a detailed account of the situation of sexual violence and rape in DRC; and a report by Amnesty International (2008) provided eyewitness testimonies of the situation in the province of Nord-Kivu, including cases of rape against men and boys by the members of armed groups.

The Armed Forces of the DRC (FARDC) have also been accused to display the kind of behavior observed among government forces in other war-torn African countries. Particularly, military personnel that were stationed away from home in these countries were reported to tend to be uncontrolled in such a way that they engaged in unsafe sexual relationships, increasing the risk of higher HIV infection among both the soldiers and the civilians. For example, "HIV infected soldiers systematically used widespread rape as a systematic tool of warfare in conflict in Liberia, Mozambique, Rwanda and Sierra Leone" (Elbe, 2002). According to a UNAIDS press release in January 2000 (as cited in Elbe, 2002), "soldiers involved in conflicts in the Great Lakes Region of Africa reportedly raped women of 'the enemy side' with the stated intent of infecting them with HIV".

The use of sexual violence and rape as a weapon of war in the eastern DRC by all the armed groups and forces involved in the conflicts could well be seen as a war strategy. In fact, rape in eastern DRC has been a cheaper weapon of war then bullets and repeated gang-rapes on same victims has been a revenge strategy each time a city or a community switches hands from being under the control of one armed group to that of another (Goodwin, 2003; Nolen, 2005).The direct consequence of this practice could be the difference in the HIV prevalence rates between the eastern provinces and the rest of the country. In fact, from the DRC DHS data, the difference between the HIV prevalence rates in the eastern provinces (1.9 %) and the prevalence rate in rest of the DRC (1.3 %) is statistically greater than zero (p-value = 0.02). Although this test provides some evidence to the impact of conflict on HIV prevalence in the general population, a more rigorous analysis is called for in a framework that account for other relevant factors, as done later on in section 4.

3 Methodology, data and variables

The data used for this analysis come from the DRC 2007 Demographic and Health Survey (DHS). From the original sample of 9240 individuals from whom blood samples were collected and tested for HIV, prevalence rates were calculated for 36 residence entities grouped in four categories: big cities, small cities, towns and countrysides. Since our aim is to determine the effect of conflict and conflict-related vulnerability factors, two vulnerability factors are considered, namely the risk of sexual violence and poverty incidence. The risk of sexual violence is captured by the average likelihood for a randomly selected respondent in a given entity of residence to be a victim of sexual violence, including rape and sexual abuse. However, all the women from whom the information on sexual violence is available in the DHS were not included in the HIV sample. As a result, a dummy variable for sexual violence could not be used in a probit-type regression for HIV infection rates. To find a measure of the risk of sexual violence we used the sexual violence module of the DHS to estimate average risk for 34 residence entities for

which the data were available, reducing our sample from 36 to 34 residence entities. The probabilities of sexual violence for each of the 34 subsamples were estimated first by running a probit model where the dependent variable, sexual violence, takes on value 1 if the woman was victim of sexual violence and 0, otherwise. The explanatory variables used in this regression were the age and wealth index of the respondent, geographic location and the fact of living in a conflict zone or not. Average predicted probabilities of sexual violence for each residence entity are then used as an explanatory variable in the linear model of HIV prevalence rates. Poverty incidence is considered to account for economic vulnerability. This variable is defined as the proportion of individuals in the first and second quintiles of the DHS classification based on the wealth index.

After the calculation of predicted probabilities of sexual violence as the measure of the risk of sexual violence, the estimation of the linear model of HIV proceeds in two steps. We first run an OLS regression with robust standard errors where the dependent variable is HIV prevalence rate and the independent variables are war, geographic location, poverty incidence, and the risk of sexual violence. An interaction term for sexual violence and civil war is introduced in the model to account for conflict-related sexual violence, sexual abuses and rape. Next, we run a seemingly unrelated regression, considering both HIV prevalence rates and poverty incidence as endogenous variables. However, geographic location was dropped from the HIV equation because it was not significant. The variables for geographic location and civil war are explained below. Geographic location (rural / urban) captures the impact of the geographic location of residence entities on HIV prevalence rates. This variable takes on value 1 if the residence entity is urban and 0 otherwise. The variable war takes on a value 1 for entities located in conflict-affected provinces in the eastern DRC (Orientale, Nord-Kivu and Sud-Kivu) and 0 otherwise. This definition does not include provinces that were battle fields until the official end of the second DRC war and that were considered as being relatively stable within their borders at the time the DHS was conducted in 2007. These include the Equateur province and part of the Katanga and the Maniema provinces.

