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Examining Determinants of HIV/AIDS

The role of Socioeconomic, Demographic, Political and Technological factors
in sub Saharan Africa 1990-2007

By

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Preface

I would like to express a warm Thank You to Therese Nilsson for her efforts in guiding me while I was writing this thesis. It has been as much of a pleasure as an academically rewarding experience to learn from Therese and receive her constructive criticism regarding all aspects of how to produce a well written thesis. Many Thanks for taking your time to be a good supervisor and answering all my questions, not just once once but even twice.

Abstract

Many infectious diseases interact with their immediate environments. Prevention strategies have to be executed on the individual level as well as within the risk environment. Risk factors refer to factors outside of the individual that influence the risk of transmission. However, this thesis focuses on macro level issues such as socioeconomic, political, demographic and technological influential factors. There is consensus that HIV/AIDS has a negative impact on economic growth and studies show evidence of that good health, often proxied by life expectancy, has a positive significant effect on labour productivity and economic growth. To fill a void in the literature, this thesis aims to examine the role of some of the socioeconomic, demographic, political and technological factors that could increase the spread of HIV/AIDS. In addition, such analysis is important in order to limit risk and allocate relief money more efficiently. Using public data from the World Bank, UNAIDS and the Integrated Network for Societal Conflict Research results from panel data analysis show that most factors examined display a negative relationship with HIV/AIDS in the sample of 45 sub Saharan African countries.

Key words: HIV/AIDS, socioeconomic-, demographic-, political- and technological determinants, sub Saharan Africa.

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1. Introduction

1.1 Research problem

Three decades have passed since the first HIV/AIDS cases were discovered in the early 1980s. The research and medical community have displayed concern regarding the **unexpected rapid development, speed and scale of the epidemic, though the magnitude and nature of the epidemic varies depending on the prevalent mode of transmission.** It has multifold surpassed the devastation of the **Black Death in the 14th** century though it has **similar demographic and epidemiological characteristics** (Caldwell, 1997:169). It is the infectious disease to have **killed the largest number of people in history** and it is the **leading cause of death** in sub Saharan Africa (SSA) (Bonnel, 2000:2). What distinguishes the HIV/AIDS epidemic from for example TB and malaria are the **different risk groups and the time lag** present for costs and losses due to the long **incubation** period (Gaffeo, 2003:36).

It is estimated that between **five and ten percent of the total population in Africa is infected**. In 2007 sub Saharan Africa accounted for 67 percent of all people worldwide living with HIV, equivalent to **22 million** people, and registered **75 percent of all AIDS related deaths** worldwide. This is remarkable, considering that sub Saharan Africa only accounts for about ten percent of the world's population (UNAIDS, 2008:30). Over 25 million people worldwide have succumbed to the disease and 33 million people are today living with the virus, mainly in low income countries and countries facing conflict, political, social and economic instability (UNAIDS, 2009:6). Some of the economic consequences of HIV/AIDS are reduced human capital, lower economic growth, increased medical costs for the individual and the state and reduced spending in other public areas. Various socioeconomic, demographic and political factors related to inequality, poverty, labour migration and political instability are believed to have an impact on the spread of the epidemic.

Most economic research on HIV/AIDS has focused on the epidemic as a determinant of economic growth, such as physical, social and human capital. Existing academic literature is both quantitative and qualitative. Regarding the former, most research on the drivers of HIV/AIDS has been conducted during the last decade by scholars such as Berhe, Gorbach, Lovász, Bonnel, Paxton and Spiegel, while the latter is written by collaborating UN agencies, NGOs and national governments. Regarding the drivers of the epidemic, part of the research has revealed somewhat unexpected results, particularly when relating HIV/AIDS to conflict situations, and in addition there is a need for improved quality of the data to be able to draw conclusions regarding the drivers. However, **little research has examined the variables influencing HIV/AIDS** (Paxton, 2009:2). Therefore, it is valuable to redirect the research focus on possible factors that could have an effect on the spread of the epidemic. There is no uniform idea regarding HIV/AIDS when it comes to understanding what factors potentially fuel the spread of the virus and **because prevalence rates greatly vary on the African continent it makes a good case to study.**

Africa consists of more than 50 countries but it is still common to speak of Africa as a one dimensional continent. The truth is that African countries differ in socioeconomic, political and demographic aspects and are not as homogenous as people sometimes are made to believe, in order to simplify causes and consequences of the virus. However, it is important to understand why some middle income and **relatively democratic countries, such as Botswana and South Africa, display high prevalence rates and war torn countries, like Congo, Somalia and Eritrea, display rather low prevalence rates in order to deliver more efficient preventative policy recommendations. The main reason for this thesis being written is that there is no general consensus on what factors** seem to propel the spread of HIV/AIDS. The paper surveys the role of demographic, socioeconomic, political and technological factors that possibly can be associated with the epidemic. Many nations present heavily increasing HIV prevalence rates while simultaneously facing an economic and social transition which is believed to enhance the spread of HIV through channels such as increased labour migration, drug use, commercial sex work and decreasing access to health care (Gorbach et al., 2002:36). **The epidemic hinders social and economic development on the African continent through reduction of its human capital.**

1.2 Aim

The aim of the paper is to examine the effects of demographic, political, socioeconomic and technological factors on HIV/AIDS prevalence levels. More specifically, the thesis will examine the impact of the factors on the change in HIV prevalence rates among 15-49 year olds in sub Saharan Africa, 1990-2007. Without understanding the factors of transmission people will continue to experience further reduced living standards, have very limited prospects of economic development and fall further into poverty (Gaffeo, 2003:33). The study will help to better implement prevention strategies. In addition, a desirable outcome of the study is that the analysis also will be able to shed light on why prevalence rates are so different between the sub Saharan countries and identify gaps in the prevention strategies. Little research provides information on these particular factors and by controlling for causality between the factors the thesis will add to the knowledge pool regarding the demographic, socioeconomic, political and technological drivers of the epidemic.

1.3 Outline

Chapter two discusses sub Saharan HIV prevalence rates, consequences of the epidemic, prevention and treatment while chapter three and four discuss the theoretical framework, hypotheses and previous research. Chapter five goes through data sources, the sample and a discussion of the variables, before descriptive statistics of the sample is presented. The sixth and the seventh chapter present the methodology and the empirical analysis. Last is the conclusion, references and the Appendix.

2. Background

This section reviews the cultural and socioeconomic variation within sub Saharan Africa in addition to the limitations of the study. Sub Saharan Africa is very culturally and

socioeconomically diverse and the chapter reflects upon that most of the countries have different needs and challenges in regard to the HIV/AIDS epidemic. Prevalence rates are varied among and within the countries but the economic, social and demographic consequences of the epidemic are the same just as they all face the challenge to provide target-based and cost effective prevention, care and treatment.

2.1 Prevalence rates and consequences of HIV/AIDS

HIV prevalence rates are highly varied among and within geographical regions, between men and women and between different socio economic groups. Striking variations are observable in cross country-comparisons just as single country studies also indicate significant differences at local and regional levels (UNAIDS, 2009). Southern Africa displays the highest HIV rates, with **Swaziland, Botswana, Lesotho, South Africa and Zimbabwe** topping the list. Swaziland has 26 percent of its population aged 15-49 infected with HIV followed by Botswana and Lesotho at 24 and 23 percent. West African counties such as Niger, Mauretania, the Gambia, Senegal and Benin display prevalence rates between two and eight percent while East African countries like **Sudan, Eritrea and Somalia** show relatively lower prevalence rates, below one point four percent as seen in *Figure 1* (UNAIDS, 2008). There are many questions to examine, for example why relatively rich countries such as South Africa and Botswana have high HIV rates and why some significantly war torn countries such as the Congo display relatively low prevalence rates while peaceful Zambia has high prevalence rates (Rosling, 2009).

One of the most intriguing questions to be answered is why there are such varying degrees of prevalence rates in sub Saharan Africa. In addition to the factors investigated in the thesis, which are gdp levels, secondary enrollment, female labour force participation rates, percentage of the population under 15, density, political status, level of conflict and technology present, there are other factors not included in the study which could influence or limit the spread. There is evidence of cultural practices and public health preventions, such as male circumcision and frequent condom use, having a dampening effect on the spread of HIV (WHO, 2009:5). When mapping the AIDS epidemic it is noticeable that it stretches north to south along inland, east central and coastal areas and it coincides with the areas where circumcision is not practiced (Caldwell et al., 1997:822).

Some African countries still see HIV prevalence rates increase while some countries show decreasing or stagnating rates, though the absolute number of infected people and people living with AIDS are increasing due to **improved treatment** (UNECA, 2008:8). According to Lovász et al **stagnation is not necessarily a sign of the epidemic slowing down but rather a possible sign of that the number of newly infected are equal to the number of people dying from AIDS**. This view is also shared by UNAIDS which also expects to see increased prevalence rates in the future, due to **increased HIV testing and to increased availability of antiretroviral** treatment (ARVs) (Lovász et al., 2009:252). The introduction of ARVs in 1996 has been slow due to the high costs of the drugs made available to people in low income countries. In addition to relatively expensive drug treatments low income countries also face the obstacle of distributing the ARVs, with insufficient infrastructure, and to make people aware of their HIV/AIDS status. Testing is done in a wider extent but a positive HIV/AIDS status is still

connected with a lot of **stigma and social discrimination** due to its association with prostitution and extra marital sexual relations (UNAIDS, 2007:9).

High prevalence rates have major **economic consequences**, both from a micro and macro perspective. Being infected with HIV/AIDS, or having to care for a sick family member, will cause **increased absenteeism** and the productivity of infected workers decrease since one's physical condition deteriorates and it becomes important to be close to medical facilities. His/her value to the employer will eventually be drastically reduced, who at some point might release the employee, when s/he no longer can be reassigned duties to allow for the circumstances (Fox et al., 2003:322). This will result in **lower household income** causing many children to prematurely have to **leave school to help generate income** resulting in current and future **loss of human capital**. Both production and consumption are affected by the epidemic and because income will have to be spent on treatment and medication instead of on other goods and services **consumption decreases** as well. The impact of HIV/AIDS on an economic macro level has widely been researched and its results are discussed as part of previous research.

In addition to economic consequences there are human, social and demographic consequences of the epidemic. The human and social consequences emerging from widespread death are **disruption of family and social community networks, increased child labour force participation and reduced school attendance to mention a few** (McDonald et al., 2005:229). Most demographic research has been focusing on consequences such as increased child and adult mortality. Other demographic consequences are reduced life expectancy, changed fertility patterns and an increased number of orphans (Bongaarts et al., 2000:55). Life expectancy fell from **62 in 1990-1995 to 48 in 2000-2005**, wiping out previous achievements in life expectancy, and some countries has reached life expectancy levels not seen since the beginning of 20th century Europe (Bonnel, 2000:3). The countries with the highest prevalence rates have life expectancies below 40 though there is great variation across sub Saharan countries, where the **highest and lowest life expectancies are slightly less than 40 years apart** (Bongaarts et al., 2000:115, UNECA, 2008:8).

In areas greatly affected by the virus there is evidence of changed fertility patterns among women infected with HIV, probably because they face direct increased risks of **miscarriage, induced abortion and stillbirths.** Gregson reports from a 1998 study that HIV infected **women have 25 to 40% lower fertility than non infected women** (Gregson et al., 1999:104). HIV positive women are also more likely to stop having children because of **vertical transmission** and **concern regarding orphaned** children. In addition to a change in behaviour, infected women face a lot of stigma and are often divorced by their husbands and with slim chances of remarriage their fertility decreases (Glynn et al., 2000:345, Gregson et al., 1999:112). In addition, **increased condom use**, as a response to measures taken to limit the spread of HIV, is also believed to moderate general fertility behaviour. Statistics show females are two to six times more likely to contract the virus than boys due to biological reasons, higher vulnerability to poverty, sex related labour, forced early marriage practice and gender based sex violence (UNECA, 2008:3, UNAIDS, 2008:30, UNICEF, Early Marriage: A Harmful Traditional Practice, 2005:2).

Lower fertility rates, high female mortality rates and a decreasing number of reproductive women at any one date in the future might in the short run lead to a negative population growth, while gdp in the short term might be fairly constant causing gdp per capita to increase in the short run. In the long run both gdp and population are decreasing reducing gdp per capita. With a reduced skilled labour supply and lack of human capital studies on African countries have estimated, not relying on the assumption that labour supply is unlimited, the 2025 population in sub Saharan Africa to be 30 percent lower than in a no AIDS scenario **reducing gdp per capita with eight percent annually until 2010** (Lovász et al., 2009:247).

