THE MACRO-ECONOMIC IMPACT OF HIV/AIDS IN SOUTH AFRICA

by

Linette Visagie

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Study Leader: Professor B.W. Smit

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DECLARATION

I, the undersigned, hereby declare that the work contained in this thesis is my own original work and that I have not previously in its entirety or in part submitted it at any university for a degree.

ABSTRACT

South Africa faces one of the world's most severe HIV/AIDS epidemics. Whereas the disease was initially only regarded as a serious health crisis, it is now clear that the epidemic will also have economic repercussions. The objective of this study is to project the extent of the macro-economic impact of HIV/AIDS in South Africa over the next 10 to 15 years.

The study commences with a discussion of the key characteristics of HIV/AIDS and the current status of the epidemic in South Africa. The demographic inputs used are based on projections produced by the HIV/AIDS model of Metropolitan Life (the Doyle model). The methodology and key assumptions behind the Doyle model are described briefly, after which the demographic projections are presented and discussed.

The paper contains a summary of previous approaches to modelling the economic impact of HIV/AIDS, as well as a presentation and discussion of their simulation results. In reviewing the available literature on the economic impact of HIV/AIDS, it becomes apparent that researchers have not yet reached consensus on the economic impact of HIV/AIDS in South Africa – estimates of the *impact* on GDP growth range anywhere between a reduction of 0.3 and 2.0 percentage points over the next 10 to 15 years.

The approach that is used in modelling the economic impact of HIV/AIDS in this study comprises the following: Firstly, a no-AIDS forecast of the South African economy is generated using the annual macro-econometric forecasting model of the Bureau for Economic Research. Secondly, the channels through which the epidemic would likely impact on the economy are identified and modelled. These include slower growth in the population and the labour force; higher employee benefit contributions by employers and employees; indirect costs to the private and public sectors (e.g. lower productivity and higher recruitment and training costs); and higher health and welfare expenditure by the government, as well as an increase in tax rates. The economic effects of each impact channel are analysed independently, after which the different impact channels are combined in the model for the aggregated AIDS inclusive simulation. The results are presented in the form of comparisons between "no-AIDS" and "AIDS" projections for key economic variables for the period 2001 to 2015. The paper also contains results from a macro-economic sensitivity analysis, in which

seven of the key assumptions are altered in order to test the sensitivity of the model to these changes.

Simulation results indicate that the epidemic will have a negative impact on economic growth in South Africa - real GDP growth could fall from a projected average of 3.7% over the period 2002-2015 without HIV/AIDS to between 3.4% and 3.1% per year with HIV/AIDS. In contrast, real per capita GDP growth is projected to be 0.7 to 1.0 percentage points higher compared to a no-AIDS scenario, as the adverse impact of the epidemic on the population will outweigh the negative impact on real GDP.

OPSOMMING

Suid-Afrika staar een van die wêreld se ernstigste MIV/VIGS epidemies in die gesig. Aanvanklik is die siekte slegs as 'n erge gesondheidskrisis beskou, maar vandag is dit duidelik dat die epidemie ook ekonomiese gevolge sal hê. Die oogmerk van hierdie studie is om die omvang van die makro-ekonomiese impak van MIV/VIGS oor die volgende 10 tot 15 jaar in Suid-Afrika te beraam.

Die proefskrif begin met 'n bespreking van die belangrikste eienskappe van MIV/VIGS en die huidige stand van die epidemie in Suid-Afrika. Die demografiese insette wat gebruik word, is gebaseer op projeksies van Metropolitan se MIV/VIGS model (die Doyle model). Die metodiek en die sleutel aannames van die Doyle model word kortliks bespreek, waarna die demografiese projeksies aangebied en bespreek word.

Die studie bevat 'n opsomming van benaderings wat van te vore gebruik is om die ekonomiese impak van MIV/VIGS te modelleer, asook 'n voorlegging en 'n bespreking van hul resultate. 'n Oorsig van beskikbare literatuur oor die ekonomiese impak van MIV/VIGS bring aan die lig dat daar in werkilikheid nog geen konsensus oor die omvang van die impak op die Suid-Afrikaanse ekonomie bereik is nie. Beramings van die *impak* op BBP groei oor die volgende 10 tot 15 jaar wissel van 'n vermindering met 0.3 tot 2.0 persentasie punte.

Die benadering wat in hierdie studie gevolg word om die ekonomiese impak van HIV/VIGS te modelleer behels die volgende: Eerstens word 'n vooruitskatting van die Suid-Afrikaanse ekonomie sonder MIV/VIGS gegenereer met die hulp van die makro-ekonometriese vooruitskattings model van die Buro vir Ekonomiese Ondersoek. Die tweede stap behels die identifisering en die modellering van die verskillende kanale waardeur die epidemie moontlik die ekonomie kan affekteer. Dit sluit onder andere die volgende in: stadiger groei in die populasie en die arbeidsmag; hoër bydraes deur werkgewers en werknemers aan werknemer-bystandfondse; indirekte onkostes vir die privaat en openbare sektore (bv. laer produktiviteit en hoër werwings- en opleidings koste); 'n toename in staatsbesteding op gesondheids en welsyns dienste; asook 'n styging in belastingkoerse. Die ekonomiese implikasies van elkeen van die kanale word individueel ontleed, waarna die

verskillende kanale saamgevoeg word vir die oorkoepelende simulasie. Die resultate word aangebied in die vorm van vergelykings tussen "geen-VIGS" en "VIGS" projeksies vir sleutel ekonomiese veranderlikes oor die periode 2001-2015. Die proefskrif bevat ook 'n voorlegging van die resultate van 'n makro-ekonomiese sensitiviteits ontleding, waarin sewe van die sleutel aannames verander is met die doel om die gevoeligheid van die model vir hierdie veranderinge te bepaal.

Die resultate toon dat die epidemie 'n negatiewe uitwerking op ekonomiese groei in Suid-Afrika sal hê – die gemiddelde groeikoers in die reële BBP oor die periode 2001-2015 mag daal van 'n geprojekteerde 3.7% sonder MIV/VIGS tot tussen 3.4% en 3.1% met MIV/VIGS. In teenstelling toon die resultate dat die gemiddelde groeikoers in per capita reële BBP tussen 0.7 en 1.0 persentasie punte hoër mag wees vergeleke met die "geen-VIGS" scenario. Die toename in per capita BBP groei kan toegeskryf word aan die skerp daling in die groei van die populasie as gevolg van MIV/VIGS.

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CHAPTER 1

INTRODUCTION

As little as twenty years ago, the terms HIV and AIDS would probably have evoked little more than blank stares from many scientists, not to mention demographers and economists. AIDS was first recognised as a specific condition in 1981 and it was only a couple of years later that the Human Immunodeficiency Virus (HIV) was isolated and identified as the cause of this fatal disease. Initially, it was erroneously thought that HIV/AIDS is mainly acquired through homosexual practices. As homosexual activities were often considered to be a "problem" of the Western or developed world, many Africans concluded that Africa would not be severely affected by the disease. However, today it is clear that the main mode of HIV transmission is through heterosexual intercourse and that Africa will all but escape the tragic consequences of this epidemic. In fact, AIDS is already considered to be the leading cause of death in sub-Saharan Africa.

The first time that terms HIV or AIDS made headlines in newspapers in South Africa was probably in 1985, when the actor Rock Hudson died of AIDS. The 1990s saw more prominent people die of AIDS, most notably Freddie Mercury of the rock band Queen and Arthur Ashe, the 1975 Wimbledon tennis champion who acquired HIV/AIDS through a blood transfusion. In the meantime, millions of unknown people became infected with HIV around the globe. During the year 2001, South Africans were particularly touched by the plight of Nkosi Johnson, an 11-year-old AIDS orphan recognised for his brave fight against AIDS after becoming infected with HIV via mother-to-child transmission. Looking at the history of HIV/AIDS, it is clear that the disease "knows no boundaries of class, status, race or sexual preference" (Medical Research Council 2001:3).

HIV/AIDS is already widespread, particularly in the developing world. It is estimated that in seven countries in the world, including South Africa, at least one in five adults are living with HIV/AIDS. HIV/AIDS differs from most other diseases in the sense that it primarily affects adults in their economically most productive years and does not spare the elite. These characteristics of the disease, and the fact that there is as yet no cure, suggests that HIV/AIDS may hold more negative demographic and economic implications for affected countries than any other disease known to mankind.

Most of the attempts that have been made to quantify the macro-economic impact of AIDS occurred during the early 1990's and relied on fairly simple models, often only projecting the impact of HIV/AIDS on overall economic growth and per capita income. Until recently, there had been no serious attempt at quantifying the economic impact of HIV/AIDS in South Africa. The year 2000 saw two such studies emerge, in the shape of research papers by ING Barings (Quattek 2000) and Arndt and Lewis (2000). Although these two studies relied on the same demographic inputs, they produced divergent projections of the economic impact of the epidemic – whereas ING Barings predicted that South Africa's GDP growth rate would be 0.3 percentage points lower on average during 2002-2010, Arndt and Lewis projected that GDP growth could be more than 2.0 percentage points lower compared to what would have been possible without AIDS. Arndt and Lewis concluded that per capita GDP levels would also be lower due to AIDS, while the ING Barings study suggests that per capita income may rise. With such divergent projections of the impact of HIV/AIDS on economic growth, the need for further quantitative research on the impact of the epidemic on the South African economy is evident.

The purpose of this research is to project the macro-economic impact of the HIV/AIDS epidemic in South Africa. The annual macro-econometric forecasting model of the Bureau for Economic Research (BER) was employed to model the impact of HIV/AIDS on the South African economy. This model can be described as a demand-orientated macro-econometric model with specific supply elements. An obvious advantage of using a large econometric forecasting model such as the BER's model is that it allows one to analyse the impact of HIV/AIDS on a large number of economic variables, such as the exchange rate, inflation and interest rates, something that is not possible with a simple production function model.

In order to simplify the modelling exercise, it was assumed that HIV/AIDS would only start to claim a toll on the economy after the year 2000. The historical period (before 2001) was therefore treated as a "no-AIDS" scenario. This allowed for the equations to be estimated up to the year 2000, without necessitating any assumptions about the economic impact that the epidemic may have had during the 1990s. Projections of the economic impact of the epidemic were only made for the forecasting period (2001 to 2015). Given that only about 0.55% of South Africa's labour force (0.38% of the total population) is projected to have been sick with AIDS in the year 2000, the economic impact of the epidemic during the 1990's was probably fairly small.

The approach that was used to model the economic impact of HIV/AIDS comprised the following: Firstly, the BER's macro-econometric model was used to generate a baseline no-AIDS forecast of the South African economy. Secondly, the channels through which the epidemic would likely impact on the economy were identified. These included slower growth in the population and labour force, lower labour productivity and higher health care and other AIDS related costs to the private and public sectors. Having identified the potential impact channels of the epidemic, a specific set of assumptions was adopted for each AIDS impact channel and the BER's model was adapted to incorporate these impact channels. The macro-economic effects of each impact channel was simulated and analysed independently, after which all the impact channels were combined in the model for the final (AIDS inclusive) simulation. The results are presented in the form of comparisons between "no-AIDS" and "AIDS" projections for key economic variables for the period 2001 to 2015.

The paper is organised as follows. The second chapter briefly describes the key characteristics of HIV/AIDS and the current status of the epidemic in South Africa. Having looked at estimates of the current level of HIV infection in South Africa, projections of the future course of the epidemic are presented and discussed. The demographic projections in the present analysis were generated by Abt Associates, using the latest version of Metropolitan Life's Doyle model. The methodology and key assumptions behind the Doyle model are described, after which the demographic projections produced by the model are presented and discussed.

In the third chapter, previous approaches to modelling the economic impact of HIV/AIDS are summarised. The assumptions with regard to the impact channels of the epidemic and the simulation results obtained in the different studies are presented and discussed.

The fourth chapter considers the approach that was adopted in this analysis to model the impact of HIV/AIDS. The chapter opens with a description of the macro-econometric model that was used to analyse the economic impact of HIV/AIDS. It provides an overview of the model structure and the estimation techniques that were used to estimate the behavioural equations in the model. The chapter also provides a detailed description of the different channels through which the epidemic is likely to impact on the economy, the assumptions that were adopted and the way in which the model was adapted to incorporate the different impact channels. The simulation results are discussed in detail.

In view of the uncertainties involved with many of the assumptions that were adopted, it was decided to vary some of the key assumptions in order to test the sensitivity of the model to changes in these assumptions. The fifth chapter contains a description of the alternative economic behavioural assumptions that were considered and a discussion of the results from the macro-economic sensitivity analysis. The final chapter concludes.

Appendix A provides a detailed specification of the behavioural equations and identities in the macro-econometric model. The variable name definitions are listed in Appendix B. Detailed results from the simulations of the economic effects of each individual AIDS impact channel are presented in Appendix C. Appendix D contains detailed simulation results from the macro-economic sensitivity analysis.

CHAPTER 2

THE DEMOGRAPHIC IMPACT OF THE HIV/AIDS EPIDEMIC

2.1) INTRODUCTION

As little as twenty years ago, the acronym "AIDS" would not been found in any medical dictionary. Today AIDS is considered to be one of the most devastating diseases known to man. The most recent UNAIDS (Joint United Nations Programme on HIV/AIDS, December 2001) estimates show that, by the end of 2001, 40 million people worldwide were infected with HIV (Human Immunodeficiency Virus) – the virus identified as the cause of this fatal disease.[1]

HIV/AIDS will impact profoundly on the developing world and South Africa will be no exception. More than 70% of the world's HIV+ population live in Sub-Saharan Africa. In seven counties in the world, all of which are SADC member countries, at least one in five adults is living with HIV/AIDS. Botswana has the highest HIV prevalence rate among adults in the world, estimated at 35.8% in 1999. This is followed by Swaziland (25.25%), Zimbabwe (25.06%), Lesotho (23.57%) and Zambia (19.95%) (UNAIDS June 2000: 124). UNAIDS estimated that, by the end of 1999, 19.94% of adults in South Africa had already been infected with HIV. Given our high HIV infection rate and the size of our population, South Africa has the largest number of people living with HIV/AIDS in the world. Barring a miracle, most those who are currently infected with HIV will die within the next 10 years.

In what follows, the key characteristics of HIV/AIDS are described briefly. A particularly important characteristic of the epidemic is the fact that it is found mainly among adults between the ages of 20 and 40, some of the most productive years of a person's life.

[1] The year 2000 saw president Mbeki publicly question the link between HIV and AIDS. He appeared to defend the views of so-called AIDS dissidents, who believe that the virus is not the cause of the disease, and suggested a re-examination of the nature of AIDS in Africa. In an effort to set the record straight, 5000 scientists (including Nobel Prize winners and directors of leading research institutions and medical societies) signed the "Durban declaration", a document that unequivocally sets out the evidence that AIDS is caused by the Human Immunodeficiency Virus (Nature 2000). The present paper subscribes to this mainstream view.

This simple feature of HIV/AIDS already suggests that the epidemic will have an adverse impact on economic growth.

Having considered some of the more important characteristics of the epidemic, the current status of the epidemic in South Africa is discussed. Unfortunately, reliable statistics on the actual number of AIDS cases or AIDS deaths in South Africa are not available. The main source of information concerning the HIV epidemic in South Africa is the Annual Survey of Women Attending Antenatal Clinics conducted by the Department of Health. This chapter contains a brief discussion of the results from the latest antenatal clinic survey.

Having looked at estimates of the current level of HIV infection in South Africa, projections of the future course of the epidemic are presented and discussed. The demographic projections in the present analysis were generated by Abt Associates, using the latest version of Metropolitan Life's Doyle model. This model is one of only two recognised HIV/AIDS models in South Africa and has the longest track record of use. The methodology and key assumptions behind the Doyle model are described, after which the demographic projections produced by the model are presented and discussed.

2.2) KEY CHARACTERISTICS OF HIV/AIDS

The AIDS (Acquired Immune Deficiency Syndrome) epidemic is a fairly new epidemic, with the first AIDS deaths only registered during the mid-1980s. AIDS is caused by a virus that attacks the human body's CD4+ lymphocytes - a key part of the body's immune system. This virus is commonly known as HIV, an acronym for the Human Immunodeficiency Virus. In order to attack a person's immune system, the virus has to enter the bloodstream. Transmission can occur through sexual intercourse, from an infected mother to her infant (through the placenta, during birth or via breast milk), through the use of contaminated blood or blood products or by sharing intravenous drug-injecting equipment. Given the modes of transmission, it is not surprising that HIV/AIDS is concentrated among infants and adults between the ages 20 and 40. People with other sexually transmitted diseases are significantly more susceptible to HIV/AIDS infection via sexual intercourse than those without sexually transmitted diseases. Furthermore, females appear to be at higher risk of becoming infected via heterosexual intercourse than males (Loewenson and Whiteside 1997: 4-6).

People who are infected with HIV may lead relatively healthy and productive lives for many years after they are infected with the virus, as the virus has a long incubation period. During this period, the virus gradually weakens the immune system and the body becomes increasingly unable to fight off infections. Symptoms of HIV infection include chronic fatigue, diarrhoea, fevers, weight loss, skin infections and swollen lymph glands. The time from infection to development of AIDS generally varies between 3 and 12 years. The second phase (AIDS) sets in when the body is no longer able to resist more severe opportunistic infections or diseases such as tuberculosis, bacterial pneumonias, meningitis, herpes and certain types of cancers and diarrhoeal diseases. AIDS victims usually die within 1-2 years after the onset of a severe infection or cancer. Although life can be prolonged with anti-retroviral treatments, there is as yet no cure for HIV/AIDS. Due to the complex nature of the virus, it is unlikely that a vaccine or a cure for HIV infection will be found for many years to come. Furthermore, any cure for the virus may well be unaffordable for many individuals in developing countries (Loewenson and Whiteside 1997: 4; Abt Associates February 2000: 7).

In all, AIDS is a fatal disease caused by the Human Immunodeficiency Virus, a virus that is mainly acquired through heterosexual intercourse. HIV/AIDS primarily affects adults in their economically most productive years and does not spare the elite. HIV/AIDS is already widespread, particularly in the developing world, and there is as yet no cure for the disease. These characteristics suggest that HIV/AIDS could be the most devastating disease man has ever faced, not only in terms of its demographic consequences, but also in terms of the economic implications of the epidemic for countries with severe epidemics.

2.3) THE CURRENT STATUS OF THE EPIDEMIC IN SOUTH AFRICA

According to the most recent UNAIDS (Joint United Nations Programme on HIV/AIDS, June 2000) estimates, South Africa's HIV prevalence rate appears to be somewhat lower compared to some of our neighbouring countries like Botswana, Swaziland, Zimbabwe and Lesotho. However, it should be noted that the HIV/AIDS epidemic started later in South Africa. Recent projections of the HIV/AIDS epidemic in South Africa have indicated that South Africa may well experience an epidemic similar in scope, if not more severe than that of its highly infected neighbouring countries in the near future (Laubscher June 2000: 2). A combination of historical, socio-economic and developmental factors have made and will continue to make South Africa more susceptible to a severe HIV epidemic than most other countries around the world. These include disrupted family and communal life - due in part to apartheid, migrant labour patterns and high levels of poverty; the low status of women in society and the high prevalence of violence against women; resistance to the use of condoms; social norms that do not frown on high numbers of sexual partners, especially in the case of men; high levels of other sexually transmitted diseases, which increase the likelihood of the transmission of HIV; and the most developed transport infrastructure of any African country, which facilitates the easier spread of the virus into new communities (Abt Associates 2001: 4-5).

Given that South Africa's epidemic is still at a fairly early stage of development and that the median incubation period appears to be around 8.5 years, the brunt of the impact of the epidemic in terms of AIDS illnesses and deaths is yet to be felt. Although reports from hospitals confirm that the number of HIV/AIDS related illnesses and deaths are rising rapidly, there is no *reliable* data available on the actual number of AIDS cases or AIDS deaths in South Africa.[2] One reason for this is that AIDS cases are not notifiable (people are not legally bound to report an AIDS case). However, even if the disease was legally notifiable, under-reporting could still take place, as many victims are never diagnosed with HIV/AIDS before they die. Furthermore, due to fear of social rejection, those who are correctly diagnosed may decide not to reveal their status (Loewenson and Whiteside 1997: 8; Abt Associates February 2000: 8).

2.3.1) ANTENATAL SURVEY DATA

Currently, the annual survey of women attending antenatal clinics by the Department of Health provides the most representative and reliable set of data concerning the HIV epidemic in South Africa. The anonymous testing of a sample of women at selected public sector antenatal clinics during October each year provides information on HIV prevalence rates among women attending these clinics (i.e. sexually active pregnant women). As the vast majority of the women attending public sector antenatal clinics are black, the survey results

[2] Official reports from Statistics SA confirm that there has been a steady increase in young, adult mortality over the last decade. However, the most recent official *cause of death* statistics available are those for 1996 (as reported by Statistics SA). (Their reports on recorded deaths are generally only published 4-5 years after the year covered.) By 1996, the number of AIDS deaths was too low to rely on to make accurate predictions of the future course of the epidemic.

provide good coverage of pregnant black women. Unfortunately, the white, coloured and Asian population groups, as well as the wealthier part of the black population group, are under-represented in this survey, as they generally attend private sector clinics.

The latest antenatal clinic survey (Department of Health 2000) revealed that 24.5% of women attending public sector antenatal clinics were infected with HIV by late 2000 (see figure 2.1). Figure 2.2 shows the age distribution of the HIV epidemic among women attending public sector antenatal clinics. HIV infection rates were highest among women between the ages of 20 and 35 (i.e. their most fertile years).

Figure 2.1: HIV prevalence among women attending public antenatal clinics

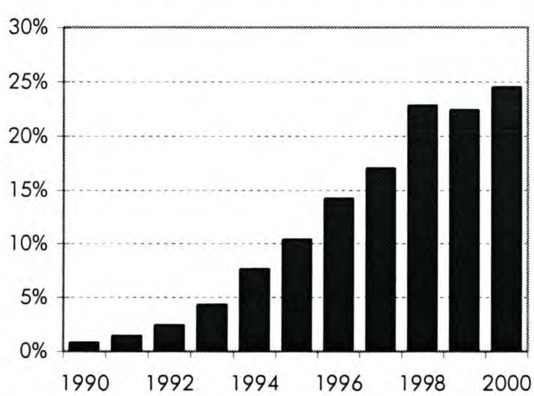
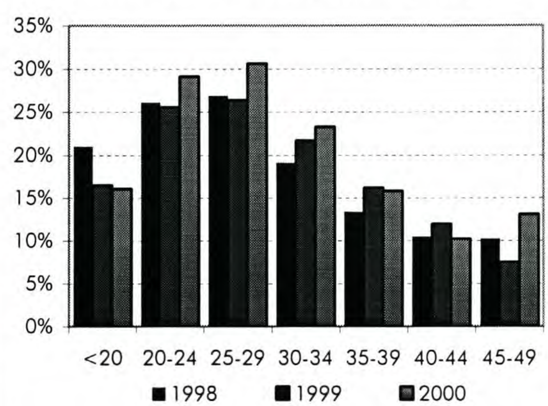


Figure 2.2: HIV prevalence among antenatal clinic attendees according to age

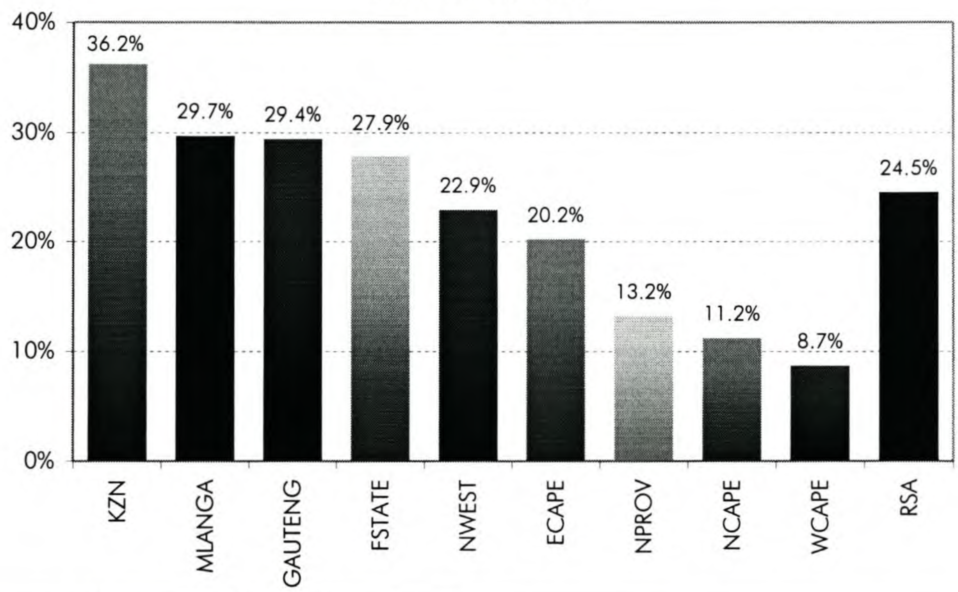


Data source: Department of Health 2000.

HIV infection rates for men are not measured in the antenatal clinic survey, but are generally projected to be somewhat lower compared to that of women. Furthermore, it is estimated that peak prevalence rates for men occur at older ages - between the ages of 25 and 40 (i.e. possibly their most productive years). The majority of people who die from AIDS will be in the 30 to 40 year age group (Abt Associates and Metropolitan Life 2000: 13; Department of Health 2000: 8-9).

The survey results suggest that the epidemic is most advanced in Kwa-Zulu Natal, with HIV prevalence of women visiting antenatal clinics estimated at 36.2%. Other provinces with very high infection rates are Mpumalanga, the Free State and Gauteng, where more than 1 in 4 women visiting public sector antenatal clinics tested HIV positive. The Western Cape's epidemic is still at a relatively early stage of development, with only 8.7% of women visiting antenatal clinics in this province testing positive for HIV (Department of Health 2000: 6-9). The latest survey results seem to indicate that the epidemic has not yet reached a plateau in any of our provinces. Further analysis of the survey results suggest that the epidemic may simply have started later in some provinces and that all the provinces will probably follow a similar pattern of rapidly increasing HIV prevalence, as seen in Kwa-Zulu Natal (Abt Associates February 2000: 9).

Figure 2.3: Provincial HIV prevalence according to antenatal clinic data (2000)



Data source: Department of Health 2000.

Due to a lack of comprehensive data on HIV prevalence in the general South African population, demographers extrapolate from this antenatal clinic survey data to the total population by making assumptions about HIV infection rates in the sub-groups of the population not covered by the survey (e.g. men). In extrapolating from the antenatal clinic survey data to the general population, researchers need to take note of the fact that the HIV prevalence among pregnant women attending public sector antenatal clinics will likely be higher than HIV prevalence among the general population. Certain sub-groups of the population that are not covered by the survey may have lower levels of HIV infection. These include men (mainly due to biological factors), people who are not sexually active and more affluent people that attend private sector clinics. On the other hand, there are smaller sub-groups of the total population that may have higher infection rates, such as sex-workers and migrant workers (Abt Associates February 2000: 9). The estimates from the antenatal clinic survey are used in combination with assumptions with regard to HIV infection rates in the sub-groups of the population not covered by the survey to develop demographic models to project the future course of the epidemic.

2.4) PROJECTING THE DEMOGRAPHIC IMPACT OF HIV/AIDS IN SOUTH AFRICA

Predicting the demographic impact of the HIV/AIDS epidemic is by no means an easy task. The brunt of the impact is likely to be felt years from now and any demographic projections are subject to limitations on, inter alia, the ability to estimate the current HIV infection rate in the population as a whole and for sub-groups of the population, projecting sexual behaviour and hence, the course of the epidemic into the future, and estimating the impact of the epidemic on fertility and mortality. Although a number of researchers have attempted to project the demographic impact of HIV/AIDS in South Africa, the only recognised HIV/AIDS models in South Africa are the Doyle model of Metropolitan Life and the model that was developed by Professor Rob Dorrington and the Actuarial Society of South Africa (ASSA). These two HIV/AIDS models are similar in structure; in fact, the ASSA model is based on the approach that was used by Peter Doyle in developing the Doyle model.

The demographic projections that were used as inputs in the present analysis were generated by Abt Associates, using the latest version of the Doyle model. This model has the longest track record of use in South Africa and is continuously updated to reflect the most recent demographic and epidemiological data (Abt Associates and Metropolitan Life June 2000: 25). Before proceeding to the methodology behind and detailed projections made with the Doyle model, it may be instructive to compare some of the key outputs of the Doyle model with those of other models. Table 2.1 provides a comparison between projections of the population and AIDS deaths in South Africa made with the Doyle model, the ASSA600 model, the United Nations and the US Bureau of the Census. From table 2.1 it is clear that the Doyle model's projection of the total number of AIDS deaths between now and 2010 lies at the low end of the spectrum of available model projections. The Doyle model's projection of the AIDS inclusive population by the year 2010 lies closer to the middle of the range of projections for total population in South Africa.

Table 2.1: Comparison of Doyle model projections with other models (figures in thousands)				
	Metropolitan/ Doyle	ASSA600	United Nations	US Bureau of the Census
Midyear population 2000	42 719	46 079	40 377	43 421
AIDS Deaths (2000-2010)	3 755	5 931	5 402	6 999
Midyear population 2010	44 626	49 336	42 515	41 108

Source: Medical Research Council 2001: 23.

Projections of the size of the South African population by 2010 do not only depend on the number AIDS deaths, but also on, among other things, the demographer's assumption with regard to the current size of the population. Projections from the available models differ significantly in terms of their choice of base population. The United Nations starts out with a very low base population estimate (their 2000 estimate is even below the 1996 census estimate), which, combined with a higher mortality estimate than the Doyle model, leads to a relatively low population estimate for 2010. Although the base population of the US Bureau of the Census is more in line with that of the Doyle model, their projection of the number of AIDS deaths is substantially higher, leading to a very low population estimate for 2010. Projections of the number of AIDS deaths by the ASSA model is well above that of the Doyle model, but so is their base population estimate, so that the ASSA model population estimate for 2010 is on the high end of the spectrum.

Clearly, the best way to test the accuracy of a model would be to compare its projections with actual data. Unfortunately, given the limited availability of reliable data on AIDS deaths and HIV infection rates, this is rather difficult. A comparison of projections made with the Doyle model with those from other models revealed that the Doyle model might paint a slightly conservative picture of the demographic impact of the HIV/AIDS epidemic. However, since the demographic projections by Abt Associates (who employed Metropolitan Life's Doyle model) included estimates of the impact of HIV/AIDS on the labour force per skill category - crucial inputs to the analysis of the economic impact of the epidemic that are not currently available with any of the other models – it was decided to proceed with the projections of Abt Associates/Metropolitan Life.

In what follows, the methodology and key assumptions behind the Doyle model are described briefly. Thereafter, the demographic projections by Abt Associates/Metropolitan Life are presented and discussed, the focus being on demographic inputs that are important to the modelling of the economic impact of the epidemic.

2.4.1) THE DOYLE MODEL

a) Methodology

The Doyle model can be described as a model that "combines features of a macro-simulation model and a micro simulation programme" (Abt Associates and Metropolitan Life June 2000: 25). From a macro-perspective, the model is calibrated to fit the latest data on HIV infection rates at national and regional levels. Central to the model is a micro-simulation programme that models the spread of the epidemic through the population via sexual interaction between 4 subgroups of the population. These subgroups are defined according to their level of exposure to the risk of a heterosexually transmitted epidemic: commercial sex workers and frequent clients; people who are prone to sexually transmitted diseases; people at (normal) risk of infection; and those who are not at risk of infection (Abt Associates and Metropolitan Life June 2000: 25). The model ignores the possibility of transmission via homosexual intercourse and through the use of contaminated blood, blood products or intravenous drug-injecting equipment, as these are uncommon means of transmitting HIV in South Africa. The epidemic is introduced into the model by injecting a small number of HIV+ individuals from outside the community into the subgroups. A pattern of contact between individuals within and between risk groups is assumed and projections of the epidemic at a micro level are produced. This includes separate projections according to race; gender; age; risk profile; geographic location etc. These projections are then aggregated to produce demographic projections at provincial and national levels.

According to Abt Associates/Metropolitan Life (June 2000: 9), the projections provide "a good indication of the absolute and relative magnitude of the impact of the HIV epidemic." However, they concede that it is unlikely that their model will produce perfect forecasts of the reality, as their projections are typically dependent on the accuracy of their inputs in the form of demographic and epidemiological data and other assumptions.

b) Key assumptions

National and provincial populations were derived from the 1996 census, while skill level profiles were based on the 1996 census and the 1995 and 1997 October Household Surveys. In the no-AIDS scenario, it was assumed that the population would grow at "the natural growth rate of the relevant race, gender and age groups in the RSA population" (Abt Associates and Metropolitan Life June 2000: 10). No allowance was made for migration or variables (other than HIV/AIDS) that may impact on the population over time.

One of the key assumptions of the Doyle model is that "the shape of the epidemic curve within population groups" is essentially the same for each province and that the epidemic simply started later in some provinces (Abt Associates and Metropolitan Life June 2000: 9). In a worst-case scenario it is assumed that the future paths of the epidemic in each province will follow that of Kwa-Zulu Natal, the province with the most advanced HIV/AIDS epidemic. Antenatal clinic survey data was used to estimate the lags between the epidemic in the different provinces. This scenario assumes no significant interventions or a change in behaviour (e.g. an increase in condom usage or improved treatment of sexually transmitted diseases). The Doyle model also produces a best-case scenario, which assumes a degree of behaviour change, but no significant interventions that could alter the course of the epidemic are assumed (e.g. a vaccine, affordable antiretroviral treatment) (Abt Associates and Metropolitan Life June 2000: 9-10).[3] As projections from the worst-case AIDS scenario are already less pessimistic than that produced by other demographic models (e.g. the ASSA model), it was decided to use projections from the worst-case AIDS scenario as inputs in the present study of the economic impact of the epidemic.

Mortality rates were derived from Dorrington et al. (1999) and future mortality rates were assumed to remain constant in the no-AIDS scenario. In the AIDS scenario, the median time from HIV infection to development of AIDS was assumed to be 8.5 years, while the median time of survival with AIDS was assumed to be 1 year. However, the model does allow for different survival times depending on the age of the infected person (Abt Associates and Metropolitan Life June 2000: 9-11).

[3] There appears to be agreement amongst researchers that it is unlikely that an effective vaccine or cure for HIV infection will be available in South Africa within the next 8 to 10 years. Furthermore, even though antiretroviral therapy can prolong life for many years, it is unlikely to be implemented in SA on a large scale due to financial and infrastructure constraints (Abt Associates and Metropolitan Life June 2000: 10-11).

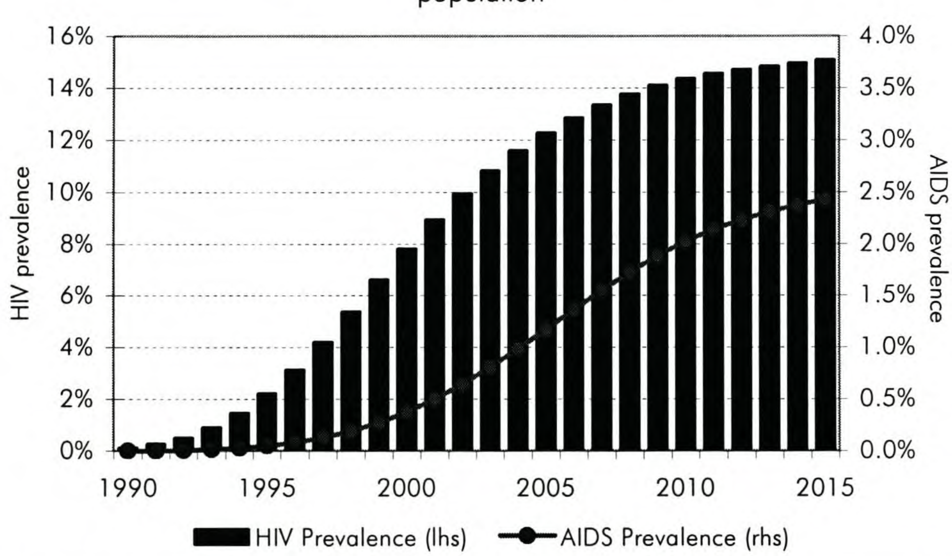
Fertility rates were derived from estimates by Sadie (1993), Udjo (1997) and recent estimates by Dorrington. It was assumed that fertility rates would continue to decline over time (even in the no-AIDS scenario) and that HIV infected women would be approximately 30% less fertile than healthy females. However, the model incorporates different fertility impacts for women of different ages. Furthermore, a mother-to-child transmission rate of 30% was assumed (Abt Associates and Metropolitan Life June 2000: 10-11).

2.4.2) MODEL PROJECTIONS

a) General population

According to Abt Associates/Metropolitan Life, approximately 9% of South Africa's total population is currently infected with HIV. Their estimates put the number of South Africans infected with HIV at just over 3.8 million. HIV prevalence among the total population is projected to increase further to 15.1% (or 6.6 million people) by 2015.

Figure 2.4: HIV prevalence vs. AIDS prevalence among total SA population



Unless stated otherwise, Abt Associates/Metropolitan Life (June 2000) is the data source for all the figures in this chapter.

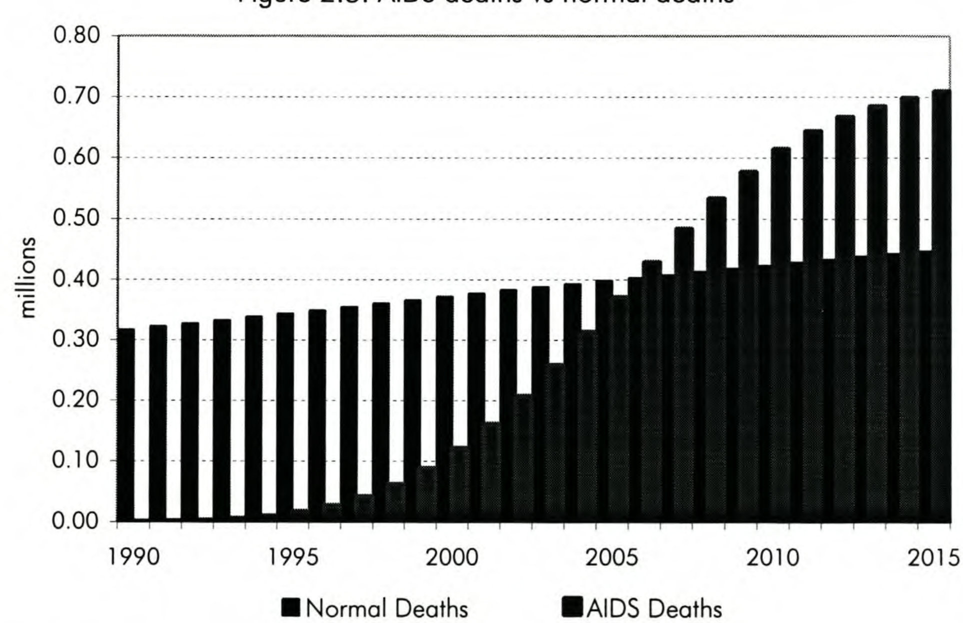
From figure 2.4 it is clear that the HIV epidemic is at a more advanced stage of development than the AIDS epidemic. This can be ascribed to the long lag between HIV infection and the development of AIDS. Abt Associates/Metropolitan Life estimates that about 0.5% of the South African population (or 213 067 people) is currently suffering from full-blown AIDS. In the absence of significant interventions or behaviour changes, this figure is projected to increase rapidly over the next 10-15 years to reach 2.4% (1.06 million) by 2015.

Table 2.2: The impact of HIV/AIDS on South Africa's total population[a]

	Population (millions)		Infected with HIV		AIDS sick		Deaths (millions)	
	No-AIDS	Including AIDS	Number (millions)	%	Number (millions)	%	Normal deaths	AIDS deaths
2001	43.104	42.653	3.818	9.0%	0.213	0.5%	0.377	0.161
2005	45.889	44.142	5.422	12.3%	0.518	1.2%	0.397	0.371
2010	49.452	44.497	6.393	14.4%	0.901	2.0%	0.423	0.614
2015	53.204	43.748	6.603	15.1%	1.062	2.4%	0.447	0.709

a. Projections for each year indicate the situation as on 1 January.
Data Source: Abt Associates and Metropolitan Life (June 2000)

Figure 2.5: AIDS deaths vs normal deaths



Abt Associates/Metropolitan Life projects that the number of AIDS deaths per year will increase from an estimated 160 913 in 2001 to over 700 000 per year by 2015.[4] Their projections indicate that the number of AIDS deaths could exceed the number of normal deaths by the year 2006. Metropolitan Life estimates that life expectancy could drop from 55 years in 2000 to only 39 years in 2010 (Medical Research Council 2001: 25). The sharp increase in the number of AIDS deaths among adults will lead to a dramatic rise in the number of orphans. According to Abt Associates (2001: 10-11), the number of orphans under the age of 15 will increase from the current ±250 000 to close to 1 million in 2005 and 2.5 million by 2010.

By increasing mortality rates and reducing fertility rates, HIV/AIDS will stunt the growth of the South African population. In the absence of HIV/AIDS, the population growth rate was projected to slow slightly from just over 2.0% in 1990 to around 1.5% by 2005, maintaining that growth rate after 2005. In light of the HIV/AIDS epidemic, population growth is expected to fall to 0.6% by 2005 and to drop into negative territory by 2010. Whereas the South African population would have been expected to grow from 43.1 million in 2001 to 53.2 million by 2015 in the absence of HIV/AIDS, the population is now expected to peak at 44.5 million in 2009. By 2015, the AIDS inclusive population is projected to be about 10 million people less (±18% smaller) than what would have been possible without HIV/AIDS.

Figure 2.6: Population growth

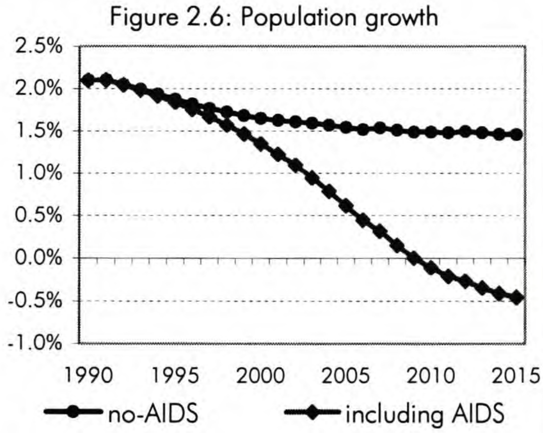
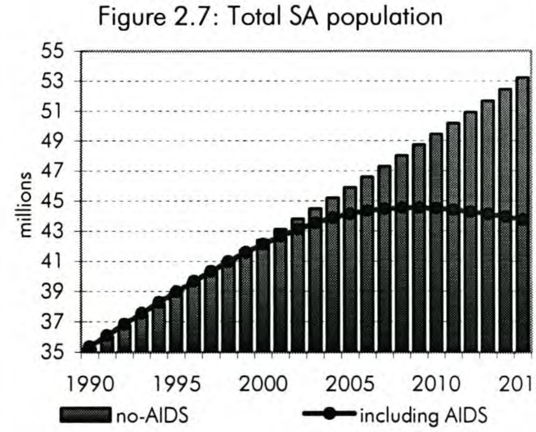


Figure 2.7: Total SA population

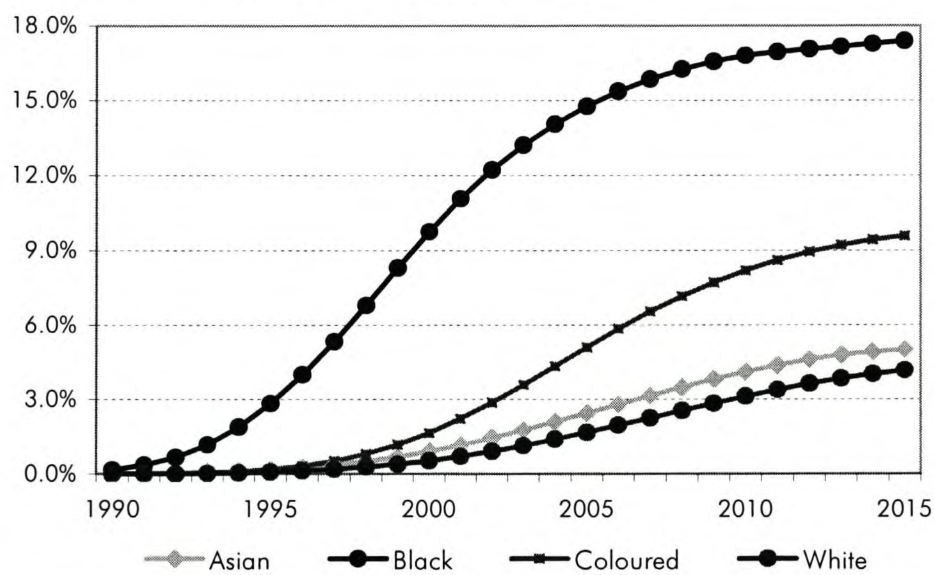


[4] The number of AIDS cases per year exceeds the number of AIDS deaths per year, as not all people with AIDS will die in a particular year.

b) Race

Figure 2.8 shows projections of the racial distribution of the HIV epidemic by Abt Associates/Metropolitan Life. Their estimates indicate that the epidemic is heavily skewed towards the black population, with estimates indicating that 11% of the black population could already be infected with HIV. This figure is expected to reach 17.4% by 2015. Their projections indicate that the black population could be 20.7% smaller by 2015 than what would have been the case without the HIV/AIDS epidemic. A number of factors have made black South Africans more susceptible to a severe HIV epidemic than other South Africans, including high levels of poverty[5], disrupted family lives and migrant labour patterns, to a large extent ascribable to the apartheid system.

Figure 2.8: HIV prevalence per race group



Abt Associates and Metropolitan Life estimate that less than 2.5% of the coloured, white and Asian population groups are currently infected with HIV. They project that the HIV prevalence rate for the coloured population group will reach 9.6% by 2015, 5.0% for Asians and 4.2% for whites. By 2015, the non-black population is projected to be about 4.6% smaller than what would have been possible without HIV/AIDS.

[5] The poorer population groups have fewer resources available to treat other sexually transmitted diseases, increasing the likelihood of the transmission of HIV.

c) Labour force by skill category

Table 2.3 shows the skills profile of the South African labour force (by latest known employment status) as estimated in Statistics South Africa's 1996 Census. The skill categories are defined as follows: Highly skilled occupations include professional, semi-professional and technical occupations; managerial, executive and administrative occupations and certain transport occupations (e.g. pilots and navigators). Skilled occupations include clerical, service and sales occupations; farmers, farm managers; artisans, apprentice and related occupations; production foremen and production supervisors. All other occupations are defined as either semi- or unskilled (Abt Associates and Metropolitan Life June 2000: 14).

Table 2.3: The structure of South Africa's labour force (1996)

	Highly skilled		Skilled		Semi & unskilled		TOTAL
Economically active	number	%	number	%	number	%	Number
Formally employed	1 300 009	92,1	2 899 334	76,5	3 509 890	40,9	7 709 233
Informally employed	100 177	7,1	289 901	7,7	710 223	8,3	1 100 301
Unemployed	11 148	0,8	598 083	15,8	4 366 238	50,8	4 975 469
Total labour force	1 411 334	100	3 787 318	100	8 586 351	100	13 785 003
Composition (%)	10,2%		27,5%		62,3%		100%
Economically inactive[a]							11 319 353
Potential manpower[b]							25 104 356

a. Mainly students, the disabled, retired people and housewives (ages 15-64).
b. Population aged 15 to 64.
Source: Laubscher et al. (2001: 11); Abt Associates and Metropolitan Life (June 2000: 14).

From table 2.3 it is clear that close to two-thirds of South Africa's labour force consists of semi- and unskilled workers, of which a massive 50.8% are unemployed. In contrast, only 15.8% of the skilled workers and 0.8% of the highly skilled workers are unemployed. Approximately 8% of South Africa's labour force is informally employed.

The HIV/AIDS epidemic will have a disproportionate impact on the labour force, with approximately 15% of South Africa's total labour force already infected with HIV. HIV prevalence among the total labour force is projected to reach 26% by 2015, while AIDS prevalence could rise to 4.4%. Figure 2.10 shows that semi- and unskilled workers are the most susceptible to the epidemic. HIV infection rates for semi- and unskilled workers, as well as skilled workers, are projected to peak above 25%. Even for the relatively less infected highly skilled labour force category HIV prevalence rates are projected to reach 18% by 2015.[6] Furthermore, the low unemployment rate for highly skilled labour implies that there is a small "reserve pool" of highly skilled labour in South Africa, so that a skilled worker will be more difficult to replace in the event of an AIDS death than an unskilled worker. The somewhat surprisingly high prevalence rates for the highly skilled category can to some extent be explained by the large number of teachers and nurses - occupations that generally include a large number of black South Africans – in the highly skilled category. However, it should be noted that the racial profile of the HIV/AIDS epidemic (and hence projections by Abt Associates/Metropolitan Life) might well exaggerate the HIV risk of the highly skilled category. In fact, research by Professor Rob Dorrington suggests that "HIV prevalence could be independent of race at senior management level" (Laubscher et al. 2001: 7).

Figure 2.9: HIV vs AIDS preva-lence among total labour force

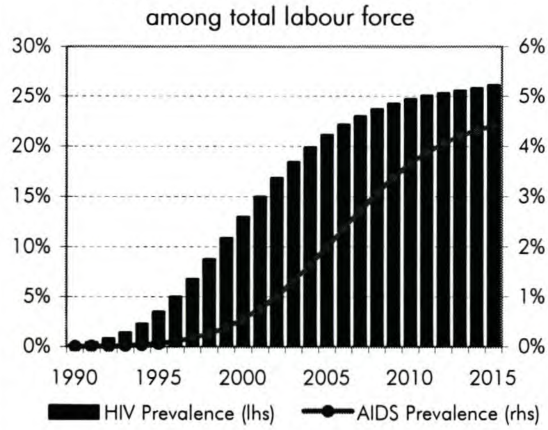
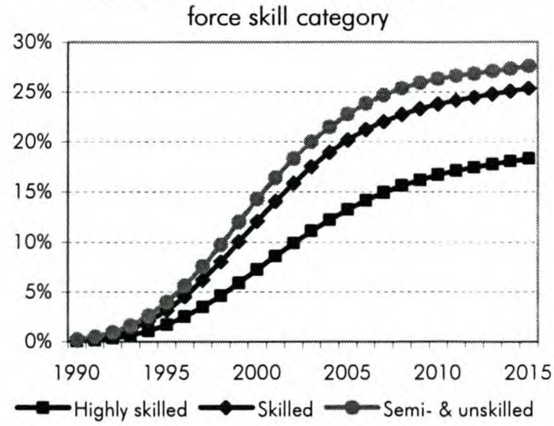


Figure 2.10: HIV prevalence per labour force skill category



[6] Dr C van der Merwe of Quantec supplied historical skills data. The skills HIV profiles were derived by overlaying the 1996 census data with age, gender and racial HIV profiles per province.

Table 2.4: The impact of HIV/AIDS on South Africa's labour force

	Labour force (millions)		HIV prevalence			AIDS prevalence		
	No-AIDS	Including AIDS	Highly skilled	Skilled	Semi- and unskilled	Highly skilled	Skilled	Semi- and unskilled
2001	14.736	14.578	8.6%	14.1%	16.4%	0.5%	0.7%	0.8%
2005	15.783	15.099	13.3%	20.2%	22.8%	1.4%	1.9%	2.2%
2010	17.214	15.137	16.7%	23.8%	26.3%	2.7%	3.5%	3.9%
2015	18.720	14.796	18.3%	25.4%	27.6%	3.5%	4.2%	4.7%

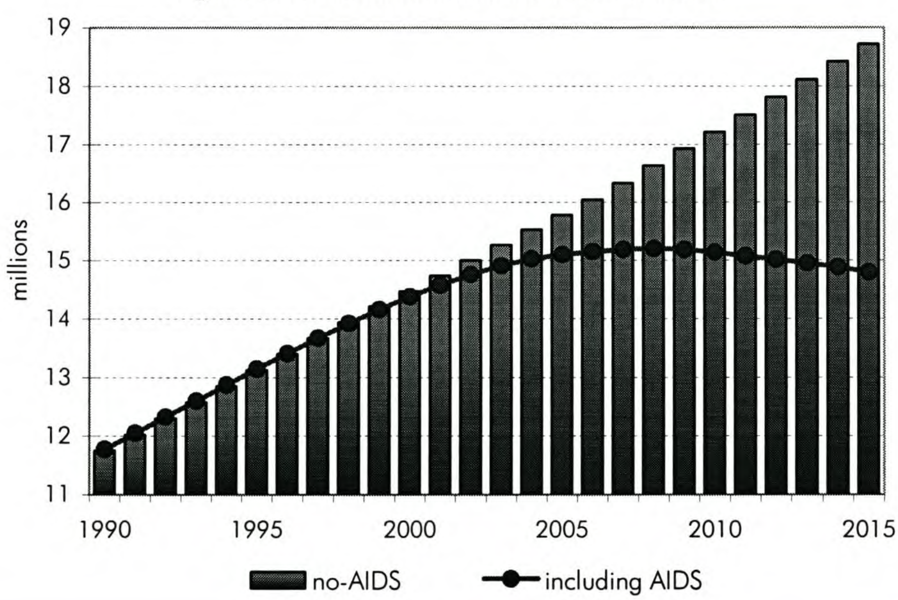
Table 2.4 shows HIV and AIDS prevalence rates for the different skill categories of the labour force. For econometric modelling purposes, it was decided to differentiate between only two skill categories of labour - skilled and unskilled labour. The skilled and highly skilled labour force (employment) data was aggregated to form the skilled labour force (employment) category that was used in the econometric modelling exercise. Semi- and unskilled labour (employment) forms the unskilled labour force (employment) category. Figure 2.11 shows that between 0.6% and 0.8% of workers in the different skill groups are currently suffering from full-blown AIDS. AIDS prevalence among the skilled and unskilled is expected to increase rapidly over the next 10-15 years, reaching 4% for skilled and highly skilled workers and 4.7% for semi- and unskilled workers by 2015.[7]

AIDS deaths among the working age population are expected to quadruple over the next decade. By 2015, the total labour force could be 21% smaller (or about 4 million people less) than what would have been attainable in the absence of the HIV/AIDS epidemic. In the case of semi- and unskilled workers, the difference between the AIDS-inclusive labour force and the labour force that would have been attainable without HIV/AIDS could be 22.2% by 2015. The corresponding figure for skilled and highly skilled workers is only slightly lower at 18.6%.

[7] AIDS prevalence rates (or the number of AIDS victims) in the different labour force categories is an important input in the modeling of AIDS induced increases in health care costs, particularly to the public health sector.

Figure 2.11: AIDS prevalence per labour force skill category

Figure 2.12: Total South African Labour Force



Even these comparatively "conservative" projections of the Abt Associates/Metropolitan Life suggest that HIV/AIDS will have a dramatic impact on the size of the South African population. Given that the brunt of the demographic impact will fall on the working age population, the national economy is bound to be affected by the epidemic.

CHAPTER 3

PREVIOUS ESTIMATES OF THE MACRO-ECONOMIC IMPACT OF THE HIV/AIDS EPIDEMIC

3.1) INTRODUCTION

HIV/AIDS tends to strike people in their economically most productive years and is almost 100% fatal. Given only this simple characteristic of HIV/AIDS, it is already evident that the disease has the potential to reduce economic growth in countries with severe epidemics, including South Africa. Before considering previous estimates of the economic impact of HIV/AIDS, it may be instructive to look at how the epidemic may affect the different levels of a society. HIV infected individuals and households will be the first to experience the economic impacts of AIDS, whereafter the effects will ripple outwards to businesses and eventually the macro-economy (Bollinger and Stover 1999:1).

