MACROECONOMIC EFFECTS OF HIV AND AIDS: EMPIRICAL EVIDENCE FROM SUB-SAHARAN AFRICA

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MACROECONOMIC EFFECTS OF HIV AND AIDS: EMPIRICAL EVIDENCE FROM SUB-SAHARAN AFRICA

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ABSTRACT

A review of previous studies on the macroeconomic effect of HIV/AIDS suggests that the effect of HIV infection after it has converted to AIDS has not been considered in empirical studies. Realising that HIV is associated with rising morbidity and AIDS is associated with rising mortality and morbidity, this study considered both in the macroeconomic analysis. Both the HIV and AIDS could have important and different consequences on the macroeconomic performance of national economies. This study investigates the effects of HIV prevalence rate and AIDS on economic growth and aggregate labour productivity in sub-Saharan Africa. It also evaluated the impact of health expenditure on HIV prevalence rate. The sensitivity of the results was examined within two alternative sub-samples – Eastern and Southern Africa (ESA) and the Rest of sub-Saharan Africa (RSA). Panel data from 42 countries for the year 1990-2013 were used. The study estimated an empirical growth equation within an augmented Solow model and applied the dynamic system generalised method of moment estimator. HIV prevalence rate was found to have significant negative effects on GDP per capita growth and aggregate labour productivity in both the full sample and the two sub-samples. The effects did not differ between the sub-samples. AIDS was found to have positive influence on GDP per capita in all the samples. It also positively influences aggregate labour productivity measured by GDP per person employed in all samples but RSA. This is however, not beneficial to both economic growth and aggregate labour productivity. Rather, it is detrimental as it was attributable to decrease in populations and total employment instead of economic growth. There was no evidence that health expenditure has a significant negative effect on HIV prevalence rate in either the full sample or any of the sub-samples. Policy makers should ensure that adequate resources are committed towards preventing people from acquiring new HIV infection as well as averting the disease to convert to AIDS. Health awareness should also be promoted through education for better population health status.

Keywords: HIV prevalence rate, AIDS, GDP per capita growth, aggregate labour productivity, health expenditure

ABSTRAK

Ulasan karya lepas berkenaan kesan HIV/AIDS terhadap makroekonomi menunjukkan ketiadaan kajian empirikal yang dilakukan dalam menganggar kesan AIDS selepas jangkitan HIV. Menyedari bahawa HIV dikaitkan dengan peningkatan morbiditi manakala AIDS dikaitkan dengan kematian dan morbiditi yang semakin meningkat, maka kajian ini menganalisis kesan kedua-duanya terhadap makroekonomi. HIV dan AIDS memberi implikasi penting dan berbeza kepada pencapaian makroekonomi sesebuah negara. Kajian ini menganggarkan kesan kadar kelaziman HIV dan AIDS terhadap pertumbuhan ekonomi dan produktiviti aggregat buruh di sub-Sahara Afrika. Ia juga menilai kesan perbelanjaan kesihatan terhadap kelaziman HIV. Kepekaan keputusan diuji dalam dua alternatif sub-sampel-Timur dan Selatan Afrika (ESA) dan lain-lain negara di sub-Sahara Afrika (RSA). Panel data dari 42 negara bagi tahun 1990-2013 telah digunakan. Kajian ini menganggarkan persamaan pertumbuhan empirikal berasakan model Solow yang diperkukuh dan menggunakan sistem penganggar GMM yang dinamik. Kadar kelaziman HIV didapati mempunyai kesan negatif yang ketara terhadap pertumbuhan KDNK per kapita dan produktiviti agregat buruh dalam sampel penuh dan dua sub-sampel. Kesan tersebut adalah tidak berbeza antara sub-sampel. AIDS turut memberi kesan positif terhadap aggregat produktiviti buruh yang diukur menggunakan KDNK per kapita individu bekerja dalam semua sampel kecuali RSA. Walau bagaimanapun, ia tidak membawa kebaikan kepada pertumbuhan ekonomi dan aggregat produktiviti buruh. Sebaliknya, ia boleh memudaratkan kerana ia menyumbang kepada penurunan populasi dan jumlah guna tenaga dan bukannya pertumbuhan ekonomi. Tidak dapat dibuktikan bahawa perbelanjaan kesihatan mempunyai kesan negatif yang ketara terhadap kadar kelaziman HIV sama ada dalam sampel penuh atau sub-sampel. Pembuat dasar perlu komited dalam memastikan sumber adalah mencukupi dalam mencegah jangkitan HIV serta mengelak penyakit ini menukar kepada AIDS. Kesedaran terhadap kesihatan perlu diterap melalui pendidikan bagi meningkatkan tahap kesihatan populasi.

Kata kunci: kadar kelaziman HIV, AIDS, pertumbuhan KDNK per kapita, agregat produktiviti buruh, perbelanjaan kesihatan

DECLARATION

Some part of the work presented in this thesis has been published as articles in the following journal:

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GLOSSARY

AIDS	Acquired Immune-deficiency Syndrome
CDC	Centres for Disease Control and Prevention
ESA	Eastern and Southern Africa
GDP	Gross Domestic Product
GMM	Generalized Method of Moments
GNI	Gross National Income
HAART	Highly Active Antiretroviral Therapy
HIV	Human Immune-deficiency Virus
H_0	Null Hypothesis
IMF	International Monetary Fund
MMWR	Morbidity and Mortality Weekly Report
OLS	Ordinary Least Squares
R1	Regression One
R2	Regression Two
RSA	Rest of Sub-Saharan Africa
SSA	Sub-Saharan Africa
TB	Tuberculosis
UNAIDS	Joint United Nations Programme on HIV/AIDS
UNDP	United Nations Development Programme
UNPD	United Nation Population Division
US	United States
UUM	Universiti Utara Malaysia
WHO	World Health Organisation

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Health which is central to individual's well-being is among the basic objectives of growth and development. Therefore, enhancing the health status of the vast majority of the populace, especially in developing countries that are prone to diseases is not only an end in itself, but also a means to achieve other ends – poverty reduction, better living standards and consequently macroeconomic development (Todaro & Smith, 2005). Essentially, health is a fundamental component of economic growth. That is, it is an important input in the form of human capital in the aggregate production function and a prerequisite for raising productivity. In essence, the health status of individuals and societies determined the vigour with which they pursue productive activities. All other human positions, status or material wealth are regarded second to individuals or societal health (Bhargava, Jamison, Lau, & Murray, 2001).

Health influences society's output directly or indirectly. Directly, healthy workers are more energetic and robust, that is, can endure a longer period of work and have a clear mental reasoning, hence capable of augmenting the level of output. Indirectly, improvement in health is an incentive to education and learning process of children, because healthier children have higher cognitive ability. Better education received means more efficiency and higher productivity which implies more income and economic growth. Greater health also means lower morbidity; hence people can increase their savings for investment purposes rather than spending the money on medication, prevention and maintenance. Conversely, illnesses and mortality associated with disease as Human Immuno-deficiency Virus (HIV) and Acquired Immuno-deficiency Syndrome (AIDS) could retard the macroeconomic performance of societies and even obstruct development effort (Mayer, 2001).

HIV is a viral infection which rapidly multiplies in host cells and damage the immunological system, especially the CD4 + T cells, thereby rendering the body vulnerable to infections and cancers leading to AIDS (Centres for Disease Control and Prevention [CDC], 1992). The virus belongs to a class of viruses called lent-viruses, some of which are collectively known as ape viruses (Kanabu & Allen, 2000). Although the origin of HIV remains debatable, Garrett (1994) and Korber *et al*. (2000) estimate that the epidemic originates in West Africa around 1930. However, the first scientific evidence on what is known as HIV/AIDS was established by Morbidity and Mortality Weekly Report (MMWR) in 1981, in a report on "Pneumocystis carinii" pneumonia on 5 earlier healthy adolescent in Los Angeles, California (CDC, 1981; 2011).

Generally, HIV is categorized into HIV 1 and HIV 2, and both are transmitted by means of heterosexual and homosexual sex, blood transfusion, and mother to child relationship (in the uterus, during child birth or breast feeding). HIV-1 being easily transmitted and virulent compared with HIV-2 has shorter incubation period (7 – 10 years) between infection to development of AIDS (Kanki *et al*. 1999). Both the HIV categories have groups as well as subgroups and their diverse global distribution prevent the development of medical treatment and cure. HIV-1 the most predominant has 3 groups: Main (M), Outlier (O), and Non M Non O (N). The main (M) group, subgroups vary from A to J and are unevenly spread all over the world. Subgroup A and D are more prominent in sub-Saharan Africa (Kanki *et al*. 1999), and as categories of the virus they vary in genetic composition, modes and speed of transmission (Mastro, Kunanusont, Dondero & Wasi, 1997).

Even though knowledge about HIV/AIDS have greatly increased since the first significant appearance of the epidemic, certain complicating issues – mobility/migration, socio-cultural practices, stigmatization, human behavioural changes, and low status of women have affected its distribution across various populations, the way it appears in certain places, and which group are highly vulnerable (May, 2003). Globally, high HIV/AIDS prevalence amid sex workers, commercial blood donors, injecting drug addicts, long distance lorry drivers and emigrant workers provides clear facts of the association of macroeconomic indicators and HIV/AIDS (Barnett & Blaikie, 1992; Bloom & Mahal, 1995).

Since its appearance over three decades ago, HIV/AIDS has become not only pandemic on a global scale but remain the most shocking disease humankind has ever faced. It causes more death than any other disease in sub-Saharan Africa (SSA) and worldwide, it is the fourth killer disease (Joint United Nations Programme on HIV/AIDS [UNAIDS], & World Health Organization [WHO], 2001; UNAIDS 2007; WHO 2008). The epidemic now is not only on health issue, but also major danger to macroeconomic growth and development. It infects people at their most productive age (15-49 years) (WHO, 1995; UNAIDS, 2006), and imposes a heavy burden on families, communities and ultimately economies (Kambou, Devarajan & Over, 1992; McDonald & Roberts, 2006).

Globally, about 95 percent of people infected with HIV/AIDS are adults within their most productive age. That is, people who could withstand the rigor of production, and suppose to be the back bone of every economy. As at late 1994, estimate shows that about 18 million persons were HIV positive with more than 4 million developed AIDS cases worldwide (WHO, 1995). Since then, the population of infected persons grows rapidly (see Table 1.1 for the global HIV prevalence rate, incidence and AIDS statistics). The Joint United Nations Programme on HIV/AIDS shows that HIV prevalence rate rose from 30.0 million in 2001 to reach 34.8 million in 2003, then up to 35.6 million by 2005. Particularly, in 2005, there was an estimated 2.9 million cases of fresh HIV infections, although lower than 3.1 million recorded in 2003 and 3.4 million in 2001. However, the number of AIDS related deaths rose to 2.6 million relative to 2.2 million in 2003 and 1.9 million in 2001 (UNAIDS, 2006; UNAIDS & WHO 2009). In 2009, estimates show that 34.0 million people were HIV positive worldwide. Within the year, there was 2.6 million new HIV infection and 2.0 million people succumbed to the disease (UNAIDS, 2010).

Recent epidemiological data shows that worldwide, 35.3 million people, representing 0.8 percent of adults within the 15 to 49 age cohort are HIV positive at the end of 2012. Specifically, within same year, about 2.3 million new HIV cases and 1.6 million deaths due to AIDS related morbidity occurred. In 2013, there was a marginal change in the HIV/AIDS estimates with 35.0 million people being HIV positive, 2.1 million fresh cases and 1.5 million AIDS mortality (WHO, 2014). From the time the epidemic was discovered, it was estimated that about 75 million persons worldwide have become HIV positive and 36 to 42 million people had died as a result of illnesses due to HIV/AIDS (UNAIDS, 2013).

Table 1.1
Global HIV/AIDS Prevalence and Incidence Rates Statistics (in Millions)

Year	People living with HIV	Total new HIV infections	AIDS related deaths
2001	30.0	3.4	1.9
2002	31.0	3.3	2.1
2003	34.8	3.1	2.2
2004	32.2	3.0	2.3
2005	35.6	2.9	2.3
2006	32.8	2.8	2.3
2007	33.2	2.7	2.2
2008	33.5	2.6	2.1
2009	34.0	2.6	2.0
2010	34.4	2.5	1.9
2011	35.0	2.5	1.2
2012	35.3	2.3	1.6
2013	35.0	2.1	1.5

Source: UNAIDS, Global AIDS Epidemic Report, Various Issues

Figure 1.1 is African political map indicating SSA, the study area which is estimated to house almost three quarter of global HIV infection (UNAIDS, 2012). The SSA consists of four regions which comprised of 48 countries as at 2012 (see Appendix I for the number of countries in each region used in the study). The region has a total population of 974.3 million people and urban population of 37 percent of the whole population as at 2014 (World Bank, 2014). In 2014, while Gross Domestic Product (GDP) was $1.018 trillion, Gross National Income (GNI) per capita remains $1,646, both at current US dollar. Similarly, GDP and per capita GDP growth rates stood at

4.3% and 1.6% respectively. In the region, average life expectancy at birth is 56 years and primary school completion rate is 70 percent of the total relevant age group. Nevertheless, governance and transparency remain weak (World Bank, 2013; 2014).

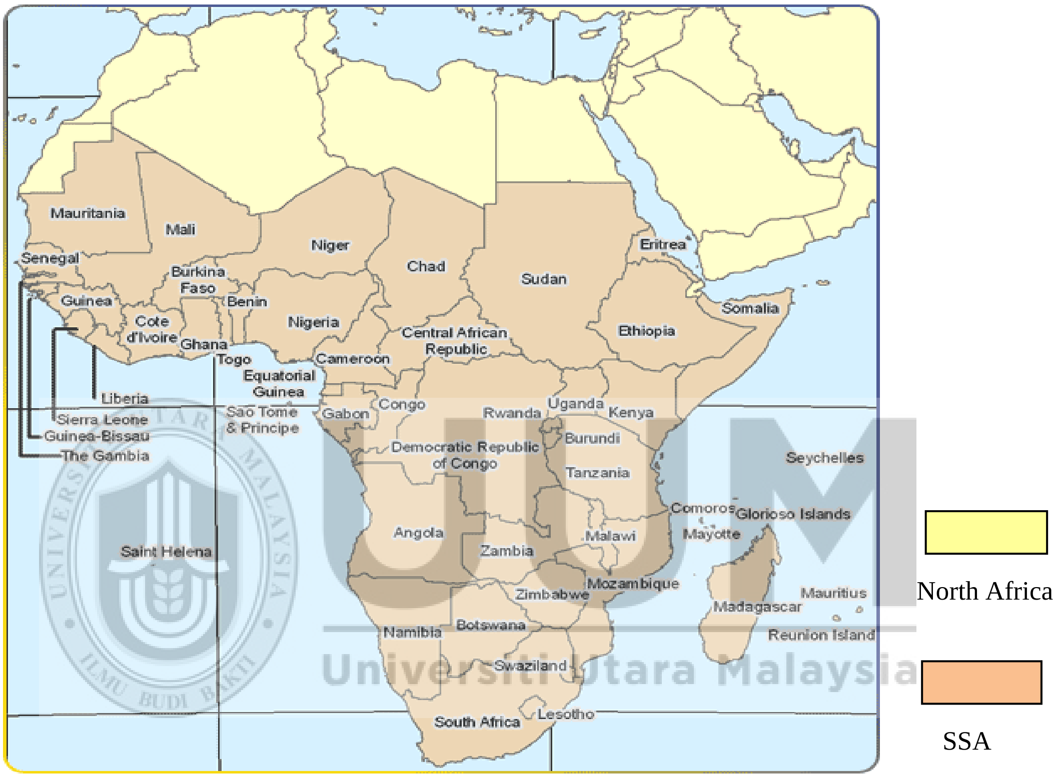

Figure 1.1
Africa Political Map Indicating SSA
Source: http://www.worldmap.org/region

In SSA, oil exporters are those countries which crude oil is their dominant export, hence the main source of foreign exchange and government revenue. Based on World Bank Atlas method of calculation, low income countries are those having GNI per capita of US $1,045 or less as at 2013, while middle income countries are those with GNI per capita greater than US $1,045 but not up to US $12,746. Fragile countries are those experiencing development problems such as political instability, bad governance and frequent religious or ethnic violence (World Bank, 2014).

The spread of HIV infection among sub-Saharan African adults during the 1990s greatly exceeds most forecasts, with infection rates in some countries reaching 25 percent by the year 2000 (Young, 2005). The SSA has the highest HIV/AIDS infected individuals compared to other global regions, with almost 1 out of each 20 adults (4.9%) being HIV positive. That is, the region approximately accounts for 69 percent of world HIV/AIDS infections (UNAIDS, 2012). Although the epidemic is widely spread and continues to infect people; the rate of new infection annually has declined to 1.5 million people in 2013 (W H O, 2014) compared with 1.9 million and 2.3 million in 2008 and 2001 respectively (UNAIDS, 2013). While SSA contains only about 12 percent of global population (UNAIDS, 2011), it accounts for two-third of all HIV/AIDS infected persons and 3/4 (75%) of all global death due to AIDS related illnesses. The sizeable lost of adults due to AIDS could lead to a large number of orphans. In SSA, by 2009 nearly 16 million children below the age of 18 years become orphans due to HIV/AIDS (UNAIDS, 2010).

The HIV infection has cut across all sexes, ethnic groups, and religions; hence it spared no one from its devastating impact which is felt not only by those infected but also by those indirectly affected and the society at large. In SSA, women being more vulnerable to HIV infection than men, account for about 60 percent of all the infections (UNAIDS, 2009). The rates of infection vary within countries as well as from one country to another in magnitude and scope. In 2007, the estimated HIV prevalence rate was greater than 28 percent in most countries in Southern Africa as Lesotho, Botswana, Namibia, South Africa and Swaziland among others. In Eastern Africa, the highly HIV infected countries include: Mozambique, Zambia and Zimbabwe among others (UNAIDS, 2008).

Recently, UNAIDS estimate shows 1.6 million new HIV infections in SSA in 2012, which brought the total number of infected persons to 25.0 million against 22.4 million in 2008. Although the cumulative number of HIV/AIDS infections in the region increase, the amount of AIDS related deaths declines from 1.4 million in 2008 to 1.2 million in 2012 (UNAIDS, 2013). In 2013, estimates indicate a marginal decline in the HIV/AIDS statistics with prevalence rate of 24.7 million people as well as 1.5 million incidence rate and 1.1 million AIDS deaths (WHO, 2014). Table 1.2 shows SSA HIV/AIDS and incidence rate statistics.

As shown in Table 1.1 and 1.2, HIV/AIDS infection in SSA is enormous relative to global infection. In 2001, 69.6% of the estimated global 30.0 million HIV infected persons are in SSA. Also, 67.6% of the total new infection and 73.6% of AIDS related deaths occurred in the region. Five years later, that is, in 2006 the situation worsened because SSA contained 75.3% of the 32.8 million global HIV/AIDS prevalence, and 91.3% of deaths due to AIDS.

However, in 2010 there was a marginal improvement on the HIV/AIDS situation in the region. The prevalence rate decline to 66.5% of the total world infection (34.4million), and AIDS related deaths reduced to 63.1%, but new HIV infection remain high at 76% of the whole total (2.5 million). In 2012 there was slight increase in global HIV/AIDS prevalence to 35.3 million people, out of which SSA housed 25.0 million (70.8%), and 69.5% of the new infection as well as 75% of mortality due to AIDS related illnesses. Thus, SSA contains much greater proportion of the global HIV/AIDS epidemic.

Table 1.2
SSA HIV/AIDS Statistics (*in Percentage and Millions*)

Year	Prevalence of HIV, total (% of population aged 15-49)	People living with HIV (million)	Total new HIV infections (million)	AIDS related deaths (million)
2001	5.8	20.9	2.3	1.4
2002	5.7	-	-	-
2003	5.6	25.0	4.8	2.9
2004	5.5	23.6	2.6	1.9
2005	5.4	-	-	-
2006	5.2	24.7	2.8	2.1
2007	5.1	22.0	2.8	2.1
2008	5.0	22.4	1.9	1.4
2009	4.9	22.5	1.8	1.3
2010	4.8	22.9	1.9	1.2
2011	4.7	23.5	1.8	1.2
2012	4.6	25.0	1.6	1.2
2013	4.5	24.7	1.5	1.1

Source: Compiled from UNAIDS, AIDS epidemic update various issues and WHO
Note: (-) Indicates Not Available

In the region, the devastating effects of the epidemic have cut across all sectors of human development imposing hardship on household, communities, firms and eventually national economies (United Nations Development Programme [UNDP], 2008). Schneider and Moodie (2002) indicate that HIV/AIDS in Africa has through its devastating effects undermined health care and educational systems as well as destabilizes the family structures and general social cohesion. Whenever the epidemic strikes, family living standard become harsh, as infected adults are less or completely could not work to sustain the family. Children education is terminated in order to take care of the sick parent(s) or to be forced in to labour market to support the family (McDonald & Roberts, 2006). In many countries populations, the epidemic has skewed the age distribution and seriously reduced average life expectancy. Average life expectancy was reduced by half, that is, to 37 years in Swaziland between 1990 and 2007, and by 20 years in South Africa (Arndt & Lewis, 2000; UNDP, 2005; 2008).

Obviously, in SSA the macroeconomic consequences of HIV/AIDS epidemic has resulted to increased health care expenditure. In a study on determinants of government HIV/AIDS financing, Avila, Loncar, Amico and De Lay (2013) shows that 10 percent rise in HIV prevalence rate is associated with 2.5 percent rise in domestic spending for the epidemic. This leads to decreased private and public savings as well as assets exhaustion (Cuddington, 1993). Several sub–Saharan African countries, received more HIV/AIDS funding for prevention and treatment than their entire national health budget (Shiffman, 2008). Table 1.3 indicates the cumulative HIV/AIDS funding by The Global Fund. With respect to productivity loss, the prediction is that in severely affected economies the levels of production could decline making it hard to meet domestic and export demand, hence raising per unit cost and obstructing growth and development process (Cuddington, 1993; Theodore, 2001).

Table 1.3
The Global Fund Cumulative Funding by Disease (*in Billion US$*)

Year	HIV/AIDS	Tuberculosis	Malaria
2002	0.36	0.5	0.17
2003	0.640	0.220	0.190
2004	1.2	0.340	0.460
2005	1.9	0.550	0.960
2006	3.0	0.870	1.3
2007	4.6	1.2	1.7
2008	5.8	1.4	2.3
2009	7.2	1.9	3.9
2010	9.5	2.8	4.7
2011	11.0	3.4	5.7
2012	13.0	3.8	6.8
2013	16.0	4.6	8.0

Source: The Global Fund. Retrieved on 25 September, 2014

The understanding among economists and policy makers that HIV/AIDS is not only on health issue, but also a serious macroeconomic problem has led several studies to investigate the economic effects of the epidemic. Some of the empirical investigations on the impact of HIV/AIDS on the economy have shown that the macroeconomic consequences are mild, hence of no serious concern (e.g., Ainsworth & Over, 1994; Bloom & Mahal, 1997; Cuddington & Hancock, 1994; Murtin & Marzo, 2013). Moreover, Bloom and Mahal (1997) contends the argument that HIV/AIDS obstruct economic growth has more flash than substance. However, one is inclined to doubt the robustness of Bloom and Mahal results, because the estimates were derived from 1980 to 1992 data, a period within which the prevalence of HIV/AIDS was very low with limited impact on morbidity and mortality. While these studies find less significant effect, a positive link between AIDS and GDP per capita was even established. According to Young (2005) the AIDS pandemic enhances the annual average per capita GDP consumption in South Africa.

On the other hand, other empirical investigations reached contrary conclusions. Their estimates indicates that the impact of HIV/AIDS on the growth of economy's is something to reckon with (Arndt & Lewis, 2000; World Bank, 2000; 2001a; 2001b; Bonnel, 2000; McDonald & Roberts 2006; Lovasz & Schipp, 2009). Yet, part of Bonnel (2000) result indicates that in low HIV prevalence countries, the effect on growth is still negligible. Whereas Dixon, McDonald and Roberts (2001) attest that although in countries with relatively low HIV prevalence rate, the epidemic's effect conforms to normal economic expectation; the macroeconomic impact is unclear, that is, ambiguous in the presence of relatively high prevalence rate. equally, Lovasz and Schipp (2009) points that among the limitations of their study is the short data period of nine years which the instruments of the Generalized Method of Moments (GMM) estimator further reduced by two years.

Apparently, the empirical investigations on the effect of HIV/AIDS on economic growth produced mixed and conflicting results. Some studies contended that the macroeconomic consequences of HIV/AIDS are mild and of no serious concern (e.g., Bloom & Mahal, 1997; Cuddington & Hancock, 1994). Other studies such as: Arndt and Lewis (2000), Lovasz and Schipp (2009) and World Bank (2000; 2001a) believed the effects were something of serious concern. Yet, another study sees a positive association between HIV/AIDS and growth (Young, 2005). These is a reflection of what Haacker (2011) explain as the complex association among HIV/AIDS and macroeconomic indicators.

The seemingly conflicting results could not be unconnected with the fact that initial quantitative investigations of the impact of HIV/AIDS on the macro economy were hampered by dearth of adequate information; thus more or less simulations were employed to estimate the economic consequences of the HIV/AIDS epidemic (Lovasz & Schipp, 2009; McDonald & Roberts, 2006). Even though most of the studies focus on country specific, there are very few that focused on SSA cross-country analyses (Bloom & Mahal, 1997; Lovasz & Schipp, 2009).

Beside lack of adequate data, institutional and academic publication biases are also factors that influence the result of certain studies which modelled the growth effect of the epidemic. Most studies that emanate at the World Bank were able to find that HIV/AIDS reduces GDP per capita. This is because such result is essential otherwise the World Bank will not regard the findings as credible. Whereas most of those studies not affiliated with the World Bank frequently discover contrary results. Moreover, some studies failed to be published in a refereed journal because they could not established substantial effect of the epidemic on growth. So, the empirical supports of the effect of the epidemic on economic growth are weak and unconvincing (Haacker, 2011).

On one side, health is a vital component of economic growth and prerequisite for increasing productivity through healthy, more energetic, and clear mental reasoning workers that endure long period of work. On the other side, HIV/AIDS epidemic could reduce aggregate labour productivity and obstruct the macroeconomic performance of societies, because sick and worried workers are physically and mentally weak hence less productive. The productivity of uninfected workers could also be negatively affected as the rates of HIV/AIDS infection among colleagues, relatives or friends increases (Cuddington, 1993). The costs due to productivity lost could be substantial as the illness of the infected workers worsen or is prolonged or as skilled and experienced workers which are difficult to replaced in the vital sectors of the economy succumbed to the disease (Dixon, McDonald & Roberts, 2002). Even with surplus labour, replacing the lost workers with less skilled and less experienced ones could not possibly offset the productivity lost (Coulibaly, 2003).

The costs due to negative labour productivity will decrease competitiveness and profit margin resulting to low government income, as tax revenue decline. Consequently, the pressure on governments to increase spending in order to cope with the HIV/AIDS pandemic will create potential fiscal crisis thereby affecting the macroeconomic progress of the economies.

Currently, medically there is no cure for HIV/AIDS (CDC, 2011); this makes the disease an expensive one because infected persons have to remain continuously on medication to prevent the development of full AIDS. The medication, Highly Active Antiretroviral Therapy (HAART) is so expensive that most of the infected individuals in SSA could not afford but rather rely on governments and donor agency such as UNAIDS free supply which is not regular and has limited coverage. Thus, coping with HIV/AIDS increases health expenditure as infected persons and their families spend more on treatment and maintenance and as governments and donor agencies substantially increase their spending on the aforementioned in addition to control and prevention of the HIV/AIDS epidemic (Shiffman, 2008). In spite of the financing by various national governments, external donor financing predominate HIV/AIDS spending in most of the SSA countries, financing 70- 80 percent of the HIV/AIDS spending (Haacker, 2009).

Obviously, the costs associated with HIV/AIDS are high. And the essence of greater HIV/AIDS spending by all stakeholders which increased health care expenditure, is to cure, control and prevent the continuous spreading and rising of the already widely spread HIV/AIDS epidemic. For policy purpose, these point the need to determine through empirical investigation the effectiveness or otherwise of the health expenditure in reducing the scourge of the epidemic.

The association among HIV/AIDS and macroeconomic indicators is complex (Haacker, 2011). As earlier pointed out HIV/AIDS could reduce aggregate labour productivity which in turn will reduce output, competitiveness, individual and government income, and subsequently lower the growth of national economies (Dixon *et al*. 2002). Similarly, rise in health expenditure due to HIV/AIDS will reduce domestic saving, except in situation where the HIV/AIDS spending is finance by cutting other expenditures or by external donor agencies. Reduction in domestic saving will reduce capital formation and investment which in turn will lead to decline in per capita income, hence dwindling economic growth (Cuddington, 1993).

AIDS is the outcome of the associations between HIV and opportunistic infections such as tuberculosis and malaria among others. HIV damages the body's immunity (CD4 cells) thereby paving the way for such infections to enter the human body and manifest and with time progress to AIDS. Globally, Tuberculosis (TB) which is caused by mycobacterium tuberculosis is the most frequent of such opportunistic infections which affects HIV positive individuals and is the leading cause of death among AIDS patients. That is, by impairing the body's immunity HIV seriously increase the risk of co-infection with Tuberculosis, and once the TB set in, it increases the viral content in the infected individual's body (Nissapatorn, Christopher, Init, Mun-Yik & Abdullah, 2003).

World over, in 2013 while nine million people became sick with TB, 1.5 million succumbed to the disease. Although among the global TB patients only 14.8 percent are co-infected with HIV, as much as 50-80 percent of such TB patients in SSA develop co-infection with HIV (see Figure 1.2 for TB patients with known HIV status). Thus, there exists a pathological re-enforcement between TB and HIV in which the former significantly worsen the later especially in SSA where HIV prevalence rate is high (WHO, 2014). The likelihood of HIV positive individual to developed active TB is up to 30 times higher than that of none positive individual (Corbett *et al*. 2003).

Figure 1.2 shows that percentage of TB/HIV co-infection in Africa is higher relative to the trends in the world and regions outside Africa. However, the TB prevalence and deaths due to TB in Africa as shown in Table 1.4, is significantly lower compared to SSA HIV prevalence rate estimates indicated in Table 1.2.

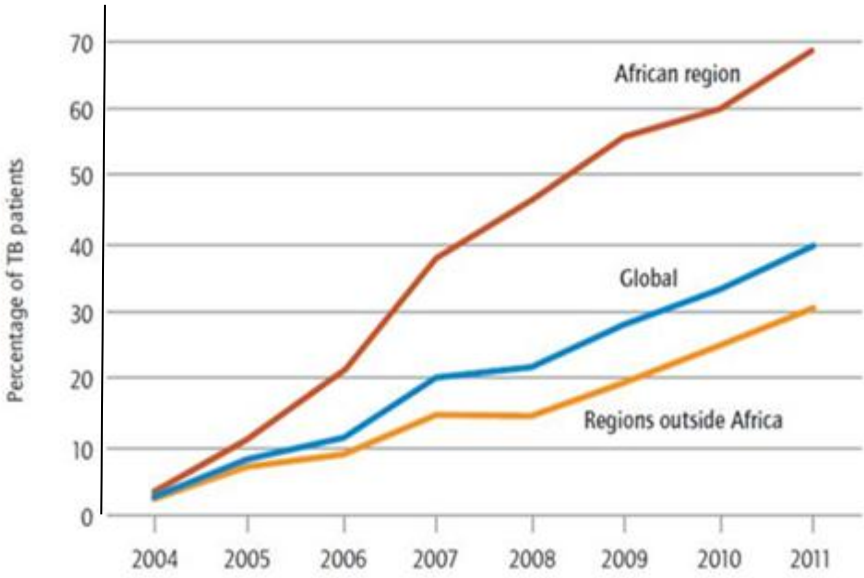

Figure 1.2
Percentage of TB Patients with Known HIV Status
Source: World Health Organization, pp 84, 2014.

The estimates shows that in SSA, in 2012 HIV prevalence rate was 25 million, incidence rate 1.6 million and deaths due to AIDS stood at 1.2 million while in Africa within same period, the TB statistics were 2.7 million, 2.3 million and 230,000 respectively, representing 10.8%, 143.7% and 19.2% of the HIV estimates. Therefore, as regards to the prevalence rate and cause of death, the estimates on HIV are much greater than those on TB. Equally, at global level, comparing the TB estimates in Table 1.4 with the HIV/AIDS statistics in Table 1.1 reveals that the TB prevalence and death due to TB were substantially lower in relation to HIV/AIDS while the incidence rate of TB is about three times higher than that of the HIV.

