Assessing the Macroeconomic Impact of HIV/AIDS in Uganda

Phase III – Analysis of Macroeconomic Impact

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Revised Draft
For comments only - not to be quoted

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Abbreviations

AGM	Aggregate Growth Model
AIDS	Acquired Immune Deficiency Syndrome
ART	Antiretroviral therapy
BoU	Bank of Uganda
CGE	Computable General Equilibrium
CHOGM	Commonwealth Heads of Government Meeting
GDP	Gross Domestic Product
GOU	Government of Uganda
HIV	Human Immunodeficiency Virus
IEC	Information, Education and Communication
IMF	International Monetary Fund
LICs	Low Income Countries
MICs	Middle Income Countries
MoFPED	Ministry of Finance, Planning and Economic Development
NSP	National Strategic Plan
ODA	Official Development Assistance
OVC	Orphans and Vulnerable Children
PRGF	Poverty Reduction and Growth Facility
PSI	Poverty Support Instrument
REER	Real Effective Exchange Rate
TFP	Total Factor Productivity
UAC	Uganda AIDS Commission
UGX	Uganda shilling
UN	United Nations
UNAIDS	Joint United Nations Programme on HIV/AIDS

USAID	United States Aid for International Development
USD	United States Dollar
WHO	World Health Organisation

Chapter 1: Evaluating the Macroeconomic Impact of HIV/AIDS in Uganda: Phase 3 – Overview

1. Introduction

This report comprises the third in a series of reports produced for the project on "Evaluating the Macroeconomic Impact of HIV/AIDS in Uganda", commissioned by the Ministry of Finance, Planning and Economic Development (MoFPED) and the United Nations Development Programme (UNDP) in Uganda. The study came about because, although there is awareness of the general economic impacts of HIV and AIDS in Uganda, little work has been done on quantifying these impacts, and particularly on quantifying the impact of alternative policies towards dealing with HIV/AIDS. The lack of quantitative information hindered macroeconomic planning and the formulation of an appropriate HIV/AIDS response. In particular, while there is awareness of the need to scale-up the response to HIV and AIDS, there is concern that macroeconomic instability could potentially result, and that this could undermine the great strides that Uganda has made in achieving macroeconomic stability over the past 15 years. Hence there has been uncertainty over the level of investment that should be made in responding to HIV and AIDS in Uganda. There has also been a lack of understanding as to whether the benefits of a rapid scale-up of treatment would be primarily economic, or social, or both.

The Terms of Reference for the study indicate that it should be conducted in three phases, as follows:

Phase I: conduct a literature review from Uganda and the region on existing micro economic and macroeconomic studies and models, detailed methodology and scope of work for phase two;

Phase II: carry out a selected number of micro-economic studies/surveys;

Phase III: carry out an aggregated macro-economic analysis, production and validation of report.

The draft Phase I Report - *Literature Review: the Macroeconomic Impact of HIV/AIDS* – was presented to a stakeholder workshop in August, 2007. Following comments received at the workshop, the draft report was revised and finalised for publication in October 2007.

Phase II of the project involved conducting five mini-studies which would provide useful results in their own right and provide essential inputs into the macroeconomic analysis work in Phase III. The agreed mini-studies were as follows:

1. Modelling the household and poverty impact of HIV/AIDS
2. Modelling of sectoral HIV-vulnerability/risk exposure
3. HIV costing, financing and expenditure
4. Preparation of demographic projections

5. Analytical (econometric) studies on macroeconomic relationships between aid flows, inflation exchange rates and exports.

The draft Phase II reports were presented to a stakeholder workshop held in June, 2008 and finalised for publication in October.

Phase III of the study comprises a modelling exercise to quantify the impact of HIV/AIDS on the Uganda economy, and of the impact of interventions related to the provision of Anti-retroviral Therapy (ART). It draws upon some of the results of the Phase II studies, particularly the demographic projections, HIV costing and financing, and the econometric studies.