Although the HIV/AIDS epidemic affects all levels of society, the most severe effects of HIV/AIDS occur at the household level. The economic impact of AIDS on households primarily stems from its impact on household income and expenditure. The loss of a breadwinner could permanently reduce the income of a household, particularly in the case of lower income households, who are often inadequately insured. The financial impact may well be exacerbated if another member of the family has to stop working to care for the sick. Moreover, HIV/AIDS typically strikes more than one member of the household. Many households may become entirely dependent on an old age pension or other social support grants. AIDS may well worsen poverty and exacerbate the skew income and wealth distribution in certain African countries, as poor households appear to be more vulnerable to the epidemic and have fewer resources available to cope with the disease

The AIDS epidemic will affect household spending patterns, as HIV/AIDS infected households will be burdened by higher health care costs, transport costs to and from health services and funeral expenses. Households may have to divert funds away from savings or other expenditure categories, such as children's education or non-essential spending. Some households may even find it necessary to liquidate fixed assets in order to be able to acquire medical care for the sick or to cover burial costs. Furthermore, AIDS deaths will reduce the absolute number of consumers in an economy, which could have a negative effect on total consumption expenditure. Similarly, private residential investment will be constrained by the slower growth in the population as a result of the epidemic (Bollinger and Stover 1999: 1-2; Laubscher 2000: 10-11; Loewenson and Whiteside 1997: 32-33; Abt Associates April 2000: 9-10).

AIDS related illnesses and deaths of managers, employees and their family members could have a significant impact on business. It is expected that companies will need to increase their contributions to pension, life, disability and medical benefits on account of the AIDS epidemic. In addition to these direct cost increases, indirect costs to companies may also rise. These costs include recruitment and training costs, cost of increased labour turnover, lost skills, worker absenteeism due to illness or compassionate leave for workers to attend funerals and to care for sick family members, lower labour productivity due to physical disability, stress and reduced morale caused by the illness or death of friends, fellow employees and relatives, legal fees and time spent on negotiations between labour and management, as well as the costs involved in ensuring occupational health and safety standards. The vulnerability of different companies will vary, depending on factors such as the labour intensity of the company; the risk profile or susceptibility of its workers; the skills of affected employees and the ease of substitution between workers; the structure of employee benefit schemes; the degree to which companies have implemented strategies to cope with HIV/AIDS in the work place, the impact of AIDS on suppliers of key production inputs, as well as on the company's target market. HIV/AIDS induced cost increases will have an adverse impact on corporate savings, constraining fixed investment by the private sector (Abt Associates February 2000: 21-24; Laubscher 2000: 11-13; Quattek 2000: 11-12).

The HIV/AIDS epidemic will put special pressures on the public sector of a country with a severe epidemic. One of the most visible consequences of the epidemic will be an increase in the number of people seeking medical care – a substantial proportion of the HIV/AIDS victims will likely turn to state hospitals for medical care. The financial strain on the public health sector could be severe, not only as a result of the sheer number of people seeking health care, but also because health care for AIDS patients is more expensive than for most other conditions. An important challenge for the government will be that the increased financial burden stemming from higher public health care and other social spending such as foster grants and institutional care for orphans will probably coincide with reduced tax revenues. Increased direct and indirect costs will reduce private sector profits, which is likely to have an adverse impact on economic growth and wages, indicating an erosion of the tax base and lower government revenue (Laubscher 2000: 14). In all likelihood, HIV/AIDS will lead to a shift in spending from "more to less productive avenues" (e.g. from public sector fixed investment to health care services) (Laubscher et al. 2001: 34).

Given all the potential impact channels, it can safely be stated that HIV/AIDS will more likely than not reduce GDP growth in countries with severe epidemics. However, predicting the extent of the impact of the HIV/AIDS epidemic on macro-economic growth is by no means an easy task. The brunt of the impact is likely to be felt years from now and projections of the economic impact of AIDS are subject to limitations on, inter alia, the ability to estimate the current rate of HIV infection, projecting the course of the epidemic into the future, predicting economic growth and estimating the economic consequences of the demographic changes caused by HIV/AIDS (Ainsworth and Over 1994: 205).

Most of the attempts that have been made to quantify the macro-economic impact of HIV/AIDS occurred during the early 1990s and relied on fairly simple models. Over the past few years there has been renewed interest in the modelling of the economic impact of HIV/AIDS, mostly due to increasing appreciation of the scope of the epidemic in Sub-Saharan Africa and in South Africa in particular. Recent studies by ING Barings (Quattek 2000) and Arndt and Lewis (2000) used somewhat more complex macro-economic forecasting models to simulate the impact of HIV/AIDS on the South African economy.

The focus of this chapter will be on the models that were used to project the economic impact of HIV/AIDS, the assumptions with regard to the channels through which the epidemic will impact on the economy and the simulation results obtained in the different studies.

3.2) Previous Estimates of the Impact of AIDS on African Economies

During the early 1990s, studies by Over (1992), Kambou, Devarajan and Over (1992), Cuddington (1993a and 1993b), Cuddington and Hancock (1994a and 1994b) and Bloom and Mahal (1995) attempted to quantify the impact of HIV/AIDS on the economic growth rates of African countries with severe epidemics. These earlier studies generally relied on relatively simple models and projected the impact of HIV/AIDS over a 15-25 year time frame by comparing "no-AIDS" and "AIDS" scenarios. With the exception of the Bloom and Mahal study, these authors typically arrived at the conclusion that the AIDS epidemic will lead to a substantial reduction in overall economic growth and that AIDS may even reduce the growth rate of per capita income, albeit it only slightly.

More recently, the Botswana Institute for Development Policy Analysis (2000) followed the approach used in the earlier studies by Cuddington and Hancock and constructed an extended Solow type growth model to simulate the macro-economic impact of AIDS on Botswana – the country with the highest HIV infection rate in the world. BIDPA projected that the average growth rate in Botswana's GDP will be substantially lower compared to a no-AIDS scenario, but that - due to the substantial drop in the population - per capita income will be virtually unaffected.

Less than a year after the publication of BIDPA's research on the macro-economic impact of HIV/AIDS in Botswana, MacFarlan and Sgherri (2001) published a working paper on the same topic. Although the modelling approach used by MacFarlan and Sgherri closely resembles that used by BIDPA, their simulation results suggest that AIDS may have a significantly more dramatic impact on Botswana's economy than what was projected by BIDPA. MacFarlan and Sgherri refrain from any statements on the impact of the epidemic on per capita GDP, but a comparison of their projections for the decline in the level of GDP and the decline in the population suggests that per capita GDP will be significantly lower due to AIDS. In contrast, a study by Haacker (2001) on the impact of HIV/AIDS on per capita incomes in a number of Southern African countries, including Botswana, suggested that per capita GDP growth would be higher in all of the countries analysed.

In what follows, the models that were employed to simulate the economic impact of AIDS in countries other than South Africa are described and the assumptions underlying the AIDS and no-AIDS scenarios, as well as the simulation results from these studies, are presented and discussed.

3.2.1) OVER (1992): PROJECTING THE MACRO-ECONOMIC IMPACT OF AIDS ON 30 SUB-SAHARAN COUNTRIES

One of the earliest attempts to quantify the macro-economic impact of the epidemic was by Mead Over of the World Bank in 1992. Over examined the macro-economic impact of AIDS on 30 Sub-Saharan countries by projecting the growth rate of GDP and per capita GDP with and without the AIDS epidemic over the period 1990 to 2025. Economic growth was modelled using two Cobb-Douglas production functions[1] - one for the urban sector, where HIV infection is generally much higher, and one for the rural sector. Rural production was assumed to comprise all agricultural production, while urban production comprised all industrial and service sector production. Three principal factor inputs were assumed to be employed in the production of output – capital, labour and arable land. All arable land was assumed to contribute to agricultural production, while all capital was assumed to be utilised in the industrial and service sectors (Over 1992: 7-8).

Over disaggregated the labour force by skills or productivity levels within the urban and rural sectors. Different levels of education - uneducated, primary schooled and secondary schooled education - were used as a proxy for skills or productivity, where uneducated workers were assumed to be the least productive and secondary schooled workers the most productive. Secondary schooled workers were assumed to contribute exclusively to urban production, while unschooled workers were assumed to contribute only to rural production (Over 1992: 9-10).

Rural output was estimated as a function of arable land, unschooled and primary schooled labour, while urban output was specified to be a function of capital, primary schooled and secondary schooled labour and a time trend. Capital stock was determined as a function of the existing capital stock, adjusted for depreciation and new investment. Gross investment was assumed to equal the sum of foreign and domestic savings. Foreign savings was projected exogenously, while domestic savings was assumed to depend on urban and rural output, as well as foreign savings (Over 1992: 13-14).

[1] The use of a Cobb-Douglas production function "captures the assumption that the marginal cost of each additional worker lost is higher than that of the last" (Over 1992:7).

After estimating the model econometrically for the period 1960-1985, Over used the model to project future economic growth under the baseline no-AIDS scenario. The no-AIDS growth projections are founded on Over's projections of the exogenous variables - foreign savings, arable land and the labour force[2] (subdivided into rural and urban labour and into the three skills categories). Over projected that arable land and the different categories of the labour force would continue to grow at their past trends. The level of foreign savings (positive or negative) was projected to move gradually towards zero after 1985 (Over 1992: 15-16).

Over assumed that AIDS would impact on economic growth to the extent that it reduced savings and the size of the labour force. In order to incorporate AIDS into the model (or to generate the AIDS scenario) and to project its impact on economic growth, it was necessary to project the epidemic's impact on savings and the different categories of the labour force. In order to model the demographic impact of AIDS on the 30 Sub-Saharan (SSA) countries in his study, Over adopted the simplifying assumption that all the SSA countries are epidemiologically similar, differing from one another only in the timing of the epidemic (when the HIV epidemic first established itself in the country) and not in the eventual magnitude of the epidemic (Over 1992: 20). Over used Bongaarts's "severe epidemic" model[3] to project the impact of AIDS on the population. Estimates of *PLIVE*, the ratio of the population size in the presence of AIDS to the size that the population would have attained in the absence of AIDS, were obtained for each country in each year (Over 1992: 19-20). In order to be able to model alternative assumptions with regard to the distribution of AIDS over the different skills categories, Over specified the proportion of the labour force lost due to AIDS for country i in year t, $(1\text{-PLIVE})_{it}$, as follows:

$$(1\text{-PLIVE})_{it} = P0_{it}\,(L0_{it}) + P1_{it}\,(L1_{it}) + P2_{it}\,(L2_{it}) \qquad (1)$$

where L0, L1 and L2 are the proportions of the labour force with no schooling, primary schooling and secondary schooling and Pk denotes the proportion of skill group k lost due to AIDS.

It was assumed that:

---

[2] By using the labour force instead of the number of people employed, Over assumed full employment.

[3] The Bongaarts model predicts that, 25 years after the epidemic established itself, 21% of the country's adult population would be infected with HIV and that the population growth rate would be 1.3% lower than it would have been in the absence of AIDS. The model also predicts that, in the 50th year of the epidemic, the population will be 32% smaller than it would have been without AIDS (Over 1992:19).

$$P2 = \alpha P1 = \alpha^2 P0 \quad (2)$$

In order to explore the sensitivity of economic growth to the distribution of the AIDS epidemic over the three skill categories, the parameter α was varied from 0.5 to 4.0 in the simulations with the model. From (2) it is evident that $\alpha = 1$ represents the epidemic scenario in which AIDS is evenly distributed across all three the skills categories, $\alpha < 1$ represents an epidemic that disproportionately infects the less educated and $\alpha > 1$ denotes the scenario in which the highly skilled section of the labour force bares the brunt of the impact of AIDS. Given the choice of α and the projections of the labour force by skill categories, Over calculated P0 (the proportion of the uneducated labour force lost due to AIDS) as follows:

$$P0_{it} = (1 - PLIVE)_{it} / (L0_{it} + \alpha L1_{it} + \alpha^2 L2_{it}) \quad (3)$$

In order to model the impact of AIDS on medical costs and savings, Over assumed that uneducated AIDS victims incur AIDS treatment costs equal to the per capita GDP of the country, while primary schooled and secondary schooled AIDS victims spend twice and four times the GDP per capita on treatment respectively (Over 1992: 22). Given the GDP per capita and the distribution of AIDS across the different skill categories, the total annual medical treatment costs of AIDS can be calculated. It was assumed that increased medical expenses would impact on economic growth to the extent that it is financed by reducing domestic savings, and hence capital formation. The parameter σ was specified to be the proportion of total AIDS treatment costs deducted from savings. In order to explore the sensitivity of projected economic growth to the fraction of AIDS costs that are financed by reducing savings, σ was varied from 0% to 100% in the simulation exercises (Over 1992: 22-23).

Over used the model to project the growth rates of GDP and per capita GDP of 30 Sub-Saharan countries with and without the AIDS epidemic over the period 1990 to 2025. The impact of AIDS was defined to be the difference between the estimated growth rates under the AIDS and no-AIDS scenarios. The impact of AIDS on the average Sub-Saharan country (calculated as the average impact over all 30 countries in the sample), as well as the average impact on the 10 countries with more advanced epidemics, was calculated under alternative assumptions about the proportion of each skills group that suffers from AIDS and the proportion of AIDS related costs that are financed by reducing savings (see table 3.1).

Under the assumptions that HIV disproportionately infects the less educated (α = 0.5) and that 50% of medical costs are financed from savings (assumptions that are fairly plausible for a country like South Africa), Over predicted that GDP growth for the 30 Sub-Saharan countries investigated could be on average 0.62 percentage points lower per year between 1990 and 2025. GDP growth rates of the ten countries that are more advanced along their epidemic paths were predicted to be 0.80 percentage points lower per year (on average and using the same assumptions) (Over 1992: 23).

Table 3.1: Over's estimates of the impact of AIDS on the GDP growth rates of a sample of African countries* - averages over the period 1990-2025

		Distribution of AIDS across skill categories (α)			
Fraction of AIDS related costs financed from reduced savings (x)		Downward Biased $\alpha = 0.5$	Evenly Distributed $\alpha = 1.0$	Upward Biased $\alpha = 1.5$	Extremely Upward Biased $\alpha = 2.0$
$\sigma = 0$	All 30 countries	-0.56	-0.68	-0.81	-0.92
	10 Most advanced epidemics	-0.73	-0.91	-1.09	-1.27
$\sigma = 0.5$	All 30 countries	-0.62	-0.75	-0.88	-1.00
	10 Most advanced epidemics	-0.80	-0.99	-1.18	-1.37
$\sigma = 1$	All 30 countries	-0.68	-0.82	-0.96	-1.08
	10 Most advanced epidemics	-0.88	-1.08	-1.28	-1.47

Source: Over 1992: 23.

* Average differences between year on year growth rates in the AIDS and no-AIDS scenarios.

Since the AIDS epidemic reduces not only economic growth, but also population growth, the impact of AIDS on GDP per capita should be less pronounced than the impact on GDP growth. Should the demographic impact of AIDS exceed the impact on economic growth, per capita GDP may even increase as a result of AIDS. It is therefore not surprising that Over's simulation results indicate that AIDS could increase GDP per capita in the average African country (and in the 10 countries with more advanced epidemics) under the scenario in which HIV disproportionately infects the less educated and 50% of medical costs are financed from savings (Over 1992: 25).

Table 3.2: Over's estimates of the impact of AIDS on the per capita GDP growth rates of a sample of African countries* - averages over the period 1990-2025

		Distribution of AIDS across skill categories (α)			
Fraction of AIDS related costs financed from reduced savings (x)		Downward Biased α = 0.5	Evenly Distributed α = 1.0	Upward Biased α = 1.5	Extremely Upward Biased α = 2.0
σ = 0	All 30 countries	0.17	0.04	-0.08	-0.18
	10 Most advanced epidemics	0.13	-0.05	-0.23	-0.40
σ = 0.5	All 30 countries	0.11	-0.02	-0.15	-0.27
	10 Most advanced epidemics	0.06	-0.13	-0.32	-0.50
σ = 1	All 30 countries	0.05	-0.09	-0.23	-0.35
	10 Most advanced epidemics	-0.02	-0.22	-0.41	-0.60

Source: Over 1992: 25.
* Average differences between year on year growth rates in the AIDS and no-AIDS scenarios.

3.2.2) KAMBOU, DEVARAJAN, & OVER (1992): SIMULATING THE ECONOMIC IMPACT OF AIDS WITH A COMPUTABLE GENERAL EQUILIBRIUM MODEL OF CAMEROON

Studies by Kambou, Devarajan, and Over (1992) and Arndt and Lewis (2000) simulated the impact of AIDS on macro-economic growth using computable general equilibrium (CGE) models. A CGE model can be described as "an economy-wide model that includes the feedback between demand, income and production structure, and where all prices adjust until decisions made in production are consistent with decisions made in demand" (Derives et al. 1982: 132). CGE models simulate the functioning of a market economy in which prices adjust to equate supply and demand in all markets. Economic decision-making is the outcome of independent optimising behaviour by producers and consumers: producers are assumed to strive towards profit maximisation subject to technological constraints, while consumers seek to maximise utility subject to budget constraints. A variety of substitution mechanisms, including substitution between different production factors, skill categories of labour, domestic and imported goods, as well as between domestic sales and exports, all of which occur in response to changes in relative prices, can be embodied in a CGE model (Kambou et al. 1992: 124; Arndt and Lewis 2000: 4).

CGE models are typically represented by a multitude of non-linear equations. Instead of being estimated econometrically, these equations are calibrated to a benchmark year so that they reproduce the historical data for that year. However, the parameters of CGE models are often based on econometric estimates from empirical literature. "These equations, which attempt to capture the structure of the economy, are used to solve endogenously for prices, wages and exchange rates, all adjusting to equate supply and demand in the markets for production, labour and foreign exchange" (Kambou et al. 1992: 124).

The CGE models employed by Kambou, Devarajan, and Over and Arndt and Lewis to model the impact of AIDS on the economies of Cameroon and South Africa respectively, each consists of a static single-period general equilibrium component and a dynamic multi-period general equilibrium component which encompasses the static component. The dynamic CGE model takes as given the equilibrium solution provided by the static model and uses a set of dynamic equations (or inter-temporal linkages or updating relationships) to update over time the various exogenous variables entering the static model (Kambou et al. 1992: 129; Arndt and Lewis 2000: 8).

Kambou, Devarajan, and Over (1992) used an 11-sector CGE model to simulate the impact of an AIDS-induced reduction in the labour supply on the performance of the Cameroonian economy for the period 1987 to 1991. In what follows, the distinctive features of the static component of the model (e.g. the model's treatment of production, foreign trade, income generation, consumption expenditure, savings and investment and price determination) and the dynamic equations in the model are described briefly. Subsequently, results from simulations with the dynamic model are presented and discussed.

The 11 sectors of the model comprise five manufacturing, three service and three agricultural sectors. Each sector is assumed to employ capital, labour and intermediate (material) inputs to produce a single composite commodity. The labour market is disaggregated into three skill categories: rural labour, urban-unskilled labour and urban-skilled labour. Since producers are assumed to maximise profits, additional workers will be employed until their marginal revenue product equals their marginal cost (i.e. their wage). A Constant Elasticity of Substitution (CES) function is used to calculate the labour composite of the three skill categories. A Cobb-Douglas production function determines how the labour composite and capital are combined to produce net sectoral output (or value added). This net output is then combined with intermediate inputs to produce gross output according to a fixed-coefficient technology (Kambou et al. 1992: 125).

Domestically produced goods are assumed to be imperfect substitutes for traded goods (imports and exports), so that the price of goods on the domestic market need not equal the local price of imports or exports. In each sector consumers attempt to minimise the cost of acquiring a composite good, defined as a CES aggregate of imported and domestically produced goods. The assumption that consumers seek to minimise costs implies that the ratio of imported to domestic goods that is preferred in each sector is negatively related to the price of imported goods relative to that of domestically produced goods. The elasticity of substitution between these goods can vary by sector, with higher elasticities reflecting smaller differences between domestically produced goods and imports, and hence greater ease in substituting one for the other should their relative prices change. The supply of imports is assumed to be perfectly elastic at a fixed world price[4]. The domestic price of an imported good is determined by the international price of imports, the exchange rate and any tariffs on imports (Kambou et al. 1992: 126).

In the Cameroonian model, the international price of exports is not fixed. Rather, exporters are confronted with a downward sloping world demand curve for their products, so that the world price of exports is endogenous. As with imports, sectoral exports are assumed to differ from goods produced for domestic consumption. Since domestic producers attempt to maximise their profits from selling on domestic and international markets, the desired ratio of exports to domestic sales in the model is positively related to the ratio of export to domestic prices (Kambou et al. 1992: 126).

The factor income that is generated by the production of goods and services is distributed to households, who pay income tax, save a fraction of their income and spend the remaining income on goods and services according to fixed expenditure shares. The Cameroonian model contains a single household sector. Private consumption expenditure by households is determined by a Cobb-Douglas utility function under the assumption that households seek to maximise utility subject to a budget constraint (Kambou et al. 1992: 126).

The government receives revenue from import tariffs, export taxes, indirect and income taxes and the proceeds from net foreign borrowing. It is assumed that the government spends money on goods and services, as well as investment. The remaining revenue is assumed to represent government savings. Expenditure by government is

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[4] The assumption that the world price of imports or exports is fixed is known as the *small country assumption*.

determined exogenously to the model so that "the level of government savings depends critically on its revenues" (Kambou et al. 1992: 126-127).

Government savings, household savings and net foreign savings determine the available supply of savings in the economy. Net foreign savings are determined exogenously. Each year total investment is set equal to total savings[5] (i.e. all the resources available for investment are assumed to be invested). Since it is assumed that total investment is determined by total savings, the model can be described as savings-driven (Kambou et al. 1992: 127).

For the model to reach equilibrium, aggregate supply (from imports and domestically produced goods) must equal aggregate demand (the sum of household, government, investment and intermediate demands). As in other CGE models, the Cameroonian model only determines relative prices, so that the absolute price level must be set exogenously. The world price of imported goods was chosen as the *numeraire* price level against which all relative prices in the model are measured (i.e. the numeraire serves as an anchor for the price level) (Kambou et al. 1992: 127).

In order to render the model capable of moving forward in time, a set of behavioural equations or updating relationships are introduced in the dynamic component of the CGE model. Whereas the capital stock is assumed to be fixed in the static model, in the dynamic model the capital stock available to each sector in each year is specified as a function of the existing capital stock, adjusted by the depreciation rate, and new investment in the sector. Investment is assumed to be allocated to different sectors according to observed sectoral profit rates, so that the more profitable sectors in the economy will attract a greater share of the resources available for investment. Another variable that is fixed in the static model and needs to be updated over time in the dynamic model is the supply of labour in each skill category. Kambou, Devarajan, and Over assumed that, in the no-AIDS scenario, the supply of rural, urban-unskilled and urban-skilled labour would grow by 2%, 3% and 1% respectively in each year over the forecasting period (Kambou et al. 1992: 127-128).

Although Kambou, Devarajan, and Over also presented results from simulations with the static single-period model, only the simulations that were carried out with the

[5] This is often referred to as the *savings-investment closure rule*.

dynamic model will be discussed here[6]. In order to produce a no-AIDS scenario that could be used as a benchmark against which the effects of an AIDS induced reduction in the labour supply could be measured, the authors needed to make assumptions about the internal and external environment that would confront the Cameroonian economy during the simulation or forecasting period (1987-1991) in the absence of AIDS. They assumed that the relevant internal, external and policy variables that underpin economic growth would remain unchanged from their 1986 levels over the 1987-1991 simulation period. As mentioned above, it was assumed that, in the absence of AIDS, the supply of rural, urban-unskilled and urban-skilled labour would grow by 2%, 3% and 1% respectively in each year over the forecasting period. The AIDS scenarios differed from the no-AIDS scenario only with regard to the assumptions that were made about the growth rates in supply of labour to the three different skill categories of the labour force (Kambou et al. 1992: 120).

Kambou, Devarajan, and Over employed the dynamic model to simulate the impact on the Cameroonian economy of a 30 000 person reduction in total labour supply (a shock of 10 000 workers to each of the three skill categories – rural, urban-unskilled and urban-skilled) in each year[7]. Their simulation results indicated that average GDP growth over the period 1987-1991 would decline by 1.9 percentage points, from 4.3% under the no-AIDS scenario to 2.4% under the AIDS-scenario (see table 3.3) (Kambou et al. 1992: 121).

They found that the fall in the supply of labour reduced consumption expenditure and increased wages, production costs and domestic prices, leading to a deterioration in international competitiveness and lower exports. The contraction of exports leads to further losses in production and employment and a deterioration in public finances (lower government savings), as export taxes constitute an important source of revenue for the government. Falling private and government savings lead to a reduction in fixed investment, reducing the GDP growth rate. The decline in output growth brought about a lower demand for imports, as imported goods are complements in production. The contraction of imports and hence import tariffs resulted in further losses in fiscal revenue (Kambou et al. 1992: 121).

[6] The focus of the single-period simulations with the static model was on the impact of an AIDS induced labour shortage on the 11 different sectors of the economy and not on its impact on the macro-economy.

[7] The supply of labour in each skill category is assumed to grow at its specified no-AIDS growth rate over the forecasting period, whereafter 10 000 workers are subtracted from each skill category in each year to account for the impact of AIDS on the labour force.

Table 3.3: Estimates of the economic performance of Cameroon under the no-AIDS and different AIDS scenarios: Average annual growth rates for the period 1987-1991

Variables	No-AIDS	Alternative AIDS (or labour shortage) scenarios			
		10000 man reduction in each skill category	10000 man reduction in rural labour	10000 man reduction in urban-unskilled labour	10000 man reduction in urban-skilled labour
GDP	4.3	2.4	4.3	4.3	2.6
Consumption	4.6	4.3	4.5	4.6	4.4
Fixed Investment	5.1	1.4	5.1	5.0	1.7
Exports	5.9	3.9	5.9	5.9	4.1
Imports	4.4	2.8	4.4	4.4	3.0
Private Savings	3.6	3.2	3.6	3.6	3.3
Government Savings	10.2	-25.2	10.1	9.3	-20.6

Source: Kambou et al. 1992: 121.

The paper also attempted to provide quantitative estimates of the relative impacts on growth (or the importance) of each type of labour shortage. This was done by means of three simulations. In each simulation, the quantity of workers in one of the skill categories was reduced by 10 000 per year, *ceteris paribus*. Kambou, Devarajan, and Over found that a shortage of rural and urban-unskilled workers had little impact on economic growth. However, a 10 000 man reduction in urban-skilled workers led to a significant decline in GDP growth - the average annual growth rate of GDP was reduced by 1.7 percentage points. They concluded that, rather than the absolute number of AIDS cases, it is the distribution of AIDS across the different skill categories that will determine the severity of the impact on economic growth (Kambou et al. 1992: 121-122).

3.2.3) Cuddington (1993a) and Cuddington & Hancock (1994a): Modelling the macro-economic effects of AIDS on Tanzania and Malawi - The single sector Solow growth model

Cuddington (1993a) developed a Solow type single-sector, two factor growth model to simulate the macro-economic impact of AIDS on Tanzania under alternative assumptions about the share of AIDS treatment costs financed from savings and the loss of productivity per AIDS victim. Cuddington and Hancock (1994a) applied the same model to simulate the impact of AIDS on the Malawian economy. In what follows, the model used in these two studies is described and the simulation results for the two countries are presented.

Cuddington (1993a) and Cuddington and Hancock (1994a) employed a Cobb-Douglas production function to model aggregate output (Y_t):

$$Y_t = \alpha \gamma^t E_t^\beta K_t^{1-\beta} \qquad (4)$$

E_t represents labour, measured in efficiency units, and K is the capital stock. The parameter β denotes the elasticity of output with respect to labour, while γ^t represents an exogenous time trend that captures technological progress over time. A constant scale factor, α, is used to calibrate the model to fit the actual data for the first year of simulation - 1985 (Cuddington 1993a: 179; Cuddington and Hancock 1994a: 364).

The AIDS epidemic is expected to impact adversely on the size of the labour force and the productivity of workers. By increasing mortality rates, AIDS will reduce the size of the labour force and tilt its composition towards younger, less experienced (and hence less productive) workers. AIDS related illnesses may increase worker absenteeism and reduce the physical capability and concentration level of an infected worker at the work place, thereby reducing labour productivity (Cuddington 1993b: 405). In order to capture the impact of AIDS on the size of the labour force as well as on its productivity, the authors incorporated labour inputs in the production function via efficiency units of labour. Labour efficiency units at time t were defined as:

$$E_t = \Sigma_i (1 - za_{it}) \rho_i L_{it} \qquad (5)$$

L_{it} denotes the number of workers of age i at time t and the parameter ρ is used to capture the productivity of a healthy worker[8]. The parameter *a* denotes the proportion of the population that has AIDS, while *z* indicates the proportion of the working year lost per AIDS victim due to his absence from work or lower productivity at work. According to Cuddington, this proportion can range between 0 and 2. The reason why the fraction of a working year lost per AIDS victim can be higher than 1 is that the loss may be not only in the AIDS victim's labour, but also in the labour of others around him or her. According to Cuddington (1993a: 179), "if a person who gets AIDS stops working immediately and that person's spouse also must stop work to provide full-time care, then z = 2."

The productivity of a worker of age i was assumed to be a quadratic function of his or her work experience. Cuddington (1993a: 179) and Cuddington and Hancock

[8] Cuddington (1993a: 182) and Cuddington and Hancock (1994a: 364) assumed the labour force to be comprised of all individuals between the ages 15 and 64.

(1994a: 365) assumed that a worker's experience could be proxied by the age of a worker minus 15 years.

$$\rho_i = \rho_1 + \rho_2 (i - 15) - \rho_3 (i - 15)^2 \qquad (6)$$

It was assumed that AIDS would impact on capital formation to the extent that AIDS related medical care costs are financed from domestic savings. Assuming that a constant fraction (x) of the total annual health care expenditure on AIDS patients is financed from domestic savings, domestic savings was modelled as:

$$S_t = s\, Y_t - x\, H_t \qquad (7)$$

where s equals the domestic savings rate out of output (GDP) in the absence of the AIDS epidemic and H_t represents the total annual health care expenditure on AIDS patients[9].

Foreign capital inflows were assumed to equal a constant fraction (s*) of domestic output in the AIDS and no-AIDS scenarios[10].

Given these assumptions, the capital stock at time t was determined as:

$$K_t = [s + s^*]\, Y_t - x\, H_t + (1 - \delta)\, K_{t-1} \qquad (8)$$

where δ denotes the depreciation rate.

Bulatao's (1990) epidemiological-demographic simulation model was used to project the number of persons in each five-year age cohort (i.e. the population) in each year from 1985 to 2010 under no-AIDS and AIDS scenarios, as well as the number of AIDS cases in each age cohort for every year (Cuddington 1993a: 182; Cuddington and Hancock 1994a: 366). These projections were used to calculate the labour force in each age cohort, L_{it}, and the proportion of the labour force in each age cohort with AIDS, a_{it}, for Tanzania and Malawi.

After specifying the values of the key parameters of the model, the model was used to project macro-economic variables such as GDP, per capita GDP and the savings

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[9] $H_t = m\, a_t\, L_t$ where L_t is the labour force, a_t is the proportion of the labour force with AIDS and m is the annual health care expenditure per AIDS patient.

[10] By assuming that the country only attracts foreign capital inflows in the form of foreign aid, the model can ignore any factor payments earned by foreign owned capital (Cuddington 1993a: 180).

rate for Tanzania for the 25 years from 1985 to 2010 under the AIDS and no-AIDS scenarios.[11] Cuddington and Hancock changed the parameter values of the model to fit the Malawian economy and applied the model to simulate the impact of AIDS on the Malawian economy over the same 25-year period.[12] Tables 3.4 and 3.5 summarise the projected impact of AIDS on the growth in GDP and per capita GDP in Tanzania and Malawi under different assumptions about the share of AIDS treatment costs financed from savings and the loss of productivity per AIDS victim.

Table 3.4: Estimates of the impact of AIDS on the GDP growth rates of Tanzania and Malawi with the single sector growth model* - averages over the period 1985-2010				
Fraction of AIDS related costs financed from reduced savings (x)		Labour productivity lost per AIDS case (z)		
		z = 0	z = 0.5	z = 1
x = 0.0	Tanzania	-0.6	-0.6	-0.7
	Malawi	-0.2	-0.2	-0.3
x = 0.5	Tanzania	-0.6	-0.7	-0.7
	Malawi	-0.2	-0.3	-0.3
x = 1.0	Tanzania	-0.7	-0.8	-0.8
	Malawi	-0.2	-0.3	-0.3

Source: Cuddington 1993a: 184-185; Cuddington and Hancock 1994a: 367.
* Average differences between year on year growth rates in the AIDS and no-AIDS scenarios.

Simulations under the no-AIDS scenario predicted that the average growth rate in GDP and per capita GDP in Tanzania for the period 1985 to 2010 would be 3.9% and 0.7% respectively (Cuddington 1993a: 185). Estimates with the model for Malawi indicated that the average growth rate in GDP over the same period would be 4.3% and average per capita GDP growth would equal 0.9% in the no-AIDS scenario (Cuddington and Hancock 1994a: 367). Under the assumptions that 50% of the AIDS treatment costs

[11] The AIDS simulations differed from the no-AIDS simulations in three ways: Whereas AIDS prevalence among adults, a_t, was set equal to zero in the no-AIDS scenario, a_t assumed a positive and increasing value under the AIDS scenario; Secondly, the labour force was smaller under the AIDS scenario; In the third place, since AIDS tilts the composition of the labour force towards younger, less experienced workers (i.e. AIDS reduces i and hence ρ_i), the labour force was less productive under the AIDS scenario (Cuddington 1993a: 183).

[12] It should be noted that the Tanzania and Malawi studies also differ with regard to the assumptions about the prevalence of AIDS in the country. Whereas Cuddington and Hancock modelled the impact of AIDS on economic growth under both a medium and an extreme AIDS prevalence scenario, Cuddington's estimates of the impact of AIDS on the Tanzanian economy were based on a more extreme AIDS prevalence scenario only. Unfortunately, Cuddington and Hancock only presented results from simulations with the medium AIDS scenario in their 1994 paper.

are financed from savings and that a worker with AIDS is half as productive as a healthy worker, Cuddington (1993a) predicted that the average growth rate in Tanzania's GDP over the period 1985-2010 would be 0.7 percentage points lower compared to a "no-AIDS" scenario. Cuddington and Hancock (1994a) predicted that average growth rate in Malawi's GDP would be 0.3 percentage points lower. Average per capita growth rates over the period 1985-2010 were projected to be 0.1 percentage points lower in both countries under this scenario.

Table 3.5: Estimates of the impact of AIDS on the per capita GDP growth rates of Tanzania and Malawi with the single sector growth model* - averages over the period 1985-2010

Fraction of AIDS related costs financed from reduced savings (x)		Labour productivity lost per AIDS case (z)		
		z = 0	z = 0.5	z = 1
x = 0.0	Tanzania	0.0	-0.1	-0.1
	Malawi	0.0	-0.1	-0.1
x = 0.5	Tanzania	-0.1	-0.1	-0.2
	Malawi	-0.1	-0.1	-0.1
x = 1.0	Tanzania	-0.1	-0.2	-0.2
	Malawi	-0.1	-0.1	-0.1

Source: Cuddington 1993a: 184-185; Cuddington and Hancock 1994a: 367.
* Average differences between year on year growth rates in the AIDS and no-AIDS scenarios).

3.3.4) CUDDINGTON (1993B) AND CUDDINGTON & HANCOCK (1994B): MODELLING THE MACRO-ECONOMIC EFFECTS OF AIDS ON TANZANIA AND MALAWI - INCORPORATING UNEMPLOYMENT AND DUAL LABOUR MARKETS

In Cuddington (1993b) and Cuddington and Hancock (1994b) the analysis was extended to incorporate the presence of underemployment and dual labour markets (a formal and informal sector). These extensions were considered to be important, as single sector full employment models could overstate the impact of AIDS on economic growth in countries characterised by unemployment (i.e. sick workers can be replaced by unemployed workers), as is the case in many African countries. However, Cuddington and Hancock rightly noted that, although AIDS could create vacancies in the formal sector for workers who are employed in the informal sector, the epidemic may well reduce the total number of formal sector jobs available: "To the extent that increases in health care expenditure are funded by reducing investment, lower formal sector capital accumulation will lead to lower employment in the formal sector. Furthermore, in a sticky-wage economy, the inability of firms to distinguish HIV-infected persons or lower wages to compensate for the reduced productivity due to AIDS will cause firms to hire less labour and switch to more capital-intensive production methods." (Cuddington and Hancock 1994b: 2)

The extended Solow type model developed by Cuddington (1993b) divides the economy into a formal and an informal sector. The formal sector was assumed to be more capital-intensive than the informal sector. Formal sector wages were assumed to be "sticky" at a level above those prevailing in the informal sector, but might adjust gradually towards the market clearing level over time.

Analogous to the single sector model, output produced in the formal sector at time t was assumed to take the following Cobb-Douglas form:

$$Y_{Ft} = \alpha_F \gamma_F^t E_{Ft}^{\beta F} K_{Ft}^{1-\beta F} \quad (9)$$

where the subscript F denotes the formal sector[13]. Effective labour demand measured in efficiency units, E_F, was defined as:

$$E_{Ft} = \Sigma_i (1 - za_t) \rho_i L_{Fit} \quad (10)$$

[13] Unless stated otherwise, all the parameters have the same interpretation as in the single sector framework.

where L_F denotes the number of workers (labour units) employed in the formal sector. It was assumed that all firms in the formal sector are faced with a known sticky wage for a unit of labour and that firms choose the number of labour units that they want to employ so as to maximise profits (Cuddington and Hancock 1994b: 5-6). Employment in the formal sector was assumed to be determined by the prevailing real wage, w_t, AIDS prevalence, a_t and the existing stock of capital, K_{Ft}, as follows:

$$L_{Ft} = \phi_{Ft} K_{Ft} \tag{11}$$

$$\text{where } \phi_{Ft} = [\alpha_F \gamma_F' \beta_F (1 - za_t)^{\beta F} / w_t]^{1/(1-\beta F)} \tag{12}$$

Since formal sector wages were assumed to be higher than those prevailing in the informal sector, workers would prefer to work in the formal sector. Workers who are unable to find work in the formal sector were assumed to find employment in the informal sector. The formal sector wage, w_t, is assumed to be rigid in the short run, but could adjust gradually to the labour market clearing level w* over time according to the following partial adjustment mechanism:

$$w_t = \min [w_{t-1} + \lambda(w_t^* - w_{t-1}) , w_t^*] \tag{13}$$

The parameter λ denotes the rate of wage adjustment and can assume values ranging from 0 to 1, where $\lambda = 0$ constitutes a completely rigid real wage and $\lambda = 1$ would denote a flexible labour market in which the real wage adjusts in each period to clear the labour market. According to Cuddington (1993b: 409), the minimum restriction ensures that during the adjustment towards full employment (where dualism ultimately disappears) workers are never forced to work in the formal sector for wages lower than those available in the informal sector.[14]

The assumption that wages are sticky implies that wages do not decline as AIDS reduces productivity. As a result, the demand for labour in the formal sector may decline significantly, forcing more workers to seek lower income employment in the less productive informal sector. Economies that are faced with rigid wages may therefore suffer greater output losses due to AIDS than economies in which labour markets are flexible.

The production and effective labour demand functions for the informal sector were analogous to equations (9) and (10) (simply substitute subscript F with I, denoting the

[14] Equations 14 and 15 describe how the informal sector wage is determined.

informal sector). Since all workers who are unable to secure work in the formal sector were assumed to find employment in the informal sector, informal sector employment at time t can be defined as:

$$L_{It} = L_t^S - L_{Ft} \quad (14)$$

where L^S represents total labour supply (the labour force) (Cuddington and Hancock 1994b: 7).

Whereas it was assumed that formal sector workers receive their marginal revenue product (because firms in the formal sector maximise profits), the income of an informal sector worker was assumed to equal his or her average revenue product - i.e. total income for the informal sector was assumed to be divided equally among all informal sector workers (Cuddington 1993b: 408; Cuddington and Hancock 1994b: 7):

$$y_{It} = Y_{It} / L_{It} = \alpha_I \gamma_I^t (1 - za_t)^{\beta I} (K_{It} / L_{It})^{1-\beta I} \quad (15)$$

As was the case in the single sector framework, the impact of AIDS on investment, and hence the capital stock, was modelled through its effect on savings (all savings were assumed to be invested). Investment in the informal sector was assumed to be limited to the amount of saving that could be generated in the informal sector, $s_I Y_{It}$ (where s_I is the informal sector saving rate). Formal sector savings, $s_F Y_{Ft}$, and the total amount of foreign savings, $s^*(Y_{Ft} + Y_{It})$, were assumed to be invested in the formal sector. It was also assumed that the formal sector would provide assistance to the informal sector by financing a proportion, ω, of the total AIDS related health care costs incurred by individuals in the informal sector. Given these assumptions, the capital stock at time t in the formal and informal sectors were specified as follows:

$$K_{Ft} = s_F Y_{Ft} + s^*(Y_{Ft} + Y_{It}) - x_F(H_t + \omega H_I) + (1 - \delta_F)K_{Ft-1} \quad (16)$$

$$K_{It} = s_I Y_{It} - x_I(1 - \omega)H_I + (1 - \delta_I)K_{It-1} \quad (17)$$

where δ is the depreciation rate and H_F and H_I represents total AIDS related health care costs incurred by individuals in the formal and informal sectors respectively[15] (Cuddington 1993b: 409; Cuddington and Hancock 1994b:8-10).

[15] H was assumed to include medical expenditures on children with AIDS whose parents are in the formal and informal sectors (Cuddington and Hancock 1994b: 9).

As in their earlier works, Cuddington (1993b) and Cuddington and Hancock (1994b) measured the impact of AIDS on an economy under alternative assumptions about the share of AIDS treatment costs financed from savings and the loss of productivity per AIDS victim by comparing economic growth under an AIDS scenario with growth under the benchmark no-AIDS scenario. The dual economy simulations also considered the effects of different speeds of wage adjustment (λ). Cuddington compared economic growth projections for Tanzania under the assumption of slow wage adjustment, where λ was set equal to 0.05 for every year, with growth projections under the assumption that the rate of wage adjustment increases gradually from 0.05 in 1985 to 0.55 in 2010 (Cuddington 1993b: 412-413). In the Malawian model, λ was set equal to 0.03 in the slow wage adjustment scenario and equal to 0.06 in the more rapid wage adjustment scenario for each year (Cuddington and Hancock 1994b: 10; 22).

Dual-economy simulations for Tanzania suggested that the macro-economic consequences of the epidemic are of the same order of magnitude as those obtained using the single sector, full employment model. Furthermore, the percentage difference between the no-AIDS and AIDS scenarios was found to be more or less the same whether wages were assumed to adjust slowly or more rapidly towards their market clearing level. Simulations with slow wage adjustment indicated that AIDS would reduce the average growth rate in Tanzania's GDP over the period 1985 to 2010 by 0.7 percentage points per year (from 4.0% under the no-AIDS scenario to 3.3%) under the assumptions that 50% of treatment costs are financed from savings and that a worker with AIDS is half as productive as a healthy worker (see table 3.6) (Cuddington 1993b: 410-411). Not surprisingly, simulations with more rapid labour market adjustment produced higher GDP and per capita GDP growth rates. Simulation results under more rapid wage adjustment indicate that average GDP growth would be reduced from 4.4% under the no-AIDS scenario to 3.7% under the AIDS scenario. This lead Cuddington to conclude that policies designed to increase labour market flexibility could help to mitigate the negative economic effects of the AIDS epidemic (Cuddington 1993b: 414-415).

Simulations with the extended model for Malawi suggested that the impact on GDP growth could be slightly smaller than projected with the single sector model (0.2 percentage points lower growth instead of 0.3 percentage points lower as estimated with the single sector model). Simulation results under slow (rapid) wage adjustment indicated that average GDP growth would be reduced from 4.4% (6.0%) under the no-AIDS scenario to 3.7% (5.8%) under the AIDS scenario[16] (Cuddington and Hancock 1994b: 15-16; 23-24).

Table 3.6: Estimates of the impact of AIDS on the GDP growth rates of Tanzania and Malawi with the dual economy model* - averages over the period 1985-2010				
Fraction of AIDS related costs financed from reduced savings (x)		Labour productivity lost per AIDS case (z)		
		z = 0	z = 0.5	z = 1
x = 0.0	Tanzania	-0.5	-0.5	-0.6
	Malawi	-0.1	-0.2	-0.2
x = 0.5	Tanzania	-0.6	-0.7	-0.7
	Malawi	-0.2	-0.2	-0.2
x = 1.0	Tanzania	-0.7	-0.8	-0.9
	Malawi	-0.2	-0.2	-0.3

Source: Cuddington 1993b: 410-411; Cuddington and Hancock 1994b: 16.
* Average differences between year on year growth rates in the AIDS and no-AIDS scenarios.

Table 3.7: Estimates of the impact of AIDS on the per capita GDP growth rates of Tanzania and Malawi with the dual economy model* - averages over the period 1985-2010				
Fraction of AIDS related costs financed from reduced savings (x)		Labour productivity lost per AIDS case (z)		
		z = 0	z = 0.5	z = 1
x = 0.0	Tanzania	0.1	0.0	-0.1
	Malawi	0.1	0.0	0.0
x = 0.5	Tanzania	0.0	-0.1	-0.2
	Malawi	0.0	0.0	-0.1
x = 1.0	Tanzania	-0.2	-0.2	-0.3
	Malawi	0.0	-0.1	-0.1

Source: Cuddington 1993b: 410-411; Cuddington and Hancock 1994b: 16.
* Average differences between year on year growth rates in the AIDS and no-AIDS scenarios.

[16] Again Cuddington and Hancock simulated the impact of AIDS under extreme and medium AIDS prevalence scenarios. As with the treatment of the single sector simulation results, only the results for the medium AIDS prevalence scenario are presented here.

Simulations with both the single and dual economy models indicated that the impact of AIDS would be less severe on the Malawian economy than on that of Tanzania. Cuddington and Hancock (1994b: 19) put forward three reasons for the less pessimistic projections for Malawi. Firstly, AIDS prevalence in Malawi is significantly lower than in Tanzania, as such the demographic consequences of the epidemic are less severe. Secondly, formal sector wages are higher in Malawi and can better absorb increased medical costs. The adverse impact of these expenses on savings and investment is therefore smaller for Malawi. Finally, a higher percentage of Malawi's population works in the informal sector. Output losses could be less severe for Malawi, as a smaller share of total medical costs (for informal and formal sector workers) will be financed by reducing capital formation in the more productive formal sector in Malawi.

Cuddington, Hancock and Rogers (1994) extended the single sector Solow model developed by Cuddington (1993a) by adding simple demographic and epidemic equations so that the consequences of two kinds of health policies, a preventative and a coping policy, could be considered[17]. The preventative policy is characterised by higher medical expenses to reduce the rate of HIV transmission (e.g. policies that would encourage the use of condoms), while coping involves the spending of resources to increase the expected life span of AIDS victims (Cuddington et al. 1994: 474-475).

The authors found that preventative policies could significantly reduce AIDS prevalence and could even bring the economy to a steady state with no-AIDS. Their analysis also indicated that output losses as a result of the AIDS epidemic may well be more severe than have been indicated by previous studies that did not explicitly model the two-way interaction between demographic and economic variables (Cuddington et al. 1994: 493-495). A common assumption of earlier macro-economic analyses has been that demographic variables affect economic variables, but not vice versa. In reality, however, demographic variables can also be influenced by changes in economic circumstances. Cuddington, Hancock and Rogers allow for this two-way interaction by including the relationship between birth rates and per capita income in their epidemic model. The dependence of birth rates or fertility on per capita income has been well documented. The World Bank described it as follows: "Below some minimum income, increases in income are associated with higher fertility. In the poorest countries in Africa

[17] Since the Cuddington model has been discussed thoroughly and the Cuddington, Hancock and Rogers study did not focus on the modelling of the economic effects of the epidemic, but rather on responses to the epidemic (e.g. the coping behaviour of private and public agents), only the main findings of the study are presented here.

and South Asia, many families are below that threshold. Above that threshold, further increases in income are associated with lower fertility." (Cuddington et al. 1994: 478).

3.2.5) BOTSWANA INSTITUTE FOR DEVELOPMENT POLICY ANALYSIS (2000): MACRO-ECONOMIC IMPACTS OF THE HIV/AIDS EPIDEMIC IN BOTSWANA

Following the approach used by Cuddington (1993b) and Cuddington and Hancock (1994b), the Botswana Institute for Development Policy Analysis (BIDPA) constructed an extended Solow type growth model to simulate the macro-economic impact of AIDS on Botswana. Analogous to the dual sector model developed by Cuddington, the BIDPA model divides the economy into a formal and an informal sector. BIDPA extended their dual sector model to distinguish between skilled and unskilled labour (BIDPA 2000: 26). Three labour markets were incorporated into the model: a skilled formal sector, an unskilled formal sector and an unskilled informal sector. (It is assumed that all skilled workers find employment in the formal sector.) Although the BIDPA report also presents results from a quantitative analysis of the impacts of HIV/AIDS on household income, poverty and inequality, as well as results from an analysis of the fiscal impact on government spending, government revenues and the budget balance, the focus of this paper is on how the impact of AIDS on certain key macro-economic variables (GDP, GDP per capita, employment and wages) was modelled.

Output[18] produced in the formal sector at time t was assumed to take the following Cobb-Douglas form:

$$Y_{Ft} = \alpha_F \gamma_F^{t} E_{FS\,t}^{\beta S} E_{FU\,t}^{\beta U} K_{Ft}^{1-(\beta S+\beta U)} \qquad (18)$$

where the subscript F denotes the formal sector. E_{FS} and E_{FU} represents the supply of skilled and unskilled labour, measured in efficiency units, and K_F denotes the capital stock. β_S and β_U denote the elasticity of output with respect to skilled and unskilled labour respectively, while γ_F^t represents an exogenous time trend that captures technological progress over time. A constant scale factor, α_F, is used to calibrate the model to fit the actual data for the first year of simulation - 1995/96. A similar production function is used to model output in the informal sector, but as skilled labour is not an input in the informal

[18] Output was defined as GDP less income from mineral rents. Although mineral rents comprise a substantial proportion of Botswana's GDP, it is not directly attributable to capital or labour, but rather to the "monopoly status inherent in mineral deposits" - hence the exclusion.

sector, there are only two factor inputs - unskilled labour and capital (BIDPA 2000: 71-73).

Following Cuddington, effective labour supply is a function of the number of workers of age i at time t (L_{Fit}), the productivity of a healthy worker (ρ_{it}), the proportion of the labour force that is HIV positive (a_{tt})and the proportion of the working year lost per AIDS victim (*z*) due to his absence from work or lower productivity at work:

$$E_{Ft} = \Sigma_i \, (1 - z a_{tt}) \, \rho_{it} \, L_{Fit} \quad (19)$$

where the productivity of a worker of age i was assumed to be a quadratic function of his or her work experience, which was proxied by the age of a worker minus 15 years : $\rho_i = \rho_1 + \rho_2 \, (i - 15) - \rho_3 \, (i - 15)^2$ (20)

AIDS could therefore impact on the supply of labour by reducing the size of the labour force and the productivity of labour (by tilting its composition towards younger, less experienced workers) (BIDPA 2000: 71-72).

Regarding the allocation of skilled and unskilled labour between the formal and informal sector, it is assumed that the skilled wage adjusts so as to equate the supply and demand for skilled labour - i.e. all skilled workers find employment in the formal sector. In contrast, the market for unskilled labour in the formal sector is characterised by a minimum wage that may lie above the market-clearing level, in which case a number of unskilled workers would be unemployed. BIDPA assumed that the supply of workers in the informal sector is equal to formal sector unemployment of unskilled workers. (The supply of workers in the informal sector therefore depends on the level of the minimum wage for unskilled workers in the formal sector.) It was assumed that unskilled wages in the informal sector adjusts to clear the informal sector labour market - i.e. all unskilled workers who are unable to secure work in the formal sector are able to find employment in the informal sector, so that these workers could be considered to be underemployed, rather than unemployed (BIDPA 2000: 72-73).

The demand for skilled labour in the formal sector can be derived from the formal sector production function and is determined as follows:

$$E_{FS}^{d} = \phi_{FS} \, K_F \quad (21)$$

where $\phi_{FS} = (\alpha_F \, \gamma_F^{t})^{1/(1-\beta S-\beta U)} \, (\beta_S/w_{FS})^{1+[\beta S/(1-\beta S-\beta U)]} \, (\beta_U/w_{FU})^{[\beta U/(1-\beta S-\beta U)]}$

The demand for skilled labour in the formal sector is therefore an increasing function of the existing stock of capital and a decreasing function of the prevailing wages for both skilled and unskilled labour in the formal sector (BIDPA 2000: 74). The effective labour demand function for unskilled labour in the formal sector is analogous to equation (21).

Similarly, the demand for unskilled labour in the informal sector can be derived from the informal sector production function and is determined as follows:

$$E_{IU}{}^{d} = \phi_I K_I \qquad (22)$$

where $\phi_I = (\alpha_I \gamma_I{}^{t} \beta_I / w_I)^{1/(1-\beta I)}$

BIDPA's approach to deriving the capital stock differs from that of Cuddington. In most African countries, increasing AIDS related medical care costs would lead to a reduction in domestic savings, and hence overall investment, as access to foreign savings is often constrained. Botswana, unlike most African countries, is not characterised by a shortage of domestic savings and hence, does not have to rely on foreign capital inflows to finance investment. Since 1985, domestic savings have exceeded investment in Botswana by a significant margin (BIDPA 2000: 22). This implies that a reduction in domestic savings will not necessarily translate into a reduction in investment. BIDPA's calculations indicated that savings would likely remain high enough to finance investment, despite increasing AIDS related medical care costs. The channel through which the reduced availability of savings would impact on investment was therefore not included in the BIDPA model. Instead, the supply of capital (in both the formal and informal sectors) is simply a function of the depreciation rate and gross fixed capital formation, where capital formation is a specified percentage of GDP (i.e. the investment rate).[19] BIDPA assumed the investment rate to be lower in the informal sector than in the formal sector.

Given the capital stock, the supply of skilled labour and the level of the unskilled wage in the formal sector (all three are determined exogenously to the model), one can easily calculate the equilibrium level of the skilled formal sector wage at any point in time. This is done by setting the supply of skilled labour equal to the demand for skilled labour (equation 21) and solving for the skilled formal sector wage, w_{FS} (BIDPA 2000: 75-76).

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[19] The investment rates for the formal and informal sectors were varied in the analysis under alternative assumptions about the impact of AIDS on investment intentions.

Since a minimum wage exists in the market for unskilled labour in the formal sector, the supply of unskilled labour does not necessarily equal the formal sector demand for unskilled labour, resulting in unemployment. Given the level of the minimum wage for unskilled workers in the formal sector, the skilled formal sector wage and the formal sector capital stock, formal sector employment of unskilled workers can be calculated using equation 21. Once the level of formal sector employment of unskilled workers has been determined, unemployment of unskilled workers (i.e. the supply of labour to the informal sector) is simply calculated as the difference between the supply of unskilled workers and unskilled employment in the formal sector (BIDPA 2000: 72-73).

As is the case in the market for skilled labour, in the informal sector, the wage level adjusts to equate supply and demand. Therefore, by setting the supply of unskilled labour to the informal sector equal to the demand for labour in the informal sector (equation 22), one can calculate the equilibrium level of the informal sector wage, w_I, at any point in time (BIDPA 2000: 73).

Together with the exogenous variables (the formal and informal sector capital stock, the supply of skilled and unskilled labour and the formal sector unskilled wage), the solutions for the endogenous variables (the equilibrium level of the skilled wage, formal sector employment of unskilled workers, the supply of labour to the informal sector and the equilibrium level of the informal sector wage) provide the necessary inputs to calculate output in the formal and informal sectors. The model was solved for five-year time intervals from 1996 to 2021 under a no-AIDS and a range of AIDS scenarios.