Table 1.4
Estimates of Epidemiological Burden of TB Statistics

Regions	TB mortality	HIV+ TB mortality	Prevalence	Incidence	Population
2012					
Africa (000)	230	250	2,700	2,300	892,529
Global (000)	940	320	12,000	8,600	7,053,684
2013					
Africa (000)	390	300	2,800	2,600	927,371
Global (000)	1,100	360	11,000	9,000	7,135,628

Source: World Health Organization, 2014

Malaria which is caused by plasmodium falciparum is another disease that is found to be co-infected with HIV. Considering the HIV infection, particularly among persons with low CD4 counts, the risk and severity of malaria is increased (Chandramohan & Greenwood, 1998). The co-infection of the HIV/malaria is more pronounced in the highly HIV infected societies like SSA where malaria transmission is unstable. Due to HIV infection across countries in SSA, the incidence malaria increased by 0.2% to 28% (Korenromp, 2005), and among pregnant women the estimated increase in malaria were 5.5% and 18.8% within populations with 10% and 40% HIV prevalence rates respectively (Ter Kuile *et al*. 2004).

The estimated 207 million annual incidence of malaria far exceeds that of HIV and TB. However, the average malaria related deaths each year of about 627, 000 is not up to half of deaths due to AIDS. This is because all deaths due to co-infection of TB/HIV or malaria/HIV are classified by international community as AIDS related deaths. Greater part of malaria cases and almost 90 percent of the consequential deaths (mostly under-five children) occurred in SSA, which is estimated to costs about US $12 billion productivity lost in Africa (WHO, 2014).

1.2 Economic Growth in Sub-Saharan Africa: A Synopsis

Few decades prior to 1990, SSA made more economic growth progress than other developing regions which was reflected in the increased income per capita and consumption. In between 1965 and 1985 consumption per capita increased to about 70 percent leading to significant improvement in other measures of well-being such as life expectancy, educational attainment and child mortality (World Bank, 1990).

However, by early 1990's economic fortune become difficult for many countries due to unfriendly external environment reflected by unfavourable effects of debt overhang, poor terms of trade, hash weather, and declined growth in export demand. GDP growth rate in the region was 1.1 percent in 1990, much lower than the 3.0 percent recorded in the previous year. In contrast, Asia witnessed improved growth rates from 5.6 percent in 1989 to 6.2 percent in 1990, indicating that average GDP per capita in SSA had fallen behind that of Asia (World Bank, 1991). The regional aggregate per capita GDP which may be low or high is accompanied by variations in growth experiences across countries in the region.

The sub-Saharan African region experience transition in mid 1990's from centrally managed to more market oriented economies, and from economic downturn to an improved per capita income growth in many countries due to reform programmes implemented and improved global economic condition. The region's GDP excluding the two largest economies – South Africa and Nigeria grew by 1.2 percent in 1994, reversing the declined growth in countries such as Zambia and Malawi, and uplifting that of Ethiopia, Ghana, Kenya, Mali, Senegal, and Uganda among others. The recovery continued through to 1998 where the region's GDP growth of 4.9 percent in 1996 is higher than the average population growth rate of 2.5 percent. Growth was shared, although rates vary across countries – 23 improved their GDP and 7 reversed GDP decline. Notwithstanding the progress made, economic growth has in cases been threatened by the HIV/AIDS pandemic and other related endemic diseases (International Monetary Fund [IMF], 2003).

In spite of the resurgence of civil crisis in some countries and the slowdown of world trade, GDP growth in 1998 was modest, although lower than the 3.8 percent recorded in 1997. While economic performance has failed to reach the required level to drastically reduce poverty, HIV/AIDS remains among the acknowledged threats to economic growth during the period. In 2000, even though growth averaged 7 percent in Mozambique, Uganda, and 5 percent in other 14 countries, the region's economic performance was weak mainly due to external shock created by higher oil prices and low market for other export products (World Bank, 1998; 2000).

There was growth resilience in 2002 which continues through 2005 where per capita GDP growth increased from 1.4 percent to 4.2 percent, a level it has not reached in the past eight years. Yet, in the region more than 60 percent of the population were living below US $1 a day which signifies lower standard of living. Moreover, HIV/AIDS continued to assert serious threat to growth and human development (IMF, 2005). The SSA economic growth strengthened up to 2007, basically due to increase production by oil exporters, real domestic investment in the oil importers; economic reform programme implemented in some countries as well as strong capital inflows and granted debt relief. Although, most of the countries experienced higher per capita growth, it was stronger among the oil exporters and fragile countries such as Sierra Leone, Democratic Republic of Congo, and Liberia trailing. However, the global financial crises which ensue in 2008 negatively affect growth performance in SSA, especially among countries with strong linkage to international capital market like South Africa. Per capita GDP growth declined from 3.2 percent in 2008 to as low as 0.3 percent in 2009 with the middle income countries suffering more of the recession effects relative to low income countries. In 2009, the recession increased unemployment, reduced income levels, and raised fiscal deficits in most of the countries (IMF, 2008; 2010).

Nevertheless, due to improvement in domestic conditions – new resource exploitation, supportive economic policies and increased export which improve fiscal balance and reduce inflation, growth in SSA picked up in 2010 – 2011 even against the sluggish world economy. GDP per capita rose from uncomfortable 0.3 percent realised in 2009 to an improved value of 3.5 percent in 2010 before settling at 3.4 percent in 2011. As usual, there were variations across countries. Although most of the low income countries achieved reasonable growth, it was slow in the middle income countries that were tracking the global economy. Similarly, in some countries that were experiencing political crises like Mali and Guinea Bissau growth was equally sluggish. The robust growth was supported by enhanced domestic demand, private and public investment, and accommodative macroeconomic policies (World Bank, 2011; IMF, 2013).

Within the 2012-2013 there was marginal slowdown in economic activities compared to previous two years. The slowdown was more pronounced in Nigeria and South Africa; the region's largest economies compared to the oil exporting and low income countries. In South Africa, the slow growth was attributed to tense labour relations, structural bottlenecks, and weak external demand. In contrast, growth in the middle income and conflict affected countries as Mali and Guinea Bissau substantially slowed down (World Bank, 2014; IMF, 2013; 2014). Appendix II and III shows the per capita GDP growth and real GDP growth respectively in SSA.

1.3 Statement of the Problem

From historical perspective, economic growth which reflects improvements in macroeconomic performance does not occur on its own. In addition to stimulating factors such as capital formation, institutional adjustment, technological progress and discipline, it requires healthy manpower as an essential element (Todaro & Smith, 2005). Healthy workers are not only happy, robust and more productive than sick and worried workers but are also associated with lower level of absenteeism. The positive effect of health on labour productivity and economic growth implies that society's economic performance is influenced by the health status of the labour force, especially when the labour force is not easily replaceable (Bloom, Canning, & Sevilla, 2004). Therefore, one can expect healthier societies to be more productive thereby leading to growth and development of the economy. Equally, high presence of disease such as HIV/AIDS could retard aggregate labour productivity as well as the levels of actual and potential economic growth of nations.

As indicated in section 1.2, the SSA economic growth trend is volatile and characterized by periods of slump. In certain periods, the average growth rate has not been growing at the required level to achieve sustainable macroeconomic development (World Bank, 1991; 1998; 2000; 2014; IMF, 2008; 2010). The widely spread HIV/AIDS epidemic could have been among the factors responsible for the slow or decline in growth of the SSA economies. Realising that HIV/AIDS is not only on health issue, but also potential threat to macroeconomic growth, some studies have investigated the economic consequences of the epidemic.

It is however argued that lack of adequate and appropriate data led to simulation by studies (e.g., Kambou *et al*. 1992; Cuddington, 1993; Cuddington & Hancock, 1994; 1995; Young, 2005). This in conjunction with institutional bias, have serious influence and are among the key reasons for the mixed and conflicting results reached by previous studies. Furthermore, it is understood that none of the previous studies takes the time lag effect of the HIV infection, that is, after it has developed to AIDS into consideration in their estimating equations. This presents a gap on the macroeconomic consequences of AIDS, which could be important and different from that of HIV. This is because while HIV is associated with rising morbidity, AIDS is associated with rising mortality and morbidity. Although very few studies as McDonald, Roberts (2006), Lovasz and Schipp (2009) used data on HIV prevalence rate as AIDS. This however, suggests that their findings show the effects of HIV prevalence rate rather than AIDS on economic growth. Bloom and Mahal (1997) estimate the numbers of AIDS using the distribution of the lag between HIV infection and the onset of AIDS. However, one could doubt the robustness of their results as the estimates were derived from 1980 to 1992 data, a period within which the HIV prevalence was very low with limited impact on morbidity and mortality. Therefore, lack of taking the effect of the HIV infection after it converts to AIDS into consideration in the estimating equation could have also undermined the robustness of previous studies hence, explains the mixed findings.

Consequently, these necessitates the need for conducting further study using much longer data horizon as well as taking the lag effect, that is, after the disease have converts to AIDS into consideration. Therefore, both the HIV which shows the instantaneous effect and AIDS which indicate the effect after HIV converts to AIDS are considered in the estimating equations. These enable the study to justify the statistical association between HIV prevalence rate and AIDS on the one hand and economic growth on the other hand, thereby filling the gap created by previous studies.

Previous empirical studies have also concentrated on the impact of HIV/AIDS on GDP per capita neglecting aggregate labour productivity which measures the contribution of persons employed in the production process. The conclusion that HIV/AIDS reduces labour productivity at certain individual firm's (Fox *et al*. 2004), cannot be applied to the whole economies and make generalization. This is because it takes more than the behaviour of few firms or even an industry to draw conclusion on entire economies (Gordon, 2012). Thus, this presents a gap on the effects of HIV prevalence and AIDS on aggregate labour productivity at macroeconomy level. Results from the literature, Cuddington (1993), Simtowe and Kinkingninhoun-

Medagbe (2011) regarding the macroeconomic association between HIV/AIDS and labour productivity remain theorising and suggestive rather than empirical, although they accord with rational thinking; illness lowers productivity. Nevertheless, rational thinking is not enough. As pointed by Friedman (1953) for a theory or hypothesis to be part of scientific inquiry, it has to be verifiable through subjecting it to empirical investigation. Therefore, the effect of HIV prevalence rate and AIDS on aggregate labour productivity is empirically investigated to fill the void left by earlier studies.

At the primitive level, one of the effects of HIV/AIDS is the increase in health expenditure. However, it is understood that the effect of health expenditure on HIV epidemic has not been empirically investigated, even though Lovasz and Schipp (2009) point it as one of the limitations of their study, hence suggested area for further investigation. Therefore, this study also investigates and determined the effect of health expenditure on HIV prevalence rate thereby filling the gap. This is an important policy tool for various governments and donor agencies in deciding whether or not the health expenditure is worthwhile in dealing with the HIV/AIDS epidemic. In order to generalize the results, the full sample is divided into two alternative sub-samples to which sensitivity analysis is conducted.

1.4 Research Questions

In SSA, obviously HIV/AIDS epidemic is widely spread, continue to infect people and is felt in all sectors of human development. In this regard, the questions of interest to the study are:

1. Is HIV prevalence rate and AIDS affecting economic growth in SSA?

2. Do HIV prevalence rate and AIDS affect aggregate labour productivity in SSA?
3. Does health expenditure reduce HIV epidemic in SSA?
4. What are the effects of the HIV prevalence rate and AIDS within the sub-regions of SSA?

1.5 Objectives of the Study

The main objective of this study is to evaluate the macroeconomic effects of HIV prevalence rate and AIDS in SSA. In line with this, the study has the following specific objectives:

1. To evaluate the effect of HIV prevalence rate and AIDS pandemic on per capita GDP growth in SSA.
2. To assess the impact of HIV prevalence rate and AIDS on aggregate labour productivity in SSA.
3. To evaluate the effect of health expenditure on HIV prevalence rate in SSA.
4. To investigate the above objectives 1, 2 and 3 within the sub-regions of the SSA

1.6 Scope of the Study

This study covers 42 countries in SSA within the period 1990 to 2013. The choice of the study period is influenced by the wide manifestation of the HIV and AIDS epidemic as well as availability of adequate and consistent data on all the variables involve to give meaningful result. Basically, the study focused on the effects HIV prevalence rate and AIDS on the aggregate economy in SSA countries. It also evaluated the impact of health expenditure on HIV prevalence rate.

1.7 Significance of the Study

This study extends on the earlier ones in investigating the effects of HIV prevalence rate and AIDS on economic growth and aggregate labour productivity within SSA. The relationship between health expenditure and HIV prevalence rate is also investigated. Moreover, the study examined the sensitivity of the results to determine whether differences exist in sub-regions of the SSA. It is believed that the widely spread HIV and AIDS epidemic could obstruct macroeconomic performance in SSA. It is equally believed that health expenditure might have been insufficient in reducing the spread of the HIV infection within the SSA.

In the search for effective solution, literatures in the subject area are systematically reviewed in order to embark on reliable empirical analysis. The analysis provides new support on the association between HIV prevalence rate and AIDS on one hand, and GDP per capita growth and aggregate labour productivity on the other hand. Furthermore, the empirical evidence shed light on the relationship between health expenditure and HIV prevalence rate. These would appropriately guide policies and actions in combating the HIV/AIDS scourge. Essentially, policy actions that are not supported by empirical findings may not necessarily yield the desired effects.

Therefore, considering the aggregate economic impact of the HIV/AIDS epidemic in such a manner that microeconomic study could not, the study offers important information to policy makers. The policy makers need to have information of how the epidemic affects their economies and budget in order to take appropriate measures and ensure availability of adequate resources in controlling the epidemic. The study also contributes to the exiting literature on macroeconomic effects of HIV prevalence rate and AIDS by investigating the cross country effect with much longer data horizon rather than relying on simulation with its fictitious assumptions. While HIV is associated with rising morbidity, AIDS is associated with rising mortality in addition to morbidity (Cuddington, 1993; Young, 2005). Consequently, both could have important and different macroeconomic consequences. Yet, previous studies mainly focused on HIV prevalence which shows the instantaneous effect of the epidemic on growth. This study further contributes to literature by evaluating with longer data, the instantaneous effect as well as the effect after the disease has converts to AIDS. Again, unlike previous studies that examined few individual firms, the study is also significant as it assessed the effects of HIV prevalence rate and AIDS on labour productivity at the macroeconomy level. This is essential, considering the fact that the productivity effect in few certain firms is not enough to make generalisation.

Furthermore, the study is significant as it determines the effectiveness of health expenditure in reducing HIV prevalence rate in SSA which hitherto has not been investigated. Equally important, the study examines the sensitivity of the results to determine whether the macroeconomic effects of the epidemic differ within the sub-regions.

1.8 Organization of the Thesis

This study consists of five chapters. Chapter one being the introductory section provides the background information and an overview of economic growth trend in SSA. The problem statement, research questions, objectives as well as scope and significance of the study are also discussed in this chapter.

Chapter two is the review of existing theoretical and empirical literature on macroeconomic effects of HIV/AIDS. The review critically synthesized relevant literature and analyzed the results in order to answer the questions stated in the chapter, thus forming the foundation for the empirical analysis.

Chapter three provides the research methodology where the method and procedure used in the empirical analysis are discussed. The theoretical framework is explained, variables inclusion is justified and hypotheses are stated. Models specification and estimations procedure are described, and sources of data are elaborated upon.

The empirical analysis and findings are presented and discussed in chapter four. Chapter five being the concluding chapter provides summary of the key findings and the main conclusion drawn. It also offers policy implications and recommendations as well as suggestions for future research.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter provides a systematic review of the literature relevant to the study. The review employs a more structural and critical procedure in reviewing the literatures to find the contribution of other researchers on the magnitude of the effect of HIV/AIDS on economic performance. It systematically reviews the empirical studies on micro and macro economic consequences of HIV/AIDS in an attempt to find research evidence relevant to the questions stated in section 2.2.1. Systematic review is not limited to medicine and is quite common in other disciplines. A lot of empirical studies in health economics have utilizes systematic review (e.g., Adetokumbo, Schooness, & Wisonge, 2014; Forrest, Sowden, Rubin, White, & Adams, 2014; Hagan *et al*. 2014; Kagina, Wiysonge, Lesosky, Mahdi, & Hussy, 2014; Samsudin, 2010; Pham *et al*. 2014).

The purpose of systematic review is to gather evidence from reliable sources and efficiently and critically review them in order to answer a specific research question. Unlike traditional review, systematic review employs more clear processes in order to find, assess, select, and then synthesized the outcome of related studies. It also identifies reasons for differences in outcomes across studies, and cites shortcomings of existing knowledge. The processes are clearly defined in advanced, in an attempt to ensure the review is clear, free from bias and could be repeated (Garg, Hackam, & Tonelli, 2008). Quality of studies is objectively screened based on a standard rubric before inclusion in the review. In this case, the Canadian Council on Learning's quality scoring rubric (2006) will be used. It should be noted that systematic review is created after reviewing and combining all the information from both reliable published and unpublished studies and then summarizing their findings. Always, for any systematic review there should be precise inclusion and exclusion criteria, together with clear search strategy and good coding that will lead to sound analysis of selected papers (The Campbell collaboration, 2013; Evidence for policy and practice information, 2013).

2.2 Review Process

Systematic review involves certain steps. Khalid *et al*. (2003) identify five steps to conducting systematic review: (1) framing the question(s), (2) identify relevant studies, (3) examine the quality of selected studies base on standard rubric, (4) summarising the results, and (5) interpretation of the results. However, Higgins and Green (2008) indicates that there are seven steps in a systematic review, four of which are comparable to those of Khalid *et al*. Whereas the remaining include collecting data/information, analysing and presenting results as well as improving and updating reviews. Although the domain of systematic review is clinical or health – related topic/question, it can be applied in any field of research (Khalid *et al*. 2003). While some adaptations are required to carry out the review in this chapter, the structural procedure is closely maintained.

2.2.1 Framing the Question

In SSA, obviously HIV/AIDS epidemic is widely spread and continue to infect people. Its effects have permeates all sectors of human development. The epidemic is no longer only on health problem, but also a considerable danger to macroeconomic performance. It inflicts serious hardship on families, then societies and eventually nations. Thus, understanding the impact of the HIV/AIDS on economic growth and aggregate labour productivity as well as the effect of health expenditure in reducing the HIV prevalence rates is necessary in order to take appropriate measures and ensure availability of adequate resources in controlling the disease. Although since its appearance, there has been a considerable development in econometrics methods of assessing the effects of the HIV epidemic on the economy, there is need for further assessment of such methods for better understanding. In this regard, five questions that will serve as a guide to subsequent empirical work in the study are expected to be answered from the review. The questions are outlined as follows:

1. Do HIV/AIDS through effect on human capital; affect economic growth in SSA?
2. What are the effects of HIV/AIDS on labour productivity in SSA?
3. Does health expenditure significantly reduce HIV prevalence rate in SSA?
4. Is the impact of the epidemic different between countries, especially the highly infected East and South African countries and Rest of SSA?
5. Which of the econometric models are employed in estimating the macroeconomic impact of HIV/AIDS?

2.2.2 Identifying Relevant Studies

2.2.2.1 Searching For Studies

This procedure aids to capture as much relevant studies as possible. To do that, different databases are searched in order to find prime studies on the impact of HIV/AIDS on the macroeconomy. Although searching could be done in various ways (electronically or manually), for the purpose of this particular review, the search was limited due to time constraint to those easily accessible electronic databases (Emerald, Science Direct & Wiley online library) which have the potential to cover literature on health economics and social sciences. These databases were assessed online through the e – journals, Sultanah Bahiyah Library, Universiti Utara Malaysia (UUM). Some articles that could not be assessed freely were requested from the interlibrary loan via the UUM library. Only published materials were search and used for the review. However, during the course of the research other databases will be searched for required references.

2.2.2.2 Developing Search Strategy

In order to retrieve as many relevant articles as possible from all the searched databases, we formed some potential 'keywords' that were used in the search process. The keywords are: 'HIV/AIDS and economic growth', 'HIV/AIDS and household', 'socioeconomic effects of HIV/AIDS', 'HIV/AIDS and labour productivity' and 'health expenditure and HIV'. To focus the review basically to empirical studies, the word 'empirical' is used in addition to the keywords to limit the search to empirical work. Based on its nature, HIV/AIDS is now a very broad issue attracting research from various disciplines, hence the review is limited by excluding studies that either focus mainly on mode of transmission of the disease, prevention strategies, vulnerability and high risk groups or stigmatization and information. In addition to being precise, the exclusion gave a sense of direction in identifying relevant studies to give meaningful results. While the inclusion criteria include studies that considers the effects of HIV/AIDS on economic growth, economic consequences of the HIV/AIDS, effect of HIV/AIDS on households, impact of HIV/AIDS on labour productivity, firms, or any sector of the economy, effect of health expenditure/HIV spending on HIV prevalence rate as well as other similar studies. English language being the language understood by the reviewer, all the included studies are published in the language. The structure of the search process for all the databases is as follows:

1. Retrieve studies on HIV/AIDS and growth or socioeconomic effect of HIV/AIDS.
2. Retrieve studies on HIV/AIDS and households or labour productivity.
3. Retrieve studies on health expenditure or HIV spending and HIV prevalence rate
4. Retrieve other studies that clearly stated either empirical or econometric analysis.
5. Joint together 1, 2, 3 and 4.
6. Retrieve studies on mode of transmission of the disease, prevention strategies, vulnerability and high risk groups or stigmatization and information
7. Exclude 6 from 5.

2.2.2.3 Documenting the Search Strategy

The search strategy was documented as follows:

I. Database: Emerald

Date search: 26 September, 2013

Table 2.1
Search Results on 26 September 2013 from Emerald

No	Keywords	Records
1.	Topic: HIV/AIDS and growth OR socioeconomic effect of HIV/AIDS	>6,297
2.	Topic: HIV/AIDS and labour productivity	>5,678
3.	From No. 1 and No. 2	1,924
4.	Topic: Empirical analysis OR panel data analysis OR overlapping generation model OR propensity score matching OR computable general equilibrium (micro simulation analysis) OR correlated fixed effect OR generalised method of moment	>3,542
5.	From No. 3 AND No. 4	543
6.	Topic: mode of transmission of the disease OR prevention strategies OR vulnerability and high risk groups OR stigmatization and information	>4,232
7.	From No. 5 NOT including No.6	362

Note: No = Number
Source: Emerald

The search was further tailored to basically include such citations under 'economic or socioeconomic category' options, which the study believes are more relevant in answering the research questions. Of the 362 records retrieved, 109 studies have the potential to form part of the review.

II. Database: Science Direct

Date search: 19 October, 2013

Table 2.2

Search Results on 09 October 2013 from Science Direct

No	Keywords	Records
1.	Topic: HIV/AIDS and growth OR socioeconomic effect of HIV/AIDS	>7,548
2.	Topic: HIV/AIDS and labour productivity	>4,825
3.	From No. 1 and No. 2	1,893
4.	Topic: Empirical analysis OR panel data analysis OR overlapping generation model OR propensity score matching OR computable general equilibrium (micro simulation analysis) OR correlated fixed effect OR generalised method of moment	>4,623
5.	From No. 3 AND No. 4	615
6.	Topic: mode of transmission of the disease OR prevention strategies OR vulnerability and high risk groups OR stigmatization and information	>3,527
7.	From No. 5 NOT including No.6	418

Note: No = Number
Source: Science Direct

Subjecting the search to studies under the ‘economics or socioeconomic category’ trimmed the citations. Out of the 418 records retrieved, 78 appear relevant to the research questions; hence have the potentials to be included in the review.

III. Database: Wiley online library

Date search: 13 November, 2013

Table 2.3
Search results on 13 November, 2013 from Wiley online library

No	Keywords	Records
1.	Topic: HIV/AIDS and economic growth OR socioeconomic effect of HIV/AIDS	>6,451
2.	Topic: HIV/AIDS and health expenditure	>2,847
3.	From No. 1 and No. 2	1,274
4.	Topic: Empirical analysis OR panel data analysis OR overlapping generation model OR propensity score matching OR computable general equilibrium (micro simulation analysis) OR correlated fixed effect OR generalised method of moment	>3124
5.	From No. 3 AND No. 4	368
6.	Topic: mode of transmission of the disease OR prevention strategies OR vulnerability and high risk groups OR stigmatization and information	>2,532
7.	From No. 5 NOT including No.6	193

Note: No = Number
Source: Wiley online library

The search was directed towards studies that are more of economics. This yield 49 articles which are believed to have the potentials of being part of the review, out of the 193 records retrieved. In both the databases, articles searched covered the period 1990 to 2013. 1990 is chosen as the base year because empirical studies on the economic consequences of HIV/AIDS started emerging at that time (example, Bulatao, 1990).

2.2.2.4 Selecting Studies

While the selection process involves the author's discretion, the choice of articles for the review was based on the aforementioned inclusion/exclusion criteria. The included studies involved those that investigate: the effects of HIV/AIDS on economic growth, economic consequences of the HIV/AIDS, impact of HIV/AIDS on households, effect of HIV/AIDS on labour productivity, effect of health expenditure/HIV spending on HIV prevalence rate as well as impact of HIV/AIDS on firms. However, studies that focused on mode of transmission, prevention strategies, stigmatization and information, vulnerability and high risk groups or any other subject outside the area of interest were excluded.

First, the possibility of having duplicate studies from all the databases was considered. Out of the 236 studies that got the potentials to form part of the review, 8 duplicate items were removed. These effectively left 228 articles to be considered in the review. Then, the titles and abstracts of these 228 articles were scrutinized in order to ascertain the relevance of each to the research questions. Consequently, 41 articles were found potentially relevant to address the research questions. Therefore, the complete texts of these articles were downloaded through the e – journals database, Sultanah Bahiyah Library, Universiti Utara Malaysia. Some texts that could not be assessed freely were requested from the interlibrary loan via the UUM library. After which, the downloaded articles were carefully examined with the tendency of additional exclusion of those studies that might be found not appropriate for the synthesis. Considering the intent of the review, 5 articles, although relevant but being theoretically/conceptually oriented rather than empirical were excluded at this point. They could however, be used as reference point during the course of the research. Those studies are Arntz and Booysen (2003), Whiteside (2006), Johnston (2008), Haacker (2011), and Veenstra and Whiteside (2005). After the exclusion, only 36 studies are considered in the analysis. Appendix IV shows the list of all the articles used in the analysis. Beside the articles used in answering the review questions, a host of other relevant literatures are also utilized as reference during the course of the study.

2.2.2.5 An Overview of Included Studies

Considering that HIV/AIDS is a global phenomenon, in most part of the world its economic impact has been or is being investigated. Unsurprisingly, most of the studies included are in Africa, the continent with the highest HIV prevalence rate, where the epidemic caused the most havoc. Of all the 36 studies reviewed, only 4 focused on SSA, 2 on Africa as a whole and 17 were based on country specific. Specifically, 8 are from South Africa, 4 from Malawi, 2 each from Nigeria and Kenya and 1 from Zambia. While 5 studies were globally based, 4 focus on developing countries, 2 on America, and 1 each on low/middle income countries, and Kazakhstan. The year of studies differs from 1993 to 2013.

With the exception of Oyekale and Oyekale (2010), El-Bassel *et al*. (2011), Canning, Mahal, Odumosu and Okonkwo (2006), Rapues *et al*. (2013), Floyd (2008), and Thornton (2005) that used primary data generated through survey (interviews/questionnaire), data in the rest of the studies are from secondary sources. Of the 30 studies that utilized secondary data in the analysis, 21 are panel, 11 cross-sectional, 3 time series while 1 study; Ozcan (2012) used both cross sectional and panel data. Four of the studies that used primary data/information have both HIV positive individuals and non positive individuals as control group in their sample elements, with age between 15 to 65 years. Also, among studies with secondary data, Fox *et al*. (2004) from the survey data they collected information on both the case group (infected individuals) and the comparison group. Similarly, Arndt and Lewis (2000), and Cuddington and Hancock (1994) simulate both 'AIDS' and 'no AIDS' as well as 'medium' and 'extreme' AIDS scenarios. The objective(s) sought to achieve by each study determine the sample size used as well as the nature of data and type of technique. All the reviewed studies empirically investigate the effects of HIV/AIDS on economic growth or economic consequences of the HIV/AIDS epidemic or effect of HIV/AIDS on households or impact of HIV/AIDS on firms, labour productivity or any other sector of the economy.

2.2.3 Assessing the Quality of the Studies

The methodological quality of all the selected studies was assessed to determine their validity and reliability in supporting the review. As mentioned in section 2.1, the Canadian Council on Learning, quality assessment rubric and scoring criteria (2006), with slight modification to fit the studies reviewed, served as the basis for assessing the quality of the studies (see Appendix V for the rubric and the scoring criteria). The methodological quality was assessed with respect to three major criteria consisting of data quality, model quality as well as results quality. Each criterion comprised of sub-criterions where each can attain a score of 1 (poor), 2 (good), and 3 (very good). When a score for a criterion is between 2 levels (1&2 or 2&3), the lower score is preferred. The score of each sub-criterion in the reviewed studies is indicated in Table 2.4. The examined criteria are:

Quality of Data

1. Sources of the data
2. Completeness of the data used
3. Adequate sample representation
4. Description of the data

Quality of Model

1. Types of techniques of analysis
2. Assumptions of the model
3. Specification of the model
4. The variables choose

Quality of Results

1. Statistical significance of the results
2. Estimation bias
3. Objectivity of the discussion

Altogether, there are eleven criterions which allow each study to have a total score of between 11 and 33 points. Studies that have scored more than or equal to 28 are judged to be of very good quality, between 22 and 27 are classified as good while below 22 are of fair quality. In line with the basic requirement for inclusion that demand each study to have empirical content, virtually all the studies have scored reasonably well in every criterion. The objectives of the studies were clearly stated in line with the economic effects of HIV/AIDS. The findings from very good quality studies provide convincing evidence for the analysis while evidence from good quality studies, notwithstanding some weaknesses in certain aspects is also used in the analytical review. However, findings from fair quality studies are not considered. Of the 36 studies reviewed, 28 are of ‘very good’ quality while the remaining 8 are considered of ‘good’ quality.

2.2.3.1 Analysis

Quality of Data

The quality of data is determined by four criterions – sources of data, completeness of the data used, adequate sample representation and description of the data. Although, 6 studies used primary data collected through a detailed survey (questionnaire/interview), majority of the studies (30) utilized data from secondary sources. All studies scored the maximum ‘3’ point for the data source, meaning that the sources are reliable and well documented.

Missing data is inevitable in most research especially for studies that are based on survey data on sensitive issue like HIV/AIDS. Therefore, in terms of data completeness, ‘2’ point is given to each study including those that have not explicitly reported missing data (e.g. Cuddington & Hancock, 1994; Michiele *et al*. 2007; Magadi, 2011). It is believed that whether or not the problem of missing data is reported, the results of the studies will not be seriously affected.

With respect samples representation, 25 studies scored the maximum ‘3’ each having a good representation of the selected samples while the remaining 11 studies each earned fair score ‘2’ with a fair representation of sample, which is believed to have not seriously affect the quality of their results. Except for Bonnel (2000), who in describing the variables used mentioned figures (2 & 3) that were not found throughout the paper, all other studies described the variables used in their analysis using either in-text explanation or tables or both. More than 25 studies use both in-text explanation and tables in describing the variables, hence obtained the highest score.

Quality of Model

Quality of model, like quality of data is assessed using four criteria which are: type of techniques of analysis, assumptions of the model, specification of the model and variables choose. None of the entire studies score more than ‘2’ point in the type of analysis criterion because they virtually employed one technique of analysis, that is econometrics without augmenting it with other acceptable approach like qualitative technique. Even though some studies like (Canning, *et al*. 2006; Fraser, *et al*. 2002; Mahmoud & Thielle, 2013; Yamano, 2004; Zimmer, 2009) have in addition to the econometrics approach provides descriptive analysis of the variables.

Most of the studies (20) have not clearly state and explain the assumptions used in the analysis. A fair score ‘2’ is given because it is believed that lack of stating the assumptions will not significantly affect the estimated results or invalidates the findings or undermine the projections/ forecast made. The remaining 16 studies score the maximum ‘3’ having indicates the assumptions used.

Score ‘3’ is given to a study if the functional form of the model specified is tested by the researcher or justified by reference to other reliable sources; otherwise score ‘2’ is given if the specified model is compatible with the study’s data and is normally use in related studies. Of all the studies, 28 score ‘3’, although they had not tested the validity of the functional form of the model specified, they had justified by making reference to reliable sources. Among the remaining 8 studies, 6 score ‘2’ having model specified consistent with the type of data used while 2 studies (Gaffeo, 2003; Rapues, *et al*. 2013) score ‘1’ point each because no any model was clearly specified in the papers.