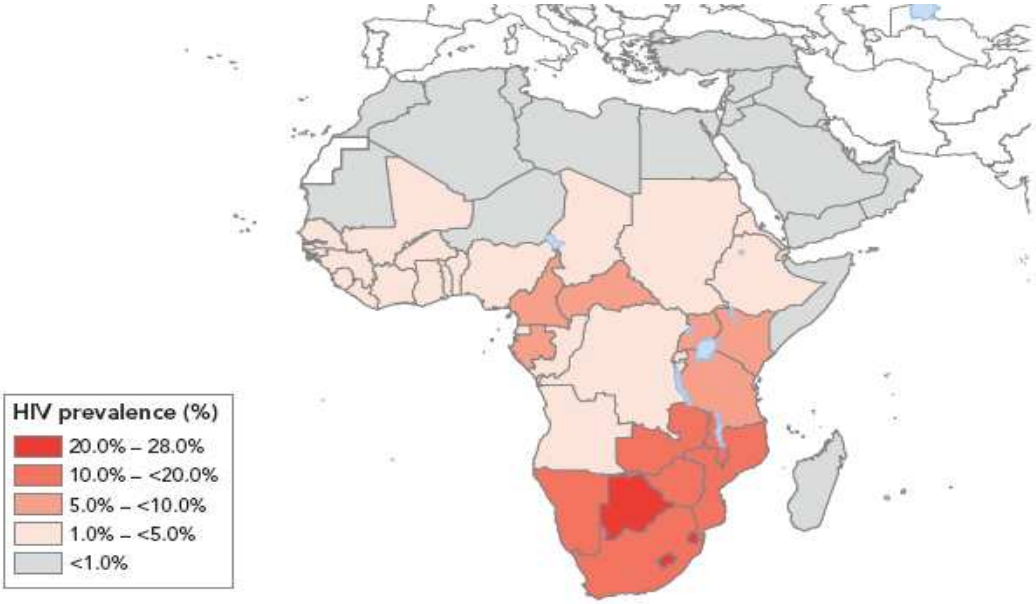

Figure 1 HIV prevalence rate in adults 15-49 in Africa 2007. Source: UNAIDS, 2008:39.

2.2 Prevention and treatment

Sub Saharan countries rely heavily on external funding from international donor organizations to fight HIV/AIDS with prevention, care and treatment activities. For prevention to be effective many different target groups must be included (World Bank, 2001:9). Studies from late 1990s indicate there was less money spent on HIV/AIDS prevention than on other health areas such as immunization, malaria and TB, though many new initiatives have sprung up over the last decade (Watts et al, 1999:1492). **Prevention activities include workplace interventions, reduced mother to child transfer, strengthening of blood transfusion systems, youth focused intervention, voluntary counseling and testing and campaigns regarding condom and STD awareness**. It is well established that the presence of STDs are linked to increased HIV/AIDS prevalence rates. Care and treatment include home based care, support for HIV orphans and HIV infected children, psychological support and antiretroviral treatments (World Bank, 2001:31). Since ARVs can't prevent the spread of the virus it is important to remember that prevention is an important part of the solution and to understand what the main drivers of the epidemic are. Prevention is very much tied in with access to information, distribution of condoms and to be able to reach people through campaigning. Abstinence, Be Faithful and Use Condoms (ABC) is probably the most well known awareness campaign over the last few years, though not successful in every country.

Whether in a high or low prevalence country prevention is equally important though the type and availability of prevention and treatment might differ between countries. The cost of prevention programmes and the interventions themselves are crucial to the success of reaching as many people as possible, and in addition it is often necessary to have the correct facilities and equipment to diagnose and monitor drug taking patients. The Trade Related Aspects of Intellectual Property Rights (**TRIPs) has made it possible for low income countries to negotiate prices of antiretroviral drugs** though they are still very expensive for ordinary citizens (Gaffeo, 2003:37). Increasing prevention, care and treatment is very costly but it is believed as the scale of **programmes increase, the average cost will be reduced** (World Bank, 2001:28). Whether focus is on prevention, care or treatment, cost will vary between countries depending on the initial situation of the programme and the cost of health personnel. It is sometimes difficult to estimate costs since care and treatment activities sometimes are overlapping. Yearly estimates regarding the costs for prevention, care and treatment each year between 2000 and 20005 and the strengths of HIV/AIDS country programmes are listed in in *Figure 2 and Figure 3*.

	Low Cost	**Medium Cost**
Prevention-related activities		
Youth focused interventions	211	313
Interventions focused on sex workers and clients	132	258
Condom social marketing	73	143
Increased public sector condom provision	12	35
Improving STD management	383	454
Voluntary counseling and testing	34	123
Workplace interventions (incl. military, truckers)	76	93
Blood safety measures	2	6
MTCT HIV	10	29
Mass media	93	99
Start-up capacity and development	8	9
Sub Total for Prevention	**1034**	**1562**
Care-related activities		
Palliative care	40	48
Clinical management of opportunistic infections	215	294
Prophylaxis for opportunistic infections	35	42
Home based care	25	79
Care for HIV infected infants	4	4
Support for orphans	162	267
Psychosocial support and counseling	2	4
Sub Total for Care	**483**	**738**

Figure 2 Annual cost of improving HIV/AIDS activities in sub Saharan African, in millions of dollars in 2000 prices. Adapted from the World Bank, 2001:34.

Very Low	**Low**	**Medium**	**Strong**
Angola	Benin	Botswana	Senegal
Congo	Burkina Faso	Cameroon	Uganda
DR Congo	Burundi	Central African Rep.	
Djibouti	Chad	Cote d'Ivoire	
Eritrea	*Equatorial Guinea*	Kenya	
Ethiopia	Gabon	Lesotho	
Liberia	Gambia	Malawi	
Nigeria	Ghana	Mauritania	
Sierra Leone	Guinea	Mozambique	
Somalia	Guinea Bissau	Tanzania	
	Madagaskar	Namibia	
	Mali	South Africa	
	Mauritius	Swaziland	
	Niger	Zambia	
	Rwanda	Zimbabwe	
	Togo		

Note: Estimates were not made for countries in italics.

Figure 3 Estimated Strength of HIV/AIDS programme activities by country. Adapted from the World Bank, 2001:22.

Many people who die in AIDS die from what is called opportunistic diseases and infections, such as TB, when the immune system is weak. HIV has the effect of destroying the human immune system which makes one very susceptible to infections and it is proven that TB actually accelerate the progress of HIV (World Bank, 2001:15). The status of AIDS is established when infections and illnesses are contracted but can't be fought off as under normal circumstances.

2.3 Limitations

This report does not include the whole range of risk factors present. Factors such as alcohol consumption, drug use, migration, the presence of STDs and malaria and the practice of circumcision are not included. These omitted variables could of course lead to unexpected results just as the lack of controlling for inter-country differences such as religion, language and culture can change the statistical output. As far as model limitations, the test for non-stationarity which could lead to spurious relationships between variables has not been conducted, and since the problem is not discussed in previous literature it will not be dealt with in this thesis. Another possible limitation regarding the model is multicollinearity between the variables. Even if multicollinearity would exist between the variables it is decided not to remove any variables since they are important to the analysis in question. Regarding the variables it is possible there are better proxies for what I intend to measure, but the variables have been chosen based on the availability of data.

3. Theoretical framework and hypotheses

This section discusses and reviews suggested theoretical relationships. The theoretical framework is based on economic theory and the assumption is that a democratic and peaceful nation, which looks after the well being of its citizens, is less likely to have high HIV/AIDS prevalence rates. Theory will be used to derive hypotheses regarding the relationship between eight chosen independent variables and HIV prevalence rates.

3.1 Socioeconomic variables

Within the field of economics it is established that risky behavior, such as **unsafe sex**, might be practiced by people who derive **little utility from their lives** and for those who face a lot of uncertainty regarding their future. This can be related to the gdp of a country, where citizens in a country with **high gdp** often have a decent standard of living with access to education, labour markets and **good health**, compared to individuals in a country with low gdp. Gdp is an index that can be associated with physical and mental well being and a certain standard of living. **Low income** countries often see high mortality, short life expectancy and great poverty where the citizens have great everyday struggles just to get by. In those circumstances physical wellbeing such as **access to health education, health care and safe sex** are often not priorities compared to other immediate problems, and unsafe and coerced sex is not seen as an extensive problem.

People who practice unsafe sex might argue the **likelihood of them still being alive** if and when they develop AIDS is rather slim, since the incubation period for HIV/AIDS can be up to a decade. This **uncertainty propels risk behaviour** and Philipson and Posner state that the shorter future life expectancy the lower the expected future cost of being infected and hence the **lower expected benefit of practicing safe sex** (Philipson et al., 1995:838). Another reason for individuals practicing unsafe sex could be the relatively **high prices of condoms** in relation to their disposable income. Condoms might simply be unaffordable.

Comparing low income countries with medium or high income countries, individuals in medium or high income countries are more **likely to access HIV/AIDS treatment and care**, which on the other hand might actually **increase their risk** taking (Philipson et al., 1995:837). It is reasonable to assume that with availability of treatment there will be an increased number of people prone to risk taking and there will be affluent people who want to engage in commercial sex. Research on the relationship between gdp levels and the spread of HIV/AIDS shows somewhat ambiguous results and sometimes produce different results depending on the country or region in question. According to **Bonnel** economic growth can either increase HIV, by increased labour migration and better infrastructure, or decrease HIV rates through education and employment. His research from **2000 shows that increased gdp levels increased African HIV rates just as Philipson and Posner suggest the same** correlation (Philipson et al., 1995:836). Hans Rosling shows evidence from Tanzania that HIV is more common among individuals with higher incomes, just as in medium to high income countries, such as South Africa and Botswana (Rosling, 2009). It is therefore hypothesized that as gdp levels increase so does HIV prevalence rates despite the fact that the epidemic is most advanced in low income countries where gdp is rather low.

Gender equality is also a factor possibly impacting prevalence rates. Female labour force **participation rates** are an indication of women's position in society and how much society values their skills and knowledge outside of the domestic sphere. If a larger proportion of females are in the official labour force it implies a certain level of economic security for women and they are less likely to resort to commercial sex work to make a living. Prostitution is often seen in countries with **great wealth inequalities between men and women** and between different socioeconomic groups and where a large majority of husbands are not able to support their families. The price for sex would in a situation with high female unemployment, as suggested by Philipson and Posner, be reduced creating higher frequencies of transmission and therefore greater numbers of HIV cases (Philipson et al., 1995:838). **The second proposed hypothesis is therefore that increased female labour force participation rates reduce HIV prevalence rates.**

Just as it is important to include all citizens in the labour force to contribute to economic growth human capital in the form of education is also seen as an important contributor to economic growth (Schultz, 1961:1). Human capital theory was developed by Gary Becker and Jacob Mincer and according to theory an individual's earnings is dependent on previous acquired human capital in the form of education and labour market experience. Therefore an individual who is well educated and have relevant work experience should be rewarded with a certain wage level, but in the situation of sub Saharan African countries much of the human capital has been wiped out. During the initial stage of the epidemic the majority of infected people were relatively well off Africans who contracted the virus through multiple sexual relations, since they had the means and resources to pay for sexual relations. **Today there has been a shift and the poor segments are equally, if not more, vulnerable to contract the virus** (Hargreaves et al. 2002:489).

It is well documented that increased human capital has a positive correlation with general health (Grossman, 1976:147, Lakhanpal et al., 2008:15). Educational investment gives people greater access to employment, higher wages and better opportunities to be economically independent making them less likely to live in poverty and resort to increased risk behavior. **It is difficult to find a clear convincing consistent pattern between educational attainment and HIV** in the sub Saharan region but research has shown that educated women and men tend to display different relationships with HIV. Female education also induces self awareness, respect and better access to information and in addition females are probably less of a risk taker than men with similar educational levels. Secondary enrollment rates act as a proxy for human capital and it is hypothesized **based on theory that increased enrollment in secondary school will decrease HIV prevalence rates.**

3.2 Demographic variables

Malthus believed that population growth would be hampered by **positive checks such as disease, famine and conflict**, with mortality historically being higher in more populous areas, such as in urban areas, often due to the rapid spread of disease and lacking hygienic measures (Lovett, 2008:462). In the initial stage of the HIV epidemic most cases were in urban areas but

today it is also affecting rural communities. **Departing from the idea that large populations** will be checked by disease it can be **deduced that nations with higher densities have a greater likelihood of disease** rates and hence higher HIV prevalence rates than countries with lower densities. Therefore the fourth **hypothesis states that increased population density increases HIV prevalence rates.**

Due to gains in child mortality and high fertility rates Africa has a very young age structure, where high fertility is more of a driving force of the young age structure than lowered child mortality rates. **In 2005 44% of the sub Saharan population was below the age of 15**, making it the youngest region in the world. There is no general consensus whether the epidemic has had an impact on the age structure or not but it has been suggested that HIV/AIDS has not had an impact on the average age structure and population sizes, except for in Botswana and Lesotho, since fertility rates are still above five (Ashford, 2007:2, Cohen, 2005). The assumption is that the larger number of sexually active young people, entering adulthood in an HIV/AIDS setting, the more weight should be put on the importance of reaching the young with education regarding preventative behavior. **Nearly half of all newly infected cases are in the age group 15-24 which speaks of lack of education, awareness and non risk averse behavior** (UNAIDS 2008, Cohen, 2005). Therefore, the fifth hypothesis states that a **higher proportion of the population aged under 15 will have an increasing effect** on HIV prevalence rates.

