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Using cross country panel regression analysis to relook at the relationship between armed conflict and HIV prevalence in Africa

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Abstract

This paper explores the relationship between armed conflict and HIV prevalence in Africa. We review the literature suggesting that conflict can exacerbate the HIV epidemic (through sex with infected soldiers, war-related rape, poverty-related unsafe sex, transactional sex, etc) and the literature arguing the contrary (such as that militaries do not always have higher prevalence rates than the surrounding populations and that war can disrupt sexual networks). Building on past econometric contributions on the debate, our parsimonious cross-country panel data regression analysis of HIV prevalence casts doubt on the argument that conflict worsens the epidemic, particularly at a country level. We do, however, find a negative, albeit statistically weak association between armed conflict, militarization, and HIV prevalence. Fully acknowledging the limitations of our analysis, we stress the importance of looking at the association between HIV prevalence and conflict on a case by case basis, taking lessons from the experiences of other conflict afflicted countries.

***Key words**: panel data; cross country regression*

1. Introduction

Africa has the distinction of being ravaged by a plethora of problems ranging from civil wars, widespread poverty and the HIV epidemic. Conventional opinion has been that the heavy militarization of fragile states and conflict zones on the continent has helped increase HIV prevalence (UNAIDS, 2003; Ba et al, 2008; Eric et al, 2003). Infection rates in African military personnel have been cited as being significantly higher than those among civilian populations, and therefore a cause of the spread of HIV in conflict zones (Abebe et al, 2003: 25-30: ICG, 2004). Postulated reasons for this are that military personnel tend to spend a lot of time away from home and have higher incomes than their

surrounding communities making them potential clients for commercial sex workers (Matchaba-Hove, 2006: p.104). Armed conflicts also create environments where women are prone to rape and abuse which further aids the spread of the disease (Carballo et al, 2001:2-6).

Indeed this view has received a lot of support especially from political circles with Graça Maçhel, the former Minister of Education in Mozambique and now wife of Nelson Mandela remarking, "*The chaotic and brutal circumstances of war aggravate all the factors that fuel the HIV/AIDS crisis. War breaks up families and communities, creating millions of refugees and placing women and children in great peril of sexual attack or systematic rape used to terrorise opposing forces*" (Maçhel, 2009). This view has also been bolstered by econometric models that suggest conflict might worsen HIV prevalence rates at a country level (see Iqbal and Zorn, 2010, and Davenport and Loyle, 2009).

However, a rival body of opinion suggests that the relationship between military conflict and HIV may be more complex than this. John Iliffe (2006: 10-18) suggests that the war and disruption of transport and communication networks in the Democratic Republic of the Congo (DRC) slowed down the epidemic by limiting the linkage of sexual networks across space. Aside from the DRC, the case of Angola is another where the country was "protected" from AIDS by nearly 40 years of war (Strand, 2007: 467-471). Other examples where HIV prevalence was very low during periods of military conflict include Liberia (Spiegel, 2008: 5), Ethiopia (Iliffe, 2006), and Mozambique (Melo, 2000: 203–207).

This paper looks at the relationship, between armed conflict and HIV. I begin by showing that the literature is divided between those who propose that conflict exacerbates the HIV epidemic (through sex with infected soldiers, war-related rape, poverty-related unsafe sex, transactional sex, etc) and those who argue that it protects countries to some extent from a major HIV epidemic by limiting mobility, disrupting sexual networks and so forth. I review the attempts that have been made at modeling the relationship between conflict and HIV at an aggregate level. I then turn to a cross-country regression analysis using panel models to investigate the cross-country relationship between HIV, conflict and militarization. This approach has a number of limitations of its own and so highlights the need for caution when making conclusions about the relationship between HIV prevalence and conflict at an aggregate level.

2. How military conflict may exacerbate the spread of HIV

The first school of thought argues that military conflict and the resulting social dislocation worsens the spread of HIV through the militarization of society, migration of infected people, breakdown of social norms and support structures, as well as the collapse of health and education infrastructure. I discuss each in turn.

Militarization

One of the key reasons why military conflict is assumed to exacerbate the spread of HIV is the belief that HIV prevalence rates in militaries are relatively high (Hankins, 2002; Elbe, 2002). Infection rates, especially in Sub-Saharan Africa amongst the military, have often been cited as being especially high, with claims that a number of militaries are experiencing rates above 50% (Eric G et al. 2003: 578; ICG, 2004; UNAIDS 2003). The International Crisis Group was confident enough of this position to declare, "*It has been an accepted assumption that the rates of HIV are higher among the military and other uniformed forces than among the general population*" (ICG, 2004).

In some reports on prevalence rates in the military, it has been argued that prevalence rates in the security forces are especially high because military culture and training encourage machismo, courage and a willingness to take risks: values that may encourage participation in riskier sexual behaviour (Tripodi, 2004: 196-200; Matchaba-Hove, 2006: 104). Troops are often away from home for long periods and may resort to commercial sex (Spiegel, 2004: 223-30; Foreman, 2002, Abebe et al. 2003, Nwokoji et al 2004: 5) especially in regions where their disposable income is higher than those around them (Plus News, 2009; Matchaba-Hove, 2006: 104).

An analysis of HIV/AIDS in African militaries by Ba et al, (2008: 88) argued that HIV is a huge security threat given that estimates of the rate of HIV within African militaries are as high as 90%. After conducting a random effects pooled analysis on 21 African militaries, they found that HIV prevalence within the military is elevated compared to the general population (Ba et al. 2008: 90-98). In 1997, UNAIDS estimated that sexually transmitted disease rates among armed forces are generally 2 to 5 times higher than in civilian populations; the difference perhaps being even greater in times of conflict (Kavvoura et al. 2006: 79).

The fact that young recruits may be socially inexperienced and that military culture tends to favour risk-taking behaviour is a reason brought forward to explain the high prevalence rates in the Zimbabwean military (Matchaba-Hove, 2006: 172). There is also the possibility of occupational infection through caring for the wounded and the possibility of receiving contaminated blood during emergency transfusions although this may be a relatively small risk (Matchaba-Hove, 2006: 104).

Recent estimates indicate that about half of Zimbabwe's soldiers were HIV-positive (SAHIDS, 2003; UNDP, 2003: 31; Carballo et al, 2001: 14). Carballo et al, (2001: 11-15) present three fronts through which the military has affected the progression of the epidemic in the civilian population.

First, young girls and women are at increased risk of sexual abuse by armed personnel during both conflict and peace times (Carballo et al, 2001: 11-15). This can be in the form of poor and vulnerable women and girls being drawn to military barracks and resorting to survival sex in search of money and food (Matchaba-Hove, 2006: 174). In countries like Zimbabwe, where unemployment rates are very high, military personnel often have higher incomes than the people in the surrounding communities (Matchaba-Hove, 2006: 174). In addition, many military barracks are single sex accommodation facilities meaning that when away from home for long periods; military personnel may visit local brothels (Matchaba-Hove, 2006: 174; Abebe et al, 2003: 25-27). There are also cases of sex in exchange for allowing women, especially cross-border traders with no documents, to cross checkpoints and borders (SAMP, 2005: 28; Dodson, 2000: 40-6). A second front is the spread of the disease from military personnel to their partners upon their return from duty (PEPFAR, 2010; Medecins du Monde report, 2010; Calderón, 1997: 27).

The third front, which actually feeds into the first two, is that of military personnel infecting each other. For instance, young female recruits in the military are at great risk of sexual abuse from their male superiors UNDP (2003: 29-33). Thus far, our discussion does not prove that heavy militarization results in a marked increase in HIV incidence and prevalence. However, it does bring to light the danger that military activity poses in the fight against AIDS/HIV. In other words, the level of militarization of a society could be a factor driving country-level HIV prevalence.