With respect to choice of variables criterion, all the studies earned the highest score ‘3’ because each had selected variables relevant to the study. Uniformity in the choice of variables should not be expected, as choice of variables depends on the nature of the problem each study sought to address.

Quality of Results

Basically, the quality of research result is explained by the quality of the data used and corrects specification of the model. Three criteria –significance of the results, estimation bias as well as objectivity of the discussion of the results determine the quality of results. Of all the 36 studies, 34 score ‘3’ for discussing the statistical significance of the results while the remaining 2 studies (Gaffeo, 2003; Cuddington & Hancock, 1994) failed to explicitly discuss the statistical significance thereby earning ‘2’ point each. In spite of this, the results of the two studies were logically discussed based on their objectives.

The delicate and sensitive nature of HIV/AIDS makes data difficult to obtain. As such, samples especially of HIV/AIDS variable may not be representative due to missing data which could lead to estimation bias. Therefore, most of the studies obtained fair score '2' for this criterion. Considering the last criteria – overall objective, in all the studies the results were objectively discussed. Inferences made and implications shown were based on the estimated results. Thus, all studies deserved '3' points.

Based on the sub-criterions scores indicated in Table 2.4, most of the reviewed studies are of high quality as shown in Figure 2.1.

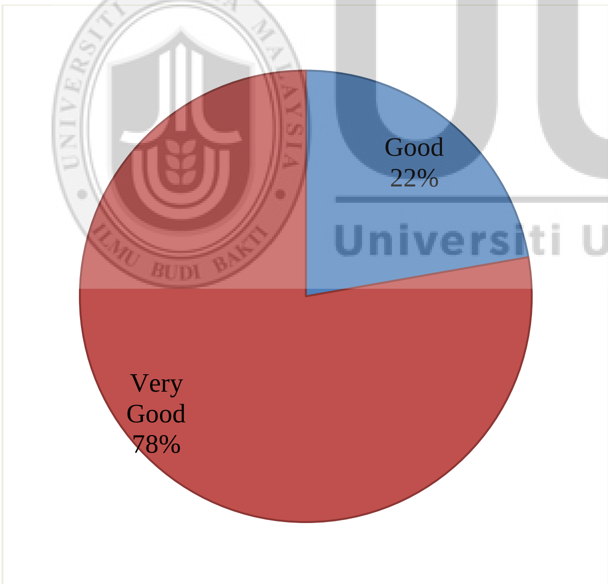

Figure 2.1
Quality of the Reviewed Studies Based on the Standard Rubric

2.2.4 Collecting Data/Information

Following the assessment of the methodological quality, important information from all the reviewed studies is extracted for further use. The extracted information comprises the following:

1. Basic information – Author, Year, objective(s)
2. Study characteristics – country, source of data, and type of data (time series/cross sectional/panel), period covered
3. Empirical content -

   Variables used

   Model type – linear, non – linear, others

   Framework – Single equation, simultaneous equation

   Estimation method – Ordinary Least Square, Difference – in – Difference, Two Stage Least Square, Computable General Equilibrium, Generalised Method of Moments, Others
4. Results

The extracted data/information is transmitted to Tables 2.5 and 2.6.

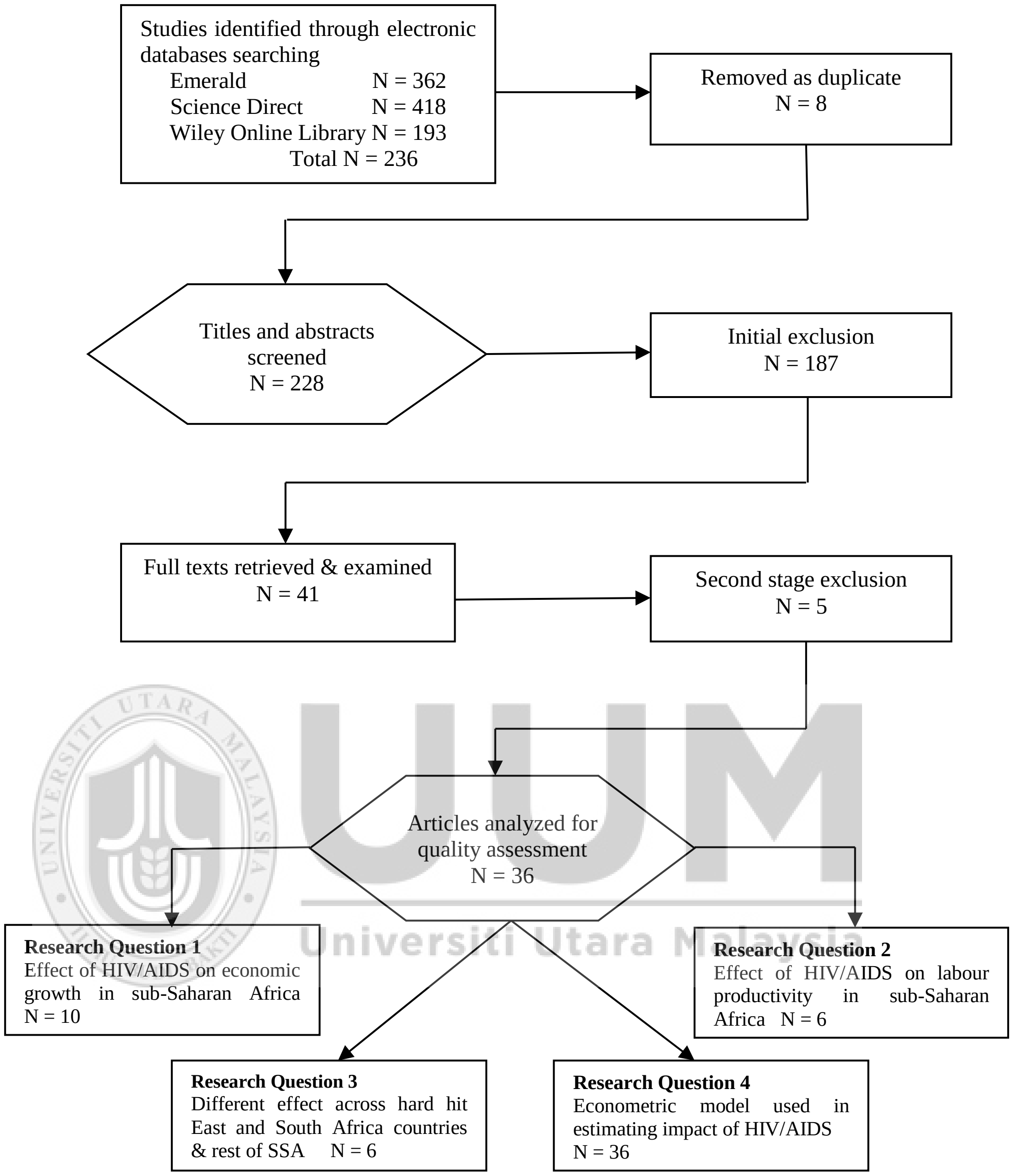

Figure 2.2
The Flow of Literature Selection through the Review

Table 2.4
Summary of the Methodological Quality

Study No	Author (Year)	Data Source	Data Completeness	Representative Sample	Data Description	Type of Analysis	Model Assumption	Model Specification	Choice of Variables	Statistical Significance	Estimation Bias	Overall Objectivity
1.	Arndt & Lewis (2000)	3	2	3	3	2	3	2	3	3	2	3
2.	Asiedu, Jin, & Kanyama (2011)	3	3	3	3	2	2	3	3	3	2	3
3.	Avila, *et al*. (2013)	3	2	2	2	2	2	2	3	3	2	3
4.	Augier & Yaly (2013)	3	2	2	2	2	3	3	3	3	2	3
5.	Agbola, *et al*. (2004)	3	2	2	3	2	2	3	3	3	2	3
6.	Bloom & Mahal (1997)	3	2	3	3	2	2	3	3	3	2	3
7.	Bonnel (2000)	3	2	3	2	2	2	3	3	3	2	3
8.	Corrigan, *et al*. (2005)	3	2	2	3	2	3	3	3	3	2	3
9.	Chicoine (2012)	3	2	3	3	2	3	3	3	3	2	3
10.	Canning, *et al*. (2006)	3	2	3	2	2	2	2	3	3	2	3
11.	Cuddington & Hancock (1994)	3	2	2	2	2	3	3	3	2	2	3

Table 2.4 (Continued)

Study No	Author (Year)	Data Source	Data Completeness	Representative Sample	Data Description	Type of Analysis	Model Assumption	Model Specification	Choice of Variables	Statistical Significance	Estimation Bias	Overall Objectivity
12.	David & Li (2010)	3	2	3	3	2	2	2	3	3	2	3
13.	Dixon, McDonald, & Roberts (2001)	3	2	3	3	2	2	3	3	3	2	3
14.	Dureval & Lindskog (2012)	3	2	2	3	2	2	2	3	3	2	3
15.	El-Bassel, *et al*. (2011)	3	2	3	2	2	2	2	3	3	2	3
16.	Floyd (2008)	3	2	3	3	2	2	2	3	3	2	3
17.	Fraser, *et al*. (2002)	3	2	2	3	2	2	2	3	3	2	3
18.	Fox, *et al*. (2004)	3	3	3	2	2	3	3	3	3	2	3
19.	Gritzman (2005)	3	3	3	2	2	3	3	3	3	2	3
20.	Gaffeo (2003)	3	2	2	3	2	2	1	3	2	2	3
21.	Lovasz & Schipp (2009)	3	2	3	3	2	3	3	3	3	2	3
22.	McDonald & Robberts (2006)	3	2	3	3	2	3	3	3	3	3	3

Table 2.4 (Continued)

Study No	Author (Year)	Data Source	Data Completeness	Representative Sample	Data Description	Type of Analysis	Model Assumption	Model Specification	Choice of Variables	Statistical Significance	Estimation Bias	Overall Objectivity
23.	Mahmoud & Thiele (2013)	3	2	3	2	2	3	3	3	3	2	3
24.	Mclntosh & Thomas (2004)	3	3	3	2	2	2	2	3	3	2	3
25.	Murtin & Marzo (2013)	3	2	3	3	2	2	3	3	3	2	3
26.	Magadi (2011)	3	2	3	2	2	3	2	3	3	2	3
27.	Nunnenkemp (2011)	3	2	2	3	2	2	3	3	3	2	3
28.	Ozcan (2012)	3	2	3	2	2	2	3	3	3	2	3
29.	Oyekale & Oyekale (2010)	3	2	3	3	2	2	2	3	3	2	3
30.	Rapues, *et al.* (2013)	3	2	3	2	2	2	1	3	3	2	3
31.	Thornton (2005)	3	2	3	3	2	3	3	3	3	2	3
32.	Michiele, *et al.* (2007)	3	3	3	3	2	2	2	3	3	2	3
33.	Vasilakis (2012)	3	2	2	3	2	2	3	3	3	2	3

Table 2.4 (Continued)

Study No	Author (Year)	Data Source	Data Completeness	Representative Sample	Data Description	Type of Analysis	Model Assumption	Model Specification	Choice of Variables	Statistical Significance	Estimation Bias	Overall Objectivity
34.	Yamano (2004)	3	2	3	2	2	2	3	3	3	3	3
35.	Young (2005)	3	2	3	3	2	3	3	3	3	2	3
36.	Zimmer (2009)	3	2	2	3	2	2	2	3	3	3	3

Table 2.5

Results of the Reviewed Studies

Study No	Author (Year)	Country	Objective of the studies	Results	Model types, estimation technique, and data
1.	Arndt & Lewis (2000)	South Africa	To examine the macroeconomic effects of AIDS in South Africa.	The result shows that, in terms of impact of the epidemic, the difference between the 'AIDS' and 'no AIDS' scenario was substantial. In the two scenarios, GDP growth rate differs steadily, to a maximum of 2.6% points, and in 2010 the level of the GDP in the 'AIDS' scenario is 17% lower. Though, some of this decline is explained by lower population attributed to the 'AIDS' scenario, GDP per capita did decline by about 8%. Largely, the worsening of growth in the economy is attributed to shifting government current expenditure to health expenses. The health expenses are in terms of treatment, control and prevention which create more budget deficit and decreases investment. The fall in investment due to financing the budget deficit reduces employment and output which in turn leads to decline in income, hence declining economic performance.	Simulation with Computable General Equilibrium. (Panel)
2.	Asiedu, Jin, & Kanyama (2011)	Developing countries	To empirically investigate the relationship between HIV/AIDS and foreign direct investment (FDI).	The results show that HIV/AIDS has non-linear negative but diminishing effect on foreign direct investment. That is, as the HIV/AIDS prevalence increases the effect diminishes. Also, the adverse effect prevails even when the prevalence rate is as little as one percent. This is because the supply and quality of labour will diminished in the present of HIV/AIDS which will adversely affect businesses and discourage foreign direct investment.	System Generalized Method of Moments (GMM), Panel, 1990-2008
3.	Avila, Loncar, Amico, & De Lay (2013)	Low & middle income countries	To evaluate the determinants of domestic spending on HIV and examine the trends of regional spending on the epidemic.	Increase in HIV/AIDS prevalence rate increases both domestic and public spending on the epidemic. There is also a positive relationship between increase in GDP per capita and public spending on HIV/AIDS. Spending increase in order to reach the universal access targets for prevention, treatment and care. The spending pattern indicates that domestic per capita HIV/AIDS expenditure rose from US $ 0.31 to US $ 1.11 in between year 2000 to 2010 and it varies with region and income level. Poor countries with high HIV prevalence, because of lower income level are unlikely to invest adequate resources to combat the scourge of the epidemic.	Regression: Ordinary Least Square. (Panel), 2000-2010

Table 2.5 (Continued)

Study No	Author (Year)	Country	Objective of the studies	Results	Model types, estimation technique and data
4.	Augier & Yaly (2013)	Global	To investigate the long term effect of HIV/AIDS on the economic equilibrium.	It was found that poor health due to infectious diseases has effect in explaining some economic downturns. This is because the disease function in a country is characterized by a critical threshold. If the country's disease level is below the critical, it progressively disappears. If, however, it rises above the critical, then the rising speed of the disease becomes a serious risk for the economy, and the state of the economy becomes exceedingly shaky. Impact of the infectious diseases also tends to depends on economic incentives, rational and preventive behaviour.	Overlapping Generation Model. General equilibrium model. (Cross-sectional)
5.	Agbola, Damoense & Saini (2004)	South Africa	An evaluation of the effect of HIV/AIDS on food demand.	The result shows that, with the spread of HIV/AIDS, the demand for rice, pork, wheat, mutton, chicken and egg tend to be greater than without HIV situation. This is because HIV/AIDS affected households will largely consume such food items to sustain the nutrition level of the infected individuals in order to boost their immune system. Meaning that in both 'WITH AIDS' and 'WITHOUT AIDS' scenarios, there is an increase in demand for the food items under consideration.	Simulation (a simple demand function). (Time series), 1970-2000
6.	Bloom & Mahal (1997)	Global	To examine the argument whether AIDS slows down economic growth.	The results suggest that the effect of AIDS on per capita income growth is not significant. This implies that the AIDS prevalence was low with limited effect on morbidity and mortality to have any significant effect on the growth of national economies. There is also no support of reverse causality. Hence, the conclusion contends the argument that AIDS obstruct economic growth has more flash than substance.	Regression: OLS three different equations. (Panel), 1980-1992

Table 2.5 (Continued)

Study No	Author (Year)	Country	Objective of the studies	Results	Model types, estimation technique, and data
7.	Bonnel (2000)	Developing countries	To investigate whether HIV/AIDS reduce the growth of per capita income.	The effect of HIV/AIDS on growth is negligible in countries with low prevalence. This is because the low HIV/AIDS prevalence will exert limited negative labour productivity effect which could have mild effect on output GDP growth. In Africa, where the average HIV prevalence rate is 8%, the growth in GDP per capita is estimated to be lower by around 0.7% point annually. This mean in countries with higher prevalence rate, the economic cost is estimated to be substantial. Higher HIV/AIDS prevalence leads to serious negative labour productivity and increase in health care expenditure which reduced domestic saving and investment. Consequently, per capita income, hence economic growth declined.	Regression: OLS and Two stage least squares, (Panel), 1990-1997
8.	Corrigan, Glomm & Mendez (2005)	South Africa	Evaluation of the effect of AIDS on human capital accumulation and growth.	The result shows that the economic consequences of the AIDS epidemic on human capital and growth are substantial. Mostly, the opportunities of orphans to obtain human capital are less than if parent(s) were alive. Often, upon the death of a parent, children's education is disrupted or terminated in order to support the sick parent or work to supplement family income. Furthermore, AIDS decreases life expectancy which in turn reduced the incentive to invest leading to declining growth. The policy of changing subsidy on HIV/AIDS medication has comparatively little effect on growth.	Simulation, dynamic general equilibrium model. (Cross-sectional)
9.	Chicoine (2012)	South Africa	To examine how HIV/AIDS mortality affect employment and wages in the labour market.	Reduction in the supply of labour due to HIV/AIDS mortality has not lead to significant rise in wages in South African economy. Rather, the employment opportunities and wages of those individual within the population with high mortality are negatively affected. The result is consistent for the black South African men and women, where the reduction in wages is estimated to be around 3% and 6% for males and females respectively. This is because falling life expectancy due to widely spread effects of HIV/AIDS could constrain firms and individuals to invest less in productivity, leading to lower wages. Also, some of the cost of provision of the antiretroviral treatment by some firms in South Africa is conceded by the workers in the form of reduced wages.	Demographic model, log likelihood function. Probit model. (Panel), 2001-2007

Table 2.5 (Continued)

Study No	Author (Year)	Country	Objective of the studies	Results	Model types, estimation technique, and data
10.	Canning, Mahal, Odumosu & Okonkwo (2006)	Nigeria	An assessment of effect of HIV/AIDS on individuals' health care utilization and expenditure.	The finding indicates that women report themselves as HIV positive much later than men. This is explained by their lack of awareness of the HIV/AIDS in relation to men. HIV positive individuals frequently reports morbidity, utilizes more of health care services provided by public facilities, expend much money on medication from out of pocket. The total lost with respect to an infected individual in terms of health care costs and income lost is around 32% of the affected households' annual per capita income. This is because of the huge amount spent on treatment and care in addition to earning lost due to frequent absenteeism.	Regression: Propensity score matching method. (cross sectional), 2004
11.	Cuddington & Hancock (1994)	Malawi	To examine the impact of AIDS on macroeconomic performance in Malawi.	Average growth rate in real GDP over 1985 – 2010 is suggested to be between 0.2 and 0.3 percent lower in the medium AIDS scenario and 1.2 to 1.5 percent lower in the extreme AIDS case. This suggests that in the medium scenario, the AIDS impact on per capita GDP is small but could be worse in the extreme situation. The negligible or small effect is because the AIDS not only reduces GDP per capita but also the population, however, in extreme situation with high prevalence rate the effect of higher mortality will upset the likely corresponding increase in per capita GDP.	Simulation: growth model (Panel). 1985-2010
12.	David & Li (2010)	Global	To evaluate the impact of HIV/AIDS on social capital.	HIV/AIDS adversely affect social capital proxy by 'trust' and consequently, significantly obstruct growth and development efforts. The epidemic could worsen uncertainty and asymmetric information leading to impossibility of monitoring sexual behaviour hence reduction in trust with adverse consequences on overall economic performance. The stigmatization associated with the HIV/AIDS will also have negative influence on trust and subsequently economic growth. A unit increase in HIV/AIDS prevalence, erode trust by at least 1%. In high prevalence countries like Uganda, evidence shows more than 11% decline in social capital. The eroding of the social capital is up to 11% in countries with high prevalence like Uganda.	Regression: OLS. (Cross-country)

Table 2.5 (Continued)

Study No	Author (Year)	Country	Objective of the studies	Results	Model types, estimation technique, and data
13.	Dixon, McDonald, & Robberts (2001)	Africa	To assess the effect of HIV/AIDS on economic growth performance.	In countries with comparatively low HIV/AIDS prevalence, the epidemic's effect is conventional to expectation. However in the presence of relatively high prevalence rate found in other countries, the macroeconomic impact remain ambiguous, that is, unclear. This finding could be due to fundamental changes in the production functions of these countries that are not explained by the model formulation.	Two way error components fixed effects model, seemingly unrelated regression (SUR). (Panel), 1960-1998
14.	Dureval & Lindskog (2012)	Malawi	An evaluation of the relationship between HIV infection and economic inequality.	There exists a significantly positive relationship between the risk of HIV infection and economic inequality at both neighbourhood as well as district levels. As economic inequality exposes individuals to risky sexual behaviour, both married and unmarried men report more non spousal sexual partners in the presence of higher district inequality, and unmarried women report more sexual partners when neighbourhood inequality is high. The inequality–HIV relationship is further explained by migration pattern as migrants bring back both wealth and the HIV from the urban to the village. While the association between individual's HIV/AIDS status and indicators of poverty remain ambiguous, there is no support that women from poor families are more susceptible to HIV infection compared to others.	Multi level logistic model. (Cross-sectional), 2004; 1997-98
15.	El-Bassel, *et al*. (2011)	Kazakhstan	To examine the relationship between mobility pattern and sexual risk behaviour for HIV among migrant market vendors.	There was large unprotected sex with both regular and casual partners among the sample respondents most of whom were young adults. This is because longer duration and frequent travel either to buy goods or visit family influence risky sexual behaviour. Two-third of men & one-fifth of women agreed to have had sex with more than one partner during the 90 days survey period. Level of HIV/AIDS knowledge was low among the participants, especially women.	Descriptive statistics & Multiple imputations by chain equation module. Multivariate analysis. (Cross-sectional), July-October 2007

Table 2.5 (Continued)

Study No	Author (Year)	Country	Objective of the studies	Results	Model types, estimation technique, and data
16.	Floyd (2008)	Malawi	To assess the impact of HIV/AIDS on the socioeconomic status of the spouses of HIV positive individuals.	The results suggest that virtually most of the marriage within 1998-2000 in which one of the spouses is HIV positive ended in widowhood, that is, the death of the infected spouse. Substantial number of surviving wives of HIV positive men becomes breadwinners in the family relative to insignificant number of such wives of uninfected individuals. Greater numbers of women whose husbands succumb to AIDS death were over 35 years with little assets to support up keep. Hence, the socioeconomic consequences of the HIV/AIDS epidemic are substantial on the spouses of HIV positive individuals as they struggled for subsistence.	Regression. (Panel), 1998-2000
17.	Fraser, Grant, Mwanza & Naido (2002)	South Africa	To investigate the effects of AIDS on small and medium scale enterprises.	Both the small and medium enterprises are witnessing the rising and devastating consequences of the HIV/AIDS epidemic. They had to contend with increase in absenteeism and deaths due to HIV/AIDS related illnesses, as well as cope with rising expenses in terms of treatment, recruitment and training and settlement allowances.	Descriptive analysis. (Longitudinal), 2 years
18.	Fox *et al*. (2004)	Kenya	To investigate the effect of HIV/AIDS on individual productivity during the disease succession.	The findings shows that HIV infected workers become less productive almost 18 month prior to termination due to AIDS and often go on leave 3 years before the termination. This is because most of the infected workers do not have access to the costly immune booster antiretroviral therapy. Due to the HIV/AIDS related illnesses they also earned 16.0% lower than normal pay in their second year prior to termination and 17.7% lower in the termination year.	Longitudinal regression: Random Effect Model, (retrospective cohort design). 1997-2002
19.	Gritzman (2005)	South Africa	To examine the role of socio-economic variables in determining individual's HIV infection.	The result suggests no any important association between education and the likelihood that an individual is affected by HIV. However, the evidence support that higher earning and socioeconomic status reduce the likelihood that an individual become infected with HIV. Higher earning reduces income inequality and promote socioeconomic status hence reduced the possibility of engaging in risky sexual behaviour.	Regression: Probit, 3 different equations. (Panel), May & December 2001

Table 2.5 (Continued)

Study No	Author (Year)	Country	Objective of the studies	Results	Model types, estimation technique, and data
20.	Gaffeo (2003)	Sub-Saharan Africa	To survey the main economic issues associated with HIV/AIDS: market failure, regional development and efficient policy design.	HIV/AIDS has micro/macro economic as well as social consequences in sub-Saharan Africa. At microeconomic level, the epidemic affects issues as peasant behaviour, and land tenancy; interactions between individual income, health and productivity; education and disinvestment in human and social capital; and ultimately access to credit and insurance. The macroeconomic issues are explained in terms of the epidemic's negative influence on growth of capital accumulation, labour inputs and aggregate factor productivity which in turn determine economic performance. Without a decisive effort to curtail HIV/AIDS, people in the region are bound to experience a further fall in standard of living in both relative and absolute terms.	Descriptive analysis. (Panel)
21.	Lovasz & Schipp (2009)	Sub-Saharan Africa	To investigation the effect of HIV/AIDS on per capita income in sub-Saharan Africa.	HIV/AIDS was found to have significant negative effect on per capita income in SSA. The epidemic through its devastating consequences on the substantial number of the infected individuals and their families, firms and various governments has culminated in slowing down the macroeconomic growth. Evidence suggests that countries where prevalence rate is high grow much slower relative to those with low prevalence. Thus, in SSA HIV/AIDS tends to substantially retards economic growth.	Generalised method of moment GMM. (Panel). 1997-2005
22.	McDonald & Robberts (2006)	Global	To evaluate the impact of AIDS on economic growth.	The effect of the AIDS epidemic tends to be substantial especially in Africa, where estimates shows that one percent increase in HIV prevalence on average leads to 0.59 percent decline in per capita income. Hence, excess labour does not appear to mitigate the growth effect of the epidemic, which was further shown to be non trivial even in countries where HIV/AIDS is low.	System of two equations, a structural growth equation. (Panel), 1960-1998
23.	Mahmoud & Thiele (2013)	Zambia	To evaluate the effect of prime age mortality due to AIDS on surviving household members.	Evidence suggests that the negative effect of the epidemic spill over to non infected households as the sick person's family/relative lived with him/her to give terminal care or contribute money for treatment. However, adult equivalent income in infected households is not influenced by the death of prime age member. Selling of productive assets and attraction of new household members, that is, change in the household composition contributes to such outcome.	Difference-in-difference – propensity score matching. (Longitudinal), 2001 & 2004

Table 2.5 (Continued)

Study No	Author (Year)	Country	Objective of the studies	Results	Model types, estimation technique, and data
24.	Mclntosh & Thomas (2004)	Global	Evaluating the economic and other determinants of HIV/AIDS prevalence.	The result suggests a negative relationship between a large population in a country and HIV/AIDS and a positive one between long duration of the epidemic and prevalence rate. That is, while countries with large population tend to have low HIV/AIDS, the longer the epidemic remain in a country the more the prevalence will spread. It was also found that political violence and income inequality stimulates the spread of the HIV/AIDS epidemic while gender equality reduces the HIV prevalence. Religion is also important predictor, as predominantly Muslim and orthodox Christian countries generally have low HIV/AIDS prevalence, due to prohibition of sex outside marriage. Public health and media are statistically irrelevant, perhaps due to inefficiency.	OLS, (Cross-sectional).
25.	Murtin & Marzo (2013)	South Africa	To evaluate the effect of HIV/AIDS on household labour and none labour income.	HIV/AIDS has no substantial effect on the labour income and participation. This is explained by the re-composition of the household's that is, adapting to the new situation through increasing labour participation of non infected healthy persons. The epidemic however, has important effect on the transfer of income among both the two settings. Additionally, illness leads to more participation in the transfer network especially for urban population accessible to public grants.	Bayesian method: Selection model with correlated fixed effects. (Panel), 3 years
26.	Magadi (2011)	Sub-Saharan Africa	To examine the extent to which households or communities with high HIV/AIDS prevalence affects under five children nutritional status in comparison to children in less affected households or communities.	Children from HIV positive mothers tends to substantially suffers from certain nutritional deficiencies such as underweight and stunted growth relative to their counterparts from same economic and social background but whose mothers are HIV negative. This outcome is explained by socio-economic factors as household wealth, mother's education and accessibility to medical care among others. However, paternal orphans' children or children that live in household with infected adults or in societies in which HIV prevalence is high are not associated with increased risk of malnutrition.	Multi level logistic regression model. (panel), 2003-2008

Table 2.5 (Continued)

Study No	Author (Year)	Country	Objective of the studies	Results	Model types, estimation technique, and data
27.	Nunnenkemp (2011)	Developing countries	Evaluation of the effectiveness of official development assistance (ODA) in curtailing HIV/AIDS.	Official development assistance is not sufficient to prevent entirely new HIV infections. However, due to efficient disbursement, monitoring and implementation strategy, official development assistance that emanates from the United States substantially contributes to medical care and treatment of the infected persons relative to official development assistance from multilateral organizations.	Difference-in-difference-in-difference model. (panel), 1990-2007
28.	Ozcan (2012)	Africa	To investigate the effect of HIV/AIDS on total fertility in Africa.	In a cross section of countries and regions, evidence shows that HIV/AIDS has significant positive influence on fertility as infected women prefer to give birth to more children hoping some may survive. However, estimates from the time series variation exhibit positive and negative influence, depending on which HIV/AIDS variable is considered, though most specifications reveal insignificant influence.	OLS. Cross-sectional and panel data. 1985-2000
29.	Oyekale & Oyekale (2010)	Nigeria	Assessing farmers' perceptions on the effect of HIV/AIDS on their socioeconomic activities and analyse their attitude toward risky behaviour	HIV infected farmers are more distance from public health facilities compared to none infected farmers. Educated farmers have lower likelihood of being involved in risky behaviour. Poverty contributes to involvement in risky behaviour and chronic diseases like tuberculosis, malaria are 84.4% in the household of affected farmers against 31.17% of non affected farmers.	Descriptive method & Logistic regression model. (cross sectional), 2004
30.	Rapues, *et al*. (2013)	San Francisco	To evaluate the correlates of HIV infection among transfemales	Weighted HIV prevalence among transfemales was 39.5%. This is because the transfemales were argued to be most at risk in main rather than casual and commercial partnerships. Being a transfemales of colour, using injection drug, and having low educational attainment were independently associated with HIV infections.	Multivariate analysis. (cross sectional), 2010

Table 2.5 (Continued)

Study No	Author (Year)	Country	Objective of the studies	Results	Model types, estimation technique, and data
31.	Thornton (2012)	Malawi	To examine the effects of learning HIV status on economic behaviour.	Learning the results of HIV status is associated with short term 2-6 months effects on individual's subjective beliefs. However, the results does not continue beyond 2 years especially among those HIV positive individuals who felt they are not likely to become infected, hence they potentially deny or erroneously deduce their infection status when they are still alive. Learning positive HIV status tends to lower savings rate among the infected individuals. This is due to increasing spending on treatment and care, and the subjective believe that life will soon end.	Econometric approach. (Panel), 1998 & 2004
32.	VanHandel, *et al*. (2012)	America	To determine the newly identify HIV positivity and the characteristics in correctional facilities.	The newly identified HIV positive (0.7%), support routine opt-out HIV testing in correctional health care facilities. The high proportion of HIV cases occurred among persons who might not perceived or acknowledge themselves to be at high risk (i.e. low-risk heterosexual contact, no acknowledge risk). A substantial portion of newly identified HIV positive detainees (30%) would not have been diagnosed if testing were conducted only among those who perceived & reported themselves as high risk for HIV.	Multiple logistic regression models. (cross sectional), 2007
33.	Vasilakis (2012)	Developing countries	To investigate the impact of HIV/AIDS in terms of increased morbidity and mortality in developing countries.	Infected individuals tends to increase their personal health expenditure while decrease that of their offspring. Due to transmission effect, parents are likely to increase spending on their children instead of themselves. Declining productivity of young parents leads them to cut back their health expenditure as well as those of their children.	Simulation: discrete time perfect foresight dynamic model. (Panel)
34.	Yamano (2004)	Kenya	To estimate the impact of adult mortality due to HIV/AIDS on household socioeconomic status in rural Kenya.	There is substantial decline in the size of households in situation where the female household head is afflicted. This drastically reduces the amount of other women and adult girls in the family. Equally, the death of male household head seriously reduces the number of women living in the household. In contrast, the passing away of common adult family member is equally offset by entry or return of another member.	Difference-in-difference (DID) model. (Panel), 2 year (1997 & 2000)

Table 2.5 (Continued)

Study No	Author (Year)	Country	Objective of the studies	Results	Model types, estimation technique, and data
35.	Young (2005)	South Africa	To evaluate the impact of AIDS on human capital accumulation of orphaned children and fertility.	The study found that even with very negative assumption about decline in the level of education, the fertility effect prevails, that is, HIV/AIDS decreases fertility due to behavioural changes where people are not willing to engage in unprotected sex. Also, the epidemic not only tends to enhances the future per capita consumption (income) but also augment it with additional resources which could be use to care for the afflicted and provide future generations with higher living standard because of the higher wages due to increased mortality and the lower fertility.	Beckerian household model & Poisson count model. Simulation, (Micro panel), 1995 & 1998
36.	Zimmer (2009)	Sub-Saharan Africa	To investigate whether cumulative AIDS deaths has positive correlation with living with grandchildren among grandparents.	The result indicates that across the SSA region significant number of older adults, almost one in every four lives with a grandchild whose parents were missing either due to HIV/AIDS or other reasons. In communities where AIDS mortality is high, it is common to find elderly people living with total orphaned grandchild.	Descriptive analysis, bivariate correlation. OLS. (Cross-sectional) 1991&1993, and 2001 & 2005

2.2.5 Analysing and Presenting Results

2.2.5.1 Effect of HIV/AIDS on Economic Growth

This section explores the effects of HIV/AIDS on economic growth based on the reviewed studies. Understanding the association between HIV/AIDS and economic growth is important for economic and health policy. In the discussion here, reference is being made to Table 2.5 where each study is referred to according to its number in the table. Out of the 36 reviewed studies, 10 specifically investigate the impact of HIV/AIDS on economic growth, although with different coverage. Five studies are country specific, which are based on South Africa [1, 8, 25, 35], and [11] is on Malawi. While two studies [6, 22] have global focus, the remaining three [7, 13, 21] are based on developing countries, Africa and SSA respectively.