3.1 Descriptive statistics

This section presents some descriptive statistics (means, standard deviations and correlations) for the variables used in our analysis. Table 1a displays the average values, the standard deviations as well as the correlations for the variables used in the analysis based on the full HIV sample. It follows from panel (a) that 1.75 percent of the respondents were HIV positive, the average age and the average schooling among the respondents were 28.3 years and 5.15 years respectively. On the other hand, 24.2 percent of the respondent lived in conflict zones, and the probability of sexual violence was 0.328. It is important to mention that the average probability of sexual violence is based on the sexual violence sample of the DHS rather than the HIV sample. Panel (b) provides the pairwise correlation coefficients between the HIV prevalence and the other variables while panel (c) provides the correlations coefficients between the poverty and the other variables. Education is the only variable that is not significantly correlated with HIV prevalence, while poverty is only marginally correlated with HIV at 10 %. The correlation coefficient for the variable war is significant at 5% while those of the variables sexual violence and wealth are significant at either 1%.

In panel (c) all the variables are strongly correlated with poverty with p-values less than 1%, except HIV prevalence. While the correlation between poverty and the other variables seems to follow the same pattern when calculated by the entities of residence level, this is not the case for the correlation between HIV prevalence. For example, panel A of Table 1b shows that HIV is significantly correlated with most of the other variables only in the urban areas as the grouping of big cities, small cities, and towns. In contrast HIV is only correlated with education in big cities, but the correlation coefficient is only significant at 10%. In small cities, HIV is significantly correlated only with age. In towns it is correlated only with age and sexual violence. In the countryside (rural area), HIV is correlated with wealth and war, but only marginally.

Table 1: Descriptive Statistics.

		(A.) Means and standard deviations		(B.)correlation with HIV		(C)Correlation with poverty	
Variables	obs.	Mean	Std. dev	Value	p-value	Value	p-value
HIV (%)	9273	1.75	0.002	1		-0.027*	0.071
War	9273	0.242	0.006	0.022**	0.033	0.041***	0.000
Sexual violence	4760	0.328	0.0004	-0.061***	0.000	0.565***	0.000
Age (years)	9273	28.3	0.138	0.029***	0.006	0.089***	0.000
Education (years)	9273	5.15	0.06	0.01	0.344	-0.529***	0.000
Wealth	9273	122.6	1.582	0.043***	0.000	-0.794***	0.000
Poverty (%)	4639	55.5	0.007	-0.027*	0.071	1	

However, the aggregated data by entities of residence and by province show significant correlation between HIV prevalence rates and the other variables. For example the coefficient of correlation between HIV prevalence rates and the variables age and poverty are significant at 5%. On the other hand, sexual violence and war-related sexual violence are correlated with HIV prevalence rates at 10% level of significance. In contrast, war-related poverty is not correlated to HIV.

4 Empirical analysis

Estimating the effect of conflict and conflict-related vulnerability factors on HIV prevalence rates may appear very challenging since appropriate factors need be accounted for. Also, some usual determinants of HIV may have ambiguous effects on HIV prevalence rates or seem completely irrelevant. For example, for a factor such as rape, it is difficult to determine whether we should consider the victims' or the perpetrators' characteristics as the relevant variables in the explanation of HIV transmissions. If one wants to focus on the characteristics of the perpetrators of rape, an additional challenge would be data availability. In the specific context of conflict in the DRC, we use the available data from the general population and include the risk of sexual violence since it is assumed that the risk of sexual violence, including rape, is higher in combat zones than in relatively stable ones. Furthermore, the motivation for sexual violence and rape may differ in time of peace and in time of war. In addition to these two variables, we include poverty incidence as a measure of economic vulnerability and control for geographic location.

Table 2: Descriptive Statistics.