The Phase III report contains the modelling results, conclusions regarding macroeconomic impact of HIV/AIDS in Uganda, and policy recommendations. The report is structured as follows. Chapter 1 provides an overview of macroeconomic issues and presentation of broad macroeconomic magnitudes associated with HIV/AIDS financial flows, and analyses the range of policy choices open to government. Chapters 2 and 3 provide details of two separate modelling exercises conducted as part of the study to quantify the macroeconomic impacts of HIV/AIDS. Based on these analytical results, Chapter 4 summarises and provides conclusions.

While the macroeconomic modelling exercises in Chapters 2 and 3 are technical in places, the more complex technical issues are contained in Appendices that can be passed over without any loss of understanding of the key analysis.

2. The Macroeconomic Impact of HIV/AIDS – Overview of the Issues

Macroeconomic Background

Uganda has achieved a highly respectable and steadily improving economic growth performance over the past two decades. Revised GDP data show that real growth has been impressive in recent years, averaging 9.5% a year from 2005/6 to 2007/8. Several factors explain this good growth performance, including macroeconomic reforms which have helped to create a favourable and stable macroeconomic environment. As policy has intended, much growth has been export-led, with the ratio of exports to GDP rising steadily. In the recent past, improved regional stability and reconstruction activity in neighbouring countries, and CHOGM stimulus for construction sector, have also contributed to higher growth.

Strong GDP growth has supported rising average real incomes, even though population growth has also remained very high. Rising income levels have in turn contributed to progress in dealing with poverty, which has fallen from an estimated 56% in 1992 to 31% in 2005/06. At the same time there has been reduced dependence upon agriculture. The share of agriculture in GDP has fallen rapidly, from 42% in 1997/98 to 29% in 2006/07, with declines in the shares of both monetary and non-monetary agricultural production, as the agricultural sector has been growing more slowly than non-agricultural sectors of the economy. This has contributed to rising incomes, as employment has shifted from (low-income) agriculture to other sectors which are characterised by higher average incomes.

The economy has benefited from extensive structural reforms, including improved public finance management, debt reduction (and debt relief), disciplined monetary policy focused on achieving sustainable low inflation, and an improved environment for private sector investment and activity.

Fiscal sustainability has been targeted through improved domestic revenue generation[1], expenditure control and the reduction of the fiscal deficit and public debt; however, the budget is still heavily dependent upon donor funding, especially for development (investment) projects.

Overall, the economy has been characterised by improved macroeconomic balance, particularly with regard to fiscal sustainability and balance of payments stability. While the balance of trade remains heavily in deficit with imports substantially exceeding exports, the situation has been helped by exports growing faster than imports in recent years, large increases in private remittances, and significant donor grants both to government and non-government entities. Capital inflows have been strong, supporting an overall surplus on the balance of payments, which has in turn supported the accumulation of foreign exchange reserves. Considerable efforts have been devoted to maintaining international competitiveness and a stable real effective exchange rate (REER), so as to underpin export-led growth. At times this task has been made more difficult, ironically, by the strength of inflows from donor funds and inward investment, which has tended to put upward pressure on the exchange rate.

Macroeconomic challenges posed by HIV/AIDS

Countries with high HIV and AIDS burdens have had to be aware of the potential macroeconomic impact of the disease. All of the countries with HIV prevalence rates high enough to have a potential macroeconomic impact are in sub-Saharan Africa, where the problem has been compounded in some cases by weak economic performance, low levels of per capita income and macroeconomic instability.

In Uganda, the burden of HIV/AIDS was at its highest during the 1980s and 1990s, when reported HIV adult prevalence rates reached nearly 19%[2]. By 2004/05, however, the recorded prevalence rate was down to 6.4%[3]. Despite this considerable success in reducing the HIV prevalence rate, there are concerns that the prevalence rate is rising again. This may in part reflect the rollout of ART which, by keeping HIV-positive people alive for longer, will tend to raise the prevalence rate. But the real concern is that HIV prevalence is rising albeit the impact of ART.