The results from the studies indicating the effects of the HIV/AIDS epidemic on economic growth are mixed and conflicting. While studies [6, 11, and 25] contend that the effect is mild and of no serious concern, others [1, 8, 21, and 22] established significant effect. Still other studies [7, 13] find that the effect of the epidemic is unclear and ambiguous. This is because with relatively low prevalence rate, the effect tends to be negligible but could be worse in the extreme AIDS situation. Above these, one study [35] argued that the epidemic has positive effect on growth because it will enhance future per capita consumption due to higher wages as a result of increased mortality and lower fertility.

McDonald and Roberts (2006), and Lovasz and Schipp (2009) attest that most of the early quantitative estimates of the effect of HIV/AIDS on economic growth were compromised by lack of adequate data; hence, they resorted to simulation. This is one of the factors explaining the mixed and conflicting results. For instance, the robustness of the results of study [6] is doubtful because it used data for the period 1980-1992 in which HIV prevalence rate was very low with little effect on mortality and morbidity. The lack of consistency in the previous findings is further buttress by Haacker (2011) that institutional bias also tempered with earlier results because most studies which emanate at the World Bank were able to find that HIV/AIDS reduces GDP per capita. Such result is essential otherwise the World Bank will not regard the findings as credible. However, most of those studies not affiliated with the World Bank frequently discover contrary results. These point the need for further study with much longer data horizon which is feasible because of the development in the HIV seroprevalence survey and epidemiological system.

2.2.5.2 Effect of HIV/AIDS on Labour Productivity

Once more, reference to Table 2.5, the effect of HIV/AIDS epidemic on labour productivity is examined based on the selected studies. Of all the 36 studies, only three [9, 18, 25,] specifically assess empirically the effect of HIV/AIDS on labour productivity. Even though, their assessment was not at the macroeconomic level, but rather microeconomic, that is, on individual agricultural estate and household labour income respectively. Other studies [1, 7, and 11] gave a suggestive and theorising rather than empirical analysis of the epidemic's effect on labour productivity. Although common sense agreed that sick workers are less productive, the pace and the magnitude of the decline in the labour productivity are not empirically described. Strauss and Thomas (1998) argue that difficulties in observing the health status and productivity of an individual worker are the reasons for the dearth of empirical studies. This left a gap which needs to be filled in order to give entrepreneurs and policy maker's information to formulate strategies to deal with the HIV/AIDS pandemic.

2.2.5.3 Impact of HIV/AIDS between the Hard Hit Eastern and Southern Africa and Rest of sub-Saharan Africa

In this section we explore the effect of the epidemic between countries, especially those in the hard hit Eastern and Southern regions and the rest of sub-Saharan countries. Reference to Table 2.5, five of the studies [1, 8, 25, 35, and 11] is based on South Africa and Malawi – countries in the hard hit region. Yet, within the same region, the results regarding the effect of the epidemic on growth are mixed and conflicting. This is because, while studies [1, 8] find substantial effect, [25] finds no effect, [35] even finds a positive effect and [11] finds low effect in the medium AIDS situation but could be worse in the extreme AIDS case. Other studies [6, 7, 13, 22] that focused on SSA or developing countries, have not examined whether the effect of the HIV/AIDS epidemic on growth in the hard hit Eastern and Southern regions is different from the rest of SSA. However, study [1] determines the effect of the HIV/AIDS epidemic in Eastern and Southern regions and the Rest of SSA. The findings reveal that in the full SSA sample HIV has significant effect on per capita GDP growth. There is however no evidence that HIV reduces the growth of GDP per capita in either Eastern and Southern regions or the Rest of SSA. This perhaps was due to the short observation period of 9 years, which was further reduced to 7 by the instruments of the GMM estimator hence, influences the robustness of the results. Therefore, it is understood that the issue of whether the effects of HIV/AIDS epidemic in the highly infected region is different from the Rest of SSA is not well empirically investigated. This gives the substance for further investigation.

Of the 36 studies reviewed, six [3, 7, 11, 22, 10, and 26] points that HIV/AIDS increase health expenditure because, infected individuals and their families, government and donor agencies increase health spending in terms of treatment, maintenance and prevention. In order to implement the mitigation programmes, donor agencies and affected governments have raised by 20 times the sum of money available for funding the HIV/AIDS response (Poku, 2006). A positive association exist between GDP per capita and HIV/AIDS prevalence; with an increase in public fund spend on HIV/AIDS. A 10 percent rise in the prevalence of HIV/AIDS increases domestic spending for the epidemic by 2.5 percent (Avila *et al*. 2013). Nevertheless, none of the reviewed studies empirically examined the impact of the increased health expenditure in mitigating the HIV epidemic. Therefore, this presents a research gap. For more understanding and policy actions, the gap needs to be filled through investigating the effect of health expenditure on HIV prevalence rate. That is, to find the effectiveness of health spending is reducing the HIV/AIDS prevalence rate. This will be vital information for governments, policy organizations and donor agencies to mobilize resources to control the epidemic.

2.2.5.4 Models and Estimation Techniques

Although the synopsis of the modelling and estimation techniques used in the reviewed studies is given in Table 2.5, this section further explores the models and estimation techniques employed, taking cognizance of the fact that some information might not have been explicitly discussed in some articles. The discussion in this section is based on the information presented in Table 2.5 and will serve as a basis for discussing the econometric methods for estimating the macroeconomic effects of HIV/AIDS in subsequent part of the research work.

HIV/AIDS is a very complex phenomenon which affects economy through different transmission mechanism. Considering the indirect transmission mechanism, some studies [4, 7, 13, 22, and 35] either employed 2 models or used a model which comprised a system of two or more equations to examine the impact of the epidemic on economic growth. Similarly, study [9 and 28] employed same technique but considers how cumulative AIDS mortality affects wage and employment in the labour market, and the effects of HIV/AIDS on total fertility respectively. From Table 2.5, it can be seen that about 11 studies work within the cross sectional data framework, but with virtually different models to suit their objectives based on the available data. While Durevall and Lindskog (2011) use multilevel logistic model which account for observed and unobserved differences across communities, Augier & Yaly (2013) employ overlapping generations' model which assumed agents of the same generation to be identical. Ordinary least squares model was utilised by David and Li (2010) and Ozcan (2012).

About 22 studies utilize panel data, but with different models just like the cross sectional studies as evidenced in Table 2.5. This is a reflection of the complexity of the HIV/AIDS epidemic. Three studies use difference–in–difference model which proceed with distinguishing feature of having a treatment group and control group. It also account for those time – invariant unobserved characteristics thereby solving the problem of endogenous selection. Two studies used Generalized Method of Moment (GMM) model which control for endogeneity in the estimation and permits for both country specific effects and time specific effects.

2.2.5.5 Variables Used in the Reviewed Studies

This section considers both the dependent and independent variables used in assessing the macroeconomic effects of HIV/AIDS. As earlier pointed out, HIV/AIDS is sensitive and complex issue. As such, uniformity in the use of variables by different studies should not be expected. The choice and use of variables depends on the problem each study sought to address. It should be noted that the complexity of HIV/AIDS warrants some studies to considered more than one dependent variable in their estimation(s).

Bloom and Mahal (1997) takes rate of growth of real GDP per capita as dependent variable while the explanatory variables consists of average annual increase in the prevalence of HIV, number of AIDS cases in the period under study, government expenditure on education and defence, average annual population growth, average birth rate and death rate, average years of schooling, as well as ratio of imports plus exports to GDP. Considering the problem from another perspective, David and Li (2010) used 'trust' as a proxy for the dependent variable 'social capital' while in addition to HIV prevalence rate, other explanatory variables includes: rule of law index, corruption index, ethnic fractionalisation, population density, average age of the population and education. Two different dependent variables 'natural log of wages' and 'employment status' were used by Chicoine (2012) to estimate different equations. The explanatory variable 'AIDS mortality' is proxy by host of indicator variables: male, female, marital status, highest level of education, African, coloured, province, and year.

The growth rate of per capita GDP is used as dependent variable by McDonald and Roberts (2006) and Lovasz and Schipp (2009). Whereas the independent variables include health capital specified through HIV prevalence rate, population growth, secondary school enrolment rate, lagged per capita income, and investment. In another study, Ozcan (2012) used total fertility rate as the dependent variable. With respect to the independent variables, HIV/AIDS is measured by HIV prevalence rate among pregnant women and projected HIV prevalence among adults 15 – 49 years. Child mortality, females schooling, contraception and GDP per capita are the other explanatory variables.

Due to complexity nature of HIV/AIDS and the problem they sought to address El–Bassel, *et al*. (2011) used entirely different variables. Mortality which is the independent variable is measured by: number of times travelled to purchase goods for the market stall, number of times travelled to visit friends or family, and number of days on last trip. While the dichotomous dependent variables includes biological assay of syphilis, having more than one sexual partner, consistent condom use, and purchasing vaginal or oral sex within the study period.

Therefore, variables employed in HIV/AIDS studies are numerous and diverse. Choice of variables of interest depends on the specific nature of the problems and the availability of relevant data. Table 2.6 shows the variables used by the various reviewed studied. Also, similar variables were used by the remaining studies not mentioned in Table 2.6.

Table 2.6
Variables Used in the Reviewed Studies

Study No	Study (Year)	Dependent variable(s)	Explanatory variables
1.	Arndt & Lewis (2000)	GDP growth rates	HIV prevalence, government health expenses, household health spending, savings, and labour.
6.	Bloom & Mahal (1997)	Rate of growth of real GDP per capita	Average annual increase in the prevalence of AIDS, number of AIDS cases in the period under study, government expenditure on education and defence, population growth, average birth rate and death rate, average schooling, and ratio of imports plus exports
9.	Chicoine (2012)	Natural log of wages, and employment status	AIDS mortality (proxy by indicator variables: male, female, marital status, highest level of education, African, coloured, province, and year)
11.	Cuddington & Hancock (1994)	Real GDP per capita, productivity, size of labour	AIDS, foreign and domestic saving, annual cost of AIDS treatment, and initial capital/output ratio
12.	David & Li (2010)	Social capital (proxy by 'trust')	HIV prevalence, rule of law, corruption index, ethnic fractionalisation, population density, average age of the population and education.
13.	Dixon, McDonald, & Robberts (2001)	Real GDP per capita, and life expectancy	HIV prevalence, population growth, log of education (proxy by primary and secondary enrolment rates), investment (proxy by part of real GDP invested), health care expenditure (proxy by either number of doctors, nurses or available beds), and malaria
14.	Dureval & Lindskog, (2012)	HIV status	Household wealth, neighbourhood, inequality, distance to road, male mobility, median consumption, and population density.

Table 2.6 (Continued)

Study No	Study (Year)	Dependent variable(s)	Explanatory variables
15.	El-Bassel, *et al*. (2011)	Assay to syphilis, having more than one sexual partner, consistent use of condom, and purchasing virginal or oral sex	Mortality (proxy by: number of times travel to purchase goods, visit family or friends, and number of days on last trip)
21.	Lovasz & Schipp, (2009)	Growth rate of per capita GDP	Education (secondary school enrolment rate), HIV prevalence rate, lagged per capita income, population, and investment
22.	McDonald & Robberts, (2006)	Growth rate of per capita GDP	Education (secondary school enrolment rate), average life expectancy at birth, infant mortality rate, lagged per capita income, population, and investment.
27.	Nunnenkemp (2011)	Treatment, new infection, and AIDS deaths	Official development assistance (foreign), log of population, log of GDP per capita, control of corruption, public health expenditure, female labour participation, food consumption, and civil war.
28.	Ozcan (2012)	Total fertility rate	HIV/AIDS (proxy by epidemiological fact, HIV prevalence among pregnant women, HIV prevalence among 15-49 years), child mortality female schooling, contraception, and GDP per capita
31.	Thornton, (2012)	Savings, hours worked, earnings, and expenditure,	HIV status, gender, age, age-squared, marital status, years of completed education
33.	Vasilakis, (2012)	Worker's productivity, fertility, population, and health investment	HIV/AIDS
34.	Yamano (2004)	Farm produce, household composition, assets/ off-farm income, initial poverty level.	Number of working-age adult (male and female deaths), number of elderly deaths, and dummy to control the village-specific time variant effect

2.2.6 Summary of the Evidence

This section summarised the evidence base on the results of the reviewed studies in line with the questions stated in section 2.2.1

1. *Do HIV/AIDS through its effect on human capital affect economic growth in SSA?*

- In addition to education and productive skills some studies considers health capital as another dimension of human capital in order to completely address the problem of misspecification bias that may arise due to partial representation of the human capital variable in the estimation.
- Most of the studies that assess the impact of HIV/AIDS on growth, measured economic growth with real GDP per capital growth. However, very few studies (about 3) used HIV data beyond year 2000.
- With reference to SSA as a whole or country specific, the effect of HIV/AIDS on economic growth is mixed and ambiguous. While some studies contend that HIV/AIDS has substantial effect on economic growth [1, 8, and 11], others argue that the epidemic has no effect on growth [6] or the effect is either negligible [7] or unclear [13]. Moreover, another study [35] maintains that HIV/AIDS has a positive effect on per capita income via increase in wages and employment.

2. *What is the effect of HIV/AIDS on labour productivity in SSA?*

- Most of the explanations on the effect of the epidemic on labour productivity were suggestive and theorising rather than empirical.
- However, the HIV/AIDS epidemic was found to reduce individual labour productivity and daily income in agricultural estate.

3. *Does health expenditure significantly reduce HIV prevalence rate in SSA*?

- None of the studies empirically investigates the effect of health expenditure on HIV prevalence rate in SSA.

- Some studies indicates that HIV/AIDS increase health expenditure as infected individuals and their families, government and donor agencies spent more on treatment, maintenance and prevention.

4. *Is the impact of the epidemic different between countries, especially the highly HIV infected Eastern and Southern African countries and Rest of SSA?*

- The studies mostly focused on country specific particularly within the hard hit southern African region without assessing the epidemic's effect in other regions.
- A particular study that considers the effect of the HIV epidemic on growth between the Eastern and Southern sub-regions and Rest of Africa find insignificant effect in both sub-regions.

5. *Which of the econometric models are employed in estimating the macroeconomic impact of HIV/AIDS*?

- Most of the studies utilize panel data that allow the use of panel data models which takes care of variation across countries and over time.
- Among the studies that use the panel data, only few dealt with the endogeneity problem associated with the regressors.
- Difference – in – Difference model was used in some studies whose assessment involve treatment group and control group.

2.2.7 Improving and Updating Reviews

As indicated in the introductory section, among the steps involved in systematic review is improving and updating the review. This would be done by searching additional relevant articles through more databases. Therefore, over time the review will be updated by replicating same process in order to have new evidence.

2.3 Conclusion

This is a systematic review of the literature on macroeconomic effects of HIV/AIDS in an attempt to answer the earlier stated research questions of the chapter. The various models and estimation techniques used as well as the variables (dependent and independent) utilized depends on the nature of the problem each research sought to address and the availability of relevant data. Some of the results are mixed, meaning that while some studies find HIV/AIDS have significant negative effects on either real GDP growth or per capita GDP others found contrary results. The findings in this review are used in supporting the subsequent empirical work in the study.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter consists of the research methodology which described the method and procedures used in conducting the research work. The potency of a method or technique depends on its ability to efficiently and reliably address the problem it was meant for (Ethridge, 1995). First, the theoretical framework upon which the research is based is explained. Secondly, the variables used in the study are defined and explained, the inclusion of each justified, and hypotheses are stated. Then, after specifying the models, the estimation procedure which involves dynamic panel data analysis is described. Finally, the sources of the data used in the analysis are explained.

3.2 Theoretical Framework

Examining the factors that influence economic growth could be approached either from the microeconomic or macroeconomic perspectives. From the microeconomic stand point, with a given production function, growth in output results from increased input usage, and any proportion of growth that is not attributed to this is explained by the technological progress. Then, an important question regarding growth is, which inputs should be used and by how much for a given level of technology. On the macroeconomic stand point, the issue is which and how macroeconomic variables influences growth for a given economic condition

(Ethridge, 1995). Through explaining the relationship between variables, theoretical framework link theory to model specification.

The neoclassical approach to growth process was refined and formalized by Solow (1956) growth model and represents the seminal contribution to the neoclassical growth theory. In line with Lovasz and Schipp (2009), this research work is based on McDonald and Roberts (2006) who in their study on AIDS and economic growth extended the Solow growth model. The model, which was initially augmented by Mankiw, Romer and Weil (1992) incorporates the research variables and predicts their direction in the growth process. Moreover, the model remains one of the best growth models. Although it treats the growth of population, level of savings and technological change as exogenous which some growth theorists would have love to understand their determinants (Mankiw, Romer & Weil, 1992; Todaro & Smith, 2005).

The Solow (1956) model takes the rates of savings, growth of population, and technological advancement as exogenous and shows how they influence economy's output and its rate of growth over time, that is, how they determine the steady-state level of per capita income. Due to variation in savings and the growth of population across countries, different countries reach different steady states. The model predict that the higher the rates of saving the more wealthy the country while the larger the rate of population growth the poorer the country. In the model, the two factor inputs-capital and labour are paid their marginal products and are associated with diminishing returns separately and jointly constant returns to both factors (Todaro and Smith, 2005).

The importance of human capital in the growth process has long been stressed to such an extent that one expects ignoring it will result to wrong conclusion. Over half of United States total capital stock in 1969 was human capital (Kendrick, 1976). Mankiw *et al*. (1992) points that the exclusion of human capital in the Solow's (1956) model can potentially lead to misspecification bias which will influence the magnitudes of the saving and population growth coefficients resulting to bias estimates. Therefore, they augment the Solow growth model to incorporate human capital (in the form of education) in addition to physical capital. Thus, inclusion of the human capital could probably alter either the theoretical modelling or the empirical analysis of the growth process. Testing the augmented Solow model in cross – country regression, Mankiw *et al*. find that accumulation of human capital is not only correlated with saving and population growth but its exclusion from the estimation equation affects the coefficients of physical capital, investment as well as population growth.

However, McDonald and Roberts (2006) argued that human capital is multidimensional consisting of more than education. Therefore, any misspecification bias will only be adequately accounted for if other dimensions of the human capital are included in the estimation. Consequently, they further extended the Mankiw *et al*. (1992) augmented Solow's (1956) model to incorporate health as component of human capital, apart from education.

At this stage, the McDonald and Roberts (2006) derivation of the extended Solow growth model which incorporate the health capital as dimension of human capital, is illustrated. As earlier mentioned, the model was also used by Lovasz and Schipp (2009) in a similar study. Considering the aggregate production function for the extended Solow model as a Cobb–Douglas function which assumes constant returns to scale and labour augmenting technological progress, McDonald and Roberts express it in the following form:

$$Y_{it} = (A_{it}L_{it})^{1-\alpha-\beta-\lambda} K_{it}^{\ \alpha} E_{it}^{\ \beta} H_{it}^{\ \lambda} \tag{3.1}$$

where *Y* is output, *A* the level of technology, *L* labour, *K* physical capital, *E* stock of educational capital, *H* stock of health capital, α, β, and λ are the output elasticities with respect to the various capital. The subscripts denote country $i = 1, 2. . . . N$, and time $t = 1, 2. . . . T$.

McDonald and Roberts (2006) indicates that equation (3.1) may as well be re-written in condensed form as:

$$y_{it} = k_{it}^{\ \alpha} e_{it}^{\ \beta} h_{it}^{\ \lambda} \tag{3.2}$$

where y_{it} is output per effective labour unit ($A_{it}L_{it}$) in country *i* at time *t*, and k_{it}, h_{it} and e_{it} are the respective quantities of capitals per effective worker.

Based on Mankiw *et al*. (1992), McDonald and Roberts (2006) derived the steady – state output per capita (y_{it}^{*}) in terms of the parameters of the production function with the assumption that labour grows at country specific rates n_i, technology grow at period specific rates g_t, and physical, educational and health capital stocks depreciate at the same rate δ_t and there are country specific initial state of technology A_{i0}, then

$$K_{it} = 1^{K}{}_{i,t-1} + (1-\delta)K_{i,t-1}$$

$$E_{it} = 1^{E}{}_{i,t-1} + (1-\delta)E_{i,t-1}$$

$$H_{it} = 1^{H}{}_{i,t-1} + (1-\delta)H_{i,t-1} \tag{3.3}$$

McDonald and Roberts (2006) points that in the model, part of each instant's output is consumed and the rest is saved and invest. Thus, when savings are divided among physical, education and health capital accumulation, and treating education and health capital as investment activity, so that

$$s_{it} = s_{it}^{K} + s_{it}^{E} + s_{it}^{H} = \frac{S_{it}}{Y_{it}} = \frac{I_{it}}{Y_{it}} = \frac{I_{it}^{K} + I_{it}^{E} + I_{it}^{H}}{Y_{it}} \tag{3.4}$$

then, the accumulation of physical, educational and health capital per unit of effective labour become

$$\hat{k}_{it} = s_i^{K}\,\hat{y}_{it} - (n_i + g_t + \delta_t)\hat{k}_{it}$$

$$\hat{e}_{it} = s_i^{E}\,\hat{y}_{it} - (n_i + g_t + \delta_t)\hat{e}_{it}$$

$$\hat{h}_{it} = s_i^{H}\,\hat{y}_{it} - (n_i + g_t + \delta_t)\hat{h}_{it} \tag{3.5}$$

where s_i^{K}, s_i^{E} and s_i^{H} are the portion of income devoted to investment in physical, educational and health capitals respectively, and δ represents the common depreciation rate, which is assumed constant over time.

McDonald and Roberts (2006) indicates that the same production function is assumed to apply to both the capitals and consumption, meaning that one unit of consumption could be costlessly transformed to either one unit of physical, educational or health capital. In addition, education and health capital are assumed to depreciate at the same rate as physical capital. In the production function, $\alpha + \beta + \lambda < 1$ implies decreasing returns to scale. (If $\alpha + \beta + \lambda = 1$, then there are constant returns to scale in the reproducible factors, and $\alpha + \beta + \lambda > 1$ indicates increasing returns to scale.

Thus, the 'asterisks' indicates the steady state values of physical, educational and health capital as

$$k^* = \left[\frac{(s_i^K)^{1-\beta-\lambda} (s_i^E)^{\beta} (s_i^H)^{\lambda}}{n_i + g_t + \delta} \right]^{1/(1-\alpha-\beta-\lambda)}$$

$$e^* = \left[\frac{(s_i^K)^{\alpha} (s_i^E)^{1-\alpha-\lambda} (s_i^H)^{\lambda}}{n_i + g_t + \delta} \right]^{1/(1-\alpha-\beta-\lambda)}$$

$$h^* = \left[\frac{(s_i^K)^{\alpha} (s_i^E)^{\beta} (s_i^H)^{1-\alpha-\beta}}{n_i + g_t + \delta} \right]^{1/(1-\alpha-\beta-\lambda)} \qquad (3.6)$$

by taking logs therefore

$$\ln k_i^* = \frac{1}{(1-\alpha-\beta-\lambda)} \left[\ln\left((s_i^K)^{1-\beta-\lambda} (s_i^E)^{\beta} (s_i^H)^{\lambda} \right) - \ln(n_i + g_t + \lambda) \right]$$

$$\ln e_i^* = \frac{1}{(1-\alpha-\beta-\lambda)} \left[\ln\left((s_i^K)^{\alpha} (s_i^E)^{1-\alpha-\lambda} (s_i^H)^{\lambda} \right) - \ln(n_i + g_t + \lambda) \right]$$

$$\ln h_i^* = \frac{1}{(1-\alpha-\beta-\lambda)} \left[\ln\left((s_i^K)^{\alpha} (s_i^E)^{\beta} (s_i^H)^{1-\alpha-\beta} \right) - \ln(n_i + g_t + \lambda) \right] \qquad (3.7)$$

and incorporating the three capitals – physical, educational and health, the augmented steady state output per capita becomes

$$\ln y_{it}^{*} = \ln A_{i0} + g_t t - \frac{\alpha+\beta+\lambda}{(1-\alpha-\beta-\lambda)}\ln(n_i + g_t + \delta) + \frac{\alpha}{(1-\alpha-\beta-\lambda)}\ln s_i^{K}$$
$$+ \frac{\beta}{(1-\alpha-\beta-\lambda)}\ln s_i^{E} + \frac{\lambda}{(1-\alpha-\beta-\lambda)}\ln s_i^{H} \quad (3.8)$$

where s_i^{K}, s_i^{E} and s_i^{H} are the investment rates devoted to physical, educational and health capitals. Except for the inclusion of the health capital term, McDonald and Roberts (2006), points that equation (3.8) is equivalent to Mankiw *et al*. (1992) equation 11 (p.417).

In addition, McDonald and Roberts (2006) explains that underlying equation (3.8) is a steady state condition in levels, exploited by Mankiw *et al*. (1992) to derived formulations of the estimating equation according to whether the augmenting capital terms are recorded as rates of accumulation as in equation (3.8), or as levels, for instance,

$$\ln y_{it}^{*} = \ln A_{i0} + g_t t \frac{\alpha}{(1-\alpha)}\ln(n_i + g_t + \delta) + \frac{\alpha}{(1-\alpha)}\ln s_i^{K} + \frac{\beta}{(1-\alpha)}\ln s_i^{E}$$
$$+ \frac{\lambda}{(1-\alpha)}\ln h_{it}^{*} \quad (3.9)$$

where the asterisk specifies that the quantity of health capital per unit of effective labour (h_{it}^{*}) is a steady state level. Whereas equation (3.8) is absolutely derived from a steady state expression in terms of levels, in deriving equation (3.9) the presumption of steady state is not required. Therefore, whether estimation is based on equation (3.8) or some variant of (3.9) depends on the availability of data.

Linearising equation (3.9) around the steady state level of income per unit of effective labour, y_{it}^*, McDonald and Roberts (2006) produces

$$\ln y_{it}^* - \ln y_{i0}^* = (1-\exp^{\lambda t})\ln A_{i0} + g_t t - \frac{(1-\exp^{\lambda t})\alpha}{(1-\alpha)}\ln(n_i + g_t + \delta) +$$

$$\frac{(1-\exp^{\lambda t})\alpha}{(1-\alpha)}\ln s_i^K + \frac{(1-\exp^{\lambda t})\beta}{(1-\alpha)}\ln s_i^E + \frac{(1-\exp^{\lambda t})\lambda}{(1-\alpha)}\ln s_i^H - (1-\exp^{\lambda t})\ln y_{i0}^* \quad (3.10)$$

An empirical advantage of this method is the permission of mixture of stock and saving/investment data for the capital components of the estimating equation. Solving equation (3.10) for lny_{it}^* and applying standard panel data notations, McDonald and Roberts (2006) produced a general specification of the econometric growth model which this study adopted in evaluating the effects of HIV prevalence rate and AIDS on economic growth and aggregate labour productivity.

$$z_{it}^* = \theta z_{i0}^* + \sum_{j=1}^{n}\phi_j x_{it}^j + \mu_t + \nu_i + \varepsilon_{it} \quad (3.11)$$

where z_{it}^* is per capita GDP growth rate, θz_{i0}^* is the initial level of per capita GDP of country i, x_{it}^j are vectors of variables that may influence the growth rate, ϕ_j are vector of parameters, μ_t is the term for cross-time variations in the rate of growth, ν_i is country specific initial states of technology and ε_{it} is the stochastic term.

As a proxy for health capital, in addition to HIV prevalence rate used in studies as David, Li (2010) and Lovasz and Schipp (2009), AIDS is equally considered, since both described the level of health status in societies (McDonald & Roberts, 2006; Murtin & Marzo, 2013). This is because while HIV is associated with rising morbidity, AIDS is associated with rising mortality in addition to morbidity (Cuddington, 1993; Young, 2005). Consequently, both could have important and different consequences on macroeconomic performance of national economies.

Other health indicators as Tuberculosis and Malaria are not considered because of their strong correlation with HIV and AIDS (Corbett *et al*. 2003; Nissapatorn *et al*. 2003; WHO, 2014) which could lead to issue of multicollinearity. The use of life expectancy as a measure of health capital, in addition to HIV prevalence and AIDS may also result to similar issue, given that the latter (HIV and AIDS) have a dramatic impact on the former (United Nation Population Division [UNPD], 2008; Murtin & Marzo, 2013). Again, given that AIDS is a chronic life threatening condition which resulted from opportunistic infections, including other disease(s) as measure of health capital, could also lead to issue of multicollinearity.

One of the main objectives of the Cobb-Douglas production function is to estimate the parameters α β λ in order to measure the returns to scale. However, in line with Dixon *et al*. (2001), McDonald, Roberts (2006), Lovasz and Schipp (2009) only the exogenous variables are estimated without examining the returns to scale. In particular, the study's interest is examining whether the health capital variables, have significant effects on economic growth and aggregate labour productivity. This could be done without necessarily measuring the returns to scale (Jones, 1998).

3.3 Definition and Justification of Variables

In this section, the variables used in the study are defined and explained, and the inclusion of each is justified. The research hypotheses are also stated. The meaning of the variables is given within the context of the research. Essentially, the choice of the variables is influenced by the problem(s) the study sought to address as well as the research objectives.

3.3.1 GDP per Capita Growth

GDP per capita refers to the income which accrues to every member of society when real GDP is divided by the population (World Bank, 2014). In order to measure economic growth, economists basically uses the growth rate of real GDP per capita from one year to another (Gordon, 2012; Mankiw, 2010). Thus, economic growth essentially means the growth in real GDP per capita, which is also a better indicator of economic well being (living standards) of societies. However, GDP per capita growth does not show the distribution of society's wealth among different income classes and ignore the welfare of the generation that have died. Several empirical growth studies have used the growth rate of GDP per capita as a measure of economic growth (among others are Bloom & Mahal, 1997; Bonnel, 2000; Ding & Knight, 2011; Hou & Chen, 2013; Mankiw *et al*. 1992; Mayer, 2001; McDonald & Roberts, 2006; Lovasz & Schipp, 2009). This justifies the use of same indicator as dependent variable in this study.

3.3.2 GDP per Persons Employed – Aggregate Labour Productivity

GDP per persons employed measures the productivity of labour in the production process in an economy. Labour productivity is generally defined as a ratio of a volume measure of output to a measure of input use. In computing the labour productivity, volume of output (goods and services) is normally measured by gross domestic product while input use which reflects the time, skills as well as the effort of labour is measured either by the total number of productive hours of all employed persons or total employment. Although total employment as a measure of labour input is easier to calculate, it does not reflects the changes in average hour worked due to either overtime, part-time or absence from work compared to total number of hours worked. However, the estimate of the hours-worked is not always clear and suffers from different degree of international comparability. Essentially, labour productivity is an informative indicator of other economic indicators and it provides a dynamic measure of economic growth and competition in an economy (Freeman, 2008). Based on the World Bank (2014) computation:

Labour productivity = volume measure of output/measure of input use

$$= \frac{GDP}{\text{Total Employment}}$$

Unlike most other infectious diseases, HIV/AIDS strikes working-age adults in their most productive working years. This affects their productivity, because sick and troubled workers are less productive than healthy happy ones (Cuddington, 1993). Various measures of labour productivity have been use by different studies. Brohult *et al*. (1981) and Pehrson *et al*. (1984) used physical working capacity as a proxy for labour productivity to assess the impact of malaria prophylaxis on productivity of Liberian industrial workers. Fox *et al*. (2004) using output per worker, estimate the effect of HIV/AIDS on the productivity of individual worker in agricultural estate. In this research, GDP per persons employed is used as measure of aggregate labour productivity (a dependent variable).