Simulations under the no-AIDS scenario predicted that the average growth rate in GDP and per capita GDP in Botswana for the period 1996 to 2021 would be 3.9% and 1.5% respectively.[20] Under the baseline or most optimistic AIDS scenario (in which it was assumed that a worker with HIV/AIDS is 90% as productive over his 10 year infection period as a healthy worker[21]; the fixed investment rate is 25% for the formal sector and 15% for the informal sector; and the annual total factor productivity growth rate is equal to 0.5% in the formal sector and 0.0% in the informal sector), BIDPA predicted that the average growth rate in Botswana's GDP over the period 1996-2021 would be 1.1

[20] BIDPA's assumptions for the no-AIDS scenario are not very clear. However, it seems as though the no-AIDS assumptions were that the fixed investment rate would be 25% for the formal sector and 15% for the informal sector and that the annual total factor productivity growth rate is equal to 0.5% in the formal sector and 0.0% in the informal sector (BIDPA 2000: 31).

[21] This is equivalent to saying that a worker that has AIDS, which is assumed to span the last two years of the 10 year HIV/AIDS infection period, is half as productive as a healthy worker.

percentage points lower compared to a no-AIDS scenario. The average per capita growth rate over the period 1996-2021 was projected to be 0.4 percentage points higher under this scenario. This is not surprising, as Botswana's population is projected to be 29% smaller as a result of the AIDS epidemic, while GDP is only 23% smaller with AIDS (BIDPA 2000: 31-32).

As a result of the negative impact of the AIDS epidemic on the supply of labour, employment of skilled labour increases at a slower rate and skilled wages increase at a higher rate compared to the no-AIDS scenario. Given faster rising skilled wages compared to the no-AIDS scenario and unskilled wages in the formal sector that remain fixed at the minimum wage level (i.e. a greater increase in the relative price of skilled labour), there is a greater amount of substitution of unskilled for skilled workers in the formal sector as a result of AIDS. Since an increase in unskilled employment in the formal sector implies a reduction in the supply of labour to the informal sector, informal sector employment declines. The relatively lower supply of unskilled labour (compared to the no-AIDS scenario) leads to a faster increase in informal sector wages. Finally, the epidemic induces the economy to become more capital intensive - the capital-output ratio increases at a faster rate, as the supply of labour declines and the cost of labour increases at a faster rate compared to the no-AIDS scenario (BIDPA 2000: 32-33).

In order to determine the sensitivity of their results to the assumptions made about the values of the parameters in the model, BIDPA varied the parameter values through a number of AIDS scenarios. BIDPA found the results not to be very sensitive to changes in the assumptions with regard to labour productivity loss, the HIV prevalence amongst skilled workers or the rate of growth of the skilled workforce. The simulation results indicated that a combination of changes in these three assumptions - an increase in productivity loss from 10% to 20%, an increase in HIV prevalence amongst skilled workers to 150% of the general prevalence rate and a 2% decline per annum in the skilled workforce - would render the economy 28% smaller after 25 years compared to the no-AIDS scenario (the corresponding figure for the baseline AIDS scenario was 23%). However, the growth in GDP per capita remained slightly higher compared to the no-AIDS scenario (BIDPA 2000: 33-36).

BIDPA found the results to be quite sensitive to changes in the assumptions with regard to the investment rates and total factor productivity growth. Their simulation results indicated that a decline in the formal sector investment rate from 25% of GDP without

AIDS to 23% with AIDS and from 12.5% to 11.5% in the informal sector would render GDP 30% smaller after 25 years. In this scenario, the growth in GDP per capita would be lower compared to the no-AIDS scenario. A reduction in the rate of total factor productivity growth with AIDS from 0.5% to 0.25% per year had a similar impact on the economy as the reduction in the investment rate (BIDPA 2000: 33-36).

BIDPA's analysis therefore clearly indicates that Botswana's economy is likely to be smaller as a result of the AIDS epidemic. Their simulation results suggest that GDP growth could decline from a projected 3.9% per year without AIDS to between 3.1% per year (the most optimistic AIDS scenario) and 2.0% per year (the worst case scenario - a combination of the changes in the 5 assumptions mentioned above). The analysis indicated that, depending on the assumptions, per capita GDP growth could be higher or lower than it would have been without AIDS. BIDPA's most optimistic AIDS scenario suggested that the growth rate in GDP per capita could increase from a projected 1.5% in the no-AIDS scenario to 1.9% per year with AIDS. However, the worst-case scenario projected that the growth rate in GDP per capita could fall to 1.0% per year (BIDPA 2000: 35-36).

3.2.6) MACFARLAN AND SGHERRI (2001): THE MACRO-ECONOMIC IMPACT OF HIV/AIDS IN BOTSWANA

Following the approach used by BIDPA (2000), MacFarlan and Sgherri (2001) constructed a dual sector Solow growth model to simulate the macro-economic impact of AIDS on Botswana. Output in the two sectors in the model (formal and informal) is represented by Cobb-Douglas production functions. Like BIDPA's model, their model comprises of three labour markets: a skilled formal sector, an unskilled formal sector and an unskilled informal sector. Skilled wages are assumed to adjust so as to equate the supply and demand for skilled labour (i.e. all skilled workers find employment in the formal sector), while the market for unskilled labour in the formal sector is characterised by a minimum wage that lies above the market-clearing level, so that a number of unskilled workers in the formal sector are unemployed. These workers form the supply of unskilled labour to the informal sector, where it is assumed that unskilled wages adjust to clear the informal sector labour market (MacFarlan and Sgherri 2001:12).

The modelling approach used by MacFarlan and Sgherri closely resembles that used by BIDPA (2000). Since the BIDPA model has been discussed thoroughly above, the discussion below only provides an overview of important differences between the two models and presents the main findings of the study by MacFarlan and Sgherri.

The main difference in the approach used by MacFarlan and Sgherri can be found in their derivation of the capital stock. BIDPA's calculations indicated that, despite increasing AIDS related medical care costs, national savings would likely remain high enough to finance investment in Botswana. The channel through which higher health care costs (and hence a lower supply of savings) would impact on investment was therefore not included in BIDPA's model. Following Cuddington (1993b), MacFarlan and Sgherri specified the process of capital accumulation in the formal and informal sectors of the economy as functions of foreign savings, domestic savings, AIDS related health care costs and the depreciation rate (see equations 16 and 17). Their model therefore differs from BIDPA's model in the sense that AIDS induced increases in health care costs are met by reduced savings and capital formation in the economy. MacFarlan and Sgherri also claim to have used more recent demographic projections (in which HIV infection rates are higher) in their analysis.

MacFarlan and Sgherri's model was calibrated to fit the actual values of non-mining output for the first year of simulation - 1998/99. The model was solved for two- to three-year time intervals from 1999 to 2010 under a no-AIDS and a range of AIDS scenarios. Simulations under the no-AIDS scenario predicted that the average growth rate in GDP in Botswana for the period 1999 to 2010 would be 5.7%, with the formal sector growing at a faster rate than the informal sector due to a higher rate of capital accumulation in the formal sector. Under the baseline AIDS scenario, MacFarlan and Sgherri predicted that the average growth rate in Botswana's GDP would slow to only 2.3% - an average reduction in non-mining GDP growth of 3.3 percentage points per year over the 12 year projection period. The underlying assumptions for this scenario are that the yearly medical cost per AIDS case is 14 495 pula; that 80% of the AIDS costs are financed via a reduction in savings and that the productivity lost per AIDS case is 100% in the formal and informal sectors.[22] Apart from incorporating these cost and labour productivity effects of HIV/AIDS on the population and the labour force, no other parameters were changed from the no-AIDS scenario.

The projected reduction in non-mining output in Botswana can mainly be attributed to the adverse implications of AIDS related health care costs for national savings and capital accumulation and the AIDS induced slowdown in the growth of the labour

[22] MacFarlan and Sgherri's productivity shock (the assumption with regard to the productivity lost per AIDS case) is double the size of BIDPA's productivity shock. Whereas MacFarlan and Sgherri assumed 100% productivity losses for AIDS victims, BIDPA assumed that AIDS victims are half as productive as healthy workers.

force and labour productivity. Given that MacFarlan and Sgherri incorporated the negative effects of extra health care costs on savings and investment and used more pessimistic demographic projections (higher HIV infection rates) than BIDPA, it is not surprising that MacFarlan and Sgherri's projections are more alarming than BIDPA's estimates.

Table 3.8: A comparison between no-AIDS and AIDS inclusive GDP growth rates for the non-mining sector in Botswana (year on year % change)

Scenario	2001	2005	2010	Average: 1999 - 2010
No-AIDS				
Overall GDP growth	6.0	5.7	5.2	5.7
Formal sector	6.1	5.8	5.3	5.8
Informal sector	4.0	3.5	3.0	3.6
Baseline AIDS				
Overall GDP growth	3.2	1.9	1.4	2.4
Formal sector	3.4	2.1	1.5	2.6
Informal sector	0.6	-1.0	-1.1	-0.3
Alternative AIDS scenarios				
Lower rate of capital inflows	2.6	1.7	1.3	2.0
Lower rate of capital accumulation	2.3	1.3	1.0	1.6
Lower total factor productivity	2.3	0.9	0.4	1.4
Higher work loss due to AIDS	2.9	1.5	1.2	2.1
Multiple Shocks	1.9	0.9	0.6	1.3

Source: MacFarlan and Sgherri 2001: 17 – 26.

The way in which the epidemic affects the two sectors of the economy differs somewhat. Due to the high capital intensity of the formal sector, the impact via the capital accumulation channel outweighs the effects of a smaller formal sector labour force. The formal sector labour force shrinks as a result of the AIDS epidemic, but since capital accumulation remains positive (despite the adverse implications of extra health care costs), growth in the formal sector continues to expand. In contrast, growth in the informal sector falls into negative territory, as the drop in the supply of workers has a more dramatic impact on the labour intensive informal sector.

In order to determine the sensitivity of their results to the assumptions made about the values of the parameters in the model, MacFarlan and Sgherri conducted a sensitivity analysis. They found their results quite sensitive to changes in the assumptions with regard to the rate of total factor productivity (TFP) growth and the rate of capital accumulation in the formal sector. Their simulation results indicated that a 50% reduction in the rate of TFP growth in both sectors would reduce non-mining GDP growth by another 1.0 percentage point per year on average between 1999 and 2010. Similarly, a 2.0 percentage point reduction in the rate of capital accumulation in the formal sector (implemented via an increase in the depreciation rate of capital stock) led to a 0.8 percentage point drop in GDP growth over the projection period. According to MacFarlan and Sgherri (2001: 20), "this shock is comparable to a permanent drop in investor confidence in the formal sector."

MacFarlan and Sgherri tested their model's sensitivity to changes in two more assumptions: they reduced the rate of capital inflows to the formal sector from 40% of non-mining GDP to 20% and they increased the productivity lost per AIDS case from 100% to 200% (i.e. the assumption is that for each AIDS victim a family member also takes time off from work to care for the sick). Their simulation results indicated that each of these shocks would lead to a 0.3 to 0.4 percentage point reduction in GDP growth compared to the no-AIDS scenario (MacFarlan and Sgherri 2001: 20-21).

In a final "multiple shock" scenario, MacFarlan and Sgherri simulated the impact of a combination of the above-mentioned shocks, but the sizes of some of the shocks were reduced somewhat compared to those implemented in the sensitivity analysis. In the multiple shock scenario it was assumed that the rate of capital inflows would drop to 30% of non-mining GDP; the rate of capital accumulation in the formal sector would be 1.0 percentage point lower compared to the no-AIDS scenario; and TFP growth would be 25% lower in both sectors compared to a no-AIDS scenario. The assumption about productivity lost per AIDS case was kept at 200%. Their simulation results indicated that the combination of these factors would render the non-mining economy close to 40% smaller by the year 2010 compared to a no-AIDS scenario (the corresponding figure for the baseline AIDS scenario was 33%). Non-mining sector GDP growth is projected to drop from 5.7% on average between 1999 and 2010 in a no-AIDS scenario to only 1.3% due to HIV/AIDS (MacFarlan and Sgherri 2001: 31). Although MacFarlan and Sgherri refrain from any statements on the impact of the epidemic on per capita GDP, a comparison of their projections for the decline in the level of GDP and the decline in the population suggests that per capita GDP will be significantly lower in the AIDS scenario (the decline in the real GDP is substantially more than the decline in the population due to AIDS). MacFarlan and Sgherri found the biggest contributor to the drop in GDP growth to be the reduction in TFP growth, followed by a slowdown in the rate of capital inflows and capital accumulation in the formal sector.

Although the model that MacFarlan and Sgherri used to model the impact of HIV/AIDS on Botswana's economy is similar to that which was employed by BIDPA, their assumptions with regard to the impact of the epidemic are more pessimistic compared to that of BIDPA. MacFarlan and Sgherri used demographic projections that suggest a more severe epidemic in Botswana and they also incorporated larger productivity and investment shocks than BIDPA. Consequently, MacFarlan and Sgherri's projections of the impact of HIV/AIDS on GDP growth are a lot more dramatic than those by BIDPA – whereas BIDPA's worst case (multiple shock) projection suggests a 1.9 percentage points reduction in GDP growth (on average per year) between 1996-2021, MacFarlan and Sgherri's least pessimistic (baseline AIDS) projection suggests a 3.3 percentage points drop in GDP growth over the next decade.

3.2.7) Bloom and Mahal (1995): Estimating the impact of AIDS on per capita GDP across 51 countries

In another attempt to quantify the economic impact of AIDS, Bloom and Mahal (1995) examined the association between changes in the prevalence of AIDS and the growth rate of per capita GDP across 51 countries (including developing as well as industrial countries) over the period 1980 to 1992. This was done by specifying a function for the growth rate of real per capita GDP that relates per capita GDP growth to a number of variables whose relationship to this growth rate is well established in empirical literature, as well as to the annual increase in the cumulative prevalence of AIDS cases:

$$GDP_i = \beta_0 + \beta_1 AIDS_i + \lambda X_i \quad (18)$$

Bloom and Mahal attempted to obtain a consistent estimate of β_1, where GDP_i is the rate of growth of real per capita GDP for country i; AIDS represents the annual average increase in the cumulative prevalence of AIDS and X is vector of variables that influence economic growth. Bloom and Mahal experimented with variables such as the initial level of per capita GDP; the lagged growth rate in real per capita GDP; the ratio of exports plus imports to GDP (a measure of the degree of openness of economy); the proportion of GDP spent on defence and education; average years of schooling; the population growth rate and birth and death rates. The AIDS variable was expected to capture the effect on economic growth of a smaller, less productive labour force and the diversion of resources to medical care (Bloom and Mahal 1995: 10-11).

Bloom and Mahal used Epimodel, an econometric package developed by Chin and Lwanga, to estimate the AIDS parameter (Bloom and Mahal 1995: 8-9). In order to calculate cumulative AIDS cases from HIV cases, Epimodel requires data on the year in which the HIV epidemic began, the number of HIV cases at some later point in time and the year in which the number of new cases of HIV infection is expected to peak. Epimodel then models the number of new HIV cases according to a gamma function: $t^{(\alpha - 1)}e^{-t} / (\alpha - 1)!$, where t refers to time and α is the gamma function parameter that needs to be estimated. Higher values of α correspond to more rapid increases in HIV incidence in the early stages of the epidemic (Bloom and Mahal 1995: 9). The AIDS variable in (18) was expressed as:

$$AIDS_i = E\ (\alpha, HIV_i, FHIV_i, PHIV_i) \qquad (19)$$

where HIV denotes the number of HIV cases at some point in time, FHIV measures number of years between when HIV epidemic first established itself and when HIV prevalence is measured and PHIV denotes the number of years between when the HIV epidemic began and when number of HIV cases is projected to peak. E represents the Epimodel function that is used to produce projections of AIDS from HIV, FHIV and PHIV (Bloom and Mahal 1995: 10-11). By specifying HIV as:

$$HIV_i = \delta_0 + \delta_1 GDP_i + \delta_2 Z_i\ (GDP_i) + \delta_3 R_i \qquad (20)$$

Bloom and Mahal allowed for the possibility that the growth rate in per capita GDP and other variables, some of which may depend on per capita GDP ($Z_i\ (GDP_i)$), could influence the transmission of HIV. Z and R are vectors of variables that may influence HIV transmission. For example, income growth may increase the spread of HIV to the extent that it stimulates urbanisation and improves the mobility of people or the demand for commercial sex. On the other hand, income growth could depress the spread of HIV by improving health and reducing the number of untreated sexually transmitted diseases (Bloom and Mahal 1995: 12).

Bloom and Mahal used the Non-linear Least Squares and Non-linear Two Stage Least Squares methods to estimate the parameters of equation 18 and α (the non-linear relationship between HIV and GDP is evident when equation 20 is substituted into equation 19 and equation 19 into 18). When only the constant and the AIDS variable were included in the regression, the estimated coefficient for the AIDS variable, β_1, turned out to be significant and sizeable, indicating that the growth in per capita GDP was lower in countries with larger increases in the cumulative prevalence of AIDS. However, the inclusion of other variables that could influence per capita GDP growth rendered β_1 insignificantly different from zero. This led Bloom and Mahal to conclude that "the raw negative association between economic growth and the change in AIDS prevalence is due to the fact that AIDS prevalence increased more in those countries that are associated with slower growth, not apparently to AIDS itself having an independent negative influence on economic growth" (Bloom and Mahal 1995: 15). The results from their study therefore indicate that the AIDS epidemic has had an insignificant effect on the growth rate of per capita income up and until 1995. Bloom and Mahal warned that predictions that the HIV epidemic will have a substantially negative impact on economic growth could overstate the seriousness of the threat that the epidemic poses to economic growth (Bloom and Mahal 1995: 4). However, it should be noted that the majority of the countries that were included in their sample have fairly low AIDS prevalence rates. Should HIV/AIDS impact in a non-linear fashion on economic growth, countries with high levels of infection may well suffer significant output losses.

3.2.8) HAACKER (2001): THE ECONOMIC CONSEQUENCES OF HIV/AIDS IN SOUTHERN AFRICA

Haacker (2001) used a fairly simple neo-classical growth model to simulate the impact of HIV/AIDS on economic growth and per capita incomes in a number of Southern African countries. Aggregate output was modelled as a Cobb-Douglas production function of total factor productivity, physical capital and effective labour supply (measured in efficiency units). Since the model that was used by Haacker is similar to that employed by Cuddington, this paper only summarises the simulation results from his study.[23]

[23] Haacker's paper also provides a qualitative analysis of the impacts of HIV/AIDS on the public sector - the focus being on the health and education sectors, as well as employee benefits - and the impact of the epidemic on households and the private sector (direct and indirect costs to companies). Some of his qualitative research results are summarised in the next chapter.

Haacker's simulation results indicated that HIV/AIDS would have a positive impact on the steady state per capita income levels of all the Southern African countries considered in his study. His estimates ranged from an increase of 5.7% in the level of per capita GDP for Mozambique to an increase of 12.9% for Botswana (Haacker 2001: 18). Haacker attempted to "decompose" the overall impact on per capita income into the contributions of impact channels such as lower total factor productivity, physical capital and human capital. (Human capital was assumed to take the form of experience, which depended on the average number of years workers remain in the labour force.) Table 3.9 shows that higher levels of per capita GDP can primarily be ascribed to an increase in the capital-labour ratio, which can be attributed to slower growth in the population due to HIV/AIDS. The upward pressure on per capita GDP levels is reduced by the negative effects of lower levels of total factor productivity (mainly due to increased absenteeism) and lower levels of experience in the labour force (due to higher mortality rates).

Table 3.9: Estimates of the impact of HIV/AIDS on the level of per capita GDP in a steady state - results for 9 Southern African countries
(% difference in levels, not % difference between year on year growth rates)

	% Change in GDP per capita	Due to change in:		
		Total Factor Productivity	Capital/labour ratio	Experience
Botswana	12.9	-1.8	16.2	-1.5
Zimbabwe	11.1	-1.3	13.4	-1.1
Lesotho	10.5	-1.2	12.7	-1.0
South Africa	10.3	-1.0	12.3	-1.0
Swaziland	9.8	-1.3	12.1	-1.0
Zambia	7.8	-1.0	9.6	-0.8
Namibia	7.7	-1.0	9.5	-0.8
Malawi	6.7	-0.8	8.2	-0.7
Mozambique	5.7	-0.7	7.0	-0.6

Source: Haacker 2001: 18.

In Haacker's model, the growth rate of new entrants to the labour force is negatively related to experience, as the higher the rate of growth in the number of new entrants, the smaller the share of older and more experienced workers in the labour market. A reduction in the rate of growth of new entrants to the labour force due to HIV/AIDS therefore has a positive impact on experience. Since the negative impact of higher mortality rates outweighed this positive effect in his analysis, the overall effect on experience was still negative. Haacker found that, if the positive effect of the reduction in the growth of the number of new entrants to the labour force was excluded, per capita GDP would be between 2.9 percentage points (Mozambique) and 4.9 percentage points (Botswana) lower. In this so-called "medium run" (15 to 20 years) scenario, the steady state level of per capita GDP in South Africa was found to be 3.1 percentage points lower (Haacker 2001: 19).

3.3) Previous Estimates of the Impact of AIDS on the South African Economy

Despite growing concern about the scope of the epidemic in South Africa, the 1990s saw little quantitative research on the impact of the epidemic on the South African economy. However, qualitative analyses often argued that the *economic impact* of HIV/AIDS could be less severe in South Africa compared to estimates for other African countries in the studies mentioned above. Reasons put forward for this argument included the following: whereas Cuddington and Hancock (1994a) assumed that HIV/AIDS is evenly spread across skill/income groups, in South Africa the epidemic is more concentrated among the semi- and unskilled sections of the labour force. Given South Africa's high rate of unemployment, unskilled workers can be replaced comparatively easily (i.e. productivity losses could be lower in South Africa). Furthermore, the analyses by Over and Cuddington assumed that a substantial proportion of the spending on health care is financed from savings, rather than by substituting from other consumption expenditure. Since the South African epidemic is concentrated mainly in the lower income groups, while income and savings capacity is concentrated among the higher income groups, the impact of HIV/AIDS on health expenditure, savings and investment is likely to be less severe (Abt Associates February 2000: 26 –27).

Over the past few years there has been renewed interest in the modelling of the economic impact of the AIDS epidemic in South Africa. Recent studies by ING Barings (Quattek 2000) and Arndt and Lewis (2000) attempted to simulate the impact of HIV/AIDS on the South African economy using somewhat more complex macro-economic models.

Although their assumptions with regard to (or projections of) the demographic impact of the epidemic are essentially the same, their assumptions with regard to *how* the epidemic will impact on the economy differ. Furthermore, the models that were employed in these two studies differ substantially from each other, the ING Barings model being estimated econometrically and the Arndt and Lewis model being a CGE model. Understandably, these two studies produced divergent projections on the impact of the epidemic. However, the deviations were substantial, leaving South Africans with no clear understanding of the extent to which HIV/AIDS will impact on the South African economy.

In what follows, the macro-economic model employed by ING Barings is described and the assumptions underlying the AIDS and no-AIDS scenarios, as well as the simulation results from the study, are presented and discussed. Subsequently, the model used by Arndt and Lewis, their assumptions and simulation results are described and discussed in similar fashion.

3.3.1) QUATTEK (2000): MODELLING THE IMPACT OF AIDS ON THE SOUTH AFRICAN ECONOMY

ING Barings (Quattek 2000) attempted to model the macro-economic impact of AIDS on the South African economy using a full supply-demand macro-econometric model, consisting of 90 equations. (23 of the equations are behavioural equations and the remaining 67 are identities and technical relationships.) The demand side of the model encompasses private consumption expenditure, fixed and inventory investment, imports, exports, the balance of payments and a government sector. The supply side of the model consists of a measure of potential output, which, in conjunction with expenditure-determined total output, provides a measure of economy-wide capacity utilisation. This capacity utilisation serves as a supply constraint in the determination of imports, investment, prices and wages. A monetary sector is also included in the model (Quattek 2000: 19).

The behavioural equations in the model are estimated with the Ordinary Least Squares method, using annual data for the period 1960 to 1998. The model was used to generate a trend forecast of different variables over the period 1999 to 2015 under an AIDS and a no-AIDS scenario. A trend forecast can be said to represent "the average growth of the economy over the business cycle" (Quattek 2000: 19). Trend forecasts therefore do not attempt to predict business cycle turning points.

According to ING Barings (2000: 19), forecasting results for the short term (the period up to 2002) are driven by projections about changes in the level of aggregate demand, as resources and technologies that can be employed are fairly constant over the short term. However, supply factors such as the growth in the population, the labour force and productivity determine the results for the second part of the long term forecast - the period 2002 to 2015.

ING Barings employed the Actuarial Society of South Africa's (ASSA) demographic model to generate forecasts of the population, the economically active population (i.e. the labour force), HIV infection rates and the number of AIDS deaths in each year of the forecasting period. Population and labour force projections for the no-AIDS scenario were obtained by adding the projected AIDS deaths to the ASSA model projections of the AIDS inclusive population and labour force and adjusting for their fertility and mortality (Quattek 2000: 5-6).

The ASSA model estimates used by ING Barings indicate that the number of AIDS deaths would exceed the number of normal deaths by 2002. The number of AIDS deaths per year are projected to peak at 879 074 in 2010, compared to the projected 343 993 normal deaths. South Africa's annual population growth rate could decline from 2.06% in 1999 to 0.73% in 2005 and become static or slightly negative from around 2011 as a result of the AIDS epidemic. In the absence of AIDS, it is projected that the growth rate in the population would not fall below 1.5% before the year 2015. ING Barings calculated that South Africa's population would have been 23.4% larger by the year 2015 in the absence of AIDS (Quattek 2000: 6).

Whereas the HIV prevalence rate among South Africa's total population is forecasted to peak at 16.67% in 2006, infection rates in the labour force are forecasted to reach 25.5% in 2006. In order to generate projection of HIV infection rates per skill category, the ASSA forecasts were combined with provincial information and overlaid with information on employment by skill categories and economic activity. Projections indicated that semi- and unskilled labour would be worst affected, with infection rates forecasted to reach 32.8% in 2008/2009. Infection rates for the skilled and highly-skilled parts of the workforce were forecasted to peak at 22.8% (in 2006) and 13.1% (in 2004) respectively (Quattek 2000: 7).

ING Barings assumed that AIDS would affect the macro-economy through channels such as a lower population and labour force, lower labour productivity, increased remuneration costs for companies, lower wage income for workers and increased private sector and government expenditure on health services. In what follows, the assumptions that were used to generate the AIDS scenario are discussed.

The first assumption pertained to the negative impact of the epidemic on the size and the productivity of the labour force. In order to ensure that the AIDS sickness or death of a highly skilled worker would have a more negative impact on potential output, ING Barings adjusted the total number of labour units available in the economy (the labour force) so as to account for the importance of skills. The average wage of a skill category was used as a proxy for that category's skills level. A skill weighted aggregate labour force was obtained by multiplying the units of labour in each skill category with the ratio of the average wage rate of the skill category to the economy-wide average wage rate and adding the three totals together. Given these adjustments, it was calculated that the weighted labour supply would be 18.1% lower by 2015 due to AIDS deaths (Quattek 2000: 9-10).

Rather than modelling productivity separately, ING Barings subtracted any AIDS induced productivity losses, also weighted by skill, from the skills weighted units of labour to generate forecasts of efficiency units of labour. It was assumed that 0.33 units of labour (or 4 months of person-year-equivalent labour supply) would be lost for every person suffering from full-blown AIDS.[24] Full-blown AIDS was assumed to span the last two years of the HIV+ term. It was estimated that skill weighted productivity losses due to AIDS would lead to a 0.8% reduction in efficiency units of labour in each year between 2005 and 2012 compared to the no-AIDS scenario (Quattek 2000: 10-11).

With regard to AIDS induced changes in company costs, ING Barings utilises Metropolitan's estimates of the direct costs (e.g. the cost of pension, life and medical benefits) and indirect costs (e.g. cost of recruitment, training, compassionate leave etc.) to employers that arise as a result of the epidemic. Metropolitan projected that the cost of an average set of employee benefits may double within the next five years and triple by 2010. This could lead to an increase of 15% in remuneration costs for companies that carry the full responsibility for the provision of benefits by 2005 and a 30% increase by 2010. It was estimated that increased indirect costs could add another 10% to wage costs by 2005 and 15% by 2010 (Quattek 2000: 11-12).

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[24] Recall from Cuddington, the proportion of a working year lost due to AIDS can range between 0 and 2 years.

Since the indirect costs such as the recruitment and training of unskilled workers are likely to be fairly limited and unskilled workers are less likely to be covered by medical and other benefits, it was assumed that AIDS would have an insignificant impact on the remuneration costs of unskilled workers. In the case of skilled and highly skilled employees, ING Barings assumed that companies would carry two-thirds of the remuneration cost increases, while the remaining one third would be absorbed by employees. It was assumed that companies would only be able to pass 50% of the proportion of the wage cost increase that they have to carry on to customers in the form of higher prices. The remaining half of the wage cost increase would have to be absorbed internally in the form of lower operating surpluses. ING Barings projected that higher wage costs could lead to an increase of 4.5 percentage points in the producer price index and reduce the overall gross operating surplus by 9.7% in each year from 2010 onwards (Quattek 2000: 12-13).

ING Barings identified and modelled three different channels through which AIDS could affect consumption expenditure: Firstly, by reducing wage income of workers who have to absorb some of the increased health care and other employee benefit costs (mainly skilled and highly skilled workers), the AIDS epidemic may effect aggregate demand and consumer spending patterns. Given ING Barings's assumption about the proportion of the higher benefit costs that have to be borne by employees, it was calculated that wage income for highly skilled and skilled workers could decrease by 15% by 2010, while economy-wide wage income could be reduced by as much as 9.2% by 2010. ING Barings projected that, although the fall in wage income would impact adversely on all consumption expenditure categories, savings and spending on durables and services would suffer the largest decline (Quattek 2000: 13-14).

Secondly, AIDS could impact on the distribution of household income and consumer spending by reducing the size of the population and hence the number of individuals per household. Given South Africa's high unemployment rate, one can assume that one income earner (the AIDS victim) could be replaced by another fairly easily, so that the total economy-wide income earned remains the same and the income per household actually increases (as the number of individuals per household decreases). ING Barings projected that the AIDS induced reduction in the population growth rate and the resulting increase in income per household would lead to a shift in consumer spending from non-durables and semi-durables to spending on durables and services and reduce the demand for residential buildings (Quattek 2000: 14-15).

Finally, the AIDS epidemic will impact on consumer spending patterns by increasing the demand for health care. It was assumed that 25% of the higher costs to companies and their employees would be spent on health care. This lead to the projection that the AIDS epidemic would increase the demand for health services by 11.4% by 2010. ING Barings calculated the net effect of all three the demand-assumptions and showed that the AIDS epidemic would lead to a reduction in aggregate consumption expenditure. Although the epidemic should stimulate the demand for services, it was projected that it would reduce the demand for savings and residential buildings and spending on durables, semi-durables and non-durables by at least 7% by the year 2010 (Quattek 2000: 15-16).

The final impact channel of the epidemic identified by ING Barings was higher government spending on health services. It was assumed that the public sector would carry the medical costs of all AIDS patients who are not part of the skilled or highly skilled sections of the labour force. According to ING Barings, official estimates indicate that the public sector already spends between R3 000 and R4 500 per AIDS victim per year. ING Barings made the assumption that the government would spend R3 750 per AIDS patient per year and calculated that by 2008, this would increase government spending on health services by some 4 billion Rand per year. It was assumed that increased government health expenditure would be financed by increasing the budget deficit, leading to a contraction in savings and the crowding out of investment and other expenditures (Quattek 2000: 16).

ING Barings employed WEFA's annual macro-econometric model to forecast the impact of AIDS (as outlined by the above mentioned assumptions) on the South African economy over the period 2000 and 2015. Their simulation results indicated that GDP growth could be on average about 0.3 percentage points lower per year between 2001 and 2015 than it would have been in the absence of the AIDS epidemic. ING Barings's projection of slower economic growth under the AIDS scenario can mainly be ascribed to their assumption that increased benefit payments would reduce the wage income of skilled and highly-skilled workers. Lower wage income translates into lower household disposable income, which leads to lower overall consumption expenditure. Although spending on health services increases as a result of the epidemic, it is insufficient to counterbalance the reduction in consumer spending on the other expenditure categories (Quattek 2000: 21).

ING Barings predicted that the AIDS epidemic would not lead to a severe reduction in real gross domestic fixed investment. Lower labour productivity may encourage some companies to switch to more capital intensive production techniques and may well counterbalance the lower investment in residential buildings due to lower wage income and slower population growth (Quattek 2000: 21-22).

Simulation results indicated that government revenue would decline more or less in line with economic activity under the AIDS scenario. However, as a result of the increased health care expenditure by the government, consumption expenditure by the government should decline less than government revenue, resulting in a higher budget deficit and lower public sector savings under the AIDS scenario. Similarly, it was projected that consumption expenditure by households would not decline in line with disposable income, so that household savings would decline in the AIDS scenario. Corporate savings should be adversely affected by increased remuneration costs that have to be financed out of the company's operating surplus. ING Barings predicted that gross domestic savings as a percentage of GDP could be on average 2.0 percentage points lower than in the absence of AIDS (Quattek 2000: 22-23).

Table 3.10: Estimates of the impact of AIDS on GDP, income, consumption expenditure and investment in South Africa* - averages over specified years

	Real GDP	Real disposable income	Real consumption expenditure	Real fixed investment: residential	GDFI	GDFI/ GDP	Capacity Utilisation
2001-05	-0.2	-0.4	-0.4	-0.6	0.1	0.0	-0.1
2006-10	-0.4	-0.6	-0.8	-0.9	-0.1	0.3	0.0
2011-15	-0.3	-0.2	-0.8	-0.2	0.0	0.7	0.0

Source: Quattek 2000:21-22.

Table 3.11: Estimates of the impact of AIDS on government finances, savings and trade in South Africa* - averages over specified years

	Government consumption expenditure	Government revenue	Public sector deficit /GDP	GDS /GDP	Exports	Imports	Current account/ GDP
2001-05	0.1	-0.2	-0.4	-1.4	0.1	0.1	-1.4
2006-10	-0.1	-0.4	-0.8	-2.1	0.1	-0.3	-2.4
2011-15	-0.2	-0.2	-0.9	-2.2	0.0	-0.5	-2.4

Source: Quattek 2000: 22-24.

* Average differences between year on year growth rates in the AIDS and no-AIDS scenarios.

The decline in domestic savings should outweigh the drop in investment demand, as some companies may switch to more capital-intensive production methods. This means that South Africa will need to attract foreign savings to satisfy the demand for investment. Due to the high country risk associated with the AIDS epidemic, these foreign savings are more likely to be in the form of foreign loans than in the form of capital investment and the resultant higher net factor payments will lead to a widening of the current account deficit. Should South Africa be unable to attract foreign savings, the higher investment demand will put upward pressure on the interest rate (Quattek 2000: 23).

ING Barings projected that the contraction in domestic demand and economic activity will translate into lower imports, while exports should increase, as domestic producers look towards more lucrative international markets. Although higher exports and lower imports will improve South Africa's trade balance, it will not be enough to counterbalance the adverse impact of the higher net factor payments on the current account deficit. The current account deficit as a percentage of GDP was projected to be 2.4 percentage points higher on average per year between 2006 and 2015 than it would have been in the absence of AIDS (Quattek 2000: 23-24).

Table 3.12: Estimates of the impact of AIDS on the inflation, interest and exchange rates and unemployment in South Africa - averages over specified years

	Inflation rate*	Prime interest rate*	Trade weighted nominal exchange rate*	Employment**	Unemploy-ment rate*
2001-05	0.4	0.1	-1.5	-3.0	0.4
2006-10	0.4	0.3	-3.0	-8.3	-0.9
2011-15	-0.1	0.6	-3.9	-14.1	-1.2

Source: Quattek 2000: 22-24.

* Average differences between year on year growth rates in the AIDS and no-AIDS scenarios.

** Real percentage difference between AIDS and no-AIDS scenarios.

Despite the contraction in domestic demand due to the epidemic, ING Barings predicted that the CPI inflation rate would be on average 0.4 percentage points higher over the next decade as a result of the epidemic. This can be ascribed to upward pressures on the PPI as companies pass some of the higher wage costs on to customers in the form of higher prices. Higher inflation will lead to a depreciation of the trade-weighted exchange rate of the rand and will put pressure on the SARB to increase interest rates in order to insure that they reach their inflation target (Quattek 2000: 24).

ING Barings predicted that both the supply of labour and the demand for labour will be lower in the AIDS scenario. Since the drop in employment should be outweighed by the decline in the supply of labour, the unemployment rate was projected to be lower under the AIDS scenario (Quattek 2000: 24).

3.3.2) ARNDT AND LEWIS (2000): SIMULATING THE IMPACT OF AIDS ON ECONOMIC GROWTH IN SOUTH AFRICA WITH A COMPUTABLE GENERAL EQUILIBRIUM MODEL

Arndt and Lewis (2000) simulated the impact of AIDS on the growth prospects of the South African economy using a 14-sector computable general equilibrium (CGE) model. Since the model that was developed for South Africa by Arndt and Lewis is similar to the CGE model that was employed by Kambou, Devarajan, and Over, the treatment of the Arndt and Lewis model in this paper is brief.

The model that was developed for South Africa has fourteen productive sectors, three of which are service sectors - medical and health services, social services and government services. A translog production function determines how the five primary factors of production (capital and four categories of labour - informal, unskilled, skilled and professional labour) are combined to produce value added or net output in each sector. In common with the Cameroonian model, net output is combined with intermediate inputs to produce gross output according to a fixed-coefficient technology.

According to Arndt and Lewis, AIDS can impact adversely on the productivity with which the production factors are combined to produce output in each sector by reducing the productivity of labour inputs, as well as overall productivity levels. Through its impact on morbidity and experience levels of the workforce, the incidence of AIDS among workers will reduce the productivity of labour inputs, so that, for example, the effective input (or productivity) of 100 workers, of which some have AIDS, will only be equivalent to that of 95 healthy workers. The prevalence of AIDS will also reduce overall productivity or total factor productivity (i.e. less output will be produced with the same combination of factor inputs), as the epidemic tends to increase worker absenteeism and labour turnover rates and firms are required to spend resources on the recruitment and training of new workers (Arndt and Lewis 2000: 5).

The treatment of exports and imports in the South African model are analogous to the Cameroonian model.

The South African model distinguishes between corporate accounts, five household categories, each representing an income distribution quintile, seven different government spending categories and three government investment categories. It is assumed that firms use their revenue, which is given by returns to their invested capital and transfers from government and the rest of the world, to pay corporate taxes and dividends to households. The remaining fraction of their income is assumed to go towards corporate savings (Arndt and Lewis 2000: 6).

Households in the five different income distribution quintiles receive remuneration for their inputs in production in the form of wages and corporate dividends and may also receive transfers from the government. With its total income, households pay income taxes at a fixed rate, save a fixed fraction of their disposable income and spend the remaining income on goods and services according to fixed expenditure shares. As in the Cameroonian model, private consumption expenditure by households is determined by a Cobb-Douglas utility function under the assumption that households seek to maximise utility subject to a budget constraint (Arndt and Lewis 2000: 6).

The main sources of government revenue are import tariffs, export taxes, value-added tax, indirect (excise) and income taxes and the proceeds from net foreign borrowing. The government uses its revenues to purchase seven categories of government goods and services and to finance three types of government investment, as well as transfers to firms and households. Government expenditure as a share of total absorption (the sum of aggregate consumption, investment and government expenditure) is determined exogenously. Government savings are obtained by subtracting government expenditures from government revenues (Arndt and Lewis 2000: 6).

Government, household and corporate savings add to net foreign savings, which are fixed exogenously, to determine the level of total savings. In common with the Cameroonian model, total saving is set equal to total investment. Arndt and Lewis chose the aggregate producer price index as their *numeraire* price level against which the relative prices in the model are measured (Arndt and Lewis 2000: 6-7).

As with the Cameroonian model, a set of dynamic equations or cumulation rules were used to update the exogenous variables that entered the static model. The capital stock available to each sector was specified to be a function of the existing capital stock, adjusted by the depreciation rate, and new investment in the sector. Investment was assumed to be allocated to sectors according to sectoral profit rate differentials so as to preserve the rental rate differentials that prevailed during the base year. Other variables that were specified exogenously were total factor productivity growth for each sector, the growth in the supplies of the different skill categories of labour and the growth trajectories of real wages for the informal, unskilled and skilled labour groups (the skill categories for which rigid wages lead to unemployment) (Arndt and Lewis 2000: 8).

Arndt and Lewis calibrated the model to fit actual data for the period 1997 to 2000 and used the dynamic CGE model to project GDP growth in South Africa over the period 2001-2010 under a benchmark no-AIDS scenario and a more likely AIDS scenario. Whereas the no-AIDS and AIDS scenarios in the Cameroonian study only differed with respect to their labour force growth rate assumptions, the South African model also incorporates the effects of AIDS through other impact channels by varying assumptions about future trends in labour productivity, total factor productivity and household and government expenditure (Arndt and Lewis 2000: 8-9).

Arndt and Lewis used ING Barings's projections of the growth rates in the population and labour force by skill categories under the no-AIDS and AIDS scenarios. According to ING Barings's projections, population growth rates are forecasted to come down from 2.28% in 2000 to 1.71% in 2010 in the no-AIDS scenario. In the AIDS scenario, population growth rates are forecasted to drop below 1% by 2004 and reach 0.02% in 2010. The growth rate of unskilled labour is projected to decline from 2.58% per year in 2000 to -0.18% in 2010 under the AIDS scenario. The growth rate of skilled labour is projected to fall to a low of 0.84% during 2007 and 2008 under the AIDS scenario. With growth rates never falling below 2.5%, professional labour will be the least affected by the AIDS epidemic (Arndt and Lewis 2000: 9, 19-20).

Arndt and Lewis assumed that AIDS prevalence would reduce both labour productivity and total factor productivity. It was assumed that workers who suffer from AIDS stay on the job for two years, but are only half as productive as healthy workers. The authors used ING Barings's projections of AIDS death rates per labour skill category to calculate the fraction of each skill category that has full-blown AIDS. The impact of AIDS on the productivity of a certain skill category in period t was assumed to be proportional to the AIDS death rate for that skill category in period t+1 (Arndt and Lewis 2000: 9-10).

The authors used the AIDS death rate for unskilled labour in their calculations of the impact of AIDS on total factor productivity growth. The fraction of total factor productivity lost in a certain year due to AIDS ($TFP_{lost,t}$) depended on the ratio of that year's AIDS death rate for unskilled workers (DR_t) to the maximum AIDS death rate of unskilled workers (DR_{max} = 3.4 deaths per hundred workers in 2010), so that $TFP_{lost,\ t} = 1 - 1/(1 + DR_t / DR_{max})$. Using this formula, total factor productivity growth rates in all sectors of the economy should be 50% lower in 2010 than it would have been in the absence of AIDS (Arndt and Lewis 2000: 10).

Arndt and Lewis also incorporated the effect of AIDS on consumer and government spending patterns. It was assumed that AIDS affected households would save nothing and increase the fraction of their total spending that goes towards health services to 10-15%, depending on the income distribution quintile they fall in (i.e. consumer spending on health services is assumed to increase at the expense of spending on other non-food items) (Arndt and Lewis 2000: 9). Whereas government expenditure on health care increased by an average of 5.7% annually in real terms over the period 1992 to 1997, it was assumed that real government spending on health care would increase by 6.9% annually from 1997 to 2010 (Arndt and Lewis 2000: 10). Spending on health care as a percentage of total government recurrent expenditure was projected to increase from 15% in 1997 to 26% in 2010. In contrast, government expenditure on social programs was assumed to increase by only 2.7% per year (Arndt and Lewis 2000: 9-10). The authors also made the assumption that non-AIDS related government spending would remain a constant share of total absorption over the forecasting period. It was assumed that increased government spending on AIDS related expenditures would be financed via a higher budget deficit. Increased government spending caused total savings as a share of GDP to decline from 17% to 14.2% in 2010. Although reduced savings by AIDS afflicted households may also contribute to the decline in total savings, household saving rates are already so low that the impact of reduced household saving rates on total savings would probably be small (Arndt and Lewis 2000: 16).

Given Arndt and Lewis's assumptions about the impact of AIDS on the population, the labour force, productivity and household and government spending[25], the authors predicted that the difference in real GDP growth rates between the AIDS and the

[25] The impact channels of the HIV/AIDS epidemic that were factored into Arndt and Lewis's CGE model were similar to that considered by ING Barings. However, it should be noted that, compared to the ING Barings study, Arndt and Lewis assumed that AIDS would have a greater impact on labour productivity.

no-AIDS scenario would increase steadily between 1997 and 2010, reaching a maximum of 2.6% in 2008. It was projected that by 2010, South Africa's real GDP would be approximately 17% smaller compared to the level that it would have attained in the absence of the AIDS epidemic, while per capita GDP would be 8% lower (Arndt and Lewis 2000: 11-12). Despite the fact that the lion's share of the AIDS infections and deaths will be borne by the skill category with the highest unemployment rate, unskilled labour, the model results indicated that the unemployment rate for unskilled labour would not decline and may even increase marginally. Arndt and Lewis ascribed this projection to slower economic growth as a result of AIDS and their assumption that real wages for the unskilled category would rise by 2% annually (Arndt and Lewis 2000: 13). Although this assumption is not unreasonable, given South Africa's history of high real wage increases for this category, a lower rate of wage growth would reduce the unemployment rate for this group over time.

Arndt and Lewis attempted to determine the share of the deterioration in economic growth that could be ascribed to each impact channel (i.e. which factors are quantitatively the most important). The CGE model was used to "decompose" the overall decline in the GDP growth rate into the contributions of the various impact channels - the share of the deterioration in economic growth that could be ascribed to a certain effect of the epidemic (e.g. its impact on total factor productivity) was determined by progressively eliminating the effects of the epidemic (or AIDS assumptions) from the AIDS scenario and comparing the resulting growth rates to the growth rates under the initial AIDS and the no-AIDS scenarios (Arndt and Lewis 2000: 14).

The first assumption that was dropped from the AIDS scenario was that AIDS would have a negative impact on total factor productivity. Arndt and Lewis found that this effect accounted for approximately a third of the difference in the real GDP between the no-AIDS and the AIDS scenarios in 2010 (Arndt and Lewis 2000: 14). After having eliminated the impact of AIDS on total factor productivity, the authors altered their assumption with regard to how the government financed its increased health care expenditure. Whereas in the initial AIDS scenario it was assumed that increased AIDS related expenditures would be financed by increasing the budget deficit, leading to a contraction in savings and the crowding out of investment, the authors assumed that increased AIDS related expenditures would only "crowd out" other government expenditures. Arndt and Lewis (2000: 15-16) found that 45% of the deterioration in the GDP growth rate could be ascribed to the assumption that the government would finance its higher health care spending via an increased budget deficit (lower government savings). The authors estimated that the slower rate of growth in the labour force and lower labour productivity only accounted for approximately 13% and 8% of difference in the real GDP between the no-AIDS and the AIDS scenarios in 2010[26] (Arndt and Lewis 2000: 15-16).

3.4) Conclusion

In reviewing the research on the economic impact of AIDS that was conducted during the early 1990s, it appears as though the authors typically relied on fairly simple models, often consisting of no more than a production function, and generally arrived at the conclusion that the AIDS epidemic will lead to a substantial reduction in overall economic growth. Excluding the projections for Malawi, it was estimated that HIV/AIDS could reduce the average annual growth rate in a country's GDP by more than 0.5 percentage points (see table 3.11). Furthermore, these earlier studies generally came to conclude that HIV/AIDS would likely have a fairly small, yet negative, impact on per capita GDP growth. In contrast, the results from the research by Bloom and Mahal (1995) suggest that the AIDS epidemic has had an insignificant effect on the growth rate of per capita income, at least up and until 1995. Bloom and Mahal warned that predictions that HIV/AIDS will have a substantially negative impact on economic growth could overstate the seriousness of the threat that the epidemic poses to economic growth (Bloom and Mahal 1995: 4).

The period 1995 – 1999 saw very little quantitative research on the economic impact of AIDS. Fortunately, research efforts were renewed during 2000/2001 and at least five papers on the economic impact of the epidemic emerged. With the exception of a paper by Haacker[27], these researchers relied on somewhat more complex, yet quite different analytical models.

[26] Any difference in the real GDP between the no-AIDS and the AIDS scenarios that can be ascribed to a shift in household spending towards health care is subsumed in the GDP effect that is attributed to the adverse impact of AIDS on the labour supply.

[27] Following the approach used by Cuddington (1993b), Haacker (2001) used a simple neoclassical growth model to simulate the impact of HIV/AIDS on per capita incomes in a number of Southern African countries. Unfortunately, his results are not easily comparable to the other studies, as he did not express the impact of HIV/AIDS in terms of GDP or per capita GDP growth rates. However, his simulation results point to an increase in per capita GDP growth in all of the countries considered in his study.

Table 3.13: Summary of results from previous studies on the macro-economic impact of AIDS on different African countries

Authors	Country	Projection period	Average differences between year on year growth rates	
			GDP	Per Capita GDP
Over (1992) [a]	30 Sub-Saharan countries	1990 - 2025	-0.56 to –1.08	0.17 to –0.35
	10 Most advanced epidemics		-0.73 to –1.47	0.13 to –0.60
Kambou, Devarajan, & Over (1992) [b]	Cameroon	1987 - 1991	-1.9	NA
Cuddington (1993a) [c]	Tanzania	1985 - 2010	-0.6 to –0.8	0.0 to –0.2
Cuddington (1993b) [c]	Tanzania	1985 - 2010	-0.5 to –0.9	0.1 to –0.3
Cuddington & Hancock (1994a) [c]	Malawi	1985 - 2010	-0.2 to –0.3	0.0 to –0.1
Cuddington & Hancock (1994b) [c]	Malawi	1985 - 2010	-0.1 to –0.3	0.1 to –0.1
BIDPA (2000) [d]	Botswana	1996 - 2021	-0.8 to –1.9	0.4 to –0.5
MacFarlan and Sgherri (2001) [e]	Botswana	1999 - 2010	-3.3 to –4.4	Negative
ING Barings (2000)	South Africa	2001 - 2015	-0.3	Positive
Arndt & Lewis (2000)	South Africa	1998 - 2010	-1.6 [f]	Negative

a) Fraction of AIDS costs financed from savings varied from 0% to 100%; The distribution of AIDS over 3 skills categories of labour was varied between fairly downwardly biased to extremely upwardly biased – at the time of this study the thinking was still that skilled labour had higher HIV infection rates than unskilled labour.

b) Simulation results of the impact of a 10 000 man reduction per year in each of three different skill categories of labour.

c) Fraction of AIDS costs financed from savings varied from 0% to 100%; Labour productivity lost per AIDS case varied from 0% to 100%.

d) Projections depend on assumptions with regard to labour productivity losses, HIV prevalence amongst skilled workers, the rate of growth of the skilled workforce, investment rates and total factor productivity (TFP) growth.

e) Projections depend on assumptions with regard to labour productivity losses, the rate of growth of capital inflows and capital accumulation in the formal sector and TFP growth.

f) Estimate derived from graph in Arndt and Lewis (2000) paper.

The Botswana Institute for Development Policy Analysis built on the work done by Cuddington and constructed an extended Solow type growth model, distinguishing between a formal and an informal sector, as well as between skilled and unskilled labour, to simulate the macro-economic impact of AIDS on Botswana. BIDPA estimated that the average growth rate in Botswana's GDP could be 1.1 percentage points lower compared to a no-AIDS scenario over the period 1996-2021. However, in a sensitivity analysis it was concluded that the decline in GDP growth may range between -0.8 and –1.9 percentage points and GDP per capita could increase or decrease, depending on a number of assumptions.

An IMF working paper by MacFarlan and Sgherri (2001) suggests that the AIDS epidemic may have an even more devastating impact on Botswana's economy. Using a broadly similar model as BIDPA, but more pessimistic assumptions about the impact of the epidemic in Botswana, MacFarlan and Sgherri's simulation results indicate that the average growth rate in Botswana's non-mining GDP could be a massive 3.3 to 4.4 percentage points lower compared to a no-AIDS scenario over the period 1999-2010. The projections by MacFarlan and Sgherri for Botswana are by far the most pessimistic estimates of the impact of HIV/AIDS on economic growth in an African country to date.

The ING Barings study (Quattek 2000) was not only the first *quantitative research* on the economic impact of AIDS in South Africa available in the public domain, but also the first study to use an *econometrically estimated demand-orientated model* to estimate the economic impact of HIV/AIDS. Their simulation results indicated that GDP growth could be on average 0.3 percentage points lower between 2001 and 2015 than it would have been in the absence of the AIDS epidemic.

Although ING Barings refrains from any statements on the impact of the epidemic on per capita GDP, a comparison of their projections for the decline in the level of GDP and the decline in the population suggests that per capita GDP will be significantly higher in the AIDS scenario (the decline in the real GDP is substantially less than the decline in the population due to AIDS). Apart from the projections by Cuddington and Hancock for the Malawian economy, this is the least pessimistic view on the impact of HIV/AIDS on an African economy. This may be related to the demand-driven nature of their model, whereby HIV/AIDS induced expenditure stimulates demand and raises economic growth.

Arndt and Lewis (2000) simulated the impact of AIDS on the growth prospects of the South African economy using a 14-sector computable general equilibrium (CGE) model similar to the one that was employed in the Cameroonian study by Kambou, Devarajan, and Over. Like Kambou, Devarajan, and Over's projections for the Cameroonian economy, the projections by Arndt and Lewis for the South African economy are quite devastating. They project that GDP growth could be as much as 1.6 percentage points lower between 1998 and 2010 compared to what would have been possible without AIDS and that per capita GDP levels may also decline due to AIDS. Clearly, their projections for economic growth in South Africa are a lot more pessimistic than that of ING Barings, yet these studies relied on the same demographic assumptions. Although their assumptions with regard to how the AIDS epidemic would affect the South African economy differed somewhat, this factor does not sufficiently explain the large differences in projections. One possible explanation for the significantly more pessimistic projections by Arndt and Lewis can be found in the type of model that was used – in contrast to the demand-driven macro-econometric model used in the ING Barings study, a CGE model is supply-constrained. It appears as though CGE models tend to magnify the adverse impact of declining production (due to lower productivity and a smaller labour force), incomes and savings on overall economic growth (Parker et al. 2000: 17). Not surprisingly, Arndt and Lewis found their simulation results to be very sensitive to their assumption with regard to the impact of HIV/AIDS on total factor productivity, a factor that directly affects the production potential of the economy. Arndt and Lewis estimated that the decline in total factor productivity growth accounted for approximately a third of the difference in the real GDP between the no-AIDS and the AIDS scenarios in 2010 (Arndt and Lewis 2000: 14). Regrettably, this is an assumption that is difficult to quantify. Nevertheless, one can speculate that Arndt and Lewis's assumption that total factor productivity growth rates would be 50% lower by 2010 in all sectors of the economy compared to a no-AIDS scenario may well be over-pessimistic. This assumption was absent from the ING Barings study, and, in combination with the workings of a CGE model, helps to explain why the projections from the Arndt and Lewis study are much more pessimistic than that of the ING Barings study.

Having reviewed the available literature on the economic impact of HIV/AIDS, it appears as though researchers have not reached consensus on the impact of HIV/AIDS on economic growth – estimates of the impact of HIV/AIDS on countries with advanced epidemics range anywhere between a reduction of 0.1 and 4.4 percentage points in the average GDP growth rate over the next 10 to 20 years. Even for South Africa, projections seem to diverge – whereas Arndt and Lewis project that per capita income levels will be lower due to AIDS, the ING Barings study suggests that per capita income may rise significantly. The divergence in the two above-mentioned estimates of the impact of HIV/AIDS on economic growth in South Africa reveals the extent of the uncertainty about the magnitude of the macro-economic impact of the South African epidemic.