HIV/AIDS can have macroeconomic impacts through a wide range of channels. The most obvious direct impact is on labour supply: by reducing population growth, HIV/AIDS leads to a smaller labour force. This is potentially important in a country such as Uganda (and many other sub-Saharan African countries), which has a highly labour-intensive production structure. HIV/AIDS also affects the *composition* of the labour force, in that there tends to be fewer older (and hence less skilled and experienced) workers. HIV/AIDS may also affect labour productivity (and hence growth), due to ill-health and absenteeism. HIV/AIDS also causes an increase in costs, for households, firms, and governments. This can indirectly affect incomes and growth; depending on how these additional costs are financed, they may lead to reduced savings and investment. Private sector investment may also be affected by reduced profitability. Besides the overall macroeconomic impact, HIV/AIDS may have different impacts across economic sectors, increasing demand and growth in some sectors and reducing it in others.

[1] The IMF notes that revised GDP data make the increase in the tax-to-GDP ratio less impressive (IMF, 2008)

[2] Although there is uncertainty over the accuracy of these early data and how representative they were for nationwide prevalence.

[3] Uganda Sero-Survey, 2004/05

It is generally expected that due to reduced labour supply, productivity and investment, HIV/AIDS will have a negative impact on economic growth. However, the impact on average (per capita) incomes is less well defined; as both economic growth and population growth will be reduced. If the magnitude of the impact on the economy is less than the impact on the population, then conceivably per capita incomes could rise.

The main channel for this seemingly perverse result works through unemployment: if deaths due to AIDS result in formerly unemployed members of the labour force finding employment, then the unemployment rate could fall. In the Ugandan context, reduced labour supply could lead to labour being drawn from low productive (and low income) agriculture to higher productive (and higher income) non-agricultural sectors of the economy.

This is not necessarily the case, however, as overall labour demand may fall and could dominate labour supply effects (the reduction in labour demand could be greater than the reduction in labour supply, leading to higher unemployment). There is also a potential problem with the availability of skilled labour, which cannot readily be replaced.

More recently, concerns about the macroeconomic impact of HIV/AIDS have changed. In the early days of the epidemic, prevalence rates were rising to much higher levels in sub-Saharan Africa than had been seen in other parts of the world. Furthermore, the cost of effective treatment through Anti-retroviral therapy (ART) was extremely high, and was only available to a small minority of the population who could afford private treatment. Dealing with HIV/AIDS focused on prevention, information, education and communication (IEC) programmes, containing opportunistic infections and the impact of this on health systems, and dealing with orphans and vulnerable children (OVCs). However, over the past decade, the overall HIV prevalence rate has dropped in many countries – in part due to the success of prevention and IEC initiatives - so the direct economic impacts are likely to be smaller. Furthermore, the cost of effective treatment (ART) has dropped, and it is now a realistic option to treat widely. The rollout of ART has also meant that HIV+ people are healthier and live longer, and hence the negative economic impacts are again reduced.

Nevertheless, the availability of treatment has raised new challenges. In middle income countries, the cost of ART and other HIV/AIDS programmes can now be largely funded from domestic resources, albeit assisted with donor contributions. In many poorer countries, the cost of ART and HIV programmes cannot be predominantly financed from domestic resources, but donor funds are now available to meet most of the costs.

These two funding scenarios raise different sets of challenges. In middle-income countries (MICs), the main issue is ensuring budget sustainability in the context of stepped up HIV/AIDS spending, and dealing with the trade-offs between competing expenditure priorities. In low-income countries (LICs), this issue also arises – given that part of the costs of ART and other HIV programmes will be met from domestic resources – but the main macroeconomic issues are different. The key macroeconomic challenges arising from HIV/AIDS treatment in LICs are:

- The sustainability and stability of donor funding (HIV/AIDS treatment is a long-term commitment);
- The extent of the local funding contribution and the impact on government budget sustainability;
- The impact of donor inflows on the real exchange rate, money supply, inflation, competitiveness, diversification, growth, incomes and poverty;

- To what extent are these negative impacts offset by the beneficial impacts on growth (e.g. reducing labour shortages) and poverty, or justified in moral terms regardless of negative economic impacts;
- To what extent does spending on HIV/AIDS create demand for goods and services that are inconsistent with productive capacity of the economy, and cause supply bottlenecks and inflation?
- How should central banks respond to increased inflows of foreign exchange resulting from donor funding?