3.3 Political variables

Many countries affected by the epidemic have gone through political transitions, not necessarily routine transfers. From previous research it has been shown there is a relationship between HIV/AIDS rates and institutional settings, such as democracies and dictatorships (Bonnel, 2000:7). Important components of a democracy are popular selection of decision makers, protecting citizen's rights and the public's ability to address social and economic inequalities, just as a functioning lawmaking body. A regime which allows for people to have equal access to healthcare, information and education, also in regard to HIV/AIDS, and which acknowledges the epidemic **as a public health problem has a better chance to prevent the epidemic** from spreading. Hence, it is the willingness and openness of a government which matters (Ammann et al., 2002:185). The impact of the level of **openness** on the epidemic is supported by the case of **Uganda where the government actively has worked together with NGOs to market sex education, condoms and to reduce the stigma attached to infected people** (Gizelis, 2009:125).

It is argued among scholars that democracies are more responsive to HIV/AIDS and can be **more efficient regarding prevention and treatment since democratically elected representatives are depending on the public's vote to stay in power**. The argument is that institutional and political decisions influence the spread. Even though it is easier for wealthy countries to allocate resources for prevention it is still the willpower of the regime to tackle to problem which is decisive factor, and it is therefore expected that countries which have been slow to respond to the epidemic and to acknowledge its presence as a public health problem display high prevalence rates (Gizelis, 2009:124). A democratic nation often has to take all segments of society into consideration in decision making, improving living conditions and

health for all people which lead to the proposed hypothesis that democratic nations will display lower HIV/AIDS rates over time.

Internal conflict is often seen where there is strong opposition to a nation's majority rulers. In democratic societies where there is an opportunity for the citizens to belong to any party there is usually less civil unrest since inefficient governments can be replaced at the next election, compared to a society with a less democratic regime. Studies suggest that democratic nations are less likely to respond to disputes and opposition with violence, both on a national or international level (Benson et al., 1998:1970). Nations in conflict are often characterized by soldiers who use rape and violence against women as a weapon of war and this behaviour could be thought to lead to higher prevalence rates. Therefore, the proposed hypothesis states there is a positive correlation between prevalence rates and increased episodes of internal or international conflict.

3.4 Technological variables

It is important to measure the progress of infrastructure and technology since it demonstrates the level of interaction and communication between people in different parts of the country or the continent. The higher level of technology, infrastructure and communication present in a country the more people are likely to migrate and to be in contact with each other. The amount of paved roads, telecommunication and internet services can all be used to measure technology and infrastructure. **Technology and infrastructure are also very important in the fight against the epidemic since it would help the health system to be more efficient and to be more successful in distributing information, testing, treatment and care in the more remote rural population.**

The variable chosen as a proxy to measure the level of technology is the number of mobile phones present in each country. Other variables would be desirable but data limitations restrict the choice. When technology is present it represents development and increased mobility which leads to more people interacting at all times which increases the risks of being exposed to sexual activities. Therefore the hypothesis is that an increasing number of mobile phones would increase the HIV prevalence rates, though it is contrary to previous research.

3.5 Conclusion

Economic and political transitions often result in decreased social control, increased causal sexual relationships and decreased access to health care as displayed in *Figure 4*, which in turn might result in increased HIV rates and STDs. **Departing from Gorbach et al's theory** regarding a country in economic and political transition, which causes changes in social values, migration and often restructuring in the health system, it is possible to build upon this particular theory. Based on their work **I have expanded the theory to include the chosen variables but additional factors such as human rights, culture, traditions and the presence of TB or malaria** in the general population can hypothetically also be included, though excluded in this thesis (Presidential AIDS Advisory Panel Report, 2001:72).

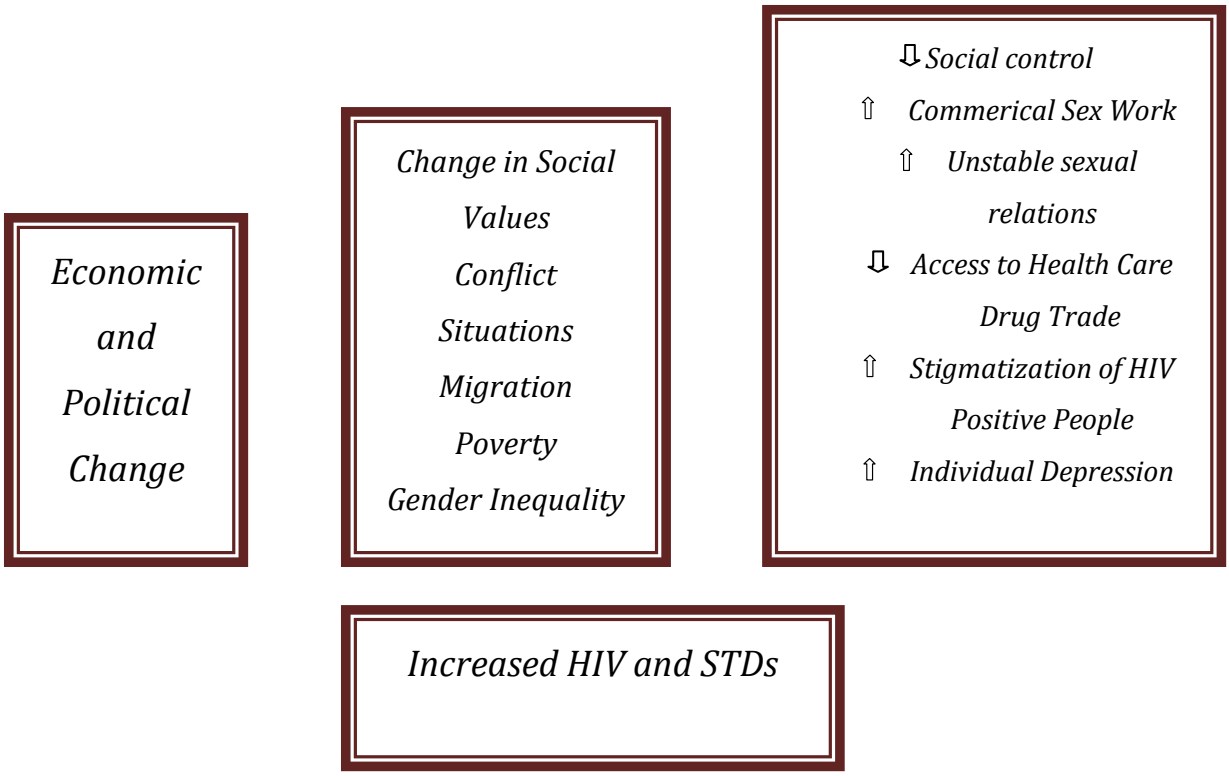

Figure 4 Social, economic and political forces impacting HIV prevalence rates. Adapted from Gorbach et al., 2002:37.

4. Previous research

Much of previous research focus on the effect HIV/AIDS has on political, social and economic spheres. However, the socioeconomic, demographic and political factors that might contribute to the increased spread of HIV/AIDS are seldom discussed in literature. This thesis puts weight on the factors possibly increasing the epidemic but also highlights the effects of the epidemic such as the impact on economic growth.

4.1 Macroeconomic research

HIV/AIDS is often analyzed and discussed as a determinant and less so as a dependent variable. In the **1980s and 1990s** the macroeconomic research on the economic impact of HIV/AIDS **showed minor negative consequences on the African economy**, but in the year 2000 Bonnel saw in his 1990-1997 cross-country comparison that the epidemic **reduced Africa's per capita** growth rate with **point seven percentage points**, which is rather significant, when the **growth in** a **no AIDS scenario** would have been **point four percentage points** (Bonnel, 2000:17). It was later established that the only scenario in which economic growth would not be negative is if external funding is available in large quantities to cover for increased government expenditure and the only African country to date to have been assigned a **positive economic growth due to the HIV epidemic is Botswana** (Lovász et al, 2009:245).

Over, Cuddington, Bloom and Mahal all concluded that the decline in economic growth due to the epidemic would be negligible compared to a no AIDS scenario, though **Bloom and Mahal did recognize that through decreasing life expectancy economic growth could eventually be affected** (Lovász et al., 2009:246). The **conclusion was drawn since not only gdp was reduced but also the population**. It is possible Malthus' framework, which describes how a reduced population can increase income per capita, influenced the early economic studies of the disease (Bonnel, 2000:2). Another possible explanation could be that the epidemic was in its early stages when many countries, with now well known high prevalence rates, were left out in analysis due to unavailable statistical data (Bonnel, 2000:3, Lovász et al., 2009:246, McDonald et al., 2005:230).

Many studies conducted after 2005 show that the epidemic has a substantial negative effect on the growth of gdp per capita. With the availability of better quantitative data and methods the number of studies on the macro economic implications of the epidemic has increased (McDonald et al., 2005:229). **Previous research by for example Barro et al, Sachs et al and Bloom et al have focused on the impact of HIV/AIDS on economic growth, democracy and other socioeconomic variables, establishing a picture of the devastation the disease has caused in all areas of society depleting human capital, productivity and personal incentives to invest in future education or job training** (Cuddington, 1993:174). The result is a reduced and less efficient workforce since healthy workers are more productive, less absent from work and physically and mentally stronger. In addition, the demand and consumption of goods change reducing production output.

How HIV is conceptualized will determine the response to the spread in the future. **Paxton** has examined the impact of economic transitions and gdp growth upon the spread of the disease and is one of the very few to bring up the problem of **intermediate factors causing a link between prevalence rates and rapid transitions. In his research from China he supports the idea that rapid economic growth actually propelled labour migration, acting as an intermediate mechanism, with increased opportunities for commercial sex.** He called for careful analysis in order not to draw quick conclusions regarding the relationship between rapid economic transitions and HIV rates (Paxton, 2009:4). When he analyzed 168 countries worldwide his **evidence showed no support of that rapid economic transition caused a direct increased spread** of the virus in any significant way. On the other hand **Bonnel** analyzed the impact of increasing gdp on HIV rates and he **found that an increased gdp seems to increase the HIV** rates in the developing countries surveyed (Bonnel, 2000:12).

In addition, Bonnel is one of the very few researchers who have examined the relationship between female labour force participation rates and HIV prevalence rates. Therefore my analysis will contribute to the knowledge pool of existing research and his findings of **declining HIV prevalence rates as the share of females in the labour force increases** is therefore fundamental to my hypothesis regarding this variable (Bonnel, 2000:11).

4.2 Social research

Just as studies show that macro economic performance is negatively affected by HIV/AIDS so is the access to education **(**Bonnel, 2000:4). Access to education is reduced because many teachers have died of AIDS, resulting in a shortage of teachers, and because school children are forced to drop out of school either to take care of sick parents or to prematurely join the labour force. **Reduced access to education** can lead to less information regarding the nature of the illness, how to protect oneself from the virus and also less incentive to protect oneself since reduced education decreases the opportunity cost of getting infected (Bonnel, 2000:9). Education raises the value in the labour force and therefore has a positive impact on health (Lakhanpal et al., 2008:15). Studies by Grossman, Wolfe and Zuvekas have shown that education has a strong positive correlation with health status since it increases the value of time and productivity while **Hargreaves' and Glynn's literature review of how educational attainment and HIV is related found that studies conducted before 1996 showed higher educational status was most often positively correlated with HIV** in Africa and in particular among the rural older cohorts (Lakhanpal et al., 2008:15, Hargreaves et al., 2002:491). Women are less likely to access education because of gender inequalities within cultural, institutional and social settings which makes them less likely to accumulate human capital and to be part of the economic labour market. Educational investment will give women higher wages and greater chances to become economically independent making them less likely to live in poverty and resort to prostitution and other activities increasing the likelihood of contracting HIV.

In addition, women are more likely to contract the virus because of biology **and gender based violence which prevent them from being in total control of their bodies, making their own decisions of when and whom to marry, deciding whether to engage in marital or non marital sexual activities and whether to use contraception** (UNAIDS, 2009:22, UNAIDS 2008:39). They are through sociocultural obstacles often shut out from participating in the economic market and hence become dependent on their husbands creating an unequal power balance, often the root to intimate partner violence. **Such an imbalance will strongly decrease a woman's ability to negotiate safe marital sex** and any refusal on her part will most likely result in the husband having extra marital sex or she is forced to have unsafe sex, increasing her risk to contract the virus. In 1994 at the International Conference on Population and Development in Cairo it was established and highlighted that violations of women's sexual and reproductive health and rights often are **causes of women's poor physical, mental and emotional well being which could result in higher probabilities of infection** (Germaine et al., 2009:843).