3.3.3 HIV Prevalence Rate

HIV is a retrovirus which rapidly multiplies in host cells, and damages the immune system (CD4 cells) hence, affects the body's ability to cope with infections resulting to AIDS (CDC, 1992). HIV is associated with rising morbidity, that is, illnesses (Cuddington, 1993). The HIV related morbidity is more pronounced in SSA; where substantial proportion (80%) of the infected working-age adults do not have access to the costly immune booster and life-saving antiretroviral therapy (UNAIDS, 2013). Consequently, frequent illnesses, absenteeism at work place as well as the psychological trauma will affect the productivity of infected workers. By extension, the productivity of uninfected workers could also be affected as the rate of infection increase and spread among colleagues and family. Moreover, to prevent the development of AIDS, infected persons have to remain continuously on antiretroviral drugs which increase health care spending and reduce savings. Thus, HIV before even converting to AIDS could have serious consequences on the macroeconomic performance of national economies in SSA.

The HIV epidemic is either generalised or concentrated. It is said to be generalised when the prevalence rate is 1% or more in the general population. whereas it is concentrated or low-level when the prevalence rate is less than 1% in the general population, but greater than 5% in specific at-risk population like commercial sex workers or injecting drug users (World Bank, 2014). HIV prevalence is the number of people living with HIV disease at a given time regardless of the time of infection, and whether the individual has received a diagnosis (aware of infection), or the stage of HIV disease. This makes prevalence different from incidence, whose numerator includes only new cases. Essentially, prevalence is most useful in measuring the burden of diseases such as HIV in a population (CDC, 2014).

In this regard, HIV prevalence rate as calculated by policy organisations at different periods (e.g., UNAIDS, 2000; UNAIDS & WHO, 2004; World Bank, 1990; 2014; WHO, 1995) is the proportion of people aged 15-49 in a population living with HIV infection at a given time. Even though HIV infects other age cohorts, in computing the prevalence rate, the policy organizations considered persons within the 15-49 age cohorts as denominator. As argued by the policy organization, the 15-49 age cohorts are the most vulnerable and risky group to HIV infection (UNAIDS & WHO, 2004; WHO, 1995; World Bank, 2014). Therefore, due to lack of data which considered all age cohorts, the study is constrained to use the HIV prevalence, total (% of population ages 15-49). The HIV prevalence rate is calculated as:

$$\text{HIV prevalence rate} = \frac{\text{number of persons infected by HIV}}{\text{population between 15 - 49 years}}$$

As previously mentioned, Mankiw *et al*. (1992) augments the Solow growth model with human capital defined in terms of education to take care of the misspecification bias that will arise if both physical and human capital exists but human capital is excluded in the equation. However, it has been argued that health capital is another important component of human capital (Fogel, 1994; McDonald & Roberts, 2006;

McDonald & Roberts, 2002; Mushkin, 1962; Schultz, 1961). Therefore, excluding it in the estimating equation is tantamount to partial addressing of the misspecification bias. Even though, no economic theory has adequately discussed the operationalization of health capital at macro level, Knowles and Owen (1995), Gallup and Sachs (1998) and Mayer (2001) used life expectancy, infant mortality, and prone to malaria respectively as indicators for health capital.

In this study, HIV prevalence rate is measured using current/instantaneous values of HIV, and is considered as one of the dimensions of the health capital. This is because it described the level of health status in societies (McDonald & Roberts, 2006). In the analysis, the HIV prevalence rate is both explanatory as well as dependent variable. As explanatory variable, it is hypothesized to (i) negatively affect the growth rate of per capita GDP and (ii) reduce aggregate labour productivity (GDP per person employed).

3.3.4 AIDS

AIDS is the final stage of HIV infection associated with rising mortality, hence could have important macroeconomic consequences different from that of HIV. People who developed AIDS have seriously damaged immune system which puts them at high risk for opportunistic infections and subsequently death. The average incubation period from HIV infection to development of AIDS is 7 – 10 years (Kanki *et al*. 1999). Direct measures of the number of AIDS prevalence are not available for the countries in the study's sample. AIDS related mortality data also are only available for a limited number of countries for few years hence; do not provide enough information for the analysis. However, AIDS can be measured from the available information on the distribution of the lag between HIV infection to onset of AIDS, and the HIV prevalence at a point in time (Bloom & Mahal, 1997).

Considering the HIV prevalence rate being cumulative, that is, resulting from successive addition, it is believed that six years is enough for the disease to converts to AIDS. Consequently, AIDS specified also as part of the health capital is measured using six years lags of HIV prevalence rate. This effectively allows six periods in the estimations given the initial twelve. Considering that the instruments of the GMM estimator could reduce the time interval (Lovasz & Schipp, 2009), having less than six periods could have been inappropriate. It is hypothesized that AIDS will be detrimental to GDP per capita and aggregate labour productivity.

3.3.5 Health Expenditure

Considering that data on HIV spending are only available for a limited number of countries for few years, health expenditure is used as its proxy. Fundamentally, the health expenditure encompasses the HIV spending. And it is measured using per capita health expenditure which is the sum of public and private health spending as a ratio of total population. It covers the provision of health services such as prevention and cure, nutritional activities, family planning activities, as well as emergency aid assigned for health but does not consists of provision of water and sanitation (World Bank, 2014).

At the primitive level, one of the effects of HIV/AIDS is increase in morbidity which subsequently led to increase in health expenditures by households, private and public health care system as well as governments and donor agencies in order to help out HIV/AIDS patients and their families in managing the deteriorating health condition (Cuddington, 1993; Benatar, 2004). In the heavily infected SSA regions, several trends indicate increased funding for prevention and treatment of HIV/AIDS which substantially increased health expenditure. Developed countries have raised extraordinary fund, reaching a total of US$ 15.6 billion in 2008 (UNAIDS, 2010). The Global Fund to Fight AIDS, Tuberculosis and Malaria assigned US$ 16.0 billion in 2013 in dealing with the HIV/AIDS epidemic (The Global Fund, 2014). In this regard, it has been shown that several SSA countries have received more HIV/AIDS fund than their entire national health budget (Shiffman, 2008). This indicates that substantial amount of money has been committed towards management of HIV/AIDS. However, it is only an empirical investigation that could determine whether such health spending have been effective in reducing the HIV infection in SSA region.

Among the possible determinants of health status of societies is the proportion of income spent on health inputs (Knowles & Owen, 1995). Thus, health expenditure per capita as an explanatory variable in the analysis is hypothesized to reduce HIV prevalence rate in SSA.

3.3.6 Population Growth

The World Bank (2014) defined population growth as the increase in a country's population during a particular period of time, usually a year, expressed as a percentage of the population in the previous period. That is, it reflects the number of births and deaths as well as net migration during the period.

Several empirical evidence has shown that population growth is one of the important determinants of economic growth (e.g., Solow, 1956; Hagen, 1959; Becker, Glaeser & Murphy, 1999). The interaction of population dynamics with economic growth could possibly results in poverty trap, especially in societies with low income but high population growth rates (Kelley & Schmidt, 1995). Renton, Wall, & Lintott (2012) however, argue that mortality declines aids economic growth and hence leads to higher standard of living. As an explanatory variable, high rate of population growth is expected to (i) reduce per capita GDP and (ii) have a significant effect on aggregate labour productivity.

3.3.7 Over Urbanization

Over-urbanization refers to increase in the proportion of a country's total population that lives in urban areas. More often it outstrips the urban system's ability to provide adequate living standard (Timberlake & Kentor, 1983). Filthy and crowded urban living conditions, and comparatively high rates of social interaction, meant that pre-transitional towns are conducive to spread and maintenance of infectious disease as HIV (Dyson, 2003). Over-urbanization is an issue which exposed many immigrants to urban areas to adopt HIV-risk related behaviour (Over & Piot, 1993). Therefore, as an explanatory variable, over urbanization is measured using urban population (% of total), and it is hypothesized to increase HIV prevalence rate.

3.3.8 Inequality

Inequality is the disparity among individuals in societies based on income or gender which represents significant source of social inequality. Both the income and gender inequality increases stress, and reduces independence and freedom which in turn lead to risky sexual behaviour with the tendency of HIV infection (Cockerham, 1997). The early spread of HIV/AIDS is track down along the steep gradient of inequality, that is, imbalances of power and access to resources among different individuals in different societies (Bancroft, 2001; Farmer, 1999). Various indicators have been use empirically to proxy inequality among individuals. Bonnel (2000) uses the share of female labour in industry to proxy income inequality. Similarly, this study measured inequality using female labour force participation rate (% of female population age 15-64). The supposition is that, as explanatory variable, higher inequality will increase HIV infection.

3.3.9 Gross Capital Formation

Gross capital formation consists of the outlays of the additions to the fixed assets of the economy including net changes in the level of inventories. That is, it comprised of improvement in land; plant and machinery; all sort of constructions; inventories and net acquisitions of valuables (World Bank, 2014). When gross domestic savings is reinvested, it gives the figures known as gross capital formation from which investment exude. A number of empirical studies have used gross capital formation in estimating growth equations (e.g., Solow, 1962; Choe, 2003; Lovasz & Schipp, 2009). Therefore, it forms part of the explanatory variables as a proxy for investment, instead of using saving in the growth equation. Furthermore, considering that the gross capital formation (investment) resulted from savings, using both will lead to problem of multicollinearity that can cause the coefficients to switch signs (Mankiw, 2010). Gross capital formation is hypothesized to have a significant effect on GDP per capita growth and aggregate labour productivity.

3.3.10 Education

Education has long been considered as an important determinant of labour productivity and economic growth. It increases the human capital inherent in the labour force, which in turn raise labour productivity and subsequently promotes growth (Hanushek, Woessmann, Jamison & Jamison, 2008; Mankiw *et al*. 1992). In line with studies as Bonnel (2000), Ding, Knight (2011), McDonald, Roberts (2006) and Lovasz and Schipp (2009), this study measured educational capital in terms of secondary school enrolment rate. This is because secondary education can equipped an individual with the basic skills to engage in gainful productive activities in societies better than primary education. Moreover, data on literacy rate are limited in terms of both coverage of countries and length of time series. This could explain why it was not used in the reviewed studies. Gross enrolment ratio is the total enrolment in secondary school, irrespective of age, expressed as a percentage of the population of official secondary education age. Considering the inclusion of over-aged and/or under-aged students due to late or early school entrance, the gross enrolment ratio could exceed 100% (World Bank, 2014). As an independent variable, it is suggested that education will (i) have positive effect on GDP per capita growth and aggregate labour productivity and (ii) reduce HIV prevalence rate.

3.3.11 Trade Openness

Trade openness refers to the sum of exports and imports of goods and services calculated as a share of gross domestic product (World Bank, 2014). Trade integration is often considered as one of the important determinants of economic growth and differences in income and growth across countries. Essentially, trade promote efficient resource allocation, facilitate the diffusion of knowledge and technological advancement as well as encourage countries to realize economies of scale (Busse & Königer, 2012). Basically, as a measure of trade openness, several empirical studies used the trade ratio being the sum of exports and imports as a share of GDP (e.g., Chang, Kaltani & Loayza, 2009; Harrison, 1996; Yanikkaya, 2003). Hence, the trade ratio has also been used in this study as a proxy of openness to trade. As an explanatory variable, trade openness is hypothesized to significantly increase GDP per capita growth and aggregate labour productivity.

3.4 Model Specification

This section presents the models specifications that are estimated in the analysis. Specifically, dynamic panel data approach was employed. Quite a number of economic relationships are dynamic in nature, and the use of panel data structure allows for better understanding of the dynamics of their adjustment (Baltagi, 2005). The dynamic panel data model is characterized over time by (i) autocorrelation due to inclusion of lagged dependent variable among the regressors, rendering standard estimators inconsistent, and (ii) individual-specific effects characterizing the heterogeneity among individuals (unobserved individual specific effects).

The dynamic panel data model is of the form:

$$Y_{it} = \sum_{j=1}^{n} \alpha_j Y_{i,t-j} + X_{it}\beta_1 + \nu_i + \varepsilon_{it} \quad (3.12)$$

where Y is denoting dependent variable, *i* refers to unit of observation, *t* refers to time, *j* is parameter, α_j are *n* parameter to be estimated, X_{it} is a 1 x *K* vector of strictly exogenous covariates, β_1 is a *K* x 1 vector of parameters to be estimated, ν_i are the panel level effects (i.e. individual specific effects, which may be correlated with the covariates), ε_{it} is the error term.

In the empirical analyses, three different models are estimated. Each model achieved one specific research objective.

3.4.1 Model One

This model addressed research objective one, which evaluates the effects of HIV prevalence rate and AIDS on per capita GDP growth. Based on Solow (1956), Mankiw *et al*. (1992), Bonnel (2000) and Yanikkaya (2003), the growth function of the model is express as follows:

$$GDPGR = f(HIV, AIDS, EDU, POP, GCF, OPN) \quad (3.13)$$

and the estimated empirical specification takes the following form:

$$\ln GDPGR_{it} = \alpha + \beta_1 \ln GDPGR_{i,t-1} + \beta_2 \ln HIV_{it} + \beta_3 \ln AIDS_{it} + \beta_4 \ln EDU_{it} + \beta_5 \ln POP_{it} + \beta_6 \ln GCF_{it} + \beta_7 \ln OPN + \lambda_i + \nu_t + \varepsilon_{it} \tag{3.14}$$

Where i = 1, **. . .**, N and t = 1, **. . .**, T, *GDPGR* denote per capita GDP growth, *HIV* is the HIV prevalence rate, *AIDS* is the six years lags of HIV prevalence rate, *EDU* refers to secondary school enrolment, *POP* is the population growth, *GCF* refers to gross capital formation, *OPN* is the trade openness, λ_i is a time invariant country specific effect, ν_t is the time effect, ε_{it} is the stochastic term. The study is interested in testing whether the effects of HIV prevalence rate and AIDS on growth, β_2 and β_3, are statistically significant.

3.4.2 Model Two

This model deals with the second objective of the research. That is, it assessed the impact of HIV prevalence rate and AIDS on aggregate labour productivity. Aggregate labour productivity which reflects the performance of economies based on the number of total employment can be examine with an aggregate production function (Bloom *et al*. 2004). The model is specified in line with Cuddington (1993), Pehrson *et al*. (1984), Fox *et al*. (2004) and Lovasz & Schipp (2009) and the functional form is given as:

$$LPR = f(HIV, AIDS, EDU, POP, GCF, OPN) \tag{3.15}$$

Empirically, the estimated model is specified as follows:

$$\ln LPR_{it} = \alpha + \beta_1 \ln LPR_{i,t-1} + \beta_2 \ln HIV_{it} + \beta_3 \ln AIDS_{it} + \beta_4 \ln EDU_{it} + \beta_5 \ln POP_{it} + \beta_6 \ln GCF_{it} + \beta_7 \ln OPN_{it} + \lambda_i + \nu_t + \varepsilon_{it} \tag{3.16}$$

where *LPR* denotes aggregate labour productivity and all other items are defined as before. The study is interested in testing whether the effects of HIV prevalence rate and AIDS on aggregate labour productivity, β_2 and β_3, are statistically significant.

3.4.3 Model Three

It addressed research objective three which investigates the effect of health expenditure on HIV prevalence rate. The model is specified in line with Bonnel (2000), Farmer (1999), Knowles and Owen (1995), and Shiffman (2008), and the functional relationship is expressed as below:

$$HIV = f(HEX, EDU, OUB, IEQ) \tag{3.17}$$

and the model estimated takes the following form:

$$\ln HIV_{it} = \alpha + \beta_1 \ln HIV_{i,t-1} + \beta_2 \ln HEX_{it} + \beta_3 \ln EDU_{it} + \beta_4 \ln OUB_{it} + \beta_5 \ln IEQ_{it} + \lambda_i + v_t + \varepsilon_{it} \tag{3.18}$$

where *HEX* is the health expenditure, *OUB* refers to urbanization population (% of total), *IEQ* is the inequality, and other variables maintained their earlier definition. The study is interested in testing whether health expenditure, β_2, has statistically significant effect on HIV prevalence rate.

Quite a number of variables have overall trends of exponential growth. Equally, strictly positive variables often have conditional distributions that are heteroskedastic or skewed. However, taking the log of the variables can mitigate, if not eliminate, both issues (Wooldridge, 2013). Some of the variables in the present study have similar features as established by Wooldridge (2013). In this respect, the present study, in line with Lovasz and Shipp (2009), Hou and Chen (2013) Avila *et al*. (2013) and McDonald and Roberts (2006) used logs of the variables in transforming the data of the analysis. Taking the log of variables also eliminates unequal variance of macroeconomic data, and symmetrically distributes the residuals. Furthermore, it linearized quadratic model into linear form. This converts multiplicative models into additive with regards to seasonality. Example, Cobb-Douglas Production Function (Wooldridge, 2013).

3.5 Estimation Procedure

In estimating the research models, Generalized Method of Moments (GMM) estimator was used. Specifically, the more efficient and less biased Blundell and Bond (1998) 'system' GMM estimator is applied. The estimator has become consistent in the empirical growth literature so as to overcome the Nickell (1981) bias and to address the issues of mismeasurement and endogeneity (Ding & Knight, 2011). Initially, Arellano and Bond (1991) derived the 'difference' GMM estimator which was further developed by Blundell and Bond. The system GMM estimator is one of the most potent techniques use in dynamic panel data models (Baltagi, 2005; Baltagi, Demetriades & Law, 2009). The GMM estimators embody the following assumptions about the data generating process:

1. The process is dynamic, with current realizations of the independent variable being influenced by the previous ones.
2. There may be arbitrarily distributed fixed individual effects in the dynamic, so that the dependent variable consistently changes faster for some

observational units than others. This argues against cross section regressions, which must essentially assume fixed effects away, and in favor of a panel set-up, where variation over time can be used to identify parameters.

3. Some regressors may be endogenous.
4. The idiosyncratic disturbances (those apart from the fixed effects) may have individual-specific patterns of heteroskedasticity and serial correlation.
5. The idiosyncratic disturbances are uncorrelated across individuals.
6. Some regressors may be predetermined but not strictly exogenous: even if independent of current disturbances, still influenced by past ones. Example, the lagged dependent variable.
7. The number of time periods of available data, *T*, may be small. (Usually, the panel is 'small *T*, large *N*'.).
8. Only 'internal' instruments based on lags of the instrumented variables are available. However, the estimators do allow inclusion of external instruments.

The system GMM estimator also takes care of time in-variant country characteristics, that is, unobserved specific effects which may be correlated with the explanatory variables. It also handles the endogeneity of the regressors and avoids dynamic panel bias. Furthermore, it accommodates unbalanced panels as well as multiple endogenous variables. Besides the benefits associated with the system GMM estimator, presence of lagged dependent variable among the regressors renders standard estimators – pooled OLS, fixed effects and random effects inconsistent and bias. From equation (3.12) which is reproduced here

$$Y_{it} = \sum_{j=1}^{n} \alpha_j Y_{i,t-j} + X_{it}\beta_1 + \nu_i + \varepsilon_{it}$$

Y_{it} is a function of ν_i, then it follows that it's lagged Y_{it-1} is also a function of ν_i hence, Y_{it-1} a right hand side regressor in the equation is correlated with the error term. This renders the OLS biased and inconsistent even in the event that the ε_{it} are not serially correlated. Equally, due to similar regressor – error term correlation, the random effect (GLS) and fixed effect models and are also inappropriate.

The Arellano and Bond (1991) difference GMM estimator, first differences the regression equation to eliminate the country specific effect. Differencing equation (3.12) is as follows:

$$y_{i,t} - y_{i,t-1} = \alpha + (y_{i,t-1} - y_{i,t-2}) + \beta^{'}(X_{i,t} - X_{i,t-1}) + (\varepsilon_{i,t} - \varepsilon_{i,t-1}) \tag{3.19}$$

Thus, the country specific effect v_i is eliminated because $(v_i - v_i) = 0$ and the equation can be put as:

$$\Delta y_{it} = \alpha\ \Delta y_{i,t-1} + \beta \Delta X_{it} + \Delta\varepsilon_{it} \tag{3.20}$$

where Δ denote change and all other variables are defined as before.

However, this leads to problems of (i) correlation in the error term. Recall that the ε is assumed to be i.i.d. But the first differenced error is not i.i.d, because $\Delta\varepsilon_{it}$ = $\varepsilon_{it} - \varepsilon_{it-1}$ and $\Delta\varepsilon_{it-1}$ = $\varepsilon_{it-1} - \varepsilon_{it-2}$ are correlated (by having a common component viz. ε_{it-1}), and (ii) regressor-error term correlation (i.e., endogeneity). This is because $\Delta y_{i,t-1}$ = $y_{it-1} - y_{it-2}$ depend on ε_{it-1}, which is part of the transformed error term. In order to deal with the problems, Arellano and Bond (1991) used the lagged values of the explanatory variables in levels as instruments. Instruments should be relevant, that is, show strong correlation with the endogenous regressors and should have no correlation with the error term.

With the assumptions that the error term is free from serial correlation and the regressors are weakly exogenous, that is, taken to be uncorrelated with the future realization of the error term, the dynamic panel GMM estimator utilizes these moment conditions:

$$E[y_{it-h}(\varepsilon_{it} - \varepsilon_{it-1})] = 0 \quad \text{for h} \geq 2;\ \text{t} = 3, \ldots\ldots \text{T} \quad (3.21)$$

$$E[X_{it-h}(\varepsilon_{it} - \varepsilon_{it-1})] = 0 \quad \text{for h} \geq 2;\ \text{t} = 3, \ldots\ldots \text{T} \quad (3.22)$$

With these moment conditions, Arellano and Bond (1991) suggest a two step GMM estimator. The first step assumed the error term to be independent and homoskedastic across countries and over time. In the second step the residuals generated in the first step are used to construct a consistent estimate of the variance-cavariance matrix thereby relaxing the assumption of independence and homoskedasticity.

However, Arellano and Bover (1995) argued that when the autoregressive process becomes too persistent or the ratio of the variance of the panel-level effects *vi* to the variance of the idiosyncratic error ε_{it} becomes too large, the lagged levels are weak instruments for the regression in differences. Valuable observations are also lost in the difference GMM estimation. In these circumstances, the difference GMM estimator is liable to perform poorly and has poor sample properties. Consequently, building on the work of Arellano and Bover, Blundell and Bond (1998) proposed a more efficient estimator – the 'system' GMM which address the weak instruments problems by using additional moment conditions. The system GMM estimator combines the moment conditions for the differenced model with those for the levels model. That is, it combines in a system the regression in differences with the regression in levels. While the instruments for the regression in differences remain the same, the instruments for the regression in levels are the lagged differences of the corresponding variables. The additional moment conditions for the second part of the system, that is, the regression in levels is:

$$E\left[(y_{it-h} - y_{it-h-1})(v_i + \varepsilon_{it})\right] = 0 \text{ for h = 1} \tag{3.23}$$

$$E\left[(X_{it-h} - X_{it-h-1})(v_i + \varepsilon_{it})\right] = 0 \text{ for h = 1} \tag{3.24}$$

Thus, the system GMM utilizes the moment conditions in equations (3.21), (3.22), (3.23) and (3.24) to generate consistent and efficient parameter estimates. The sufficient conditions are for the series X_{it} and y_{it} to have time-invariant (stationary) means. These allow as instruments for the level equations, the use of the lagged first differences of dependent and independent variables (Hou & Chen, 2013). The system GMM performs much better especially when the series are persistent or the variables are close to random walk (Law, 2014).

However, in applying the system GMM estimation, caution is needed in certain respects. First, the problem of instrument proliferation tends to be severe when the cross-section dimension is small. As *T* rises, the instrument count can easily increase relative to the sample size. This makes some asymptotic results about the estimators and related specification tests misleading. Controlling the instrument proliferation would however improve the efficiency of the system GMM to address such problems (Roodman, 2009). Second, the issue of cross-sectional error dependence which can leads to problems in estimating short dynamic panels. Under cross-sectional error dependence, as $N \rightarrow \infty$ for fixed T, the GMM estimator become inconsistent; regardless of lag length of the instruments use (Sarafidis & Robertson, 2009).

The issue of instrument proliferation is addressed by restricting the instrument count through limiting the number of lags included in the estimation which produced valid instrument ratio (Roodman, 2009). In addressing the influence of cross-sectional error dependence in the short dynamic panel, time-specific effects are included in the regressions to deals with common variations in the dependent variable (Ding & Knight, 2011). Following Ding, Knight (2011), Asiedu, Jin, Kanyama (2011) and Lovasz and Schipp (2009), two-step GMM estimator which is more efficient and robust to heteroskedasticity is used in estimating the regression equations. In each model, the full sample observation is estimated before conducting the sensitivity analysis in the two alternative sub-samples.

The consistency or otherwise of the GMM estimator depends on two specification tests/diagnostic (Arellano & Bond, 91; Arellano & Bover, 1995; Law, 2014).

1. The Sargan test of overidentifying restrictions which test the validity of the instruments in the GMM estimation. The null hypothesis states that overidentifying restrictions are valid. Failure to reject the H_0 implies the

instruments are valid (i.e., not correlated with the error term) and the model is correctly specified.

2. The Arellano-Bond serial correlation test in the disturbances with the null hypothesis that the residuals are not serially correlated. First order serial correlation (AR1) is expected while there should be no second order serial correlation (AR2). The null of absence of the first order serial correlation should be rejected, and fail to reject the absence of second order autocorrelation. Failing to reject H_0 in respect of second order serial correlation, means the GMM estimator is consistent. Whereas the presence of (AR2) is an indication of specification error.

3.6 Data

The study employed panel data in the analysis. The data are essentially chosen based on the problem which the study sought to address as well as specification and availability. Panel data has certain benefits in estimation process. First, is controlling for individual heterogeneity. Many individual or country characteristics are unobserved and vary across the individuals or countries. If they influence the variable of interest, that is, are correlated with observed explanatory variable, then the estimated effects of these variables will be biased. Second, there is less collinearity among variables and higher degree of freedom. Third, panel data are better in studying the dynamics of adjustment. While cross sectional data does not explain dynamics, time series has to be lengthy to provide good estimates of dynamic behavior. Fourth, panel data are better in identification of parameter that will not be identified with pure cross sectional or time series data.

The main source of data for the empirical analysis is the World Bank (2014). The World Bank contains the most current and accurate national, regional and global development indicators, compiled from international sources that are officially recognized by the Bank. Due to lack of adequate data on the proxy variables for all the SSA countries, the study covers only 42 countries, and the panel is balanced. The full sample observation is further divided into two alternative sub-samples; 18-country Eastern and Southern Africa and 24-country Rest of sub-saharan Africa. The data are annual spanning from 1990-2013. As it is standard in the cross-country growth literature (Islam, 1995; Ding & Knight, 2011; Law, 2014) the data are averaged however, over non-overlapping 2-year time intervals. Essentially, the 2-year average setup sufficiently allows 6 periods after lagging the HIV prevalence rate to introduce AIDS in the estimating equations. It equally lessens the influence of temporary factors associated with business cycles.

The data on some variables as GDP per capita growth and population growth are negative for some of the observations. To enable taking their log, adding the highest negative value plus one across all the observations ensures that all are positive. These changed only the intercept, while essentially, the slope remains unchanged, Asiedu *et al*. (2011) and Ali and Imai (2015).

Table 3.1

Data and their Sources

S/N	Variable	Source
1.	GDP per capita Growth	World Development Indicators, The World Bank
2.	GDP per person employed (labour productivity)	World Development Indicators, The World Bank
3.	HIV/AIDS prevalence rate	Health Stats, World Bank Group
4.	Health expenditure	Health Stats, World Bank Group
5.	Population growth	Health Stats, World Bank Group
6.	Urban population (% of total)	World Development Indicators
7.	Female labour force participation (% of female pop. age 15-64)	Gender Statistics, The World Bank
8.	Gross capital formation	World Bank National Account, World Development Indicators
9.	Secondary school enrolment	World Bank EdStats, Unesco Institute for Statistics
10.	Trade openness	World Bank National Account, World Development Indicators

3.7 Conclusion

This chapter presented the procedures and techniques applied in achieving the outlined research objectives. The theoretical framework of the study which is the Mankiw *et al*. (1992) augmented Solow model as further extended by McDonald and Roberts (2006), contained the research variables and predict their direction in growth process. On the basis of the model, health capital which dimension of human capital is defined in terms of HIV prevalence rate and AIDS. Three models are specified each achieved one research objective. The estimation technique is the system GMM estimator which is more efficient and unbiased. It addresses the endogeneity of the regressors, panel-level effects which maybe correlated with the explanatory variables, and avoid dynamic panel bias. The consistency of the GMM estimator depends on satisfying the specification and serial correlation tests. Annual data spanning from 1990-2013 is used. The choice of the study period is influenced by the manifestation of the problem and desire to get sufficient data on the variables involved to give meaningful results.

CHAPTER FOUR

EMPIRICAL RESULTS AND DISCUSSION

4.1 Introduction

In this chapter, the statistical method and procedures discussed in chapter three are applied to empirically analyse the research data. The study's hypotheses on the relationship between the dependent variables and the explanatory variables are tested. The results of the analyses provide answers to the research questions and as well achieved the objectives outlined in chapter one. First, descriptive statistics which provides basic features of the data is presented. This is followed by correlation analysis that describes the strength and direction of the linear relationship among the variables used. Subsequently, in each model, the regression results and discussions of the full sample is presented before that of the two alternative sub-samples sensitivity analysis. Finally, the robustness regression in which some of the control variables are substituted with comparable proxies is put forth.

4.2 Descriptive Statistics

Before any complex inferential statistical analysis, it is essential to provide simple summary statistics of the data to show an overall distribution of the variables involved. Descriptive statistics is an analysis that describes the basic features of data in a clear and meaningful manner. Therefore, it enables simple interpretation of the data. Typically, two types of statistic: measures of central tendency which consist of mean and median; and measures of spread represented by variance and standard deviation are the most commonly used to describe data.

Tables 4.1 and 4.2 presents some descriptive statistics of the variables used in this study. The upper part of the Tables shows the descriptive statistics for the full sample (sub- Saharan Africa [SSA]) whereas the remaining parts indicate the corresponding information for the two alternative sub-samples (Eastern and Southern Africa [ESA] and Rest of sub-Saharan Africa [RSA]). Similar statistics for the robustness variables are presented in Appendix VI and VII. Although, the minimum and maximum values in the full sample are reflection of the corresponding values in either ESA or RSA sub-samples, the mean and standard deviation differ in all the samples. The summary statistics with respect to the key variables is briefly discussed.

The HIV prevalence rate in the full sample has a mean value of 5.45%, which is above alarming proportion (UNAIDS, 2010; Kanekar, 2011). This figure, on the one hand, is below the corresponding prevalence rate 9.67% in the ESA sub-sample – mostly the highly HIV infected countries. On the other hand, it is higher than the value 2.29% obtained in the low HIV prevalence rate countries of the RSA sub-sample. It follows that the ESA sub-sample has an average HIV prevalence rate above the full sample's average. The highest rates of increase are also seen in the ESA sub-sample from 1994-2009, particularly in countries such as Botswana, Lesotho, South Africa, and Swaziland among others. In general, the HIV prevalence rate has increased rapidly in the RSA sample, although at a lower base. With respect to the GDP per capita growth, the full sample has 1.77% as its mean value, whereas the corresponding figures for the ESA and RSA sub-samples are 1.79% and 1.75% respectively. Obviously, across all the samples, the mean per capita GDP growth just differs slightly, although a bit higher in the ESA sample compared to other two samples. Figure 4.1 shows the trend exhibited by the GDP per capita growth and HIV prevalence rate.