This report presents the results of analysis of these issues in the Uganda context.

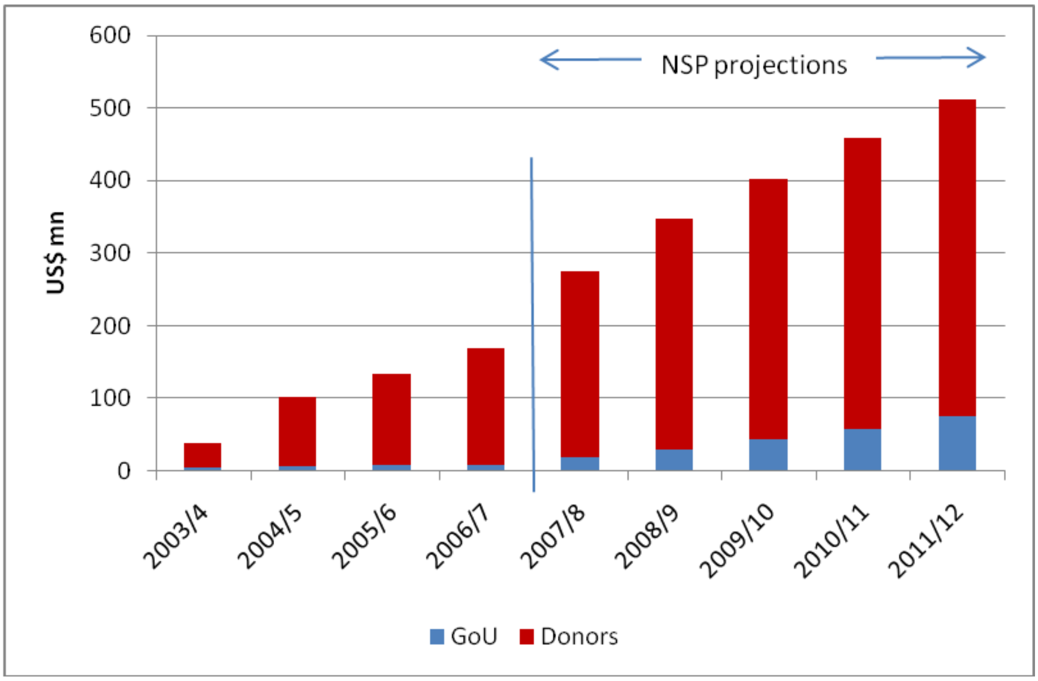
3. The Magnitude of Expenditure Related to HIV/AIDS

Total Spending and Donor inflows for HIV/AIDS in context

Spending on HIV/AIDS programmes in Uganda has increased sharply in recent years, up from $38.4mn in 2003/4 to an estimated $170mn in 2006/7 (Lake & Mwijuka, 2006). Of these total spending amounts, the contribution from the Government of Uganda (GoU) rose from $5.9mn to $8m over this period, but this represented a decline from 16% to 5% of total spending.

The National Strategic Plan (NSP) for 2007/08 to 2011/12 envisages further steady increases in spending on HIV/AIDS programmes, rising to $511mn in 2011/12, and for the GoU share to increase to 15% ($77mn)[4].