CHAPTER 4

MODELLING THE MACRO-ECONOMIC IMPACT OF HIV/AIDS

4.1) INTRODUCTION

Although the 1990s saw a number of researchers attempting to quantify the impact of HIV/AIDS on different African economies, these attempts generally relied on fairly simple models, often only projecting the impact of HIV/AIDS on overall economic growth and per capita income. Despite growing concern about the scope of the epidemic in South Africa, quantitative research on the impact of the epidemic on the South African economy remained scarce. In fact, until recently, their had been no serious attempt at quantifying the economic impact of HIV/AIDS in South Africa.

Fortunately, the year 2000 saw two such studies emerge, in the shape of research papers by ING Barings (Quattek 2000) and Arndt and Lewis (2000). Although these two studies relied on the same demographic assumptions, their assumptions with regard to how the AIDS epidemic would affect the South African economy and the econometric models that were employed differed from each other. Understandably, they produced divergent projections of the economic impact of the epidemic. However, the deviations were substantial, to say the least – whereas ING Barings predicted that GDP growth rates could be 0.4 percentage points lower on average during 2006-2010 (when the impact on economic growth was projected to reach a maximum), Arndt and Lewis projected that GDP growth could be more than 2.0 percentage points lower compared to what would have been possible without AIDS. ING Barings came to a fairly modest projection of a 3% lower level of GDP between 2006-2010, compared to Arndt and Lewis's projection that the level of GDP could be as much as 13% below the level that could have been attained in the absence of the epidemic. With such a substantial drop in the level of GDP, it does not come as a surprise that Arndt and Lewis concluded that per capita GDP levels would also be lower due to AIDS. In contrast, the ING Barings study suggests that per capita income may rise.

With such divergent projections of the impact of HIV/AIDS on economic growth in South Africa, the need for further quantitative research on the impact of the epidemic on the South African economy became evident. It was in this light that the Bureau for Economic Research (BER) undertook its research on "The Macro-Economic Impact of HIV/AIDS in South Africa" (Laubscher et al. 2001), an exercise that provided the basis for this thesis. The BER's annual macro-econometric forecasting model was employed to model the impact of HIV/AIDS on the South African economy. Like the model that was used in the ING Barings analysis, the BER's model can be described as a demand-orientated macro-econometric model with specific supply elements. The majority of the individual behavioural equations in the BER's model were estimated according to the two-step Engle-Granger procedure. This involved estimating a long-run cointegration (equilibrium) equation using the Ordinary Least Squares (OLS) method, followed by a short-term dynamic equation, which includes the error correction term derived from the long-run equation. The first section of this chapter contains a brief description of the model that was used to analyse the economic impact of HIV/AIDS. It considers the origins of the concept of cointegration and the development of the two-step Engle-Granger procedure. Furthermore, it provides an overview of the model structure and the estimation techniques that were used to estimate the behavioural equations in the model.

In order to simplify the modelling exercise, it was assumed that HIV/AIDS would only start to claim a toll on the economy after the year 2000. The historical period (before 2001) was therefore treated as a "no-AIDS" scenario, at least in terms of the economic environment. This allowed for the equations to be estimated up to the year 2000, without necessitating any assumptions about the economic impact that the epidemic may have had during the 1990s. Given that only about 0.55% of South Africa's labour force (0.38% of the total population) is projected to have been sick with AIDS[1] in the year 2000, the economic impact of the epidemic during the 1990's was probably fairly small.

The second part of the chapter describes how the BER's model was adapted to account for the impact of HIV/AIDS on the South African economy and presents the results in the form of comparisons between "no-AIDS" and "AIDS" projections for key economic

[1] People who are infected with HIV may lead relatively healthy and productive lives for many years after they are infected with the virus, as the virus has a long incubation period. The economy will only be affected by the epidemic once HIV infected individuals start to change their spending patterns (e.g. increase their spending on health care) or when their productivity is adversely affected. This will probably happen once they become aware of their HIV status or become sick with an AIDS-related illness. Stephen Kramer (the manager of Metropolitan Life's AIDS Research Unit) estimated that only about 10% of HIV+ South Africans are aware of their HIV status (personal correspondence, May 2001).

variables for the period 2001 to 2015.[2] It provides a detailed description of the different channels through which the epidemic is likely to impact on the economy, the assumptions that were adopted and how they were incorporated into the model. The macro-economic effects of each impact channel are analysed independently, before the different impact channels are combined in the model for the final (aggregated) AIDS inclusive simulation. The results are discussed in detail in the final section of the chapter.

4.2) THE MODEL

The majority of the behavioural equations in the BER's model were estimated with estimation techniques based on cointegration. In what follows, the concepts of stationarity and cointegration are discussed and the two-step Engle-Granger procedure is described. Subsequently, the structure of the BER's model is described with reference to the specification of the behavioural equations in the model.

4.2.1) STATIONARITY AND COINTEGRATION

One of the critical assumptions of empirical work based on time series data is that the underlying time series is stationary. A time series is said to be stationary if its mean, variance and autocovariance do not change over time (Gujarati 1995: 713). Estimating equations with non-stationary data can give rise to misleading values of the R-squared, Durbin-Watson and t-test statistics. Estimation results such as high R-squared and t-test statistics obtained from regressions with non-stationary data may mislead econometricians into thinking that a meaningful relationship exists between the regression variables, when the results may in fact be spurious (i.e. inferences using OLS are invalid).

Despite the fact that the pitfalls of using non-stationary data had already been noted in the early 1900's, econometricians proceeded to run regressions on non-stationary data, at least until the 1970's. Partly as a reaction to this widespread disregard for the problems implied by non-stationary data, Box and Jenkins proposed a modelling approach which involved differencing time series data to render it stationary before proceeding to run regressions on the data.[3] During the early 1970's, a large amount of

[2] More detailed simulation results are presented in Appendix C.

[3] A variable is said to be integrated of order d, written I(d), if it has to be differenced d times in order to produce a stationary series. A stationary time series can therefore be classified as being I(0). The order of integration of a time series can be determined by applying unit root tests such as the augmented Dickey-Fuller or Phillips unit root tests (Kennedy 1998: 268 – 269).

support was generated for the use of Box-Jenkins techniques, as a number of studies appeared that showed that Box-Jenkins forecasting models were out-performing traditional econometric models. However, this approach was not without drawbacks - by estimating regressions with only the changes in time series (i.e. data that has been differenced one or more times), important information from economic theory about the long-run relationship between the levels of the variables is lost (Kennedy 1998: 269 – 270; Brooks and Gibbs 1991: 7 - 8).

Fortunately, in 1981 Granger discovered a solution to this problem and introduced the concept of cointegration into econometric literature. This concept admits the possibility that two or more non-stationary (or integrated) time series can be combined to form a stationary variable. Such variables are said to be cointegrated. Since estimating equations with cointegrated variables does not give rise to spurious results, cointegrated variables do not have to be differenced before running regressions. The concept of cointegration therefore provides a "formal framework for testing and estimating long-run (equilibrium) relationships among economic variables" (Kennedy 1998: 270). Apart from these attractive features, it can also be shown that OLS can be used to obtain consistent coefficient estimates of a cointegration equation. In fact, it turns out that OLS estimation of a cointegrating relationship is "super-consistent" in that the coefficient estimates converge to their true values at a faster rate than OLS estimation with stationary time series (Brooks and Gibbs 1991: 8).

Although cointegration implies that a long-run equilibrium relationship exists between the cointegrating variables, there may still be disequilibrium in the short-term. Engle and Granger (1987) popularised an error correction mechanism that corrects for this disequilibrium and provides a means of reconciling the short-run behaviour of an economic variable with its long-run behaviour. The first step in the two-step procedure suggested by Engle and Granger involves estimating the long-run cointegration (equilibrium) equation with OLS and deriving the error correction term from the long-run equation. Secondly, the short-term dynamic equation, which includes the error correction term, is estimated [4] (Smit and Pellissier 1997: 3; Brooks and Gibbs 1991: 8 – 9).

[4] This error-correction procedure was presented by Engle and Granger in their 1987 paper, "Cointegration and Error Correction: Representation, Estimation and Testing", and has subsequently been used by the Reserve Bank of New Zealand in the estimation of their macro-econometric model of the New Zealand economy (Brooks and Gibbs: 1991).

4.2.2) ESTIMATION TECHNIQUE

In view of the obvious advantages of estimation techniques based on cointegration over more traditional econometric techniques, the majority of the individual behavioural equations in the BER's model were estimated according to the two-step Engle-Granger procedure. This involved the following: Firstly, economic theory was consulted and the general form of the long-run cointegration relationship was specified on the basis of theoretical considerations. In most cases, behavioural equations were specified in the log-linear form, so that the coefficients of the explanatory variables could be interpreted as elasticities. The second step in the modelling exercise was to determine the order of integration of the time series that were to be included in the long-term equation. The Augmented Dickey-Fuller test for a unit-root was used to test the order of integration of the relevant variables. Since the variables that enter the long-run equation need to be integrated of order one, variables that were integrated of order 2 or higher were differenced until they were I(1).[5] Having completed the specification of long-run relationship by ensuring that the variables that enter the long-run equation are I(1), the long-run equation was estimated using OLS. The residual from the regression was then tested for a unit-root using the Phillips Zt test - cointegration was rejected if the residual contained a unit root. If cointegration was not achieved, economic theory was revisited and the long-run equation was re-specified, re-estimated and re-evaluated (Smit and Pellissier 1997: 3; Brooks and Gibbs 1991: 9).

Once cointegration was achieved, the next step was to formulate and estimate the short-term error correction equation. The dependent variable in each of the short-term equations in the BER's model was taken as the first difference of the dependent variable in the long-term equation. The explanatory variables that entered a short-term equation generally consisted of the first differences of the explanatory variables that were included in the long-term equation (with or without lags). However, variables that were not included in the long-term equation were also considered, provided that they are stationary. Each short-term equation also includes an error correction term that consists of the lagged residual from the long-term regression. The error correction term entered the short-term equation as the lagged actual value of the dependent variable less the lagged estimated value of the dependent in the long-term cointegration equation (Smit and Pellissier 1997: 3; Brooks and Gibbs 1991: 9).

Having estimated the short-term error correction equation, the estimation results were evaluated using theoretical considerations and statistical tests. Generally, the error-correction model was only considered to be acceptable if it met standard economic and statistical criteria, but in some cases economic theory was given precedence over minor statistical inadequacies.

Unfortunately, it was not possible to use the Engle-Granger approach to estimate all the equations in the BER's model. For some variables, obtaining economically sensible and statistically reliable results for the short-term equation proved to be very difficult. Attempts at introducing explanatory variables that were considered to be important inputs to the equation often resulted in either the wrong sign or in coefficient estimates that were statistically insignificant. In these cases, precedence was given to economic theory and the relationship was specified as a simple log-linear function and estimated with OLS (i.e. only a long-term equation was estimated).

4.2.3) STRUCTURE OF THE MODEL

The BER's macro-econometric model of the South African economy contains 135 equations, of which 31 are econometrically estimated equations and 104 are identities and transformations. The model was designed for the purpose of medium-term forecasting of the macro-economy. The latest version of the E-views econometric package, E-Views 4, was employed to estimate the equations and to compile the model. Annual data was used and the period of estimation varied between 1970 and 2000, depending on data availability and other concerns.

The broad structure of BER's model can be described as that of a demand-orientated macro-econometric model. Although the model essentially forecasts South Africa's gross domestic product (GDP) from the demand side[6], specific supply elements in the form of a measure of potential output and economy-wide capacity utilisation have been included in an attempt to capture the production side of the economy. Capacity utilisation, which is measured as the inverse of the gap between actual and potential

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[5] Variables that enter the long-run equation need to be integrated of order one I(1), so that the residual that is formed from the long-run cointegration equation is stationary (integrated of order zero) and could therefore be included in the short-term stationary regression without generating spurious results.

[6] Expenditure on GDP is determined as the sum of final consumption expenditure by households, final consumption expenditure by general government, gross capital formation and exports of goods and services, less imports of goods and services.

output, enters the equations for imports and prices as a variable supply constraint[7] (Smit and Pellissier 1997: 4).

Historical labour force data (1970 – 2000) per skill category were supplied by Dr. Claude van der Merwe of Quantec. The labour force data was derived from census estimates and served as inputs to the demographic analysis of Abt Associates/Metropolitan Life. For econometric modelling purposes, it was decided to differentiate between (only) two skill categories of labour - skilled and unskilled labour. Skilled and highly skilled labour force (employment) data was aggregated to form the *skilled labour force* (employment) category. Semi- and unskilled labour (employment) forms the *unskilled labour force* (employment) category.[8] Given South Africa's high unskilled unemployment rate and the comparatively "small reserve pool of skilled people", it is important to differentiate between skilled and unskilled labour (Laubscher et al. 2001: 14). Whereas unskilled employees can be replaced fairly easily (and at a lower cost) from unemployed resources, this is not the case for skilled employees. Furthermore, HIV/AIDS prevalence is significantly lower for skilled labour - the labour category with the relatively higher contribution to the country's GDP.

A more detailed description of the BER's model is given with reference to the specification of the econometrically estimated equations in the model. Appendix A provides a detailed specification of the behavioural equations and identities in the macro-econometric model. The variable name definitions are listed in Appendix B.

a) Private consumption expenditure

In order to determine total private consumption expenditure, the largest component of expenditure on GDP, it was disaggregated into its four standard categories: durable goods (CD1), semi-durable goods (CSD1), non-durable goods (CND1) and services (CS1). The consumption equations for durable goods, semi-durable goods and services are specified as positive functions of real personal disposable income (YD1) and negative functions of the prime interest rate. In order to account for the sharp increase in

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[7] Attempts at introducing capacity utilisation to investment equations resulted in either the wrong sign (i.e. a negative sign) or in coefficient estimates that were statistically insignificant.

[8] The skill categories were defined as follows: Highly skilled occupations include professional, semi-professional and technical occupations; managerial, executive and administrative occupations and certain transport occupations (e.g. pilots and navigators). Skilled occupations include clerical, service and sales occupations; farmers, farm managers; artisans, apprentice and related occupations; production foremen and production supervisors. All other occupations are defined as either semi- or unskilled (Abt Associates and Metropolitan Life June 2000: 14).

consumer spending on services during the 1990s, a time trend was included in the services equation. Consumption of non-durable goods is explained by the real tax-adjusted wage bill (YWDB1) and real tax-adjusted income from property (YPHHD1).[9]

b) Investment

Total real fixed investment expenditure (I1) is the sum of gross private sector investment (IP1), fixed investment expenditure by public corporations (IPC1) and fixed investment expenditure by the general government (IG1). Only private sector investment is explained by the model - investment expenditure by public corporations and by general government enters the BER's model as exogenous variables. Investment expenditure by the private sector was split into investment in residential buildings (IPRB1) and private fixed investment excluding residential buildings (IPZRB1). Investment in residential buildings is specified as a positive function of the real tax-adjusted wage bill and the non-black population[10] and a negative function of the prime interest rate. Private fixed investment excluding residential buildings was explained by current and lagged changes in real GDP (Y1), the prime interest rate, the private fixed capital stock and the ratio of corporate savings to GDP.

Real inventory investment (II1) enters the BER's model as an exogenous variable, while nominal inventory investment (II) was used to close the savings-investment gap.[11]

c) Balance of payments and exchange rates

Consistent with the South African Reserve Bank's balance of payment's definition, the current account of the balance of payments is determined (in nominal terms) as the sum of merchandise exports, net gold exports, non-factor service receipts and current transfers (net receipts) less merchandise imports, non-factor services payments and net factor payments (i.e. income payments less income receipts). Of the different components of the balance of payments, only merchandise exports (BEM), merchandise imports (BMM), non-factor service receipts (BESN) and non-factor service payments (BMSN) are explained by behavioural equations in the model. Merchandise exports is split into two categories -

[9] Attempts at introducing interest rates to the non-durable goods consumption equation resulted in either the wrong sign (i.e. a positive sign) or in coefficient estimates that were statistically insignificant.

[10] The non-black population proved a better fit than the overall population. The use of the non-black population also accounts for the fact that a substantial proportion of the AIDS deaths among the highly infected lower income groups (consisting predominantly of black consumers) will not affect residential investment in the private sector.

[11] Nominal inventory investment was calculated as the difference between total domestic savings on the one hand and total fixed investment and the current account balance on the other hand.

manufacturing and non-manufacturing exports. Both real manufacturing exports (BEMAN1) and real non-manufacturing exports (BEZMAN1) are explained by a measure of total real output in the G7-countries (G7Y1) and the real effective exchange rate of the rand (REXEFR).[12] Real merchandise imports is modelled as a function of an appropriate domestic demand variable (YDOM1), capacity utilisation (YCU) and relative prices - import prices (PM) relative to domestic producer prices (PPI).[13] Non-factor service receipts and non-factor service payments are modelled in current prices as functions of merchandise exports and merchandise imports. The other components of the current account of the balance of payments, as well as capital flows, essentially enter the BER's model as assumptions. The change in net gold and other foreign reserves owing to balance of payments transactions is an identity - the sum of the current account balance (BCA) and total capital flows (BNCF).

The R/$ exchange rate is explained by an inflation rate differential and the change in net gold and other foreign reserves owing to balance of payments transactions relative to GDP.

d) Potential output and capacity utilisation

The supply side of the BER's macro-econometric model centres around a Cobb-Douglas production function. In the BER's model, the economy's production potential is measured as the maximum output obtainable with the optimal utilisation of the factors of production - capital and labour. In order to obtain the coefficient estimates for the production function, the private sector's contribution to real GDP at basic prices (YBZG1) (a proxy for output) was estimated as a function of non-government fixed capital stock and two skill categories of employment (skilled and unskilled employment in the private sector).[14] Using these values of the parameter estimates and substituting labour supply for employment, potential GDP (YPOT) is constructed as a function of non-government fixed capital stock, the supply of skilled and unskilled labour to the private sector and total factor productivity. The BER's measure for economy-wide capacity utilisation (YCU) was then derived as the ratio of real GDP at basic prices to potential GDP.

[12] Manufacturing exports are typically more sensitive to the exchange rate and changes in output (or demand) in industrial countries than non-manufacturing exports.

[13] The relative price variable in the short-term equation for real merchandise imports was replaced with the real effective exchange rate.

[14] The estimation results indicated that output is significantly more sensitive to changes in skilled labour supply than to changes in unskilled labour supply.

e) Employment

The BER's model differentiates between skilled and unskilled employment and also between employment in the private sector and employment by government. Private sector employment of skilled workers (LEMHZG) is modelled as a positive function of the private sector's contribution to real GDP at basic prices (YBZG1) and the private sector fixed capital stock at constant prices (KZGG1) and a negative function of the real (PPI deflated) wage rate for skilled employees in the private sector (WRMHZG).[15] Similarly, private sector employment of unskilled workers (LEUSZG) is explained by the private sector's contribution to real GDP at basic prices (YBZG1) and the real (PPI deflated) wage rate for unskilled employees in the private sector (WRUSZG). Private sector employment of unskilled workers was also found to be positively related to the real (PPI deflated) user cost of capital. Government employment of skilled and unskilled workers enters the model as assumptions.

f) Prices and wages

The approach that was used to model the price sector involved estimating cointegration and error-correction equations for one core price index - the producer price index - and then specifying and estimating the other price indices, where feasible, as functions of the producer price index. Pricing behaviour is essentially modelled as a mark-up over input costs - the primary explanatory variables in the long term producer price inflation (PPI) equation are unit labour costs (proxied by the ratio of non-government wage bill to GDP) and the import price index (PM). Capacity utilisation also enters the short-term equation for PPI as a proxy for excess or inadequate demand.[16] The private consumption (PC) and government consumption (PGC) deflators were modelled as functions of the PPI. In the case of PC, the influence of indirect taxes was provided for and in the case of PGC the government wage rate was included as an explanatory variable. The consumer price index (PCI) was simply estimated as a function of the PPI.

Apart from the PPI, an appropriate world import price variable (PWM) relative to the effective exchange rate also enters the equation for non-gold exports (PEZG). The import price index was estimated as a function of the effective exchange rate of the rand, foreign prices (proxied by consumer prices in the G7-countries) and the rand oil price. The investment price deflator (PI) was modelled as a function of the PPI and PM.

[15] The producer price inflation rate (and not the CPI) is used to deflate the wage rate in order to account for the increase in labour costs relative to the inflation rate experienced by producers (and not by consumers).

The BER's model distinguishes between wage rates for skilled and unskilled employees and also, within those categories, between wage rates for private sector and government employees. The average annual wage rate for skilled (unskilled) private sector employees is modelled in current prices as a positive function of the private consumption deflator and the productivity of private sector employees, proxied by output per private sector employee, and a negative function of the skilled (unskilled) unemployment rate of private sector employees.[17] Skilled and unskilled wage rates for government employees are modelled as functions of the skilled and unskilled wage rates for private sector employees respectively.

g) Monetary sector

The BER's model has only limited representation of the monetary aggregates. The M3 money supply (FM3) enters the model as an identity - the sum of net foreign assets (FNFA), net claims on the government sector (FNCG), claims on the private sector (FCP) and net other assets and liabilities (FOTH). Of the constituent parts of the M3 money supply, only *claims on the private sector* are modelled as a behavioural equation. FCP, deflated by the gross domestic expenditure deflator (PGDE), is a function of real gross domestic expenditure and the prime interest rate.

Similar to the approach that was used to model the price sector, the principle that was adopted to explain the various interest rates was to explain one core interest rate - the bank rate - and then to estimate the other interest rates as functions of the core interest rate. The bank rate (FRB) is modelled as a function of expected inflation (proxied by the current inflation rate), the change in net reserves relative to GDP and the (lagged) growth in the M3 money supply less the CPI inflation rate. A lagged dependent variable was also included in the equation.

[16] The underlying assumption is that capacity under utilisation reflects the imbalance of supply and demand.

[17] The unemployment rate is the variable through which changes in the demand and supply of labour influence the wage rate. A fall in the unemployment rate (i.e. a lower supply of available workers) leads to a rise in the wage rate. As the South African labour market is characterised by a shortage of skilled labour and an abundance of unskilled labour, skilled wages are typically more sensitive to changes in the unemployment rate of skilled workers than unskilled wages are to changes in unskilled unemployment.

4.3) THE MACRO-ECONOMIC IMPACT CHANNELS OF AIDS, THE KEY ASSUMPTIONS AND THEIR ECONOMIC EFFECTS

Modelling the macro-economic effects of the HIV/AIDS epidemic is a complex exercise. The way in which this problem was approached was to do a baseline no-AIDS forecast of the economy with the BER's macro-econometric model and then to identify the key macro-economic impact channels of the epidemic and to adopt a specific set of assumptions for each AIDS impact channel. The macro-economic effects of each impact channel was then analysed independently, after which all the impact channels were combined in the model for the final (AIDS inclusive) simulation.

One or a combination of the following three methods was used to incorporate an assumption into the model:

- Replace the no-AIDS forecast of an exogenous variable with an AIDS-inclusive forecast for the variable (e.g. the no-AIDS forecast of the labour force is replaced with the AIDS-inclusive forecast).

- In order to account for the impact of AIDS on the dependent variable in an equation, the no-AIDS (baseline) addfactor[18] to the equation was adapted. Addfactors are indicated by the suffix _A in this paper (e.g. the addfactor for durable goods (CD1) is written as CD1_A).

- Another way in which the forecast of an endogenous variable was influenced involved introducing new variables to the equations and identities in the model to account for the impact of AIDS. These variables are only assigned values in the AIDS scenario. In the no-AIDS scenario, they are set equal to zero (or equal to 1 where they are multiplied with other endogenous variables).

[18] An addfactor is simply an exogenous variable or amount that is added to the solved value for the dependent variable of an equation. An addfactor is generally assigned values that would ensure that an equation solves accurately for the historical values of the dependent variable. However, an addfactor can also be assigned values for the forecasting period, in which case it would influence the forecast of the dependent variable.

Broadly, the following impact channels of the epidemic were analysed:

- Firstly and most notably, AIDS slows the growth in the population and the labour force, with negative implications for both the production and expenditure sides of the economy.

- Secondly, it is expected that employers and employees will need to increase their contributions to pension, life, disability and medical funds on account of the AIDS epidemic. This implies extra direct or wage costs for companies and a shift in consumption expenditure on the part of households.

- Thirdly, AIDS related illnesses and deaths of employees will lead to indirect costs to companies, including costs related to absenteeism, lost experience and skills, recruitment and training costs and lower labour productivity. AIDS will also reduce the growth in total factor productivity (or multi-factor productivity), which can be seen as another indirect cost to companies due to the epidemic.

- The final impact channel analysed was the implications of the epidemic for government expenditure. Like private sector companies, the government will need to increase its contributions to employee benefit funds due to the epidemic (implying extra direct or wage costs to government). Similarly, AIDS related illnesses and deaths of government employees will bring about substantial indirect costs to the government. The AIDS epidemic will also lead to an increase in the demand for public health care and welfare grants for orphans, all of which will put upward pressure on the government's budget deficit. This analysis therefore also explores the impact of higher personal and corporate taxes to fund the additional AIDS related costs.

The next section of the paper provides a more detailed description of the economic impact channels of the epidemic, the assumptions that were adopted, how they were incorporated into the model and a discussion of their economic effects. More detailed simulation results are presented in Appendix C.

Changing an addfactor to an equation by a certain amount is tantamount to adding or subtracting that amount from the solution for the dependent variable of the equation.

4.3.1) LOWER POPULATION AND LABOUR FORCE DUE TO LOWER FERTILITY AND AIDS DEATHS

South Africa faces one of the world's most severe HIV/AIDS epidemics, with different estimates putting the number of South African's currently infected with HIV/AIDS between 4 and 6 million. Abt Associates/Metropolitan Life (June 2000) projects that South Africa's population could be approximately 18% lower (close to 10 million people less) by 2015 compared to a no-AIDS scenario.

The HIV/AIDS epidemic has a disproportionate impact on the labour force, with HIV/AIDS infection rates for skilled and semi- and unskilled workers projected to peak above 25%. Infection rates for highly skilled workers are projected to reach 18.3% by 2015. Abt Associates projects that the total labour force could be 21% lower by 2015 compared to a no-AIDS scenario.

Since the working age population will bear the brunt of the impact, HIV/AIDS is bound to have an adverse impact on the economy. Both the production and expenditure sides of the economy will be adversely affected. By slowing the growth in the labour force, HIV/AIDS will have an adverse impact on the production potential of the economy. Similarly, AIDS deaths will reduce the absolute number of consumers compared to a no-AIDS scenario, which should have a negative effect on final consumption expenditure (FCE). A smaller population also implies a lower demand for private fixed residential investment and possibly lower government consumption expenditure (e.g. spending on welfare, education and pensions).

The assumptions made with regard to the first impact channel will attempt to capture the economic effects of a smaller labour force and a lower absolute number of consumers compared to a no-AIDS scenario. (AIDS effects such as lower labour productivity and the increase in the demand for health care due to the epidemic are not accounted for in this impact channel.)

a) Assumptions

The first step in modelling this impact channel was to replace the no-AIDS forecasts (2001-2015) of the exogenous demographic variables in the model - the skilled and unskilled labour force and the non-black population - with AIDS-inclusive forecasts. A lower supply of skilled and unskilled labour impacts directly on potential GDP and the unemployment rate, while the inclusion of the non-black population as an explanatory variable in the private fixed residential investment equation captures the adverse impact of AIDS deaths on residential investment (see equation 7 in Appendix A). The non-black population proved a better fit than the overall population. The use of the non-black population also accounts for the fact that a substantial proportion of the AIDS deaths among the highly infected lower income groups (consisting predominantly of black consumers) will not affect residential investment in the private sector.[19]

By reducing the size of the population, AIDS will lead to a lower demand for government services compared to a no-AIDS scenario, which could have an adverse impact on government employment. As skilled and unskilled government employment enters the BER's model as exogenous variables, assumptions had to be made about the impact of the lower population on government employment. It was assumed that the AIDS death rate among government employees would be the same as the AIDS death rate in the non-government labour force (differentiated between skilled and unskilled labour). In order to account for the impact on government employment of the lower demand for government services due to the smaller population (compared to a no-AIDS scenario) and the difficulty government will experience in finding skilled workers to replace AIDS sick employees, it was assumed that that only 50% of government employees lost due to AIDS would be replaced from unemployed or other sources.[20] In other words, government employment of skilled and unskilled workers was reduced by 50% of the decline in the skilled and unskilled (aggregate) labour forces respectively.

Modelling the impact of a lower population on FCE is a complex exercise, as a number of issues should be taken into account. Firstly, it is likely that there will be a less than proportional decline in FCE due to AIDS deaths among the population, as the majority of the HIV/AIDS infected consumers are from the lower income groups - those with little spending power. Secondly, as the demographic impact of the epidemic will likely outweigh the economic impact, per capita income levels could actually increase. Given South Africa's high unskilled unemployment rate, one can assume that an unskilled income earner could be replaced fairly easily, so that the economic production and income will not be "fully exposed to the impact of the deceased worker" (Laubscher et al. 2001: 16). The resulting increase in income per household could lead to a shift in consumer spending

[19] "This implicitly assumes that the AIDS mortality among home-owning blacks is similar to that of non-blacks, which could be a reasonable assumption." (Laubsher et. al. 2001: 15)

[20] The government labour force in the BER's model is set equal to government employment (i.e. technically, there can be no unemployment in the government sector).

from non-durables and semi-durables to spending on durables and services (Quattek 2000: 14-15).[21] Finally, the adverse impact of AIDS deaths on FCE may to some extent be offset by an increase in spending by family members of the deceased who liquidate the victim's assets.

Attempts to include the population as an explanatory variable in the consumption functions or to use per capita consumption as the dependent variable either lead to statistically insignificant coefficient estimates or distorted the economic impact of the epidemic.[22] Only income variables, such as real disposable income, the real after tax wage bill and income from property, and the prime interest rate therefore entered the consumption functions as explanatory variables. As the consumption functions in the model account for the demographic impact of AIDS via the adverse impact of AIDS on employment and hence, the wage bill, only the reduction in FCE tied to the deaths amongst the unemployed and dependents of the employed need to be accounted for outside of (exogenous to) the model. This was done in the following way: Firstly, the consumption functions in the BER's macro-econometric model were used to forecast the consumer spending on the four main FCE categories - durables, semi-durables, non-durables and services - in the absence of AIDS. Secondly, racial FCE data supplied by Quantec (2001) was used to split each of the four FCE components into consumption expenditure by race group. The consumption patterns of the different race groups witnessed over the past 3 decades (1970 - 2000) were used to project the racial structure of the components of FCE for 2001 to (approximately) 2006, whereafter the contributions of the different race groups to each of the four main components of FCE were assumed to remain more or less constant [23] (see figure 4.1). The BER's no-AIDS forecast of consumer spending on the four main sub-components of FCE was used in conjunction with the projections of the racial structure of the components of FCE to produce no-AIDS forecasts of the racially disaggregated sub-components of FCE.

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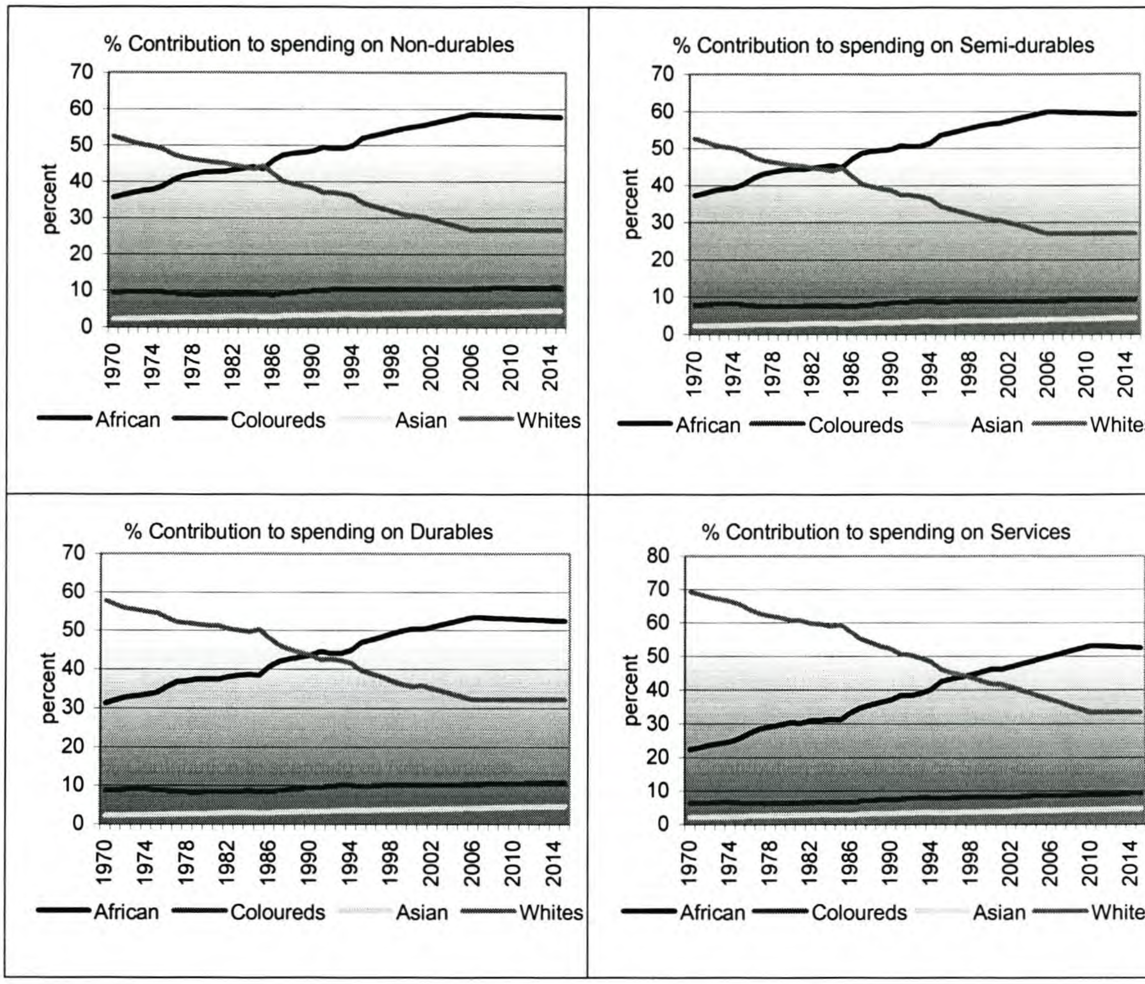
[21] It seems as though ING Barings only accounted for the impact of a lower population (per se) on FCE through its positive impact on per capita income, ignoring the possible adverse implications of a lower absolute number of consumers.

[22] Overall consumption expenditure in South Africa is more constrained by the spending power of consumers (i.e. consumer income) than by the absolute number of consumers, which may to some extent explain the statistically insignificant results.

[23] Abt Associates projects that the black population will start to decline in 2007 due to HIV/AIDS, but that the non-black population will continue to grow (Abt Associates and Metropolitan Life June 2000). In the absence of better information, it was decided to halt the increasing trend in the contribution of the black population to FCE in 2006 and rather assume that the contributions of the different race groups to each of the four main components of FCE would remain constant after 2006.

Figure 4.1: Contributions to spending on FCE categories per race group



Thirdly, using Abt Associates' projections of the AIDS and no-AIDS population groups and racial income distribution data from the SA Advertising Foundation[24] (1998), income-weighted deviations between the AIDS and no-AIDS projections for each race group were produced (see table 4.1). Since the vast majority of black consumers fall in the lower income groups and therefore have relatively less spending power, the impact on FCE resulting from AIDS deaths in the black population was down-weighted.[25] Table 4.1 shows that the income-weighted deviation between the AIDS and no-AIDS black population group is substantially smaller than the unweighted deviation. In contrast, the income-weighted deviations between the AIDS and no-AIDS white, coloured and Asian population groups are larger than the unweighted deviations.

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[24] Quoted in the December 2000 *Fast Facts* by the South African Institute of Race Relations.

[25] Although the black population constitutes approximately 78% of South Africa's population, their share in the national disposable income is only about 43.4%. In contrast, whites constitute only about 11.2% of South Africa's population, but earn a massive 44% of the national disposable income (Bureau of Market Research 2000: 39). It was therefore assumed that a reduction in the black population (the population group with the

Table 4.1: Deviation between AIDS and no-AIDS population projections - Unweighted % Difference vs. Income-Weighted % Difference										
	Blacks		Coloureds		Asians		Whites		Total	
	% Diff.	Weigh-ted % Diff.	% Diff.	Weigh-ted % Diff.	% Diff.	Weigh-ted % Diff.	% Diff.	Weigh-ted % Diff.	% Diff.	Weigh-ted % Diff.
2000	-0.8	-0.3	-0.1	-0.1	-0.1	-0.1	0.0	0.0	-0.7	-0.3
2005	-4.7	-1.4	-0.7	-0.8	-0.4	-0.5	-0.3	-0.3	-3.8	-2.0
2010	-12.0	-3.7	-2.9	-3.1	-1.5	-1.8	-1.0	-1.2	-10.0	-5.3
2015	-20.7	-6.4	-7.0	-7.4	-3.6	-4.2	-2.6	-3.2	-17.8	-9.4

The next step was to apply the income-weighted deviations between the AIDS and no-AIDS population groups to the no-AIDS forecasts of the racially disaggregated sub-components of FCE (at constant 1995 prices) to generate AIDS inclusive projections. The racially disaggregated data was aggregated to produce AIDS inclusive projections of the four main components of FCE. From table 4.2 it is clear that the deviations between the AIDS and no-AIDS projections of real FCE on non-durable and semi-durable goods are higher than that for the other 2 sub-components of FCE. This can be attributed to the proportionally larger exposure of these sectors to black consumers - the population group with the highest HIV/AIDS prevalence. However, this factor was countered by the lower weight that was assigned to consumers who fall in the lower income groups (of which the vast majority are black consumers). The deviations between the AIDS and no-AIDS projections of real FCE on durable goods and services are only slightly lower than that for the non-durable and semi-durable components of FCE. Although durable goods and services have a higher exposure to the less infected population groups (i.e. white, coloured and Asian consumers) compared to semi- and non-durables, the higher shares of these population groups in the higher income groups worked to counter this factor. In all, this part of the analysis indicated that the negative impact on the four main sub-components of FCE (from the lower population per se) could range between 5.32% and 5.56% in real terms by 2015.

highest HIV infection rate, but below average household income) would have a smaller negative impact on FCE than the same reduction in the white, coloured or asian population groups.

Table 4.2: Percentage difference (in levels) in real FCE between AIDS and no-AIDS scenarios due to the impact of AIDS on the population (weighted by income)					
	Total	Durables	Semi-durables	Non-durables	Services
2000	-0.16	-0.15	-0.17	-0.16	-0.14
2005	-0.98	-0.97	-1.03	-1.03	-0.92
2010	-2.81	-2.76	-2.89	-2.89	-2.73
2015	-5.43	-5.39	-5.54	-5.56	-5.32

The final step involved reducing the impact so that it would only account for the reduction in consumption levels tied to deaths amongst the unemployed or dependents of the employed.[26] The unemployment rate (the percentage of the total labour force that are not employed in the formal or informal sectors, represented by UNEMPL) was used to adjust the absolute differences between the AIDS and no-AIDS projections of the sub-components of FCE and the resulting figures enter the model as addfactors in the respective consumption functions. This reduced the negative impact on aggregate FCE to 2.12% in real terms by 2015, ranging between -2.08% (services) and -2.17% (non-durables). Equation 1 below indicates how the addfactor (CD1_A) that enters the durable goods equation (equation 1 in Appendix A) is adapted to account for the adverse impact of a lower absolute number of consumers on durable goods consumption expenditure:

EQ 1: CD1_A = CD1_A_BASE - (CD1D_NPT * UNEMPL)

CD1_A_BASE represents the baseline no-AIDS addfactor that enters the durable goods equation. CD1D_NPT represents the deviation (in billions of rands) between the AIDS and no-AIDS projections of real FCE on durable goods due to the adverse impact of HIV/AIDS on the absolute number of consumers, while UNEMPL is the unemployment rate in the economy.

[26] The equations in the model already account for the reduction in consumption levels tied to deaths amongst the employed via the adverse impact of AIDS on employment and hence, the wage bill.

b) Macro-economic effects

Potential GDP[27], which is determined by the supply of labour, capital and technology, is substantially lower due to the adverse impact of HIV/AIDS on the labour force.[28] Compared to a no-AIDS scenario, the level of potential GDP is projected to be 6.7% lower by 2010 and 12.3% lower by 2015 (see table C.1 in Appendix C). Similarly, actual GDP will also be lower, mainly due to the adverse impact of lower levels of employment on consumption expenditure. The simulation results indicate that the level of actual GDP could be 2.9% lower by 2010 and 5.95% lower by 2015 compared to a no-AIDS scenario. Since the adverse impact of the epidemic on potential output (via the sharp decline in the labour force), outweighs the negative impact on actual output, the gap between actual and potential GDP declines. This implies an increase in the capacity utilization of firms, which puts upward pressure on production prices. Compared to a no-AIDS scenario, the producer price inflation rate is projected to be 0.84 percentage points higher by 2010 and 1.99 percentage points higher by 2015. Given the government's monetary policy of inflation targeting, this exerts upward pressure on interest rates, which constrains domestic demand and investment.

The simulation results indicate that HIV/AIDS would reduce the supply of available workers to such an extent that skilled and unskilled unemployment rates would decline, putting upward pressure on wage rates. Higher wage rates, in turn, reduce the demand for labour.[29] Employment is also negatively affected by the lower level of economic activity. Since the drop in employment more than counters the increase in wages, aggregate household income declines.

As personal disposable income is the most important determinant of private consumption expenditure, lower consumer income translates into lower consumer spending. Consumption expenditure is also adversely affected by the higher interest rates and the reduction in the absolute number of consumers due to the epidemic. Compared to a no-AIDS scenario, the level of real FCE is projected to be 4.1% lower by 2010 and 7.5% lower by 2015. Consumer spending on non-durable and semi-durable goods is projected to be most vulnerable. A notable feature of the simulation results from the first impact

[27]Potential GDP gives an indication of an economy's production potential or *production frontier*.

[28] The coefficients in the production function are such that a change in the supply of skilled labour has a substantially larger impact on potential GDP compared to a change in the unskilled labour supply.

[29] The analysis indicated that the increase in wages for skilled workers (and hence the decline in skilled employment) would be more pronounced than that for unskilled workers, as skilled wages are more sensitive to changes in unemployment rates (i.e. the availability of workers) than unskilled wages.

channel is that personal savings is substantially higher in the AIDS scenario, as personal disposable income declines by substantially less than the decline in FCE.

A smaller population also implies a lower demand for housing - private fixed residential investment is projected to be 12.1% lower by 2015. The higher levels of interest rates and the lower level of economic activity explain the lower level of aggregate fixed investment. Furthermore, a lower level of government employment (due to the negative impact of a smaller population on the demand for government services) translates into a lower level of government consumption expenditure - the level of real government consumption expenditure is projected to be 6.3% lower by 2015 in the AIDS scenario.

The negative effects of a smaller population and labour force on final consumption expenditure, investment and government consumption expenditure is enough to ensure a substantially lower GDP than could have been possible in the absence of HIV/AIDS.

4.3.2) DIRECT COSTS OF HIV/AIDS TO THE PRIVATE SECTOR

AIDS related illnesses and deaths of managers, employees and their family members will have a significant impact on business. It is expected that companies will need to increase their contributions to pension, life, disability and medical benefits on account of the AIDS epidemic. While it is certain that the AIDS epidemic will lead to an increase in the cost of providing benefits for most companies, it is difficult to determine the magnitude of these direct costs to companies over an extended period of time. The reason for this is that some companies will attempt to shift a large proportion or even or all of the increased benefit costs to employees. Should companies succeed in restructuring their risk benefits so that employees carry a larger share of the responsibility, a proportion of the direct costs of HIV/AIDS will be absorbed by employees who will have to increase their own benefit contributions (and hence reduce their personal savings or expenditure on other consumer products and services), accept lower benefits or opt out of schemes altogether.

A number of studies have attempted to estimate the magnitude of the costs of AIDS, including the following:

- The AIDS Research Unit of the Metropolitan Group projected that the cost of an average set of employee benefits could double by 2005 and triple by 2010. Metropolitan estimated that, where companies have the full responsibility for the provision of benefits, these direct cost increases could add approximately 15% to the (no-AIDS) salary and wage costs of an average manufacturing company by 2005 and around 30% by 2010 (Quattek 2000: 11-12). ING Barings based their direct cost calculations on these estimates. Furthermore, ING Barings assumed that HIV/AIDS would only bring about extra direct costs in the case of skilled employment (i.e. it was assumed that only skilled labour would be covered by employee benefit schemes) and they assumed that employers would be responsible for two-thirds of the cost increases, of which 50% would be passed on to customers through price increases.

- In May 2001, Stephen Kramer (the manager of Metropolitan's AIDS Research Unit) noted that, based on current *expected* employee benefit structures, the direct cost increases could be lower than Metropolitan's original estimates.[30] He suggested that direct cost increases could add 10% to salary and wage costs by 2005 and around 20% by 2010. Furthermore, he estimated that close to 60% of the direct cost increases would be related to increases in the cost of medical benefits, while the other 40% of the cost increases would go towards pension, life and disability funds.

- Amalgamated Beverage Industries (a company that bottles and distributes soft drinks in southern Africa) recently estimated that about 4% of their current salary expenses relate to HIV/AIDS costs such as contributions to pension funds, medical aid and funeral benefits, as well as recruitment and training costs.[31] They projected that 8% (12%) of their salary expenses would go towards HIV/AIDS related costs by 2005 (2010) (Deutche Securities 2000: 9).

- Due to the sheer number of mineworkers infected with HIV[32], the mining sector in South Africa is particularly vulnerable to the impact of HIV/AIDS. Total direct and indirect costs (including opportunity costs) to the mining

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[30] Personal correspondence with Stephen Kramer at Metropolitan's AIDS Research Unit, May 2001.

[31] For the purpose of this analysis, costs such as recruitment and training costs, cost of increased labour turnover, lost skills, worker absenteeism and lower labour productivity are treated as indirect costs of the AIDS epidemic.

[32] It is estimated that about 30% of the ±500 000 mine workers in South Africa could be infected with HIV (Source B-Day article?).

industry are projected to increase from R114 million in 1995 to R1.5 billion by 2010 (in constant 1993 prices) (Bollinger and Stover 1999: 10). Table 4.3 shows that direct costs such as HIV/AIDS treatment and compensation for AIDS sick workers could comprise a substantial proportion of total HIV/AIDS related costs to the mining industry.

Table 4.3: The costs of HIV/AIDS to the mining sector (Rand million, constant 1992 prices)

	1995		2010	
	Cost	% of total	Cost	% of total
Prevention	5	4.4%	10	0.7%
Treatment	38	33.3%	600	39.8%
Compensation	39	34.2%	480	31.8%
Research	1	0.9%	5	0.3%
Replacement	1	0.9%	16	1.1%
Foregone earnings	19	16.7%	230	15.2%
Productivity loss	11	9.6%	168	11.1%
Total costs	114	100%	1509	100%

Source: Bollinger and Stover 1999: 10

- Gold Fields Ltd, South Africa's second-largest gold producer, estimated that HIV/AIDS related costs (including medical treatment, absenteeism and funeral leave, training and the loss of productivity) could amount to $10 per ounce of gold produced, unless the company took action. However, it is believed that the successful implementation of HIV/AIDS prevention programmes and programmes that could extend the working lives of HIV+ employees, as well as the introduction of an early retirement scheme for AIDS victims, could bring the costs down to about $2 per ounce (Ryan 2001).[33]

- A study that was conducted on the HIV/AIDS induced costs incurred by a South African sugar mill puts the cost per HIV/AIDS infected worker per year at R9 544 (Morris and Cheevers 2000: 7). Of this amount, only about 11% were estimated to go towards hospitalisation and medical care costs. According to Morris and Cheevers (2000: 8), the fact that medical care and hospitalisation costs constituted such a small share of the total costs reflects

[33] Gold Fields' all-in costs of producing an ounce of gold are currently between $240 and $250 (Ryan 2001).

the lack of treatment and the limited availability of medical care programmes. Absenteeism, replacement of workers and lost productivity each accounted for 28% of the costs, while training costs make up the remainder. Furthermore, according to Morris and Cheevers (2000: 7), costs appear to be concentrated in the final two years of employment.

- A study on the impact of AIDS on a Zimbabwean transport company with 11 500 workers projected that the total cost of AIDS to the company could rise from Z$39 million in 1996 (equal to about 20% of the company's profits) to Z$108 million by 2005. This company offers significant health benefits to its employees and it was estimated that health expenditure accounts for about 56% of this amount. Absenteeism accounted for 24% of the costs, while training costs made up the remainder (Bollinger and Stover 1999: 4; Haacker 2001: 10).

- For Botswana, a 5 company pilot study suggested that HIV/AIDS related direct and indirect costs could amount to 11.8% of each company's wage bill by 2004 (Abt Associates February 2000: 21).

- For Kenya, a study on the impact of HIV/AIDS on the commercial sector projected that the direct and indirect costs of AIDS on 16 Kenyan companies could amount to an average of 16% of the salary bill by 2005 (Abt Associates February 2000: 21).

- A study on the macro-economic impact of HIV/AIDS on three manufacturing firms in Abidjan (Côte d'Ivoire) projected that the direct and indirect costs of the epidemic could be between 10% and 15% of the wage bill if HIV infection rates increase to 15%. (Aventin and Huard 2000: 171 - 172).

- A study of the costs of HIV/AIDS to two South African companies and one company in Botswana (undertaken by the AIDS economics team of the Centre of Health at Boston University) suggested that AIDS costs could vary between 2% to 8% of annual salaries by 2010, depending on the production and employee benefit structures of the company (Brookings Institute 2001: 4-5).

a) Assumptions

These studies suggest that HIV/AIDS related costs will lead to a substantial increase in employment costs, particularly in a country like South Africa where the HIV infection rate of the labour force is expected to peak above 20%. However, given that employee benefit structures differ between companies and that the HIV infection rate in South Africa is different from that of other countries, it is quite difficult to project (quantify) the HIV/AIDS induced direct cost increases to the average company in South Africa. It was decided to base the direct cost calculations on the latest estimates from Metropolitan's AIDS research unit, as the information that can be gained from company specific studies is sketchy and often does not relate the direct and indirect costs of the epidemic to the wage bill, making it difficult to incorporate into a macro-economic model. Furthermore, medical and other employee benefits appear to be lower in other African countries compared to South Africa.

It was decided to exclude semi- and unskilled labour from the direct cost calculations, as it is likely that many of these workers are not covered by medical and other benefits.[34] Since HIV/AIDS prevalence is lower for the skilled and highly skilled groups and it is conceivable that the cost of AIDS drugs and treatment could decline substantially, I propose to use a more conservative estimate than that of Metropolitan - it was assumed that, if companies were to have the full responsibility for the provision of benefits, direct costs would add around 5% to the (no-AIDS) remuneration costs of skilled and highly skilled employees by 2005 and 10% by 2010.[35] [36] [37]

[34] Only about 20% of South Africa's total population is currently covered by employment-related health insurance (Abt Associates 2001: 16).

[35] AIDS prevalence rates in the skilled labour force were used to interpolate between 2001 and 2010. Cost increases were kept constant (at 10%) after 2010.

[36] According to an article by Dr Regensberg in AIDS Analysis Africa (April/May 1999: 11), there were two levels of antiretroviral therapy available to medical schemes in 1999. The first option covers the cost of dual therapy and amounted to R25 000 per annum. The second option allows for triple therapy and cost R45 000 per annum. Treatment commences only when the HIV+ patient starts to show symptoms of AIDS or once the patient's CD4+ count drops below a certain level. According to Stephen Kramer, the cost of AIDS drugs and antiretroviral therapy has come down substantially over the last few years and is expected to decline further in the future (Personal correspondence, May 2001).

[37] The assumption that direct costs would add around 5% to the (no-AIDS) remuneration costs of skilled employees by 2005 implies that the wage of an average skilled worker (i.e. the total skilled wage bill per worker) per annum will be about R4 500 higher in real terms by 2005 in the AIDS scenario compared to the no-AIDS scenario. Looking at it in another way, if companies agreed to carry all of the direct costs, extra benefit contributions by firms would amount to roughly R22 500 (in constant 2001 prices) per annum per HIV-infected worker in the skilled category. From this perspective, the assumption does not appear to be too conservative. Metropolitan's latest estimate of a 10% increase in direct costs by 2005 was therefore used as an alternative in the sensitivity analysis discussed below.

Having made the assumption with regard to the magnitude of the additional direct costs, the first step in modelling this impact channel was to create a variable, AIDSFC, to represent the additional direct (employee benefit) costs (in billions of rands) to employers and employees due to HIV/AIDS. AIDSFC was calculated by applying the assumption (expressed as a percentage of the skilled wage bill) to the no-AIDS forecast of the (nominal) private sector skilled wage bill. The next step was to create a variable, FS, representing the proportion of the direct cost increases that would be carried by employers (i.e. firms). It was assumed that firms would carry 50% of the direct (employee benefit) costs increases due to HIV/AIDS. Since additional employee benefit contributions for skilled employees *by firms* imply higher remuneration (wage rates) of skilled employees[38], AIDSFC enter the model through an addfactor in the private sector skilled wage rate equation. The increase in the average wage per skilled worker due to the increase in benefit contributions by firms was proxied by the direct cost increases that would be carried by employers (i.e. FS * AIDSFC) divided by the no-AIDS (baseline) forecast of private sector skilled employment (LEMHZG_BASE).[39] Equation 2 below indicates how the addfactor (WRMHZG_A) that enters the private sector skilled wage rate equation (equation 70 in Appendix A) is adapted to account for the increase in employee benefit contributions for skilled employees by firms:

EQ 2: WRMHZG_A = WRMHZG_A_BASE + (FS * AIDSFC / LEMHZG_BASE)

WRMHZG_A_BASE represents the baseline no-AIDS addfactor that enters the private sector skilled wage rate equation.

Having determined the magnitude of the direct cost increases to firms, we turn to how firms will finance these wage cost increases. It was assumed that firms would pass 50% of their share of the wage cost increases on to its customers through price increases

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[38] The SARB includes employers' contributions to pension, life, disability and medical benefits in their calculation of the compensation of employees in the national accounts. Higher contributions by employers therefore translate into higher remuneration (i.e. wage income) for employees. The assumption that firms carry 50% of the increase in direct costs therefore implies a 2.5% increase in the skilled wage rate by 2005 and 5% by 2010.

[39] Since AIDSFC is calculated as the assumption (expressed as a percentage of the skilled wage bill) multiplied by the private sector skilled wage bill, the amount that is added to the addfactor for the private sector skilled wage rate (wrmhzg) equation can be written as :

FS * AIDSFC / LEMHZG = FS * (assumption * YWBMHZG) / LEMHZH
= FS * assumption * (WRMHZG * LEMHZG) / LEMHZG
= FS * assumption * WRMHZG

so that the amount that is added to the addfactor for the WRMHZG equation can be expressed as a percentage of the WRMHZG.

(producer price inflation), while the remaining 50% of their share of the cost increases is absorbed through a reduction in their operating surpluses (lower company profits).[40] The private sector wage bill is expected to be substantially higher due to the increase in the private sector skilled wage rate. (Ignoring the adverse effect of higher wages on employment, the private sector wage bill should be approximately FS*AIDSFC higher in the AIDS scenario compared to the no-AIDS scenario.) Since the private sector wage bill enters the PPI equation as an explanatory variable, close to the full wage effect will work through to higher PPI inflation. Since the assumption is that firms will only be able to pass 50% of their share of the cost increases on to customers in the form of price increases, it was decided to reduce the private sector wage bill that enters the PPI equation by 50% * FS * AIDSFC (see equation 60). Furthermore, the private sector wage rate that enters the government skilled wage rate equation is reduced by FS * AIDSFC divided by private sector skilled employment (a proxy of the amount with which it would have increased), so that government wages do not increase due to higher employee benefit contributions by private sector firms.