Female circumcision, or female genital mutilation, is also strongly considered a violation of women's human rights in addition to violation of their sexual and reproductive rights. Male circumcision is not considered a violation of their human rights for reasons that are outside the scope of this thesis. In **2007 WHO recognized that male circumcision is a good prevention strategy together with condom use to prevent the spread of HIV/AIDS and it is now part of prevention programmes** (Doyle et al., 2010:21, Peltzer et al., 2009:84). According to studies on male circumcision conducted in Botswana, Kenya and South Africa most men who belong to

an ethnic group which does not use circumcision as an initiation into manhood would go through with the procedure if it was free of charge. The understanding of circumcision as an important part in HIV prevention is today better understood and accepted even among tribes that traditionally don't practice circumcision (Kebaabetswe et al., 2003:215, Seppa, 2009:14).

4.3 Demographic research

West African women are regarded to have greater **economic and social freedom**, than their Eastern and Southern counterparts, where paternal family systems often are prevalent and women belong to the husband's family as soon as married. **West** African women are more often involved in the **local market trade** and they are therefore less likely to be involved in prostitution. In addition, there has been a tradition of a more balanced sex ratio in West African cities than in East and Southern African cities, where on average there used to be a higher proportion of males than females in the population (Caldwell et al., 1997:838). Just as the **sex ratio might influence the spread** of HIV it is possible that population density and the proportion of under 15 in the population have an effect on HIV rates. **Population density has proven to be a factor in explaining macro level mortality differences between countries** and although not often mentioned in the HIV/AIDS literature it might be good to examine its effect on the spread of the virus. Investigating ethnic groups within various African countries it was found that population density had a large impact on child death rates (Root, 1997:414). When different Zimbabwean ethnic groups were researched with **similar demographic, socioeconomic**, nutritional and cultural factors, the most notable variable affecting mortality rates was population density and it might be possible that density indeed could affect HIV prevalence rates.

It is also reasonable to believe that high density can be linked to a large number of young people in the population. Many sub Saharan countries display a large percentage of young people population where high rates of young girls and boys have their sexual debut, often coerced, before their 15th birthday as *Figure 5* shows. It is very unlikely that safe sex is practiced under these circumstances (Dixon-Mueller, 2009:101). In *Figure 5*, note the large differences between the percentage of boys and girls under the age of 15 who have had intercourse and the percentage of HIV positive females aged 15-24. **Other demographic factors possibly impacting prevalence rates are age at marriage and marriage traditions**. Men get married at later ages than women and they have often had many sex partners. After they get married some traditions in Western and Central Africa allow men to be in a polygynous marriage, less frequent in Eastern and Southern Africa, and it has been **suggested that when men have access to multiple wives the spread of the virus should decrease** (Caldwell et al., 1997:835). There are certain countries, such as **Mozambique, Angola, Uganda, Zaire and Zambia which display high HIV prevalence rates and low polygyny rates** which fit this theory but a number of studies propose the opposite (Reniers et al. 2008:1812). In addition, cultural practices, such as postpartum abstinence, can also deny men access to sexual activity and hence multiple wives could be a substitution for prostitution.

		Ever had intercourse		Two+ partners		HIV+ 15-24	
		Male	Fem.	Male	Fem.	Male	Fem.
Western Africa							
2005	Senegal	34.5	8.1	21.2	4.1	0.2	0.5
Eastern Africa							
2004	Zambia	45.2	29.1	26	23.3	8.1	20.9
2003	Kenya	45.1	23.3	-	-	6	15.6
2003	Uganda	29.4	14	16.1	6.2	2	4.6
	Rural	35.2	14.3	18.5	7.2	-	-
	Urban	25	13.8	14.3	5.5	-	-
	Zimbabwe	-	-	-	-	12.4	33
	Manicaland	28	9.6	22.2	8.6	-	-
	Harare City	17.5	3.9	9.9	1.7	-	-
2006	Tanzania	-	-	-	-	3.6	8.1
	Dar Es Salaam	14.9	3.8	10.9	2.8	-	-
Southern Africa							
2004	Namibia	37.9	18.8	20.4	8.9	11.1	24.2
2005	Botswana	26.9	10.3	15.5	5.8	16.1	37.5
2003	Swaziland	19.9	6.7	12.4	3	15.2	39.5

Figure 5 Percentages of males and females 13-15 year old students who have had sexual intercourse and more than one partner. Adapted from Dixon-Mueller, 2009:104.

4.4 Political research

Democratic and efficient governments are less likely to be involved in conflict, whether civil or ethnic unrest or international disputes. **Democratic governments seem to prefer to solve their problems with non violence and generally display less political instability** (Benson et al., 1998:197). It is believed by the international community that political instability and conflict might have an impact on the spread, and part of their aim is to prevent conflict by peace keeping and capacity building to help build stable African nations. In 2000 the UN agreed that conflict act as tool for HIV/AIDS which was reflected in UN Security Council Resolution 1308 and it was believed, and still is, that the quick spread of the virus in Uganda, South Africa and Cambodia was connected to their conflict situations (McInnes, 2006:325). Therefore, it might to some people seem rather reasonable to conclude that people in conflict situations, internally displaced persons (IDPs) and refugees, are at a higher risk of contracting the HIV virus after reports covering rampant sexual violence as a weapon of war in Rwanda, Liberia, Uganda, Somalia and the Democratic Republic of Congo. Studies by Gardiner, McGinn, Pharoah and the US Institute of Peace are among those who claim there is a direct link between conflict and increased HIV/AIDS transmission (Spiegel, 2004:324). An interesting claim by Gardiner is that women run six times the risk of contracting the virus in a refugee camp compared to outside of a camp. This claim is not in line with general opinions regarding health and safety in refugee camps which is often better than what is experienced outside of the refugee camps.

Speigel did not establish a direct link between increased HIV rates and conflict but instead raised the concern regarding data collected during the course of his study. In addition, he strongly believes the link between HIV and conflict to be indirect and via an intermediate causal

mechanism**, such as increased occurrence of rape, though he did realize the difficulty of tracking an accurate incidence of rape** (Paxton, 2009:3, Spiegel, 2007:323). There is a general assumption that HIV prevalence rates among soldiers and uniformed staff are higher than among the general population, especially in sub Saharan Africa where 50 percent higher prevalence rates have been quoted among the armed forces (McInnes, 2006:319). What has been firmly established in Siegel's study is that a population in a conflict setting is more vulnerable to rape than a population in a non conflict setting and hence the probability of contracting HIV increases in the population exposed to conflict. Initial prevalence rates also influence the vulnerability just as the duration of the conflict and whether you are inside or outside of a refugee camp. These factors are seen in *Figure 6.*

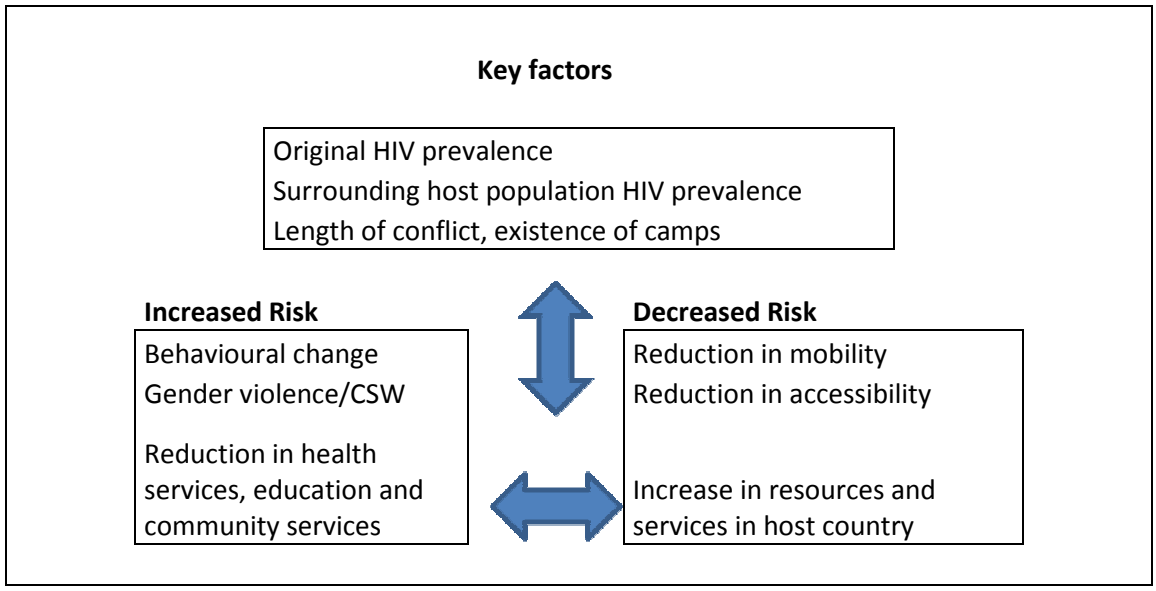

Figure 6 HIV risk factors for conflict. Adapted from Spiegel, 2004:325.

Much research points to the fact that the relationship between HIV prevalence rates and conflict is complex. Findings such as those of the **US Centre for Disease Control and Prevention in Southern Sudan, Sierra Leone and Angola, all with a long history of conflict, showed lower HIV prevalence rates among these countries** compared to neighboring conflict free countries (Spiegel, 2007:325). But what needs to be remembered is that these countries essentially display low prevalence rates and that the results might have looked different if they were high prevalence countries. Another study along the same lines, though very limited in its scope, examined the impact of the **1998-2000 Ethio-Eritrean war on the Tigray region in Ethiopia, where the majority of the military forces were stationed with a high presence of commercial sex work and refugees. When analyzing the HIV prevalence rates among the soldiers and the general population before, during and after the war no hard evidence of increased HIV prevalence rates among the two populations were displayed** (Berhe et al., 2002:1). This study is very limited in quality and quantity and will have to be viewed with skepticism in addition to recognizing that the war differed compared to many other African conflicts since the war was not characterized by the armed forces using rape as a weapon of war.

In addition to research regarding the link between conflict and HIV/AIDS there are studies regarding the impact of political transitions on the epidemic. Globalization brings new ideas and ideals which infiltrate changing societies as transitions often create temporarily weakened institutions. **Research from the former USSR, Cambodia, Western Balkans and China which all have experienced political transitions in a non democratic setting have displayed surging HIV prevalence rates. Unstable political environments create an opportunity for commercial sex work, linked with human trafficking, in a weakening labour market** (Gorbach, 2002:41). Political transitions often see health systems fall apart because of declining subsidies and increasing private health care, often only accessible to a small minority. South Africa is one country which has experienced both political and economic transition since 1994 and the statistics, 15 years after the new regime, show that poverty is extensive and HIV/AIDS is the norm rather than the exception. The rapid spread of HIV and high prevalence rates in South Africa was for a long time denied by the government as a public health problem which have worsened the conditions (Beall et al., 2005:6).

4.5 Technological research

Other factors to be considered within previous research are the level of technology and infrastructure available in a country. With improved infrastructure such as paved roads, mobile phones and internet communications there is greater chance for mobility and establishing connections in different parts of the country or the continent which could lead to heightened opportunities for the spread of HIV/AIDS. There has been an enormous increase in labour migration from rural to urban areas and movement because of conflict, facilitated by improved infrastructure and telecommunications. People migrate to urban regions and mining areas in search of a job and better services such as education and health services, which often results in unregulated settlements due to overcrowding causing increased risk of contracting the virus (Todaro, 1997:7). **Truck drivers and uniformed staff, almost exclusively men, are often among the high risk groups travelling on the roads while migrating women tend to get jobs that somehow, either directly or indirectly, are connected with commercial sex work. Bonnel found in his research that the natural log of the number of phones per capita was negatively correlated, and highly significant, with HIV/AIDS prevalence rates.** Since research regarding the relationship between HIV rates and technology is fairly infrequent it is important to further examine its impact on the spread of HIV/AIDS (Bonnel, 2000:11).

5. Data

This chapter is divided into four sections. The first part discusses the data sources used in analysis while the second section looks at the sample in question. The third section discusses the chosen variables, whose data sources are listed in *Figure 7* in the Appendix, in addition to the scatter plots which show how each variable change over time, presented in *Figure* 8 *to 17*. The fourth and final section presents descriptive statistics and correlation of the sample.

5.1 Data sources

All data comes from the World Bank's online database, the 2008 UNAIDS online HIV prevalence database and from the **Integrated Network for Societal Conflict Research online** database, more specifically the **Armed Conflict and Intervention Database** and the **Polity IV Regime Authority Characteristics and Transitions Database**. The two political datasets used were the Major Episode of Political Violence **1946-2004 (MEPV**) and the **Polity IV Annual Time Series 1800-2008** database which were produced and compiled by the Center for Systemic Peace in collaboration with George Mason University. The data is updated and cross checked as often as possible on a yearly basis and is considered reliable. The MEPV lists time series data on the level of national and international violence for each country, while the Polity IV dataset is ranking the degree of democracy in each country. The MEPV is a well respected trademark and part of the Polity IV Project.