	A. Correlation with HIV/AIDS									
	Big Cities		Small Cities		Towns		2cCountryside		Urban Area	
Variable	value	p-value	value	p-value	value	p-value	value	p-value	value	p-value
War	0.03	0.11	-	-	0.042	0.134	0.023*	0.099	0.034**	0.025
Sexual violence	-0.033	0.21	-0.139	0.12	-0.092**	0.019	-0.026	0.198	-0.054**	0.01
Age (years)	0.022	0.25	0.175***	0.006	0.066**	0.019	0.023	0.106	0.041***	0.007
Education (years)	-0.035*	0.07	-0.009	0.888	-0.017	0.555	0.012	0.391	-0.026*	0.085
Wealth	0.003	0.85	-0.035	0.585	-0.001	0.971	0.026*	0.069	0.004	0.789
Poverty (%)	0.002	0.99	-0.074	0.417	0.043	0.228	0.015	0.451	0.007	0.742
	B. Correlation with poverty									
War	-0.036**	0.043	-	-	-0.180***	0.000	-0.120***	0.000	-0.054***	0.000
Sexual violence	0.354***	0.000	0.449***	0.000	0.383	0.000	0.180***	0.000	0.467***	0.000
Age (years)	0.061***	0.000	0.051	0.412	0.090***	0.001	0.035**	0.011	0.068***	0.000
Education(years)	-0.232***	0.000	-0.42***	0.000	-0.310***	0.000	-0.150***	0.000	-0.338***	0.000
Wealth	-0.521***	0.000	-0.62***	0.000	-0.720***	0.000	-0.740***	0.000	-0.648***	0.000

The following regression model is considered:

(1) $hiv_i = \alpha + \beta_1 war_i + \beta_2 risk_i + \beta_3 risk_i \times war_i + \beta_4 poverty_i + \beta_5 urban_i + \varepsilon_i$

where hiv_i is the HIV prevalence rate in the ith entity of residence; war_i equals 1 for residence entities located in a war zone and 0 otherwise; $risk_i$ is the average likelihood of sexual violence in the ith entity of residence; $risk_i \times war_i$ is an interaction term for riski and wari; $urban_i$ takes on value 1 if the entity of residence is urban an 0 if it is rural; $poverty_i$ is the poverty incidence in the ith entity of residence. Finally, ε_i is the disturbance term that is assumed to be normally distributed with zero mean and constant variance. The disturbance term accounts for measurement errors and unobserved variables that explain HIV prevalence, especially in war setting. Such variables can include factors such as the characteristics of rape perpetrators that are technically difficult to determine.

The regression model (1) allows calculating the following effects of conflict and sexual violence on HIV prevalence rates:

(2) Effect of war: $\partial hiv \partial war = \beta_1 + \beta_3 \overline{risk}$

(3) Effect of the probability of sexual violence: $\partial hiv \partial risk = \beta_2 + \beta_3 \overline{war}$

where the bar over a variable denotes the value of the variable at which the expression is evaluated. Both expressions in (2) and (3) are evaluated at the mean values of the variables. The average probability of sexual violence is 0.3328 while the average value for the variable war is 0.25. However, the variable war was set to 1 in order to evaluate the effect of sexual violence in conflict-affected zones. The average values of the variables sexual violence and war mean that, on average, the probability was one-third for a randomly selected respondent to be a victim of sexual violence, and that one-quarter of the residence entities were located in conflict regions at the time of the survey.

Table 3: Robust OLS and SUR Estimation.

Variables	(1) Robust OLS	(2) Robust OLS	(3) Robust OLS	(4) SUR
War	-49.0***	-46.03***	-46.12***	42.62***
	(0.000)	(0.000)	(0.000)	(0.000)
Risk	-0.324	-0.345**	-0.263	-0.329***
	(0.054)	(0.036)	(0.100)	(0.008)
War*risk	1.536***	1.445***	1.446***	1.333***
	(0.000)	(0.000)	(0.000)	(0.000)
Urban		0.792**		
		(0.029)		
Poverty			-0.0129*	-0.017**
			(0.059)	(0.019)
Constant	12.28**	12.28**	10.51*	12.84***
	(0.035)	(0.026)	(0.056)	(0.002)
Observations	34	34	34	34
R-squared	0.399	0.458	0.450	0.433