Regarding the calculation of company profits in the model, by increasing the wage bill, AIDSFC has an adverse impact on the nominal gross operating surplus (YGOS) (see identity 94 in Appendix A). Since the net operating surplus of incorporated business enterprises (JNOS) is determined as a ratio (RJNOS) of YGOS less depreciation allowances (IDT), JNOS is automatically lower due to the increase in the wage bill. In order to ensure that the full impact of the increase in private sector wages centres completely on JNOS, JNOS was reduced by a further fraction of AIDSFC (see identity 96 in Appendix A).

Since it was assumed that companies would carry only 50% of the increases in the costs of employee benefits, employees would have to be responsible for the other half - i.e. the nominal amount (in billions of rands) that households are responsible for can be expressed as (1 - FS) * AIDSFC. It was assumed that households would finance 50% of their share of the direct costs from personal savings and the other half by reducing their expenditure on a number of consumer products and services. A new variable, HSUB, was created to represent the proportion of households' share of the direct costs that would be financed by reducing their FCE. HSUB * (1 - FS) * AIDSFC indicates the (nominal) amount that households have to finance through reducing FCE. It was assumed that households

[40] ING Barings assumed that companies would carry two-thirds of the wage cost increases, of which 50% would be passed on to customers through price increases (Quattek 2000: 12).

would cut back spending on the four sub-components of FCE according to each sub-component's share in FCE. The no-AIDS addfactors for the four sub-components of FCE were adjusted to account for this assumption. Equations 3-6 below indicates how the addfactors that enter the four FCE equations were adapted to account for the cutback in consumer spending on the four main components of FCE due to the increase in employee benefit contributions by employees:

EQ 3: $$\text{CD1\_A} = \text{CD1\_A\_BASE} - (\text{HSUB} * (1 - \text{FS}) * \text{AIDSFC} * 0.079 / (\text{PCI\_BASE} / 100))$$

EQ 4: $$\text{CSD1\_A} = \text{CSD1\_A\_BASE} - (\text{HSUB} * (1 - \text{FS}) * \text{AIDSFC} * 0.109 / (\text{PCI\_BASE} / 100))$$

EQ 5: $$\text{CND1\_A} = \text{CND1\_A\_BASE} - (\text{HSUB} * (1 - \text{FS}) * \text{AIDSFC} * 0.421 / (\text{PCI\_BASE} / 100))$$

EQ 6: $$\text{CS1\_A} = \text{CS1\_A\_BASE} - (\text{HSUB} * (1 - \text{FS}) * \text{AIDSFC} * 0.391 / (\text{PCI\_BASE} / 100))$$

Looking at equation 3 (for example), CD1_A_BASE represents the no-AIDS (baseline) addfactor that enters the real durable goods equation, while 0.079 (or 7.9%) is the average share of durable goods in total FCE over the past 5 years. Furthermore, in the calculation of each addfactor, AIDSFC was deflated with the (baseline) consumer price index (PCI_BASE) in order to determine the amount in constant prices that needed to be subtracted from each sub-component of FCE.

Having looked at how firms and households finance their higher contributions to employee benefit schemes, we turn to the effects of this impact channel on FCE. Presumably, close to the full amount of the contributions by employers and employees to employees' pension, life, disability and medical benefits will eventually be paid out to employees and will be used to contract a range of products and services. It was assumed that 60% of the extra direct costs to employers and employees due to HIV/AIDS would be related to increases in the cost of medical benefits and would be spent on health-related products and services. The other 40% of the cost increases is assumed to go towards pension, life and disability funds and would be spent by households in the normal fashion (i.e. on health-related and other goods and services). In order to be able to allocate the employee benefits disbursed by medical and other employee benefit schemes in this way, it was decided to adjust the addfactors in the four consumption equations. The addfactors to the equations for the sub-components of FCE were increased by 40% of AIDSFC multiplied by each sub-component's share in FCE (as it was assumed that households would spend this money in their normal fashion) in order to account for the positive impact on FCE of the disbursement of employee benefits other than medical benefits (i.e. the 40% of the cost increases that is assumed to go towards pension, life and disability funds):

$$\text{EQ 7: } \mathrm{CD1\_A} = \mathrm{CD1\_A\_BASE} - [\mathrm{HSUB} * (1 - \mathrm{FS}) * \mathrm{AIDSFC} * 0.079 / (\mathrm{PCI\_BASE} / 100)] + [0.4 * \mathrm{AIDSFC} * 0.079 / (\mathrm{PCI\_BASE} / 100)]$$

$$\text{EQ 8: } \mathrm{CSD1\_A} = \mathrm{CSD1\_A\_BASE} - [\mathrm{HSUB} * (1 - \mathrm{FS}) * \mathrm{AIDSFC} * 0.109 / (\mathrm{PCI\_BASE} / 100)] + [0.4 * \mathrm{AIDSFC} * 0.109 / (\mathrm{PCI\_BASE} / 100)]$$

$$\text{EQ 9: } \mathrm{CND1\_A} = \mathrm{CND1\_A\_BASE} - [\mathrm{HSUB} * (1 - \mathrm{FS}) * \mathrm{AIDSFC} * 0.421 / (\mathrm{PCI\_BASE} / 100)] + [0.4 * \mathrm{AIDSFC} * 0.421 / (\mathrm{PCI\_BASE} / 100)]$$

$$\text{EQ 10: } \mathrm{CS1\_A} = \mathrm{CS1\_A\_BASE} - [\mathrm{HSUB} * (1 - \mathrm{FS}) * \mathrm{AIDSFC} * 0.391 / (\mathrm{PCI\_BASE} / 100)] + (0.4 * \mathrm{AIDSFC} * 0.391 / (\mathrm{PCI\_BASE} / 100)]$$

Regarding the extra direct costs related to increases in the cost of medical benefits (60% of AIDSFC), it was assumed that, initially, 40% of the *health spending* would go towards health products such as HIV/AIDS drugs (implying an increase in consumer spending on non-durable goods) and 60% towards medical care (implying an increase in consumer spending on services). However, since it is expected that the cost of HIV/AIDS drugs will decline in the future, it was assumed that the share of health spending that goes towards non-durable goods would gradually decline to 25% in 2010. The addfactors that enter the equations for FCE on non-durable goods and services were adjusted to account for the positive effects of the disbursement of medical benefits (see equations 10 and 11 below). The variable AIDSFCND1 indicates the share of health spending that would go towards non-durable goods, while AIDSFCS1 represents the share that would go towards medical services (AIDSFCS1 = 1 - AIDSFCND1).

$$\text{EQ 11: } \mathrm{CND1\_A} = \mathrm{CND1\_A\_BASE} - [\mathrm{HSUB} * (1 - \mathrm{FS}) * (\mathrm{AIDSFC}) * 0.421 / (\mathrm{PCI\_BASE} / 100)] + [0.4 * \mathrm{AIDSFC} * 0.421 / (\mathrm{PCI\_BASE} / 100)] + [0.6 * \mathrm{AIDSFCND1} * \mathrm{AIDSFC} / (\mathrm{PCI\_BASE} / 100)]$$

$$\text{EQ 12: } \mathrm{CS1\_A} = \mathrm{CS1\_A\_BASE} - [\mathrm{HSUB} * (1 - \mathrm{FS}) * \mathrm{AIDSFC} * 0.391 / (\mathrm{PCI\_BASE} / 100)] + [0.4 * \mathrm{AIDSFC} * 0.391 / (\mathrm{PCI\_BASE} / 100)] + [0.6 * \mathrm{AIDSFCS1} * \mathrm{AIDSFC} / (\mathrm{PCI\_BASE} / 100)]$$

Having adjusted the addfactors to the consumption equations to account for the positive impact on FCE due to the disbursement of employee benefits, one cannot allow the increase in skilled wages due to the increase in benefit contributions to impact on FCE via the real disposable income and real after tax wage bill variables in the consumption equations, as it would lead to double counting. Furthermore, the positive impact of higher benefit contributions on the real after tax wage bill should not lead to an increase in private fixed residential investment. Therefore, the real disposable income and real after tax wage bill variables in the consumption and residential investment equations were reduced by FS * AIDSFC - a proxy of the amount with which they would have increased due to the increase in the private sector skilled wage rate (see equation 1-4 and 7 in Appendix A). Moreover, as some employee benefits are not taxable, it was decided to reduce the wage bill that enters the personal tax identity by FS * AIDSFC (see identity 104 in Appendix A).

b) Macro-economic effects

Higher contributions by employers to medical and other employee benefit schemes translate into higher wages for skilled employees in the private sector. The simulation results indicate that the average wage per skilled employee in the private sector could be 12.1% higher in nominal terms by 2010 and 19.6% higher by 2015 compared to a no-AIDS scenario (see table C.2 in Appendix C). The projected increase in the unskilled wage in the private sector is in line with the increase in the PPI inflation rate. Higher real wages for skilled employees in the private sector reduces the demand for skilled labour, but since the wage increases more than counter the decline in skilled employment, the aggregate wage bill (and hence household income) still increases.

Total consumption expenditure is stimulated by the rise in consumer income. However, this is to some extent countered by the higher level of the prime overdraft rate (see next paragraph). Spending on non-durable goods (e.g. AIDS medicine/drugs) and services (e.g. medical care) is substantially higher compared to a no-AIDS scenario, as the largest part of the increase in the skilled wage rate stems from the disbursement of medical benefits. Spending on durable and semi-durable goods also benefits from the increase in household income, but this is countered by a shift in consumption expenditure, as it is assumed that households finance 50% of the increase in their benefit contributions by reducing their non-health care expenditure. Similarly, personal savings also suffer from the increase in benefit contributions by households. However, by 2015 the adverse impact on personal savings is counterbalanced by the fact that FCE increases by slightly less than disposable income (possibly due to the negative impact of the higher interest rate on FCE).

Since it was assumed that firms would be able to pass 50% of their share of the direct cost increases on to customers through price increases, producer price inflation is significantly higher. As this implies a deterioration in South Africa's inflation differential with its major trading partners, the (nominal) effective exchange rate of the rand depreciates. Furthermore, given the government's inflation targets, higher inflation exerts upward pressure on interest rates. Corporate savings are negatively affected, as a proportion of the higher skilled wage bill is financed out of the operating surpluses of companies. The higher levels of interest rates and the lower level of corporate savings explain the lower level of aggregate fixed investment. The simulation results indicate that, despite the higher level of economic activity, the level of real fixed investment could be 3.5% lower by 2010 and 4.5% lower by 2015 compared to a no-AIDS scenario.

The effect of this impact channel on the current account of the balance of payments is less straightforward. The rise in HIV/AIDS induced domestic expenditure leads to a higher level of imports compared to a no-AIDS scenario. (A significant proportion of health care products and services are generally imported.) Imports are also stimulated by the lower relative cost of imports, as the increase in domestic inflation exceeds the increase in imported inflation. Higher imports translate into a deterioration in South Africa's trade balance, which leads to a depreciation in the rand exchange rate. In turn, exports are stimulated by the real depreciation of the rand exchange rate. The current account on the balance of payments expressed as a percentage of GDP initially deteriorates, but eventually improves, as the increase in exports starts to predominate.

In all, the AIDS-induced increase in final consumption expenditure (which constitutes more than 50% of GDP) is just enough to counter the decline in investment, so that GDP increases slightly.

4.3.3) INDIRECT COSTS OF HIV/AIDS TO THE PRIVATE SECTOR

In addition to direct cost increases, indirect costs to companies may also rise. These costs include recruitment and training costs; cost of increased labour turnover; lost skills; worker absenteeism due to illness or compassionate leave for workers to attend funerals and to care for sick family members; lower labour productivity due to physical disability, stress and reduced morale caused by the illness or death of friends, fellow employees and relatives; legal fees and time spent on negotiations between labour and management; as well as the costs involved in ensuring occupational health and safety standards (Laubscher 2000: 11-13; Quattek 2000: 11-12). Studies have shown that indirect costs could comprise a substantial proportion of the total HIV/AIDS related costs:

Table 4.4: Types of HIV/AIDS costs to companies as a proportion of total HIV/AIDS costs.

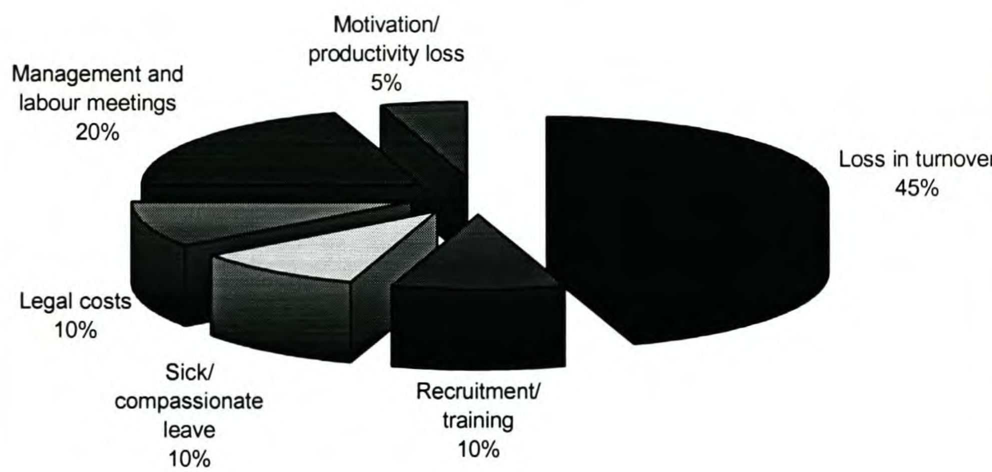
	Botswana (1997)	Zambia (1992/93)	Kenya (1994)	Malawi (1995/96)	SA (1999/ 2000)
Absenteeism/lost productivity	54%	32%	54%	25%	56%
Training and recruitment	23%	20%	24%	-	33%
Funerals and travel	1%	18%	10%	5%	-
Medical costs	14%	15%	12%	38%	11%
Other benefits	8%	16%	-	32%	-
Total	100%	100%	100%	100%	100%

Source: Abt Associates February 2000: 21; Morris and Cheevers February/March 2000: 7.

Metropolitan estimated that indirect costs such as recruitment and training costs; cost of increased labour turnover; sick or compassionate; lower labour productivity; legal costs and time spent on labour could add 10% to the remuneration costs of an average manufacturing company by 2005 and around 15% by 2010 (Quattek 2000: 12). Figure 4.2 provides a breakdown of the type of indirect costs as a proportion of the total indirect costs of HIV/AIDS.

AIDS related illnesses and deaths of managers and other employees may also reduce overall productivity - or *total factor productivity*. Total factor productivity refers to "efficiency improvements (or declines) which are not attributable solely to one or the other of the two factor inputs (labour and capital), but rather to their combination in production" (Parker et al. 2000: 17). Absenteeism, delays in finding replacement workers, disruption of teams, the loss of experience and skills and adjustment problems will increase the possibility of idle machinery and slow down production, thereby reducing the productivity with which capital and labour combine in the production process.

Figure 4.2: Source of additional indirect costs to companies



a) Assumptions

Some indirect costs are difficult to quantify and often accumulate for a long time before companies recognise their significance. Our assumption with regard to the indirect costs to the private sector is threefold: Firstly, we assumed a 40% reduction in the productivity of both skilled and unskilled workers who are sick with AIDS. This mainly affects the potential GDP, as the "effective" labour force is reduced due to the impact of AIDS on labour productivity. The variables AIDSPROLFMH and AIDSPROLFUS were employed to adjust the private sector skilled labour force (LFMHZG) and the private sector unskilled labour force (LFUSZG) in the production function for labour productivity lost due to the epidemic. Since a 40% reduction in the productivity of AIDS sick workers is assumed, AIDSPROLFMH is calculated as 1 - 40%* AIDSPREVLFMH, where AIDSPREVLFMH represents AIDS prevalence among the skilled labour force. Similarly, AIDSPROLFUS is calculated as 1 - 40%* AIDSPREVLFUS, where AIDSPREVLFUS represents AIDS prevalence among the unskilled labour force.[41] Furthermore, it was assumed that a

[41] e.g. LFMHZG * AIDSPROLFMH = LFMHZG * (1 - 40% * AIDSPREVLFMH)
= LFMHZG - 40% * AIDSPREVLFMH * LFMHZG
= private sector skilled labour force - 40% * the number of AIDS victims in the skilled labour force

reduction in labour productivity would have an adverse impact on the demand for labour. Since lower labour productivity can be seen as higher wage costs per productive unit (in the sense that the wage bill remains the same, but the "effective" labour force declines), it was decided to model this part of the productivity impact by increasing the wage rates that enter the employment equations (which should induce a decline in employment) (see equations 47 and 48 in Appendix A). The wage rate that enters the private sector skilled (unskilled) employment equation was multiplied by 1/AIDSPROLFMH (1/AIDSPROLFUS).[42]

The second indirect cost channel that is modelled is the impact of reduction in the rate of total factor productivity growth compared to the no-AIDS scenario. The impact of a gradual reduction in the rate of total factor productivity growth to about 79% of what it could have been without AIDS was explored - this 21% reduction in the rate of total factor productivity growth is based on the 21% reduction in the total labour force due to AIDS.[43] This was achieved by multiplying the exogenously determined no-AIDS growth rate in TFP with the ratio of the AIDS inclusive labour force and the no-AIDS labour force.

Thirdly, like ING Barings, it was assumed that AIDS-induced indirect costs would increase employment costs to companies. Metropolitan estimated that indirect costs could add 10% to the remuneration costs of an average manufacturing company by 2005 and around 15% by 2010 (Quattek 2000: 12). Since some of the indirect costs have already been accounted for by reducing the effective labour force, I opted for a more conservative indirect cost estimate - it was assumed that indirect costs would add around 5% to the (no-AIDS) remuneration costs of unskilled employees by 2005 and 7.5% by 2010.

[42] The wage rate that enters the private sector skilled employment equation was adapted as follows:

WRMHZG * [1/AIDSPROLFMH] = WRMHZG * [1/(1 - 40% * AIDSPREVLFMH)]
= (YWBMHZG/LEMHZG) * [1/(1 - 40% * AIDSPREVLFMH)]
= YWBMHZG/ [LEMHZG * (1 - 40% * AIDSPREVLFMH)]
= YWBMHZG/ (LEMHZG - 40% * AIDSPREVLFMH * LEMHZG)
= YWBMHZG / (private sector skilled employment - 40% * the number of AIDS victims among the skilled employed)

From this it is clear that the private sector wage rate that enters the private sector employment equation was increased slightly in the AIDS scenario.

[43] The impact of HIV/AIDS on overall productivity is especially difficult to quantify and has been absent in many of the earlier macro-econometric analyses (e.g. the ING Barings study). Arndt and Lewis (2000: 10) did include this impact channel and linked their reduction in total factor productivity growth to the AIDS death rate for unskilled labour. Their assumption was that the rate of total factor productivity growth could be 50% lower by 2010 than what would have been possible in the absence of AIDS (Arndt and Lewis 2000: 9).

The indirect costs (calculated as a percentage of the remuneration of employees) to companies that rely on skilled labour could be lower than the indirect costs of employing unskilled labour due to the lower HIV/AIDS prevalence among the skilled labour group. Furthermore, skilled labour is more likely to be covered by health insurance, which would render HIV/AIDS drugs and medical care more affordable. The right kind of medical care (e.g. antiretroviral treatment) may well prolong the life of an HIV infected employee, keeping the worker healthier, and hence more productive, for a longer period of time. It was therefore assumed that indirect costs would add only 2.5% to (no-AIDS) remuneration costs of skilled employees by 2005 and 5% by 2010.[44]

Having made these assumptions, the first step in modelling this channel was to create variables, AIDSIFCMH and AIDSIFCUS, to represent the additional indirect costs (in billions of rands) to employers of skilled and unskilled labour respectively. AIDSIFCMH and AIDSIFCUS are calculated by applying the assumptions for the extra indirect costs (expressed as percentages of the skilled and unskilled wage bills) to the no-AIDS forecast of the private sector skilled and unskilled (nominal) wage bills. AIDSIFC represents total indirect cost increases to firms (i.e. AIDSIFC = AIDSIFCMH + AIDSIFCUS)

It was assumed that firms would be responsible for all of the indirect costs due to HIV/AIDS. As some of these indirect costs are tied to increased economic activity and possibly employment (e.g. associated with recruitment and training), 20% of the indirect costs were added back in the form of increased employment. In order to account for the extra private sector employment, the no-AIDS (baseline) addfactor for private sector skilled employment (LEMHZG_A_BASE) was increased by 20% of the extra indirect costs divided by the (no-AIDS) private sector skilled wage rate, represented by WRMHZG_BASE (AIDSIFCMH / WRMHZG_BASE is used as a proxy for the additional skilled labour units employed). Similarly, 20% of the extra indirect costs divided by the (baseline) private sector unskilled wage rate (WRUSZG_BASE) was a dded to the addfactor for private sector unskilled employment:

EQ 13: LEMHZG_A = LEMHZG_A_BASE + (0.2 * AIDSIFCMH / WRMHZG_BASE)

EQ 14: LEUSZG_A = LEUSZG_A_BASE + (0.2 * AIDSIFCUS / WRUSZG_BASE)

[44] AIDS prevalence rates in the skilled labour force were used to interpolate between 2001 and 2010. Cost increases were kept constant (at 5%) after 2010.

Regarding the financing of the indirect cost increases, it was assumed that firms would pass 50% of the costs on to its customers through prise increases (producer price inflation), while the remainder would be absorbed through a reduction in their operating surpluses (lower company profits). Looking at the PPI equation (see equation 60 in Appendix A), the private sector wage bill (YWBZG) that enters this equation should be somewhat higher due to the increase in employment associated with some of the indirect costs. (The private sector wage bill should be approximately 20%* AIDSIFC higher.) Since the assumption is that firms will be able to pass 50% of the cost increases on to customers in the form of higher prices, the private sector wage bill that enters the PPI equation is increased by another (50%-20%)* AIDSIFC.

Regarding the calculation of company profits in the model, AIDSIFC is subtracted from YGOS and the necessary adjustments are made to JNOS to ensure that the full impact of the cost increases centres on JNOS. Intuitively, it would seem as though YGOS should only be reduced by 50% of AIDSIFC, as only 50% of the indirect costs are assumed to be absorbed through lower company profits - the other 50% is financed via price increases. However, model simulations indicated that YGOS increased substantially due to the higher PPI inflation rate, so that the full amount of AIDSIFC had to be subtracted from YGOS (and JNOS) in order to see that company profits are negatively affected by the cost increases in the model.

b) Macro-economic effects

By reducing the effective labour force and total factor productivity, HIV/AIDS will have an adverse impact on the economy's production potential. Actual GDP will also be lower due to the negative impact of indirect costs to companies on private sector employment and hence on household consumption expenditure, as well as on fixed investment. Compared to a no-AIDS scenario, the level of actual GDP is projected to be 2% smaller by 2010 and 3% smaller by 2015 (see table C.3 in Appendix C). The adverse impact on potential GDP is only slightly more severe, so that the output gap and capacity utilization remains relatively unaffected.

Although it was assumed that 20% of indirect cost increases would translate into higher employment in the private sector, this effect is eventually counterbalanced by a decline in the demand for labour, due to lower labour productivity and a lower level of economic activity. Naturally, a lower level of employment translates into lower real wage income, which negatively affects FCE. Furthermore, it was assumed that companies would finance indirect cost increases by increasing their selling prices and through lower operating surpluses. Therefore, analogous to the direct cost effects, this puts upward pressure on prices and interest rates and leads to a reduction in corporate savings and investment. Lower company profits will also have negative repercussions for the government's budget deficit, as lower private sector profits will translate into lower government revenue from corporate taxation.[45]

4.3.4) HIGHER GOVERNMENT EXPENDITURE

a) Assumptions

The public health sector will be faced with a number of challenges as a result of the HIV/AIDS epidemic. Like private sector companies, the government will need to increase its contributions to pension, life, disability and medical benefits of its employees on account of the AIDS epidemic and indirect costs will arise from the absenteeism and replacement of public sector employees who have fallen victim to HIV/AIDS. Increased morbidity and mortality among government employees is likely to lead to a deterioration in the quality of public sector services (Laubscher 2000: 14).

In addition, the epidemic will put special pressures on the public health sector. HIV/AIDS increases the number of people seeking health care and the majority of HIV/AIDS victims will turn towards the public sector for medical care. HIV/AIDS will also put upward pressure on other forms of social spending by the government, such as foster grants and institutional care for orphans. Given the scarce resources available, the government will be faced with trade-offs such as spending resources on the treatment of AIDS patients versus preventing new HIV infections; treating AIDS patients versus treating patients with other illnesses; and spending on health care versus spending on other objectives (Bollinger and Stover 1999:6).

The increased financial burden stemming from higher public health care and an increase in the demand for social spending, such as disability and child support grants and institutional care for orphans, will probably coincide with reduced government tax revenues. Increased costs as a result of HIV/AIDS will have an adverse impact on economic growth and reduce private sector profits, indicating an erosion of the tax base

[45] Since it was assumed that companies are responsible for all of the indirect costs increases (as opposed to only 50% of the direct cost increases), AIDS induced indirect firm costs impact more negatively on government tax revenues than direct firm costs.

and lower government revenue. It is thus apparent that HIV/AIDS will create pressure on the budget deficit on two fronts: higher health and other social expenditure and lower government revenues (Laubscher 2000: 14).

a.1) Direct and indirect costs of HIV/AIDS to the government as an employer

Increased morbidity and mortality among government employees will bring about substantial direct and indirect costs for the government as an employer. Unfortunately, not many studies have attempted to quantify the impact of HIV/AIDS on the employment costs of the government. Both the ING Barings study and the Arndt and Lewis paper ignored this impact channel. Haacker (2001: 4) estimated that, if the number of AIDS victims among public sector employees in Swaziland should increase to 4.8% by 2010, the cost of sick leave and death-related benefits to public sector employees could rise to 14% of Swaziland's public sector wage bill. These projections are based on estimates from a study by the Ministry of Education of Swaziland on the impact of HIV/AIDS on their education sector.

BIDPA (2000: 56-57) attempted to quantify the impact of HIV/AIDS on certain key areas of government expenditure in Botswana. Their analysis indicated that HIV/AIDS would exacerbate Botswana's shortage of skilled labour, which would put upward pressure on skilled wages, to such an extent that Botswana's public sector wage bill could increase by 6% by 2010. Since government wages comprise approximately 36%-40% of Botswana's total government expenditure, this figure translates into an increase of about 2.3% in total government spending by 2010.

With regard to other wage costs to Botswana's government, BIDPA ignored the possibility that Botswana's government may have to increase its contributions to the medical funds of public sector employees. They estimated that government pension liabilities could be somewhat lower due to the impact of HIV/AIDS on the mortality of government employees - it was projected that savings on pension costs could reduce total government spending by 0.6% by 2010. With regard to indirect costs to the government, it was estimated that extra training and recruitment costs could add 0.3% to total government expenditure by 2010.

For lack of a better estimate, the assumptions with regard to the size and the distribution of the direct (employee benefit) costs are analogous to the direct cost assumption for the private sector. It was assumed that only skilled and highly skilled government employees are covered by medical and other benefits. As in the case of direct costs to the private sector, it was assumed that the direct costs would amount to about 5% of the (no-AIDS) remuneration costs of skilled government employees by 2005 and 10% by 2010. The variable AIDSDCG was created by applying this assumption to the government skilled wage bill and represents the additional direct costs (in billions of rands) to the public sector and its employees due to HIV/AIDS.

It was assumed that the government would carry 50% of the direct cost increases due to HIV/AIDS and that employees would have to be responsible for the other half. As in the case of direct costs to the private sector, direct costs to the government enter the model through an addfactor (represented by WRMHG_A below) in the government skilled wage rate equation (equation 72 in Appendix A). The increase in the average wage per skilled government employee due to the increase in benefit contributions by government is proxied by the direct cost increases that are carried by the government (50% of AIDSDCG) divided by the no-AIDS (baseline) forecast of public sector skilled employment (LEMHG_BASE):

EQ 15: WRMHG_A = WRMHG_A_BASE + [(0.5 * AIDSDCG) / LEMHG_BASE]

where WRMHG_A_BASE represents the addfactor to the government skilled wage rate in the no-AIDS (baseline) scenario. It was assumed that the government would not cut back on public sector employment (which is exogenous to the model) due to the increase in wages for skilled public sector employees and that the resulting increase in the government wage bill would be deficit financed.

The assumption with regard to how households finance their share of cost increases and how the benefit disbursements would be divided between the four main consumption expenditure categories is analogous to the direct cost assumption for the private sector. The addfactors that enter the four FCE equations were adapted in the following way:

EQ 16: CD1_A = CD1_A_BASE - [HSUB * (0.5 * AIDSDCG) * 0.079 / (PCI_BASE / 100)] + [0.4 * AIDSDCG * 0.079 / (PCI_BASE / 100)]

EQ 17: CSD1_A = CSD1_A_BASE - [HSUB * (0.5 * AIDSDCG) * 0.109 / (PCI_BASE / 100)] + [0.4 * AIDSDCG * 0.109 / (PCI_BASE / 100)]

EQ 18: CND1_A = CND1_A_BASE - [HSUB * (0.5 * AIDSDCG) * 0.421 / (PCI_BASE / 100)] + [0.4 * AIDSDCG * 0.421 / (PCI_BASE / 100)] + [0.6 * AIDSFCND1 * AIDSDCG / (PCI_BASE / 100)]

EQ 19: CS1_A = CS1_A_BASE - [HSUB * (0.5 * AIDSDCG) * 0.391 / (PCI_BASE / 100)] + [0.4 * AIDSDCG * 0.391 / (PCI_BASE / 100)] + [0.6 * AIDSFCS1 * AIDSDCG / (PCI_BASE / 100)]

The assumption with regard to the size of the indirect costs to government as an employer is similar to the assumption for the indirect costs to the private sector. It was assumed that indirect costs would amount to about 2.5% (5%) of the no-AIDS remuneration costs of skilled (unskilled) employees by 2005 and 5% (7.5%) by 2010 and that the government would be responsible for all of the indirect cost increases. (No other indirect costs were assumed to occur for government as an employer.) The variables AIDSICGMH and AIDSICGUS were created to represent the additional indirect costs (in billions of rands) to the public sector as an employer of skilled and unskilled labour respectively. Whereas the extra direct costs increased the wages of skilled government employees, it was assumed that the AIDS-induced indirect costs would lead to an increase in government employment and non-wage government expenditure. As in the case of indirect costs to the private sector, it was assumed that 20% of the extra indirect cost increases would translate into higher government employment. Furthermore, given the tight fiscal deficit targets, we assumed that the government would cut back its employment and non-wage consumption expenditure to such an extent that government consumption expenditure would only increase by 50% of the indirect costs. The variable GNOSUB represents the proportion (50%) of the indirect costs that would be financed via a higher budget deficit (i.e. not by substituting between/ cutting back spending in certain government departments). Equations 20 and 21 below indicate how the baseline (exogenous) forecasts of skilled and unskilled government employment were adapted to account for the increase in government employment tied into higher indirect costs to the government:

EQ 20: LEMHG = LEMHG_BASE + [GNOSUB * (0.2 * AIDSICGMH) / WRMHG_BASE]

EQ 21: LEUSG = LEUSG_BASE + [GNOSUB * (0.2 * AIDSICGUS) / WRUSG_BASE]

From equation 20 it is clear that 20% of the extra indirect costs of employing skilled workers (0.2 * AIDSICGUS), multiplied by the proportion that would be financed via a higher budget deficit (GNOSUB) and divided by the government skilled wage rate (WRMHG_BASE), is added to the no-AIDS (baseline) forecast for government skilled employment (LEMHG_BASE). (Again, AIDSICGMH / WRMHG_BASE is used as a proxy for the additional skilled labour units employed.) Unskilled employment by the public sector (LEUSG) in the AIDS scenario is determined in a similar way.

a.2) Higher public health care expenditure

One of the most visible consequences of the epidemic will be an increase in the number of people seeking medical care. Since only ±20% of South Africa's population is covered by employment-related and other private medical schemes, the vast majority of HIV/AIDS victims will look towards publicly funded hospitals for medical care (Abt Associates 2001: 16). Public hospitals are funded out of general tax revenue and essentially provide medical services free of charge. The financial strain on the public health sector will be severe, not only as a result of the sheer number of people seeking health care, but also because health care for AIDS patients is more expensive than for most other conditions.

A number of studies on the impact of HIV/AIDS on public sector health expenditure have linked their projections to some estimate of the health care cost per AIDS victim and the number of AIDS victims that would turn to the public sector for medical care. According to Ainsworth and Over's "rule of thumb", AIDS treatment costs generally lie between two and four times per capita income[46] (Parker et al. 2000: 15). The SARB estimated per capita GDP in South Africa to be R19 999 in 2000, which puts treatment costs between R40 000 and R80 000 according to Ainsworth and Over's rule of thumb (SARB Quarterly Bulletin June 2001). An estimate by the World Bank suggests that for on average, the cost of AIDS treatment in an African country is roughly equal to 2.7 times the per capita GDP (Haacker 2001:5).

According to ING Barings, more conservative estimates suggest that the current average annual cost to the *public sector* of treating an AIDS patient is between R3 000 and R4 500 (Quattek 2000: 16). ING Barings assumed that government would spend only R3 750 per full-blown AIDS case and that the government would have to provide medical care for all AIDS victims in South Africa, except those who are a part of the skilled and highly skilled labour force (as they were assumed to be covered by employment

[46] Presumably, their rule of thumb applies mainly to developing countries, as it is unlikely that treatment costs in industrial countries with high per capita incomes (e.g. USA) would be this high.

related medical insurance). This amounted to roughly R3.5bn of extra public sector spending on health care by the year 2005 and R4bn by 2010. (Quattek 2000: 16-17).

Arndt and Lewis (2000:19) assumed that government spending on health care as a percentage of total government expenditure would increase from 15% in 1997 to 20% in 2010. Whether this is linked to an estimate of the cost of care per victim is unclear.

BIDPA (2000: 58-59) used an estimate of health care per AIDS victim in Botswana of between 1 and 4 times per capita GDP and assumed that Botswana's government would be responsible for 85% of the total cost of care for AIDS victims in Botswana. (It was assumed that private insurance would cover the remaining 15% of the health care costs.) Based on these assumptions, it was projected that total government expenditure in Botswana could be between 4.1% and 16.5% higher by 2010.

This analysis explores the impact of providing public health care at a cost of R16 900 per full-blown AIDS case. This is based on Abt Associates' estimate of the average cost of care per infected person per year in the public health sector (see table 4.5).

Table 4.5: Average cost of care per infected person per year by stage and sector[47]

	Public Sector			Private Sector		
	Inpatient	Outpatient	Total	Inpatient	Outpatient	Total
Stage 1 and 2	R 700	R 600	R 1,300	R 1,600	R 1,400	R 3,000
Stage 3	R 5,200	R 1,100	R 6,300	R 11,800	R 2,400	R 14,200
Stage 4	R 15,500	R 1,400	R 16,900	R 35,100	R 3,200	R 38,300

Source: Abt Associates 2001: 16

It was assumed that 75% of all the AIDS victims who are not employed in the skilled and highly skilled sectors (i.e. the economically inactive population, the unemployed and semi- and unskilled employees) would look towards publicly funded hospitals for medical care.[48] This amounted to roughly R6bn of extra public sector

[47] It should be noted that neither the public nor the private sector cost estimates include anti-retroviral therapy. Abt Associates also considered the cost implications of providing triple anti-retroviral therapy at current market prices in the public sector. Assuming that triple therapy costs around R44 000 per year, with another R7 000 per year for monitoring, it was estimated that it would cost R70 billion per year by 2010 to provide this therapy to all public sector patients in the last two stages of AIDS. Since this would mean that the South African government would have to triple its public health care budget for that year, widespread use of anti-retroviral therapy for AIDS victims does not appear to be a realistic option (Abt Associates April 2000: 16 - 18).

[48] In other words, 25% of the AIDS victims who are not employed in the skilled or highly skilled sectors (e.g. children and housewives) will not rely on free medical services at public hospitals. These individuals either receive financial support and care from family members or friends, or they are able to afford medical

spending on health care (in constant 2001 prices) by the year 2005 and R11.7bn by 2010. Given that the Minister of Finance allocated only R296 million rand in the 2001 Budget to measures aimed at combating HIV/AIDS, this assumption appears to be more realistic than projections based on the cost of care per AIDS victim as suggested by Ainsworth and Over and the World Bank.

Given these assumptions, AIDSHGOV - the nominal increase in public health care expenditure due to HIV/AIDS in billions of rands - can be calculated as:

$$\text{EQ 22: } AIDSHGOV = [0.75 * (AIDSVICNPT - AIDSVICLEMH) * (R16\,900 / 1000\,000\,000) * (PCI / 146.34)]$$

where AIDSVICNPT represents the number of AIDS victims in the total population and AIDSVICLEMH is the number of AIDS victims among the skilled employed. The average cost of care per infected person (R 16 900 in the year 2000) is multiplied by the CPI inflation index divided by the index value in 2000 to ensure that the (nominal) cost of care rises with inflation.

It was assumed that 60% of this extra health expenditure would be used to employ more doctors, nurses and other health workers and the remaining 40% would go towards other government health expenditure. The extra employment related health expenditure is assumed to be split 90%/10% between skilled and unskilled government employment, as skilled employees comprise approximately 90% of the government labour force. In order to account for the budget constraints of the government, it was assumed that the government would finance 50% (GNOSUB) of the extra health expenditure by cutting back spending in other departments or within the health department. Equations 23 and 24 below indicate how the baseline (exogenous) forecasts of government employment were adapted to incorporate the extra employment related health expenditure:

$$\text{EQ 23: } LEMHG = LEMHG\_BASE + [GNOSUB * (0.2 * AIDSICGMH) / WRMHG\_BASE] + [0.9 * GNOSUB * (0.6 * AIDSHGOV) / WRMHG]$$

$$\text{EQ 24: } LEUSG = LEUSG\_BASE + [GNOSUB * (0.2 * AIDSICGUS) / WRUSG\_BASE] + [0.1 * GNOSUB * (0.6 * AIDSHGOV) / WRUSG]$$

services at private hospitals, either because they have health insurance via a parent or spouse's insurance or because they are able to finance the AIDS induced medical costs from savings and by cutting back spending on non-essential products and services.

Extra employment related health expenditure divided by the government wage rate is used as a proxy for the additional number of doctors, nurses and other health workers employed by the government due to the epidemic.

a.3) Welfare expenditure for orphans

One of the most tragic consequences of the HIV/AIDS epidemic is the growth in the number of children who lose one or more parents to AIDS - the number of orphans under the age of 15 is expected to increase from the current ±250 000 to close to 1 million in 2005 and 2.5 million by 2010 (Abt Associates 2001: 10-11). A quadrupling in the number of orphans over the next four years is bound to have a significant impact on government welfare expenditure.

A report by Niresh Ramklass of the Child Welfare Society (June 2000) recommended that foster care grants to the value of R472 per orphan per month be awarded to foster parents and that care dependency grants be extended to all children that fall victim to HIV/AIDS. This analysis explores the impact of providing foster care grants at a cost of R570 per orphan per month. The foster care figure assumed in this analysis is somewhat on the high side, but the impact of HIV/AIDS on care dependency grants is ignored. It was assumed that only about 30% of foster parents would actually turn to government for financial assistance, as many potential caregivers would not want to go through the official channels to get approved as foster parents. This amounted to roughly R2.9bn of extra welfare spending on orphans (in constant 2001 prices) by the year 2010.[49] Additional welfare expenditure on orphans (AIDSORPHAN) enters the model via the identity for government transfers to households (see identity 114 in Appendix A).

a.4) Higher personal and corporate tax rates

The HIV/AIDS epidemic is likely to impact adversely on the government's fiscal position. Direct and indirect employment costs to the government and higher public health and welfare expenditure will lead to an increase in the budget deficit (or a lower budget surplus) and will exacerbate the public sector borrowing requirement. AIDS related costs will also create pressure on the government's fiscal position from another front – lower government tax revenues. Increased direct and indirect costs related to HIV/AIDS reduce

[49] Considering that the government's budget deficit is projected to decrease to less than R6bn in the no-AIDS scenario (in constant 2001prices), extra spending on orphans to the tune of R2.9 is certainly substantial and will lead to a significant increase in the budget deficit, ceteris paribus.

private sector profits and hence, lowers corporate taxes, which has negative repercussions for the budget deficit.

Given the resolve that the government has shown in sticking to its fiscal deficit target, it is unlikely that government would allow the budget deficit to get out of hand. It was therefore assumed that personal and corporate tax rates would be about 0.5 and 3.0 percentage points higher respectively between 2001 and 2015 (on average) than what would have been possible without AIDS. Higher taxes will generate extra revenue to fund the additional AIDS related expenditure and will reduce the impact of increasing employment costs and higher government health expenditure on the budget deficit.

b) Macro-economic effects

Higher contributions by the government to medical and other employee benefit schemes translate into higher wages for skilled government employees (see table C.4 in Appendix C). Furthermore, skilled and unskilled government employment is stimulated by the HIV/AIDS induced increase in public sector health expenditure and indirect costs to the government as an employer. Higher wages for skilled government employees and a higher level of government employment translates into a larger wage bill compared to a no-AIDS scenario. The increase in wage income to government employees stimulates aggregate consumption expenditure - consumer spending on non-durable goods and services in particular gain from the disbursement of medical benefits. However, the positive impact of a higher government wage bill is to some extent counterbalanced by the increase in personal tax rates. Higher personal tax rates also reduce households' tax adjusted income, thereby constraining FCE. Spending on semi-durable and durable goods declines the most, as skilled government employees finance a proportion of their higher benefit contributions by reducing their non-health care expenditure. Furthermore, higher corporate tax rates adversely affect corporate savings and fixed investment.

Direct and indirect employment costs to the government and higher public health care expenditure translate into higher government consumption expenditure compared to a no-AIDS scenario. Similarly, higher welfare expenditure on orphans leads to a substantial rise in government transfers to households. Higher government expenditure has adverse implications for the government's budget deficit. However, in this scenario, the negative impact on the budget deficit is counterbalanced by an increase in personal and corporate taxes.

4.4) THE MACRO-ECONOMIC IMPACT OF HIV/AIDS: OVERALL RESULTS

Having analysed the macro-economic effects of each impact channel independently, the four impact channels were combined in the model for the final (aggregated) AIDS inclusive simulation (see table C.5 in Appendix C). The overall results are discussed in more detail below:

4.4.1) INFLATION AND INTEREST RATES

The simulation results indicate that prices could increase at a substantially higher rate compared to a no-AIDS scenario. Producer price inflation is projected to be 2.3 percentage points higher in average over the forecasting period. The deviation in producer price inflation from the no-AIDS scenario is expected to increase from 1.4% during 2002-05 to 2.9% during 2011-15. This is not surprising, as there are a number of factors that exert upward pressure on inflation in the AIDS scenario:

- Higher contributions by employers to medical and other employee benefit schemes (i.e. direct costs) translate into higher wages, putting upward pressure on production prices. Furthermore, the assumption that firms will also be able to recoup some of their indirect costs by passing a proportion of the costs on to customers through price increases contributes to the inflationary bias of the epidemic.

- The higher inflation outcome can also be ascribed to the narrower output gap in the economy compared to a no-AIDS scenario. The gap between actual and potential GDP declines, as the adverse impact of the epidemic on potential output (via the sharp decline in the labour force and productivity), outweighs the negative impact on actual output.[50] A narrower output gap implies higher economy-wide capacity utilization, which puts upward pressure on production prices.

The upward pressures on the PPI inflation rate is largely responsible for the increase in the CPI inflation rate - the CPI inflation rate is projected to be 2.56 percentage points higher on average between 2002 and 2015 compared to a no-AIDS scenario.

[50] Moreover, a slightly larger budget deficit compared to a no-AIDS scenario boosts actual GDP and therefore also contributes to the decline in the output gap.

Given the government's current monetary policy of inflation targeting, higher domestic inflation will put upward pressure on interest rates. The pressure on interest rates is exacerbated by the deterioration in the overall balance of payments position (a decline in net reserves due to balance of payments transactions). The (nominal) prime overdraft rate is projected to be 2.9 percentage points higher over the forecasting period compared to a no-AIDS scenario. As the increase in the nominal prime interest rate exceeds the increase in the inflation rate, the real prime interest rate is also projected to increase compared to a no-AIDS scenario.

Table 4.6: The impact on inflation and interest rates

		2002-05	2006-10	2011-15	2002-15
PPI Inflation	Level[a]	6.79%	7.35%	7.10%	7.10%
	Difference[b]	1.42	2.34	2.90	2.28
CPI Inflation	Level[a]	6.76%	7.69%	8.28%	7.63%
	Difference[b]	1.61	2.62	3.26	2.56
Prime Overdraft Rate (Nominal)	Level[a]	15.76%	15.11%	14.77%	15.18%
	Difference[b]	1.39	2.95	4.07	2.90
Prime Overdraft Rate (Real)	Level[a]	8.97%	7.76%	7.67%	8.07%
	Difference[b]	-0.04	0.61	1.17	0.62

a. Inflation/interest rate in the AIDS scenario.

b. Average percentage point difference between AIDS and no-AIDS scenarios.

It should be noted that the magnitude of the increase in inflation and interest rates may be overstated by the simulation results, as competition from abroad may well limit firms' ability to pass cost increases on to consumers (Laubscher et al. 2001: 31). Nevertheless, the results suggest that inflation and interest rates will be substantially higher due to AIDS, with obvious adverse implications for the interest sensitive sectors in South Africa's economy.

4.4.2) SAVINGS AND FIXED INVESTMENT

The AIDS epidemic will likely lead to a deterioration in savings formation in South Africa. HIV/AIDS induced cost increases will have a negative impact on corporate and public sector savings, while personal savings will suffer as households divert funds away from savings in order to finance their higher spending on health care. Total domestic savings as a percentage of GDP is projected to be 2 percentage points lower on average over the forecasting period compared to a no-AIDS scenario.

Table 4.7: The impact on fixed investment

		2002-05	2006-10	2011-15	2002-15
Private residential[a]		-1.20%	-1.19%	-1.29%	-1.23%
Private (excluding residential)[a]		-1.45%	-1.56%	-1.83%	-1.63%
Total Private[a]		-1.43%	-1.54%	-1.79%	-1.60%
Total GDFI[a]		-1.05%	-1.17%	-1.32%	-1.19%
Total GDFI as % of GDP	Level[b]	17.90%	19.71%	20.49%	19.47%
	Difference[c]	-0.45	-1.29	-1.98	-1.30
Total domestic savings as % of GDP	Level[b]	14.92%	16.16%	18.15%	16.52%
	Difference[c]	-0.65	-1.96	-3.08	-1.99

a. Average y.o.y. growth rate differentials.

b. Ratios in AIDS scenario.

c. Percentage points difference in ratios of no-AIDS and AIDS scenarios.

The simulation results indicate that private fixed investment could be severely affected by the HIV/AIDS epidemic - the growth rate of private residential investment is projected to be about 1.2 percentage points lower on average between 2002 and 2015 compared to a no-AIDS scenario, while the growth rate of private non-residential investment could fall by as much as 1.6% compared to a no-AIDS scenario. Total gross domestic fixed investment (GDFI) as a percentage of GDP is projected to be more than 2 percentage points lower by the year 2015 compared to what could have been attained without AIDS (see table C.5 in Appendix C).

The sharp decline in fixed investment is largely attributable to higher interest rates, a lower level of economic activity and lower corporate savings due to HIV/AIDS induced cost increases. Apart from these factors, private residential investment will also be constrained by the slower growth in the population as a result of the epidemic. Although public sector fixed investment may also be lower for the same reasons as the drop in private sector fixed investment, no assumptions were made about the impact of HIV/AIDS on investment by the general government or parastatals. The sharp decline in gross domestic fixed investment to some extent reflects the AIDS induced shift in spending "from more to less productive avenues" (Laubscher et al. 2001: 34).

One factor that may have boosted fixed investment in the AIDS scenario is the increase in capacity utilization. As capacity utilization increases, firms may want to invest more in capital and technology in order to increase their production capacity. However, since attempts at introducing capacity utilisation to the investment equations during the model estimation resulted in either the wrong sign (i.e. a negative sign) or in coefficient estimates that were statistically insignificant, this variable was not included in the investment equations. It was decided not to intervene in the investment equations (via addfactors or otherwise), as it is difficult to determine by what amount investment should increase due to the increase in capacity utilization. Furthermore, one should consider the question whether investment should increase at all when the "increase in capacity utilization is caused by a decline in the supply potential as opposed to an increase in actual GDP", as is largely the case in the AIDS scenario (Laubscher et al. 2001: 34).

4.4.3) WAGES AND EMPLOYMENT

The simulation results indicate that *skilled* wages may rise in real terms due to HIV/AIDS, but that real *unskilled* wages will likely be lower compared to a no-AIDS scenario. Table 4.8 shows that the growth rate in real wages for skilled employees in the private (public) sector could be 0.5 percentage points (0.7 percentage points) higher on average over the forecasting period compared to a no-AIDS scenario, while the growth rate in real wages for unskilled private (public) sector employees could be 0.3 percentage points (0.4 percentage points) lower. In all, the economy-wide average wage is projected to be higher in real terms compared to that attainable without AIDS.

Higher real wages for skilled employees can largely be ascribed to higher contributions by employers to medical and other employee benefit schemes. Increased labour shortages, as reflected by the decline in the unemployment rate, also heighten the pressure on skilled wages. In case of unskilled wages, the upward pressure from higher labour shortages is more than countered by the negative impact of a decline in labour productivity, so that real unskilled wages are significantly lower in the AIDS scenario. (Since it was assumed that unskilled employees are not covered by employee benefit schemes, unskilled wages do not benefit from higher employee benefit contributions by employers.)

The increase in real skilled wage rates reduces the demand for skilled labour - skilled employment growth is projected to be 0.8 percentage points lower on average over the forecasting period compared to a no-AIDS scenario. The negative impact on skilled employment manifests gradually, with skilled employment growth declining at a relatively low rate during 2002-2005. This can be ascribed to positive employment effects associated with some of the indirect costs of the epidemic and a higher level of economic activity between 2002-2005 compared to a no-AIDS scenario. Apart from these positive influences, the demand for *unskilled labour* is also stimulated by slower growth in real wages for unskilled workers, so that unskilled employment growth increases during 2002-2005. However, by the second half of the forecasting period, real economic activity slows to such an extent that even unskilled employment growth falls compared to a no-AIDS scenario. Consequently, total formal sector employment growth is projected to be 0.6 percentage points lower on average over the forecasting compared to a no-AIDS scenario. By 2015, the level of formal sector employment is projected to be 7.2% below the level attainable without AIDS (see table C.5 in Appendix C).

Table 4.8: The impact on employment and wages

		2002-05	2006-10	2011-15	2002-15
Real Skilled Wage Rate[a]	Private Sector	0.15%	0.61%	0.67%	0.50%
	Government	0.26%	0.83%	1.00%	0.73%
Real Unskilled Wage Rate[a]	Private Sector	-0.60%	-0.29%	-0.12%	-0.32%
	Government	-0.96%	-0.42%	-0.01%	-0.43%
Real wage rate (average)[a]		-0.09%	0.39%	0.54%	0.31%
Skilled employment[a]		-0.18%	-0.73%	-1.31%	-0.78%
Unskilled employment[a]		0.31%	-0.27%	-0.92%	-0.34%
Total formal sector employment[a]		-0.01%	-0.54%	-1.13%	-0.60%
Real wage bill[a]		-0.10%	-0.15%	-0.62%	-0.31%
Labour productivity[b]		-1.04%	-0.60%	0.53%	-0.32%
Unemployment rate	Level[c]	41.29%	37.99%	31.62%	36.66%
	Difference[d]	-1.78	-4.56	-8.98	-5.34

a. Average y.o.y. growth rate differentials between AIDS and no-AIDS scenarios.

b. Percentage difference between levels in no-AIDS and AIDS scenarios (not y.o.y. growth rate differentials).

c. Percent of labour force outside the formal sector in the AIDS scenario.

d. Percentage points difference in ratio of no-AIDS and AIDS scenarios.

As the decline in formal sector employment outweighs the increase in real wage rates, the growth in the real aggregate wage bill slows in the AIDS scenario. Simulation results indicate that the growth in the real aggregate wage bill could be 0.3 percentage points lower on average over the forecasting period compared to a no-AIDS scenario, the deviation increasing from 0.1 percentage points between 2002 and 2005 to 0.6 percentage points between 2011 and 2015. A lower wage bill compared to a no-AIDS scenario implies a reduction in the spending power of consumers and will impact negatively on private consumption expenditure and residential investment.

4.4.5) FINAL HOUSEHOLD CONSUMPTION EXPENDITURE

The impact of HIV/AIDS on household consumption expenditure is not straightforward, as there are opposing factors that affect consumer spending. Overall consumption expenditure is adversely affected by the slower growth in the population (i.e. the number of consumers) and in real disposable income (as a result of lower levels of employment and higher personal tax rates due to HIV/AIDS induced cost increases), as well as higher interest rates compared to a no-AIDS scenario. However, the negative impact on FCE is to some extent countered by consumers that activate their personal savings to finance some of their medical and other HIV/AIDS induced expenses. The simulation results indicate that the growth in total FCE could be only about 0.3 percentage points lower on average over the forecasting period compared to a no-AIDS scenario. The comparatively small drop in total FCE growth can largely be attributed to the (initial) increase in spending on services, as spending on the other main categories of consumption is projected to decline significantly.

Apart from the impact on overall FCE, a shift in consumer spending between the different expenditure categories is likely to occur, as HIV/AIDS infected households will be burdened by higher health care costs. Households may have to divert funds away from savings or other non-essential expenditure categories in order to finance their higher spending on health care products and medical services, implying a shift in consumer spending in favour of non-durable goods and services.

Higher per capita incomes in the AIDS scenario may also affect household spending patterns. Since the decline in the population due to AIDS outweighs the projected decline in disposable income compared to a no-AIDS scenario, per capita income is projected to be higher in the AIDS scenario. The increase in per capita income will most likely lead to a shift in consumer spending from non-durables and semi-durables to spending on durables and services.

Table 4.9 shows that there are divergent reactions between the four main components of FCE. Whereas the growth rate of consumer spending on durable goods and semi-durable goods is already substantially lower during 2002-2010, the negative impact on non-durable goods spending manifests more gradually. The growth rate of consumer spending on services is significantly higher during 2002-2010, but also lower during the rest of the forecasting period.

Table 4.9: The impact on final consumption expenditure

		2002-05	2006-10	2011-15	2002-15
Durable goods[a]		-0.84%	-0.59%	-0.52%	-0.64%
Semi-durable goods[a]		-0.62%	-0.67%	-0.99%	-0.77%
Non-durable goods[a]		-0.19%	-0.32%	-0.98%	-0.52%
Services[a]		0.41%	0.66%	-0.57%	0.15%
Total FCE[a]		-0.05%	0.03%	-0.75%	-0.27%
Real disposable income[a]		-0.17%	-0.11%	-0.47%	-0.26%
Personal savings as % of disposable income	Level[b]	0.25%	1.29%	2.78%	1.53%
	Difference[c]	-0.63	-1.32	-0.75	-0.92

a. Average y.o.y. growth rate differentials.

b. Ratio in AIDS scenario.

c. Percentage points difference in ratio of no-AIDS and AIDS scenarios.

Consumer spending on durable and semi-durable goods is projected to be most vulnerable to the epidemic - consumer spending on durable goods is projected to be about 7.9% lower in level terms by 2015 compared to a no-AIDS scenario, while consumer spending on semi-durable goods could be as much as 9.8% lower (see table C.5 in Appendix C). Both of these sectors are adversely affected by the shift in consumer spending in favour of health care products and medical services. Semi-durable goods are particularly vulnerable due to their relatively large exposure to black consumers - the population group with the highest HIV/AIDS prevalence. Although durable goods are significantly less exposed to the black consumer market, durable goods are more sensitive to interest rate changes than semi-durable goods.