Migration and social disruption

Military conflict can also spread HIV through the resulting forced migration of refugees and attendant social disruption. More specifically, HIV is likely to spread if HIV prevalence amongst the refugees is higher than in the destination areas and spread HIV there (Smith, 2002: 38; Hankins, 2002), or if refugees flee from low-prevalence to high-prevalence regions and become infected (Becker et al, 2008: 2). Furthermore, displacement places people in chaotic circumstances where condoms are likely to be scarce and where social institutions and support structures which protect women from sexual abuse are disrupted (UNAIDS, 2004: 175).

Armed conflict can also increase the likelihood of exposure to HIV infection through the breakdown of traditional sexual norms (UNAIDS, 2004: 174). As Hankins et al. (2002) argue, the chaotic conditions associated with conflict can lead to the disintegration of traditional values and norms regarding sexual behavior thereby leading to an overall increase in risk of HIV exposure (Hankins et al, 2002: 2245-52). Women and girls are particularly vulnerable in conflict situations. For instance, armed conflict can create conditions of such severe deprivation that women and girls, in particular, are coerced into exchanging sex for money, food or protection (UNAIDS, 2004: 175). The same UNAIDS report explained how the presence of large numbers of armed men in uniforms often means a sex industry springs up, increasing HIV risk for sex workers and uniformed services personnel (UNAIDS, 2004: 175).

Rape has been used as weapon of war and subjugation across the world, most recently in Bosnia-Herzegovina, DRC, Liberia, and Rwanda (UNAIDS, 2004: 175; UN Dispatch, 2010; OHCHR, 2010). Assuming that prevalence rates in the armed forces are indeed higher than in the general population, these rapes would increase the risk of infection in the civilian population. A report on a study carried out in Rwanda revealed 17% of women who had been raped tested HIV-positive, compared with 11% of women who had not been raped (De Waal, 2005: 8; UNAIDS/UNHCR, 2003). The Stop Rape Now Campaign, a United Nations initiative, reports that in some conflicts, such as the DRC, it is not just the women who have been abused but young men and boys have also been raped (Stop Rape Now, 2010).

Other potential links between military conflict and HIV include the use of illicit drugs (to cope with the stress of war) which diminish responsibility and in the case of injected drugs, increase the risk of HIV directly through shared needles (Strathdee et al. 2002; Smith, 2002: 4-7; Hankins et al. 2002: 2250). However, for most Sub-Saharan countries, the low average incomes levels would make it

less likely that intravenous drug use is a major vector for HIV transmission in the armed forces.

The collapse of health systems that results from conflict almost inevitably worsens the progression of the HIV/AIDS epidemic. This is because when conflict triggers health system malfunction and collapse, national blood supply safety is threatened, and HIV prevention and care programs can disintegrate (UNAIDS 2004). AIDS programs are also poorly managed during conflicts and often under-staffed as skilled personnel leave the conflict zones (Ellman et al. 2005; Barnett, 2005). Although this might lead to lower prevalence rates, (as AIDS deaths increase because of shortages of antiretrovirals and other medications) they also may lead to higher prevalence rates, as preventative programs (including condom distribution) are incapacitated and HIV incidence rises. Resistant forms of the virus may also arise as fighting undermines the supply of antiretrovirals to conflict regions.

That the prevention and care of HIV patients is greatly diminished as a direct result of conflict is further evidenced by the fact that sexually transmitted infections (STIs) often rise in post-conflict situations (Betsi et al 2006: 363).

3. How Military Conflict may slow the spread of HIV

In contrast to the evidence and hypotheses presented above, a rival literature maintains that the relationship between HIV and military conflict is complex, often contradictory, and possibly even protective.

Is HIV in African militaries really higher than in civilian populations?

Spiegel et al (2007) and Whiteside et al, (2006) observe that because data on the military are difficult to obtain and verify, the analysis of prevalence in militaries is especially challenging. They point out that in the case of South Africa, HIV prevalence in the military may actually be lower than that in the civilian population (2006: 202). Population based surveys such as South Africa's 2004 Reproductive Health Research Unit (RHRU) survey of 15-24 year olds show than in the general population, HIV prevalence was 7.3% for males (aged 15-19) compared to 24.5% for women (aged 15-19) (Pettifor, 2004: 31). They thus conclude that because the majority of recruits are males between the ages of 17-

22, most South Africa army recruits probably have lower prevalence rates than the average national (male plus female) adult prevalence rates.

However, this does not speak to the issue as to whether men in the SA military have higher prevalence than their male counterparts in the general population. Indeed infection rates in the South African military have been reported to be slightly higher than among the general population (Plus News, 2006). As much as 40% of the South African military was reported to have been HIV positive in 2001 (compared to 16.9% among 15-49 year olds in the general population) (Lovgren, 2001: 1).

Whiteside et al (2006: 203) also argue that HIV prevalence in African militaries is a function of the number of years of service. This makes it hard to make generalizations about HIV prevalence in armies with different age structures. They argue that the longer serving officers have often been more prone to infection owing to exposure to higher prevalence areas during multiple foreign missions (Whiteside et al, 2006: 203). This implies that even if young recruits came in with lower prevalence rates, after more years of service in the military, they are likely to have infection rates comparable to or even higher than that of the general population. Evidence from a 1989/90 study of Nigerian troops returning home from foreign missions in Liberia and Sierra Leone found that infection rates in these peace keepers were more than double of those in non peace keeping troops (Whiteside et al, 2006: 206). The study also showed that a service member's risk of infection doubled each year spent on deployment in war zones (Fleshman, 2004: 10).

Secondly, there are reports of some militaries, notably Uganda, screening recruits for HIV to exclude infected applicants (Whiteside, 2006: 203). In countries like South Africa and Namibia, such measures are illegal and there have been court cases debating the constitutionality of such screening (South African AIDS Law Project, 2003). The screening of recruits would mean that HIV prevalence in the army on entry would be minimal (Whiteside, 2006: 203). A case in point is the HIV screening system that was in place in Ethiopia between 1998 and 2000. Only those testing negative, (93% of all candidates tested) were admitted to the army (Abebe et al, 2003: 1835-40). As a result, HIV prevalence in the Ethiopian military during this mobilization would probably have been as low as 2.8% (Whiteside et al, 2006: 203; Berhe, 2005: 107–14). What I draw from Whiteside and others is that the issue of HIV prevalence in the military is complex and probably varies from case to case. Simplistic claims about HIV prevalence always being higher in the military should be avoided.

Military Conflict may help prevent the spread of HIV

Iliffe (2006: 18) suggests that war and related disruption and destruction of transport and communication networks in the DRC actually slowed the spread of HIV by preventing the linking of sexual networks between Kinshasa (the epicenter of the epidemic) and the surrounding forested areas (Iliffe, 2006: 10-18). This argument for a 'protective' effect of war has been bolstered by evidence from empirical studies in other countries like Angola, Liberia and Mozambique where HIV prevalence was subdued during the conflicts in those regions, but started rising in the post conflict reconstruction period (Spiegel, 2008: 5; Melo, 2000: 203-207: Strand, 2007: 467-471; PlusNews, 2010; WHO, 2000).

Mock (2004: 6) has observed that in most cases, conflict countries seem to have lower levels of HIV infection than those with relative peace. One of the most significant contributions to the debate on whether conflict lowers HIV prevalence in affected areas was by Spiegel et al (2007). They compared HIV prevalence in populations directly affected by conflict with that in those areas not directly affected. They also compared HIV prevalence in refugee camps and in the closest surrounding host communities in sub-Saharan Africa. Their search of the international literature obtained 295 articles on conflict and HIV prevalence in Africa which identified seven countries with a history of widespread conflict that had original data on HIV prevalence in the five years from 2001 to 2007 (Spiegel et al, 2007: 2188). These were the DRC, Sudan, Rwanda, Uganda, Sierra Leone, Somalia, and Burundi (see Tables 1 – 3).