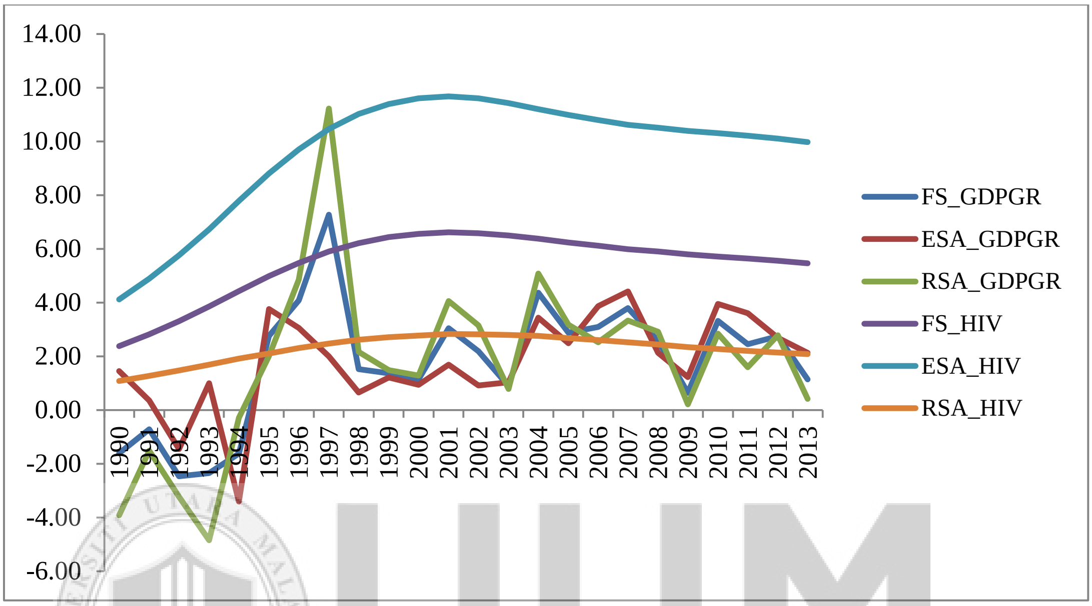

Figure 4.1
GDP per Capita Growth and HIV Prevalence Rate

Similarly, the mean value (US $3641.48) of GDP per person employed (i.e. labour productivity) in the ESA sub-sample is higher than the corresponding values for the full and RSA samples. This means that the level of labour productivity in either the full sample or RSA sub-sample is below what is obtainable in the ESA sub-sample. This is not surprising since the latter sample has lower total employment compared to either of the former samples. As a consequence, dividing GDP by smaller number of total employment gives the resultant higher value of the labour productivity. Figure 4.2 shows the trend exhibited by the labour productivity and HIV prevalence rate.

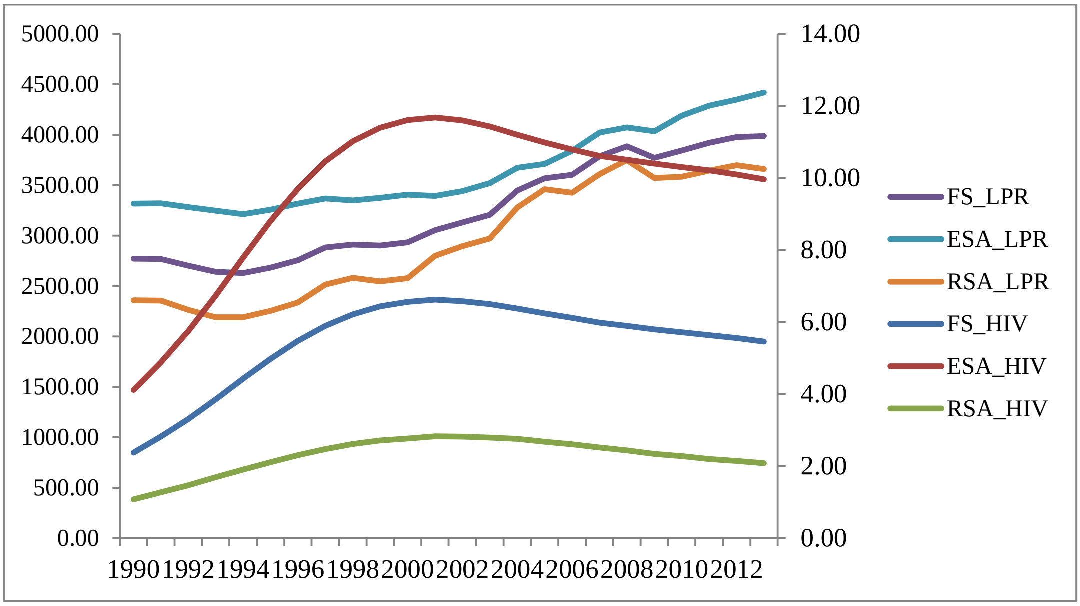

Figure 4.2
Labour Productivity and HIV Prevalence Rate

As regards to the health expenditure per capita, the mean value $177.54 in ESA sub-sample is much higher relative to $145.38 and $121.27 in the full sample and RSA sub-samples respectively. This could be due to the large number of population in the full sample and RSA sub-sample which lowers the per capita health expenditure. Furthermore, most of the heavily HIV infected countries in the ESA sample received more HIV/AIDS funding for prevention and treatment that substantially increased their health expenditure. Figure 4.3 shows the trend of health expenditure and HIV prevalence rate.

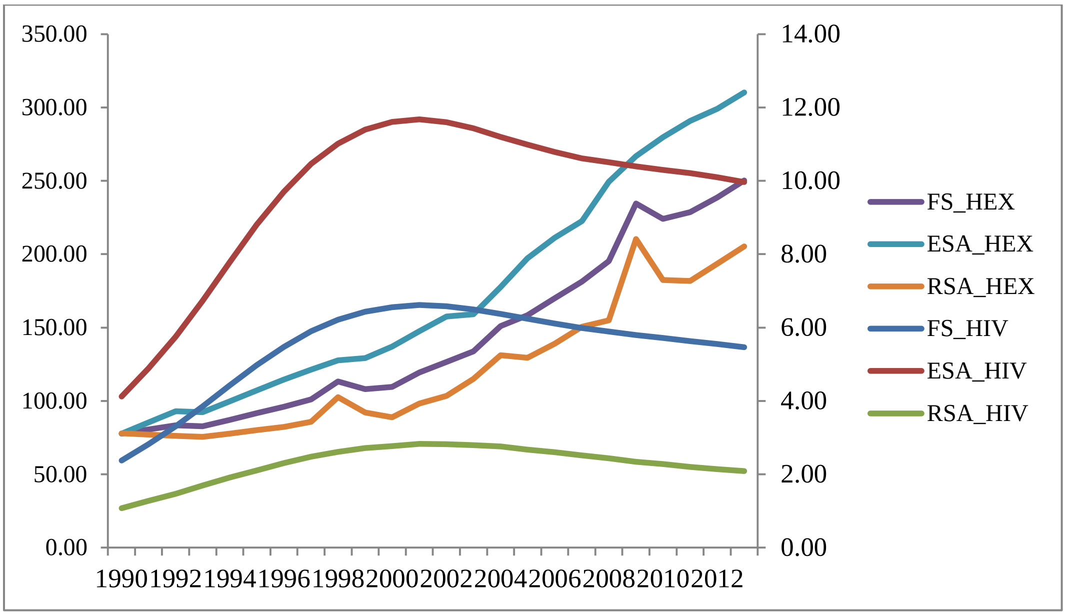

Figure 4.3
Health Expenditure and HIV Prevalence Rate

With regard to standard deviation, in all the samples, the variables: HIV prevalence rate, population growth and gross capital formation have smaller standard deviations, indicating they cluster around their mean value. While the remaining variables have large standard deviation, meaning that they are more disperse to the mean.

Table 4.1
Descriptive Statistics in Levels

VARIABLE	Mean	Std. Dev.	Min	Max
Full Sample				
GDP per capita growth	1.77	7.17	-33.06	101.67
HIV prevalence rate	5.45	6.68	0.10	28.40
GDP per person employed	3239.71	4703.87	154.52	27348.23
Population growth	2.52	1.12	-6.97	9.68
Gross capital formation/GDP (%)	23.49	18.30	2.58	186.73
Trade/GDP (%)	78.24	51.15	13.08	471.93
Health exp. Per capita (ppp 2011 Int.$)	145.38	194.29	1.16	1367.98
Urban population (% of total)	34.93	14.96	5.45	86.51
Female LFP rate (% of fem. age 15-64)	63.49	16.27	18.60	90.55
Sch. enrolment secondary (% gross)	32.97	20.73	1.22	106.33
Eastern and Southern Africa				
GDP per capita growth	1.79	3.30	-13.25	9.66
HIV prevalence rate	9.67	8.28	0.10	28.40
GDP per person employed	3641.48	4551.45	274.09	16577.48
Population growth	2.27	1.34	-6.97	9.68
Gross capital formation/GDP (%)	21.86	9.47	3.02	68.70
Trade/GDP (%)	71.83	40.26	13.08	204.67
Health exp. Per capita (ppp 2011 Int.$)	177.54	222.74	7.11	1105.94
Urban population (% of total)	27.79	13.53	5.45	63.53
Female LFP rate (% of fem. age 15-64)	67.85	18.15	26.05	90.55
Sch. enrolment secondary (% gross)	37.82	24.43	5.30	106.33
Rest of sub-Saharan Africa				
GDP per capita growth	1.75	9.06	-33.06	101.67
HIV prevalence rate	2.29	1.82	0.10	8.95
GDP per person employed	2938.39	4800.80	154.52	27348.23
Population growth	2.70	0.89	-1.69	7.38
Gross capital formation/GDP (%)	24.71	22.71	2.58	186.73
Trade/GDP (%)	83.05	57.59	26.03	471.93
Health exp. Per capita (ppp 2011 Int.$)	121.27	166.22	1.16	1367.98
Urban population (% of total)	40.28	13.72	13.94	86.51
Female LFP rate (% of fem. age 15-64)	60.22	13.86	18.60	80.70
Sch. enrolment secondary (% gross)	29.34	16.59	1.22	92.74

Source: Author's calculation using STATA 12.0 Software

Table 4.2

Descriptive Statistics in Logs

VARIABLE	Mean	Std. Dev.	Min	Max
Full Sample				
Lgdpgr	3.56	0.25	-0.06	4.91
Lhiv	0.94	1.33	-2.30	3.35
Llpr	7.40	1.08	5.04	10.22
Lpop	2.24	0.28	-3.50	2.81
Lgcf	2.98	0.57	0.95	5.23
Lopn	4.21	0.53	2.57	6.16
Lhex	4.39	1.08	0.15	7.22
Lurb	3.45	0.49	1.70	4.46
Lieq	4.13	0.30	2.95	4.52
Ledu	3.28	0.70	0.20	4.67
Eastern and Southern Africa				
Lgdpgr	3.57	0.10	3.03	3.78
Lhiv	1.58	1.51	-2.30	3.35
Llpr	7.40	1.26	5.61	9.72
Lpop	2.20	0.41	-3.50	2.81
Lgcf	3.00	0.43	1.10	4.23
Lopn	4.12	0.56	2.57	5.32
Lhex	4.51	1.16	1.96	7.01
Lurb	3.20	0.53	1.70	4.15
Lieq	4.20	0.30	3.28	4.52
Ledu	3.40	0.74	1.67	4.67
Rest of sub-Saharan Africa				
Lgdpgr	3.54	0.32	-0.06	4.91
Lhiv	0.47	0.92	-2.30	2.19
Llpr	7.41	0.92	5.04	10.22
Lpop	2.27	0.10	1.67	2.67
Lgcf	2.97	0.65	0.95	5.23
Lopn	4.27	0.51	3.26	6.16
Lhex	4.31	1.01	0.15	7.22
Lurb	3.64	0.36	2.63	4.46
Lieq	4.08	0.28	2.95	4.42
Ledu	3.19	0.66	0.20	4.53

Source: Author’s calculation using STATA 12.0 Software

4.3 Correlation Analysis

Table 4.3 present the full sample correlation analysis which shows the strength and direction of the linear association between the research variables. Corresponding correlation matrix for the ESA and RSA sub-samples is also presented in Appendix VIII. Correlations between an outcome variable and explanatory variables, especially key variables gives useful pre-estimation hints concerning the potential relationship suggested by theory (s). On the other hand, correlation coefficient amongst the explanatory variables informs the likely problem of the data; like multicollinearity. In a regression model, the problem of multicollinearity exists whenever two or more of the explanatory variables are either moderately or highly correlated. Though, moderate multicollinearity might not necessarily be an issue. Multicollinearity problem can cause the coefficients to change signs, and weaken the statistical power of the analysis by denouncing the influence of the related *t* statistic and *p*-value to assess the significance of the explanatory variables (Bowerman, O'Connell, & Orris, 2004).

Rather than implying causality, correlation (*r*) only indicates the relationship between one variable and another, where the values r = -1 and r = 1 means perfect negative and positive correlations respectively. Conversely, a value r = 0 indicates absence of any relationship between the variables concerned. In between the two extreme cases (r = -1 and r = 1), generally, a correlation coefficient of r = 0.1 is considered as weak relationship, whereas r = 0.5 and above a strong relationship with moderate association lying in-between (Acock, 2014; Gujarati & Porter, 2010).

The correlation coefficients among the study's variables as presented in Table 4.2 shows that, the strength of the relationship between the three dependent variables and most of their corresponding regressors is moderate. Nevertheless, few extreme correlations were seen. For instance, of the dependent variables; GDP per capita growth is weakly but as expected negatively correlated to HIV prevalence rate (-0.01) while labour productivity is strongly correlated to education (0.58). As expected, there is weak association among the regressors but in few instances. While the correlation between HIV prevalence and AIDS is moderate, that of gross capital formation and trade openness is strong (0.73). Equally, health expenditure and over urbanization exhibit strong correlation to education with coefficients (0.64) and (0.55) respectively. Regarding the two alternative sub-samples, the correlation between the dependent variables and the independent variables as well as among the explanatory variables is in line with the full sample. However, in the ESA sub-sample, among the explanatory variables, health expenditure shows strong correlation to over urbanization (0.72) and inequality (-0.50).

Table 4.3
Pairwise Correlation Matrix

	gdpgr	hiv	AIDS	lpr	pop	gcf	opn	hex	urb	ieq	Edu
gdpgr	1.00										
hiv	-0.01	1.00									
AIDS	-0.02	0.46	1.00								
lpr	0.07	0.22	0.04	1.00							
pop	0.19	-0.31	-0.33	-0.19	1.00						
gcf	0.48	-0.06	-0.11	0.21	-0.01	1.00					
opn	0.32	0.15	-0.05	0.31	-0.18	0.73	1.00				
hex	0.07	0.32	0.10	0.90	-0.24	0.17	0.26	1.00			
urb	0.01	-0.06	0.00	0.54	-0.13	0.14	0.25	0.45	1.00		
ieq	0.06	0.12	0.18	-0.23	0.05	0.07	-0.04	-0.20	-0.32	1.00	
edu	0.11	0.32	0.20	0.58	-0.32	0.15	0.26	0.64	0.55	-0.24	1.00

Source: Author generated using STATA 12.0 Software.

4.4 Econometric Analysis

This section reports the estimated results of the research models and their evaluation. In models with more than one parameter of interest, the study opted to start the estimations with the variables of interest alone before controlling for other explanatory variables in subsequent regressions. This informs the potential effects which the variables of interest might have on the dependent variable. However, in line with the existing growth literature, conclusions and policy recommendations are made based on estimations to which other explanatory variables are controlled. Specifically, the estimations starting point is the full sample regression which is considered as the benchmark. After which, the sensitivity of the results is examined within the two alternative ESA and RSA sub-samples. In all the samples, Regression one (*R1*) estimates the effects of the variables of interest on the dependent variable without controlling for other explanatory variables while Regression two (*R2*) after controls are introduced. Finally, the robustness of the results is checked by substituting some of the control variables with comparable proxies.

The step process apply in the estimations is similar to procedures used by Ali and Imai (2015) and Asiedu *et al*. (2011). Furthermore, following Lovasz and Schipp (2009), Cotte Poveda (2012) and Asiedu *et al*. the estimation does not begin with the pooled OLS estimator, which is particularly a tradition in some quarters rather than pre-estimation requirement(s). This is because, as explained in chapter three, the pooled OLS and other traditional panel data techniques such as fixed effects or random effects could not address the issue of endogeneity in this analysis. The econometric analysis is done in line with the outlined objectives of the research.

4.4.1 Model One Full-sample Regression: HIV and AIDS and GDP per Capita Growth

This model is empirically specified as equation (3.14), where GDP per capita growth is hypothesized to be a function of the following: HIV prevalence rate, AIDS, education, population growth, gross capital formation, and trade openness. In order to generalise the results on the effects of HIV prevalence rate and AIDS on economic growth, the study first explored their effects on growth in the full sample before investigating the two alternative sub-samples. The full sample as well as the ESA and RSA sub-samples sensitivity results is reported in Table 4.4.

The full sample *R1* results as shown in Table 4.4 which considers only the variables of interest have the estimated coefficient on the lagged dependent variable significant at 1 % level. This suggests that current GDP per capita growth is determined by its past level, and in so doing, affirmed the dynamic nature of the model. The inclusion of lagged dependent variable(s) can reduce the occurrence of autocorrelation arising from model misspecification. Accordingly, accounting for lagged dependent variables helps to defend the existence of autocorrelation in a model (Baltagi, 2005). By implication, not including the lagged dependent variable among the regressors would have lead to omitted variable bias which might have resulted to unreliable results. The variables of interest in the model are: (i) HIV prevalence rate which shows the instantaneous effect of the HIV and (ii) AIDS which accounts for the epidemic's incubation period and shows the effect after HIV has converts to AIDS. The results show that the estimated coefficient on HIV prevalence rate (*LnHIV*) is negative as expected and significant. The estimated coefficient on AIDS ($LnAIDS_6$)

is also significant and returns with positive sign. This suggests that HIV prevalence rate has a negative effect on per capita GDP growth while AIDS has a positive effect.

The specification and autocorrelation tests are sound. The Sargan test of overidentifying restrictions fails to reject the null hypothesis that the instruments are valid that is, not correlated with the error term. This means the instruments are consistent, not biased, and the model and overidentifying conditions are correctly specified. The regression passes the serial correlation test. The Arellano and Bond test for autocorrelation indicates the absence of second order serial correlation in the first-differenced errors. That is, the test fails to reject the null hypothesis of no second-order autocorrelation. In line with the GMM theoretical expectation, however, the null hypothesis of no first-order serial correlation is rejected. Thus, the tests uphold the validity and reliability of the system GMM estimator in the analysis.

The full sample *R2* to which other explanatory variables are controlled is being estimated. The result is also shown in Table 4.4. The growth equation shows that even with the controls, the estimated coefficient on the lagged dependent variable remains significant, confirming the influence of previous GDP per capita growth on current value. The significant coefficient on the lagged per capita income indicates that convergence is taking place as being reflected in (McDonald & Roberts, 2006). Regarding the variables of interest, interestingly, apart from slight changes in magnitude, the results basically remain the same as in the full sample's *R1*. That is, the estimated coefficient on HIV prevalence rate is still negative as expected while that of AIDS retains its positive sign, and both are as well significant at 1% level.

This suggests that within the observation period, HIV prevalence rate is negatively associated with per capita GDP growth while AIDS has a positive association. The time trend is found to be negative and statistically significant, suggesting that factors which are common to the sample countries, but changed over time, are reducing economic growth. The estimated coefficients on education, gross capital formation and trade openness are statistically significant with the predicted sign. The coefficient on population growth returns positive and significant.

Even though controlling for other explanatory variables increases the instruments count in the full sample *R2*, the p-values for the Sargan test reaffirmed the validity of the instruments. Furthermore, the Arellano-Bond tests indicate the absence of second-order serial correlation in the error term of the first-differenced equation as shown by the p-value. Furthermore, the serial correlation tests satisfy the assumption of first-order autocorrelation.

The HIV prevalence rate is mainly associated with rising morbidity than mortality, which due to treatment and maintenance led to increase in private and public health expenditure and consequently decline in domestic savings. The fall in domestic savings reduces capital formation and investment which in turn leads to decline in per capita income, hence declining economic performance as argued in Cuddington (1993) and Theodore (2001).

The results show that HIV prevalence rate has a significant negative effect on the growth of GDP per capita. This suggests that HIV epidemic reduces economic growth in the region within the observation period. For instance, an increase in HIV prevalence rate by one percentage point is, on average, associated with decrease in the growth rate of GDP per capita by 0.08 percentage points, which appear to be substantial. Therefore, this finding gives strong support to the claim that in SSA, HIV epidemic reduces the growth of national economies, and is in line with McDonald and Robberts (2006) and Lovasz and Schipp (2009). Thus, the HIV epidemic through its devastating consequences on the substantial number of the infected individuals and their families, firms and various governments has culminated in slowing down the economic growth in the region as being reflected in Cuddington (1993).

However, this finding contradicts the conclusion of Bloom and Mahal (1997) that HIV/AIDS has statistically insignificant effect on per capita income growth, hence there is more flash than substance to the argument that the epidemic obstructs economic growth. Their estimates were based on 1980 to 1992 data, a period when the HIV/AIDS prevalence rate was very low with limited effect on morbidity and mortality. Considering that there have been significant improvements in scientifically designed seroprevalence surveys in several countries, this study has gone further to use substantial and appropriate data on the HIV epidemic that covers the periods which the effects are most devastating. Hence this result tends to be more robust.

Consequently, after the disease has developed to AIDS – associated with rising mortality in addition to morbidity, it is found to have positive influence on GDP per capita. This corroborates Young (2005) that increased death and lower fertility due to

AIDS will reduce workforce hence, raise wages leading to higher per capita consumption. It also reflects Munro (2005), who in a study on economic conditions following pandemics, points that the Black Plague which struck Europe in mid-14th century leads to increase in wages and rising incomes hence, raised real per capita income. This phenomenon is explained by reduced supply of workforce. As proprietors competed for the reduced labour supply, wages increased. In addition, as workers had more land and capital to work with, they become more productive. The bigger picture, however, remains clear, that is, total output fell and the Black Plague was not good for European economies (Munro, 2005).

As put forth by UNAIDS and WHO (2009), AIDS related deaths has substantially increase the number of death in sub-Saharan Africa. For instance, in 2012, United States Census Bureau (2013) indicates that ten SSA countries viz: Tanzania, Mozambique, Zambia, Angola, Congo, Kenya, Uganda, Ethiopia, Ghana and Liberia suffered combined loss of more than 14.5 million people to AIDS. These suggests that in the region, as deaths increased due to AIDS and other causes, population growth declined, resulting to lower population at certain periods leading to higher GDP per capita. Especially if the population declined is not offset by proportional decline in GDP. However, the positive effect of AIDS on per capita GDP should not be construed as beneficial to economic growth in the region. In essence, it is harmful to growth, as it was due to decrease in populations rather than growth augmenting activities. Basically, growing sub-Saharan African economies needs growing populations to increase the supply of both labour and consumers. In essence, the average GDP per capita growth could have been much higher without the AIDS pandemic as being reflected in Bonnel (2000) and Dixon *et al*. (2001).

Essentially, in the long-run as more productive and experienced labour succumbed to AIDS, output could be so low, that even in the face of increased death, AIDS will in essence have negative effect on GDP per capita growth. Therefore, through effect on population, especially the working population AIDS influences growth in sub-Saharan Africa. This result provides evidence to support the hypothesis that AIDS has detrimental effect on economic growth in sub-Saharan Africa.

One might argue that the death rate could be nullified by birth rate. However, Bos and Bulatao (1992) maintain that the effect of higher mortality rates will offset any change in birth rates, resulting to decline in population growth rate. They further indicates that birth rate could be affected by the AIDS epidemic, because fertility rate will change as women alter their childbearing behaviour due to economic and non economic considerations in response to increased AIDS prevalence. Moreover, higher AIDS prevalence could change the number of women within the childbearing age cohort, thereby affecting the overall birth rate. These will eventually results to lower population than it would have been in the absence of the AIDS pandemic.

The positive effects of education on GDP per capita growth is in line with Mankiw *et al*. (1992), Lovasz, Schipp (2009) and Ding and Knight (2011). This suggests that secondary education attainment; which the net enrolment ratio is expanding (UNESCO, 2014), augments the performance of economies in the region. Although studies as Islam (1995), points that this variable has no positive effect on growth. Gross capital formation (investment) as found conducive to growth, is in consonance with Dixon *et al*. (2001), and Hou and Chen (2013). This implies that investment spending on capital assets/inventories and technological innovations promote growth as being reflected in Ding and Knight (2011). Remarkably, the results show that education contributes more to growth than gross capital formation in the region. Equally, trade and capital flows improve the region's economic growth. This corroborates Chang *et al*. (2009) and Ding and Knight (2011) that a prosperous export sector is among the essential ingredients of high and sustained growth, especially in the early stages. Furthermore, population growth rate tends to increase GDP per capita growth in the region; hence it is beneficial to growth of the economies. However, this does not mean there is exponential increase in populations in the region. Rather, it implies that within the observation period, the population has been growing at rates that warrant positive influence on GDP per capita. As argued in Solow (1956) and Mankiw *et al*. (1992), the lower the rate of population growth, the higher the income per capita, meaning the richer is the country.

4.4.2 Model One Sub-samples Regression: HIV and AIDS and GDP Per capita Growth

As earlier mentioned, the full sample observation is divided into two alternative ESA and RSA sub-samples to examine whether differences exists in the two samples. In line with the step process, the estimation begins with *R1* which considers only the variables of interest. The estimated results for the two alternative sub-samples are also reported in Table 4.4. The ESA sub-sample contains most of the highly HIV/AIDS infected countries compared to RSA. Consequently, the average HIV prevalence rate is higher in the ESA sub-sample. In the RSA sub-sample, the *R1* results virtually remain the same as in the full sample's equivalent. That is, the estimated coefficient on HIV prevalence rate is negative while that on AIDS remain positive, and both are equally significant as the coefficient on the lagged per capita GDP. In a similar *R1* on the ESA sub-sample, all the coefficients except HIV prevalence rate are similar to what is obtainable in the full sample and the RSA sub-sample as well. This is because the HIV prevalence rate returns with the unexpected sign although insignificant. This could have been due to the lack of controlling for other explanatory variables in the *R1* estimation. Consequently, after controlling for other factors in the subsequent ESA sub-sample *R2*, the coefficient on the HIV prevalence rate assumed the expected negative sign.

In both the two alternative sub-samples *R1*, the specification and the autocorrelation tests are as-well sound. That is, neither the Sargan nor the Arellano-Bond tests detect any problem with the instruments validity or the second-order serial correlation.

At this stage, the two alternative sub-samples *R2* to which other explanatory variables are controlled are being estimated. The results are equally indicated in Table 4.4. In the ESA sub-sample, the instrument ratio is not consistent even after restricting the number of lagged levels to reduce the instruments count. Therefore, in order to have consistent instruments ratio – greater or equal to one (≥ 1) (Roodman, 2009), the study opted to exclude one of the insignificant variables from the estimation. Excluding education in the regression validate the instruments ratio. The result before the exclusion is shown in Appendix IX. As shown in Table 4.4, the coefficient on the lagged per capita income in both ESA and the RSA sub-samples is significant. This further confirmed the dynamic nature of the model. Regarding the variables of interest, the results in both the two sub-samples are similar to what is obtainable in the full sample. This means, the estimated coefficient on HIV prevalence rate is negative as expected and significant, while the estimated coefficient on AIDS retained its positive sign as well as significant.

Interestingly, the results in both the two alternative sub-samples are consistent with the full sample equivalent. That is, in both ESA and the RSA the HIV prevalence rate is found to have negative effect on economic growth. This finding disagrees with the conclusion of Lovasz and Schipp (2009) that in Southern and Eastern Africa and the Rest of Africa sub-samples, there is no evidence that HIV epidemic reduces the growth of per capita GDP. Their findings are based on relatively short observation period of only nine years. Furthermore, the instruments of the system GMM estimator shortened the time by two years, as a result seven years periods was used effectively (Lovasz & Schipp, 2009). This might have affected their results after the full sample was divided into two alternative sub-samples. This study has gone further to use much longer observation period of 24 years and applied two-step system GMM estimator which is asymptotically more efficient and robust to heteroskedasticity than one-step (Asiedu *et al*. 2011; Hou & Chen, 2013). Similarly, in both the two sub-samples, AIDS which reduces the population, particularly the labour force, is found to be detrimental to growth. This suggests that without the AIDS pandemic, the growth performance in the two sub-samples would have been much higher as being reflected in Bonnel (2000) and Dixon *et al*. (2001).

The sensitivity analysis indicates that the effect of the HIV prevalence rate on the growth of GDP per capita does not differ in the two sub-samples. In each sub-sample the HIV epidemic is found to have a significantly negative effect on growth. However, the magnitude of the effect differs in the two sub-samples. Surprisingly, the effect of HIV prevalence rate on growth is higher in the low prevalence RSA sub-sample compared to the highly infected ESA sub-sample. As shown in Table 4.4, a one percentage point rise in HIV prevalence rate, on average, reduces GDP per capita growth by 0.15 percentage points in the RSA against 0.03 percentage points in the ESA. As established by the IMF Regional Economic Outlook (2009; 2013), some of the countries in the ESA sub-sample as South Africa, Mozambique, Ruwanda and Ethiopia among others have recorded strong economic performance between 2004 and 2011. Even though growth has faltered in many economies in sub-Saharan Africa during the 2008 and 2009 global recession (IMF, 2010), the strong economic performance might have contributes to mitigate the effect of the HIV prevalence rate on growth in the ESA sub-sample.

Similarly, based on the sensitivity analysis, the effect of AIDS on growth does not significantly differ in the two sub-samples. In both ESA and the RSA sub-samples, AIDS is found to be positively associated with per capita GDP growth. However, this came at the expense of decrease in population due to AIDS related deaths and otherwise. Therefore, the AIDS pandemic through the population, especially the work force, reduces growth in each sub-sample. The effect of AIDS like that of the HIV prevalence rate is more pronounced in the RSA sub-sample compared to the other one. As further indicated by the sub-samples analysis there is only slight differences on the coefficients of the control variables.

In the RSA, the estimated coefficients on secondary school enrolment and gross capital formation, as in the full sample, return with the expected positive sign and are significant. Whereas in the ESA sub-sample the former coefficient is excluded in the estimation, the latter shows no significance nevertheless, has the predicted sign. Therefore, investments in human capital and physical assets are beneficial to growth in the RSA sub-sample. In both the sub-samples the coefficient on population growth is similar to what is obtainable in the full sample, that is, significant with unexpected sign. The value of trade openness is significant in the ESA sub-sample and more than twice the coefficient in the full sample. This suggests that as in the full sample, openness to trade is conducive to growth in the ESA sub-sample. In the other alternative sub-sample this parameter shows no significant effect nevertheless return with the expected sign.

The specification and the autocorrelation tests are sound. That is, neither the Sargan nor the Arellano-Bond tests detect any problem with the instruments validity or the second-order serial correlation. This means the instruments are consistent, unbiased, and the model and overidentifying conditions are correctly specified. Equally, there is zero second-order autocorrelation in the first-differenced errors. However, in line with the GMM theoretical expectation, the null hypothesis of no first-order serial correlation is rejected. Thus, the tests uphold the validity and reliability of the system GMM estimator in the analysis.

Table 4.4
GMM Estimates for Model One Full Sample and Alternative Sub-samples

Variable	Sub-Saharan Africa		Rest of SSA (low prevalence)		East & South Afr. (high prevalence)	
	R1	R2	R1	R2	R1	R2
$LnGDPGR_{it-1}$	0.146*** (0.018)	0.117*** (0.027)	0.200*** (0.019)	0.146*** (0.040)	0.066* (0.038)	-0.078* (0.043)
LnHIV	-0.077*** (0.014)	-0.084*** (0.016)	-0.106*** (0.014)	-0.145*** (0.026)	0.001 (0.014)	-0.025** (0.013)
$LnAIDS_6$	0.026*** (0.005)	0.042*** (0.006)	0.048*** (0.007)	0.054*** (0.013)	0.018* (0.011)	0.035*** (0.008)
LnEDU		0.066** (0.031)		0.119** (0.050)		
LnPOP		0.256*** (0.091)		0.194*** (0.069)		0.659*** (0.134)
LnGCF		0.040*** (0.012)		0.047*** (0.012)		0.007 (0.014)
LnOPN		0.043** (0.020)		0.029 (0.019)		0.144*** (0.043)
Time trend	-0.007*** (0.002)	-0.024*** (0.003)	-0.019*** (0.003)	-0.038*** (0.006)	0.000 (0.002)	-0.009*** (0.002)
Constant	3.194*** (0.075)	2.338*** (0.256)	3.101*** (0.071)	2.373*** (0.199)	3.335*** (0.167)	1.872*** (0.378)
Observations	252	252	144	144	108	108
Countries	42	42	24	24	18	18
Sargan test	0.221	0.160	0.366	0.155	0.166	0.326
AR (1) test	0.002	0.002	0.014	0.019	0.033	0.052
AR (2) test	0.576	0.799	0.802	0.958	0.409	0.465
Instruments	25	34	20	24	15	18

Note: Standard errors in parentheses. ***, ** and * denotes significance at the 1, 5 and 10% levels, respectively.

4.4.3 Model One Robustness Regression

As a robustness check, the model is re-estimated by substituting secondary school enrolment and population growth with other comparable proxies in order to examine the stability of the coefficients estimates of the variables of interest.