The growth in consumption of non-durable goods is projected to be about 0.2-0.3 percentage points lower on average over the period 2002-2010, after which the adverse impact could rise to 1 percentage point between 2010-2015 (in year on year growth rate terms). Non-durable goods benefit from the shift in consumer spending in favour of medical products, but this positive effect is eventually counterbalanced by the slower growth in consumer income and, in particular, by the slower growth in the absolute number of consumers due to HIV/AIDS - of the four main components of FCE, non-durable goods has the highest exposure to the relatively more infected black population. Non-durable goods consumption expenditure is projected to be 6.3% below the level attainable without AIDS by the year 2015 (see table C.5 in Appendix C).

Consumer spending on services is projected to grow at a higher rate during 2002-2010. However, like the other consumption categories, growth in spending on services is expected to be significantly lower compared to a no-AIDS scenario during 2011-2015, as higher interest rates and slower growth in consumer income eventually take their toll on consumption expenditure. The initial increase in spending on services can largely be explained by the shift in consumer spending in favour of medical services and the activation of savings to finance some of the increase in health care spending. Furthermore, the services sector has a relatively low exposure to black consumers and services are less sensitive to interest rate increases than durable and semi-durable goods. Consumer spending on services is projected to be 6.3% higher by 2010 compared to the level attainable without AIDS, but this increase compared to a no-AIDS scenario is projected to come down to 3.5% by 2015 (see table C.5 in Appendix C). Although total spending on services is projected to be higher due to HIV/AIDS, one should keep in mind that the non-health care components of spending on services could suffer the same fate as spending on semi-durable and durable goods. (The same goes for the non-health care components of spending on non-durable goods.)

Another way of drawing attention to the potential impact of HIV/AIDS on consumer demand is to show the projected impact of the epidemic on the composition of final consumption expenditure. Projections for the AIDS scenario indicate that the share of spending on services in total consumption expenditure could increase from approximately 40.5% in 2001 to 44.1% in 2010. This can mainly be ascribed to the AIDS induced increase in spending on medical services and higher per capita incomes compared to the no-AIDS scenario. The simulation results suggest that the shift in favour of spending on services (and durable goods) due to the increase in per capita income occurs mainly at the expense of spending on non-durable goods – the share of non-durable goods in total consumption expenditure is projected to decline from 40.7% in 2001 to 34.4% in 2010. Apart from the above-mentioned adverse impact that increasing per capita incomes have on the share of non-durables in total FCE, spending on non-durable goods is also more vulnerable to the demographic impact of the epidemic due to its large exposure to black consumers. The share of spending on semi-durables in total FCE is projected to remain more or less at the current 11.1%, while that of durable goods is projected to increase from 7.8% in 2001 to 10.3% in 2010 (mainly due to the increase in per capita incomes). It should be noted that the shares of durable goods and services are projected to rise significantly (at the expense of spending on non-durables) even in the no-AIDS scenario[51], as per capita incomes are projected to increase even in the absence of the epidemic.

4.4.6) GOVERNMENT INCOME AND EXPENDITURE

The HIV/AIDS epidemic will put pressure on the government's fiscal position. Higher employment costs and health care expenditure by the public sector implies higher government consumption expenditure and an increase in foster grants for AIDS orphans boosts government transfers to households. However, the impact of these factors on government expenditure will be reduced by cutbacks in non-health care expenditure and lower government employment due to the lower demand for non-health care services (as per assumption). Table 4.10 shows that government consumption expenditure as a percentage of GDP is projected to increase very little over the forecasting period.

The increased financial burden stemming from higher employment costs and an increase in the demand for public health care and welfare spending due to HIV/AIDS will probably coincide with reduced government tax revenues. Increased costs as a result of HIV/AIDS will have an adverse impact on economic growth and reduce private sector profits, indicating an erosion of the tax base and lower government revenue. Given the fiscal discipline that the government has shown thus far, it is unlikely that government would allow the budget deficit to get out of hand. It was therefore assumed that personal and corporate tax rates would be higher in the AIDS scenario in order to generate extra revenue to fund the AIDS related expenditure, limiting the adverse impact on the government's budget deficit. The budget deficit is projected to be only 0.13 percentage

[51] The contributions of services and durables to total FCE are projected to increase to 41.8% and 11.0% respectively in 2010 in the no-AIDS scenario. The corresponding figures for semi-durables and non-durables are 12.0% and 35.3%.

points higher on average over the forecasting period compared to the level attainable without AIDS.[52] Total government debt was not modeled, but the projections of a higher budget deficit and higher interest rates compared to a no-AIDS scenario suggest that the national government debt and debt servicing costs will be higher compared to what would have been possible without HIV/AIDS, *ceteris paribus*.

Table 4.10: The impact on government income and expenditure

		2002-05	2006-10	2011-15	2002-15
Real Government consumption expenditure[a]		0.11%	-0.03%	-0.40%	-0.12%
Government consumption expenditure as % of GDP	Level[b]	16.64%	15.71%	14.60%	15.58%
	Difference[c]	0.04	0.21	0.45	0.24
Total taxes as % of GDP	Level[b]	26.52%	25.91%	24.85%	25.70%
	Difference[c]	0.37	0.52	0.80	0.58
Budget deficit as % of GDP	Level[b]	1.56%	0.99%	0.44%	0.96%
	Difference[c]	-0.19	0.07	0.46	0.13

a. Average y.o.y. growth rate differentials.

b. Ratio in AIDS scenario.

c. Percentage points difference in ratio of no-AIDS and AIDS scenarios.

4.4.7) THE BALANCE OF PAYMENTS AND THE EXCHANGE RATE

Despite a more sluggish domestic business environment, both exports and imports are projected to grow at higher rates compared to a no-AIDS scenario. Table 4.11 shows that the growth in real exports is projected to be 0.16 percentage points higher on average over the forecasting period compared to a no-AIDS scenario, while the increase in import volumes could be slightly larger. Exports are stimulated by a small depreciation of the real effective rand exchange rate (due to a deterioration in the inflation differential and a weaker balance of payments position), while import demand increases as a result of the higher capacity utilization and the lower relative cost of imports (since the increase in domestic inflation exceeds the increase in imported inflation). Furthermore, the rise in imports also reflects the higher demand for health care products, of which a substantial

[52] It should be noted that the projected impact on the budget deficit would have been more dramatic had different assumptions been adopted (e.g. no increase in tax rates compared to the no-AIDS scenario). Being aware of the uncertainties involved with these assumptions, some of the assumptions regarding government spending and taxation were changed and modelled in the sensitivity analysis. The sensitivity analysis suggests that the budget deficit could in fact increase to about 3.1% of GDP due to HIV/AIDS (see chapter 5).

proportion will be imported. The slowdown in domestic economic activity and the real deprecation of the rand exchange rate were not enough to counterbalance the positive effect of these factors on real imports.

Table 4.11: The impact on the balance of payments and the exchange rate

		2002-05	2006-10	2011-15	2002-15
Nominal Effective Exchange Rate[a]		-1.52%	-2.50%	-3.01%	-2.41%
Real Effective Exchange Rate[a]		-0.09%	-0.18%	-0.08%	-0.12%
Real Exports[a]		0.36%	0.14%	0.01%	0.16%
Real Imports[a]		-0.13%	0.40%	0.23%	0.19%
Current Account Balance as % of GDP	Level[b]	-1.73%	-1.81%	-1.76%	-1.77%
	Difference[c]	0.04	0.16	0.56	0.27
Change in Net Reserves as % of GDP	Level[b]	0.40%	0.39%	0.40%	0.40%
	Difference[c]	-0.05	-0.12	-0.03	-0.07

a. Average y.o.y. growth rate differentials.

b. Ratio in AIDS scenario.

c. Percentage points difference in ratio of no-AIDS and AIDS scenarios.

Since the increase in import volumes is somewhat larger than the increase in export volumes, the trade balance deteriorates slightly. However, as a result of the depreciation of the rand exchange rate, the terms of trade (the ratio of export prices to import prices) improves (i.e. increases), counterbalancing the deterioration in the trade balance. (The terms of trade improve because the depreciation of the effective rand exchange rate leads to a larger increase in exports prices than in import prices.) As a result, the nominal increase in exports outweighs the nominal increase in imports, so that the current account on the balance of payments expressed as a percentage of GDP actually improves somewhat over the forecasting period.

In light of the weaker economic outlook for the South African economy due to the HIV/AIDS epidemic, it is unlikely that South Africa will attract the same amount of foreign capital (in US dollar terms) compared to a no-AIDS scenario. In an attempt to capture the negative impact of HIV/AIDS on the capital account of the balance of payments, it was assumed that the rand value of capital inflows (which is exogenous to the model) would remain unchanged between the AIDS and no-AIDS scenarios. Since the exchange rate of the rand against the dollar depreciates significantly in the AIDS scenario, this translates into a lower value of capital inflows in dollar terms. Simulation results indicate that the adverse impact on the capital account more than counters the marginal improvement on the current account of the balance of payments, so that the overall balance of payments deteriorates. Table 4.11 shows a less favourable change in net gold and other foreign reserves owing to balance of payments transactions (expressed as a % of GDP) compared to a no-AIDS scenario. The weaker balance of payments position explains the real depreciation of the effective exchange rate and heightens the upward pressure on interest rates (Laubscher et al. 2001: 36-37).

4.4.8) OVERALL GDP

HIV/AIDS will have a negative impact on South Africa's gross domestic product. The level of real GDP is projected to be 5.7% lower by 2015, while the GDP growth rate is expected to be 0.47 percentage points lower on average over the forecasting period.

Table 4.12: The impact on overall GDP

	2002-05	2006-10	2011-15	2002-15
Real GDP	-0.08%	-0.33%	-0.91%	-0.47%
Real GDE	-0.21%	-0.25%	-0.81%	-0.44%
Potential GDP	-0.67%	-1.46%	-1.95%	-1.41%
Real per capita GDP	0.64%	1.05%	0.95%	0.90%

a. Average y.o.y. growth rate differentials.

Of the four different impact channels considered in this analysis, the largest share of the deterioration in GDP growth can be attributed to the slower growth in the population (the first AIDS impact channel) - in particular, the slower growth in the labour force. The production potential of the economy is severely negatively affected by the drop in the labour force (compared to a no-AIDS scenario), leading to a narrowing of the output gap. This implies an increase in economy-wide capacity utilization, which puts upward pressure on prices, which, in turn, spills over into higher interest rates and slower growth in household consumption expenditure and fixed investment. Furthermore, the smaller labour force compared to a no-AIDS scenario implies a lower supply of available workers, which puts upward pressure on wages. Higher wages reduce the demand for labour (i.e. employment) and exacerbates the upward pressure on producer price inflation.

Lower levels of employment and higher interest rates have an adverse impact on consumption expenditure and investment and explain the bulk of the deterioration in the real economic performance (Laubscher et al. 2001: 38).

AIDS induced cost increases is another key impact channel of the epidemic. Employment is negatively affected by increases in the direct and indirect costs of labour, while the upward pressure on prices (and hence on interest rates) is heightened as companies pass some of the cost increases on to customers via price increases. The flip side of the HIV/AIDS induced cost increases is higher consumption expenditure (e.g. on private and public sector health services), which lessens the negative impact on economic growth. Furthermore, the adverse impact on the economy may also be softened by the implementation of "more productive technologies and increasing production per worker", as companies strive to remain profitable in the face of cost increases (Laubscher et al. 2001:29). The GDP growth rate is projected to be only 0.1 percentage points lower compared to a no-AIDS scenario during 2002-2005 (as higher spending on private and public sector health services due to HIV/AIDS reduces the negative impact on economic growth). However, the adverse impact increases to 0.3 percentage points between 2006-2010 and 0.9 percentage points between 2011-2015, as the lower levels of employment and higher interest rates start to take their toll on the economy.

Since the decline in the real GDP is substantially less than the decline in the population, real per capita GDP actually increases. Real per capita GDP growth is projected to be 0.9 percentage points higher on average over the forecasting period compared to a no-AIDS scenario. The level of per capita GDP is projected to be about 14.8% higher (in real terms) by 2015 (see table C.5 in Appendix C). As mentioned earlier, the increase in per capita income will most likely change the composition of consumer demand, leading to a shift in consumer spending from non-durables and semi-durables to spending on durables and services.

Figure 4.3: Real GDP growth - AIDS vs. no-AIDS scenario

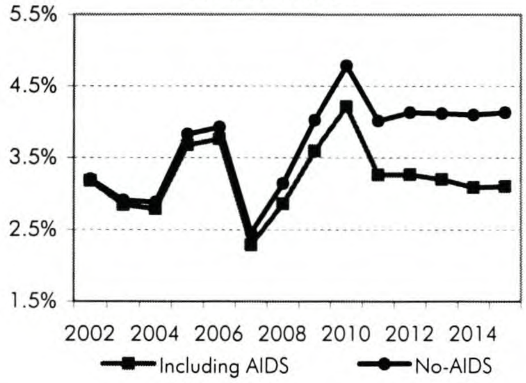


Figure 4.4: Real per capita GDP growth - AIDS vs. no-AIDS scenario

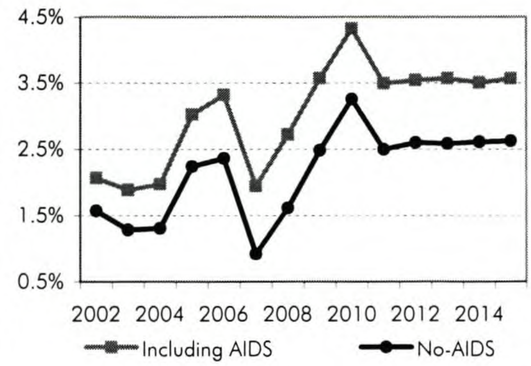


Table 4.13. Comparison with previous studies on the economic impact of AIDS in South Africa – Average year on year GDP growth rate differential

	2002-2005	2006-2010	2011-2015	2002-2010	2002-2015
This study /BER (2000)	-0.1	-0.3	-0.9	-0.2	-0.47
ING Barings (2000) [a]	-0.2	-0.4	-0.3	-0.3	-0.3
Arndt and Lewis (2000) [b]	-1.7	-2.5	NA	-2.1	NA

a. Quattek (2000: 21-22).

b. Derived from graph - Arndt and Lewis (2000: 11).

Table 4.13 shows that projections of the impact of AIDS on overall economic growth from this analysis are a lot less devastating compared to that of Arndt and Lewis, but slightly more pessimistic compared to that of the ING Barings study (if evaluated over the whole forecasting period).

As mentioned in the previous chapter, it appears as though supply constrained models such as the one used by Arndt and Lewis tend to magnify the adverse impact of declining production, incomes and savings on overall economic growth. Furthermore, Arndt and Lewis's assumption regarding the impact of HIV/AIDS on total factor productivity growth is significantly more pessimistic than that of the current analysis. The ING Barings study did not include this impact channel in their analysis. Combined with the workings of a CGE model, this rather pessimistic outlook for total factor productivity growth helps to explain why the projections from the Arndt and Lewis study are much more pessimistic than that of the current analysis and the ING Barings study.

In contrast to the projections from the ING Barings study, projections from this analysis suggest that the brunt of the economic impact is only likely to be felt after 2010. One possible explanation for the significantly more pessimistic projections for the period 2011-2015 may be found in the modelling of the AIDS induced cost pressures on the producer price inflation rate. Whereas ING Barings used an input-output model to approximate the cost impact on inflation (i.e. the impact of cost increases on the PPI inflation rate appears to be determined outside of the macro-econometric model), the price effects are endogenously determined in the BER's model. Despite having assumed smaller cost increases than ING Barings, the pressure on producer prices stemming from the direct and indirect costs to companies builds up to such an extent in the BER's model that the projections of inflation and interest rates in the AIDS scenario are substantially higher than that of ING Barings, particularly in the latter part of the forecast. This may be an accurate projection of how AIDS related costs will accumulate (multiply) over time, but it could also be that the model overstates the impact of cost increases on inflation and interest rates. The comparatively sharper deterioration in economic growth after 2010 in this analysis can to a large extent be ascribed to the adverse impact of significantly higher real interest rates on consumption expenditure and investment.

CHAPTER 5

SENSITIVITY ANALYSIS

5.1) INTRODUCTION

Being aware of the uncertainties involved with many of the assumptions that were adopted, it was decided to vary some of the key assumptions in order to test the sensitivity of the model to changes in these assumptions. For this purpose, 7 of the assumptions in the baseline AIDS scenario were altered and simulated individually.[1] The simulation results were compared to the baseline AIDS scenario. The alternative assumptions are presented as alternative AIDS *scenarios* and can be summarised as follows:

- Scenario 1: Larger negative impact on total factor productivity
- Scenario 2: Higher direct cost increases for the private and public sectors
- Scenario 3: Higher indirect cost increases for the private and public sectors
- Scenario 4: Companies shoulder less of the direct cost increases
- Scenario 5: Households finance a smaller proportion of the direct costs by reducing their personal savings
- Scenario 6: Extra public sector health expenditure and direct and indirect costs to government as an employer are deficit financed
- Scenario 7: Government does not increase tax rates

Lower and upper ranges were calculated for some of the key economic variables – the ranges were calculated in such a way that the full spectrum of possible outcomes for each of the selected economic variables would be covered for any combination of the alternative assumptions (see table 5.1). In the case of the majority of the variables in table 5.1, the upper range represents the best-case scenario for that particular variable (e.g. highest possible outcome for GDP, employment, consumption, investment and export

[1] In other words, in each scenario, only one of the baseline AIDS assumptions was altered.

growth). However, it could be argued that the upper range is a worst-case scenario for variables such as the inflation rate, the prime interest rate, imports, total taxes and the budget deficit in terms of what is desirable for our economy. Furthermore, when considering the simulation results in table 5.1, it becomes apparent that a best-case scenario for one variable does not guarantee the best outcome (or even a favourable outcome) for other variables in the model. For example, in the scenarios in which real GDP growth is positively influenced (scenarios 2, 6 and 7), the upward pressure on inflation and interest rates is exacerbated and fixed investment is adversely affected.

It should be noted that the demographic or epidemiological inputs were not altered in the analysis, so that the sensitivity analysis only pertains to changes in *economic* parameters. In what follows, the alternative economic behavioural assumptions are described briefly and the results from the macro-economic sensitivity analysis are presented and discussed. More detailed simulation results are presented in Appendix D in the form of comparisons between projections for the no-AIDS and the alternative AIDS scenarios for certain key economic variables. Table 5.2 at the end of this chapter provides a summary of all the macro-economic simulation results in this paper.

5.2) ALTERNATIVE ASSUMPTIONS AND SIMULATION RESULTS

SCENARIO 1: LARGER NEGATIVE IMPACT ON TOTAL FACTOR PRODUCTIVITY

The impact of HIV/AIDS on overall productivity is especially difficult to quantify and has been absent in many of the earlier macro-econometric studies. Nevertheless, the impact of a gradual reduction in the rate of total factor productivity growth to about 79% of what it could have been without AIDS was explored in the baseline AIDS scenario - this 21% reduction in the rate of total factor productivity (TFP) growth was based on the 21% reduction in the total labour force due to AIDS. Given that this is a fairly conservative assumption compared to that of Arndt and Lewis (2000: 9-10) - the only other study on the impact of AIDS on the South African economy to include this impact channel - a larger negative impact on TFP was explored in the sensitivity analysis. The alternative assumption is that TFP growth would be 42% lower compared to a no-AIDS scenario (i.e. double the reduction in TFP growth compared to the baseline AIDS scenario).

Table 5.1. The Macro-economic impact of HIV/AIDS in South Africa: A sensitivity analysis										
	Baseline AIDS scenario[a]	Alternative Scenarios (Difference from baseline AIDS scenario)[b]							Ranges[c]	
		Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 7	Lower	Upper
Growth and employment										
Real GDP growth	-0.47%	-0.05%	0.08%	-0.07%	-0.01%	-0.04%	0.02%	0.02%	-0.63%	-0.33%
Real Per Capita GDP growth	0.90%	-0.05%	0.08%	-0.07%	-0.01%	-0.04%	0.02%	0.02%	0.73%	1.03%
Potential GDP growth	-1.41%	-0.21%	-0.05%	-0.04%	0.02%	0.01%	-0.04%	-0.01%	-1.76%	-1.38%
Formal Sector Employment growth	-0.60%	-0.03%	-0.02%	-0.02%	0.04%	-0.01%	0.01%	0.000%	-0.67%	-0.54%
Inflation and interest rates										
PPI inflation rate	2.28%	0.09%	0.48%	0.22%	-0.22%	-0.11%	0.16%	0.08%	1.94%	3.30%
Prime Interest Rate	2.90	0.08	0.87	0.32	-0.31	-0.23	0.34	0.18	2.37	4.69
Real Prime Interest Rate	0.62	-0.01	0.39	0.10	-0.08	-0.11	0.18	0.10	0.42	1.39
Consumer sector										
Total Real FCE growth	-0.27%	-0.05%	0.24%	-0.06%	-0.06%	-0.08%	0.04%	0.05%	-0.52%	0.06%
Non-durables	-0.52%	-0.08%	0.29%	-0.09%	-0.09%	-0.14%	0.09%	0.09%	-0.91%	-0.05%
Semi-durables	-0.77%	-0.06%	0.07%	-0.06%	-0.05%	-0.10%	0.05%	0.08%	-1.05%	-0.57%
Durables	-0.64%	-0.04%	-0.01%	-0.04%	0.00%	-0.03%	0.01%	0.03%	-0.76%	-0.61%
Services	0.15%	-0.03%	0.31%	-0.04%	-0.06%	-0.06%	0.01%	0.03%	-0.04%	0.50%
Investment and savings										
Total Real Fixed Investment growth	-1.19%	-0.04%	-0.30%	-0.15%	0.13%	0.07%	-0.12%	-0.04%	-1.84%	-1.00%
Fixed Investment as % of GDP	-1.30%	0.00%	-0.57%	-0.15%	0.17%	0.16%	-0.26%	-0.12%	-2.40%	-0.96%
Domestic Savings as % of GDP	-1.99%	0.01%	-1.21%	-0.54%	0.41%	0.29%	-0.85%	-1.34%	-5.93%	-1.28%
Balance of payments and exchange rate										
Effective Exchange Rate	-2.41%	-0.10%	-0.63%	-0.18%	0.25%	0.18%	-0.22%	-0.12%	-3.65%	-1.98%
Real Effective Exchange Rate	-0.12%	-0.02%	-0.17%	0.07%	0.04%	0.07%	-0.05%	-0.04%	-0.40%	0.06%
Real Export growth	0.16%	0.01%	0.20%	-0.12%	-0.03%	-0.09%	0.07%	0.06%	-0.08%	0.49%
Real Import growth	0.19%	0.03%	0.23%	-0.08%	-0.05%	-0.09%	0.06%	0.06%	-0.04%	0.57%
Current Account Balance as % of GDP	0.27%	-0.01%	-0.04%	0.08%	0.00%	0.03%	-0.01%	-0.05%	0.17%	0.38%
The fiscus										
Real Government Consumption Expenditure growth	-0.12%	-0.02%	0.06%	0.03%	-0.02%	0.00%	0.19%	0.00%	-0.16%	0.16%
Government Consumption as % of GDP	0.24%	0.02%	-0.09%	0.12%	0.01%	0.06%	0.34%	-0.05%	0.10%	0.79%
Total Taxes as % of GDP	0.58%	0.01%	0.07%	-0.03%	0.08%	-0.06%	0.12%	-0.45%	0.04%	0.86%
Budget Deficit as % of GDP	-0.13%	-0.01%	0.03%	-0.45%	0.24%	-0.23%	-0.71%	-1.52%	-3.06%	0.14%

a. Average annual differentials between no-AIDS and baseline AIDS scenario – figures pertain to the average impact over the complete projection period (2002-2015).

b. Average annual differentials between baseline AIDS scenario and alternative AIDS scenario.

c. Lower and upper impact ranges compared to no-AIDS projection.

As can be seen from table 5.1 and table D.1 in Appendix D, the alternative assumption with regard to the impact of AIDS on total factor productivity primarily affects the projection of the production potential of the economy – the simulation results indicate that potential GDP growth could be 0.21 percentage points lower on average over the forecasting period than what was projected in the baseline AIDS scenario (i.e. potential GDP growth could be 1.62 percentage points lower compared to the no-AIDS projection).

Such a sharp reduction in production potential implies an increase in the capacity utilization of firms, which puts upward pressure on production prices. Given the inflation target, the monetary authorities will likely increase interest rates. The relatively more pessimistic GDP outlook can mainly be attributed to the negative implications that higher interest rates hold for consumption expenditure and fixed investment. Compared to a no-AIDS scenario, GDP growth is projected to be 0.52 percentage points lower between 2002 and 2015 (instead of the 0.47 percentage points decline projected in the baseline AIDS scenario).

SCENARIO 2: HIGHER DIRECT COST INCREASES FOR THE PRIVATE AND PUBLIC SECTORS

As the assumptions with regard to the magnitude of the direct (employee benefit) cost increases are fairly conservative compared to what Metropolitan's AIDS research unit suggested, it was decided to increase these costs by 50% in the sensitivity analysis. The alternative assumption is therefore that direct costs to the private and public sectors will amount to 7.5% (instead of 5%) of the skilled wage bill by 2005 and 15% (instead of 10%) of the skilled wage bill by 2010.[2]

It can be seen from table 5.1 and table D.2 in Appendix D that the alternative direct cost assumption leads to a significantly smaller reduction in the growth rate of real GDP. Under this scenario, GDP growth is projected to be 0.39 percentage points lower (instead of 0.47 percentage points) on average over the forecasting period compared to a no-AIDS scenario. The relatively more positive GDP outlook can mainly be attributed to higher wage income to skilled private and public sector employees, which translates into higher final consumption expenditure (mainly on health care products and medical services). Furthermore, households are forced to divert more funds from savings to finance

[2] AIDS prevalence rates in the skilled labour force were used to interpolate between 2001 and 2010. Cost increases were kept constant (at 15%) after 2010.

the higher employee benefit contributions, stimulating FCE via the disbursement of medical and other employee benefits.

The positive impact on GDP is to some extent countered by the sharp decline in real fixed investment - investment is adversely affected by the reduction in corporate savings due to wage increases and by the higher level of interest rates that follows from the increase in producer price inflation.

Scenario 3: Higher indirect cost increases for the private and public sectors

As in the case of the alternative direct cost assumption, it was decided to increase the indirect costs faced by the private and public sectors by 50% in the sensitivity analysis. The alternative assumption is that indirect costs for unskilled labour will amount to 7.5% of the unskilled wage bill by 2005 (11.3% by 2010) and that indirect costs for skilled labour will amount to 3.8% of the skilled wage bill by 2005 (7.5% by 2010).[3]

Higher indirect costs have a negative impact on economic growth – the simulation results indicate that GDP growth could be 0.07 percentage points lower on average over the forecasting period than the baseline AIDS projection. The deterioration in GDP growth can be attributed to higher interest rates and lower levels of employment. Since it was assumed that indirect cost increases to private sector companies would be financed through price increases and through lower operating surpluses, higher indirect costs exacerbate the upward pressure on prices and interest rates and lead to further reductions in corporate savings and investment. The upward pressure on prices is to some extent countered by the somewhat larger output gap compared to the baseline AIDS scenario – the output gap increases (capacity utilization decreases) because the decline in real GDP outweighs the decline in potential GDP.

Due to the assumption that 20% of the indirect cost increases would be related to higher employment, formal sector employment initially increases compared to the baseline AIDS scenario. However, the lower level of economic activity eventually leads to a sharp reduction in employment. Lower employment and higher interest rates negatively affect FCE.

[3] AIDS prevalence rates in the unskilled labour force category were used to interpolate between 2001 and 2010. Cost increases were kept constant after 2010.

The government's budget deficit comes under pressure from both the income and expenditure sides – lower company profits translate into lower government revenue from corporate taxes, while higher indirect costs to government as an employer implies higher government expenditure.

SCENARIO 4: COMPANIES SHOULDER LESS OF THE DIRECT COST INCREASES

In the baseline AIDS scenario it was assumed that firms would come under social pressure to absorb a substantial proportion (50%) of the increases in employee benefit contributions due to the HIV/AIDS epidemic. Being aware of the fact that some companies will attempt to shift a large proportion or even all of the cost increases onto employees, the alternative assumption is that companies succeed in shifting 75% of the cost increases onto employees – i.e. private sector companies absorb only 25% of the cost increases. (The assumption is still that the government will carry 50% of the employee benefit cost increases for public sector employees.)

The simulation results indicate that altering the assumption with regard to the proportion of the costs shouldered by companies has a relatively small effect on overall economic growth – GDP growth is projected to be 0.48 percentage points lower on average over the forecasting period, compared to 0.47 percentage points lower in the baseline AIDS scenario. The slightly slower rate of GDP growth can mainly be attributed to the lower rate of growth in consumer income, which negatively affects FCE. The lower rate of income growth can be ascribed to lower private sector wages (as companies shoulder a smaller proportion of the employee benefit cost increases). Although lower skilled wages stimulates skilled employment, the decline in private sector skilled wages outweighs the increase in employment, so that real disposable income is lower compared to the baseline AIDS scenario.

Lower employee benefit contributions by companies imply less pressure on producer prices and company profits and translate into lower levels of interest rates and higher corporate savings. Lower interest rates and higher corporate savings explain the higher level of private sector fixed investment. Higher investment counteracts the negative impact from lower FCE on GDP growth.

The government's fiscal position improves significantly in this scenario (compared to the baseline AIDS scenario), as lower direct costs to companies imply higher corporate profits, which translate into higher government revenue from corporate taxes.

Scenario 5: Households finance a smaller proportion of the direct costs by reducing their personal savings

In the baseline AIDS scenario, it was assumed that households would finance 50% of their share of the direct costs from personal savings and the other half by reducing their expenditure on a number of consumer products and services. Given the uncertainty with regard to what proportion of the HIV/AIDS induced cost increases will be financed from household savings, it was decided to test the model's sensitivity to this assumption – the alternative assumption is that households finance only 25% of their share of the cost increases from savings (i.e. 75% is financed by cutting back spending on certain goods and services).

The main effect of this assumption is to increase personal savings and to reduce total FCE, constraining GDP growth. However, higher growth in fixed investment (due to lower inflation rates, and hence, lower interest rates) compared to the baseline AIDS scenario reduces the adverse impact on GDP growth - real GDP growth is projected to be 0.04 percentage points lower compared to the baseline AIDS scenario. Lower consumer spending also implies lower government revenue from VAT, putting upward pressure on the budget deficit.

Scenario 6: Extra public sector health expenditure and direct and indirect costs to government are deficit financed

In the baseline AIDS scenario, direct costs to the government as an employer were assumed to be deficit financed (i.e. extra wage costs to the government simply translated into higher government consumption expenditure and a larger budget deficit). However, given the tight fiscal deficit of the government, it was assumed that the government would finance 50% of its extra *indirect* costs and health care expenditure by cutting back spending in other departments or within the health department. The alternative assumption that is tested in the sensitivity analysis is that the government does not substitute away from spending in other departments to finance indirect cost increases or higher public sector health care expenditure – i.e. all AIDS induced expenditure by the government is financed via a larger budget deficit.

The main effect of this assumption is a substantial increase in the government's budget deficit – the budget deficit as a percentage of GDP is projected to increase from 0.13% in the baseline AIDS scenario to 1.01% in the alternative scenario. GDP growth is boosted by the increase in government consumption expenditure. However, the higher level of actual output translates into a smaller output gap/ higher capacity utilization. Higher capacity utilization puts upward pressure on producer prices, which spills over into higher interest rates and lower fixed investment. Slower growth in fixed investment compared to the baseline AIDS scenario reduces the positive impact on GDP growth of the higher government consumption expenditure. In the end, real GDP growth is projected to be only 0.02 percentage points better on average between 2002 and 2015 compared to the baseline AIDS scenario.

SCENARIO 7: GOVERNMENT DOES NOT INCREASE TAX RATES

Given the uncertainty with regard to the government's response to the financial implications of the HIV/AIDS epidemic, it was decided to vary the assumption with regard to tax increases – the alternative assumption is that the government does not increase personal or corporate tax rates (i.e. tax rates are the same as in the no-AIDS scenario).

The slightly higher GDP growth rate in this scenario can be attributed to the higher rate of growth in FCE compared to the baseline AIDS scenario - FCE is stimulated by the increase in real disposable income due to the lower personal tax rates. An important implication of this tax assumption is a substantially higher budget deficit - the budget deficit as a percentage of GDP is projected to increase from 0.13% in the baseline AIDS scenario to 1.52% if the government does not increase tax rates in response to HIV/AIDS related cost/expenditure increases.

5.3) CONCLUSION

The results from the sensitivity analysis indicate that the model is most sensitive to the assumptions with regard to the size of the AIDS induced direct and indirect cost increases to the private and public sectors. Higher direct costs have a positive impact on economic growth via the extra consumption expenditure in the economy (mainly on health care products and services) – table 5.1 shows that GDP growth could be on average 0.08 percentage points higher between 2002 and 2015 in the alternative direct cost scenario compared to the baseline AIDS projection. In contrast, the alternative indirect cost assumption could see GDP growth slow by another 0.07 percentage points between 2002 and 2015 compared to the baseline AIDS projection. GDP growth also proved to be fairly sensitive to the assumptions with regard to the impact of HIV/AIDS on total factor productivity growth and the proportion of the HIV/AIDS induced costs financed from household savings. The alternative assumptions with regard to the proportion of the costs shouldered by companies and the government's response to the financial implications of the HIV/AIDS epidemic had little impact on overall economic growth. However, this is not to say that altering these assumptions does not have significant effects on the constituent parts of the total GDP (e.g. fixed investment) or some other economic variable (e.g. the budget deficit).

The simulation results clearly indicate that the AIDS epidemic will likely lead to substantially lower levels of domestic savings and fixed investment growth in South Africa, even in a best-case scenario. The negative impact of HIV/AIDS on the growth in real fixed investment could range between 1 and 2 percentage points per annum. At first glance, the impact on overall consumption expenditure appears to be less dramatic – as a matter of fact, in a best-case scenario overall consumption expenditure may even be higher than what would have been possible without HIV/AIDS. However, it should be noted that it will mainly be spending on health care products and services that will benefit from the epidemic – consumer spending on non-health care products and services are likely to be severely negatively affected.

The impact on inflation and interest rates will be pronounced – the simulation results indicate that, even in the best inflation/interest rate scenario, the PPI inflation rate and the prime interest rate could be 2 percentage points higher compared to a no-AIDS scenario. In contrast, the impact on the current account of the balance of payments may well be fairly limited. It is projected that the current account on the balance of payments expressed as a percentage of GDP will improve slightly over the forecasting period.

Depending on how the government plans to finance the HIV/AIDS related costs to the public sector, the epidemic may well put substantial pressure on the government's budget deficit – the budget deficit may well increase to over 3% of GDP.

In all, the sensitivity analysis indicates that HIV/AIDS is bound to have a negative impact on formal sector employment and economic growth in South Africa, even in a "best-case" scenario. However, we are not heading towards a doomsday scenario, in the sense that HIV/AIDS will not be the most important determinant of economic growth in South Africa - the impact of HIV/AIDS on economic growth could range between -0.33 and -0.63 percentage points on average per annum. Furthermore, the baseline AIDS projection suggests that real GDP growth could still come in at above 3% on average over the next 15 years (see table 5.2), which is a lot better than seen during the 1990s. Real per capita GDP should increase, as the decline in the population (compared to the no-AIDS scenario) will most likely outweigh the negative impact on GDP - real per capita GDP growth is projected to be between 0.7 and 1.0 percentage points higher on average between 2002 and 2015 compared to a no-AIDS scenario.

At first glance, the economic impact numbers do not appear that disturbing, especially when compared to the extremely pessimistic projections of the Arndt and Lewis study. However, a number of factors should be kept in mind when evaluating the seriousness of the situation. Whilst the magnitude of the impact on *overall economic growth* does not appear to be alarming, the epidemic will have a pronounced negative impact on the financial sector (inflation and interest rates) and economic aggregates such as gross domestic savings and fixed investment, to name a few. The macro-economic projections may also conceal more negative impacts on specific markets in the economy (a more disaggregated level). Sales of products that are aimed at the mass consumer market, as well as products and services that are sensitive to interest rate changes will be particularly vulnerable to the epidemic. Furthermore, the macro-economic projections do little to convey the seriousness of the impending human development crisis – the implications of the epidemic for life expectancy and human suffering are a lot more dramatic.

Table 5.2: Summary of macro-economic projections: 2002-2015

	No-AIDS vs. AIDS projections (Averages; AIDS-inclusive figures in parenthesis)				**Impact range**
	2002-05	**2006-10**	**2011-15**	**2002-15**	**2002-15**
	% p.a.	% p.a.	% p.a.	% p.a.	% points p.a.
Demographics					
Total population growth	1.6 *(0.9)*	1.5 *(0.2)*	1.5 *(-0.3)*	1.5 *(0.2)*	-1.3%
Total labour force growth	1.7 *(0.9)*	1.8 *(0.1)*	1.7 *(-0.5)*	1.7 *(0.1)*	-1.6%
Growth & employment					
Real GDP growth	3.2 *(3.1)*	3.7 *(3.3)*	4.1 *(3.2)*	3.7 *(3.2)*	-0.3% to -0.6%
Real GDE growth	3.5 *(3.3)*	3.9 *(3.7)*	4.4 *(3.6)*	4.0 *(3.5)*	-0.4% to -0.7%
Potential GDP growth	3.6 *(3.0)*	4.0 *(2.6)*	4.2 *(2.2)*	4.0 *(2.6)*	-1.4% to -1.8%
Real per capita GDP growth	1.6 *(2.2)*	2.1 *(3.2)*	2.6 *(3.5)*	2.1 *(3.0)*	1.0% to 0.7%
Formal sector employment growth	1.2 *(1.2)*	1.9 *(1.3)*	2.1 *(1.0)*	1.7 *(1.1)*	-0.5% to -0.7%
Unemployment**	43.1 *(41.3)*	42.5 *(38.0)*	40.6 *(31.6)*	42.0 *(36.7)*	-5.2% to -6.2%
Consumer sector					
Total FCE growth	3.1 *(3.1)*	3.4 *(3.4)*	3.8 *(3.1)*	3.5 *(3.2)*	0.1% to -0.5%
Durable goods	6.2 *(5.4)*	8.1 *(7.5)*	7.9 *(7.4)*	7.5 *(6.8)*	-0.6% to -0.8%
Semi-durable goods	3.5 *(2.8)*	4.6 *(3.9)*	4.3 *(3.3)*	4.2 *(3.4)*	-0.6% to -1.0%
Non-durable goods	2.3 *(2.1)*	1.2 *(0.8)*	1.6 *(0.7)*	1.7 *(1.1)*	-0.1% to -0.9%
Services	3.2 *(3.7)*	4.0 *(4.7)*	4.3 *(3.8)*	3.9 *(4.1)*	0.5% to 0.0%
Real personal disposable income growth	3.4 *(3.2)*	3.7 *(3.6)*	4.1 *(3.6)*	3.8 *(3.5)*	-0.1% to -0.4%
Personal savings ratio	0.9 *(0.2)*	2.6 *(1.3)*	3.5 *(2.8)*	2.4 *(1.5)*	2.6% to -5.7%
Fixed investment & saving					
Private residential GDFI growth	3.4 *(2.2)*	3.3 *(2.1)*	3.1 *(1.8)*	3.3 *(2.0)*	-1.1% to -1.5%
Total GDFI growth	6.4 *(5.4)*	6.3 *(5.1)*	5.1 *(3.7)*	5.9 *(4.7)*	-1.0% to -1.8%
GDFI as % of GDP	18.4 *(17.9)*	21.0 *(19.7)*	22.5 *(20.5)*	20.8 *(19.5)*	-1.0% to -2.4%
Domestic savings as % of GDP	15.6 *(14.9)*	18.1 *(16.2)*	21.2 *(18.2)*	18.5 *(16.5)*	-1.3% to -5.9%
Inflation & interest rates					
CPI inflation	5.1 *(6.8)*	5.1 *(7.7)*	5.0 *(8.3)*	5.1 *(7.6)*	2.2% to 3.8%
PPI inflation	5.4 *(6.8)*	5.0 *(7.4)*	4.2 *(7.1)*	4.8 *(7.1)*	1.9% to 3.3%
Prime overdraft interest rate	14.4 *(15.8)*	12.2 *(15.1)*	10.7 *(14.8)*	12.3 *(15.2)*	2.4% to 4.7%
Real prime rate	9.0 *(9.0)*	7.1 *(7.8)*	6.5 *(7.7)*	7.4 *(8.1)*	0.4% to 1.4%
Bop & exchange rate					
Real export growth	5.5 *(5.9)*	5.9 *(6.1)*	4.5 *(4.5)*	5.3 *(5.5)*	0.5% to -0.1%
Real import growth	7.0 *(6.8)*	6.9 *(7.3)*	5.5 *(5.7)*	6.4 *(6.6)*	0.0% to 0.6%
Current account balance as % of GDP	-1.8 *(-1.7)*	-2.0 *(-1.8)*	-2.3 *(-1.8)*	-2.0 *(-1.8)*	0.2% to 0.4%
Nominal effective rand (% p.a.)	-4.5 *(-6.0)*	-3.7 *(-6.2)*	-2.5 *(-5.5)*	-3.5 *(-5.9)*	-2.0% to -3.6%
Real effective rand (% p.a.)	-1.6 *(-1.7)*	-0.9 *(-1.0)*	0.4 *(0.4)*	-0.6 *(-0.7)*	0.1% to -0.4%
The fiscus					
Real govt consump. expenditure growth	1.8 *(1.9)*	1.8 *(1.8)*	2.4 *(2.0)*	2.0 *(1.9)*	0.2% to -0.2%
as % of GDP	16.6 *(16.6)*	15.5 *(15.7)*	14.2 *(14.6)*	15.3 *(15.6)*	0.8% to 0.1%
Total taxes as % of GDP	26.2 *(26.5)*	25.4 *(25.9)*	24.0 *(24.8)*	25.1 *(25.7)*	0.0% to 0.9%
Budget deficit as % of GDP	-1.8 *(-1.6)*	-0.9 *(-1.0)*	0.0 *(-0.4)*	-0.8 *(-1.0)*	0.1% to -3.1%

** Defined as the "% of the total labour force outside the formal sector".

CHAPTER 6

SUMMARY AND CONCLUDING REMARKS

South Africa faces one of the world's most severe HIV/AIDS epidemics. Whereas the disease was initially only regarded as a serious health crisis, it is now clear that the epidemic also holds economic consequences for our country. The purpose of this research was to quantify the economic impact that the HIV/AIDS epidemic will possibly have in South Africa over the next 10 to 15 years.

Given this objective, the first step was to obtain estimates of the current level of HIV infection in South Africa, as well as projections of the demographic impact of the epidemic over the next 15 years. The main source of information concerning the HIV epidemic in South Africa is an annual survey of pregnant women attending public antenatal clinics conducted by the Department of Health. The latest antenatal clinic survey revealed that 24.5% of women attending public sector antenatal clinics were infected with HIV by late 2000 and that HIV prevalence is still increasing. Demographers use estimates from the antenatal clinic survey in combination with assumptions with regard to HIV infection rates in the sub-groups of the population not covered by the survey (e.g. men and people who are not sexually active) to develop demographic models to project the future course of the epidemic.

Two generally accepted HIV/AIDS models exist in South Africa, namely the Doyle model of Metropolitan Life and the model that was developed by Professor Rob Dorrington and the Actuarial Society of South Africa (ASSA). The Doyle model has the longest track record of use in South Africa and is the model that was employed by Abt Associates to produce the demographic projections that were used in the present analysis. An important consideration in the choice of demographic projections was the availability of projections of the impact on the labour force per skill category - crucial inputs to the analysis of the economic impact of the epidemic.

In chapter one it was noted that projections made with the Doyle model paint a somewhat more conservative picture of the demographic impact of the epidemic compared to that of the ASSA model. However, even these relatively conservative projections suggest that

HIV/AIDS will have a dramatic impact on the South African population. According to Abt Associates/Metropolitan Life, approximately 9% of South Africa's population (3.8 million people) are already infected with HIV, a figure that is projected to increase to 15.1% (6.6 million people) by 2015. The HIV/AIDS epidemic will have a disproportionate impact on the labour force, with approximately 15% of South Africa's labour force already infected with HIV. HIV prevalence among the labour force is projected to reach a massive 26% by 2015. Although semi- and unskilled workers are the more susceptible to HIV/AIDS, highly skilled labour will not escape the epidemic.

If no cure is found for the disease, most HIV+ South Africans will die within 10 years after becoming infected. Abt Associates/Metropolitan Life projects that the number of AIDS deaths could exceed all other deaths by the year 2006 and that life expectancy in South Africa could drop from 55 years in 2000 to only 39 years in 2010. By increasing mortality rates and reducing fertility rates, HIV/AIDS will stunt the growth of the South African population. By 2015, the AIDS inclusive population is projected to be about 18% smaller (±10 million people less) than would have been possible without HIV/AIDS, while the labour force could be as much as 21% smaller (±4 million people less). Given the magnitude of the problem, the national economy is bound to be affected by the epidemic.

Predicting the extent to which economic growth will be affected by the HIV/AIDS epidemic is by no means an easy task. The brunt of the impact is likely to be felt years from now and projections of the economic impact of HIV/AIDS are subject to limitations on, inter alia, the ability to estimate the current scope of the epidemic, projecting the course of the epidemic into the future and estimating the economic consequences of the demographic, productivity and health care cost implications of the epidemic. Most of the attempts that have been made to quantify the macro-economic impact of HIV/AIDS occurred during the early 1990's and relied on fairly simple models, often only projecting the impact of HIV/AIDS on overall economic growth and per capita income. The second chapter in this paper provides a summary of previous approaches to modelling the economic impact of HIV/AIDS, as well as a presentation and discussion of their simulation results. In reviewing the research that was conducted during the early 1990s, it appears as though the authors typically arrived at the conclusion that the HIV/AIDS epidemic would lead to a substantial reduction in overall economic growth and that HIV/AIDS could even reduce the growth rate of per capita income.

The year 2000 saw the first serious attempts at quantifying the economic impact of HIV/AIDS in South Africa, in the shape of research papers by ING Barings (Quattek 2000) and Arndt and Lewis (2000). Although ING Barings and Arndt and Lewis relied on the same demographic inputs, the models that were employed differed, as did their assumptions with regard to how the epidemic would affect the economy. The two studies produced divergent projections of the impact of HIV/AIDS on economic growth - whereas ING Barings predicted that GDP growth would be only 0.3 percentage points lower on average during 2002-2010 compared to what would have been possible without AIDS, Arndt and Lewis projected that GDP growth could be as much as 2.0 percentage points lower. Arndt and Lewis concluded that per capita GDP levels would also be lower due to AIDS, while the ING Barings study suggests that per capita income may rise.

With such divergent projections on the impact of HIV/AIDS on economic growth, the need for further quantitative research on the impact of the epidemic on the South African economy became evident. It was in this light that the Bureau for Economic Research undertook its research on the macro-economic impact of HIV/AIDS in South Africa, an exercise that provided the basis for this thesis. The BER's annual macro-econometric forecasting model was adapted and employed to model the impact of HIV/AIDS on the South African economy. The third chapter in this paper provides a description of the model structure and the estimation techniques that were used to estimate the behavioural equations in the model. The chapter also contains a description of the way in which the model was adapted. The different economic impact channels of the epidemic were discussed in detail. These include slower growth in the population and the labour force; higher employee benefit contributions by employers and employees; indirect costs (e.g. lower productivity and higher recruitment and training costs) to the private and public sectors; and higher health and welfare expenditure by the government, as well as an increase in personal and corporate tax rates. The macro-economic effects of each impact channel were analysed independently, after which the different impact channels were combined in the model for the final (aggregated) AIDS inclusive simulation.

The simulation results from the (baseline) AIDS scenario indicated that the HIV/AIDS epidemic will have a negative impact on overall economic growth in South Africa. The rate of GDP growth could fall from a projected average of 3.7% over the period 2002-2015 to 3.2%

per year due to the HIV/AIDS epidemic. Simulation results suggest that the South African economy will be 5.7% smaller by the year 2015 than it would have been without HIV/AIDS. In contrast, the level of per capita GDP is projected to be about 14.8% higher (in real terms) by 2015, as the adverse impact of the epidemic on the size of the population will outweigh the negative impact on real GDP. These projections are notably less devastating compared to that of Arndt and Lewis, but slightly more pessimistic compared to that of the ING Barings study.

Results from independent simulations of the four key impact channels showed that the effects of the first impact channel - slower growth in the population and the labour force - are responsible for the largest share of the deterioration in GDP growth. The production potential of the economy is severely negatively affected by the decline in the labour force (compared to a no-AIDS scenario). The gap between actual and potential output narrows, so that economy-wide capacity utilisation increases. The outcome of this is upward pressure on prices, which spills over into higher interest rates and slower growth in household consumption expenditure and fixed investment. Furthermore, a lower supply of available workers puts upward pressure on wages, reducing the demand for labour (i.e. employment). The rise in employment costs exacerbates the upward pressure on producer price inflation, and hence, on interest rates. In the end, higher interest rates and lower levels of employment explain the bulk of the deterioration in the real economic performance.

Other key impact channels of the epidemic are the direct and indirect cost implications for the private and public sectors. Employment is adversely affected by the increase in employment costs, while the pressure on prices (and interest rates) is heightened as companies pass some of the cost increases on to customers via price increases. Lower levels of employment and higher interest rates have an adverse impact on consumption expenditure and investment. However, the contraction in economic growth resulting from these effects is to some extent countered by an increase in HIV/AIDS related health care spending by households and the government.

In view of the uncertainties involved with many of the assumptions that were adopted, it was decided to vary seven of the key assumptions in order to test the sensitivity of the model to changes in these assumptions. The model proved to be most sensitive to changes in the assumptions with regard to the size of the AIDS induced direct and indirect cost increases to the private and public sectors. Higher employee benefit contributions (the alternative direct cost assumption) have a positive impact on economic growth via the extra consumption expenditure in the economy (mainly on health care products and services). In contrast, higher indirect costs could see GDP growth slow further, as higher employment costs to companies are likely to translate into more pressure on producer prices and interest rates and a further decline in the demand for labour. GDP growth also proved to be somewhat sensitive to the rate of total factor productivity growth and the proportion of the HIV/AIDS induced costs financed from household savings. Changes in the assumptions with regard to the proportion of the direct costs shouldered by companies and the government's response to the financial implications of the HIV/AIDS epidemic had a negligible effect on overall economic growth. Simulations incorporating the whole range of the potential effects (i.e. overall results from the sensitivity analysis) suggest that the impact on GDP growth could be between -0.33 and -0.63 percentage points on average per annum over the period 2002-2015, while real per capita GDP growth could be 0.7 to 1.0 percentage points higher compared to a no-AIDS scenario.

Regarding the impact on other economic variables, the simulation results indicate that HIV/AIDS will lead to substantially higher inflation and interest rates and lower levels of domestic savings, fixed investment and employment in South Africa, even in a best-case scenario. Depending on how the government plans to finance the HIV/AIDS related costs to the public sector, the impact on the government's budget deficit could be pronounced. The balance of payments will most likely be worse off and the exchange rate of the rand will be weaker. The impact on overall private consumption expenditure may be less dramatic, but this is only due to the HIV/AIDS induced increase in the demand for health care products and services. Spending on the non-health related consumption categories are likely to be severely negatively affected by the smaller population, lower levels of disposable income and higher interest due to the epidemic.

Having presented the econometric projections, it should be noted that the precision of the projections is typically dependent on the accuracy of the assumptions. One of the inherent difficulties involved in modelling work of this nature is the large number of assumptions required. A number of the assumptions were based on somewhat flimsy data or insufficient evidence (e.g. how will firms react to the AIDS-induced cost pressures?), which may well compromise the accuracy of the projections. Even the demographic projections require a multitude of assumptions. Furthermore, no allowance was made for behavioural change (e.g. an increase in condom usage) and it was assumed that no significant interventions (e.g. the development of a vaccine or affordable antiretroviral treatment) would take place, both of which appear to have the potential to change the course of the epidemic, in which case the economic impact of the epidemic may be less severe than projected.

As the focus of this research was on the macro-economic impact of HIV/AIDS, the social and developmental consequences of the epidemic received scant attention. The implications of HIV/AIDS for development are probably graver than the economic effects of the epidemic. Life expectancy, a key development indicator, will plunge, infant mortality will rise and the epidemic will compromise educational attainment. Furthermore, HIV/AIDS will worsen poverty and exacerbate the already skew income and wealth distribution in South Africa, as poor households are more vulnerable to the epidemic and have the least resources available to cope with the disease. In the end, the epidemic will reverse years of hard-won developmental progress.

Although this paper did consider some of the implications of HIV/AIDS for health and welfare spending by the government, little mention was made of the impact on the education system. HIV/AIDS related illnesses and deaths will reduce the number of experienced teachers, thereby impacting on the education department's capacity to provide education. The death or absence of even a single educator is particularly serious, since it will affect the education of 20 to 50 children. According to Abt Associates (April 2000), there are already indications that educators are at above average risk of HIV/AIDS infection, as their income and status within their communities provide ample opportunity for high-risk behaviour. The AIDS epidemic may well exacerbate existing shortages of educators with science, mathematical and technical skills in South Africa. This will happen at a time when the education system will be faced with the challenge of increasing its output to compensate for the skills losses among working adults. The HIV/AIDS epidemic will also lead to a reduction in the number of pupils, as fewer children are born (due to the negative impact of HIV/AIDS on fertility) and many HIV-infected infants will not survive to school-going age. This will affect the supply of human capital in the long run. As the BER's model has only limited representation of the public sector and the supply of labour is projected exogenously, the link between the education system and the supply of skilled labour was not modelled. Considering the above-mentioned pressures on the education system, the impact of the epidemic on the supply skilled labour (and hence on wages, employment and ultimately, economic growth) may well be more severe than projected in this analysis.

The social and economic effects at the household level also received little attention in this paper. AIDS related sickness and death will cause enormous levels of grief and emotional stress within households and communities. The trauma of being diagnosed with HIV/AIDS or watching a loved one die will be exacerbated by the stigma attached to HIV/AIDS. The stigmatisation of HIV/AIDS can lead to social rejection, not only of the AIDS victims, but also of their family members, and can compromise employment. Disability or death could permanently alter the structure and functioning of the family, as single parents, grandparents or older children may have to take up the responsibilities of running a household. Whereas some children will have to drop out of school to care for the sick or to perform household chores, others may resort to crime or sex work to secure income for household needs. The economic consequences of further increases in the crime rate in South Africa were not considered in this analysis.

In sum, the results from the macro-economic impact analysis indicate that HIV/AIDS will undoubtedly have a negative impact on economic growth in South Africa. However, it is important to note that the country is not faced with a doomsday scenario. The economic impact of the epidemic will manifest gradually - the brunt of the impact of the epidemic will most likely only be felt during the period 2010 - 2015 and even then, GDP growth will remain positive. The level of GDP will be significantly higher than it is now, while the size of the population could be similar than the current level. This implies that real per capita incomes will not only be higher in 10-15 years time than they are now, but also higher compared to a no-AIDS scenario. The economic impact numbers from this analysis are less alarming, especially when compared to the extremely pessimistic projections of the Arndt and Lewis study. However, the simulation results presented in this paper make no reference to the human suffering caused by the disease. Although projections suggest that per capita incomes will rise due to the epidemic, one should keep in mind that it is only the survivors that will be "better-off".

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APPENDIX A

DETAILED MODEL SPECIFICATION

This section provides a detailed specification of the behavioural equations and identities in the BER's macro-econometric model. The title of each equation indicates the endogenous variable that is determined by the behavioural relationship or identity. Adjusted R^2 (R^{-2}), Durbin-Watson (DW) and t-test statistics are provided for the econometrically estimated equations. Where the Engle-Granger technique was used, only the short-term (error-correction) equation is given. The long-term cointegration equation that enters the short-term equation as the error-correction term is indicated with bold letters and in square brackets in the short-term equation. The term "LOG(X)" indicates the natural logarithm of the variable X, while "DLOG(X)" indicates the first difference of the natural logarithm of X, i.e. DLOG(X_t) = LOG(X_t) - LOG(X_{t-1}). The term "@PCHY" indicates a year on year percentage change. A variable name starting with "AIDS" indicates a variable that was created to incorporate the impact of HIV/AIDS.