4.1 Regression Results

Table 2 displays the estimated coefficients from three robust OLS regressions [columns (1)-(3)] and from a SUR estimation of the HIV equation (column 4). The SUR estimation was performed by considering the economic vulnerability as an endogenous variable . In column (1) HIV prevalence rates are regressed on the variables war, risk and their interaction terms war?risk. The estimated coefficients of war and war?risk are significant at 1% while the estimated coefficient of risk is only marginally significant at 10%. Both variables war and risk together with their interaction term explain 40% of variations in HIV prevalence rates. Column (2) includes the variable urban to controls for the effect of geographical location. As a result, the estimated coefficient of the variable risk becomes significant at 5%. However, the estimated coefficient for risk now becomes insignificant when economic vulnerability is included in the model as shown in column (3). On the other hand, the OLS estimation in column (3) shows that poverty, when considered as an exogenous factor, has only a marginal effect on HIV prevalence rates.

In contrast, poverty incidence is significant at 5 % when considered as an endogenous variable (see column 4). Considering poverty as an endogenous factor is motivated by the fact that HIV and economic vulnerability can feedback each other especially in war setting where individuals are more likely to engage in unsafe sexual relationships because of economic precarious conditions. Column (4) of Table 2 displays the estimated coefficients from the HIV equation in a SUR system of two simultaneous equations, one for HIV and one for poverty. Two important points need to be noted from this regression. First the variable risk which has an ambiguous effect in the OLS regressions becomes strongly significant. Second, the variable poverty which was only marginally significant in the robust OLS regression in column (3) becomes significant at 5%. On the other hand the estimated coefficients of the variables war and war?risk are both significant at 1%. It is worth mentioning that the regressions in columns (1), (3) and (4) of Table 2 include only the conflict and conflict-related vulnerability variables. However, the SUR regression in column (4) is preferred to the regressions in columns (1) and (3) for two reasons. First, the regression in column (1) does not account for economic vulnerability. In addition, the regression in column (4) explains 43% of the variations in the HIV prevalence rates while the one in column (1) explains only 40% of the variations. Second, because of the possibility of a feedback relationship between HIV prevalence rates and the level of economic vulnerability, SUR estimates in column (4) are more plausible than the OLS estimates in column (3). Moreover, the estimated coefficient of the variable risk is not significant in the OLS regression in column (3) even thought this regression explains 45 % of variations in HIV prevalence rates compared to 43% for the regression in column (4). From now on, we shall refer to the regression in column (4) of Table 2 as the HIV equation.

The variable urban is dropped from the HIV equation and from the regression in column (3) because it was not significant. In addition, the variables risk and poverty become insignificant when included in the same regression with the variable urban. However, the variable urban is significant in the OLS regression in column (2). Notice that the OLS regression in column (2) does not include the variable poverty. This suggests that the geographic lo-

cation matters in terms of HIV infections in war setting only when economic vulnerability is not accounted for and that geographic location and economic vulnerability do not jointly explain HIV prevalence rates.

4.2 Robustness checks

To check the robustness of the results in Table 2, we controlled for some socioeconomic determinants (age, education and wealth levels) of HIV infection rate as for example in Fortson(2008), De Walque (2006), Mishra et al. (2007) and Glynn et al.(2004). While these papers consider the socioeconomic characteristics at the level on individual respondents, our data is aggregated at the level of the entities of residence as earlier defined. Education is defined as the average years of education for each entity in contrast to using dummy variables as in Mishra et al. (2007) or the respondent's number of years of schooling as in De Walque (2006). Likewise, average age in the entities of residence is used instead of dummy variables for age groups as in Fortson (2008), Mishra et al. (2007) and De Walque (2006). Finally we use the average wealth index instead of dummy variables for the DHS quintiles as in Mishra et al. (2007) or the respondent's wealth index as in Fortson (2008).