As shown in Table 4.5, the coefficients on both the HIV prevalence rate and AIDS in the full sample retained their signs and are equally significant. Similarly, these coefficients in both ESA and the RSA sub-samples remained unchanged and are significant. Furthermore, across the specifications, the magnitude of the parameters estimate is fairly stable. Therefore, overall, the main results survived the substitution of some of the explanatory variables, hence are robust.

The results are also robust to specification and the serial autocorrelation tests. Neither the Sargan test of overidentifying restrictions nor the Arellano-Bond autocorrelation test detects any problem with the instrument validity or second order serial correlation in first-difference errors.

As regards to the included proxies, secondary education general pupil in the full sample and the RSA sub-sample return with the unexpected sign nevertheless, significant. However, in the ESA sub-sample this coefficient is excluded in the estimation in order to have valid instrument ratio. The estimated coefficient on total population has unexpected sign in all the samples nevertheless significant in the full sample and the ESA sub-sample.

Table 4.5

GMM Estimates for Model One Robustness Regression

Variable	Sub-Saharan Africa	Rest of SSA (low prevalence)	East & South Afr. (high prevalence)
$LnGDPGR_{it-1}$	0.114***	0.169***	-0.076***
	(0.021)	(0.021)	(0.029)
LnHIV	-0.077***	-0.168***	-0.016
	(0.014)	(0.031)	(0.021)
$LnAIDS_6$	0.036***	0.050***	0.052***
	(0.005)	(0.009)	(0.010)
LnSED	-0.031**	-0.011	
	(0.016)	(0.038)	
LnPLN	0.048***	0.002	0.038***
	(0.014)	(0.038)	(0.014)
LnGCF	0.051***	0.061***	0.054**
	(0.007)	(0.011)	(0.023)
LnOPN	0.037**	0.004	0.138***
	(0.017)	(0.013)	(0.052)
Time trend	-0.013***	-0.027***	-0.014***
	(0.002)	(0.004)	(0.003)
Constant	2.683***	3.244***	2.601***
	(0.152)	(0.259)	(0.272)
Observations	252	144	108
Countries	42	24	18
Sargan test	0.192	0.182	0.424
AR (1) test	0.002	0.016	0.061
AR (2) test	0.723	0.830	0.556
Instruments	34	24	18

Note: Standard errors in parentheses. ***, ** and * denotes significance at the 1, 5 and 10% levels, respectively

4.4.4 Summary of Model One

This model investigates the effects of the HIV prevalence rate and AIDS on GDP per capita growth. In order to generalise the results, the full sample as well as the ESA and the RSA sub-samples are examine. In the full sample analysis (i.e. *R1* and *R2*) the significant coefficient on the lagged per capita GDP indicates that the model is dynamic. The HIV prevalence rate is found to have a negative effect on GDP per capita growth as in McDonald, Robberts (2006) and Lovasz and Schipp (2009) hence; reduces the growth of national economies. Thus, the HIV prevalence through increased health expenditure reduces domestic savings which in turn leads to decline in capital formation and investment. The fall in investment reduces per capita income, hence declining economic performance as argued in Cuddington (1993). The estimated coefficient on AIDS is positively associated with GDP per capita growth. This agrees with Young (2005) that increased death and lower fertility due to AIDS will reduce workforce hence, raise wages leading to higher per capita consumption. However, this could not be construed as beneficial to growth because it has resulted due to decease in population rather than growth augmenting policies or activities. Therefore, the AIDS pandemic is also detrimental to economic growth in sub-Saharan Africa region.

Interestingly, the sensitivity analysis shows that the results in ESA and the RSA sub-samples are consistent with the full sample. That is, in each sub-sample the HIV prevalence rate has negative effect on GDP per capita growth. Similarly, AIDS is detrimental to growth in both ESA and the RSA sub-samples. Consequently, except in their magnitude, these effects do not differ in the two sub-samples. Surprisingly, the magnitude of these effects is higher in the low HIV prevalence RSA sub-sample relative to the highly HIV infected ESA sub-sample. As regards to the robustness check, the coefficients on the variables of interest are robust to substitution of some control variables with other comparable proxies.

In the full sample as well as the two alternative sub-samples the specification tests are sound. That is, neither the Sargan test for overidentifying restrictions nor the Arellano-Bond autocorrelation tests detect any problem with the instruments validity or second-order serial correlation. Furthermore, the assumption of first-order serial correlation is satisfied. Thus, the model is correctly specified and the instruments are consistent and unbiased hence, valid.

4.4.5 Model Two Full-sample Regressions: HIV and AIDS and Aggregate Labour productivity

This section reports the estimated results for the specification of equation (3.16) which specified aggregate labour productivity as a function of: HIV prevalence rate, AIDS, education, population growth, gross capital formation and trade openness. The full sample as well as the ESA and RSA sub-sample sensitivity results is reported in Table 4.6.

In Table 4.6, the full sample results (*R1* and *R2*) shows that the coefficient on the lagged GDP per person employed is significant, suggesting that current labour productivity is determined by its past level. This confirmed that the model is dynamic. Therefore, failure to include the lagged dependent variable among the predictors would have led to omitted variable bias and consequently questionable results. In the full sample's *R1*, the estimated coefficient on the HIV prevalence rate has the expected sign and is significant. This suggests that the HIV epidemic has negative effect on GDP per person employed hence, reduces aggregate labour productivity. The coefficient on AIDS is also significant and returns with positive sign. This implies that AIDS tend to augments the GDP per person employed. The time trend is negative and significant, suggesting that factors which are common to the sampled countries, but which change over time, tend to reduce labour productivity within the period.

In the full sample *R2*, other explanatory variables are controlled. The results of the variables of interest-HIV prevalence rate and AIDS remain the same as in the full sample *R1*. That is, the estimated coefficient on the HIV prevalence rate remains negative while that on AIDS retain its positive sign and both are significant. In general, almost all the control variables are consistent with the a priori expectations. More specifically, population growth, gross capital formation and trade openness are statistically significant. However, education return with the unexpected sign nonetheless, significant.

In the full sample regressions, the specification and the autocorrelation tests are well-behaved. The Sargan test for overidentifying restrictions fails to reject the null hypothesis that the instruments are valid, that is, not correlated with the error term. This means the instruments are consistent and unbiased. Therefore, the model and overidentifying conditions are correctly specified. Equally, the regression passes the serial correlation test. The Arellano and Bond test for autocorrelation indicates the absence of second-order serial correlation in the first-differenced errors. That is, the test fails to reject the null hypothesis of no second-order autocorrelation. Similarly, in line with a priori expectation, the null hypothesis of no first-order serial correlation is rejected. Thus, the tests support the validity and reliability of the system GMM estimator in the estimation.

The negative effect of the HIV prevalence rate on labour productivity is explained by the rising morbidity associated with the epidemic (Cuddington, 1993). In sub-Saharan Africa, the widely spread HIV infection impairs the infected labours' immune system. In so doing, paves the way for several opportunistic infections which led to frequent illnesses and absenteeism at work place. Consequently, the productivity of the labour declined because sick and worried workers are physically and mentally weak. Moreover, the productivity of the uninfected workers could have also declined, leading to lower output. This is because the continued infection among colleagues, families/relative, and the progression of the disease to AIDS, influences the performance of the affected individuals and also requires more time for care and management. This result confirms the hypothesis that HIV epidemic reduces aggregate labour productivity in sub-Saharan Africa. And it supports the findings of Fox *et al*. (2004) in a micro analysis of labour market, where HIV reduces labour productivity. For instance, a one percentage point increase in the HIV prevalence rate, on average, tends to reduce labour productivity by 0.06 percentage point. These justifies the assertion of UNAIDS (2013) that in sub-Saharan Africa, substantial proportion (80%) of the HIV infected working-age adults do not have access to the costly immune booster and life-saving antiretroviral therapy. The result also support the finding's of Simtowe and Kinkingninhoun-Medagbe (2011) that in tea producing firm, HIV infection reduces the productivity of infected workers.

As earlier mentioned, labour productivity is measured using GDP per persons employed. The positive influence of AIDS on GDP per persons employed stems from declining total employment due to sizeable deaths by AIDS and other causes as being reflected in Young (2005). The AIDS epidemic has considerably reduced work force in SSA (UNAIDS & WHO, 2009; US Census Bureau, 2013). Thus, at the macroeconomy level, labour productivity as a ratio of GDP to total employment, will continue to increase as the GDP is divided by diminishing total employment. Especially in periods where the proportional lost in total employment is not offset by lost in the GDP. The seemingly positive influence of AIDS on GDP per persons employed could not be construed as beneficial to labour productivity. In essence, it is rather detrimental, since it came at the expense of decreasing total employment, instead of labour training. This suggests that the aggregate labour productivity would have been much higher without the AIDS pandemic. Essentially, in the long-run, as more skilled and experienced workers that could not be easily replaced succumbed to AIDS, output will be very low. Consequently, the AIDS pandemic will out-rightly begins to have negative effect on the labour productivity. Therefore, the result supports the hypothesis that through effects on total employment, AIDS reduces aggregate labour productivity in sub-Saharan Africa.

Regarding the control variables, all except education are found to be beneficial to labour productivity. This implies that in the region, the level of investment in physical capital and inventories matters for the labour productivity within the period. And it is in consonance with Liu, Parker, Vaidya and Wei (2001) that investment in technology, physical assets and management skills enhances labour productivity. Similarly, openness to trade, perhaps by relaxing credit and investment restrictions, and thus improving capital accumulation and transfer of technology benefits labour productivity as being reflected in Van Biesebroeck (2005). Furthermore, population growth is equally associated with improved labour productivity. This is because it provides sustain supply of labour to replace those that had succumbed to the disease, especially the skilled and experienced ones that are not easily replaceable.

However, there is no evidence that investment in education via secondary school enrolment has the expected positive influence on labour productivity. Although, this is in line with Islam (1995) and McDonald and Roberts (2002; 2006), it is somewhat disturbing as it contradict expectation; however it is a variable which does not perfectly measure the skill component of human capital. Yet, it is difficult to precisely define other measures of skills (McDonald & Roberts, 2006). This suggests that secondary school attainment is perhaps not enough to provide the necessary training and skills to enhance labour productivity. Augmenting labour productivity requires rigorous tertiary education to train and equip individuals with the required advanced knowledge (Psacharopoulos, 1994). Therefore, it is not surprising that secondary enrolment does not enhance labour productivity, although it is beneficial to growth. This is because secondary school education can equip an individual with just the basic skill necessary to engage in productive activities recorded in GDP. Whereas enhancing labour productivity requires higher education as well as training and development.

4.4.6 Model Two Sub-samples Regression: HIV and AIDS and Aggregate Labour productivity

In line with the analytical process, the full sample observation is separated into the two alternative sub-samples for the sensitivity analysis. The results are reported in Table 4.6. In both ESA and the RSA sub-samples *R1*, the estimated coefficient on the lagged GDP per person employed is significant; hence re-affirm the dynamic nature of the model. The coefficient on HIV prevalence rate is negative as expected and significant. The estimated coefficient on AIDS in the ESA sub-sample retains its positive sign as in the full sample, but it is insignificant. In the RSA sub-sample this coefficient is also insignificant with the unexpected sign. This perhaps could have been due to the lack of controlling for other explanatory variables in the estimation.

The two sub-samples *R2* to which other explanatory variables are controlled are being estimated. In the ESA sub-sample, the instrument ratio is not consistent even after restricting the number of lagged levels to reduce the instruments count. The study opted to exclude one of the insignificant variables, that is, education to have valid instruments ratio. For the result before the exclusion see Appendix X. In each sub-sample the coefficient of the lagged GDP per person employed remains significant. As in the full sample, the estimated coefficient on HIV prevalence rate is negative and significant in both ESA and the RSA sub-samples. This implies that the HIV epidemic tends to reduce aggregate labour productivity in each sub-sample as it does in the full sample. In the highly HIV infected ESA sub-sample, the coefficient on AIDS is significant and positive as in the full sample. However, as earlier mentioned, this seemingly positive influence of AIDS could not be interpreted as beneficial to labour productivity. This is because it has resulted due to reduction in total employment rather than labour training and development. Therefore, as in the full sample, the AIDS pandemic tends to reduce aggregate labour productivity in the ESA sub-sample. In the low HIV infected RSA sub-sample there is no evidence that

AIDS has significant effect on labour productivity. This could be due to the low HIV infection that mitigates the development of the AIDS.

Regarding the control variables, in the two sub-sample the estimated coefficients on population growth and trade openness are both significant with expected sign. This implies that population growth and trade policies are associated with improve labour productivity. On the other hand, in both ESA and the RSA sub-samples, there is no evidence that gross capital formation has the expected positive effect on labour productivity. The estimated coefficient on education in the RSA sub-sample is positive as expected but insignificant. In the ESA sub-sample, however, this coefficient is dropped in order to validate the instrument ratio.

The sensitivity analysis indicates that the effect of the HIV prevalence rate on labour productivity does not differ in both the two sub-samples. That is, the HIV epidemic tends to reduce labour productivity in each sub-sample as it does in the full sample. However, the effect of AIDS differs in the two sub-samples. In the ESA sub-sample AIDS tends to have detrimental effect on labour productivity as in the full sample. Whereas in the other sub-sample there is no evidence that it significantly reduces labour productivity. With respect to the control variables, there is virtually little difference on the estimated coefficients. In the sensitivity analysis, the Sargan test for overidentifying restrictions shows that the instruments are valid, unbiased and consistent. Equally, the results pass the Arellano-Bond autocorrelation test, indicating the absence of second-order serial correlation in the error term of the first-differenced equation. The assumption of first-order autocorrelation is equally satisfied.

Table 4.6
GMM Estimates for Model Two Full Sample and Alternative Sub-samples

Variable	Sub-Saharan Africa		Rest of SSA (low prevalence)		East & South Afr. (high prevalence)	
	R1	R2	R1	R2	R1	R2
$LnLPR_{it-1}$	-0.466*** (0.030)	-0.359*** (0.029)	1.047*** (0.020)	1.049*** (0.024)	-0.661*** (0.046)	-0.507*** (0.042)
LnHIV	-0.078*** (0.018)	-0.055*** (0.015)	-0.150*** (0.034)	-0.075* (0.040)	-0.032** (0.015)	-0.059*** (0.014)
$LnAIDS_6$	0.017** (0.007)	0.020** (0.008)	-0.008 (0.022)	-0.021 (0.018)	0.009 (0.006)	0.041*** (0.009)
LnEDU		-0.041 (0.043)		0.082 (0.074)		
LnPOP		0.557*** (0.089)		0.461** (0.208)		0.555*** (0.073)
LnGCF		0.040*** (0.013)		-0.005 (0.015)		0.023 (0.015)
LnOPN		0.075** (0.031)		0.135*** (0.043)		0.149*** (0.024)
Time trend	-0.011*** (0.003)	-0.010 (0.006)	-0.010 (0.008)	-0.012 (0.011)	-0.009*** (0.001)	-0.023*** (0.003)
Constant	0.360*** (0.084)	-1.150*** (0.278)	-0.119 (0.135)	-2.054*** (0.627)	0.115 (0.095)	-1.719*** (0.162)
Observations	252	252	144	144	108	108
Countries	42	42	24	24	18	18
Sargan test	0.308	0.159	0.566	0.377	0.486	0.446
AR (1) test	0.008	0.006	0.058	0.030	0.095	0.080
AR (2) test	0.206	0.230	0.735	0.703	0.242	0.304
Instruments	20	24	15	19	15	18

Notes: Standard errors in parentheses. ***, ** and * denotes significance at the 1, 5 and 10% levels, respectively

4.4.7 Model Two Robustness Regression

To check the robustness of the results of the variables of interest, the model is re-estimated by substituting some control variables with comparable proxies. Secondary education general pupil and total population are included to show the stability or otherwise of the coefficients of the key explanatory variables. The results are also shown in Table 4.7.

Across all the specifications, the results of the key variables remain unchanged. That is, the estimated coefficient on HIV prevalence rate remains negative and significant in the full sample and the two alternative sub-samples. The coefficient on AIDS retains its positive sign and significant in the full sample and ESA sub-sample. Whereas the insignificant effect of AIDS in the RSA sub-sample is equally retain. Therefore, the main results are robust to substitution of some control variables. Furthermore, the magnitude of the parameters is fairly stable across the specifications. The results are also robust to the specification tests, as neither the Sargan nor the Arellano-Bond tests detects any problem with the instruments validity or second order serial correlation in first-difference errors.

With respect to the included variables, in the full sample as well as the ESA sub-sample the estimated coefficient on education return with the unexpected sign nevertheless significant. However, in the ESA sub-sample this coefficient is excluded to validate the instruments ratio. The coefficient on total population in the full sample and the two sub-samples is positive and significant.

Table 4.7
GMM Estimates for Model Two Robustness Regression

Variable	Sub-Saharan Africa	Rest of SSA (low prevalence)	East & South Afr. (high prevalence)
$LnLPR_{it-1}$	-0.373***	1.031***	-0.540***
	(0.026)	(0.017)	(0.051)
LnHIV	-0.055***	-0.135***	-0.048**
	(0.015)	(0.029)	(0.015)
$LnAIDS_6$	0.015*	-0.009	0.039***
	(0.009)	(0.017)	(0.008)
LnSED	-0.069***	-0.082**	
	(0.018)	(0.039)	
LnPLN	0.062**	0.073*	0.010**
	(0.025)	(0.041)	(0.017)
LnGCF	0.039***	0.012	0.058
	(0.015)	(0.020)	(0.011)
LnOPN	0.060*	0.108***	0.121***
	(0.036)	(0.030)	(0.021)
Time trend	-0.004	-0.003	-0.020**
	(0.003)	(0.007)	(0.003)
Constant	-0.054	-0.670**	-0.671
	(0.413)	(0.325)	(0.330)
Observations	252	144	108
Countries	42	24	18
Sargan test	0.335	0.509	0.608
AR (1) test	0.008	0.032	0.074
AR (2) test	0.203	0.759	0.330
Instruments	24	19	18

Note: Standard errors in parentheses. ***, ** and * denotes significance at the 1, 5 and 10% levels, respectively

4.4.8 Summary of Model Two

This model investigates the effects of HIV prevalence rate and AIDS on aggregate labour productivity within the full sample and two alternative sub-samples. In the full sample, the significant coefficient on lagged GDP per persons employed shows that the model is dynamic, meaning current labour productivity is determined by previous value. The HIV epidemic in the full sample has a negative and significant effect on aggregate labour productivity. This supports the findings of Simtowe, Kinkingninhoun-Medagbe (2011) and Fox *et al*. (2004) in micro analyses, where HIV prevalence is found to reduce firm's labour productivity. The epidemic is associated with rising illnesses and absenteeism at work place. Consequently, the productivity of the labour declined because sick and worried workers are physically and mentally weak as being reflected in Cuddington (1993). AIDS is found to be positively associated with aggregate the labour productivity. However, this could not be interpreted as beneficial to the aggregate labour productivity; rather it is detrimental as it was due to decreased total employment as reflected in Young (2005).

The sensitivity analysis indicates that the HIV epidemic also has negative effect on labour productivity in either of the sub-samples as it does in the full sample. However, the effect of AIDS differs in the two sub-samples. In the ESA sub-sample, the AIDS pandemic via reduced total employment is detrimental to aggregate labour productivity. While in the other sub-sample, there is no evidence that AIDS has the expected negative effect on aggregate labour productivity. With respect to robustness of the results, the estimated coefficients of the key variables are stable and robust to substitution of some explanatory variables.

In the full sample as well as ESA and the RSA sub-samples, the specification tests are well-behaved. That is, neither the Sargan nor the Arellano-Bond tests detect any problem with the instruments validity or second-order serial correlation.

Furthermore, the assumption of first-order serial correlation is satisfied. Thus, the model is correctly specified and the instruments are consistent and unbiased hence, valid.

4.4.9 Model Three Full-sample Regression: Health Expenditure and HIV

In this section, the results for the specification of equation (3.18) are reported. The equation specified HIV as a function of: health expenditure, education, over-urbanization and inequality. The full sample as well as the two sub-samples sensitivity results is reported in Table 4.8. In this model, there is single variable of interest which is health care expenditure.

As shown in Table 4.8, in the full sample regression, the estimated coefficient of the lagged dependent variable is significant. This implies that current HIV prevalence rate is influenced by previous prevalence hence, the model is dynamic. Therefore, not including the lagged dependent variable among the regressors would have lead to omitted variable bias and consequently unreliable results. The estimated coefficient on health expenditure per capita is negative as expected nevertheless, insignificant. This suggests that the health expenditure has no significant effect on HIV prevalence rate. On the other hand, the estimated coefficient on education is significantly negative, indicating that secondary school enrolment tend to reduce the rate of HIV infection. The coefficient on inequality has the expected positive sign but insignificantly related to HIV prevalence rate. The coefficient on over urbanization is significant and as expected, positively associated with the HIV prevalence rate. The time trend is positive however, insignificant. This suggests that factors as culture and weather among others, which are common to the sampled countries, but which change over time, have no significant effect on HIV prevalence rate within the period.

In the full sample regression, the specification and serial correlation tests are sound. The Sargan test for overidentifying restrictions fails to reject the null hypothesis that the instruments are valid, that is, not correlated with the error term. This means the instruments are unbiased and consistent. The Arellano and Bond test for autocorrelation indicates the absence of second order serial correlation in the first-differenced errors. That is, the test fails to reject the null hypothesis of no second-order autocorrelation. However, in line with a priori expectation, the null hypothesis of no first-order serial correlation is rejected. Therefore, the tests support the validity and reliability of the system GMM estimator in the analysis.

Although health expenditure returns with the expected negative sign, it has no significant effect on HIV prevalence rate within the observation period. Perhaps the health expenditure per capita is insufficient hence, does not mitigate the spread of the HIV epidemic in the region. As argued by Amico, Aran and Avila (2010), sub-Saharan Africa has less per capita health spending than any other region in the world. This is further indicated by the region's average per capita health expenditure of just \$145.38 (World Bank, 2014). Therefore, the result does not support the hypothesis that health expenditure reduces HIV infection in sub-Saharan Africa. Yet, the insignificant effect of health expenditure on the HIV prevalence is rather surprising, considering that in SSA, HIV funding as part of health spending in various heavily infected countries, may actually exceed their entire health budget (Avila *et al*. 2013).

The negative effect of investment in education on HIV prevalence rate corroborates Gregson, Waddell, Chandiwana (2001) and Vaughan, Rogers, Singhal and Swalehe (2000) that massive awareness, enlightenment and sensitization campaign in schools facilitates HIV control. This implies that the campaign programs are essentially paying dividend. Youths, who are amongst the highly vulnerable groups, are informed about HIV and its concerns. On the contrary, evidence shows that higher urban population increases the spread of the HIV prevalence rate in the sub-Saharan Africa. This could be attributed to risky behaviour such as commercial sex work, homosexuality, drug use injection and marriage without test among others which characterized most of the urban areas as being reflected in Dyson (2003). Consequently, lack of taking proper precaution due to negligence, recklessness as well as culture could have substantially increases the spread of the HIV epidemic among those who engaged in such risky behaviour and their associates including the community at large.

However, there is no evidence that inequality through female labour force participation has the expected positive influence on HIV infection. This contradicts Cockerham (1997) that income and gender inequality lead to risky sexual behaviour with the tendency of HIV infection. As World Bank (2013) indicates, women feature significantly in trade in Africa. Thus, the disparity in the labour force participation rate is not sufficient to increase stress and reduce independence among women which could have lead to risky sexual behaviour and consequently increased the HIV infection in the region.

4.4.10 Model Three Sub-samples Regression: Health Expenditure and HIV

The full sample observation is divided into the two alternative sub-samples to examine the sensitivity of the results. The estimated results are also reported in Table 4.8. In both the two sub-samples, the coefficient estimate on per capita health expenditure is insignificant with unexpected sign. This implies that health expenditure has no significant effect on HIV infection in ESA and RSA. In spite of this being similar to what is obtainable in the full sample, it is surprising, especially in the highly HIV infected ESA sub-sample. This is because HIV funding which form part of health expenditure has actually in certain periods exceeded the entire health budget of various countries in the ESA sub-sample (Amico *et al*. 2010; Avila *et al*. 2013). Therefore, the sensitivity analysis shows no difference regarding the effect of health expenditure on HIV infection in all the samples.

All the control variables are consistent with the a priori expectations in the RSA sub-sample. More specifically, the coefficient on education is negative and significant. The estimated coefficients on over urbanization and inequality are significant and positive as expected. On the other hand, in the ESA sub-sample, there is no evidence that education and over urbanization have significant effects on HIV prevalence rate. The coefficient on inequality is significant but with unexpected sign. Neither the Sargan nor the autocorrelation tests detects any problem with the instruments validity or second-order serial correlation in first-difference errors.

Table 4.8
GMM Estimates for Model Three Full Sample and Alternative Sub-samples

Variable	Sub-Saharan Africa	Rest of SSA (low prevalence)	East & South Afr. (high prevalence)
$LnHIV_{it-1}$	-0.714***	-0.586***	0.988***
	(0.032)	(0.036)	(0.010)
LnHEX	-0.008	0.015	0.020
	(0.008)	(0.012)	(0.014)
LnEDU	-0.045**	-0.061*	-0.011
	(0.018)	(0.036)	(0.027)
LnURB	0.158***	0.246***	0.070
	(0.038)	(0.055)	(0.051)
LnIEQ	0.042	0.0256***	-0.401***
	(0.034)	(0.041)	(0.025)
Time trend	0.002	-0.010***	-0.015***
	(0.002)	(0.003)	(0.002)
Constant	-0.547***	-1.688***	1.594***
	(0.186)	(0.184)	(0.233)
Observations	252	144	108
Countries	42	24	18
Sargan test	0.393	0.302	0.109
AR (1) test	0.026	0.082	0.085
AR (2) test	0.651	0.542	0.520
Instruments	30	24	18

Note: Standard errors in parentheses. ***, ** and * denotes significance at the 1, 5 and 10%levels, respectively

4.4.11 Model Three Robustness Regression

In order to check the robustness of the results, in line with the previous analytical procedures, the model is re-estimated by substituting some control variables with comparable proxies. Urban population growth and labour force participation rate, female (ages 15 +) are the comparable proxies included as substitute. The stability of the coefficient estimate of the health expenditure is examined across all the samples. The results are also reported in Table 4.9. Across all the specifications, the coefficient on the lagged HIV prevalence rate is significant. In the full sample the estimated coefficient on health expenditure per capita remains negative and insignificant. Equally, in ESA and the RSA sub-samples this coefficient is unchanged. That is, it remains positive and insignificant. Therefore, as in the main regressions, the sensitivity analysis indicates that health expenditure has no significant effect on HIV infection in either of the samples. The results survived the substitution of some of the explanatory variables hence, are robust.

The results are also robust to the specification tests. The Sargan test of over-identifying restrictions fails to reject the null hypothesis that the instruments are valid. Similarly, the regressions pass the Arellano-Bond autocorrelation test, confirming that there is no second-order serial correlation in the error term of the first-differenced equation. Finally, the assumption of first order serial correlation is equally satisfied.

With regards to the included variables, the coefficient on urban population growth in the full sample and ESA sub-sample is positive and significant. While in the RSA sub-sample this coefficient is insignificant but has the expected positive sign. In both ESA and the RSA sub-samples, the estimated coefficient on female labour force participation rate is significant with the expected sign only in the latter sub-sample. However, in the full sample there is no evidence that this coefficient has significant effect on HIV prevalence rate.

Table 4.9

GMM Estimates for Model Three Robustness Regression

Variable	Sub-Saharan Africa	Rest of SSA (low prevalence)	East & South Afr. (high prevalence)
$LnHIV_{it-1}$	-0.717***	-0.684***	0.991***
	(0.032)	(0.031)	(0.010)
LnHEX	-0.007	0.010	0.015
	(0.008)	(0.007)	(0.014)
LnEDU	-0.045**	-0.069***	-0.008
	(0.018)	(0.026)	(0.027)
LnOUB	0.157***	0.043	0.088*
	(0.039)	(0.046)	(0.049)
LnLFP	0.051	0.195***	-0.402***
	(0.035)	(0.031)	(0.024)
Time trend	0.002	0.001	-0.015***
	(0.002)	(0.003)	(0.002)
Constant	-0.587***	-0.686***	1.553***
	(0.189)	(0.179)	(0.216)
Observations	252	144	108
Countries	42	24	18
Sargan test	0.413	0.165	0.108
AR (1) test	0.026	0.083	0.080
AR (2) test	0.652	0.485	0.533
Instruments	30	24	18

Note: Standard errors in parentheses. ***, ** and * denotes significance at the 1, 5 and 10% levels, respectively

4.4.12 Summary of Model Three

This model examines the effect of health expenditure on HIV prevalence rate. The significant lagged dependent variable in the full sample as well as ESA and the RSA sub-samples indicates that the model is dynamic. Although in the full sample the estimated coefficient on health expenditure per capita return with the expected negative sign, it is insignificant. Perhaps the health expenditure per capita is insufficient to affect significant effect on HIV infection in the region. As argued by Amico *et al*. (2010) sub-Saharan Africa has less per capita health spending than any other region in the world. Moreover, World Bank (2014) points that SSA average per capita health expenditure is just $145.38. Yet, the insignificant effect of health expenditure on HIV prevalence is rather surprising, considering that HIV funding as part of health spending in various heavily infected countries, might actually exceed their entire health budget (Avila *et al*. 2013). Similarly in both the two sub-samples this coefficient is insignificant and return with the unexpected sign.

The sensitivity analysis further indicates that the effect of health expenditure on HIV prevalence rate does not differ in the two sub-samples. Across all the specifications, the estimated coefficient on health expenditure is stable and robust to substitution of some explanatory variables. In all the samples, the specification tests are sound. There is no problem with the instruments validity or second order serial correlation in the error term of the first-differenced equation.

4.5 Conclusion

In this chapter, the effects of HIV prevalence rate and AIDS on economic growth and aggregate labour productivity are analysed. The impact of health expenditure on HIV prevalence is also investigated. Across all the specifications, the models being dynamic justified the use of the system GMM estimator to handles the endogeneity of the regressors. The system GMM estimator addresses weak instrument problems by using additional moment conditions. It combines in a system, the regression in first differences with the regression in levels. Therefore, the estimator resulted in consistent and efficient estimates, and has better asymptotic and finite sample properties than the first-differences GMM estimator.

The macroeconomic effects of HIV prevalence rate and AIDS are greatly pronounced in sub-Saharan Africa. That is, both have devastating consequences on GDP per capita growth and aggregate labour productivity. In the full sample (42 countries), the empirical results indicate that HIV prevalence rate have significant negative effect on economic growth and aggregate labour productivity. Similar results are also found in both the ESA and RSA sub-samples. This indicates that the effect of HIV prevalence rate on growth and aggregate labour productivity in both the two sub-samples is consistent with the full sample. Furthermore, it does not differ across the sub-samples. AIDS is found to be detrimental to growth of national economies in both the full sample as well as the two alternative sub-samples. In the RSA sub-sample, AIDS has no detrimental effect on aggregate labour productivity, even though it exists in the full sample and the ESA sub-sample. This could have been due to the low HIV infection in the RSA sub-sample that mitigates the development of AIDS. Therefore, the effect of AIDS on growth does not differ in the two sub-samples, yet the effect of AIDS on aggregate labour productivity differs.

The insignificant effect of health expenditure on HIV prevalence rate across all the samples suggests that per capita health expenditure has not been effective in reducing the HIV infection. This partly explained the widely spread and continuing infection of the HIV. It also implies the persistence of financing gaps and. That is, the health expenditure is insufficient to significantly reduce the HIV infection, the epidemic is so high and widely spread as to defy the impact of the health expenditure or the health expenditure might have been misappropriated.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATION

5.1 Introduction

This chapter presents summary of the key findings according to the research objectives. It also contains the research conclusions. Theoretical and policy implications based on the research findings are also discussed. While the theoretical implication contributes to literature in the subject, policy implication offers information to policy makers that could be use in combating the HIV epidemic. Finally, limitations of the study and recommendations for future research are equally highlighted.

5.2 Summary of Findings

This study provides new empirical evidence on the macroeconomic effects of HIV prevalence rate and AIDS in sub-Saharan Africa (SSA). Specifically, it investigates the effects of HIV prevalence rate and AIDS on GDP per capita growth and aggregate labour productivity. The impact of health expenditure on HIV prevalence rate is also evaluated. The motivations for the study are three folds. First, it is understood that the effect of HIV infection after it has converts to AIDS has not been taken into consideration in estimating equations. Realising that HIV is associated with rising morbidity, in addition AIDS is associated with rising mortality and morbidity, suggesting they could have different effects on growth, this study considered both in the estimating equations. Second, it is also understood that there is lack of empirical studies on the effects of HIV prevalence and AIDS on aggregate labour productivity. To this effect, this study examined the relationships between the HIV prevalence rate and AIDS and aggregate labour productivity. Third, the growing concern about the high and widely spread HIV infection necessitates the need to evaluate the effect of health expenditure in reducing the epidemic.