Table 1: Prevalence of HIV infection in eastern DRC (2004) and in nearest neighboring country sentinel sites

	Prevalence 95% CI	Neighboring country* and nearest site	Prevalence
Bukavu (urban)	3.1 % (1.9-5.1)	Burundi	
		Kayanza (semi-urban)	10.2%
		Muramvya (rural)	14.7%
Bunia (urban)	3.2 % (2.0-5.1)	Uganda, Arua (rural)	5.2%
Goma (urban)	5.4 % (3.8-7.6)	Rwanda, Gisenyi (rural)	7.1%
Kindu (urban)+	3.7 % (2.4-5.8)		
Kisangani (urban)+	6.3 % (4.4-8.8)		
Lodja (rural)+	6.6 % (4.8-9.1)		
Neisu (rural)	6.7 % (4.7-9.2)	No site near border in Sudan	
Karawa (rural)	4.5 % (2.9-6.6)	Central African Republic, Bangassou (rural)	9.0%

Source: Spiegel et al (2007)

Table 1 shows that HIV prevalence in both rural and urban sites in the DRC was generally lower than that in comparable sentinel sites in neighboring Uganda and Burundi (Spiegel et al, 2007: 2189). However, the DRC Goma site had prevalence rates (3.8%-7.6%) similar to those in the Gisenyi site in Rwanda (7.1%).

Table 2 shows that Burundian refugees at the Mtabila and Muyovosi camps had higher prevalence rates than that in the comparable Kigoma region of Tanzania. These are exceptions to the rule as all the other refugee camps in Tanzania show that prevalence was lower than in the host Kagera population.

Table 2: Prevalence of HIV infection in Tanzania (refugee host country)

	Prevalence 95 % CI	Year	Host population	Prevalence 95 % CI	
Burundian refugees Mtabila and Muyovosi Camps	1.70%	2001	Kigoma region*[1]	2.00%	2003
	4.50%	2003			
Nduta and Mtendeli	1.30%	2001			
	1.60%	2002			
	1.70%	2003			
Lukole Camp	4.80%	2001	Kagera region*	3.70%	2003
	3.10%	2002			
	1.60%	2003			
DRC refugees Lugufu and Nyaragusu Camps	1.00%	2001	Kagera region*	3.70%	2003
	2.50%	2002			
	1.80%	2003			

Source: Spiegel et al (2007)

A look at Table 3 also reveals that there was insufficient evidence that HIV transmission increases in populations (refugees hosted in Rwanda, Sudan Kenya and Zambia) affected by conflict. Most of the conflict sites (in the column to the left) show much lower prevalence rates than the host sites to the right. There was also insufficient data to support the theory that refugees have a higher prevalence of HIV infection than the communities that host them (Spiegel et al, 2007: 2192). Another observation they made is that there was no evidence that the extensive rape incidences reported in a number of sites in Rwanda, Sierra Leone and the DRC fuelled the epidemic (Spiegel et al, 2007: 2193).

Table 3: Prevalence of HIV infection in Rwanda, Sudan Kenya and Zambia (refugee host countries).

	Prevalence 95 % CI	Year	Host population	Prevalence 95 % CI	
DRC refugees in Rwanda Gilembe camp	1.50% (0.4-3.8)	2002	Byumba site	6.70% (4.7-9.4)	2002
DRC refugees in Zambia Mwange camp Kala camp	1.20% 3.40%	2005 2005	Nchelenge site	18.90%	2002
Eritrean refugees in Sudan Several camps in eastern Sudan	4.10%	2002	El Gadarif site	4.00%	1998
Sudaneese refugees in Uganda Palorinya settlement Kyangwali settlement	1.00% (0.3-1.8) 2.70% (1.3-4.0)	2004 2004	Surrounding population Moyo site Surrounding population Hoima site	5.90% (1.7-10.1) 4.30% 2.80% (1.0-6.6) 4.60%	2004 2002 2004 2002
Sudaneese refugees in Kenya Kakuma camp	5.00% (3.5-7.0)	2002	Lodwar site	18.00%	2002
Somali refugees in Kenya Dadaab camps	0.60% (0.01-1.1) 1.40% (0.5-2.2)	2003 2005	Garissa site	26.00% 11.00%	2002 2004

Source: Spiegel et al (2007)

Because data collection during conflict is very difficult, Tables 1 – 3 should be treated with caution (Spiegel et al, 2007: 2192). Violence afflicted people may not be willing to be surveyed or to provide an HIV test (Spiegel et al, 2007: 2193). In other words, uncertainties with data quality mean gross generalizations should be avoided. The argument that conflict helps spread the epidemic may hold true in certain countries but as we have seen, the counter argument put forward by Whiteside et al (2006), Spiegel et al, (2007), Iliffe (2006) and others has some empirical backing.

Evidence from the above study by Spiegel et al (2007) leans towards the Iliffe view that military conflict may have helped slow the HIV epidemic in Africa.

However, the approach used did not provide an analysis of the extent to which each country's level of governance and the strength of state institutions may have influenced these community-level results. As De Waal et al (2010: 34) point out, the sheer diversity of HIV epidemics particularly in states considered to be fragile point to the importance of tracing context-specific links between HIV and weak governance. In as much as it is important to "know your epidemic", knowing your social, economic and political context is equally important (Buse et al, 2008).

Modeling of the relationship between HIV and Armed Conflict

One of the most recent econometric attempts to model the link between armed conflict and HIV is that of Iqbal and Zorn (2010) who developed an econometric model attempting to link armed conflict to HIV/AIDS in sub-Saharan Africa. They argued that armed conflict and political violence are related to HIV in that conflict increases the likelihood that uninfected and infected populations will come into contact with one another through the movement of affected peoples (Iqbal and Zorn, 2010: 151). In addition, they argue that armed conflict not only depletes a country's capacity to fight the epidemic by affecting the country's wealth and development but it increases the probability of the occurrence of HIV/AIDS transmission events. In so doing, they control for contextual factors such as religion, GDP per capita, population density, level of education, and economic openness which affect each country's ability to mobilize domestic resources for HIV prevention programs and safe-sex/drug abuse education.

Iqbal and Zorn (2010) use Ordinary Least Squares regression models to look at the link between HIV and armed conflict in 43 African countries for the years 1997, 1999 and 2001. Their measure of armed conflict is taken from the International Peace Research Institute in Oslo and includes all armed conflict resulting in at least 25-battle deaths per year. Iqbal and Zorn (2010) also use this dataset to distinguish between domestic and international conflicts. Their measure of HIV prevalence was obtained from UNAIDS. (UNAIDS/WHO, 2002). .

When they pool all the data together, Iqbal and Zorn (2010) find that the occurrence of international military conflict (i.e. wars between countries) has a large and statistically significant positive relationship with HIV prevalence. The occurrence of domestic conflict (i.e. armed conflict within countries) was not, however, statistically significantly associated with HIV prevalence. They conclude that the impact of conflict on the progression of HIV fell over time,

probably owing to efforts by the international community to fight the epidemic. Iqbal and Zorn (2010: 23) argue that, "our results strongly imply that the vicious cycle of war, poverty, refugee status, and HIV is slowly, breaking down."

Davenport and Loyle (2009) warn that the challenges of carrying out a cross country econometric analysis of the relationship between HIV prevalence and armed conflict are great, and that caution should be taken when interpreting the results. Specifically, there are a number of methodological and theoretical limitations to the study by Iqbal and Zorn. First, they do not make an attempt to determine whether a refugee is from a higher or lower HIV prevalence country than the host country. HIV prevalence would only rise in the host country if refugees come from predominantly higher prevalence nations.