1.) PRIVATE CONSUMPTION EXPENDITURE: DURABLE GOODS

DLOG(CD1) = C(1)*DLOG((YD - FS*AIDSFC - (1/2*AIDSDCG)) / PCI) + C(2)*D(FRP(-1)) + C(3)*D(FRP(-2)) + C(4)*[(LOG(CD1(-1)) - (2.464 + 0.992*LOG((YD(-1) - FS(-1)*AIDSFC(-1) - (1/2*AIDSDCG(-1)))/PCI(-1)) - 0.004*FRP(-2) - 0.006*FRP(-3) + 0.171*DUM80_83(-1) - 0.197*DUM85_15(-1)))] + C(5)*DUM84_6 + C(6)*DUM80

Variable	Coefficient	t-Statistic		
C(1)	0.913	4.082	Period: 1978 2000	
C(2)	-0.008	-3.014	R -2	0.866
C(3)	-0.003	-0.883	DW statistic	1.291
C(4)	-0.707	-4.164		
C(5)	-0.118	-4.938		
C(6)	0.140	3.223		

2.) PRIVATE CONSUMPTION EXPENDITURE: SEMI-DURABLE GOODS

DLOG(CSD1) = C(1)*DLOG((YD - FS*AIDSFC - (1/2*AIDSDCG))/PCI) + C(2)*D(FRP(-1)) + C(3)*[(LOG(CSD1(-1)) - (2.088 + 1.262*LOG((YD(-1) - FS(-1)*AIDSFC(-1) - (1/2*AIDSDCG(-1)))/PCI(-1)) - 0.004*FRP(-2) + 0.098*DUM81_83(-1))))] + C(4)*DUM80_81 + C(5)*DUM84

Variable	Coefficient	t-Statistic		
C(1)	0.944	7.454	Period: 1979 2000	
C(2)	-0.003	-2.154	R -2	0.782
C(3)	-0.586	-2.733	DW statistic	1.787
C(4)	0.074	4.944		
C(5)	-0.092	-4.090		

3.) PRIVATE CONSUMPTION EXPENDITURE: NON-DURABLE GOODS

DLOG(CND1) = C(1)*DLOG(YWBD1 - (FS*AIDSFC + (1/2*AIDSDCG))*(1 - TPR)/(PC/100)) + C(2)*DLOG(YPHHD1) + C(3)*[(LOG(CND1(-1)) - (-0.827 + 0.940*LOG(YWBD1(-1) - (FS(-1)*AIDSFC(-1) + (1/2*AIDSDCG(-1)))*(1 - TPR(-1))/(PC(-1)/100)) + 0.148*LOG(YPHHD1(-1)) - 0.047*DUM80(-1) + 0.048*DUM86(-1)))] + C(4)*DUM76(1) + C(5)*DUM80 + C(6)*D(DUM86)

Variable	Coefficient	t-Statistic		
C(1)	0.929	13.781	Period: 1971 2000	
C(2)	0.104	4.670	R -2	0.753
C(3)	-0.737	-4.609	DW statistic	1.665
C(4)	-0.033	-2.508		
C(5)	-0.043	-3.095		
C(6)	0.044	4.883		

4.) PRIVATE CONSUMPTION EXPENDITURE: SERVICES

DLOG(CS1) = C(1)*DLOG(YD1 - ((FS*AIDSFC + (1/2*AIDSDCG))/PCI)) + C(2)*D(FRP(-1)) + C(3)*[(LOG(CS1(-1)) - (0.576*LOG(YD1(-1) - ((FS(-1)*AIDSFC(-1) + (1/2*AIDSDCG(-1)))/PCI(-1))) - 0.002*FRP(-2) + 0.081*DUM90_91(-1) + 0.026*DUM92_93(-1) + 0.031*(@TREND)))] + C(4)*DUM90 + C(5)*DUM92

Variable	Coefficient	t-Statistic		
C(1)	0.723	7.705	Period: 1982 2000	
C(2)	-0.002	-1.841	R -2	0.873
C(3)	-0.810	-9.510	DW statistic	1.893
C(4)	0.083	7.893		
C(5)	-0.045	-4.396		

5.) PRIVATE CONSUMPTION EXPENDITURE: TOTAL

CP1 = CD1 + CSD1 + CND1 + CS1

6.) PRIVATE CONSUMPTION EXPENDITURE (NOMINAL): TOTAL

CP = CP1 * PC / 100

7.) FIXED INVESTMENT: PRIVATE RESIDENTIAL INVESTMENT

DLOG(IPRB1) = C(1)*DLOG((YWBD1 - FS*AIDSFC*(1 - TPR)/(PC/100))) + C(2)*DLOG(FRP(-1)) + C(3)*DLOG(IPRB1(-1)) + C(4)*[(LOG(IPRB1(-1)) - (0.234*LOG(YWBD1(-1) - FS(-1)*AIDSFC(-1)*(1 - TPR(-1))/(PC(-1) /100)) - 0.091*LOG(FRP(-2)) + 9.910*DLOG(NPT_NB(-1)) + 0.186*DUM84(-1) + 0.462*LOG(IPRB1(-2))))] + C(5)*DUM85(-4) + C(6)*DUM85

Variable	Coefficient	t-Statistic		
C(1)	0.831	2.016	Period: 1980 2000	
C(2)	-0.094	-1.580	R -2	0.833
C(3)	0.593	4.207	DW statistic	1.824
C(4)	-0.471	-2.776		
C(5)	-0.154	-3.472		
C(6)	-0.198	-4.175		

8.) FIXED INVESTMENT: PRIVATE INVESTMENT EXCLUDING RESIDENTIAL INVESTMENT

D(IPZRB1) = C(1)*D(IPZRB1(-1)) + C(2)*D(D(Y1)) + C(3)*D(D(Y1(-1))) + C(4)*D(FRP(-1)) + C(5)*D(SAVC(-1)/Y(-1)) + C(6)*[(IPZRB1(-1) - (0.783*IPZRB1(-2) + 0.043*KP1(-2) + 0.077*D(Y1(-2)) -0.985*FRP(-2) + 77.170*(SAVC(-2)/Y(-2))))]

Variable	Coefficient	t-Statistic		
C(1)	0.801	7.269	Period: 1984 2000	
C(2)	0.080	1.755	R -2	0.879
C(3)	0.100	3.329	DW statistic	2.028
C(4)	-0.659	-3.348		
C(5)	60.163	1.531		
C(6)	-0.975	-4.204		

9.) FIXED INVESTMENT: PRIVATE

IP1 = IPRB1 + IPZRB1

10.) FIXED INVESTMENT: GOVERNMENT

IG1 = IGF1 + IGG1

11.) FIXED INVESTMENT: TOTAL

I1 = IP1 + IG1 + IPC1

12.) FIXED INVESTMENT (NOMINAL): TOTAL

I = I1 * PI / 100

13.) DEPRECIATION (CONSUMPTION OF FIXED CAPITAL): TOTAL

LOG(IDT) = C(1)*LOG(IDT(-1)) + C(2)*LOG(I)

Variable	Coefficient	t-Statistic		
			Period: 1970 2000	
C(1)	0.828	57.447	R -2	0.999
C(2)	0.188	14.726	DW statistic	0.717

14.) INVENTORY INVESTMENT (NOMINAL)

II = SAVP + SAVC + GSUR + IDT - I - BCA

15.) FIXED CAPITAL STOCK: PRIVATE, RESIDENTIAL

KIPRB1 = (1 - KIPRB1DEPR) * KIPRB1(-1) + IPRB1

16.) FIXED CAPITAL STOCK: PRIVATE

KP1 = (1 - KP1DEPR) * KP1(-1) + IP1

17.) FIXED CAPITAL STOCK: GENERAL GOVERNMENT

KGG1 = (1 - KGG1DEPR) * KGG1(-1) + IGG1

18.) FIXED CAPITAL STOCK: TOTAL

K1 = (1 - K1DEPR) * K1(-1) + IP1

19.) FIXED CAPITAL STOCK: TOTAL, EXCLUDING GENERAL GOVERNMENT

KZGG1 = K1 - KGG1

20.) USER COST OF CAPITAL

UCK = [PI * [FRLG + KZGG1DEPR - ((1- KZGG1DEPR / 100)* (@PCHY(PI)))]] /100

21.) BOP: MANUFACTURING EXPORTS

DLOG(BEMAN1) = C(1)*DLOG(G7Y1(-1)) + C(2)*DLOG(REXEFR) + C(3)*DLOG(REXEFR(-1)) + C(4)*[(LOG(BEMAN1(-1)) - (2.523*LOG(G7Y1(-2)) - 0.315*LOG(REXEFR(-1)) - 1.484*LOG(REXEFR(-2)) - 0.553*DUM86_91(-1)))] + C(5)*DUM90_91(-1) + C(6)*DUM93(-2) + C(7)*DUM86

Variable	Coefficient	t-Statistic		
C(1)	2.007	4.791	Period: 1976 2000	
C(2)	-0.353	-2.322	R -2	0.670
C(3)	-0.825	-4.120	DW statistic	2.405
C(4)	-0.359	-2.835		
C(5)	0.199	4.263		
C(6)	0.161	2.640		
C(7)	-0.316	-3.804		

22.) BOP: NON-MANUFACTURING EXPORTS

DLOG(BEZMAN1) = C(1)*DLOG(G7Y1(-1)) + C(2)*DLOG(REXEFR) + C(3)* [(LOG(BEZMAN1(-1)) - (1.323*LOG(G7Y1(-1)) - 0.293*LOG(REXEFR(-2)) -0.149*LOG(REXEFR(-3)) - 0.104*DUM86_91(-1) - 0.129*DUM92(-1)))] + C(4)*DUM84 + C(5)*DUM82

Variable	Coefficient	t-Statistic		
C(1)	1.723	8.633	Period: 1976 2000	
C(2)	-0.167	-1.941	R -2	0.816
C(3)	-1.037	-8.057	DW statistic	1.614
C(4)	-0.113	-3.489		
C(5)	-0.073	-2.442		

23.) BOP: MERCHANDISE EXPORTS (NOMINAL)

BEM = (BEMAN1 + BEZMAN1) * PEZG / 100

24.) BOP: NET GOLD EXPORTS

BEG = (BEGKG * 32.1507 * PAUS) / 1000000

25.) BOP: EXPORTS OF NON-FACTOR SERVICES (RECEIPTS)

DLOG(BESN) = C(1) + C(2)*DLOG(BEM) + C(3)*DLOG(BMM) + C(4)*DUM88(-1) + C(5) * [(LOG(BESN(-1)) - (-1.662 + 0.454*LOG(BEM(-1)) + 0.544*LOG(BMM(-1)) - 0.229*DUM88(-1)))]

Variable	Coefficient	t-Statistic		
C(1)	0.045	2.134	Period: 1977 2000	
C(2)	0.438	3.693	R -2	0.631
C(3)	0.156	1.825	DW statistic	1.529
C(4)	0.196	3.900		
C(5)	-0.400	-2.384		

26.) EXPORTS OF GOODS AND NON-FACTOR SERVICES (TOTAL, NOMINAL)

E = BEM + BESN + BEG

27.) EXPORTS OF GOODS AND NON-FACTOR SERVICES (TOTAL, REAL)

E1 = E / PE * 100

28.) DOMESTIC DEMAND PROXY

YDOM1 = 0.15 * (CD1 + CSD1) + 0.07 * CND1 + 0.02 * CS1 + 0.07 * GC1 + 0.31* IP1 + 0.35 * IPC1 + 0.13 * IG1 + 0.018 * E1 + 0.18 * (YB1 - GC1)

29.) BOP: MERCHANDISE IMPORTS, DEFLATED

DLOG(BMM/PM) = C(1)*DLOG(YDOM1) + C(2)*DLOG(REXEFR(-1)) + C(3)*DLOG(YCU) + C(4)*[(LOG(BMM(-1)/PM(-1)) - (-12.215 + 1.90*LOG(YDOM1(-1)) - 1.150*LOG(PM(-2)/PPI(-2)) + 0.224*DUM94_15(-1) + 0.640*LOG(YCU(-1))))]

Variable	Coefficient	t-Statistic		
C(1)	2.404	4.488	Period: 1980 1999	
C(2)	0.320	1.412	R -2	0.650
C(3)	0.826	1.272	DW statistic	0.982
C(4)	-0.742	-2.356		

30.) BOP: Imports of Non-Factor Services

DLOG(BMSN) = C(1) + C(2)*DLOG(BMM) + C(3)*DLOG(BEM) + C(4)*[(LOG(BMSN(-1)) - (-1.355 + 0.287*LOG(BEM(-1)) + 0.684*LOG(BMM(-1)) - 0.199*DUM76(-1) - 0.123*DUM88(-1)))] + C(5)*DUM93

Variable	Coefficient	t-Statistic
C(1)	0.055	2.782
C(2)	0.343	3.880
C(3)	0.232	1.969
C(4)	-0.681	-4.018
C(5)	0.105	2.225

Period: 1978 2000	
R -2	0.648
DW statistic	1.973

31.) Imports of Goods and Non-Factor Services (Total, Nominal)

M = BMM + BMSN

32.) Imports of Goods and Non-Factor Services (Total, Real)

M1 = M / PM * 100

33.) BOP: Current Transfers (Net Receipts +)

BON = OWH + OWG - OHW - OGW - OFW

34.) BOP: Current Account Balance

BCA = BEM + BEG - BMM - YFACP - BMSN + BESN + BON

35.) BOP: Total Capital Flows

BNCF = (BNCF$ * REX)

36.) BOP: Change in Net Reserves due to BOP Transactions

BRDB = BCA + BNCF

37.) BOP: Change in Gross Reserves

BRDT = BRDB + BKSR + BSDR

38.) BOP: CHANGE IN GROSS RESERVES

FGFA = FGFA(-1) + BRDT

39.) BOP: CHANGE IN GROSS RESERVES

FGFA$$ = FGFA / REXEND

40.) EXCHANGE RATE: R/$

@PCH(REX)*100 = C(1)*(@PCH(PCI)*100 - @PCH(USCPI)*100) + C(2)*((BRDB/Y)*100) + C(3)*DUM84_85 + C(4)*DUM85(-2)

Variable	Coefficient	t-Statistic		
C(1)	1.062	4.521	Period: 1975 2000	
C(2)	-1.935	-1.615	R -2	0.573
C(3)	29.353	4.512	DW statistic	1.504
C(4)	-20.923	-2.300		

41.) EXCHANGE RATE: EFFECTIVE

REXEF = ((1/ ((0.391* (REX/3.627)) + (0.357 * (REXREU/ 4.691)) + (0.149 * (REXPD/5.724)) + (0.103 * ((1/ REXYN)/0.039)))* 100))

42.) EXCHANGE RATE: REAL EFFECTIVE

REXEFR = ((REXEF * (PCI/100)) / (0.391 * (USCPI /100) + 0.357 * (PCPIEU/100) + 0.149 * (PCPIUK / 100) + 0.103 * (PCPIJP / 100)))

43.) EXCHANGE RATE: R/£

REXPD = (REX * REX$PD)

44.) EXCHANGE RATE: R/EU

REXREU = (REX * REX$EU)

45.) EXCHANGE RATE: YEN/R

REXYN = (REXYN$ / REX)

46.) GOLD PRICE: LONDON (RAND)

PAUS = PAUL * REX

47.) FORMAL EMPLOYMENT: SKILLED AND HIGHLY SKILLED, PRIVATE SECTOR

LOG(LEMHZG*1000000) = C(1)*LOG(YBZG1*1000) + C(2)*LOG(((WRMHZG*(1/AIDSPROLEMH)) /1000)/PPI) + C(3)*LOG(KZGG1*1000) + C(4)*DUM88_15

Variable	Coefficient	t-Statistic
C(1)	0.794	13.250
C(2)	-0.427	-9.282
C(3)	0.090	1.689
C(4)	0.051	2.840

Period: 1970 2000	
R -2	0.967
DW statistic	0.673

48.) FORMAL EMPLOYMENT: SEMI- AND UNSKILLED, PRIVATE SECTOR

LOG(LEUSZG*1000000) = C(1)*LOG(YBZG1*1000) + C(2)*LOG(((WRUSZG*(1/AIDSPROLEUS)) /1000)/PPI) + C(3)*LOG(UCK/PPI) + C(4)*DUM93 + C(5)*DUM88

Variable	Coefficient	t-Statistic
C(1)	0.672	62.342
C(2)	-0.777	-38.726
C(3)	0.180	6.147
C(4)	0.088	3.544
C(5)	-0.092	-3.669

Period: 1974 2000	
R -2	0.953
DW statistic	1.566

49.) FORMAL EMPLOYMENT: TOTAL, GOVERNMENT

LEG = LEUSG + LEMHG

50.) FORMAL EMPLOYMENT: TOTAL, PRIVATE SECTOR

LEZG = LEUSZG + LEMHZG

51.) FORMAL EMPLOYMENT: TOTAL, SEMI- AND UNSKILLED

LEUST = LEUSG + LEUSZG

52.) Formal Employment: Total, Skilled and Highly Skilled

LEMHT = LEMHG + LEMHZG

53.) Formal Employment: Total

LEFT = LEZG + LEG

54.) Employment: Total

LET = LEFT + LEIT

55.) Unemployment Rate: Semi- and Unskilled, Private Sector

UNUSZG = (LFUSZG - LEUSZG) / LFUSZG

56.) Unemployment Rate: Skilled and Highly Skilled, Private Sector

UNMHZG = (LFMHZG - LEMHZG) / LFMHZG

57.) Labour Productivity: Total, Private Sector

LPRODZG = (Y1 - YBG1) / (LEFT - LEG)

58.) Potential GDP

YPOT = AMAX * (((KZGG1 * 1000)^0.279) * (((0.9 * (LFUSZG * AIDSPROLFUS) * 1000000))^0.135) * (((LFMHZG * AIDSPROLFMH) * 1000000)^0.474))

59.) Capacity Utilisation

YCU = (YBZG1 * 1000) / YPOT * 100

60.) PRICE INDEX: PRODUCTION PRICE INDEX

DLOG(PPI) = C(1)*DLOG((YWBZG - (1/2*FS*AIDSFC) - (AIDSIFEMPL*AIDSIFC) + (1/2*AIDSIFC)) / Y1) + C(2)*DLOG(YCU) + C(3)*DLOG(PM) + C(4)*[(LOG(PPI(-1)) - (0.676*LOG((YWBZG(-1) - (1/2*FS(-1)*AIDSFC(-1)) - (AIDSIFEMPL(-1)*AIDSIFC(-1)) + (1/2*AIDSIFC(-1))) / Y1(-1)) + 0.2868*LOG(PM(-1)) + 3.948))]

Variable	Coefficient	t-Statistic		
C(1)	0.726	7.761	Period: 1975 2000	
C(2)	0.282	1.607	R -2	0.693
C(3)	0.258	3.297	DW statistic	1.345
C(4)	-0.282	-1.781		

61.) PRICE DEFLATOR: PRIVATE CONSUMPTION

DLOG(PC/(1+TIVATR*TIVATRR)) = C(1)*DLOG(PPI) + C(2)*DLOG(PPI(-1)) + C(3)* [(LOG(PC(-1) / (1 + TIVATR(-1)*TIVATRR(-1))) - (1.138*LOG(PPI(-1)) - 0.728))] + C(4)*DUM86(-1) + C(5)*DUM92

Variable	Coefficient	t-Statistic		
C(1)	0.432	3.474	Period: 1980 2000	
C(2)	0.643	5.109	R -2	0.848
C(3)	-0.150	-2.244	DW statistic	1.649
C(4)	-0.037	-2.221		
C(5)	0.040	2.647		

62.) PRICE INDEX: CONSUMPTION PRICE INDEX

DLOG(PCI) = C(1)*DLOG(PC) + C(2)*DUM90

Variable	Coefficient	t-Statistic		
			Period: 1980 2000	
C(1)	0.982	56.028	R -2	0.931
C(2)	-0.031	-3.182	DW statistic	1.468

63.) PRICE DEFLATOR: GOVERNMENT CONSUMPTION

DLOG(PGC) = C(1)*DLOG(PPI) + C(2)*DLOG(YWRG) + C(3)*DUM93(-1)

Variable	Coefficient	t-Statistic		
C(1)	0.684	8.103	Period: 1981 2000	
C(2)	0.383	6.432	R -2	0.732
C(3)	0.056	2.993	DW statistic	2.031

64.) PRICE DEFLATOR: IMPORTS

DLOG(PM) = C(1)*DLOG(REXEF) + C(2)*DLOG(REXEF(-1)) + C(3)*DLOG(G7CPI(-1)) + C(4)*DLOG(POILUS$*REX)

Variable	Coefficient	t-Statistic		
C(1)	-0.425	-6.414	Period: 1981 2000	
C(2)	-0.100	-1.670	R -2	0.703
C(3)	1.132	7.396	DW statistic	1.610
C(4)	0.069	3.053		

65.) PRICE DEFLATOR: NON-GOLD EXPORTS

DLOG(PEZG) = C(1)*DLOG(PPI(-1)) + C(2)*DLOG(PWM/REXEF) + C(3)*DUM84_85 + C(4)*DUM86_87(-1)

Variable	Coefficient	t-Statistic		
C(1)	0.480	5.776	Period: 1973 2000	
C(2)	0.329	6.417	R -2	0.646
C(3)	0.071	2.943	DW statistic	1.107
C(4)	-0.064	-2.819		

66.) PRICE DEFLATOR: EXPORTS

PE = 0.179 * (PAUS / 1393.48 * 100) + 0.821 * PEZG

67.) PRICE DEFLATOR: FIXED INVESTMENT

DLOG(PI) = C(1)*DLOG(PPI-0.27*PM) + C(2)*DLOG(PM)

Variable	Coefficient	t-Statistic		
			Period: 1975 2000	
C(1)	0.678	10.990	R -2	0.847
C(2)	0.345	6.472	DW statistic	1.610

68.) PRICE DEFLATOR: GDE

PGDE = 0.64 * PC + 0.2 * PGC + 0.16 * PI

69.) PRICE DEFLATOR: GDP

PY = Y / Y1 * 100

70.) WAGE RATE: SKILLED AND HIGHLY SKILLED, PRIVATE SECTOR

DLOG(WRMHZG/1000) = C(1)*DLOG(PC(-1)) + C(2)*DLOG(LPRODZG(-1)) + C(3)*DLOG(UNMHZG(-1)) + C(4)*DUM88 + C(5)*DUM80_81 + C(6)*D(DUM85(1)) + C(7)

Variable	Coefficient	t-Statistic		
C(1)	0.887	8.327	Period: 1972 2000	
C(2)	0.279	1.771	R -2	0.808
C(3)	-0.117	-2.529	DW statistic	2.011
C(4)	-0.031	-2.193		
C(5)	0.044	4.075		
C(6)	0.020	1.938		
C(7)	0.026	2.020		

71.) WAGE RATE: SEMI- AND UNSKILLED, PRIVATE SECTOR

DLOG(WRUSZG/1000) = C(1)*DLOG(PC(-1)) + C(2)*DLOG(LPRODZG(-1)) + C(3)*LOG(UNUSZG(-1)) + C(4)*DUM80 + C(5)*DUM88

Variable	Coefficient	t-Statistic		
C(1)	0.889	9.666	Period: 1978 2000	
C(2)	0.654	3.925	R -2	0.684
C(3)	-0.023	-1.976	DW statistic	2.062
C(4)	0.055	2.535		
C(5)	-0.027	-1.269		

72.) WAGE RATE: SKILLED AND HIGHLY SKILLED, GOVERNMENT

LOG(WRMHG/1000) = C(1) + C(2)*LOG((WRMHZG - (FS*AIDSFC / LEMHZG_BASE)) /1000)

Variable	Coefficient	t-Statistic		
			Period: 1970 2000	
C(1)	0.265	5.262	R -2	0.997
C(2)	1.083	94.427	DW statistic	0.732

73.) WAGE RATE: SEMI- AND UNSKILLED, GOVERNMENT

LOG(WRUSG/1000) = C(1) + C(2)*LOG(WRUSZG(-1)/1000)

Variable	Coefficient	t-Statistic		
			Period: 1971 2000	
C(1)	0.677	6.765	R -2	0.992
C(2)	1.078	61.170	DW statistic	0.375

74.) WAGE BILL: SEMI- AND UNSKILLED, GOVERNMENT

YWBUSG = WRUSG * LEUSG

75.) WAGE BILL: SKILLED AND HIGHLY SKILLED, GOVERNMENT

YWBMHG = WRMHG * LEMHG

76.) Wage Bill: Semi- and Unskilled, Private Sector

YWBUSZG = WRUSZG * LEUSZG

77.) Wage Bill: Skilled and Highly Skilled, Private Sector

YWBMHZG = WRMHZG * LEMHZG

78.) Wage Bill: Private Sector

YWBZG = YWBUSZG + YWBMHZG

79.) Wage Bill: Government

YWBG = YWBUSG + YWBMHG

80.) Wage Bill: Total

YWB = YWBZG + YWBG

81.) Wage Rate: Private Sector

YWRZG = YWBZG / LEZG

82.) Wage Rate: Government

YWRG = YWBG / LEG

83.) Wage Rate: Average

YWR = YWB / LEFT

84.) Wage Rate: Average, Real

YWR1 = YWR / (PC / 100)

85.) MONETARY SECTOR: CLAIMS ON THE PRIVATE SECTOR, DEFLATED

D(DLOG(FCP/PGDE)) = C(1)*D(DLOG(YGDE1)) + C(2)*DLOG(FRP(-1)) + C(3)*[(DLOG(FCP(-1)/PGDE(-1)) - (0.761*DLOG(YGDE1(-1)) - 0.063*DUM86(-1)))] + C(4)*DUM86

Variable	Coefficient	t-Statistic		
C(1)	0.579	3.790	Period: 1975 2000	
C(2)	-0.037	-0.623	R -2	0.670
C(3)	-0.503	-2.369	DW statistic	1.888
C(4)	-0.074	-1.962		

86.) MONETARY SECTOR: NET FOREIGN ASSETS (RESERVES)

FNFA = (FNFA(-1) + BRDB)

87.) MONETARY SECTOR: NET OTHER ASSETS AND LIABILITIES

FOTH = (1 + (@PCHY(PCI)) + RFOTH / 100) * FOTH(-1)

88.) MONETARY SECTOR: M3 MONEY SUPPLY

FM3 = FCP + FNCG + FNFA + FOTH

89.) MONETARY SECTOR: WEALTH (PROXY)

FWEALTH = KIPRB1 + (FM3 / (PC / 100))

90.) INTEREST RATE: BANK RATE

FRB = C(1)*FRB(-1) + C(2)*(@PCHY(PCI)) + C(3)*(BRDB/Y) + C(4)*(@PCHY(FM3(-1))-@PCHY(PCI(-1)))

Variable	Coefficient	t-Statistic		
C(1)	0.501	5.020	Period: 1991 2000	
C(2)	68.854	4.509	R -2	0.777
C(3)	-68.419	-2.548	DW statistic	1.565
C(4)	52.335	5.397		

91.) INTEREST RATE: LONG-TERM

FRLE = C(1)*FRB + C(2)*(@PCHY(PCI)) + C(3)*(GDEF(-1)/Y(-1)) + C(4)*DUM93 + C(5)

Variable	Coefficient	t-Statistic		
C(1)	0.193	2.071	Period: 1985 2000	
C(2)	18.170	2.850	R -2	0.564
C(3)	-41.940	-2.091	DW statistic	2.647
C(4)	-3.586	-3.220		
C(5)	9.080	4.540		

92.) INTEREST RATE: PRIME OVERDRAFT

FRP = C(1)*FRB + C(2)*(FRP(-1)-FRB(-1))

Variable	Coefficient	t-Statistic		
			Period: 1990 2000	
C(1)	1.035	25.992	R -2	0.980
C(2)	0.822	4.376	DW statistic	1.808

93.) INTEREST RATE: 3 MONTH BA

FRS = C(1)*FRB + C(2)*(FRB(-1)-FRS(-1)) + C(3)*DUM80(-1)

Variable	Coefficient	t-Statistic		
C(1)	0.978	78.716	Period: 1975 2000	
C(2)	-0.698	-5.708	R -2	0.954
C(3)	4.369	4.858	DW statistic	2.248

94.) GROSS OPERATING SURPLUS

YGOS = 0.967 * (YB - (YWB + (1 - AIDSIFEMPL) * AIDSIFC))

95.) NET OPERATING SURPLUS

YNOS = YGOS - IDT

96.) Net Operating Surplus: Incorporated Business Enterprises

JNOS = (RJNOS * YNOS) - ((1 - RJNOS) * ((FS * 2) * AIDSFC + (1 - AIDSIFEMPL) * AIDSIFC))

97.) Personal Saving

SAVP = YD - CP

98.) Corporate Saving

SAVC = (SAVCR * (JNOS - TC))

99.) Total Domestic Savings

SAVDT = SAVP + SAVC + GSUR + IDT

100.) Taxes: Corporate

TC = TCR * JNOS

101.) Taxes: Indirect (Excluding VAT)

TIO = TRIO * (CP + BMM)

102.) Taxes: Indirect (VAT)

TIVAT = (TRVAT / 100) * TRVATF * (CP + 0.5 * GC + IPRB1 * PI / 100)

103.) Taxes: Indirect (Total)

TI = TIVAT + TIO

104.) Taxes: Personal

TP = TPR * ((YWB - FS * AIDSFC) - YWBNR + YPHH + OGH + OFH + OWH)

105.) Government Interest Payments

GINT = GINT(-1) - (GDEF * FRLE / 100)

106.) Government Subsidies

GSUB = (1 + (@PCHY(PCI)) + RGSUB / 100) * GSUB(-1)

107.) Government Income from Property

GYPR = ((1 + (@PCHY(PCI)) + RGYPR / 100) * GYPR(-1))

108.) Government Savings

GSUR = GYPR - GINT + TI + TC + TP + OFG + OHG + OWG - GC - GSUB - OGH - OGW

109.) Government Consumption Expenditure (Excluding Wages)

GCOTH = GCOTH1 * (PPI / 100) + GNOSUB * (0.4 * AIDSHGOV) + GNOSUB * AIDSICG * (1 - AIDSIGEMPL)

110.) Government Consumption Expenditure (Total)

GC = YWBG + GCOTH

111.) Government Consumption Expenditure (Total, Real)

GC1 = GC / (PGC / 100)

112.) Government Deficit

GDEF = (GSUR - (IGG1 * (PI / 100)))

113.) Transfers: Households to Government

OHG = (1 + (@PCHY(PCI)) + ROHG / 100) * OHG(-1)

114.) Transfers: Government to Households

OGH = ((1 + (@PCHY(PCI)) + ROGH / 100) * OGH(-1)) + (AIDSORPHAN - AIDSORPHAN(-1)) * (PCI / PCI_BASE)

115.) Transfers: Households to Rest of World

OHW = (1 + (@PCHY(PCI)) + ROHW / 100) * OHW(-1)

116.) Transfers: Rest of World to Households

OWH = (1 + (@PCHY(PCI)) + ROWH / 100) * OWH(-1)

117.) Transfers: Business to Households

OFH = (1 + (@PCHY(PCI)) + ROFH / 100) * OFH(-1)

118.) Transfers: Business to Government

OFG = (1 + (@PCHY(PCI)) + ROFG / 100) * OFG(-1)

119.) Transfers: Business to Rest of World

OFW = (1 + (@PCHY(PCI)) + ROFW / 100) * OFW(-1)

120.) Transfers: Government to Rest of World

OGW = (1 + (@PCHY(PCI)) + ROGW / 100) * OGW(-1)

121.) Transfers: Rest of World to Government

OWG = (1 + (@PCHY(PCI)) + ROWG / 100) * OWG(-1)

122.) Personal Disposable Income

YD = YWB - YWBNR + YPHH + OGH + OFH + OWH - OHG - OHW - TP

123.) Personal Disposable Income (Real)

YD1 = YD / PC * 100

124.) Net National Income at Factor Cost

YNN = Y - IDT - TI + GSUB - YFACP

125.) Real, After Tax, Remuneration of Employees

YWBD1 = ((YWB * (1 - TPR)) / (PC / 100))

126.) Income from Property to Households

YPHH = ((1 + (@PCHY(PCI)) + RYPHH / 100) * YPHH(-1))

127.) Real, After Tax, Income from Property to Households

YPHHD1 = ((YPHH * (1 - TPR)) / (PC / 100))

128.) Gross Domestic Product at Basic Prices (Nominal)

YB = Y - (TI - GSUB)

129.) Gross Domestic Product at Basic Prices (Real)

YB1 = Y1 - (TI - GSUB) / (GC / GC1)

130.) Gross Domestic Product at Basic Prices (Real, Excluding Government)

YBZG1 = YB1 - YBG1

131.) Unit Labour Cost

ULC = YWB / Y1

132.) Gross Domestic Expenditure (Real)

YGDE1 = CP1 + GC1 + I1 + II1

133.) Gross Domestic Expenditure (Nominal)

YGDE = (YGDE1 * PGDE / 100)

134.) Gross Domestic Product (Real)

Y1 = YGDE1 + E1 - M1

135.) Gross Domestic Product (Nominal)

$$Y = CP + GC + I + II + E - M$$

Appendix B

Codes and Variable Descriptions

Code	***Description***
AIDSDCG	Increase in direct costs of AIDS to the government (in Rand billion) - total
AIDSDCGMH	Increase in direct costs of AIDS to the government (in Rand billion) – skilled employees
AIDSIFEMPL	Percentage of increase in indirect costs of AIDS to the private sector related to higher employment (ratio)
AIDSIGEMPL	Percentage of increase in indirect costs of AIDS to the government related to higher employment (ratio)
AIDSFC	Increase in direct costs of AIDS to the private sector (in Rand billion) - total
AIDSFCR	Increase in direct costs of AIDS to the private sector (as % of skilled wage bill)
AIDSHGOV	Increase in government health care expenditure
AIDSICG	Increase in indirect costs of AIDS to the government (in Rand billion) - total
AIDSICGMH	Increase in indirect costs of AIDS to the government (in Rand billion) – skilled employees
AIDSICGUS	Increase in indirect costs of AIDS to the government (in Rand billion) – unskilled employees
AIDSIFC	Increase in indirect costs of AIDS to the private sector (in Rand billion) - total
AIDSIFCMH	Increase in indirect costs of AIDS to the private sector (in Rand billion) - skilled employees
AIDSIFCUS	Increase in indirect costs of AIDS to the private sector (in Rand billion) - unskilled employees
AIDSIFCMHR	Increase in indirect costs of AIDS to the private sector (as % of skilled wage bill) - skilled employees
AIDSIFCUSR	Increase in indirect costs of AIDS to the private sector (as % of unskilled wage bill) - unskilled employees

AIDSORPHAN	Increase in government welfare expenditure on orphans
AIDSPREVLFMH	AIDS prevalence among skilled labour force
AIDSPREVLFUS	AIDS prevalence among unskilled labour force
AIDSPROLFMH	Productivity of skilled labour force in AIDS scenario (ratio)
AIDSPROLFUS	Productivity of unskilled labour force in AIDS scenario (ratio)
AIDSVICNPT	AIDS victims among the total population
AIDSVICLEMH	AIDS victims among the skilled and highly skilled employed
AMAX	Total Factor Productivity
AMAXG	Growth rate in Total Factor Productivity
BCA	Balance of Payments: Current Account Balance
BEG	Balance of Payments: Net gold exports
BEGKG	SA Gold Production - Volume (1000 kg)
BEM	Balance of Payments: Merchandise exports
BEMAN1	Balance of Payments: Manufacturing exports
BESN	Balance of Payments: Non-factor services receipts
BEZMAN1	Balance of Payments: Non-Manufacturing exports
BKSR	Balance of Payments: Capital Flows - Change in Reserve Related Liabilities
BMM	Balance of Payments: Merchandise imports
BMSN	Balance of Payments: Non-factor services payments
BNCF	Balance of Payments: Total Capital Flows
BON	Balance of Payments: Net transfers
BRDB	Balance of Payments: Change in net reserves
BRDT	Balance of Payments: Change in gross reserves
BSDR	Balance of Payments: SDR and Valuation Adjustments
CD1	Private Consumption Expenditure: Durables (constant 1995 prices)
CND1	Private Consumption Expenditure: Non-Durables (constant 1995 prices)

CND1_BASE	Private Consumption Expenditure: Non-Durables (constant 1995 prices) (Baseline no-AIDS forecast)
CP	Private Consumption Expenditure: Total
CP1	Private Consumption Expenditure: Total (constant 1995 prices)
CS1	Private Consumption Expenditure: Services (constant 1995 prices)
CS1_BASE	Private Consumption Expenditure: Services (constant 1995 prices) (Baseline no-AIDS forecast)
CSD1	Private Consumption Expenditure: Semi-Durables (constant 1995 prices)
DUM	Dummy variable for specified period
E	Exports of goods and non-factor services
E1	Exports of goods and non-factor services (constant 1995 prices)
FCP	Monetary sector: Claims on the private sector
FGFA	Balance of Payments: Gross Foreign Reserves
FGFA$$	Balance of Payments: Gross Foreign Reserves ($)
FM3	Monetary sector: M3 Money Supply
FNCG	Net claims on the government sector
FNFA	Monetary sector: Net foreign assets
FOTH	Monetary sector: Net other assets and liabilities
FRB	Bank rate
FRLE	Long term Eskom rate
FRLG	Yield on government bond (10 years and over)
FRP	Prime overdraft rate
FRS	3-month BA discount rate
FS	Proportion of AIDS-induced cost increases shouldered by firms (employers)
FWEALTH	Wealth proxy
GC	Government Consumption Expenditure
GC1	Government Consumption Expenditure (constant 1995 prices)

GCOTH	Government Consumption Expenditure - Excluding wages
GCOTH1	Government Consumption Expenditure - Excluding wages (constant 1995 prices)
GDEF	Government Deficit
GINT	Government Interest Payments
GNOSUB	Proportion of higher government expenditure that is financed via higher budget deficit (not substituted away from spending in other departments)
GSUB	Government Subsidies
GSUR	Government Savings
GYPR	Government Income from Property
G7CPI	Consumer price index - G7 countries
G7Y1	Real gross domestic product - G7 countries
I	Fixed investment: Total
I1	Fixed investment: Total (constant 1995 prices)
IDT	Depreciation: Total
IG	Fixed investment: Government
IG1	Fixed investment: Government (constant 1995 prices)
IGF1	Fixed investment: General Government - Business Enterprises (constant 1995 prices)
IGG1	Fixed investment: General Government (constant 1995 prices)
II	Inventory investment
II1	Inventory investment (constant 1995 prices)
IP1	Fixed investment: Private Sector, Total (constant 1995 prices)
IPC1	Fixed investment: Public Corporations (constant 1995 prices)
IPRB1	Fixed investment: Private Residential Buildings (constant 1995 prices)
IPZRB1	Fixed investment: Private Sector Excluding Residential Buildings (constant 1995 prices)
JNOS	Net Operating Surplus - Incorporated Business Enterprises
K1	Fixed Capital Stock: Total (constant 1995 prices)

K1DEPR	Depreciation rate: Fixed Capital Stock - Total
KGG1	Fixed Capital Stock: General Government (constant 1995 prices)
KGG1DEPR	Depreciation rate: Fixed Capital Stock - General Government
KIPRB1	Fixed Capital Stock: Private Residential Buildings (constant 1995 prices)
KIPRB1DEPR	Depreciation rate: Fixed Capital Stock - Private Residential Buildings
KP1	Fixed Capital Stock: Private Sector (constant 1995 prices)
KP1DEPR	Depreciation rate: Fixed Capital Stock - Private Sector
KZGG1	Fixed Capital Stock: Excluding General Government (constant 1995 prices)
KZGG1DEPR	Depreciation rate: Fixed Capital Stock - Excluding General Government
LEFT	Formal Employment: Total
LEG	Formal Employment: Total, Government
LEMHG	Formal Employment: Skilled and Highly Skilled, Government
LEMHG_BASE	Formal Employment: Skilled and Highly Skilled, Government (Baseline no-AIDS forecast)
LEMHT	Formal Employment: Skilled and Highly Skilled, Total
LEMHZG	Formal Employment: Skilled and Highly Skilled, Private Sector
LEMHZG_BASE	Formal Employment: Skilled and Highly Skilled, Private Sector (Baseline no-AIDS forecast)
LET	Formal Employment: Total
LEIT	Informal Employment: Total
LEUSG	Formal Employment: Semi- and Unskilled, Government
LEUSG_BASE	Formal Employment: Semi- and Unskilled, Government (Baseline no-AIDS forecast)
LEUST	Formal Employment: Semi- and Unskilled, Total
LEUSZG	Formal Employment: Semi- and Unskilled, Private Sector
LEZG	Formal Employment: Total, Private Sector
LFMHG	Labour Force: Skilled and Highly Skilled, Government

LFMHT	Labour Force: Skilled and Highly Skilled, Total
LFMHZG	Labour Force: Skilled and Highly Skilled, Private Sector
LFT	Labour Force: Total
LFUSG	Labour Force: Semi- and Unskilled, Government
LFUST	Labour Force: Semi- and Unskilled, Total
LFUSZG	Labour Force: Semi- and Unskilled, Private Sector
LPRODZG	Labour Productivity: Private Sector
M	Imports of goods and non-factor services
M1	Imports of goods and non-factor services (constant 1995 prices)
NPT	Total Population
NPT_NB	Total Population - Non Black
OFG	Transfers: Business to Government
OFH	Transfers: Business to Households
OFW	Transfers: Business to Rest of World
OGH	Transfers: Government to Households
OGW	Transfers: Government to Rest of World
OHG	Transfers: Households to Government
OHW	Transfers: Households to Rest of World
OWG	Transfers: Rest of World to Government
OWH	Transfers: Rest of World to Households
PAUL	Gold Price: London ($)
PAUS	Gold Price: London (Rand)
PC	Price Deflator: Private Consumption
PCI	Consumer Price Index
PCI_BASE	Consumer Price Index (Baseline no-AIDS forecast)
PCPIEU	Consumer Price Index: Europe
PCPIJP	Consumer Price Index: Japan

PCPIUK	Consumer Price Index: United Kingdom
PE	Price Deflator: Exports
PEZG	Price Deflator: Non-Gold Exports
PGC	Price Deflator: Government Consumption
PGDE	Price Deflator: GDE
PI	Price Deflator: Fixed Investment
PM	Price Deflator: Imports
PPI	Production Price Index
PY	Price Deflator: GDP
POILUS$	Price Index: Oil Price ($)
PWM	Price Index: World import price
REX	Exchange Rate: R/$
REXEF	Exchange Rate: Effective
REXEFR	Exchange Rate: Real Effective
REXPD	Exchange Rate: R/£
REXREU	Exchange Rate: R/EU
REXYN	Exchange Rate: Yen/R
REX$EU	Exchange Rate: $/EU
REX$PD	Exchange Rate: $/£
REXEND	Exchange Rate: R/$ (year end)
REXYN$	Exchange Rate: $/Yen
RFOTH	Real rate of increase in net other assets and liabilities (monetary sector)
RGSUB	Real rate of increase in Government Subsidies
RGYPR	Real rate of increase in Government Income from Property
RJNOS	Proportion of Net Operating Surplus (YNOS) attributable to Incorporated Business Enterprises
ROFG	Real rate of increase in transfers: Business to Government
ROFH	Real rate of increase in transfers: Business to Households

ROFW	Real rate of increase in transfers: Business to Rest of World
ROGH	Real rate of increase in transfers: Government to Households
ROGW	Real rate of increase in transfers: Government to Rest of World
ROHG	Real rate of increase in transfers: Households to Government
ROHW	Real rate of increase in transfers: Households to Rest of World
ROWG	Real rate of increase in transfers: Rest of World to Government
ROWH	Real rate of increase in transfers: Rest of World to Households
RYPHH	Real rate of increase in Income from Property to Households
SAVCR	Proportion of Net Operating Surplus of Incorporated Business Enterprises that is saved
SAVC	Corporate Savings
SAVDT	Total Domestic Savings
SAVP	Personal Savings
TC	Taxes: Corporate
TCR	Tax Rate: Corporate
TI	Taxes: Indirect (Total)
TIO	Taxes: Indirect (Excluding VAT)
TIVAT	Taxes: Indirect (VAT)
TIVATR	Tax Rate: Indirect (VAT)
TIVATRR	Tax Recovery Rate: Indirect (VAT)
TP	Taxes: Personal
TPR	Tax Rate: Personal
TRIO	Tax Rate: Indirect (Excluding VAT)
TRVAT	Tax Rate: Indirect (VAT)
UCK	User cost of Capital
ULC	Unit Labour Cost
UNMHZG	Unemployment Rate: Skilled and Highly Skilled, Private Sector
UNUSZG	Unemployment Rate: Semi- and Unskilled, Private Sector

USCPI	Consumer Price Index: United States
WRMHG	Wage Rate: Skilled and Highly Skilled, Government
WRMHG_BASE	Wage Rate: Skilled and Highly Skilled, Government (Baseline no-AIDS forecast)
WRMHZG	Wage Rate: Skilled and Highly Skilled, Private Sector
WRUSG_BASE	Wage Rate: Skilled and Highly Skilled, Private Sector (Baseline no-AIDS forecast)
WRUSG	Wage Rate: Semi- and Unskilled, Government
WRUSZG	Wage Rate: Semi- and Unskilled, Private Sector
Y	Gross Domestic Product
Y1	Gross Domestic Product (constant 1995 prices)
YB	Gross Domestic Product at Basic Prices
YB1	Gross Domestic Product at Basic Prices (constant 1995 prices)
YBG1	Gross Domestic Product at Basic Prices - Government (constant 1995 prices)
YBZG1	Gross Domestic Product at Basic Prices - Excluding Government (constant 1995 prices)
YCU	Capacity Utilization
YD	Personal Disposable Income
YD1	Personal Disposable Income (constant 1995 prices)
YDOM1	Domestic Demand Proxy
YFACP	Balance of Payments: Net Factor Payments
YGDE	Gross Domestic Expenditure
YGDE1	Gross Domestic Expenditure (constant 1995 prices)
YGOS	Gross Operating Surplus
YNN	Net National Income at Factor Cost
YNOS	Net Operating Surplus
YPHH	Income from Property to Households
YPHHD1	Real, After Tax, Income from Property to Households
YPOT	Potential GDP

YWB	Wage Bill: Total
YWBD1	Real, After Tax, Remuneration of Employees
YWBG	Wage Bill: Government
YWBMHG	Wage Bill: Skilled and Highly Skilled, Government
YWBMHZG	Wage Bill: Skilled and Highly Skilled, Private Sector
YWBMHZG_BASE	Wage Bill: Skilled and Highly Skilled, Private Sector (Baseline no-AIDS forecast)
YWBUSG	Wage Bill: Semi- and Unskilled, Government
YWBUSZG	Wage Bill: Semi- and Unskilled, Private Sector
YWBZG	Wage Bill: Private Sector
YWR	Wage Rate: Average
YWR1	Wage Rate: Average, Real
YWRG	Wage Rate: Government
YWRZG	Wage Rate: Private Sector
YWRZG_BASE	Wage Rate: Private Sector (Baseline no-AIDS forecast)
YWBNR	National disposable income, saving and net borrowing at current prices: less net compensation to non-residents

Appendix C

Simulation Results of the Economic Effects of the Different HIV/AIDS Impact Channels

Table C.1: Impact of lower population, labour force and government employment

	2002	2005	2008	2010	2013	2015	Average 01-15
Real GDP[a]	-0.27	-0.83	-1.92	-2.91	-4.65	-5.95	-2.37
Formal Sector Employment[a]	-0.21	-0.72	-1.85	-2.83	-4.65	-5.84	-2.30
Prime Overdraft Rate[b]	0.02	0.19	0.36	0.58	1.10	1.83	0.56
Producer Price Index[a]	0.26	1.05	2.42	3.91	7.25	11.01	3.56
Producer Price Inflation Rate[b]	0.14	0.32	0.52	0.84	1.30	1.99	0.77
Effective Exchange Rate[a]	-0.10	-0.68	-1.63	-2.66	-5.25	-8.27	-2.52
Budget Deficit as % of GDP[b]	0.04	0.09	0.12	0.10	-0.04	-0.21	0.04
Production side							
Potential GDP[a]	-0.65	-2.06	-4.53	-6.68	-10.02	-12.31	-5.27
Capacity Utilization[a]	0.38	1.21	2.58	3.80	5.55	6.73	2.96
Total Labour Force[a]	-1.77	-4.47	-8.74	-12.19	-17.6	-21.08	-9.70
Skilled Labour Force[a]	-1.48	-3.81	-7.58	-10.66	-15.5	-18.6	-8.47
Unskilled Labour Force[a]	-1.94	-4.83	-9.37	-13.02	-18.71	-22.38	-10.35
Employment							
Government Employment[a]	-0.76	-1.95	-3.86	-5.43	-7.88	-9.45	-4.31
Private Sector Employment[a]	-0.06	-0.39	-1.34	-2.19	-3.88	-5.01	-1.81
Unemployment Rate[b]	-0.88	-2.36	-4.60	-6.66	-10.12	-12.78	-5.42

Table C.1 continued: Impact of lower population, labour force and government employment							
	2002	2005	2008	2010	2013	2015	Average 01-15
Consumer sector							
Real Disposable Income[a]	-0.29	-0.75	-1.52	-2.12	-3.02	-3.53	-1.66
Real FCE[a]	-0.50	-1.39	-2.88	-4.09	-6.15	-7.54	-3.28
Real FCE: Non-Durables[a]	-0.63	-1.71	-3.67	-5.36	-8.3	-10.26	-4.33
Real FCE: Semi-Durables[a]	-0.53	-1.58	-3.26	-4.63	-7.01	-8.75	-3.74
Real FCE: Durables[a]	-0.47	-1.36	-2.57	-3.45	-4.90	-5.93	-2.75
Real FCE: Services[a]	-0.37	-1.02	-2.13	-3.03	-4.60	-5.68	-2.45
Personal savings as % of Disposable Income[b]	0.21	0.63	1.34	1.96	3.11	3.98	1.61
Investment							
Real Residential Investment[a]	-0.87	-2.39	-4.67	-6.64	-9.88	-12.14	-5.32
Real gross domestic fixed investment[a]	-0.20	-0.57	-1.24	-1.84	-3.03	-4.08	-1.55
Real gross domestic fixed investment as % of GDP[b]	0.01	0.05	0.15	0.24	0.38	0.45	0.19
The fiscus							
Real Government Consumption Expenditure[a]	-0.62	-1.51	-2.82	-3.88	-5.39	-6.31	-3.05
Real Government Consumption Expenditure as % of GDP[b]	-0.06	-0.11	-0.14	-0.15	-0.11	-0.05	-0.10

a. Percentage difference between levels in no-AIDS and AIDS scenarios.

b. Percentage points difference between no-AIDS and AIDS scenarios.

Table C.2: Impact of direct cost increases to firms							
	2002	2005	2008	2010	2013	2015	Average 01-15
Real GDP[a]	0.43	0.91	1.43	1.52	1.09	0.59	1.01
Formal Sector Employment[a]	0.19	0.33	0.2	-0.14	-0.88	-1.43	-0.17
Prime Overdraft Rate[b]	0.40	0.76	1.26	1.53	1.53	1.55	1.09
Producer Price Index[a]	0.45	1.82	3.95	5.72	8.47	10.45	4.48
Producer Price Inflation Rate[b]	0.29	0.54	0.77	0.91	0.89	0.96	0.73
Effective Exchange Rate[a]	-0.88	-2.98	-5.8	-7.79	-10.31	-11.95	-5.90
Budget Deficit as % of GDP[b]	-0.03	-0.06	-0.10	-0.14	-0.28	-0.44	-0.16
Employment and wages							
Skilled Private Sector Wage Rate (Nominal)[a]	1.41	4.17	8.69	12.13	16.61	19.60	9.25
Unskilled Private Sector Wage Rate (Nominal)[a]	0.20	1.39	3.73	5.80	9.10	11.21	4.50
Skilled Private Sector Employment[a]	-0.04	-0.21	-0.77	-1.40	-2.48	-3.30	-1.14
Unskilled Private Sector Employment[a]	0.51	1.02	1.25	1.08	0.38	-0.07	0.75
Real After Tax Wage Bill[a]	0.55	1.19	2.10	2.59	2.73	2.65	1.85
Consumer sector							
Real Disposable Income[a]	0.42	0.86	1.46	1.76	1.77	1.67	1.26
Real FCE[a]	0.71	1.38	2.27	2.63	2.12	1.61	1.75
Real FCE: Non-Durables[a]	0.59	1.09	1.72	1.91	1.73	1.33	1.37
Real FCE: Semi-Durables[a]	-0.13	-0.48	-0.99	-1.44	-2.33	-3.11	-1.21
Real FCE: Durables[a]	-0.20	-0.76	-1.47	-1.94	-2.67	-3.21	-1.51
Real FCE: Services[a]	1.26	2.63	4.59	5.6	5.12	4.66	3.79
Personal savings as % of Disposable Income[b]	-0.29	-0.50	-0.78	-0.83	-0.33	0.05	-0.48

Table C.2 continued: Impact of direct cost increases to firms							
	2002	2005	2008	2010	2013	2015	Average 01-15
Business sector							
Net Operating Surplus - Inc. Business Enterprises[a]	-3.12	-4.64	-5.93	-5.94	-2.76	-0.73	-4.08
Corporate Savings as % of GDP[b]	-0.10	-0.13	-0.12	-0.22	-0.20	-0.14	-0.15
Investment							
Real gross domestic fixed investment[a]	0.04	-0.80	-1.79	-2.56	-3.80	-4.48	-1.95
Real gross domestic fixed investment as % of GDP[b]	-0.07	-0.32	-0.67	-0.87	-1.09	-1.15	-0.63
Balance of Payments							
Real Effective Exchange Rate[a]	-0.57	-1.30	-1.95	-2.18	-1.98	-1.82	-1.57
Real Exports[a]	0.74	2.03	3.22	3.83	4.31	4.31	2.87
Real Imports[a]	0.82	1.36	2.04	2.61	2.64	2.72	1.91
Current Account Balance as % of GDP[b]	-0.18	-0.11	0.00	0.05	0.31	0.37	0.04

a. Percentage difference between levels in no-AIDS and AIDS scenarios.

c. Percentage points difference between no-AIDS and AIDS scenarios.

Table C.3: Impact of indirect cost increases to firms							
	2002	2005	2008	2010	2013	2015	Average 01-15
Real GDP[a]	-0.26	-0.82	-1.56	-2.04	-2.69	-3.05	-1.56
Formal Sector Employment[a]	0.40	0.21	-0.3	-0.56	-1.35	-1.60	-0.42
Prime Overdraft Rate[b]	0.51	0.57	0.61	0.69	0.5	0.52	0.54
Producer Price Index[a]	0.98	2.43	3.96	5.19	6.41	7.40	3.99
Producer Price Inflation Rate[b]	0.30	0.54	0.50	0.64	0.40	0.50	0.48
Effective Exchange Rate[a]	-0.71	-1.42	-2.47	-3.50	-4.90	-6.10	-2.80
Budget Deficit as % of GDP[b]	-0.19	-0.49	-0.83	-1.02	-1.26	-1.41	-0.84
Production side							
Potential GDP[a]	-0.29	-0.82	-1.65	-2.36	-3.62	-4.58	-1.93
Capacity Utilization[a]	0.01	-0.11	-0.13	0.02	0.55	1.14	0.16
Employment							
Skilled Private Sector Employment[a]	0.20	-0.24	-0.91	-1.31	-2.25	-2.60	-1.01
Unskilled Private Sector Employment[a]	0.80	0.74	0.15	-0.09	-1.06	-1.28	-0.01
Consumer sector							
Real Disposable Income[a]	-0.37	-0.72	-1.26	-1.63	-2.08	-2.36	-1.26
Real FCE[a]	-0.44	-0.89	-1.56	-2.01	-2.59	-2.98	-1.56
Personal savings as % of Disposable Income[b]	0.06	0.17	0.30	0.38	0.50	0.61	0.30

Table C.3 continued: Impact of indirect cost increases to firms

	2002	2005	2008	2010	2013	2015	Average 01-15
Business sector							
Net Operating Surplus - Inc. Business Enterprises[a]	-3.73	-6.43	-8.60	-9.70	-8.62	-7.87	-7.29
Corporate Savings as % of GDP[b]	-0.11	-0.14	-0.13	-0.23	-0.21	-0.14	-0.16
Investment							
Real gross domestic fixed investment[a]	-0.36	-1.42	-2.21	-2.61	-3.17	-3.46	-2.03
Real gross domestic fixed investment as % of GDP[b]	-0.02	-0.12	-0.14	-0.13	-0.11	-0.10	-0.10
The fiscus							
Real Government Consumption Expenditure as % of GDP[b]	-0.01	0.06	0.16	0.21	0.30	0.34	0.16
Total Taxes as % of GDP[b]	-0.08	-0.15	-0.18	-0.13	-0.04	0.00	-0.11

a. Percentage difference between levels in no-AIDS and AIDS scenarios.

b. Percentage points difference between no-AIDS and AIDS scenarios.