Figure 1: Total Spending on HIV/AIDS Programmes ($mn)



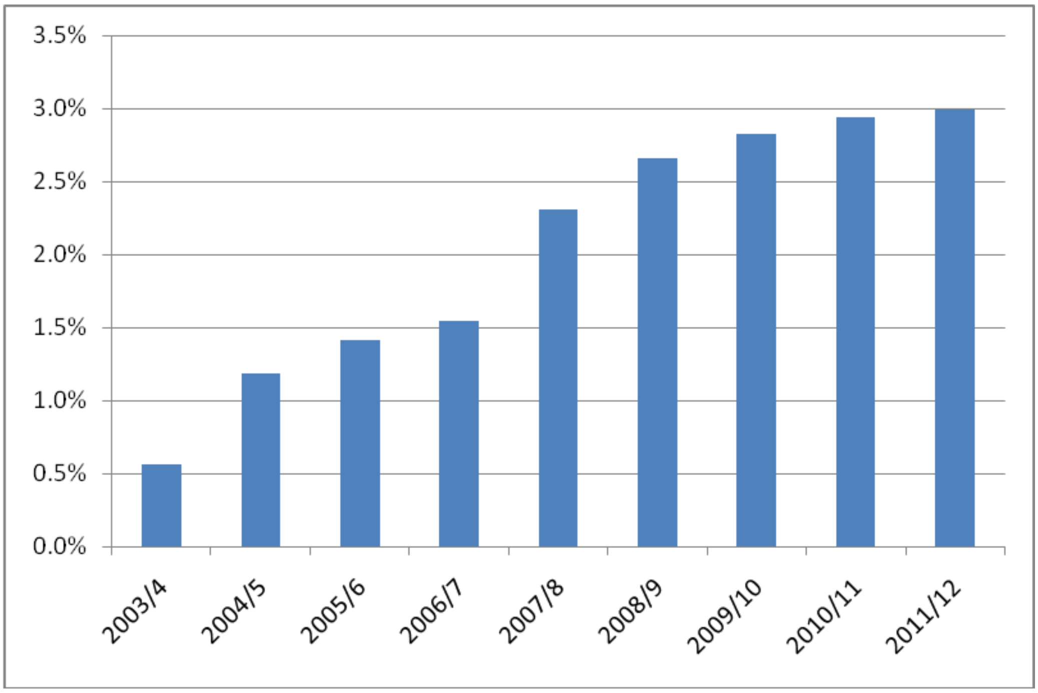
Source: Lake & Mwijuka (2006); UAC (2007)

The increase in spending on HIV/AIDS programmes also represents a steady increase relative to GDP. Already, spending has risen from around 0.6% of GDP in 2003/04 to an estimated 1.5% in 2006/07. It

[4] Uganda AIDS Commission, National Strategic Plan 2007/08 – 2011/12. These data reflect the "high funding" scenario.

is set to increase further, to 3.0% of GDP in 2011/12. While this increase is large, one of the issues addressed in this paper is whether it is likely to be a problem.

Figure 2: Spending on HIV/AIDS Programmes as % of GDP



Source: own calculations

It should be noted that this level of spending on HIV/AIDS, relative to GDP, is high but not out of line with other countries. Total spending on HIV/AIDS programmes is estimated to peak at 2.5% - 3% of GDP in Botswana (Jefferis et al, 2006) – where a much higher prevalence rate (approximately four times the level in Uganda) is balanced by a much higher GDP per capita (approx US$5500).

Across a range of countries, Uganda's spending on HIV/AIDS is relatively high as a proportion of GDP (Figure 3), especially when the level of HIV prevalence is taken into account (Figure 4).