The Iqbal and Zorn (2010) model suggests that there are differences between domestic and interstate types of armed conflict without looking at how the duration or intensity of each episode of armed conflict affects their model. Another concern is that the theoretical model takes snap shots of the countries without accounting for the conflict histories of each country. This is a huge omission as countries ravaged by conflict prior to 1997, 1999 or 2001 will have greatly diminished institutional and social capacity to run successful HIV prevention programs despite them not qualifying as conflict countries in 1997, 1999 or 2001.

Another limitation of their study is one that plagues most attempts at modeling the link between HIV and armed conflict at an aggregate level. The issue here is the use of UNAIDS/WHO HIV prevalence rate estimates that rely on antenatal surveys in host countries. Each country has different capacity and quality constraints which compromise the comparability of the estimates across countries. In conflict countries, some regions have been unstable for so long that it is conceivable that they have lost the capacity to collect such data in any systematic manner. The margins of error around those HIV estimates are thus likely to be wide indeed.

In critiquing cross country models of HIV and conflict, it has been suggested that the UNAIDS/WHO estimates are not comparable across time because of yearly updates to the WHO/UNAIDS estimation models for HIV prevalence (Davenport and Loyle, 2009: 19-20)[1]. This criticism is only valid if Iqbal and Zorn use HIV prevalence estimates from three separate UNAIDS/WHO reports.

[1] Davenport and Loyle (2009) critiqued a preliminary version of the Iqbal and Zorn paper. The actual Iqbal and Zorn paper was subsequently published in the Journal of Politics in 2010 (a year after the Davenport and Loyle critique).

This is because each report would have been compiled using assumptions that might not be uniform. However, the 1997, 1999 and 2001 HIV prevalence numbers were taken from the 2002 report and so are estimates obtained from the same fitted curve and so are subject to the same assumptions.

Another econometric contribution to the literature on HIV and conflict was by Davenport and Loyle (2009). The scope of the study was global although they also tested their results using a smaller sample of Sub-Saharan African countries. Their work is a slight deviation from the Iqbal and Zorn study in a number of theoretical and methodological aspects. Firstly, Davenport and Loyle incorporate some controls that were not accounted for by Iqbal and Zorn. Secondly, their econometric methodology is different from that used by Iqbal and Zorn (2010).

To operationalize their theoretical model, Davenport and Loyle run an Ordinary Least Squares regression on 2007 HIV prevalence rates and a series of conflict and other control variables. They use the UNAIDS/WHO 2007 estimates of HIV prevalence. All of their explanatory variables are averages (or aggregates) of the period 1997 to 2007. Their logic here is that HIV/AIDS has an 8 to 10 year incubation period and so the one year lag applied with most social science statistical models may not be appropriate (Davenport and Loyle, 2009: 19). The explanatory variables they use include conflict data from the Centre for the Study of Civil War at the International Peace Research Institute and the Uppsala Conflict Data Program to measure interstate and civil armed conflict.

Davenport and Loyle (2009) ingeniously use a scope (conflict) variable which is created by dividing the total area of the armed conflict by the total land area of the country. They also incorporate other variables including one to measure conflict duration, the number of battle related deaths to measure conflict magnitude, the number of refugees from high HIV prevalence rate countries, the number of refugees from low HIV prevalence rate countries, population density, trade, health expenditure, region, presence of peace keeping forces and the level of state repression.

One fundamental finding of the Davenport and Loyle study is that both at a global and Sub-Saharan Africa level, domestic and international conflict have a positive but not statistically significant impact on HIV prevalence rates. Additionally, the conflict duration, scope and magnitude variables were also found to be statistically insignificant (despite having positive associations with HIV prevalence). Davenport and Loyle conclude that regardless of what aspect of conflict one highlights, the presence of armed conflict itself does not have a significant influence on the HIV prevalence rate of a given country. Another

significant finding is that refugees from high HIV prevalence countries have a positive and statistically significant effect on a country's HIV prevalence rate[2].
I argue that conflict, militarization and HIV are dynamic in nature and so they should ideally be analyzed over time. This is in contrast with the Davenport and Loyle approach of aggregating the explanatory variables by summing or averaging them over time. It may be more useful to investigate how the epidemic evolves over time as each country's economic, social and political context changes – and as the epidemic itself changes for exogenous epidemiological reasons (such as high risk individuals dying out).

Using a very parsimonious cross country panel regression model as a base, I build on the work by Iqbal and Zorn (2010) and that by Davenport and Loyle (2009). I do not purport to investigate all the possible correlates of HIV prevalence in the countries sampled. My approach is to use panel data on HIV, GDP (Gross Domestic Product), conflict and militarization and investigate if there is a link between these variables at an aggregate level. I proceed first, with a discussion of the data in section 4. In section 5, I review the empirical methodology and discuss our results in section 6. Finally, section 7 concludes.

4. The data

My analysis uses 34 Sub-Saharan countries, which had prevalence rates (adult (15-49) prevalence) higher than 1% (i.e. had generalised HIV epidemics) in at least one year between 1990 and 2005. HIV prevalence data on the 34 countries for the 16-year period (1990 to 2005) was drawn from the 2008 UNAIDS/WHO report on the global AIDS epidemic (UNAIDS 2008). As there is very little data on HIV prevalence in militaries, I turn to data on the level of militarization of a country to see if the level of militarization is associated with the observed trend in HIV prevalence in the general population over time.

The national force ratio and national military expenditure are the two measures of militarization commonly used in social science (see Onyeiwu, 2004). The national force ratio is the number of people in the military divided by the total population. For comparison between countries, military expenditure/GNP data are also used. The force ratio is preferable for our purposes because military expenditure on advanced fighter jets and other equipment is often for reasons other than internal threats and may not reflect the internal security situation of a

[2] On the other hand, when refugees from medium or low HIV prevalence countries are tested, the effect of interaction on the host country is not significant.

country or be a reliable indicator of the number of people involved in the military. It has also been argued that in less developed countries, expenditure-based measures tend to be inflated while the size of the economy is underestimated (Weede, 1995: 229) hence the ratio itself is probably unreliable.

Time series data (1990-2005) on force ratios for each of the 34 countries was obtained from the Stockholm International Peace Research Institute (SIPRI)[3]. To account for the possibility that economically developed countries might have greater capacity to maintain a bigger military even when they are not engaged in armed conflicts, GDP per capita data is included in our analysis. To proxy the size of the economy, time series data (1990 to 2005) on per capita GDP (in constant $US) for each of the 34 countries was obtained from the World Bank's DataBank[4]. The force ratio, HIV prevalence and GDP per capita variables were logged to create normal distributions and allow easy interpretation of the coefficients in our model.

A good amount of the research that has been done on conflict has worked with and built on the Correlates of War (COW) database (see Miguel et al, 2004; Sambanis, 2002). However, this database has been reported to be inconsistent. For instance, it is not clear whether the COW database uses a minimum of 1000 cumulative deaths or a minimum of 1000 deaths per year to classify a country as a conflict country (Sarkees et al, 2003: 50-9). Furthermore, the COW criterion risks excluding armed conflicts that may be major for smaller countries, including many African countries (Miguel et al, 2004: 730). In our analysis, I opt for the UCDP/PRIO conflict data as it has a more transparent definition of conflict-related deaths and it takes into account countries with less than 1000 reported deaths (Miguel et al, 2004: 730). It is also unique in that a time series on the data can be constructed so that it matches the consistent HIV prevalence data (HIV prevalence estimates are available for each country for each year in the period 1990-2005).

The UCDP/PRIO conflict data comprises many variables but I select four in particular. The UCDP/PRIO minor conflict variable is a simple binary variable, which assigns a value of 1 to countries that have had at least 25 but not more than 1000 battle related deaths during the year. A battle is defined as armed conflict carried out with the purpose of realizing domination of a government or a specific territory.[5] The second variable I use is the UCDP/PRIO major conflict

[3] See http://www.sipri.org/

[4] See http://databank.worldbank.org/ddp/home.do

[5] See online: http://www.pcr.uu.se/research/UCDP/data_and_publications/definitions... 2010/05/17 UCDP – Definitions

variable, which is also a dummy variable that assigns a value of 1 to countries that have had more than 1000 battle related deaths during the year. The minor and major conflict dummy variables are crude measures of the intensity of armed conflict and I use them together with the militarization, GDP per capita and HIV prevalence data to create a balanced panel data set comprising 34 countries and spanning 16 years (1990-2005).