We also considered illiteracy rates as an alternative indicator to the education variable. However, in contrast to Gregson et al. (2001) who used the literacy rates, we use adult illiteracy rates to emphasize on the effect of the deprivation rather than the achievement of different entities of residence in terms of knowledge on HIV infection rates. The variables education and illiteracy were assumed to be mutually exclusive and therefore included in different regressions. We found that our variables of interest (war, risk, war?risk and poverty) are all significant at 1%, except for one case where the variable risk was significant at 10%. Table 3 display two robust OLS regressions and two SUR variants of the HIV equation. Columns (1) and (3) control for age and education while columns (2) and (4) control for illiteracy rates and wealth. As for the variables education and illiteracy, the variables poverty and wealth are mutually exclusive. Columns (1) and (3) show a significant inverted-U relationship between HIV prevalence rates and the av-

Table 4: Robustness Checks.

Variables	(1) Robust OLS	(2) Robust OLS	(3) SUR	(4) SUR
War	-48.33***	-53.17***	–47.24***	-58.27***
	(0.002)	(0.000)	(0.000)	(0.000)
Risk	-0.308*	-0.639***	-0.344***	-0.684***
	(0.065)	(0.002)	(0.003)	(0.000)
War*risk	1.493***	1.629***	1.447***	1.783***
	(0.001)	(0.000)	(0.000)	(0.000)
age	6.426**		5.956*	-0.217*
	(0.045)		(0.082)	(0.079)
age2	-0.098**		-0.090*	
	(0.036)		(0.073)	
educ	-0.458*		-0.623***	
	(0.075)		(0.005)	
poverty	-0.035**		-0.048***	
	(0.025)		(0.001)	
illiteracy		0.108***		0.125***
		(0.003)		(0.001)
illiteracy2		-0.001**		-0.001***
		(0.024)		(0.006)
wealth		0.0411**		0.0356**
		(0.019)		(0.041)
wealth2		-0.0001**		-0.0001 **
		(0.016)		(0.028)
Constant	-89.86	18.14***	-79.78	26.87***
	(0.106)	(0.007)	(0.172)	(0.001)
Observations	34	34	34	34
R-squared	0.558	0.621	0.544	0.650

erage age. The coefficients of the variables age and its quadratic term (age2) are significant at 5% in the robust OLS regression in column (1) and significant at 10% in the SUR estimated equation in column (3). The coefficient of the variable education is negative and significant at 10% in the regression in column (1) and at 1% in the regression in (3). The inverted-U relationship between HIV prevalence rates and education was not significant; therefore education enters only linearly in the model. Our variables of interest are all significant at 1% except for the variable risk which is significant at 10% in the regression in column (1). Compared to the regressions in columns (3) and (4) in Table 2, controlling for age and education increases the coefficient of determination by more than 10%. Again, for the same reasons as those we evoked earlier, the regression in column (3) is more plausible than the one in column (1).

In columns (2) and (4) we control for illiteracy rates and wealth. Note that since education and illiteracy on one hand and poverty and wealth on the other hand are assumed to be mutually exclusive, poverty and education were not included in the estimation. In the SUR estimation of the HIV equation, the variable wealth was used instead of the variable poverty. The variable wealth and its quadratic term wealth2 are significant at 5% in both regressions in columns (2) and (4). The coefficient of the variable wealth is positive and the coefficient of wealth2 is negative, suggesting an inverted-U relationship between HIV prevalence rates and wealth levels. The coefficient of literacy is positive and significant at 1% in both regressions (2) and (4). The coefficient of the quadratic term of illiteracy, illiteraty2, is negative and significant at 5% in the regression in column (2) and negative and significant at 1% in the regression in column (4). Columns (2) and (4) suggest that the inverted-U relationships between HIV prevalence rates and wealth on one hand and between HIV prevalence rates and illiteracy rates on the other hand are significant.

The pursued aim of the regressions in columns (2) and (4) was to show the robustness of the estimation of the coefficients of the variables war, risk, and war?risk in the presence of alternative control variables than those used in columns (1) and (3). For the sake of our analysis of the effects of civil war

and conflict-related factors on HIV prevalence rates, the regression in column (3) of Table 3 is more relevant. It is important to note that the regressions in Table 3 provide interesting insights about critical values of the variables age, illiteracy and wealth at which HIV prevalence rates reach their maximum values. Unfortunately, this is not the main objective of this paper. We shall now turn to the calculation of the marginal effects of the variables war, risk and poverty on the HIV prevalence rates.