The World Bank and UNAIDS collect and make available national and international statistics on economic and social factors for countries worldwide. With respect to source criticism it is necessary that all figures be regarded as estimates since they are gathered under difficult conditions. On the other hand, recent data collection and surveillance systems have greatly improved the quality, quantity and reliability of the estimates, especially in sub Saharan Africa, and **underreporting and over estimation are issues which have received increased attention by the international scientific community** (Ghys et al., 2008:2).

5.2 Sample

In the World Bank database there are 48 sub Saharan countries present while the **UNAIDS database only includes HIV prevalence rates for 45 sub Saharan countries.** Data is annual time series and **cover the period 1990-2007 for all variables except for the political violence index which ends in 2004**. Eight independent variables were chosen and the final sample used for analysis consists of time series data for 45 sub Saharan African countries. The sample is heterogeneous due to different economic, social, demographic and political settings in sub Saharan Africa and it consists of 270 observations where the vector $X_{i,t}$, for each country *i* during time period *t*, represents the chosen set of variables.

Because of data **randomly missing, the data set is referred to as an unbalanced panel**. The data is divided into **six time periods**, each with a three year range and consequently the data set is **short and wide** and **N>T** (Hill et al., 2008:383). Averages for each time period is created for all variables making it easier to spot trends in the data and reducing noise in the data.

5.3 Variable description

5.3.1 Dependent variable

HIV prevalence estimates (*hiv*)

HIV prevalence estimates, in percent, among 15-49 year olds are based on the actual number of people living with HIV/AIDS at the time of the survey, not those who have died. It is important to measure health status, not just the number of deaths, to approximate the number of people of working age living with HIV. HIV data collection sometimes vary slightly between high and low prevalence countries where **high prevalence countries, or countries with a generalized epidemic, use either population based surveys or make use of sentinel surveillance, often at antenatal clinics which sample pregnant women.** This might on the other hand **not be as representative as general population surveys. In low prevalence countries, or in countries where the epidemic is more concentrated, it is more common to conduct data collection among high risk groups such as commercial sex workers**, soldiers and migrating workers (UNAIDS, 2008:31).

Collected data is analyzed using the **Estimation and Projection Package (EEP) software**. It is practice to identify a rural and an urban epidemic before aggregate figures are produced to create national HIV estimates. A small number of studies have recently compared population based estimates and antenatal clinic surveillance estimates where the outcome shows that **ANC estimates were 0.25 times higher than survey based estimates** (Heaton et al., 2008:2). A steering committee, made up of academics and professionals, are continuously training epidemiologists on new methods, tools and assumptions to ensure that every country is consistent in their estimation (Ghys et al., 2008:2). Analyzing a larger segment of the population, such as 15-49 year olds, gives a more accurate picture of the current state of the epidemic rather than focusing on the prevalence rates of 15-24 year olds. The scatter plot of HIV, *Figure 8* in the Appendix, **reveals there was not yet a country with recorded prevalence rates over 20% in 1990-1992, but over time and with increased access to HIV testing prevalence rates increased.**

5.3.2 Independent variables

Gdp per capita (*gdp*)

Aggregate economic output is measured by gross domestic product per capita, in PPP constant 2005 international dollars, measuring the economic climate and general standard of living. In *Figure 9* it is noticeable that between **1990 and 1998 most countries had a gdp per capita below 5000, whereas afterwards there is a small and gradual increase for a few countries**.

Female labour force participation rates (*flfpr*)

Female labour force participation rates, as a percentage, among the female population 15-64, are used as a proxy for economic and gender equality. The variable indicates to what extent women

are integrated into the labour market and if they can be expected to support themselves and their families. It is generally believed that high female HIV rates are related to low women's social, economic and political status and that structural injustices in the form of elimination from participation in the labour force has serious consequences (Bonnel, 2000:8). **Over time, this variable seems to be fairly constant without much variation** as *Figure 11* shows.

Secondary enrollment in education (*edu*)

This variable measures to what extent the general population has access to secondary education and measures human capital. Secondary enrollment rates are good indicators of a country's priority for individual development and knowledge in order to boost competition, economic growth and productivity (Bloom et al, 2006:1). It is often believed that secondary education is a better indicator to capture human capital rather than primary or tertiary education, since primary education is too low of an educational level to escape poverty and tertiary education often is only accessed through wealth. **Enrollment rates are somewhat increasing over** time in *Figure 12*.

Density (*dens*)

Population density measures the number of people per square km and is sometimes used as an indicator of living standards. It is a variable not frequently used in HIV analysis. *Figure 13* shows that **density increases slightly over time** which is an interesting observation considering the amount of people who have died in AIDS.

Proportion of population under 15 (*under_15*)

This variables measures the population aged 0-14, as a percent of the total population, accounting for the very young. Over time, **the variable shows slightly fluctuating minimum values and it is observed that the maximum values never climb above 50%.** The variable has to my knowledge not been used in previous HIV research, which provides me with the opportunity to bring more information regarding its impact on HIV. *Figure 14* shows a positive though rather weak correlation between the variable and HIV prevalence rates.

Major Episodes of Political Violence (Polity IV) (*confl*)

The MEPV index is based on conflicts that resulted in more than **500 causalities per episode** and it is annual time series data from the Center for Systematic Peace. The conflict variable measures the level of instability **and registers seven types of armed conflict**. The categories are **international violence and war, international independence war, civil violence and war and ethnic violence and war. The magnitude of conflict, involving a particular state, ranges between 0 and 10 where 0 denotes no episode of instability**. The index is determined by when **conflict arises, how long it lasts, if organized by groups, degree of military involvement, whether technology is involved and if infrastructure and human resources are destroyed.** When more than one episode of a particular kind occurs in a year the scores are added

(Marshall, MEPV Codebook). *Figure 15* in the Appendix shows that in period 5, 2002-2004, there were less severe episodes of conflict than in previous time periods.

Democracy (*demo*)

The official name of this variable is POLITY2 and it is indexed from -10 to 10, with -10 representing strong autocracy and 10 strong democracy, taking into consideration transition periods that can be present in politics. In addition, **the index also considers procedures for citizens to elect new leaders, institutional constraints on how power is exercised by the executives and what sort of civil liberties that are present** (Marshall et al, 2009). After conflicts in the Former Republic of Yugoslavia, Rwanda, Sudan, Sierra Leone and the Republic of Congo, just to mention a few nations, UNICEF believes that armed conflict fuels the spread of HIV through rape as a weapon of war, commercial sex, displacement, lack of information and communication (UNICEF, 2003:2). This variable is often used in political science but less often in social or economic research and hence it is important to see how it relates with HIV and the other variables. *Figure 16* indicates there are a similar number of countries with a negative index as with a positive index.

Mobile phone subscriptions *(users)*

This variable is intended to be a proxy for mobility and level of infrastructure within a country. It measures the number of mobile phone users in each country each year. *Figure 17* shows a slight increase in the number of mobile phones over time.

5.4 Descriptive statistics and correlation

HIV prevalence rates, gdp per capita, female labour force participation rates, secondary enrollment, density and the number of mobile phone users have large differences between their min and max values. It indicates how different the sub Saharan countries are from a socioeconomic, demographic, political and technological perspective. The correlation matrix gives us an indication as to the degree of covariation between the variables and HIV is most correlated with education, gdp and democracy. **The negative correlations between gdp per capita and female labour force participation rates and between gdp per capita and the number of mobile phone users are unexpected, just as the negative relationships between education and female labour force participation.** However, many relationships behave according to what would be theoretically expected. Gdp per capita displays correlations with democracy, conflict, density and the percentage of young people in the population that are theoretically reasonable. However, relationships that are more difficult to explain are those involving female labour force participation rates. *Figure 18* and *Figure 19* presents the descriptive results.

Variable	Obs	Mean	Std. Dev.	Min	Max
hiv	270	4.98679	6.467222	0.1	28.7
gdp	252	2279.484	3398.918	170.7733	26020.78
flfpr	264	61.49015	15.22978	24.3	91.06662
edu	242	27.31634	19.11503	5.112545	94.13851
dens	264	69.28903	104.5108	1.784477	616.9018
under 15	264	43.50151	3.889486	24.24329	49.62346
demo	269	0.013637	5.295049	-10	10
confl	214	4.957165	5.117743	0	24.6667
users	264	2.6*10^15	4.17*10^16	2.02*10^10	6.77*10^17

Table 18 Descriptive statistics of sample.

Obs 186	hiv	gdp	flfpr	edu	dens	under 15	demo	confl	users
hiv	1								
gdp	0.28	1							
flfpr	0.1154	-0.3348	1						
edu	0.3905	0.7095	-0.3823	1					
dens	-0.1267	0.1234	0.0785	0.2271	1				
under 15	-0.0915	0.5656	0.3645	-0.7107	0.4951	1			
demo	0.1819	0.2127	-0.1853	0.3851	0.1834	-0.4582	1		
confl	-0.0432	-0.2856	0.0747	-0.2561	-0.2140	0.384	-0.2384	1	
users	0.128	-0.0756	-0.0006	-0.0784	-0.0895	0.1525	-0.0525	0.1146	1

Figure 19 Correlation coefficients of the sample.

By creating scatter plots, presented in *Figures 18 to 26* in the Appendix, the relationships between HIV prevalence rates and the independent variables are examined. Taking all variables into consideration, except for gdp per capita and mobile phone users which will be logged, no evidence was found to support the presence of nonlinear relationships and only a few outliers were present among the variables *hiv, gdp, dens, under_15* and *ln_users.*

6. Methodology

The variables are classified into four groups and analyzed in four separate regressions to examine if **they ought to be included in the final model, whether non linearity is present and to indicate what type of model to use.** This is done by creating four partial regressions labelled (Eq1), (Eq2), (Eq3) and (Eq4), representing socioeconomic, demographic, political and

technological models. Both fixed effects models and random effects models are run in addition to the Hausman test. This procedure is also repeated for the full model specification, (Eq5) and (Eq6), where the difference between (Eq5) and (Eq6) is that the latter includes lagged variables. The methodology section presents a discussion on the empirical model.

6.1 Empirical model

The OLS regression model is not applicable since it assumes that all countries have **identical estimates for all time periods**, that is, it assumes that the constants and coefficient estimates are fixed for all countries over all time periods. Therefore it will be necessary to opt either for the fixed effects model or the random effects model, since the **assumption is that all the countries display different constants** (Hill et al., 2008:385). The fixed effects model accounts for variables that can't be measured, or have been omitted, but does not control for time varying variables. In the fixed effects model the constant adjusts for unobserved factors which might vary between countries, though not within countries, while the parameters are fixed across countries and time (Hill et al., 2008:391). The generic fixed effects model is written as $y_{it} = \alpha_i + \beta_1 x_{1it} + \beta_2 x_{2it} + ...\varepsilon_{it}$ where the **constant only varies across countries, not over time**. It is assumed that each **ε_{it} which is the random variation for each country in each time period has zero mean, constant variance and is statistically independent of all the x_{it}.** Hence, in a fixed effects model the **unobserved country differences are taken up by the different country intercepts** while in a random effects model it is assumed that a portion of the unobserved country effects are random and not fixed. In other words, a random effects model assumes that the **intercept is a random variable that is a function of a mean value plus a random error, which must be uncorrelated with the error terms of the variables.**

The Hausman test, shown in *Figure 27* in the Appendix, conducted on (**Eq5) indicates that** H_0, which says there is a significant difference between the random and fixed effects estimators, should be rejected, and technically a **fixed effects model can be chosen**. Before the Hausman test is conducted **on (Eq6), a test for joint significance**, in *Figure 28*, is run to examine whether to include the time period dummy variables in (Eq6). The test indicates that it is not necessary to include the dummies. The **Wooldridge test for autocorrelation in panel data, to examine if error terms at time *t* are correlated with error terms in at time *t-1*** or *t+1,* is also performed before the Hausman test. The Wooldridge test shows that the null **hypothesis of no first order** correlation is **rejected. Consequences of autocorrelation are similar to heteroskedasticity** which is common in cross-country panel data, and therefore **robust estimators** are used in the regressions to compensate for such shortcomings (Hill, 2008:200). The Hausman test conducted on (Eq6) indicates a difference between the **estimates that is not systematic and a random effects model should be chosen.** However, it is decided to show regression results for both the fixed and the random effects models for comparison.

In (Eq6) the variables gdp per capita, education and density are lagged to **prevent the possibility of reverse causality** with HIV prevalence since research has proven that HIV has an impact on economic growth and education. In addition it is believed that these variables lagged will have a greater impact on current HIV rates than the variables at current time (Lakhanpal et al., 2008:16). The **density variable is lagged since it is assumed that as people succumb to**

AIDS the density is reduced over time which possibly could lead to less people being infected with HIV in the future.