I include dummy variables to indicate whether the conflict was interstate or domestic. Following Iqbal and Zorn (2010) as well as Davenport and Loyle (2009), I also incorporate a variable measuring the geographical scope of each conflict. This is calculated by dividing the radius of the region affected by the conflict by the total land area of the country. I also include a population density control variable obtained from the World Bank DataBank[6].

Table 4 shows the summary statistics for each of the variables in our sample. As is expected, there is great variation in HIV prevalence in the dataset as a whole (log of HIV prevalence has a standard deviation of 1.55). In addition, there is more variation in HIV prevalence between countries than within each country over time. This is unsurprising given the broad spectrum of countries in the sample (see Table 5 for a list of countries in the sample). Some countries had much higher prevalence rates than others as shown in Table 5. Countries like Cote d'Ivoire had an average prevalence rate of around 0.3% in the 16-year period versus Zimbabwe with an average prevalence rate at 23.9%.

[6] See http://databank.worldbank.org/ddp/home.do?Step=12&id=4&CNO=2 (World Development Indicators)

Table 4: Summary Statistics for the main variables

Variable		Mean	Std. Dev.	Min	Max	Observations	
Log of HIV prevalence	Overall	1.004	1.554	-4.605	3.364	N =	544
	between		1.444	-3.29	3.156	n =	34
	Within		0.623	-1.67	2.964	T =	16
Log of GDP per capita	Overall	75.484	540.106	-0.116	6876.65	N =	544
	between		404.274	0.001	2363.43	n =	34
	Within		364.406	-1765.8	4588.7	T =	16
Minor conflict	Overall	0.208	0.406	0	1	N =	544
	between		0.271	0	0.938	n =	34
	Within		0.306	-0.73	1.145	T =	16
Major conflict	Overall	0.112	0.316	0	1	N =	544
	between		0.196	0	0.813	n =	34
	Within		0.25	-0.7	1.05	T =	16
Domestic conflict	Overall	0.176	0.391	0	2	N =	544
	between		0.297	0	1	n =	34
	Within		0.259	-0.761	2.051	T =	16
Interstate conflict	Overall	0.026	0.158	0	1	N =	544
	between		0.069	0	0.313	n =	34
	Within		0.143	-0.287	0.963	T =	16
Conflict scope	Overall	0.048	0.134	0	1.878	N =	544
	between		0.083	0	0.329	n =	34
	Within		0.107	-0.28	1.809	T =	16
log of force ratio	Overall	0.911	0.896	-1.096	3.541	N =	544
	between		0.832	-0.394	2.679	n =	34
	Within		0.363	-1.07	2.66	T =	16
log population density	Overall	3.363	1.281	0.543	6.417	N =	544
	between		1.293	0.731	6.341	n =	34
	Within		0.12	3.101	3.671	T =	16

Source: Stata summary statistics

The level of militarization also exhibits more variation between countries than within each country. It is likely to be a function of each country's specific policies, socio-political priorities and economic prosperity. Note also that the level of militarization is not necessarily a function of the number of conflicts a country has had. As shown in Table 5, Somalia was the most militarized country (if one takes an arithmetic mean of the force ratio over the 16 years) and it did have a relatively high number of conflict years. However, some heavily militarized countries such as Djibouti, Gabon, Namibia, Botswana and Zimbabwe had no conflicts between 1990 and 2005. Angola and Burundi are the only other heavily militarized countries to have had more than ten conflict years (major and minor) from 1990 to 2005.

Table 5: Summary Statistics for the main conflict variables

Country (mean force ratios)	Country (minor conflicts)	Country (major conflicts)	Country (mean HIV prevalence)
Somalia (17.38)	Ethiopia (14)	Sudan (12)	Zimbabwe (23.91)
Djibouti (15.21)	Uganda (13)	Angola (11)	Botswana (20.06)
Mauritius (14.0)	Chad (11)	Senegal (5)	Swaziland (16.97)
Cameroon (14.0)	Burundi (10)	Rwanda (5)	Lesotho (16.44)
Angola (9.42)	Senegal (9)	Burundi (4)	Zambia (14.86)
Gabon (7.0)	Somalia (8)	DRC (4)	Malawi (10.84)
Namibia (5.89)	Sierra Leone (8)	Uganda (3)	South Africa (10.52)
Liberia (5.62)	Liberia (7)	Somalia (3)	Uganda (10.2)
Burundi (5.47)	Rwanda (6)	Liberia (3)	Namibia (9.66)
Botswana (5.39)	Niger (5)	Sierra Leone (2)	Kenya (8.07)
Cote d'Ivoire (5.17)	Congo, Rep. (4)	Congo, Rep. (2)	Mozambique (6.95)
Chad (4.87)	CAR (4)	Chad (1)	Tanzania (6.74)
Zimbabwe (4.6)	Cote d'Ivoire (3)	Ethiopia (0)	Congo, Rep. (5.74)
Congo, Rep. (4.29)	Sudan (3)	Eq. Guinea (0)	CAR (5.12)
Sudan (3.12)	Angola (2)	Niger (0)	Cameroon (4.6)
Swaziland (2.98)	Nigeria (2)	CAR (0)	Gabon (3.93)
Ethiopia (2.97)	Cameroon (1)	Cote d'Ivoire (0)	Burundi (3.79)
South Africa (2.81)	DRC (1)	Nigeria (0)	Eq. Guinea (2.82)
Uganda (2.49)	Lesotho (1)	Cameroon (0)	Chad (2.47)
Zambia (2.03)	Djibouti (0)	Lesotho (0)	Nigeria (2.42)
Sierra Leone (1.99)	Eq. Guinea (0)	Djibouti (0)	Ethiopia (2.09)
Senegal (1.87)	Mauritius (0)	Mauritius (0)	Djibouti (2.04)
Rwanda (1.81)	Gabon (0)	Gabon (0)	Rwanda (1.73)
Madagascar (1.71)	Namibia (0)	Namibia (0)	DRC (1.36)
DRC (1.44)	Botswana (0)	Botswana (0)	Sudan (1.34)
Mozambique (1.41)	Zimbabwe (0)	Zimbabwe (0)	Liberia (1.21)
CAR (1.20)	Swaziland (0)	Swaziland (0)	Angola (1.12)
Tanzania (1.17)	South Africa (0)	South Africa (0)	Sierra Leone (1.03)
Lesotho (1.11)	Zambia (0)	Zambia (0)	Cote d'Ivoire (1)
Eq. Guinea (1.0)	Madagascar (0)	Madagascar (0)	Mauritius (0.51)
Nigeria (0.96)	Mozambique (0)	Mozambique (0)	Niger (0.48)
Kenya (0.91)	Tanzania (0)	Tanzania (0)	Senegal (0.32)
Niger (0.85)	Kenya (0)	Kenya (0)	Somalia (0.3)
Malawi (0.71)	Malawi (0)	Malawi (0)	Madagascar (0.06)

Source: Own calculations, the numbers in the minor and major conflict columns represent the sum total of conflict years in each country between 1990 and 2005

Table 4 shows that the minor, major, domestic, and interstate conflict variables exhibit more variation within than across countries. Only a few countries such as Ethiopia, Sudan, Angola, Somalia, Uganda, Burundi, and Chad had sustained conflicts in the 16-year period (UCDP, 2010). These are the countries with the highest number of conflict years, as shown in Table 5. To understand the broad relationship among the variables, I calculate the pair-wise correlation between each of the variables and present them in Table 6.