Figure 3: Spending on HIV/AIDS (% of GDP) - International Comparisons, 2007

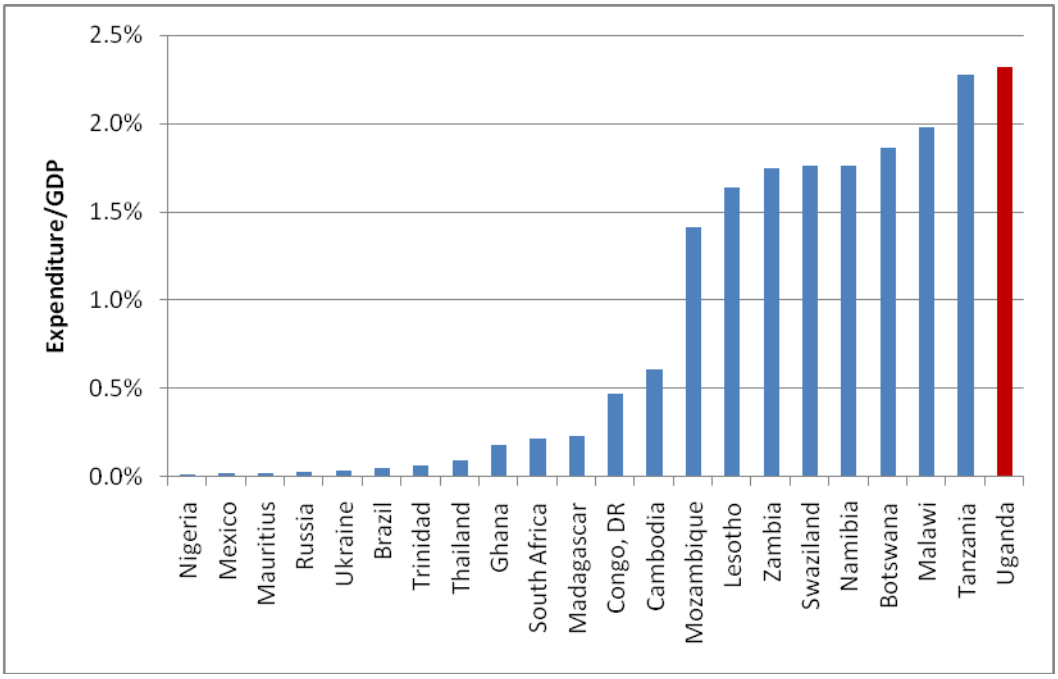
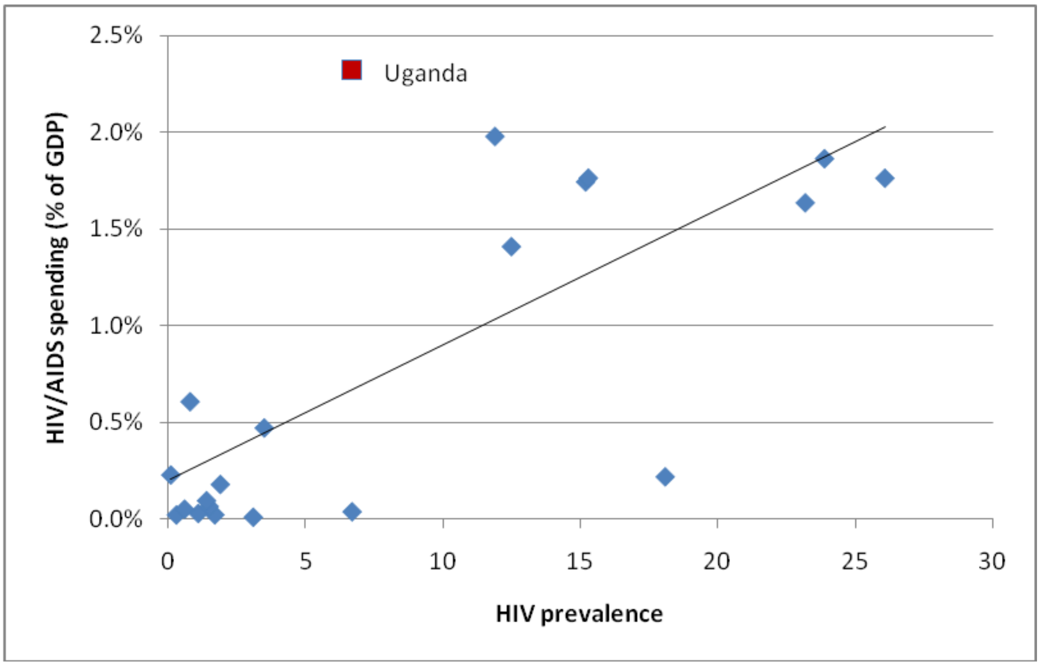