7. Empirical analysis

Before presenting regression results of (Eq5) and (Eq6) regression results of the partial models are presented in section one, with STATA outputs presented in the Appendix, *Figures 29 to 32*. The second section presents a variable discussion and a comparison of the different regression results, including (Eq5) and (Eq6). All regressions are run using both the fixed and the random effects model with robust standard errors. Regression results for (Eq5) and (Eq6) are shown in *Figure 33 to 34*.

7.1 Statistical results

7.1.1 Partial models

$hiv_{it} = \alpha_i + \beta_1(ln\_gdp)_{it} + \beta_2(flfpr)_{it} + \beta_3(edu)_{it} + \varepsilon_{it}$ socioeconomic regression (Eq1)

$hiv_{it} = \alpha_i + \beta_4(dens)_{it} + \beta_5(under\_15)_{it} + \varepsilon_{it}$ demographic regression (Eq2)

$hiv_{it} = \alpha_i + \beta_6(demo)_{it} + \beta_7(confl)_{it} + \varepsilon_{it}$ political regression (Eq3)

$hiv_{it} = \alpha_i + \beta_8(ln\_users)_{it} + \varepsilon_{it}$ technological regression (Eq4)

In the random effects model all variables in (Eq1) show a positive relationship with HIV, with *flfpr* and *edu* significant at the 1% level. In the fixed effects model all variables but *flfpr* have a positive relationship with HIV and its coefficient is very weak and not significant. The **coefficient for *ln_gdp* is more than twice as large in the fixed effects model compared to the random effects** model, though only significant at the 10% level. **Only the fixed effects model displays results in line with the relevant proposed hypotheses.** All coefficients, except for the *flfpr* in the fixed effects model, are significant, either at the 1, 5 or 10% level. The Hausman test shows it is not possible to reject the hypothesis that the estimates of fixed and random effects models are significantly different and hence the random fixed effects model should be used. In the fixed effects model R-square is 0.100 and in the random effects model the overall R-square is 0.24.

Among all partial models, (Eq2) shows the highest R-squared at 0.291. Both the *dens* and *under_15* variables show a **negative relationship with HIV rates, which was not expected**, and the density variable is twice as large in the fixed effects model as in the random effects model. In addition, the coefficient for *under_15* is larger than the *dens* coefficient. Both variables are significant at the 1% level in the fixed and random effects models and therefore it is reasonable to believe they all have a significant relationship with HIV prevalence rates. The Hausman test shows that it is possible to reject the hypothesis that there is a significant difference between the estimates at the 10% level and a fixed effects model should be preferred.

(Eq3) shows that the conflict and democracy variables have the same relationship with HIV in the fixed effects model as in the random effects model. **Conflict has a negative relationship with HIV, not supporting my hypothesis** regarding a positive relationship, while **democracy has a positive relationship with HIV, supporting previous research though not my hypothesis**. The conflict coefficient is larger in size than the democracy coefficient. All coefficients except for the democracy variable in the fixed effects model are significant at the 1% level. There is a large difference between the R-squares in the fixed and random effects model. The Hausman test shows that we cannot reject the hypothesis regarding a significant difference between the fixed and random effects estimates. The last equation, **(Eq4), displays a positive relationship between the number of mobile phone users and HIV, as proposed by the hypothesis,** but the coefficients are not significant for either model. The Hausman test shows it is not possible to reject a significant difference between the estimates of the two models.

Partial Models	*(Eq1) fe*	*(Eq1) re*	*(Eq2) fe*	*(Eq2) re*	*(Eq3) fe*	*(Eq3) re*	*(Eq4) fe*	*(Eq4) re*
ln_gdp	*4.042** (2.077)	*1.549** (0.806)						
flfpr	*-0.019 (0.182)*	*0.111*** (0.033)*						
edu	*0.095** (0.040)*	*0.108*** (0.030)*						
dens			*-0.070*** (0.016)*	*-0.034*** (0.007)*				
under_15			*-1.330*** (0.2338)*	*-1.038*** (0.179)*				
demo					*0.220** (0.087)*	*0.212*** (0.072)*		
confl					*-0.665*** (0.158)*	*-0.488*** (0.120)*		
ln_users							*0.197 (0.295)*	*0.154 (0.1663)*
constant	*-25.323** (11.117)*	*-16.056*** (5.591)*	*67.744*** (11.131)*	*52.582*** (8.139)*	*8.370*** (0.781)*	*7.486*** (1.202)*	*-0.771 (8.733)*	*0.493 (5.341)*
Nr countries	42	42	**44**	44	43	43	44	44
Observations	233	233	264	264	214	214	264	*264*
R-squared within	0.1		0.291		0.255		0.006	
R-squared overall		0.2407		0.058		0.0061		0.0001

***significant at 1%, **significant at 5%, *significant at 10%. Robust Standard Errors in parenthesis.

Figure 33 Partial Regressions Output, Fixed and Random effects model. Source: STATA.

7.1.2 Full models

The difference between (Eq5) and (Eq6) is that (Eq6) includes three lagged variables. As the test for joint significance of time period dummies indicates they don't need to form part of the model they are excluded. It is decided that (Eq6) is the final model and the differences between the estimates of the fixed and random effects model in (Eq6) are not consistent and the random effects model is therefore the preferred model. Regressions are shown in *Figure 34*.

$hiv_{it} = \alpha_i + \beta_1(ln\_gdp)_{it} + \beta_2(flfpr)_{it} + \beta_3(edu)_{it} + \beta_4(dens)_{it} + \beta_5(under\_15)_{it} + \beta_6(demo)_{it} + \beta_7(confl)_{it} + \beta_8(ln\_users)_{it} + \varepsilon_{it}$ (Eq5)

$hiv_{it} = \alpha_i + \beta_1(L.ln\_gdp)_{it} + \beta_2(flfpr)_{it} + \beta_3(L.edu)_{it} + \beta_4(L.dens)_{it} + \beta_5(under\_15)_{it} + \beta_6(demo)_{it} + \beta_7(confl)_{it} + \beta_8(\ln\_users)_{it} + \varepsilon_{it}$ (Eq6)

Focusing on the **random effects model in (Eq5), all variables except for *ln_gdp*, *edu* and *ln_users* were significant, where *flfpr, dens* and *under_15* were significant at the 1% level.** In the fixed effects model only *dens, under_15* and *confl* were significant, and that at the 1% level. The coefficients in the fixed effects model are generally larger than in the random effects model. **R-squared within in the fixed effects model is 52.5% suggesting that the independent variables account for 52% of the variation in HIV prevalence compared to the overall R-squared in the random effects model which is 14.52%.** The model chosen to be the final model, (Eq6), with the variables *ln_gdp, edu* and *dens* lagged, displays an R-square of 0.3595 and 0.2237 respectively, for the fixed effects model and the random effects model.

Full models	*(Eq5) fe*	*(Eq5) re*	*(Eq6) fe*	*(Eq6) re*
ln_gdp	*1.373* *(1.558)*	*0.035* *(0.870)*		
flfpr	*0.240* *(0.147)*	*0.189**** *(0.040)*	*0.262* *(0.211)*	*0.175* *****(0.041)*
edu	*0.002* *(0.059)*	*0.060* *(0.049)*		
dens	*-0.086**** *(0.018)*	*-0.033**** *(0.007)*		
under_15	*-1.559**** *(0.278)*	*-0.869**** *(0.245)*	*-1.179 **** *(0.375)*	*-0.691*** *(0.292)*
demo	*0.121* *(0.105)*	*0.138** *(0.081)*	*-0.062* *(0.078)*	*-0.026* *(0.072)*
confl	*-0.491**** *(0.149)*	*-0.293*** *(0.116)*	*-0.293 *** *(0.142)*	*-0.128* *(0.091)*
ln_users	*0.237* *(0.299)*	*0.115* *(0.225)*	*-0.012* *(0.201)*	*-0.055* *(0.203)*
constant	*50.39**** *(18.821)*	*29.826*** *(13.598)*	*42.729* *(28.451)*	*27.312* *(17.207)*
L.ln_gdp			*0.364* *(1.652)*	*-0.163* *(0.997)*
L.edu			*0.064* *(0.057)*	*0.118*** *(0.05)*
L.dens			*-0.062**** *(0.228)*	-0.030*** (0.009)
Nr countries	*186*	*186*	*152*	*152*
Observations	*40*	*40*	*40*	*40*
R-squared within	*0.525*		*0.3539*	
R-squared overall		*0.1452*		0.2237

***significant at 1%, **significant at 5%, *significant at 10%. Robust Standard Errors in parenthesis.

Figure 34 Full regression outputs. Source: STATA.

There are **two noteworthy differences to point out regarding the regression result between (Eq5) and (Eq6). Firstly, the variables *demo* and *ln_users* have in (Eq6) acquired negative signs, compared to the positive signs in (Eq5) which reflects previous research**. **Secondly, *L.ln_gdp* has a negative coefficient in (Eq6)'s random effects model, which contradicts all previous research.** In addition, in (Eq6) there are four significant variables in the random effects model compared to three significant variables in the fixed effects model. In the fixed effects model the significant estimates are those for *L.dens, under_15, confl* and *L.dens.* In the random effects model *flfpr, under_15, L.edu and L.dens* are significant, making *under_15* and *L.dens* the significant variables in common.

7.2 Variable discussion

Neither *ln_gdp* nor *L.ln_gdp* is significant in (Eq5) or (Eq6). This is unexpected but at least the coefficient for *L.ln_gdp* is larger than for *ln_gdp* which supports our expectations of lagging the variable. **In both (Eq5) and (Eq6) the relationship between gdp and HIV is fairly weak one,** though mainly positive as both theory and the hypothesis predicted. Since the **random effects model in (Eq6) displays a negative coefficient for *L.ln_gdp* the proposed hypothesis is rejected contradicting previous research by Bonnel, Philipson et al and Rosling**.

The lagged educational variable *L.edu* is more difficult to evaluate since we are looking at a **generic variable measuring the overall percentage of men and women** with secondary education. It is very likely the variable does **not take into consideration that more men than women possibly are educated and higher educational enrollment is probably accounted for by men.** Hence, the correlation between HIV and educational enrollment in (Eq5) is rather weak while the **random effects model in (Eq6) displays the largest and the only significant coefficient for the education variable.** According to the random effects result in (Eq6) the **proposed hypothesis of a negative relationship between education and HIV is therefore rejected** and indeed the results support previous analytical research of a positive relationship. It might be explained by that **increased educational enrollment is strongly correlated to gdp**, as seen in the descriptive statistics, **which is related to increased HIV rates.**

A similar explanation might also be applicable to understand the positive relationship between HIV and female labour force participation rates. (Eq5) and (Eq6) both display positive coefficients for the *flfpr* variable, but only the random effects model coefficients are significant, and that at the 1% level, a similar pattern seen in the partial random effects model. Therefore, the **proposed hypothesis regarding a negative relationship between HIV and *flfp*r found by Bonnel is rejected.**

The variable *under_15* displays a **negative relationship with HIV in the random effects** model in (Eq6) which is unexpected compared to previous research, **though generally only weak relationships were found.** However, the coefficients in (Eq6) are significant at the 1 and 5% significance level. The **proposed hypothesis that an increase in the population of people**

aged 15 or younger will increase HIV rates is therefore rejected. Lagging the variable does not change the relationship. However, the second demographic variable, the density variable was lagged in (Eq6). Since not much research has been done on this variable it is necessary to take precaution in evaluation. **A one unit increase in *L.dens* decreases the HIV prevalence rate in the random effects model with 0.03%** and the coefficient is significant at the 1% level, similarly as in (Eq5). The **hypothesis that increased density will increase HIV rates is therefore rejected.** A reason for this might be because of that **the number of people with which the population increases is in the lower age groups, and as seen in the regressions, *under_15*, does not have a positive relationship with HIV.** That could be one plausible explanation as the correlation between the two variables is fairly strong according to the correlation coefficient.

The next set of variables is the political variables. In (Eq1) to (Eq5) the democracy variable has displayed a positive relationship with HIV while **both models in (Eq6) display a negative coefficient for the democracy variable. This serves as the basis for not rejecting the hypothesis, confirming previous studies by Bonnel, that an increase in democracy decreases the HIV prevalence rates. T**he coefficient is however rather weak and not significant. The conflict variable follows findings by US Institute of Peace and that an increase in **conflict is related with a decrease in HIV prevalence rates compared to a situation in which conflict did not occur.** Paxton propose the idea that HIV infected people are more vulnerable in conflict since health care is limited and they might not be as likely as non infected people to escape conflict which means they might have a higher probability of death, reducing the ration of number of HIV infected in the total population (Paxton, 2009:17). The proposed **hypothesis that conflict will increase HIV rates must then be rejected.**

Ln_user is the last variable to be discussed. **As the number of mobile phones increase there is a decrease in HIV prevalence rates in (Eq6) verifying previous research by Bonnel**. The coefficients are not significant for (Eq1) to (Eq6), dissimilar from Bonnel's research, though the sizes of the coefficients are rather small. As a result the **proposed hypothesis is rejected** because of the negative sign in the random effects model in (Eq6).