GDP per capita is positively correlated with HIV prevalence, a partial correlation result also found by Nattrass (2009: 2) when she looked at the cross country relationship between HIV and poverty (using 2005 data on HIV prevalence and GDP per capita)[7].

Table 6: Summary statistics for the main variables

	Log of HIV	Log of GDP per cap	Minor conflict $_{t-1}$	Major conflict $_{t-1}$	Domestic conflict $_{t-1}$	Interstate conflict $_{t-1}$
Log of GDP per cap	0.190	1				
P value	0.000					
Minor conflict $_{t-1}$	-0.133	-0.174	1			
P value	0.001	0.000				
Major conflict $_{t-1}$	-0.202	0.006	-0.124	1		
P value	0.000	0.893	0.004			
Domestic conflict $_{t-1}$	-0.286	-0.101	0.453	0.287	1	
P value	0.000	0.018	0.000	0.000		
Interstate conflict $_{t-1}$	-0.034	0.035	0.060	0.273	0.045	1
P value	0.425	0.415	0.163	0.000	0.290	
Conflict scope $_{t-1}$	-0.039	-0.057	0.364	0.325	0.041	0.167
P value	0.359	0.187	0.000	0.000	0.338	0.000
Log of force ratio $_{t-1}$	-0.072	0.335	0.113	0.248	0.124	-0.003
P value	0.092	0.000	0.008	0.000	0.004	0.949
Log of population density $_{t-1}$	0.082	0.006	0.157	0.0831	-0.113	-0.070
P value	0.645	0.9717	0.3758	0.64	0.525	0.698

Source: Own calculations in Stata 10.

Interestingly enough, the force ratio or militarization variable also has a negative, albeit statistically insignificant (5% level), relationship with the logarithm of HIV prevalence. It is likely that the link between HIV prevalence and militarization is not direct. As such, the pair-wise correlation between the

[7] This result does not hold later in our panel regression models, just as in Nattrass (2009)

logarithm of the force ratio (or any of the other dependent variables) and the logarithm of HIV prevalence shown in Table 6 is inadequate.
Notwithstanding, the minor and major conflict dummy variables have negative and statistically significant partial correlations with the logarithm of HIV prevalence. This is not surprising given that most of the conflict countries had low average HIV prevalence rates between 1990 and 2005. Somalia, Angola, Liberia, Chad, Sudan, Uganda, and the DRC are some of the countries that had major conflicts in the 1990 to 2005 period. Table 5 shows that all these countries, with the exception of Uganda, had low HIV prevalence rates. Therefore, the correlation between the major conflict variable and HIV prevalence is negative and statistically significant. Niger, Sierra Leone, Senegal, Ethiopia, and Cote d'Ivoire are some of the countries that had minor conflicts. The fact that these countries also had low average HIV prevalence rates drives the negative correlation coefficient between the minor conflict dummy variable and the logarithm of HIV prevalence variable. Of these countries, Ethiopia probably had the biggest influence on the correlation result as it had minor conflicts, mostly in the Oromiya region throughout most of the 1990 to 2005 period.

The benefit of panel data is that I can run partial correlations for each country over the 16 years sampled. Table 7 actually shows us is that it is primarily countries which had conflict (minor or major) between 1990 and 2005 that show a negative and statistically significant linear relationship between militarization (force ratio) and HIV prevalence. Countries such as Mauritius, Namibia, Botswana, Zimbabwe, Kenya, and Uganda are among those that are not classified as having had conflict between 1990 and 2005 according to the UCDP/PRIO criterion. For these countries, HIV prevalence has a positive linear relationship with the level of militarization or force ratio.

Although partial correlations cannot be used to draw definitive conclusions, the correlation matrices give us broad indications of the link between the different variables. I turn to regression models in order to explore the link between conflict, militarization and HIV prevalence more comprehensively.

Table 7: Within country correlation coefficients (correlation with HIV prevalence)

Country	Force ratio $_{t-1}$ coefficient	P value	Minor conflict $_{t-1}$ Coefficient	P value	Major conflict $_{t-1}$ coefficient	P value
Somalia	-0.32	0.23	0.21	0.44	-0.85	0.00
Djibouti	0.79	0.00	0.00	0.00	0.00	0.00
Angola	-0.85	0.00	0.23	0.39	-0.47	0.07
Gabon	-0.68	0.04	0.00	0.00	0.00	0.00
Namibia	0.33	0.21	0.00	0.00	0.00	0.00
Liberia	0.39	0.14	-0.05	0.85	-0.49	0.05
Burundi	-0.24	0.38	0.11	0.68	0.05	0.87
Botswana	0.83	0.00	0.00	0.00	0.00	0.00
Cote d'Ivoire	-0.93	0.00	0.11	0.68	0.00	0.00
Chad	-0.93	0.00	0.06	0.82	-0.57	0.02
Zimbabwe	0.61	0.01	0.00	0.00	0.00	0.00
Congo	0.35	0.19	0.18	0.51	0.12	0.66
Cameroon	0.03	0.91	0.13	0.64	0.00	0.00
Mauritius	0.79	0.00	0.00	0.00	0.00	0.00
Sudan	0.65	0.01	0.05	0.85	-0.05	0.85
Swaziland	-0.94	0.00	0.00	0.00	0.00	0.00
Ethiopia	-0.25	0.35	0.04	0.90	0.00	0.00
South Africa	-0.20	0.45	0.00	0.00	0.00	0.00
Uganda	0.80	0.00	0.33	0.21	-0.33	0.21
Zambia	0.13	0.63	0.00	0.00	0.00	0.00
Sierra Leone	0.38	0.15	-0.30	0.26	0.15	0.57
Senegal	-0.78	0.00	-0.19	0.48	0.01	0.98
Rwanda	-0.51	0.05	0.34	0.19	0.09	0.73
Madagascar	-0.61	0.01	0.00	0.00	0.00	0.00
DRC	-0.05	0.85	-0.12	0.65	-0.28	0.30
Mozambique	-0.89	0.00	0.00	0.00	0.00	0.00
CAR	-0.36	0.17	0.33	0.22	0.00	0.00
Tanzania	-0.29	0.28	0.00	0.00	0.00	0.00
Lesotho	-0.85	0.00	0.16	0.55	0.00	0.00
Nigeria	0.47	0.07	0.20	0.46	0.00	0.00
Kenya	0.56	0.02	0.00	0.00	0.00	0.00
Niger	0.68	0.00	-0.51	0.04	0.00	0.00
Equatorial Guinea	-0.75	0.00	0.00	0.00	0.00	0.00
Malawi	-0.43	0.10	0.00	0.00	0.00	0.00

Source: Own calculations in Stata 10

5. Empirical Methodology

Using our short panel data set (i.e. n>T), I investigate the link between conflict, militarization and HIV prevalence. Because all countries have observations for all variables and time periods, I have a balanced panel data set. This means that the total number of observations is 544 (nT). Panel data allows one to control for variables you cannot observe or measure like cultural factors (when comparing countries or states within a country –i.e. Ethiopia versus South Africa) (Torres-Reyna, 2010: 3). In addition, panel data helps to control for unobservable variables that change over time within but not across countries (i.e. national policies and HIV interventions, federal regulations) (Torres-Reyna, 2010: 3).

Dynamic Panel Models

A number of aspects of politics are inherently dynamic and there have been attempts to model the dynamics of political phenomena by including lags of dependent variables (Wawro, 2002: 2). These have ranged from dynamic models of party identification (Green and Palmquist, 1990; Green and Yoon, 2002) and campaign finance (Krasno et al, 1994). However, as noted by Wawro (2002: 3), these studies estimate models on a period by period basis and do not take advantage of the panel structure of the data and the efficiency it provides. Such studies estimate a separate, cross sectional model for each time period. Dynamic panel models however, include both lagged dependent variables and unobserved individual-specific effects.