Table C.4: Impact of higher government spending and taxes							
	2002	2005	2008	2010	2013	2015	Average 01-15
Real GDP[a]	0.41	0.60	0.87	0.89	0.49	0.13	0.59
Formal Sector Employment[a]	0.68	0.91	1.15	1.11	0.55	0.15	0.80
Prime Overdraft Rate[b]	0.51	0.46	0.60	0.53	0.06	-0.22	0.35
Producer Price Index[a]	0.49	1.16	1.88	2.31	2.37	2.01	1.62
Producer Price Inflation Rate[b]	0.24	0.22	0.24	0.21	-0.08	-0.22	0.13
Effective Exchange Rate[a]	-0.88	-1.73	-2.76	-3.35	-2.99	-2.06	-2.24
Budget Deficit as % of GDP[b]	0.38	0.44	0.23	0.01	-0.21	-0.37	0.12
<u>Employment and wages</u>							
Skilled Government Wage Rate (Nominal)[a]	1.45	3.60	6.25	7.78	8.40	8.24	5.56
Unskilled Government Wage Rate (Nominal)[a]	0.00	0.54	1.40	2.05	2.92	3.09	1.47
Skilled Government Employment[a]	0.77	1.32	1.84	2.03	2.03	1.97	1.60
Unskilled Government Employment[a]	1.59	2.77	3.77	4.25	4.38	4.30	3.36
Aggregate Wage Bill (Nominal)[a]	1.17	2.6	4.26	5.09	5.16	4.63	3.63

Table C.4 continued: Impact of higher government spending and taxes							
	2002	2005	2008	2010	2013	2015	Average 01-15
Consumer sector							
Real Disposable Income[a]	0.30	0.38	0.83	1.05	0.93	0.79	0.68
Real Tax Adjusted Income from Property[a]	-0.27	-0.67	-0.84	-0.87	-0.89	-0.87	-0.71
Real FCE[a]	0.37	0.44	0.77	0.76	-0.03	-0.66	0.35
Real FCE: Non-Durables[a]	0.39	0.35	0.54	0.40	-0.45	-1.20	0.12
Real FCE: Semi-Durables[a]	-0.10	-0.67	-1.13	-1.47	-2.4	-3.17	-1.29
Real FCE: Durables[a]	-0.22	-0.83	-1.25	-1.52	-2.06	-2.45	-1.25
Real FCE: Services[a]	0.61	1.10	2.00	2.3	1.57	1.00	1.42
Personal savings as % of Disposable Income[b]	-0.07	-0.06	0.06	0.28	0.92	1.38	0.32
Business sector							
Corporate Savings as % of GDP[b]	-0.10	-0.07	-0.04	-0.06	-0.06	-0.04	-0.07
Investment							
Real gross domestic fixed investment[a]	0.03	-0.77	-1.14	-1.40	-1.65	-1.57	-1.02
Real gross domestic fixed investment as % of GDP[b]	-0.07	-0.26	-0.42	-0.49	-0.48	-0.39	-0.34
The fiscus							
Non-Wage Government Consumption (Nominal)[a]	3.06	5.92	8.98	10.59	10.78	10.38	7.87
Transfers: Government to Households (Nominal)[a]	2.34	5.45	10.94	14.96	16.92	16.54	10.38
Real Government Consumption[a]	1.58	3.03	4.61	5.38	5.61	5.67	4.08
Real Government Consumption Expenditure as % of GDP[b]	0.19	0.39	0.57	0.65	0.71	0.74	0.51
Total Taxes as % of GDP[b]	0.49	0.70	0.79	0.81	0.78	0.74	0.71

a. Percentage difference between levels in no-AIDS and AIDS scenarios.

b. Percentage points difference between no-AIDS and AIDS scenarios.

Table C.5: Overall Impact of HIV/AIDS							
	2002	2005	2008	2010	2013	2015	Average 01-15
Real GDP[a]	0.37	0.08	-0.53	-1.48	-3.86	-5.73	-1.43
Real per capita GDP[a]	2.12	4.20	7.39	9.65	12.80	14.83	7.66
Formal Sector Employment[a]	1.11	0.84	-0.41	-1.79	-5.15	-7.18	-1.54
Prime Overdraft Rate[b]	1.56	2.2	3.29	3.98	4.05	4.57	3.01
Producer Price Index[a]	2.27	6.88	13.44	19.32	28.79	36.9	15.61
Producer Price Inflation Rate[b]	1.02	1.69	2.22	2.81	2.78	3.36	2.28
Effective Exchange Rate[a]	-2.74	-7.31	-13.72	-18.74	-25.60	-30.55	-14.59
Budget Deficit as % of GDP[b]	0.22	0.12	-0.16	-0.33	-0.52	-0.72	-0.20
Production side							
Potential GDP[a]	-1.06	-3.18	-6.74	-9.77	-14.57	-17.91	-7.76
Capacity Utilization[a]	1.51	3.43	6.63	9.00	12.04	14.07	6.96
Total Labour Force[a]	-1.77	-4.47	-8.74	-12.19	-17.6	-21.08	-9.70
Skilled Labour Force[a]	-1.48	-3.81	-7.58	-10.66	-15.50	-18.60	-8.47
Unskilled Labour Force[a]	-1.94	-4.83	-9.37	-13.02	-18.71	-22.38	-10.35
Employment and wages							
Government Employment[a]	0.09	-0.49	-1.84	-3.2	-5.66	-7.31	-2.56
Private Sector Employment[a]	1.38	1.19	-0.05	-1.44	-5.03	-7.15	-1.28
Skilled Private Sector Employment[a]	0.61	-0.3	-2.18	-4.05	-8.09	-10.76	-3.37
Unskilled Private Sector Employment[a]	2.11	2.63	2.07	1.23	-1.75	-3.18	0.86
Skilled Government Employment[a]	0.04	-0.57	-1.94	-3.3	-5.74	-7.37	-2.64
Unskilled Government Employment[a]	0.64	0.44	-0.73	-2.02	-4.69	-6.56	-1.65
Unemployment Rate[a]	-1.54	-3.07	-5.30	-7.24	-9.86	-11.93	-5.78

Table C.5 continued: Overall Impact of HIV/AIDS							
	2002	2005	2008	2010	2013	2015	Average 01-15
Employment and wages continued							
Skilled Private Sector Wage Rate (Nominal)[a]	1.96	8.01	17.72	26.14	40.69	52.37	21.10
Unskilled Private Sector Wage Rate (Nominal)[a]	0.15	3.91	10.28	16.1	26.95	34.87	13.07
Skilled Government Wage Rate (Nominal)[a]	2.02	8.48	18.92	28.07	44.16	57.18	22.77
Unskilled Government Wage Rate (Nominal)[a]	0.00	2.49	8.18	13.76	24.68	32.89	11.37
Real After Tax Wage Bill[a]	0.08	-0.19	-0.49	-1.05	-2.76	-3.96	-1.07
Aggregate Wage Bill (Nominal)[a]	2.34	7.44	14.86	20.88	29.87	37.11	16.45
Consumer sector							
Real Disposable Income[a]	0.07	-0.19	-0.37	-0.73	-2.02	-2.96	-0.80
Real Tax Adjusted Income from Property[a]	-0.36	-1.01	-1.54	-1.88	-2.42	-2.83	-1.52
Real FCE[a]	0.54	0.66	1.00	0.8	-1.22	-2.77	0.10
Real FCE: Non-Durables[a]	0.25	-0.07	-0.63	-1.63	-4.22	-6.28	-1.60
Real FCE: Semi-Durables[a]	-0.73	-2.37	-4.17	-5.43	-7.88	-9.84	-4.47
Real FCE: Durables[a]	-1.04	-3.06	-4.73	-5.66	-6.95	-7.92	-4.45
Real FCE: Services[a]	1.52	3.02	5.33	6.32	4.72	3.45	4.00
Personal savings as % of Disposable Income[b]	-0.47	-0.84	-1.34	-1.50	-0.79	-0.18	-0.88
Inflation and interest rates							
Consumer Price Index[a]	1.97	6.87	14.31	20.86	31.93	40.84	16.82
Consumer Price Inflation Rate[b]	1.47	1.89	2.62	3.13	3.14	3.63	2.56
Real Prime Overdraft Rate[b]	0.54	0.51	1.07	1.17	1.27	1.21	0.74

Table C.5 continued: Overall Impact of HIV/AIDS							
	2002	2005	2008	2010	2013	2015	Average 01-15
Business Sector							
Net Operating Surplus - Inc. Business Enterprises[a]	-4.59	-5.94	-5.39	-3.04	7.98	16.57	-0.66
Corporate Savings as % of GDP[b]	-0.30	-0.30	-0.24	-0.40	-0.33	-0.20	-0.30
Investment and savings							
Real Residential Investment[a]	-1.27	-4.39	-7.37	-9.76	-13.08	-15.22	-7.61
Real gross domestic fixed investment[a]	-0.49	-3.71	-6.71	-8.91	-12.4	-14.5	-6.93
Real gross domestic fixed investment as % of GDP[b]	-0.15	-0.73	-1.31	-1.64	-2.00	-2.12	-1.21
Domestic savings as % of GDP[b]	-0.52	-1.24	-2.29	-3.03	-3.11	-3.06	-2.06
Balance of Payments							
Real Effective Exchange Rate[a]	-0.84	-0.96	-1.40	-1.83	-1.87	-2.23	-1.42
Real Exports[a]	0.78	1.78	2.2	2.44	2.59	2.5	1.97
Real Imports[a]	0.72	1.03	1.93	2.94	3.33	4.06	2.16
Current Account Balance as % of GDP[b]	-0.08	0.13	0.21	0.20	0.59	0.68	0.23
The Fiscus							
Non-Wage Government Consumption Expenditure (Nominal)[a]	4.87	11.76	20.89	28.17	38.14	46.49	22.31
Transfers: Government to Households (Nominal)[a]	3.94	11.34	24.27	35.42	49.98	60.11	27.15
Real Government Consumption[a]	0.49	0.86	1.05	0.69	-0.34	-1.25	0.40
Real Government Consumption as % of GDP[b]	0.02	0.13	0.24	0.32	0.51	0.64	0.27
Total Taxes as % of GDP[b]	0.32	0.42	0.49	0.63	0.81	0.89	0.56

a. Percentage difference between levels in no-AIDS and AIDS scenarios.

b. Percentage points difference between no-AIDS and AIDS scenarios.

APPENDIX D

SIMULATION RESULTS FROM THE SENSITIVITY ANALYSIS

Table D.1: Larger negative impact on total factor productivity

	2002	2005	2008	2010	2013	2015	Average 01-15
Real GDP[a]	0.34	-0.06	-0.84	-1.92	-4.54	-6.60	-1.79
Real per capita GDP[a]	2.09	4.05	7.06	9.16	12.00	13.77	7.25
Formal Sector Employment[a]	1.09	0.73	-0.64	-2.08	-5.58	-7.73	-1.78
Prime Overdraft Rate[b]	1.54	2.16	3.20	3.87	3.91	4.39	2.93
Producer Price Index[a]	2.28	6.83	13.3	19.15	28.56	36.57	15.48
Producer Price Inflation Rate[b]	1.02	1.66	2.19	2.80	2.76	3.32	2.26
Effective Exchange Rate[a]	-2.69	-7.02	-13.23	-18.18	-24.96	-29.87	-14.18
Budget Deficit as % of GDP[b]	0.21	0.08	-0.26	-0.47	-0.72	-0.97	-0.31
Production side							
Potential GDP	-1.13	-3.49	-7.52	-10.98	-16.63	-20.62	-8.76
Capacity Utilization	1.55	3.6	7.15	9.93	13.86	16.7	7.80
Total Labour Force	-1.77	-4.47	-8.74	-12.19	-17.6	-21.08	-9.70
Skilled Labour Force	-1.48	-3.81	-7.58	-10.66	-15.5	-18.6	-8.47
Unskilled Labour Force	-1.94	-4.83	-9.37	-13.02	-18.71	-22.38	-10.35
Employment and wages							
Government Employment	0.09	-0.49	-1.84	-3.20	-5.65	-7.30	-2.56
Private Sector Employment	1.36	1.05	-0.33	-1.8	-5.56	-7.83	-1.57
Skilled Private Sector Employment	0.58	-0.45	-2.51	-4.49	-8.74	-11.55	-3.71
Unskilled Private Sector Employment	2.09	2.50	1.83	0.94	-2.18	-3.73	0.62
Skilled Government Employment	0.04	-0.57	-1.94	-3.3	-5.74	-7.36	-2.64

Table D.1 continued: Larger negative impact on total factor productivity

	2002	2005	2008	2010	2013	2015	Average 01-15
Employment and wages continued							
Unskilled Government Employment	0.64	0.44	-0.73	-2.02	-4.68	-6.55	-1.65
Unemployment Rate	-1.54	-3.07	-5.17	-7.05	-9.60	-11.60	-5.64
Skilled Private Sector Wage Rate (Nominal)	1.96	7.96	17.51	25.76	39.99	51.29	20.78
Unskilled Private Sector Wage Rate (Nominal)	0.15	3.89	10.14	15.85	26.53	34.3	12.88
Skilled Government Wage Rate (Nominal)	2.02	8.43	18.69	27.67	43.38	55.98	22.41
Unskilled Government Wage Rate (Nominal)	0.00	2.49	8.09	13.56	24.3	32.36	11.20
Real After Tax Wage Bill	0.05	-0.3	-0.75	-1.46	-3.47	-4.91	-1.42
Aggregate Wage Bill (Nominal)	2.32	7.28	14.42	20.18	28.68	35.42	15.87
Consumer sector							
Real Disposable Income	0.05	-0.26	-0.53	-0.99	-2.45	-3.54	-1.01
Real Tax Adjusted Income from Property	-0.36	-1.00	-1.54	-1.87	-2.41	-2.82	-1.51
Real FCE	0.52	0.59	0.83	0.52	-1.72	-3.46	-0.14
Real FCE: Non-Durables	0.22	-0.18	-0.91	-2.1	-5.09	-7.52	-2.01
Real FCE: Semi-Durables	-0.75	-2.44	-4.34	-5.71	-8.38	-10.55	-4.71
Real FCE: Durables	-1.06	-3.09	-4.8	-5.78	-7.17	-8.22	-4.55
Real FCE: Services	1.50	2.98	5.24	6.16	4.43	3.05	3.86
Personal savings as % of Disposable Income	-0.47	-0.84	-1.33	-1.48	-0.73	-0.08	-0.86
Inflation and interest rates							
Consumer Price Index[a]	1.98	6.83	14.17	20.66	31.67	40.5	16.68
Consumer Price Inflation Rate[b]	1.48	1.86	2.58	3.11	3.13	3.60	2.54
Real Prime Overdraft Rate[b]	0.52	0.50	1.01	1.07	1.15	1.07	0.67

Table D.1 continued: Larger negative impact on total factor productivity							
	2002	2005	2008	2010	2013	2015	Average 01-15
Business Sector							
Net Operating Surplus - Inc. Business Enterprises[a]	-4.58	-6.02	-5.66	-3.45	7.31	15.66	-0.99
Corporate Savings as % of GDP[b]	-0.30	-0.29	-0.24	-0.40	-0.32	-0.19	-0.30
Investment and savings							
Real Residential Investment	-5.40	-14.53	-22.93	-28.78	-35.64	-39.19	-22.18
Real Total Fixed Investment	-0.80	-4.42	-7.79	-10.27	-14.17	-16.53	-8.02
Real gross domestic fixed investment as % of GDP[b]	-0.20	-0.83	-1.48	-1.85	-2.27	-2.42	-1.48
Domestic savings as % of GDP[b]	-0.42	-0.98	-2.07	-2.82	-3.34	-3.36	-2.12
Balance of Payments							
Real Effective Exchange Rate[a]	-0.78	-0.68	-0.95	-1.29	-1.21	-1.50	-1.01
Real Exports	0.77	1.62	1.83	1.94	1.88	1.66	1.59
Real Imports	0.56	0.72	1.46	2.33	2.53	3.13	1.67
Current Account Balance as % of GDP	-0.04	0.18	0.24	0.22	0.60	0.68	0.25
The Fiscus							
Non-Wage Government Consumption Expenditure (Nominal)	4.88	11.71	20.75	28.00	37.91	46.16	22.18
Transfers: Government to Households (Nominal)	3.95	11.3	24.12	35.21	49.68	59.72	26.99
Real Government Consumption	0.49	0.86	1.04	0.65	-0.44	-1.40	0.36
Real Government Consumption as % of GDP[b]	0.00	0.10	0.24	0.34	0.53	0.67	0.29
Total Taxes as % of GDP	0.32	0.42	0.50	0.65	0.85	0.95	0.58

a. Percentage difference between levels in no-AIDS and AIDS scenarios.

b. Percentage points difference between no-AIDS and AIDS scenarios.

Table D.2: Higher direct cost increases for the private and public sectors							
	2002	2005	2008	2010	2013	2015	Average 01-15
Real GDP[a]	0.71	0.75	0.60	-0.19	-2.65	-4.67	-0.52
Real per capita GDP[a]	2.46	4.90	8.61	11.09	14.21	16.13	8.67
Formal Sector Employment[a]	1.34	1.18	-0.02	-1.51	-5.26	-7.57	-1.37
Prime Overdraft Rate[b]	1.92	2.77	4.18	5.01	4.94	5.34	3.73
Producer Price Index[a]	2.63	8.14	16.17	23.32	34.7	44.04	18.72
Producer Price Inflation Rate[b]	1.22	2.01	2.68	3.31	3.15	3.66	2.66
Effective Exchange Rate[a]	-3.40	-9.10	-16.96	-22.81	-30.32	-35.40	-17.56
Budget Deficit as % of GDP[b]	0.18	0.04	-0.24	-0.38	-0.54	-0.74	-0.25
Production side							
Potential GDP	-1.06	-3.27	-6.99	-10.18	-15.27	-18.83	-8.09
Capacity Utilization	1.90	4.3	8.27	11.09	14.52	16.75	8.51
Total Labour Force	-1.77	-4.47	-8.74	-12.19	-17.6	-21.08	-9.70
Skilled Labour Force	-1.48	-3.81	-7.58	-10.66	-15.5	-18.6	-8.47
Unskilled Labour Force	-1.94	-4.83	-9.37	-13.02	-18.71	-22.38	-10.35
Employment and wages							
Government Employment	0.09	-0.50	-1.87	-3.23	-5.70	-7.35	-2.59
Private Sector Employment	1.68	1.62	0.45	-1.09	-5.16	-7.62	-1.06
Skilled Private Sector Employment	0.74	-0.18	-2.15	-4.21	-8.71	-11.68	-3.53
Unskilled Private Sector Employment	2.55	3.35	3.01	2.10	-1.37	-3.14	1.47
Skilled Government Employment	0.03	-0.58	-1.97	-3.34	-5.79	-7.42	-2.67
Unskilled Government Employment	0.65	0.45	-0.71	-2.00	-4.68	-6.56	-1.63
Unemployment Rate	-1.61	-3.27	-5.49	-7.37	-9.79	-11.73	-5.85

Table D.2 continued: Higher direct cost increases for the private and public sectors							
	2002	2005	2008	2010	2013	2015	Average 01-15
Employment and wages continued							
Skilled Private Sector Wage Rate (Nominal)	2.72	10.46	23.04	33.90	52.13	66.27	27.17
Unskilled Private Sector Wage Rate (Nominal)	0.27	4.86	12.81	20.15	33.63	43.27	16.30
Skilled Government Wage Rate (Nominal)	2.80	11.03	24.55	36.38	56.62	72.46	29.30
Unskilled Government Wage Rate (Nominal)	0.00	3.11	10.18	17.21	30.91	41.06	14.22
Real After Tax Wage Bill	0.57	0.80	1.17	0.91	-0.79	-2.07	0.34
Aggregate Wage Bill (Nominal)	3.12	9.78	19.78	27.81	39.42	48.19	21.71
Consumer sector							
Real Disposable Income	0.42	0.48	0.71	0.53	-0.79	-1.81	0.12
Real Tax Adjusted Income from Property	-0.38	-1.08	-1.70	-2.10	-2.72	-3.18	-1.68
Real FCE	1.27	2.2	3.69	4.12	2.35	0.89	2.51
Real FCE: Non-Durables	0.93	1.35	1.87	1.49	-0.49	-2.27	0.77
Real FCE: Semi-Durables	-0.63	-2.16	-3.72	-4.79	-7.04	-8.90	-3.99
Real FCE: Durables	-1.04	-3.16	-4.86	-5.75	-6.97	-7.87	-4.51
Real FCE: Services	2.62	5.39	9.52	11.5	9.99	8.76	7.65
Personal savings as % of Disposable Income	-0.85	-1.68	-2.87	-3.48	-3.06	-2.64	-2.32
Inflation and interest rates							
Consumer Price Index[a]	2.24	8.10	17.20	25.22	38.67	49.11	20.24
Consumer Price Inflation Rate[b]	1.48	1.86	2.58	3.11	3.13	3.60	2.54
Real Prime Overdraft Rate[b]	0.70	0.76	1.50	1.70	1.79	1.68	1.07
Business Sector							
Net Operating Surplus - Inc. Business Enterprises	-6.07	-7.97	-7.64	-4.81	8.66	18.77	-1.72
Corporate Savings as % of GDP	-0.35	-0.35	-0.29	-0.49	-0.40	-0.24	-0.36

Table D.2 continued: Higher direct cost increases for the private and public sectors							
	2002	2005	2008	2010	2013	2015	Average 01-15
Investment and savings							
Real Residential Investment	-5.27	-14.64	-23.22	-29.2	-36.11	-39.58	-22.42
Real Total Fixed Investment	-0.73	-5.00	-9.04	-12.01	-16.61	-19.27	-9.31
Real gross domestic fixed investment as % of GDP[b]	-0.25	-1.09	-2.02	-2.57	-3.23	-3.49	-2.05
Domestic savings as % of GDP[b]	-0.67	-1.61	-3.25	-4.36	-5.24	-5.41	-3.34
Balance of Payments							
Real Effective Exchange Rate[a]	-1.26	-1.77	-2.72	-3.41	-3.44	-3.74	-2.56
Real Exports	0.91	2.28	3.18	3.76	4.26	4.24	2.93
Real Imports	1.27	1.91	3.44	4.95	5.53	6.49	3.64
Current Account Balance as % of GDP	-0.19	0.07	0.17	0.17	0.72	0.82	0.22
The Fiscus							
Non-Wage Government Consumption Expenditure (Nominal)	5.23	13.04	23.69	32.3	44.26	53.89	25.52
Transfers: Government to Households (Nominal)	4.21	12.63	27.41	40.31	57.64	69.51	30.98
Real Government Consumption	0.59	1.13	1.56	1.36	0.53	-0.28	0.91
Real Government Consumption as % of GDP[b]	-0.02	0.02	0.11	0.18	0.38	0.54	0.18
Total Taxes as % of GDP	0.30	0.40	0.52	0.74	1.00	1.14	0.63

a. Percentage difference between levels in no-AIDS and AIDS scenarios.

b. Percentage points difference between no-AIDS and AIDS scenarios.

Table D.3: Higher indirect cost increases for the private and public sectors							
	2002	2005	2008	2010	2013	2015	Average 01-15
Real GDP[a]	0.29	-0.30	-1.24	-2.38	-4.95	-6.87	-2.08
Real per capita GDP[a]	2.03	3.81	6.62	8.65	11.52	13.44	6.92
Formal Sector Employment[a]	1.53	1.24	-0.18	-1.62	-5.31	-7.44	-1.37
Prime Overdraft Rate[b]	1.90	2.51	3.51	4.14	3.93	4.32	3.14
Producer Price Index[a]	2.89	8.31	15.59	21.95	31.56	39.59	17.54
Producer Price Inflation Rate[b]	1.21	1.94	2.38	2.97	2.72	3.24	2.39
Effective Exchange Rate[a]	-3.18	-7.86	-14.36	-19.45	-26.1	-30.84	-15.12
Budget Deficit as % of GDP[b]	0.09	-0.23	-0.76	-1.08	-1.44	-1.74	-0.81
Production side							
Potential GDP	-1.08	-3.32	-7.06	-10.22	-15.22	-18.68	-8.10
Capacity Utilization	1.45	3.15	6.12	8.4	11.41	13.53	6.55
Total Labour Force	-1.77	-4.47	-8.74	-12.19	-17.6	-21.08	-9.70
Skilled Labour Force	-1.48	-3.81	-7.58	-10.66	-15.5	-18.6	-8.47
Unskilled Labour Force	-1.94	-4.83	-9.37	-13.02	-18.71	-22.38	-10.35
Employment and wages							
Government Employment	0.16	-0.34	-1.61	-2.93	-5.39	-7.04	-2.37
Private Sector Employment	1.90	1.65	0.19	-1.3	-5.29	-7.53	-1.11
Skilled Private Sector Employment	0.87	-0.23	-2.39	-4.39	-8.78	-11.52	-3.58
Unskilled Private Sector Employment	2.86	3.47	2.75	1.86	-1.57	-3.12	1.42
Skilled Government Employment	0.10	-0.44	-1.72	-3.04	-5.49	-7.11	-2.46
Unskilled Government Employment	0.78	0.71	-0.37	-1.60	-4.28	-6.16	-1.33
Unemployment Rate	-1.74	-3.27	-5.43	-7.31	-9.79	-11.79	-5.86

Table D.3 continued: Higher indirect cost increases for the private and public sectors							
	2002	2005	2008	2010	2013	2015	Average 01-15
Employment and wages continued							
Skilled Private Sector Wage Rate (Nominal)	2.10	8.94	19.46	28.37	43.40	55.02	22.71
Unskilled Private Sector Wage Rate (Nominal)	0.06	4.47	11.51	17.75	29.14	37.11	14.25
Skilled Government Wage Rate (Nominal)	2.18	9.49	20.83	30.54	47.18	60.14	24.54
Unskilled Government Wage Rate (Nominal)	0.00	2.85	9.22	15.29	26.91	35.31	12.46
Real After Tax Wage Bill	-0.12	-0.56	-1.12	-1.82	-3.69	-4.93	-1.65
Aggregate Wage Bill (Nominal)	2.75	8.57	16.62	23.00	32.02	39.02	17.96
Consumer sector							
Real Disposable Income	-0.07	-0.45	-0.81	-1.28	-2.65	-3.61	-1.20
Real Tax Adjusted Income from Property	-0.40	-1.09	-1.67	-2.03	-2.57	-2.97	-1.63
Real FCE	0.37	0.34	0.48	0.19	-1.91	-3.47	-0.35
Real FCE: Non-Durables	0.06	-0.42	-1.27	-2.45	-5.31	-7.50	-2.23
Real FCE: Semi-Durables	-0.89	-2.75	-4.74	-6.07	-8.58	-10.56	-4.96
Real FCE: Durables	-1.28	-3.55	-5.28	-6.17	-7.32	-8.2	-4.85
Real FCE: Services	1.37	2.77	4.95	5.88	4.26	3.01	3.67
Personal savings as % of Disposable Income	-0.44	-0.78	-1.27	-1.44	-0.74	-0.14	-0.83
Inflation and interest rates							
Consumer Price Index[a]	2.58	8.37	16.76	23.89	35.33	44.19	19.04
Consumer Price Inflation Rate[b]	1.48	1.86	2.58	3.11	3.13	3.60	2.54
Real Prime Overdraft Rate[b]	0.69	0.57	1.13	1.17	1.21	1.08	0.75
Business Sector							
Net Operating Surplus - Inc. Business Enterprises	-6.36	-9.07	-9.89	-8.46	2.17	10.18	-4.88
Corporate Savings as % of GDP	-0.36	-0.36	-0.29	-0.50	-0.42	-0.26	-0.37

Table D.3 continued: Higher indirect cost increases for the private and public sectors							
	2002	2005	2008	2010	2013	2015	Average 01-15
Investment and savings							
Real Residential Investment	-5.62	-15.18	-23.68	-29.40	-35.91	-39.16	-22.62
Real Total Fixed Investment	-0.96	-5.21	-8.94	-11.51	-15.44	-17.72	-8.95
Real gross domestic fixed investment as % of GDP[b]	-0.22	-0.94	-1.64	-2.03	-2.49	-2.65	-1.63
Domestic savings as % of GDP[b]	-0.56	-1.28	-2.59	-3.49	-4.19	-4.26	-2.66
Balance of Payments							
Real Effective Exchange Rate[a]	-0.69	-0.15	-0.02	-0.21	0.00	-0.28	-0.23
Real Exports	0.73	1.28	0.96	0.76	0.33	-0.06	0.75
Real Imports	0.25	0.18	0.63	1.32	1.28	1.74	0.88
Current Account Balance as % of GDP	0.07	0.30	0.35	0.31	0.65	0.72	0.34
The Fiscus							
Non-Wage Government Consumption Expenditure (Nominal)	6.18	14.59	25.29	33.54	43.7	51.98	26.23
Transfers: Government to Households (Nominal)	4.56	12.9	26.92	38.82	53.84	63.92	29.60
Real Government Consumption	0.53	1.07	1.49	1.2	0.21	-0.72	0.75
Real Government Consumption as % of GDP[b]	0.00	0.15	0.36	0.48	0.69	0.82	0.39
Total Taxes as % of GDP	0.28	0.35	0.43	0.62	0.87	0.98	0.54

a. Percentage difference between levels in no-AIDS and AIDS scenarios.

b. Percentage points difference between no-AIDS and AIDS scenarios.

Table D.4: Firms shoulder a smaller proportion of the direct cost increases							
	2002	2005	2008	2010	2013	2015	Average 01-15
Real GDP[a]	0.30	-0.13	-0.89	-1.90	-4.27	-6.07	-1.72
Real per capita GDP[a]	2.04	3.99	7.00	9.19	12.32	14.41	7.34
Formal Sector Employment[a]	1.16	0.88	-0.32	-1.63	-4.93	-6.88	-1.42
Prime Overdraft Rate[b]	1.46	1.94	2.79	3.31	3.2	3.64	2.52
Producer Price Index[a]	2.17	6.3	11.94	16.91	24.56	31.13	13.57
Producer Price Inflation Rate[b]	0.95	1.49	1.90	2.41	2.29	2.84	1.95
Effective Exchange Rate[a]	-2.55	-6.42	-11.85	-16.13	-21.85	-26.1	-12.58
Budget Deficit as % of GDP[b]	0.29	0.25	0.03	-0.13	-0.32	-0.51	-0.03
<u>Production side</u>							
Potential GDP	-1.07	-3.22	-6.81	-9.86	-14.67	-18.01	-7.82
Capacity Utilization	1.45	3.25	6.3	8.61	11.65	13.75	6.70
Total Labour Force	-1.77	-4.47	-8.74	-12.19	-17.6	-21.08	-9.70
Skilled Labour Force	-1.48	-3.81	-7.58	-10.66	-15.5	-18.6	-8.47
Unskilled Labour Force	-1.94	-4.83	-9.37	-13.02	-18.71	-22.38	-10.35
<u>Employment and wages</u>							
Government Employment	0.09	-0.49	-1.84	-3.19	-5.65	-7.29	-2.56
Private Sector Employment	1.44	1.24	0.07	-1.24	-4.75	-6.79	-1.13
Skilled Private Sector Employment	0.80	0.04	-1.60	-3.31	-7.25	-9.82	-2.81
Unskilled Private Sector Employment	2.04	2.39	1.72	0.87	-2.09	-3.45	0.60
Skilled Government Employment	0.04	-0.57	-1.94	-3.29	-5.73	-7.35	-2.64
Unskilled Government Employment	0.64	0.43	-0.75	-2.04	-4.71	-6.59	-1.66
Unemployment Rate	-1.54	-3.14	-5.37	-7.31	-9.99	-12.12	-5.85

Table D.4 continued: Firms shoulder a smaller proportion of the direct cost increases							
	2002	2005	2008	2010	2013	2015	Average 01-15
Employment and wages continued							
Skilled Private Sector Wage Rate (Nominal)	1.30	6.20	13.81	20.46	32.18	41.52	16.56
Unskilled Private Sector Wage Rate (Nominal)	0.08	3.47	8.94	13.83	22.85	29.24	11.15
Skilled Government Wage Rate (Nominal)	1.98	7.87	16.93	24.59	37.51	47.87	19.73
Unskilled Government Wage Rate (Nominal)	0.00	2.21	7.15	11.88	21	27.68	9.72
Real After Tax Wage Bill	-0.12	-0.65	-1.31	-2.06	-3.89	-5.07	-1.81
Aggregate Wage Bill (Nominal)	2.07	6.39	12.36	17.07	23.8	29.27	13.38
Consumer sector							
Real Disposable Income	-0.09	-0.54	-0.96	-1.45	-2.75	-3.65	-1.31
Real Tax Adjusted Income from Property	-0.36	-0.98	-1.46	-1.75	-2.2	-2.55	-1.42
Real FCE	0.41	0.36	0.42	0.05	-2.07	-3.64	-0.43
Real FCE: Non-Durables	0.20	-0.29	-1.17	-2.44	-5.40	-7.61	-2.20
Real FCE: Semi-Durables	-0.80	-2.57	-4.57	-5.96	-8.53	-10.52	-4.85
Real FCE: Durables	-1.10	-3.11	-4.78	-5.69	-6.92	-7.84	-4.47
Real FCE: Services	1.28	2.54	4.54	5.38	3.79	2.57	3.32
Personal savings as % of Disposable Income	-0.50	-0.89	-1.36	-1.48	-0.67	-0.01	-0.86
Inflation and interest rates							
Consumer Price Index[a]	1.90	6.33	12.78	18.31	27.31	34.45	14.64
Consumer Price Inflation Rate[b]	1.48	1.86	2.58	3.11	3.13	3.60	2.54
Real Prime Overdraft Rate[b]	0.51	0.45	0.89	0.90	0.91	0.80	0.57
Business Sector							
Net Operating Surplus - Inc. Business Enterprises	-2.86	-3.05	-1.51	0.93	9.95	16.85	1.95
Corporate Savings as % of GDP	-0.25	-0.24	-0.18	-0.31	-0.24	-0.14	-0.24

Table D.4 continued: Firms shoulder a smaller proportion of the direct cost increases							
	2002	2005	2008	2010	2013	2015	Average 01-15
Investment and savings							
Real Residential Investment	-5.25	-14.18	-22.32	-27.97	-34.62	-37.95	-21.56
Real Total Fixed Investment	-0.77	-4.13	-7.15	-9.31	-12.65	-14.64	-7.26
Real gross domestic fixed investment as % of GDP[b]	-0.19	-0.77	-1.33	-1.64	-1.97	-2.08	-1.31
Domestic savings as % of GDP[b]	-0.35	-0.81	-1.72	-2.34	-2.67	-2.60	-1.72
Balance of Payments							
Real Effective Exchange Rate[a]	-0.71	-0.50	-0.60	-0.80	-0.51	-0.65	-0.62
Real Exports	0.75	1.53	1.64	1.66	1.43	1.07	1.36
Real Imports	0.47	0.52	1.05	1.68	1.58	1.91	1.16
Current Account Balance as % of GDP	-0.01	0.19	0.25	0.24	0.58	0.64	0.26
The Fiscus							
Non-Wage Government Consumption Expenditure (Nominal)	4.77	11.17	19.34	25.68	33.77	40.52	20.20
Transfers: Government to Households (Nominal)	3.87	10.78	22.6	32.56	44.73	52.85	24.71
Real Government Consumption	0.52	0.90	1.05	0.63	-0.52	-1.49	0.35
Real Government Consumption as % of GDP[b]	0.01	0.11	0.25	0.34	0.49	0.60	0.28
Total Taxes as % of GDP	0.38	0.52	0.63	0.75	0.87	0.93	0.65

a. Percentage difference between levels in no-AIDS and AIDS scenarios.

b. Percentage points difference between no-AIDS and AIDS scenarios.

Table D.5: Households finance a smaller proportion of their cost increases through savings

	2002	2005	2008	2010	2013	2015	Average 01-15
Real GDP[a]	0.24	-0.26	-1.13	-2.19	-4.62	-6.49	-1.94
Real per capita GDP[a]	1.98	3.85	6.75	8.86	11.90	13.91	7.09
Formal Sector Employment[a]	0.99	0.53	-0.92	-2.33	-5.66	-7.66	-1.94
Prime Overdraft Rate[b]	1.43	1.95	2.84	3.43	3.46	3.94	2.61
Producer Price Index[a]	2.16	6.35	12.18	17.43	25.8	33.00	14.09
Producer Price Inflation Rate[b]	0.94	1.53	1.98	2.55	2.51	3.07	2.06
Effective Exchange Rate[a]	-2.45	-6.22	-11.67	-16.1	-22.25	-26.84	-12.62
Budget Deficit as % of GDP[b]	0.16	-0.05	-0.50	-0.79	-1.12	-1.40	-0.57
Production side							
Potential GDP	-1.07	-3.23	-6.84	-9.89	-14.74	-18.11	-7.85
Capacity Utilization	1.39	3.13	6.07	8.34	11.33	13.39	6.49
Total Labour Force	-1.77	-4.47	-8.74	-12.19	-17.6	-21.08	-9.70
Skilled Labour Force	-1.48	-3.81	-7.58	-10.66	-15.5	-18.6	-8.47
Unskilled Labour Force	-1.94	-4.83	-9.37	-13.02	-18.71	-22.38	-10.35
Employment and wages							
Government Employment	0.09	-0.49	-1.84	-3.2	-5.66	-7.31	-2.56
Private Sector Employment	1.23	0.79	-0.69	-2.12	-5.66	-7.74	-1.77
Skilled Private Sector Employment	0.45	-0.68	-2.82	-4.74	-8.76	-11.36	-3.86
Unskilled Private Sector Employment	1.95	2.21	1.42	0.56	-2.37	-3.75	0.37
Skilled Government Employment	0.04	-0.57	-1.94	-3.3	-5.74	-7.37	-2.64
Unskilled Government Employment	0.64	0.43	-0.75	-2.04	-4.7	-6.57	-1.66
Unemployment Rate	-1.48	-2.95	-5.05	-6.92	-9.53	-11.66	-5.57

Table D.5 continued: Households finance a smaller proportion of their cost increases through savings

	2002	2005	2008	2010	2013	2015	Average 01-15
Employment and wages continued							
Skilled Private Sector Wage Rate (Nominal)	1.93	7.63	16.55	24.17	37.2	47.63	19.47
Unskilled Private Sector Wage Rate (Nominal)	0.13	3.64	9.36	14.5	24.12	31.11	11.76
Skilled Government Wage Rate (Nominal)	1.99	8.07	17.64	25.92	40.29	51.89	20.96
Unskilled Government Wage Rate (Nominal)	0.00	2.34	7.49	12.45	22.13	29.35	10.24
Real After Tax Wage Bill	0.01	-0.34	-0.76	-1.38	-3.16	-4.37	-1.32
Aggregate Wage Bill (Nominal)	2.20	6.77	13.21	18.4	26.02	32.22	14.49
Consumer sector							
Real Disposable Income	0.03	-0.27	-0.51	-0.91	-2.2	-3.13	-0.92
Real Tax Adjusted Income from Property	-0.36	-0.98	-1.47	-1.78	-2.26	-2.64	-1.44
Real FCE	0.28	0.12	0.06	-0.36	-2.47	-4.05	-0.74
Real FCE: Non-Durables	-0.05	-0.73	-1.89	-3.29	-6.2	-8.43	-2.82
Real FCE: Semi-Durables	-1.00	-2.96	-5.2	-6.69	-9.24	-11.25	-5.38
Real FCE: Durables	-1.26	-3.42	-5.22	-6.18	-7.39	-8.32	-4.84
Real FCE: Services	1.29	2.57	4.6	5.44	3.84	2.58	3.36
Personal savings as % of Disposable Income	-0.25	-0.39	-0.56	-0.53	0.26	0.91	-0.18
Inflation and interest rates							
Consumer Price Index[a]	1.90	6.37	13.00	18.82	28.59	36.48	15.17
Consumer Price Inflation Rate[b]	1.48	1.86	2.58	3.11	3.13	3.60	2.54
Real Prime Overdraft Rate[b]	0.49	0.42	0.86	0.88	0.95	0.87	0.55

Table D.5 continued: Households finance a smaller proportion of their cost increases through savings

	2002	2005	2008	2010	2013	2015	Average 01-15
Business Sector							
Net Operating Surplus - Inc. Business Enterprises	-4.71	-6.70	-7.33	-6.03	3.16	10.36	-3.05
Corporate Savings as % of GDP	-0.30	-0.30	-0.24	-0.42	-0.35	-0.21	-0.31
Investment and savings							
Real Residential Investment	-5.41	-14.37	-22.57	-28.24	-34.87	-38.29	-21.79
Real Total Fixed Investment	-0.82	-4.23	-7.34	-9.59	-13.15	-15.32	-7.51
Real gross domestic fixed investment as % of GDP[b]	-0.19	-0.76	-1.32	-1.64	-2.02	-2.15	-1.32
Domestic savings as % of GDP[b]	-0.35	-0.82	-1.77	-2.44	-2.94	-2.96	-1.83
Balance of Payments							
Real Effective Exchange Rate[a]	-0.60	-0.25	-0.19	-0.32	-0.02	-0.15	-0.27
Real Exports	0.72	1.37	1.28	1.17	0.76	0.32	0.99
Real Imports	0.3	0.25	0.63	1.16	1.02	1.3	0.77
Current Account Balance as % of GDP	0.02	0.23	0.28	0.27	0.60	0.68	0.29
The Fiscus							
Non-Wage Government Consumption Expenditure (Nominal)	4.76	11.23	19.59	26.23	35.05	42.47	20.74
Transfers: Government to Households (Nominal)	3.87	10.83	22.85	33.14	46.19	55.15	25.31
Real Government Consumption	0.52	0.94	1.16	0.79	-0.27	-1.20	0.47
Real Government Consumption as % of GDP[b]	0.02	0.14	0.30	0.40	0.57	0.70	0.33
Total Taxes as % of GDP	0.30	0.38	0.43	0.57	0.76	0.85	0.52

a. Percentage difference between levels in no-AIDS and AIDS scenarios.

b. Percentage points difference between no-AIDS and AIDS scenarios.

Table D.6: Extra public sector health expenditure and direct and indirect costs to government are deficit financed (i.e. no substitution by government)

	2002	2005	2008	2010	2013	2015	Average 01-15
Real GDP[a]	0.63	0.45	-0.07	-1.03	-3.5	-5.45	-1.07
Real per capita GDP[a]	2.38	4.58	7.89	10.15	13.22	15.17	8.06
Formal Sector Employment[a]	1.59	1.45	0.22	-1.24	-4.83	-7.00	-1.06
Prime Overdraft Rate[b]	1.86	2.48	3.55	4.16	4.05	4.47	3.18
Producer Price Index[a]	2.62	7.68	14.63	20.69	30.18	38.16	16.62
Producer Price Inflation Rate[b]	1.19	1.82	2.30	2.85	2.73	3.27	2.33
Effective Exchange Rate[a]	-3.28	-8.28	-14.93	-19.95	-26.56	-31.26	-15.52
Budget Deficit as % of GDP[b]	0.01	-0.38	-1.02	-1.42	-1.91	-2.29	-1.10
Production side							
Potential GDP	-1.19	-3.47	-7.23	-10.38	-15.35	-18.78	-8.24
Capacity Utilization	1.94	4.18	7.77	10.32	13.53	15.67	8.01
Total Labour Force	-1.77	-4.47	-8.74	-12.19	-17.6	-21.08	-9.70
Skilled Labour Force	-1.48	-3.81	-7.58	-10.66	-15.5	-18.6	-8.47
Unskilled Labour Force	-1.94	-4.83	-9.37	-13.02	-18.71	-22.38	-10.35
Employment and wages							
Government Employment	0.94	0.98	0.17	-0.99	-3.47	-5.20	-0.82
Private Sector Employment	1.76	1.57	0.24	-1.3	-5.15	-7.42	-1.11
Skilled Private Sector Employment	0.93	0.04	-1.92	-3.93	-8.23	-11.04	-3.22
Unskilled Private Sector Employment	2.54	3.05	2.37	1.38	-1.87	-3.43	1.06
Skilled Government Employment	0.81	0.76	-0.10	-1.29	-3.76	-5.46	-1.06
Unskilled Government Employment	2.26	3.30	3.22	2.46	-0.05	-1.97	1.88
Unemployment Rate	-1.74	-3.40	-5.62	-7.50	-10.05	-12.06	-6.02

Table D.6 continued: Extra public sector health expenditure and direct and indirect costs to government are deficit financed (i.e. no substitution by government)

	2002	2005	2008	2010	2013	2015	Average 01-15
Employment and wages continued							
Skilled Private Sector Wage Rate (Nominal)	2.14	8.84	19.27	28.14	43.16	54.94	22.56
Unskilled Private Sector Wage Rate (Nominal)	0.19	4.52	11.52	17.73	28.98	36.96	14.22
Skilled Government Wage Rate (Nominal)	2.22	9.38	20.61	30.28	46.91	60.05	24.38
Unskilled Government Wage Rate (Nominal)	0.00	2.92	9.26	15.29	26.76	35.13	12.45
Real After Tax Wage Bill	0.43	0.40	0.35	-0.13	-1.85	-3.09	-0.35
Aggregate Wage Bill (Nominal)	2.99	8.94	17.23	23.66	32.85	39.97	18.52
Consumer sector							
Real Disposable Income	0.29	0.17	0.13	-0.19	-1.48	-2.44	-0.36
Real Tax Adjusted Income from Property	-0.38	-1.05	-1.61	-1.96	-2.50	-2.90	-1.58
Real FCE	0.76	1.02	1.55	1.42	-0.54	-2.08	0.60
Real FCE: Non-Durables	0.59	0.53	0.3	-0.54	-3.04	-5.09	-0.76
Real FCE: Semi-Durables	-0.52	-2	-3.6	-4.75	-7.12	-9.05	-3.94
Real FCE: Durables	-0.95	-2.94	-4.51	-5.37	-6.6	-7.53	-4.23
Real FCE: Services	1.64	3.2	5.61	6.64	5.08	3.84	4.25
Personal savings as % of Disposable Income	-0.46	-0.84	-1.37	-1.57	-0.92	-0.36	-0.94
Inflation and interest rates							
Consumer Price Index[a]	2.26	7.72	15.67	22.47	33.66	42.46	17.99
Consumer Price Inflation Rate[b]	1.48	1.86	2.58	3.11	3.13	3.60	2.54
Real Prime Overdraft Rate[b]	0.67	0.66	1.25	1.31	1.32	1.20	0.84

Table D.6 continued: Extra public sector health expenditure and direct and indirect costs to government are deficit financed (i.e. no substitution by government)							
	2002	2005	2008	2010	2013	2015	Average 01-15
Business Sector							
Net Operating Surplus - Inc. Business Enterprises	-4.47	-5.74	-5.56	-3.78	5.91	13.33	-1.40
Corporate Savings as % of GDP	-0.31	-0.31	-0.25	-0.43	-0.36	-0.23	-0.32
Investment and savings							
Real Residential Investment	-5.09	-14.33	-22.69	-28.5	-35.24	-38.65	-21.88
Real Total Fixed Investment	-0.73	-4.79	-8.40	-10.98	-14.92	-17.25	-8.51
Real gross domestic fixed investment as % of GDP[b]	-0.24	-1.00	-1.76	-2.18	-2.67	-2.84	-1.74
Domestic savings as % of GDP[b]	-0.60	-1.42	-2.87	-3.87	-4.71	-4.90	-2.98
Balance of Payments							
Real Effective Exchange Rate[a]	-1.11	-1.22	-1.63	-2.00	-1.88	-2.11	-1.58
Real Exports	0.87	1.99	2.42	2.64	2.69	2.48	2.11
Real Imports	0.99	1.3	2.24	3.24	3.47	4.06	2.40
Current Account Balance as % of GDP	-0.12	0.15	0.24	0.23	0.64	0.72	0.24
The Fiscus							
Non-Wage Government Consumption Expenditure (Nominal)	7.82	17.48	29.59	38.47	48.99	57.43	30.08
Transfers: Government to Households (Nominal)	4.23	12.23	25.74	37.23	51.94	61.94	28.44
Real Government Consumption	1.72	3.12	4.32	4.38	3.37	2.36	3.23
Real Government Consumption as % of GDP[b]	0.13	0.34	0.59	0.74	0.93	1.05	0.61
Total Taxes as % of GDP	0.34	0.47	0.60	0.80	1.05	1.18	0.69

a. Percentage difference between levels in no-AIDS and AIDS scenarios.

b. Percentage points difference between no-AIDS and AIDS scenarios.

Table D.7: No increase in personal and corporate taxes							
	2002	2005	2008	2010	2013	2015	Average 01-15
Real GDP[a]	0.47	0.30	-0.27	-1.27	-3.73	-5.63	-1.26
Real per capita GDP[a]	2.22	4.43	7.67	9.88	12.96	14.96	7.85
Formal Sector Employment[a]	1.19	1.01	-0.31	-1.80	-5.31	-7.38	-1.52
Prime Overdraft Rate[b]	1.63	2.33	3.36	3.97	3.89	4.32	3.01
Producer Price Index[a]	2.34	7.14	13.85	19.65	28.73	36.44	15.75
Producer Price Inflation Rate[b]	1.07	1.75	2.22	2.75	2.64	3.20	2.25
Effective Exchange Rate[a]	-2.89	-7.77	-14.25	-19.04	-25.43	-30.11	-14.78
Budget Deficit as % of GDP[b]	-0.47	-1.10	-1.87	-2.33	-3.02	-3.55	-1.97
Production side							
Potential GDP	-1.06	-3.23	-6.87	-9.98	-14.91	-18.33	-7.92
Capacity Utilization	1.62	3.72	7.07	9.49	12.63	14.76	7.36
Total Labour Force	-1.77	-4.47	-8.74	-12.19	-17.6	-21.08	-9.70
Skilled Labour Force	-1.48	-3.81	-7.58	-10.66	-15.5	-18.6	-8.47
Unskilled Labour Force	-1.94	-4.83	-9.37	-13.02	-18.71	-22.38	-10.35
Employment and wages							
Government Employment	0.09	-0.49	-1.84	-3.2	-5.66	-7.31	-2.56
Private Sector Employment	1.49	1.4	0.09	-1.46	-5.22	-7.4	-1.25
Skilled Private Sector Employment	0.71	-0.09	-2.04	-4.04	-8.24	-10.96	-3.32
Unskilled Private Sector Employment	2.22	2.84	2.19	1.18	-2.00	-3.47	0.87
Skilled Government Employment	0.04	-0.57	-1.94	-3.3	-5.75	-7.37	-2.64
Unskilled Government Employment	0.64	0.44	-0.73	-2.03	-4.70	-6.58	-1.65
Unemployment Rate	-1.54	-3.20	-5.37	-7.18	-9.79	-11.86	-5.79

Table D.7 continued: No increase in personal and corporate taxes							
	2002	2005	2008	2010	2013	2015	Average 01-15
Employment and wages continued							
Skilled Private Sector Wage Rate (Nominal)	1.99	8.24	18.25	26.74	41.02	52.26	21.39
Unskilled Private Sector Wage Rate (Nominal)	0.17	4.10	10.77	16.72	27.45	35.07	13.40
Skilled Government Wage Rate (Nominal)	2.05	8.72	19.5	28.75	44.53	57.06	23.09
Unskilled Government Wage Rate (Nominal)	0.00	2.61	8.58	14.37	25.31	33.29	11.71
Real After Tax Wage Bill	0.38	0.51	0.35	-0.22	-1.97	-3.20	-0.39
Aggregate Wage Bill (Nominal)	2.44	7.82	15.5	21.48	30.06	36.83	16.77
Consumer sector							
Real Disposable Income	0.35	0.47	0.41	0.03	-1.27	-2.21	-0.15
Real Tax Adjusted Income from Property	-0.12	-0.43	-0.86	-1.2	-1.72	-2.11	-0.94
Real FCE	0.79	1.27	1.75	1.57	-0.41	-1.94	0.75
Real FCE: Non-Durables	0.57	0.71	0.39	-0.57	-3.11	-5.15	-0.74
Real FCE: Semi-Durables	-0.45	-1.61	-3.18	-4.41	-6.82	-8.74	-3.64
Real FCE: Durables	-0.81	-2.53	-4.15	-5.07	-6.35	-7.3	-3.94
Real FCE: Services	1.70	3.44	5.83	6.84	5.28	4.06	4.44
Personal savings as % of Disposable Income	-0.44	-0.79	-1.30	-1.49	-0.84	-0.27	-0.88
Inflation and interest rates							
Consumer Price Index[a]	2.02	7.13	14.8	21.31	31.99	40.46	17.01
Consumer Price Inflation Rate[b]	1.48	1.86	2.58	3.11	3.13	3.60	2.54
Real Prime Overdraft Rate[b]	0.56	0.58	1.14	1.22	1.25	1.12	0.76
Business Sector							
Net Operating Surplus - Inc. Business Enterprises	-6.25	-8.82	-9.82	-8.82	-0.67	5.59	-5.76
Corporate Savings as % of GDP	-0.22	-0.27	-0.24	-0.42	-0.36	-0.23	-0.29

Table D.7 continued: No increase in personal and corporate taxes							
	2002	2005	2008	2010	2013	2015	Average 01-15
<u>Investment and savings</u>							
Real Residential Investment	-5.1	-14.00	-22.47	-28.36	-35.1	-38.49	-21.71
Real Total Fixed Investment	-0.68	-4.36	-7.91	-10.42	-14.26	-16.53	-8.05
Real gross domestic fixed investment as % of GDP[b]	-0.20	-0.89	-1.61	-2.01	-2.47	-2.63	-1.60
Domestic savings as % of GDP[b]	-0.80	-1.83	-3.38	-4.39	-5.33	-5.61	-3.46
<u>Balance of Payments</u>							
Real Effective Exchange Rate[a]	-0.95	-1.21	-1.59	-1.81	-1.60	-1.86	-1.44
Real Exports	0.82	1.93	2.45	2.61	2.51	2.25	2.04
Real Imports	0.87	1.32	2.08	2.98	3.15	3.73	2.23
Current Account Balance as % of GDP	-0.12	0.09	0.24	0.23	0.59	0.65	0.22
<u>The Fiscus</u>							
Non-Wage Government Consumption Expenditure (Nominal)	4.94	12.03	21.31	28.51	38.09	46.02	22.46
Transfers: Government to Households (Nominal)	3.99	11.61	24.8	35.93	50.05	59.68	27.36
Real Government Consumption	0.47	0.83	1.06	0.75	-0.24	-1.13	0.43
Real Government Consumption as % of GDP[b]	-0.01	0.05	0.16	0.25	0.44	0.57	0.22
Total Taxes as % of GDP	-0.10	-0.12	-0.03	0.19	0.47	0.62	0.12

a. Percentage difference between levels in no-AIDS and AIDS scenarios.

b. Percentage points difference between no-AIDS and AIDS scenarios.