Although in the course of this study a host of relevant literature has been used as reference, prior to the empirical investigations, a set of thirty six empirical studies have been systematically reviewed. Unlike traditional review, systematic review employs more structural, critical and clear processes in order to find, assess, select, and then synthesized the outcome of related studies. It also identifies reasons for differences in outcomes across studies, and cites shortcomings of existing knowledge. The processes are clearly defined in advance to ensure the review is apparent, unbiased and could be repeated (Garg, Hackam, & Tonelli, 2008). Five questions were underlined for which answers are sought from the review.

First, is whether through effect on human capital, HIV/AIDS affect economic growth in SSA. The literature review shows that the effects of HIV/AIDS on economic growth are mixed and conflicting. For instance; some reviewed studies (11.1%) reveals that the effect is mild and of no serious concern while others (16.6%) established significant effect. Yet, another study (2.8%) finds that the effect of the epidemic on growth is positive, as (5.5%) believed the effect is unclear and ambiguous. The review also reveals that most of the early quantitative estimates of the effect of HIV/AIDS on economic growth were compromised by lack of adequate data hence, resorted to simulations in their estimations (e.g., Kambou *et al*. 1992;

Cuddington, 1993; Cuddington & Hancock, 1994). Furthermore, none of the reviewed studies considered the time lag, which shows the effect after the HIV infection converts to AIDS in their estimations. These facts indicate that the effects of HIV/AIDS epidemic on economic growth within SSA remains debatable therefore, it will not be rational to make any generalization. To this effect, for better understanding and policy actions, more empirical study using adequate and appropriate data, and considering the epidemic's effect after it converts to AIDS is needed.

The second question of the systematic review aims to identify whether HIV/AIDS affects aggregate labour productivity in the SSA region. Based on the review, only few studies empirically assessed the effect of HIV/AIDS on labour productivity. Yet, it was rather microeconomic assessment than macroeconomic as it was based on individual firm or household labour. Due to difficulty in observing the health status and productivity of an individual worker, most of the studies on the relationship between HIV/AIDS and labour productivity are suggestive and theorising rather than empirical. Consequently, generalization of the impacts of HIV/AIDS on aggregate labour productivity could not be made. Therefore, for more understanding and policy purpose, more empirical investigation is needed to examine the effects of the epidemic on aggregate labour productivity.

The aim of the third question is to help identify whether health expenditure reduces HIV prevalence rate in SSA. None of the reviewed studies however, empirically examined the impact of health expenditure on HIV prevalence rate. Due to this fact, no any meaningful conclusion could be reached on the impact of health expenditure on HIV infection. Consequently, for more understanding and policy actions, empirical research on the relationship between health expenditure and HIV prevalence rate is needed.

The fourth question is whether the impact of HIV/AIDS epidemic in the highly infected Southern and Eastern Africa differs from the Rest of SSA. The review shows that only a single study investigates the macroeconomic effect of the epidemic in the two sub-regions, with the epidemic having no effect in either of the sub-region. Considering this, and the fact that it is the sub-regions that made up the SSA region, no any generalization could be made about the macroeconomic effects of HIV/AIDS in SSA. Therefore, for more understanding and policy implication, additional empirical investigation within the sub-regions is needed.

The last question aimed to identify the econometric models used in estimating the macroeconomic effects of HIV/AIDS. Most of the studies utilize panel data that allow the use of panel data models which takes care of variation across countries and over time. Among the studies that use the panel data, only few dealt with the endogeneity problem associated with the regressors. This informs the use of the system GMM estimator in the analysis which is a potent technique in dynamic panel data models.

In order to achieve the research objectives, three different models are estimated. Each model empirically achieved one specific research objective. The study used panel data and applied the system GMM estimator which takes care of the individual specific effects, endogeneity among the regressors and the dynamic relationships in the specifications. The theoretical framework used is the Mankiw *et al*. (1992) augmented Solow growth model that was further extended by McDonald and Roberts (2006) to incorporate health capital as dimension of human capital in addition to education. In simple terms, the model takes the rates of savings, growth of population, and technological advancement as exogenous and shows how they influence economy's output and its rate of growth over time, that is, how they determine the steady-state level of per capita income.

In models with more than one parameter of interest, the estimations begin with the variables of interest before controlling for other explanatory variables in subsequent regressions. Furthermore, the robustness of the results is checked by substituting some control variables with comparable proxies. The study's conclusions and policy implications are however based on the estimations to which other explanatory variables are controlled. The findings of this study provide new empirical evidence of the effects of HIV prevalence rate and AIDS on economic growth and aggregate labour productivity. Evidence on the impact of health expenditure on HIV prevalence rate is also provided.

Model one, relying on HIV prevalence rate data and measuring AIDS using lags of the HIV prevalence rate, shows the effects of HIV and AIDS on GDP per capita growth within the full sample and the two alternative sub-samples. Although there are differences with respect to rates of HIV infection between countries, this study finds that in the full sample, HIV prevalence rate has negative effect on GDP per capita growth. That is, the HIV epidemic reduces economic growth in SSA region within the observation period. For instance, the finding indicates that an increase in HIV prevalence rate by one percentage point, on average, reduces the growth rate of GDP per capita by 0.08 percentage points, which appear to be substantial. The study found that AIDS has positive influence on GDP per capita growth. This is not surprising as the AIDS pandemic is closely associated with rising mortality. Increasing deaths due to AIDS and other causes resulted to lower populations at certain periods, leading to higher GDP per capita. Especially, if the population declined is not offset by proportional decline in GDP. But this positive effect of AIDS on per capita GDP could not be construed as beneficial to growth in the region. In essence, it is harmful to growth, as it was due to decrease in populations rather than growth augmenting policies or activities. Essentially, the average GDP per capita growth could have been much higher without the AIDS pandemic. Therefore, AIDS is by implication detrimental to economic growth in the SSA region.

For the sensitivity analysis, the full sample is divided into two alternative sub-samples. The highly HIV infected Eastern and Southern Africa (ESA) and low HIV infected Rest of sub-Saharan Africa (RSA). The effects of HIV prevalence rate and AIDS are evaluated to examine whether differences exists in the two sub-samples. The study found that in each sub-sample, HIV prevalence rate negatively affects GDP per capita growth. That is, not only in the highly HIV infected ESA, but also in the low HIV infected RSA, the HIV epidemic reduces the growth of national economies. Similarly, in both the two sub-samples, the result shows that AIDS which reduces the population, particularly the labour force, is detrimental to growth. This suggests that without the AIDS pandemic, the growth performance in the two sub-samples would have been much higher.

Based on the sensitivity analysis, the study found that the effects of HIV prevalence rate and AIDS on the growth of GDP per capita do not differ in the two alternative sub-samples. What however differ are the magnitudes of the effects. Surprisingly, the effect of HIV prevalence rate is more pronounce in the low HIV infected RSA sub-sample. For example, a one percentage point rise in HIV prevalence rate, on average, reduces GDP per capita growth by 0.15 percentage points in the RSA against 0.03 percentage points in the ESA. Interestingly, the results in both the two alternative sub-samples are consistent with the full sample equivalent.

Model two investigates the effect of HIV prevalence rate and AIDS on aggregate labour productivity measured using GDP per person employed. The study found that HIV prevalence rate has negative effect on GDP per person employed in the full sample. That is it reduces aggregate labour productivity in SSA. A one percentage point increase in the HIV prevalence rate, on average, reduces aggregate labour productivity by 0.06 percentage point. The result shows that AIDS has positive influence on GDP per person employed. This is however not beneficial to aggregate labour productivity. Rather it is detrimental as it resulted at the expense of decreasing total employment due to AIDS related deaths and otherwise, instead of labour training.

The findings from the sensitivity analysis shows that in both the ESA and RSA sub-samples HIV prevalence rate reduces aggregate labour productivity as it does in the full sample. With respect to AIDS, in the highly HIV infected ESA sub-sample; it is found that it has positive influence on GDP per person employed. As earlier mentioned, this however, could not be interpreted as beneficial to aggregate labour productivity, because it resulted due to decreasing total employment. Therefore, AIDS is detrimental to aggregate labour productivity in the ESA sub-sample. However, in the low HIV infected RSA sub-sample, there is no evidence that AIDS has significant influence on aggregate labour productivity. This could be due to the low HIV infection that might have mitigates the development of AIDS.

In accordance with the sensitivity analysis, the effect of HIV prevalence rate on aggregate labour productivity does not differ in the ESA and RSA sub-samples. There is however, a difference regarding the effect of AIDS on aggregate labour productivity in the two sub-samples. While the AIDS pandemic is found to be detrimental to aggregate labour productivity in highly infected ESA sub-sample, there is no evidence of significant association between AIDS and aggregate labour productivity in less infected RSA sub-sample.

Model three focus on the effect of health expenditure on HIV prevalence rate using data on health expenditure per capita while controlling other factors that influence the epidemic. Although the coefficient on health expenditure is as expected, the study finds that it has no significant effect on HIV prevalence rate in SSA. The negative sign however, indicates that the relationship between the health expenditure and HIV infection is consistent with theoretical expectation.

The sensitivity analysis shows that in both the two sub-samples there is no evidence that health expenditure has significant effect on HIV prevalence rate. This indicates that there is no any difference regarding the effect of health expenditure on HIV prevalence rate in the two alternative sub-samples. Unlike in the full sample, the coefficient on the health expenditure returned with unexpected sign in each sub-sample. The results underscored the problem of access to the costly immune booster and life-saving antiretroviral therapy.

In all the models, the robustness of the results is checked. All the variables of interest are found robust to substitution of some control variables with other proxies. Similarly, in all the regressions, the specification and serial correlation tests are sound. The Sargan test for overidentifying restrictions fails to reject the null hypothesis that the instruments are valid. The Arellano and Bond test for autocorrelation also indicates the absence of second order serial correlation in the first-differenced errors. Therefore, the tests support the validity and reliability of the system GMM estimator in the analysis.

5.3 Conclusion

In spite of differences in the rates of infection across countries, the pronounced effects of HIV prevalence and AIDS on economic growth and aggregate labour productivity indicates that the epidemic has quite advanced in SSA as a whole. These findings implied that the seemingly comforting believe that excess supply of labour in many countries would be enough to relatively cushion the macroeconomic effects of the HIV prevalence rate and AIDS does not appear to be holding. The sub-sample analyses reflect the existence of these substantial effects of HIV prevalence and AIDS on the growth of national economies and aggregate labour productivity. Essentially, there are no differences between the ESA and RSA sub-samples regarding the relationship between HIV prevalence and AIDS on the one hand and macroeconomic performance on the other hand. Among the least satisfactory aspect of the results is the absence of significant effect of AIDS on GDP per person employed in RSA sub-sample, which could be due to low HIV infection that might have mitigates the development of AIDS.

The impacts of HIV prevalence on GDP per capita growth and aggregate labour productivity is of magnitude that suggest a substantial proportion of the poor economic performance of many SSA economies at certain times within the observation period can be attributed to the HIV epidemic. Moreover, the effects are large enough to imply that they threatened the macroeconomic stability, which is fragile in the poorer countries that are also prone to high HIV infection.

As regard to health expenditure, it has not been effective in reducing HIV infection in the full sample. Equally, the health spending does not reduce the spread of HIV epidemic in both the ESA and RSA sub-samples. This implies the persistence of financing gaps. That is, either the epidemic is so high and widely spread as to defy the impact of the health expenditure or the health spending is insufficient to reduce the HIV infection. Although, most countries in the ESA sub-sample received substantial HIV funding that supplements their health budget.

5.4 Policy Implications

Findings from this study provide some theoretical implications as well as information that could be used by policy makers in designing health and economic policies to combat the HIV and AIDS epidemics. Unlike previous studies (e.g., Cuddington, 1993; McDonald & Roberts, 2006; Lovasz & Schipp, 2009) both HIV prevalence rate and AIDS are considered in the analyses. Both have important and different consequences on macroeconomic performance in the region. HIV which is associated with rising morbidity is found to have negative effect on GDP per capita growth and aggregate labour productivity. AIDS which is the final stage of HIV infection, associated with rising mortality in addition to morbidity, has positive influence on GDP per capita growth and GDP per persons employed (aggregate labour productivity). This however is not beneficial because it was due to decrease in populations and total employment. In fact, GDP per capita growth and aggregate labour productivity would have been higher without the AIDS pandemic. Therefore, by implication, AIDS through reduction in populations and total employment is found to have detrimental effect on GDP per capita growth and aggregate labour productivity. From the analysis in this study, it is obvious that HIV prevalence and AIDS have detrimental effects on the growth of national economies and aggregate labour productivity. Health expenditure has not been effective in reducing the HIV infection in the region, which suggests the persistence of financing gaps. With respect to the research findings, some policy options are offered.

Considering that HIV prevalence rate has negative effects on GDP per capita and aggregate labour productivity, policy makers should take appropriate measures to prevent people from acquiring new HIV infection. This could be done through nationwide health awareness and education. That is by including health education in the curricula of secondary schools and tertiary institutions as compulsory subject/course. Health knowledge will equip individuals, especially youth who are among the highly vulnerable and risky groups on medical conditions and needs. By preventing new HIV infection, the money that otherwise will be spent on treatment and maintenance could be saved and invested in other productive sectors of the economies. Consequently, the poor economic performance attributed to the HIV epidemic would be replaced by prosperity and growth.

Governments should take appropriate measures to prevent the HIV infection from converting to AIDS. This is because the positive influence which AIDS has on GDP per capita and aggregate labour productivity was due to decrease in populations and total employment rather than economic growth. Therefore, AIDS being a disease, its development has to be prevented like the Europe's 14th century Black Plague, which in spites of the fact that it increase real per capita income of survivors', it was dealt with. Preventing the development of AIDS will reduce the workforce lost and consequently raise the potentials for increasing total output. Essentially, in the long-run as more productive and experienced labour succumbed to AIDS, output will be so low, that even in the face of lower populations and total employment, AIDS will in essence negatively influences GDP per capita and aggregate labour productivity.

Health expenditure per capita has not been effective in reducing the HIV infection, although the estimated coefficient returns with the expected negative sign. This suggests that perhaps the health expenditure per capita has not been sufficient. Therefore, policy makers should design budget to increase the health expenditure as well as ensure that it is judiciously utilised. This could be done by ensuring that all health policies/programme are accompanied with detail implementation strategy. Increasing the health expenditure to the level that it reduces the HIV infection would improve the health status of individuals and societies. Consequently, healthy workers being more energetic and productive, output and income will increase, leading to higher macroeconomic performance.

As education capital through secondary school enrolment was found to be positively associated with GDP per capita growth and at the same time reduces HIV infection, governments should invest more on it. Investing in secondary school attainment would equip individuals, especially those not opportune to attain tertiary education, with basic knowledge to engage in meaningful productive activities. This would improve the macroeconomic performance of the economies. Investing in the education will also enlightened the youth, who are among the highly vulnerable/risky groups, about HIV and its concern. Consequently, the rate of new infection will reduce. However, same variable has not been influencing labour productivity. Perhaps, secondary school attainment is not sufficient to improve labour productivity. Therefore, governments have to invest in tertiary education which offer the required training and advanced knowledge.

International transactions are found to be beneficial to growth and labour productivity. Therefore, government should design policies to stimulate foreign trade, perhaps by relaxing credit and investment restrictions in order to facilitate capital accumulation and transfer of technology. This will create more employment, increase income, raise living standard and subsequently improve the macroeconomic performance of the economies.

As gross capital formation is beneficial to growth and aggregate labour productivity, Policy makers should design policies to encourage investment in capital assets and inventories. This could be done by consolidating the tax concession given to investors and enterprises. The net effect will be increase in output and income which could lead to growth and development.

The population growth rate was found appropriate for the growth of the economies and aggregate labour productivity. Therefore, governments should design policies/programme to sustain it. This will ensure the supply of necessary labour as well as consumers for growth and development.

Over urbanization was found to have positive influence on HIV infection. The authorities should therefore design and implement appropriate programmes and environmental policies to decongest the urban areas. This could be done by providing basic amenities and job opportunities in the rural areas to discourage rural-urban migration. Decongesting the urban areas will reduce the high rates of social interaction and risky behaviour thereby reduces new HIV infection.

5.5 Limitations

Like any other research studies, this study also has some limitations which are pointed out in this section. In the literature review, due to time and financial constraints, in spite of the availability of many databases, the study concentrated on three which cover considerable proportion of published empirical studies on macroeconomic consequences of HIV/AIDS – Emerald, Science Direct and Wiley online Library. Only studies in English language are also considered.

The main constraint of the present study is the unavailability of data on some necessary variables in some countries. This necessitates the exclusion of 6 out of the 48 SSA countries in the analyses. It also calls for lagging of the HIV prevalence rate to measured AIDS which reduced the panel periods to 6. The data on HIV prevalence rate used in the analyses is computed by the policy organizations (World Bank, UNAIDS, WHO) using the age cohort 15-49, which is considered as the most high risk group while other cohorts are neglected. The study examined the aggregate economy excluding the various sectors of the national economies.

5.6 Recommendations for Future Research

With respect to the literature review, the review could be updated over time by replicating the protocol. Including more databases which could offer more relevant studies could also improved the review. Since there is improvement in the HIV seroprevalence surveys, including other age cohorts in the computation of the HIV prevalence rate would give more accurate statistics on the epidemic. There is also a need for the epidemiological data to include AIDS prevalence rate. Therefore, when the data sets are upgraded, the macroeconomic effects of HIV and AIDS prevalence rates can be further investigated in future researches by using the upgraded and new data. Various sectors of the national economies which may be affected by the HIV prevalence and AIDS are not considered in this study. Therefore, future studies could focus on these sectors by using the application of different methods and techniques in order to understand the extent of the effects of the epidemic on each.

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Appendix 1

Sub-Saharan African Country Classification (by Region)

	Western	Eastern	Central	Southern
Countries				
	Benin	Burundi	Angola	Botswana
	Burkina Faso	Ethiopia	Cameroon	Lesotho
	Cape Verde	Kenya	Central Africa	Namibia
	Cote d’Ivoire	Madagascar	Chad	South Africa
	Gambia	Malawi	Congo, Rep.	Swaziland
	Ghana	Mauritius	Congo, Dem. Rep.	
	Guinea	Mozambique	Equatorial Guinea	
	Guinea-Bissau	Ruwanda	Gabon	
	Liberia	Somalia		
	Mali	Tanzania		
	Mauritania	Uganda		
	Niger	Zambia		
	Nigeria	Zimbabwe		
	Senegal			
	Sierra Leone			
	Togo			

Source: World Bank, 2014; IMF, 2008. Retrieved on 2 February, 2014

Appendix II

SSA per Capita GDP Growth (US Dollar at 2000 Prices)

Year	SSA (%)	Oil exporters (%)	Non oil exporters (%)	SSA ($)	Oil exporters ($)	Non oil exporters ($)
1997-2001	1.0	1.5	0.9	528	468	555
2002	1.4	0.8	1.6	526	451	555
2003	2.1	5.2	1.1	545	482	570
2004	2.7	5.3	2.1	562	504	585
2005	4.2	5.2	3.7	581	531	601
2006	3.5	3.2	3.4	598	552	617
2007	4.9	6.2	4.1	664	724	642
2008	3.2	4.2	2.7	681	752	655
2009	0.3	2.0	-5.0	679	768	645
2010	3.5	3.9	3.3	684	790	646
2011	3.4	3.3	3.5	700	816	657
2012	2.6	2.5	2.6	717	849	669
2013	2.5	2.9	2.3	735	877	684

Source: World Bank annual reports & IMF regional economic outlook: various issues
Retrieved on 2 February, 2014

Appendix III

SSA Real GDP Growth (Percentage)

Year	Sub-Saharan Africa	Oil exporters	Non oil exporters	Middle income countries	Low income countries	Fragile countries
1997-2001	3.4	4.3	2.8	2.9	4.3	0.5
2002	3.2	3.8	3.3	-	-	-
2003	4.1	8.1	2.9	3.2	3.9	3.1
2004	5.0	8.2	4.5	4.9	6.6	5.4
2005	6.1	7.1	5.4	4.9	6.7	5.3
2006	5.5	5.7	5.2	4.8	6.4	4.4
2007	6.5	9.2	5.9	5.5	6.4	3.2
2008	5.5	7.0	4.9	3.7	6.3	3.5
2009	2.5	4.8	1.3	1.7	4.7	3.0
2010	5.3	6.7	5.1	4.0	6.5	4.2
2011	5.2	6.1	5.2	4.8	5.7	2.4
2012	4.9	5.3	4.6	3.4	6.3	7.0
2013	4.1	5.7	4.4	2.7	6.8	6.0

Source: World Bank annual reports and IMF regional economic outlook: Sub-Saharan Africa, various issues. Retrieved on 2 February, 2014

Appendix IV

List of the Selected Studies for the Systematic Review

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Appendix V

Scoring Criteria for Methodological Quality

Quality Dimensions	Score 1 Criteria	Score 2 Criteria	Score 3 Criteria
		Quality of Data	
Data Source	Study either does not discuss sources, population, sampling or respondents.	Data sources either external or surveys are not explicitly documented.	Data sources are well documented.
Data completeness	A considerable amount of data is missing which could affect the reliability of the results of the study.	Missing data is mention. Though the missing data is not discussed, but is believed not to hamper the results of the study.	No any missing data.
Representative Sample	Sample size is poor and not sufficient to truly represent the population of interest.	Sample size is satisfactory for the statistical analyses and there is reasonable generalization of results.	Sample size is sufficient for all statistical analyses and there is substantial generalization of results.
Data description	Variables used in the study are not described.	The variables used are described but not explicitly description.	The variables used in the study are explicitly discussed.
		Quality of Model	
Type of Analysis	The study relies only on descriptive analysis without employing any of the econometric methods.	Only econometric methods are use in the study to estimate the results.	The study uses a mixture of quantitative techniques and any other acceptable type of analysis to improve the results.
Model Assumptions	Assumptions made are irrational and without any explanation.	Assumptions made are irrelevant to the study, non intuitive and not explicitly discussed.	Assumptions are rational, and used in other relevant studies. Also, the assumptions are essential for the study and are justify by reasonable Explanations

Appendix V (Continued)

Quality Dimensions	Score 1 Criteria	Score 2 Criteria	Score 3 Criteria
Model Specification	The specification is not familiar or poor or without explanation.	The specification is familiar in relevant studies.	The validity of the functional form of the model specified is tested by the researcher.
	The chosen specification is not in-line with the problem with regard to the type of data used	The specification is in line with the type of data used	The specification is justified by reference to reliable and related sources. The specification excellently match the type of the data used in the study
Choice of Variables	Many of the important variables are not included in the model specified.	Many of the important variables are included in the model specified.	All important variables of interest are included in the model.
	Proxy variable(s) are not good representation of the underlined factors.	Proxy variable(s) if used are good representation of the underlined factors.	Proxy variable(s) if used are significantly good representation of the underlined factors.
		Quality of Results	
Statistical Significance	Information on the estimates that capture statistical significance is not reported.	Information on the estimates that capture statistical significance is reported, but the study failed to discuss the Statistical significance of the results.	Information on the estimates that capture statistical significance is clearly reported.
	Statistical significance of the results is not discussed.		Statistical significance of the results is discussed.
Estimation Bias	The study produces bias results.	Though the result is biased, but the direction of the effect is reliable	The study's results are not biased.
Objectivity of the Discussion	The study objectively discusses the results, but implications and inferences are made beyond the estimated results, or the discussion considerably exaggerates the results.	The discussion to some extent exaggerates the estimated results.	The study objectively discusses the results and implications as well as inferences are made base on the estimated results.

Source: Canadian Council on Learning (2008) and Samsudin (2010).

Appendix VI

Descriptive Statistics of Robustness Variables in Levels

VARIABLE	Mean	Std. Dev	Min	Max
Full Sample				
Female LFP rate (% of fem. age 15+)	63.49	16.27	18.60	90.55
Total population ('000)	16200	23700	355.801	171000
Secondary edu. general pupil	655394	1139535	749	7500000
Urban pop. growth (annual %)	3.93	1.85	-6.92	18.50
Eastern and Southern Africa				
Female LFP rate (% of fem. age 15+)	67.85	18.15	26.05	90.55
Total population ('000)	18500	18600	874.988	92900
Secondary edu. general pupil	788003	1081455	29898	4700000
Urban pop. growth (annual %)	3.87	2.34	-0.42	18.50
Rest of sub-Saharan Africa				
Female LFP rate (% of fem. age 15+)	60.22	13.86	18.60	80.70
Total population ('000)	14500	26800	355.801	171000
Secondary edu. general pupil	555938	1173259	749	7500000
Urban pop. growth (annual %)	3.97	1.37	-6.92	8.17

Source: Author generation using STATA 12.0 Software

Appendix VII

Descriptive Statistics of Robustness Variables in Logs

VARIABLE	Mean	Std. Dev.	Min	Max
Full Sample				
llfp	4.11	0.30	2.92	4.51
lpln	15.81	1.34	12.78	18.96
lsed	12.42	1.44	6.62	15.83
loub	2.47	0.18	0.08	3.28
Eastern and Southern Africa				
llfp	4.17	0.32	3.26	4.51
lpln	16.09	1.31	13.68	18.35
lsed	12.78	1.27	10.31	15.36
loub	2.46	0.18	2.02	3.28
Rest of sub-Saharan Africa				
llfp	4.06	0.29	2.92	4.39
lpln	15.61	1.33	12.78	18.96
lsed	12.15	1.50	6.62	15.83
loub	2.47	0.18	0.08	2.78

Source: Author generation using STATA 12.0 Software

Appendix VIII

Pairwise Correlation Matrix of Alternative Sub-samples

Eastern and Southern Africa

	gdpgr	hiv	Lpr	pop	Gcf	opn	hex	urb	ieq	edu
gdpgr	1.00									
hiv	-0.03	1.00								
lpr	0.07	0.27	1.00							
pop	0.03	-0.31	-0.31	1.00						
gcf	0.37	0.02	0.08	-0.06	1.00					
opn	0.12	0.49	0.37	-0.39	0.41	1.00				
hex	0.11	0.34	0.91	-0.32	0.11	0.32	1.00			
urb	0.08	0.28	0.78	-0.21	0.11	0.21	0.72	1.00		
ieq	-0.04	-0.07	-0.61	0.19	-0.05	-0.34	-0.50	-0.44	1.00	
edu	0.10	0.32	0.89	-0.37	0.14	0.42	0.85	0.75	-0.63	1.00

Rest of sub-Saharan Africa

	gdpgr	hiv	Lpr	pop	Gcf	opn	hex	urb	ieq	edu
gdpgr	1.00									
hiv	-0.05	1.00								
lpr	0.08	0.26	1.00							
pop	0.32	-0.11	-0.04	1.00						
gcf	0.49	-0.11	0.27	-0.02	1.00					
opn	0.38	0.01	0.30	-0.08	0.81	1.00				
hex	0.07	0.24	0.92	-0.07	0.25	0.27	1.00			
urb	0.00	0.24	0.51	-0.25	0.13	0.24	0.42	1.00		
ieq	0.11	0.19	0.06	-0.02	0.16	0.19	0.07	-0.07	1.00	
edu	0.14	0.05	0.28	-0.18	0.23	0.22	0.30	0.68	0.15	1.00

Source: Author generated using STATA 12.0

Appendix IX

GMM Estimates for Model One without Education: ESA Sub-sample

```
--------------------------------------------------------------------------------
       log:  C:\Users\Shuaibu Isa\Desktop\STATA SE\kk.log
  log type:  text
 opened on:  14 Dec 2015, 09:24:25

. xtdpdsys lgdpgr lhiv lhivL6 ledu lpop lgcf lopn i. period, lag(1) maxldep(1)
twostep

System dynamic panel-data estimation         Number of obs         =       108
Group variable: id                           Number of groups      =        18
Time variable: period
                                             Obs per group:    min =         6
                                                               avg =         6
                                                               max =         6

Number of instruments =     19               Wald chi2(8)          =    534.99
                                             Prob > chi2           =    0.0000
Two-step results
------------------------------------------------------------------------------
      lgdpgr |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      lgdpgr |
         L1. |  -.0868357   .0389733    -2.23   0.026     -.163222   -.0104494
             |
        lhiv |  -.0306551   .0189739    -1.62   0.106    -.0678432    .0065331
      lhivL6 |   .0338912   .0104569     3.24   0.001     .0133961    .0543863
        ledu |  -.0069753   .0312728    -0.22   0.823    -.0682689    .0543183
        lpop |   .6228538   .1816923     3.43   0.001     .2667434    .9789643
        lgcf |   .0103898   .0142446     0.73   0.466    -.0175291    .0383087
        lopn |   .1463623   .0484032     3.02   0.002     .0514937    .2412308
      period |  -.0099844   .0049884    -2.00   0.045    -.0197615   -.0002072
       _cons |   2.013271   .5384839     3.74   0.000     .9578621     3.06868
------------------------------------------------------------------------------
Warning: gmm two-step standard errors are biased; robust standard
         errors are recommended.
Instruments for differenced equation
        GMM-type: L(2/2).lgdpgr
        Standard: D.lhiv D.lhivL6 D.ledu D.lpop D.lgcf D.lopn D.period
Instruments for level equation
        GMM-type: LD.lgdpgr
        Standard: _cons

. estat sargan
Sargan test of overidentifying restrictions
        H0: overidentifying restrictions are valid

        chi2(10)     =  10.22016
        Prob > chi2  =    0.4214

. estat abond

Arellano-Bond test for zero autocorrelation in first-differenced errors
  +-----------------------+
  |Order |  z     Prob > z|
  |------+----------------|
  |   1  |-1.9564  0.0504 |
  |   2  | .68225  0.4951 |
  +-----------------------+
   H0: no autocorrelation
```

Source: Author generated using STATA 12.0

Appendix X

GMM Estimates for Model Two without Education: ESA Sub-sample

```
--------------------------------------------------------------------------------
      name:  <unnamed>
       log:  C:\Users\Shuaibu Isa\Desktop\STATA SE\dj.log
  log type:  text
 opened on:  14 Dec 2015, 09:30:40

. xtdpdsys llpr lhiv lhivL6 ledu lpop lgcf lopn i. period, lag(2) maxldep(1)
twostep

System dynamic panel-data estimation         Number of obs         =       108
Group variable: id                           Number of groups      =        18
Time variable: period
                                             Obs per group:    min =         6
                                                               avg =         6
                                                               max =         6

Number of instruments =     19               Wald chi2(9)          =  34519.11
                                             Prob > chi2           =    0.0000
Two-step results
------------------------------------------------------------------------------
        llpr |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        llpr |
         L1. |   1.492205    .072158    20.68   0.000     1.350778    1.633632
         L2. |  -.4371486   .0798795    -5.47   0.000    -.5937095   -.2805877
             |
        lhiv |  -.0361358   .0189767    -1.90   0.057    -.0733295    .0010579
      lhivL6 |   .0282701   .0077802     3.63   0.000     .0130213     .043519
        ledu |  -.1219957   .0307517    -3.97   0.000    -.1822679   -.0617236
        lpop |   .5155304   .0766529     6.73   0.000     .3652936    .6657673
        lgcf |   .0025356    .015474     0.16   0.870    -.0277928     .032864
        lopn |   .1670756    .050506     3.31   0.001     .0680856    .2660655
      period |    -.00671   .0034564    -1.94   0.052    -.0134844    .0000644
       _cons |  -1.711361   .1696189   -10.09   0.000    -2.043808   -1.378914
------------------------------------------------------------------------------
Warning: gmm two-step standard errors are biased; robust standard
         errors are recommended.
Instruments for differenced equation
        GMM-type: L(2/2).llpr
        Standard: D.lhiv D.lhivL6 D.ledu D.lpop D.lgcf D.lopn D.period
Instruments for level equation
        GMM-type: LD.llpr
        Standard: _cons

. estat sargan
Sargan test of overidentifying restrictions
        H0: overidentifying restrictions are valid

        chi2(9)      =  7.864648
        Prob > chi2  =    0.5478

. estat abond

Arellano-Bond test for zero autocorrelation in first-differenced errors
  +-----------------------+
  |Order |  z     Prob > z|
  |------+----------------|
  |   1  |-1.7036  0.0885 |
  |   2  | 1.1766  0.2394 |
  +-----------------------+
   H0: no autocorrelation
```

Source: Author generated using STATA 12.0