In addition, dynamic panel models allow for dynamics to be modeled while accounting for individual level heterogeneity. Another reason I opt for dynamic panel analysis is because the Fixed Effect[8] (FE) and ordinary least squares (OLS) models do not account for the dynamic nature of HIV prevalence. If conflict at time t results in the increase of HIV prevalence at time t+1, then regardless of whether there is another conflict at time t+1, HIV prevalence at time t+2 will be dependent on HIV prevalence the year before (t+1). Secondly, because epidemics in different countries are likely to be influenced by country specific characteristics, a dynamic model would serve us well as it includes as part of its specification, unobserved individual level heterogeneity (Wawro,

[8] Fixed effects remove the effect of those time-invariant characteristics from the predictor variables so we can assess the predictors' net effect (Torres-Reyna, 2010: 7).

2002: 3). In this way, dynamic models are similar to fixed effects models as they remove country specific effects (time invariant country specific characteristics).

Dynamic panel models explicitly include variables to account for past levels of HIV prevalence and time invariant country specific effects. This affords us an opportunity to understand better what factors drive HIV prevalence over time whilst distinguishing between what Wawro (2002: 3) "true" dynamics and factors that vary across, but not within, countries over time (unobservable). The basic dynamic panel model can be estimated as follows;

$$Y_{it} = \alpha Y_{it-1} + X_{it}\beta + \mu_i + v_{it}$$

Where i, denotes the cross sectional units, t the time periods, X_{it} and a vector of exogenous explanatory variables, μ_i is an unobservable country level effect which is constant across time within individuals and v_{it} is a random disturbance term.

Ordinary Least Squares (OLS) produces biased and inconsistent estimates when used in dynamic panel data analysis. Other standard within country or LSDV (Least Squares Dummy Variable) transformations remove the individual effects but produce biased and inconsistent estimates because there is correlation between the transformed lagged dependent variable and the transformed disturbance (Baltagi, 2008: 125-126). In actual fact, the OLS estimates will be biased upwards whilst the within country estimates are biased downwards (Bond, 2002: 7). An alternative is the Generalized Method of Moments (GMM) estimator, which is an attempt to find middle ground (Bond, 2002: 7).

The Arellano and Bond (1991) estimator is a GMM estimator that includes p lags of the dependent variable as covariates and contains unobserved panel-level effects (fixed or random). Arellano and Bond (1991) derived a consistent generalized method-of-moments (GMM) estimator that deals with the correlation between the lagged dependent variables and the unobserved panel-level effects. This was later improved by Arellano and Bover (1995).

I present the Arellano and Bover/Blundell and Bond (1995, 1998)[9] estimator, which built on the Arellano and Bond (1991) by using additional moment conditions so as to improve the performance of the Arellano and Bond (1991). These dynamic models can be modeled strictly as GMM estimators or with an option for robust standard errors, corrected for panel level autocorrelation and heteroscedasticity. Unless the Blundell-Bond (1998) estimator is adjusted for spatial dependence, it might produce inconsistent results. I, therefore, also present a Panel Corrected Standard Errors (PCSE) model that automatically does a Prais-Winsten regression to deal with temporal correlation and has an option to deal with spatial correlation.

Summary of the models

A summary of the models is presented in Table 8. In addition to the pooled OLS, fixed effects, PCSE and system GMM dynamic models, I present one more model. This is an aggregated OLS model that follows Davenport and Loyle (2009). I present the model not to make a direct comparison with Davenport and Loyle (2009) but with the dynamic models

Table 8: Dynamic panel regression model characteristics.

Model	Transformation	Regressors	Consistency
LSDV/FE	Within	$Y_{i,t-1}$, X_{it}	No
PCSE (Prais-Winsten)	Within, Between	$Y_{i,t-1}$, X_{it}	No
First Difference GMM (Arellano-Bond (1991))	Δ	$\Delta Y_{i,t-1}$, ΔX_{it}	Yes
System GMM (Arellano-Bover/Blundell-Bond (1995,1998)	Δ	$\Delta Y_{i,t-1}$, ΔX_{it} , $Y_{i,t-1}$, X_{it}	Yes

Source: Adapted from Eigner (2009)

[9] In stata xtdpdsys is used for the Arellano-Bover/Blundell-Bond (1995, 1998) estimator and xtabond estimates the Arellano and Bond (1991). The panel corrected standard errors can be obtained using the xtpcse command. Using the Wald test, we found evidence of heteroscedasticity and also found evidence of serial correlation (AR1) using the Wooldridge test. There also was no evidence of multi-colinearity. The Pesaran's test for cross sectional independence confirmed our suspicion of the presence of spatial dependence in the foxed effects specification

6. Results

Table 9 shows that in all our specifications, there is no statistically significant relationship between armed conflict and HIV prevalence. Nevertheless, unlike in Davenport and Loyle (2009) as well as in Iqbal and Zorn (2010), the coefficients on the armed conflict variables are negative. In addition, the pooled OLS and fixed effects estimators predict a statistically significant and negative relationship between the level of militarization and HIV prevalence. The two models also show a positive and statistically significant relationship between population density and HIV prevalence. However, these are biased estimators as I discussed earlier and so I will not interpret these coefficients. Interestingly, the pooled OLS model also shows a statistically significant, negative relationship between HIV prevalence and interstate conflict. This result is not maintained in the other models estimated.

The Blundell-Bond (1998) system GMM estimator corrects for the bias in the pooled OLS and fixed effects estimators. Model 3 shows that under system GMM, the previously statistically significant relationships between HIV prevalence and the population density and militarization variables become less statistically powerful. The performance of the GMM estimator is dependent on the validity of the instrumental variables used. The Sargan test confirms the validity of the GMM instruments even though the test may have little power under heteroscedasticity. Furthermore, a model that accounts for the spatial dependence in the data set may provide better estimates. In other words the results shown in model 3 should be taken with caution. Model 4, which corrects for cross sectional dependence, reaffirms the GMM results

One main disadvantage of using the dynamic panel models is that one needs to make a very difficult assumption regarding the length of time it takes for conflict to affect prevalence rates at a country level. The key question to ask is whether I would expect to see declines in nationwide HIV prevalence a year after a conflict or changes in the population density. This is exactly what I assume in models 1 to 4 (where q = 1, i.e. I assume one year lags). For instance, it may not be sensible to assume that one year is a long enough period for the effects of war and conflict to have resulted in new infections and for those infected to have been tested. HIV symptoms do not show immediately after infection and even when they do, they appear in the form of opportunistic infections which may not be immediately identifiable as HIV-related (Morgan et al. 2001). Secondly, the incubation period for HIV symptoms can be as long as 8 to 10 years (Bacchetti and Moss 1989). In any case, even if diagnosed, it is difficult to determine where and when HIV was contracted (Davenport and Loyle, 2009).