Variables	Relation with HIV	Results support previous research	Hypothesis rejected
L.ln_gdp	-		√
L.edu	+	√	√
flfpr	+		√
L.dens	-		√
under_15	+		√
demo	-	√	
confl	-	√	√
ln_users	-	√	√

Figure 35 Results compared with previous research.

8. Conclusion

The aim of the thesis was to examine possible factors regarding the spread of HIV/AIDS in sub Saharan Africa. The hypotheses were not complicated and overall the analysis has displayed the expected results according to previous research. Four out of eight variables show results that are in line with previous research, using the random effects model in (Eq6) as the reference equation, and seven out of the eight theory based hypotheses were rejected. A reason for this is that in quite a few cases it was decided to focus on theory and not on what previous research necessarily has shown. It seems reasonable to suggest that this type of analysis should be conducted on country level data since there are country differences such as religion, culture and languages which could be limiting the analysis and making it difficult to draw conclusions as some of the analysis show. Results revealed slightly weak explanatory power of the chosen variables and omitted variables such as male circumcision, the level of multiple sex partners in a marriage, migration and religion can in addition contribute to the spread. The most interesting findings are that female labour force participation rates are positively correlated with HIV rates and the negative relationship between HIV and density which further need to be researched.

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Appendix

hiv	http://data.unaids.org/pub
gdp	http://ddp-ext.worldbank.org/ext/DDPQQ/member
flfpr	http://ddp-ext.worldbank.org/ext/DDPQQ/member
edu	http://ddp-ext.worldbank.org/ext/DDPQQ/member
dens	http://ddp-ext.worldbank.org/ext/DDPQQ/member
under_15	http://ddp-ext.worldbank.org/ext/DDPQQ/member
demo	http://www.systemicpeace.org/inscr/inscr.htm
confl	http://www.systemicpeace.org/inscr/inscr.htm
users	http://ddp-ext.worldbank.org/ext/DDPQQ/member

Figure 7 Data sources.

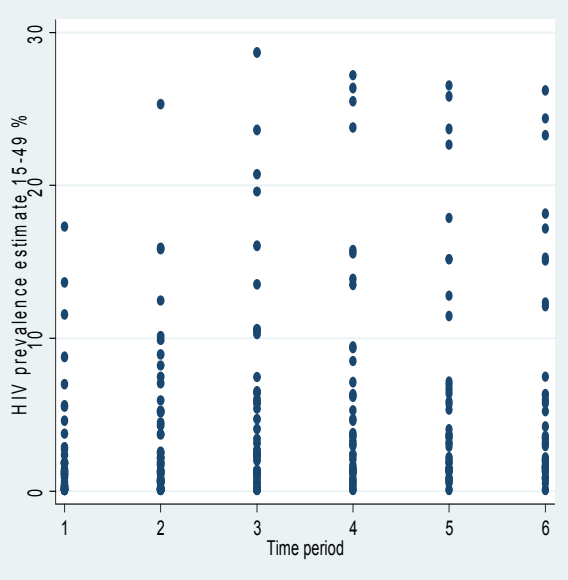

Figure 8 HIV over time.

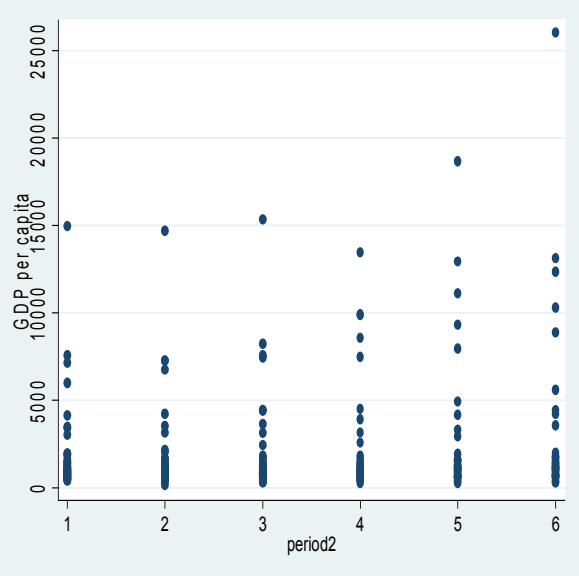

Figure 9 GDP over time.

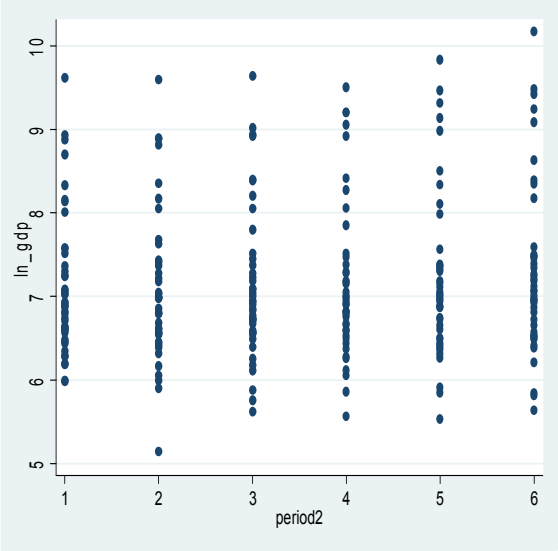

Figure 10 Ln_gdp over time.

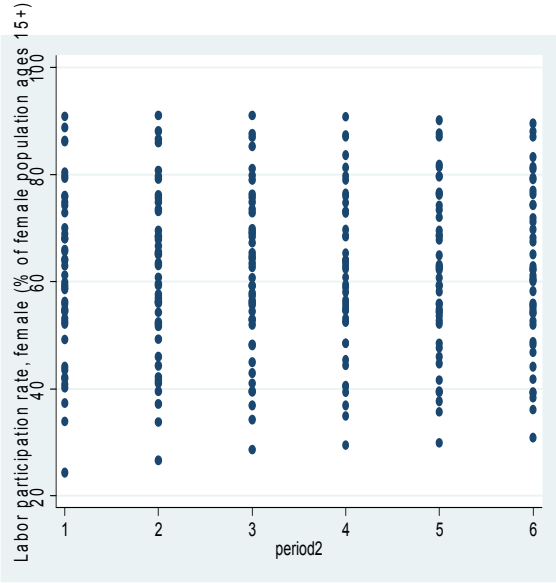

Figure 11 Flfpr over time.

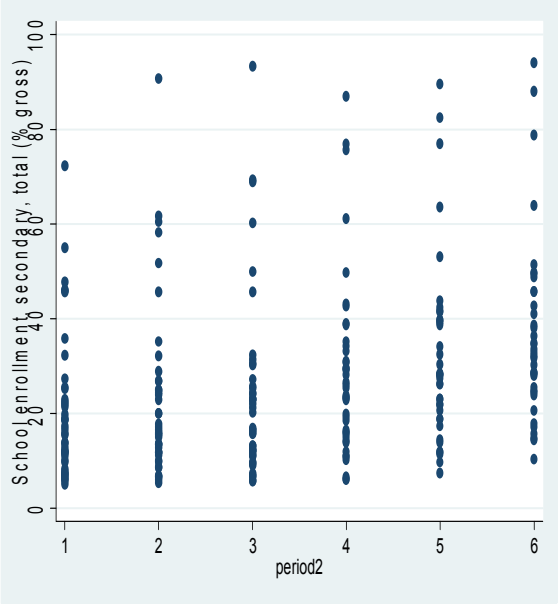

Figure 12 Secondary Enrollment over time.

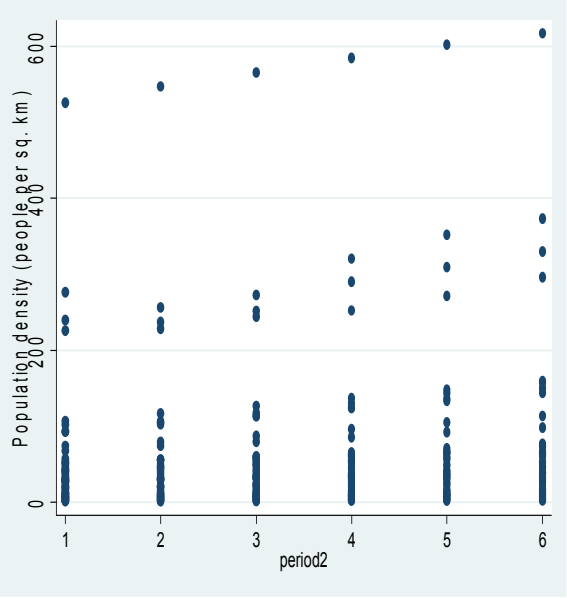

Figure 13 Density over time.

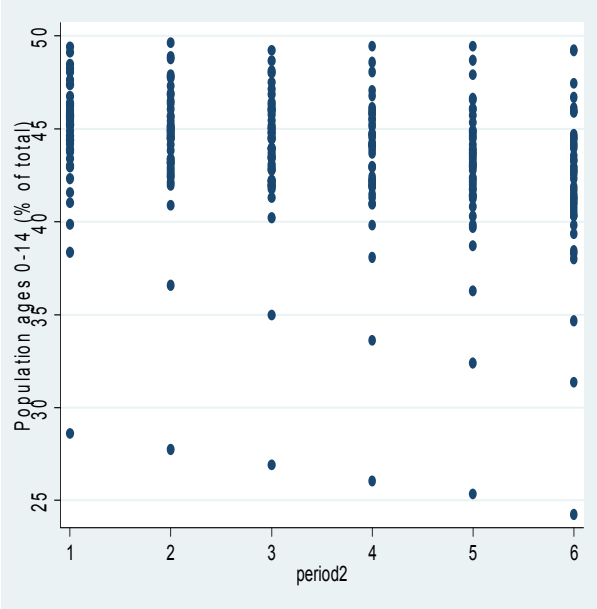

Figure 14 Population under 15 over time.

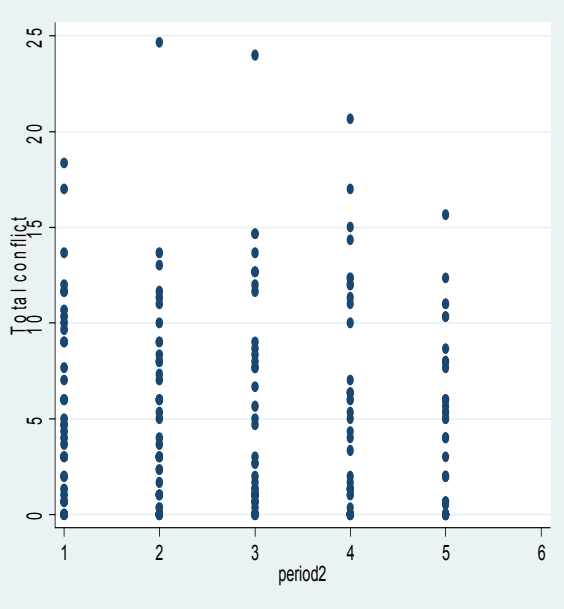

Figure 15 Conflict over time.

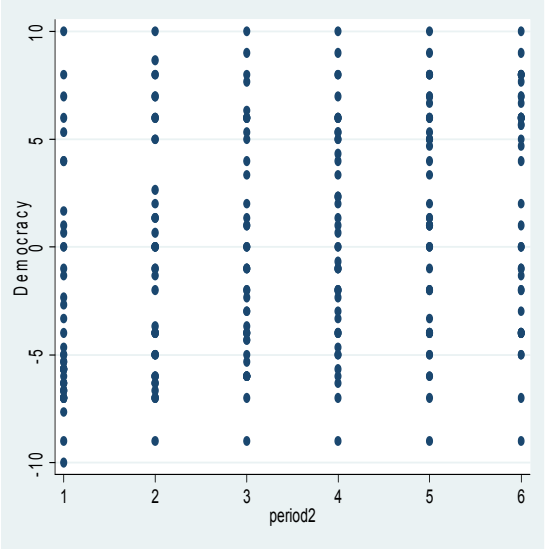

Figure 16 Democracy over time.