4.3 Marginal Effects of war, sexual violence and poverty on HIV prevalence rates

The only variable that does not require further calculations in computing its marginal effect on HIV prevalence rates is poverty. The coefficient of this variable is negative and significant at 5% in the HIV equation (Column 4 of Table 2) when no control variable is used; while it is negative and significant at 1% when education and the inverted-U relationship in the variable age are controlled for (Column 3 of Table 3). The results in Table 2 and Table 3 show that a one percent point decrease in poverty, that is a decrease in the economic vulnerability, will increase HIV prevalence rates by 0.017 percent point when age and education are not controlled for, and by 0.048 percentage points when age and education are controlled for. Economic vulnerability here is to be understood in terms of economic deprivation in the general population rather than conflict-related. In fact, the war-related economic vulnerability variable was not a significant factor in all the regressions of HIV prevalence rates, and was therefore dropped from them all.

The effect of the variables war and risk are calculated using equations (2) and (3) which involve their coefficients. Panel (a) of Table 4 shows the calculated marginal effects of these two variables based on the regressions in Table 2. Each column in panel (a) of Table 4 numerically corresponds to one column of Table 2. From equation (2), the marginal effect of conflict on HIV prevalence rates is about 2 (see Table 4) for all the estimation alternatives in Table 2, suggesting that HIV prevalence rates are on average about 2% higher in conflict-affected zones than elsewhere in the DRC. This effect varies

Table 5: Marginal Effects

	(a) Columns of Table 3				
	(1)	(2)	(3)	(4)	Range
Variable					
Civil War	2.25	2.23	2.14	1.64	1.6-2.3
Sexual violence on average	0.06	0.02	0.10	0.004	0.0-0.1
Sexual violence in war zones	1.19	0.99	1.10	1.10	1.0-1.2
Combined effect	1.54	1.45	1.45	1.33	1.3-1.5
	(b) Columns of Table 4				
	(1)	(2)	(3)	(4)	
Civil War	1.26	1.34	2.14	1.64	1.0-1.3
Sexual violence on average	0.07	-0.23	0.10	-0.24	-0.2-0.1
Sexual violence in war zones	1.19	0.99	1.10	1.10	1.0-1.2
Combined effect	1.49	1.63	1.45	1.78	1.5-1.8

from 1.64% to 2.25% depending on the specifications in each of the columns of Table 2. However, the HIV equation in column 4 of Table 2 produces the lowest effect (1.64%). The effect of war on HIV prevalence rates was evaluated at the average value of the risk of sexual violence (33.28%).

From equation (3), the calculated marginal effect of risk is positive, suggesting that increased risk of sexual violence leads to increased HIV prevalence rates. The estimated impact of sexual violence varies from 0.004 to 0.1 percentage points on average for the whole sample. Based on column (4) in panel (a) of Table 4, the effect of sexual violence on HIV infection rates is significantly positive (+0.004) on average for the country as a whole and 1.10 in conflict-affected zones, meaning that a one percentage point increase in the risk of sexual violence increases HIV prevalence rate by 1.10 percentage points in war-affected zones, holding constant all the other variables in the model. Moreover, the impact of sexual violence on HIV infection rates is 1 percentage point higher in the conflict-affected regions than on average. Finally, the combined effect of civil war and sexual violence on HIV prevalence rate is positive and varies from 1.3 to 1.5. The estimated effect from column (4) of panel (a) in Table 4 is 1.33. This estimate is comparable with the

estimates of the combined effect of war and sexual violence obtained from column (1) – (3). This suggests that the chosen regression for HIV prevalence rates makes little difference in terms of the estimation of the effect of conflict and conflict-related vulnerability factors on HIV prevalence rates.

Panel (b) of Table 4 shows the marginal effects of civil war and sexual violence as well as their combined effects calculated from Table 3. It is important to mention at this point that column (3) in panel (b) corresponds to column (4) in panel (a). As a matter of refreshment, column (4) in panel (a) corresponds to the SUR estimated HIV equation and column (3) in panel (b) corresponds to the SUR estimated HIV equation that is augmented with the variables age, age2 and educ (see Table 3, column 3). It follows from the comparison of results in panel (a) and (b) of Table 4 that not controlling for age and education overestimate the effect of civil war and underestimate the average effect of sexual violence on HIV prevalence rates. However, the effect of sexual violence in conflict zones is the same regardless of accounting for education and age or not. The estimated effect of sexual violence in conflict-affected zones is also the same when the variable wealth is used instead of the variable poverty. The estimated effect of sexual violence in conflict-affected zones is 1.1 in both cases. Finally, the calculated combined effect of civil war and sexual violence is slightly underestimated when educ and age are not included in the HIV equation.