Table 9: Regression results (The dependant variable is the Log of HIV prevalence $_t$)

	Pooled OLS (1)	Fixed Effect (2)	System GMM (3)	PCSE (4)
Log HIV prevalence $_{t-q}$	0.878 ***	0.876 ***	0.878 ***	0.940 ***
	(0.006)	(0.026)	(0.097)	(0.022)
Log GDP per capita $_t$	-0.004	1.3e-3	-0.004	-1.0e-4
	(0.001)	(5.9e-4)	(0.021)	(1.9e-4)
Minor conflict $_{t-q}$	-0.022	-0.196	-0.018	-0.030
	(0.020)	(0.019)	(0.087)	(0.024)
Major conflict $_{t-q}$	-0.035	-0.017	-0.020	-0.030
	(0.031)	(0.023)	(0.303)	(0.029)
Domestic conflict $_{t-q}$	-0.002	-0.001	-0.004	-0.005
	(0.020)	(0.012)	(0.119)	(0.019)
Interstate conflict $_{t-q}$	-0.072 *	-0.038	-0.021	-0.018
	(0.037)	(0.022)	(0.587)	(0.028)
Conflict scope $_{t-q}$	-0.010	-0.006	-0.010	-5.9E-5
	(0.006)	(0.004)	(0.150)	(0.007)
Log force ratio $_{t-q}$	-0.037 ***	-0.027 **	-0.023	-0.008
	(0.017)	(0.020)	(0.203)	(0.012)
Log of Population density $_{t-q}$	0.222 ***	0.306 ***	0.235	0.015
	(0.019)	(0.076)	(0.580)	(0.011)
R^2	0.128	0.963		0.969
corr (x_i,mu_i)		0.064		
sigma_u		0.420		
sigma_e		0.109		
Rho		0.937		
Pesaran AR		6.274		
Pesaran p_value		0.000		
F test	14.04	1324.76		
t statistics	Robust	Robust	Corrected	Corrected
Wald Chi-2			2246.84	7731.04
P value	0.000	0.000	0.000	0.000
Sargan test			1.000	
Arello-Bond test (AR2)			0.069	
No of Instruments			128	
Number of observations	510	510	510	510

Source: Stata 10

Model 5, in Table 10 follows Davenport and Loyle (2009) by averaging (or aggregating) the data over the 1996-2005 ten year period. This way, I account for the suggested 8 to 10 year incubation period. However, aggregating the data negates our efforts to benefit from the improvement in efficiency that panel data affords. Nonetheless, it is interesting to note that model 5 does not contradict any of our dynamic models. In other words, despite the fact that none of the specifications are perfect, the overarching theme they highlight is that the association between HIV prevalence, militarization and conflict may be negative. This is in tune with our dataset's summary statistics that suggest this result is driven by countries such as Angola, Liberia, Somalia, and the Democratic Republic of the Congo.

Table 10: Regression results

Dependant Variable	OLS
Log HIV prevalence 2005	(5)
Log GDP per capita	-0.003 *
	(0.008)
Minor conflict	-0.106
	(0.111)
Major conflict	-0.097
	(0.152)
Domestic conflict	-0.087
	(0.113)
Interstate conflict	-0.128
	(0.144)
Conflict scope	-0.511
	(0.564)
Log force ratio	-0.169
	(0.298)
Log of Population density	0.204
	(0.249)
R^2	0.211
F test	4.91
t statistics	Robust
P value	0.000
Number of observations	34

Source: Stata 10 Regression analysis

The first case of HIV in Angola was diagnosed in 1985 (UNAIDS, 2005). HIV prevalence was reported to be at 2.5% in 2005, making it the lowest rate of prevalence in continental southern Africa (USAID, 2008: 1). In the period from 1990 to 2005, Angola has had a major conflict (more than 1000 battle related deaths) in each year except for 1996, 1998 and 2004 which had minor conflicts. These have primarily been internal contestations over territory (UCDP, 2010). In Angola, conflict predated the HIV epidemic and it is likely that the virus could not spread quickly as transport and communication infrastructure had already collapsed. This is evidenced by the fact that the percentage of paved roads was virtually zero for the 1980s and 1990s[10] (World Bank DataBank, 2008).

In addition, the conflict in Angola is seen as having limited human mobility rather than causing large refugee flows (Bing et al, 2008: 578). The conflict was protracted and widespread with the MPLA controlling most of the major towns while UNITA dominated in the rural regions for long periods (UCDP, 2008). Even in the regions not directly affected by war, they were impacted mainly through the overall decay of their economic and social infrastructure and general impoverishment (Agadjanian, 2001: 9). In addition, the population density was very low with estimates being put at 5 people per square kilometre in 1975, 11 in 2000 and 13 in 2005 (UN, 2006)[11]. Owing to the poor infrastructure it is plausible that the degree of mixing and creation of new sexual networks as refugees and troops moved from one area to another was limited.

It is plausible that the same factors would have contributed to the low prevalence rates in Somalia, Liberia and the DRC but with a few variations. For instance, in the DRC, the conflict began when the HIV epidemic was advanced and leveling off[12]. This would have made the rapid spread of the epidemic unlikely. Another variation is that in the DRC, Somalia and Rwanda, the fighting was unlike that in Angola as it was more along ethnic lines. McInnes (2009: 12) argues that conflicts of identity within states are likely to generate higher levels of antipathy which could make acts of sexual violence more likely. Much of the fighting in the eastern part of the DRC has been between Banyamulenges or other Tutsi linked groups versus government forces (McInnes, 2009: 27). According to UNAIDS (2005), HIV prevalence among

[10] Data from World Bank http://ddp-ext.worldbank.org/ext/DDPQQ last accessed 24 October 2008.
[11] http://esa.un.org/unpp/p2k0data.asp.
[12] The four years from 1997 to 2000 are classified as major conflict years (UCDP, 2010). In addition, the epidemic appears to have reached its peak in the 1990s, when life expectancy had dropped to 9% (USAID, 2008).

women who have suffered sexual violence in areas of armed conflict in the DRC may be as high as 20%. There are also estimates that put the number of women raped everyday across the country at 67 (USAID, 2008: 1).

In Rwanda, sexual violence against women and girls constituted a central part of the genocidal strategy (Amnesty International, 2004). Some have alleged that this was done so as deliberately infect Tutsi women with HIV. An example of this is a view by Paula Donovan (Donovan, 2002: 17) that has repeatedly been cited by many scholars including McInnes (2009: 15).
"Integral to the plan to annihilate the Tutsi population was the systematic sexual molestation, mutilation, and rape of women and girls...Most survivors describe the genocide as a bloodbath during which rape was inevitable for practically all females... Eyewitnesses recounted later that marauders carrying the virus described their intentions to their victims: they were going to rape and infect them as an ultimate punishment that would guarantee long-suffering and death."

However, Donovan concedes that it is impossible to calculate how many women who were raped were subsequently killed. It is also difficult to know how many rapists claiming to be HIV actually were primarily because testing was not extensive (Donovan, 2002: 18). All these factors make the task of assessing if such sexual violence had an impact on the trajectory of the epidemic extremely challenging.

The alarming rates of sexual violence in the DRC and Rwandan conflicts may have resulted in an increase in the spread of HIV in the communities affected but it is conceivable that the fact that most of the fighting was localised and not national in scope may have limited country wide upsurges in prevalence. Further, the collapse in transport and communication infrastructure may have limited mobility and disassortive mixing.

It is apparent that all the issues I have highlighted illustrate the need for a more detailed analysis of country cases so as to reveal the differences in the conflict experiences of each. Admittedly, our dynamic models do not provide exhaustive and instructive explanations to the link between HIV and conflict. However, taking a parsimonious dynamic panel approach reveals that it is plausible that the hypothesized (in current econometric literature) positive association between armed conflict and aggregate HIV prevalence may be inappropriate.

7. Conclusion

The study of the link between HIV and conflict is a complex undertaking. It has however been made even more complicated by the political nature of conflict analysis. The debate has been steered primarily by those seeking to bring attention to the rapes and other abuses that happen during conflict which put large numbers of people at risk. However, the leap from linking such community or region level effects of conflict to changes in national level HIV prevalence is not supported by the evidence. Our cross-country regression analysis of HIV prevalence casts a doubt over the argument that armed conflict necessarily worsens the epidemic, particularly at a country (aggregate) level. I find a negative albeit statistically weak association between armed conflict, militarization and HIV prevalence. This is in support of the arguments put forward by Mock (2004), Iliffe (2006), Spiegel et al (2007) and others. However the models I present are very parsimonious and far from perfect. Further, every model is dependent on the quality of its inputs and the lack of actual data on HIV prevalence for most countries is a cause for caution when interpreting them.

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