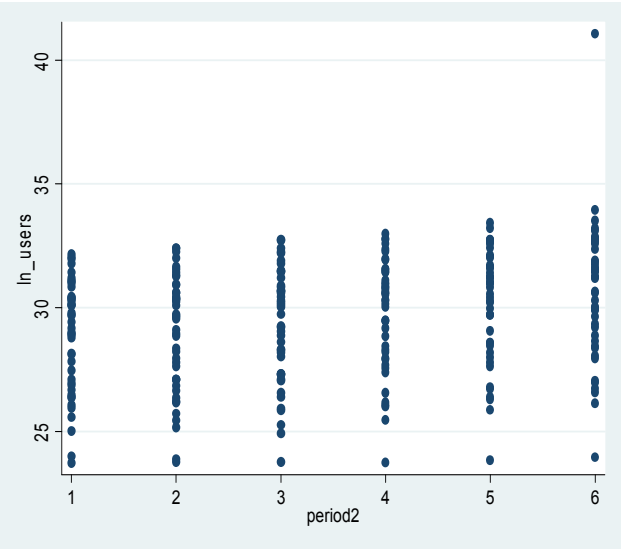

Figure 17 Ln_users over time.

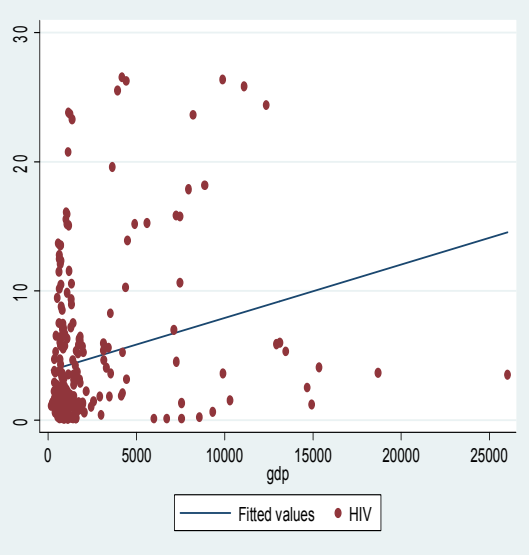

Figure 18 GDP per capita and HIV.

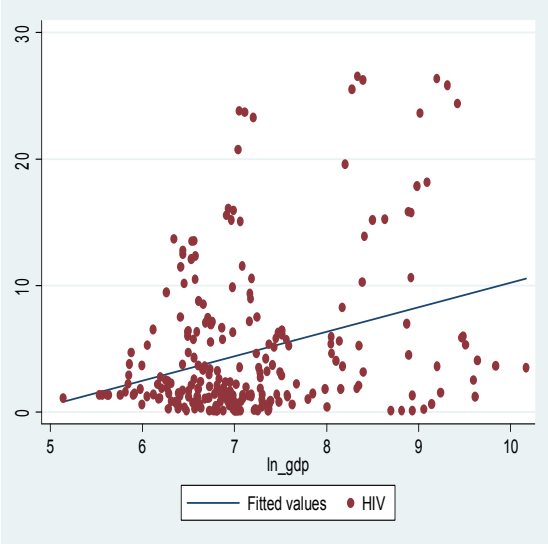

Figure 19 Ln_gdp and HIV.

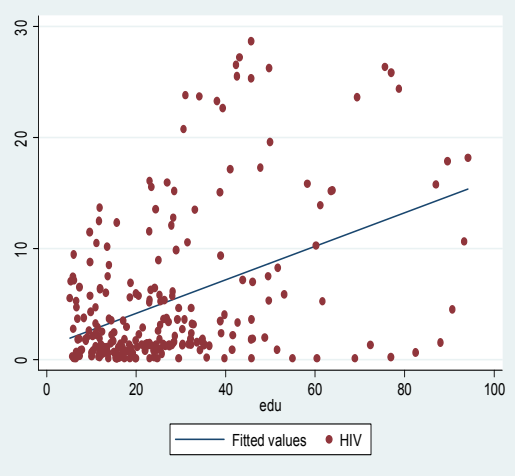

Figure 20 Secondary enrollment and HIV.

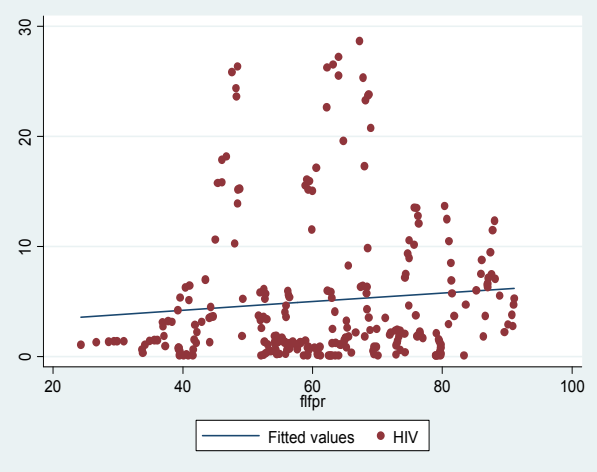

Figure 21 Flfpr and HIV.

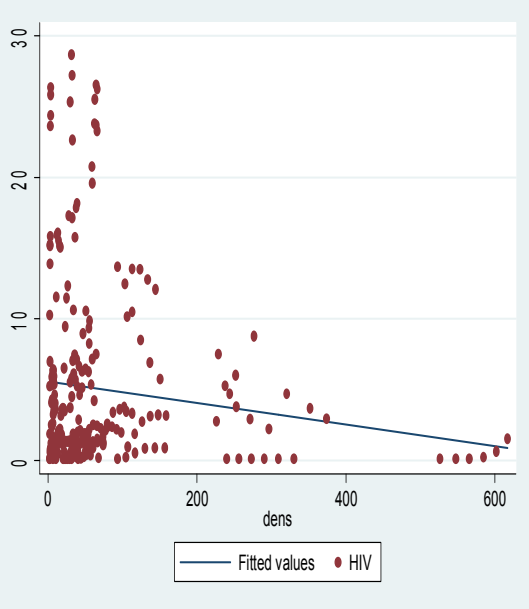

Figure 22 Density and HIV.

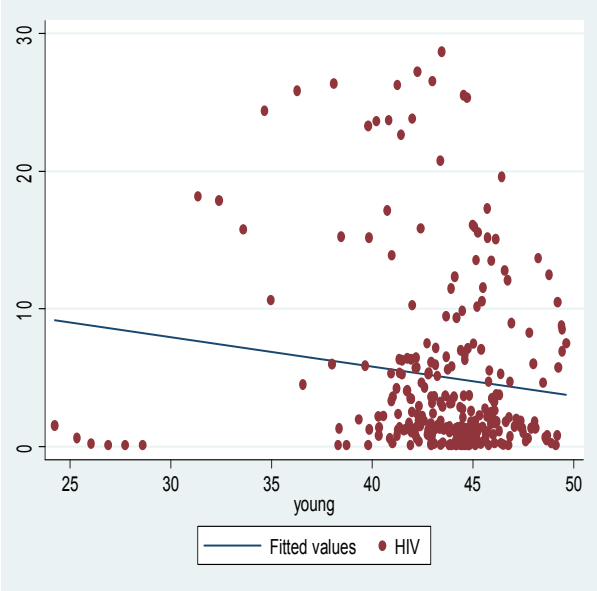

Figure 23 Population under 15 and HIV.

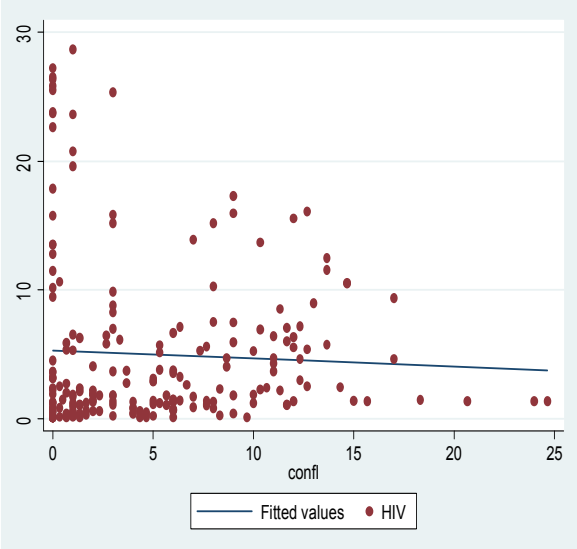

Figure 24 Conflict and HIV.

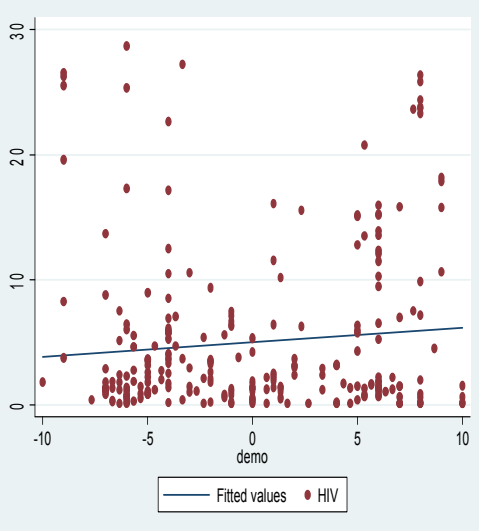

Figure 25 Democracy and HIV.

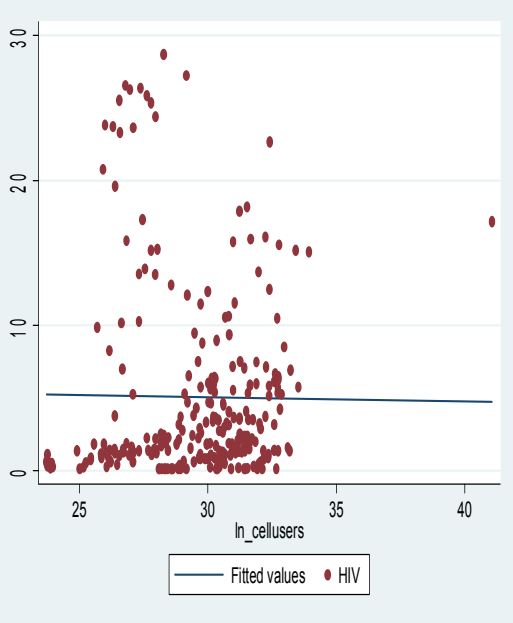

Figure 26 Ln_users and HIV.

```
. hausman fe re
```

	Coefficients (b) fe	(B) re	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
ln_gdp	1.373293	.0345048	1.338788	1.292449
flfpr	.2399866	.1892361	.0507505	.1411417
edu	.0023689	.0608181	-.0584492	.0335438
dens	-.0856577	-.0333992	-.0522584	.0164598
under_15	-1.558963	-.8685565	-.6904064	.1326269
demo	.121343	.138039	-.016696	.0672948
confl	-.4909123	-.2932611	-.1976511	.0947962
ln_users	.2369463	.1154363	.12151	.1978394

```
                b = consistent under Ho and Ha; obtained from xtreg
     B = inconsistent under Ha, efficient under Ho; obtained from xtreg

  Test:  Ho:  difference in coefficients not systematic

              chi2( 8) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                       =          34.02
            Prob>chi2 =         0.0000
            (V_b-V_B is not positive definite)
```

Table 27 Hausman Test. (Eq5). Source: STATA.

```
. test  per1 per2 per3 per4 per5 per6

 ( 1)  per1 = 0
 ( 2)  per2 = 0
 ( 3)  per3 = 0
 ( 4)  per4 = 0
 ( 5)  per5 = 0
 ( 6)  per6 = 0
       Constraint 5 dropped
       Constraint 6 dropped

       F(  4,   134) =      4.49
            Prob > F =      0.0019
```

Table 28 Test for joint significance. (Eq6).

```
. hausman fe re

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |       fe           re         Difference          S.E.
-------------+----------------------------------------------------------------
      ln_gdp |    4.04172     1.549048        2.492672        1.913927
       flfpr |   -.0191735     .1105152       -.1296887        .1793795
         edu |     .094761     .1082364       -.0134753        .0259707
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2( 3) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                           =          2.01
                Prob>chi2 =        0.5703
```

Figure 29 Hausman Test. Socioeconomic regression model. Source: STATA.

```
. hausman fe re

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |       fe           re         Difference          S.E.
-------------+----------------------------------------------------------------
        dens |   -.0695917    -.0339979       -.0355938         .014574
   under_15 |    -1.33032    -1.038485       -.2918351        .1564321
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2( 2) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                           =          5.97
                Prob>chi2 =        0.0505
```

Figure 30 Hausman Test. Demographic regression model. Source: STATA.

```
. hausman fe re

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |       fe           re         Difference          S.E.
-------------+----------------------------------------------------------------
       confl |   -.6653239    -.4887216       -.1766023        .1030852
        demo |    .2198565     .2120425        .0078139        .0489022
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2( 2) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                           =          2.95
                Prob>chi2 =        0.2286
```

Figure 31 Hausman Test. Political regression model. Source: STATA.

```
. hausman fe re

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |       fe           re         Difference          S.E.
-------------+----------------------------------------------------------------
    ln_users |    .1967944     .1540475        .0427469        .2436435
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2( 1) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                           =          0.03
                Prob>chi2 =        0.8607
```

Figure 32 Hausman Test. Technological regression model. Source:STATA.