4.4 Discussion of the results

The results presented above suggest that civil war, sexual violence and economic vulnerability do have a significant impact on HIV infection rates. The estimated coefficients of these variables were strongly significant when economic vulnerability is allowed to endogenously enter the model. The significance of the estimated coefficients was not altered by the inclusion of variables age, education, illiteracy, and wealth which were significant in the regression where they were included. The quadratic relationships were verified for the variables age, illiteracy and wealth, but not for education. Hence, the results in this paper are comparable with the existing literature on the

socioeconomic determinants of HIV infection rates. For example, using DHS data at individual level, Fortson (2008) found significant quadratic relationship between HIV prevalence rate and wealth levels in Burkina Faso, Ghana and Tanzania. These results can be interpreted as evidence, at individuals level, that the rich are more likely (Burkina Faso) or less likely to be infected with HIV (Ghana and Tanzania). With the data aggregated at the level of the entities of residence, the finding of a significant concave relationship between HIV and average wealth means that rich entities of residence have lower average HIV prevalence rates.

The main contribution of this paper consists in the estimation of the marginal effects of war, sexual violence and economic vulnerability on HIV prevalence rates. The regression results show that conflict, conflict-related sexual violence and economic vulnerability increase HIV prevalence rates in conflict affected zones. These conclusions are robust to the inclusion of variables such as age, education, illiteracy and wealth in the model. For example, the effect of sexual violence in the conflict zones in numerically the same whether we control for other age and education or not [compare column 4 in panel (a) and column 3 in panel (b) of Table 4], and when wealth is considered instead of poverty in the HIV equation [column 4 in panel (b)]. These results are of uttermost importance in the sense that they provide empirical evidence to the claim that civil war and conflict-related vulnerability factors such as sexual violence and rape do increase HIV prevalence rates among the affected populations. It is worthwhile noting that the results of this paper lead to a different conclusion compared to the current literature on the impact of civil war and conflict-related vulnerability factors on HIV infection rates (see for example Spiegel, 2004; Spiegel et al., 2007 and Becker et al., 2008). They also indicate that looking at within-borders differences rather than cross-borders differences provides an alternative way, but with completely different implications, to look at the impact of conflict and conflict related vulnerability factors on HIV prevalence.

5 Conclusion

The analysis in this paper was aimed at estimating the impact of conflict and conflict-related vulnerability factors (sexual violence and economic vulnerability) on HIV prevalence rates. Our approach consisted in comparing the impact of conflict and conflict-related vulnerability factors within the borders of a conflict-affected country, the Democratic Republic of the Congo. The conclusion from this analysis points in a different direction compared to the trend in the current literature on the impact of conflict on HIV transmissions. We find that HIV prevalence rates are higher in conflict-affected regions than in relatively stable ones in the DRC when economic vulnerability in not accounted for. On the other hand, HIV prevalence rates are positively related with conflict-related sexual violence. But economic vulnerability, as measured by poverty incidence, affects HIV prevalence rates only as an endogenous factor in the general population rather than as a conflict-related vulnerability factor. These findings are robust to accounting for other determinants of HIV prevalence such as age, education and wealth as well as to illiteracy rates that were used as an alternative indicator of the access to knowledge.

The findings of the paper can be summarized as follow, based on Table 4: (i) the prevalence rate of HIV infections is about 2 percentage points higher in conflict-affected zones than elsewhere in the DRC; (ii) a one percent increase in the rate of sexual violence risk increases the prevalence rate of HIV by 1.10 percentage points in conflict-affected regions compared to 0.02 percentage points on average for the country as a whole. In addition, the impact of sexual violence, including rape, is more than 55 times higher in conflict-affected entities than on average when education and age are included in the model; (iii) Civil war and sexual violence jointly increase HIV prevalence rates by 1.33 percentage points. However, this combined effect is even higher (1.45 percentage points) when education and age are accounted for; (iv) HIV prevalence and poverty incidence in the general population are negatively and significantly correlated. In addition, a one percentage point decrease in the poverty incidence, that is a reduction in economic vulnerability, increase

HIV prevalence by 0.048 percentage points when average years of education and age are accounted for.

A relevant policy implication is that the situation of armed conflict needs to be dealt with in a reasonably and possibly shorter period of time to avoid the short run destructive effects in terms of its social costs including HIV/AIDS and other sexually transmittable diseases; and in the long run, the disastrous effects on the labor force and productivity. Indeed, once started, an armed conflict has unpredictable effects and an uncertain end. The role of a government is to effectively deal with conflict generating factors, and the responsibility of all the armed groups and forces involved in an armed conflicts is to eliminate sexual violence and rape proclivity among their troops.

6 References

AMNESTY.org: Nord-Kivu: no end to war on women and children (2008). Accessed on January 17, 2010 from http://www.amnesty.org/en/library/asset/AFR62/005/2008/en/f37d4534-8e4a-11dd-8e5e-43ea85d15a69/afr620052008en.pdf

Becker, J.U., Theodosis, C., and Kukarni, R., (2008). HIV/AIDS, conflict and security in Africa: rethinking relationships. *Journal of International AIDS Society*. Accessible at http://www.jiasociety.org/content/11/1/3

Coghlan, B., Ngoy, P., et al. (2007). *Mortality in the Democratic Republic of Congo: An Ongoing crisis.* New York: International Rescue Committee. Accessible at http://www.theirc.org/sites/default/files/resource-file/2006-7_congoMortalitySurvey.pdf

De Walque, D., (2006). Who gets AIDS and how? Evidence from Burkina Faso, Cameroon, Ghana, Kenya and Tanzania. *World bank Policy Research Working Paper* 3844.

Elbe, S. (2002). HIV/AIDS and the changing landscape of war in Africa. *International Security 27,* 159 – 177.

Fortson, J.G., (2008). The gradient in sub-Saharan Africa: Socioeconomic status and HIV/AIDS. *Demography* 45, 687 – 714.

Glynn et al., (2004). Does increased general schooling protect against HIV infection? A study in four African cities. *Tropical Medicine and International Health* 9, 4 – 14.

Goodwin, J. (2003). Silence = Rape. *The Nation*. See http://www.thenation.com/doc/20040308/goodwin accessed on March 27, 2010.

Gregson et al., (2001). School education and HIV control in Sub-Saharan Africa: from discord to harmony? *Journal of International Development* 13, 467 – 485.

HRW.org: *Soldiers who rape, commanders who condone*. (2009) Retrieved December 24, 2009 from http://www.hrw.org/sites/default/files/reports/drc0709webwcover.pdf

HRW.org: *The War in the War: Sexual violence against women and Girls in eastern Congo.* (2002). Retrieved December 24, 2009 from http://www.hrw.org/sites/default/files/reports/congo0602.pdf .

Kristof, N. D., (February 2010). The World Capital of Killing. New York Times, accessed on Mach 29, 2010 from http://www.nytimes.com/2010/02/07/opinion/07kristof.html

Mishra et al.,(2007). A study of the association of HIV infection with wealth in Sub-Saharan Africa. *DHS Working Paper 31*.

Nolen, S. (2005). "Not women anymore": Congo's rape survivors face pains, shame and AIDS. *Ms Magazine*. See http://www.msmagazine.com/spring2005/congo.asp , accessed on March 27, 2010.

OHCHR.ORG: DRC: Mapping Human Rights Violations 1993 – 2003 (2010). Retrieved October 8, 2010 from http://www.ohchr.org/Documents/Countries/ZR/DRC_MAPPING_REPORT_FINAL_EN.pdf

Spiegel P. B. et al. (2007): Prevalence of HIV infection in conflict affected and displaced people in seven sub-Saharan African countries: a systematic review. *Lancet* 2007, 369:2187-95.

Spiegel, P. B., (2004). HIV/AIDS among conflict-affected and displaced populations: Dispelling myths and taking action. *Disasters* 28, 322 – 339.