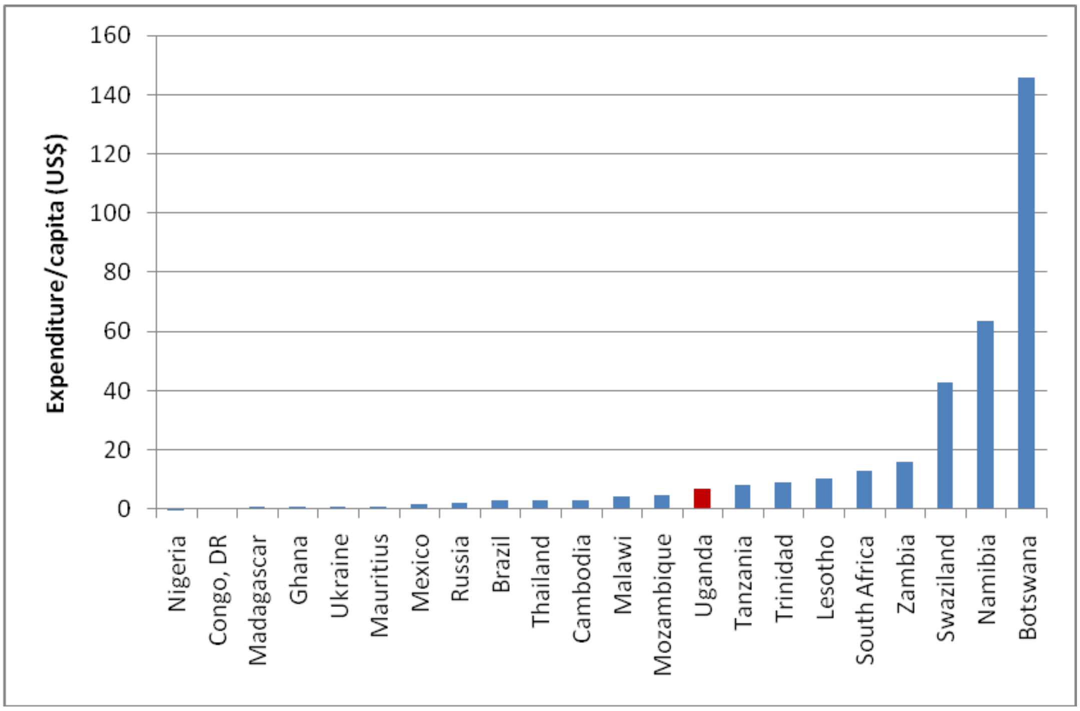
Figure 4: HIV/AIDS Spending (% GDP) and HIV Prevalence



Source: own calculations based on data from UNAIDS (2008) and IMF (www.imf.org)

In terms of HIV/AIDS spending per capita, Uganda's level of expenditure is similar to that of low-income countries (Tanzania, Mozambique) but much below the middle-income, high prevalence countries of southern Africa.

Figure 5: Spending on HIV/AIDS ($ per capita) - International Comparisons



Domestic budget implications

Under the NSP, the majority of spending on HIV/AIDS will continue to be externally financed, but the NSP envisages an increase in the GoU share from 5% of the total in 2006/7 to 15% in 2011/12, i.e. from US$8mn to US$75mn. As a share of domestic revenues (assuming the ratio of domestic revenues to GDP remains unchanged), government spending on HIV/AIDS would increase from 0.6% of total spending to 2.3% - a large increase, but still not to a very high level - or from 0.1% to 0.4% of GDP. Even if this entirely goes through to the budget deficit – and is not compensated by cuts in spending elsewhere – this would only increase the deficit by 0.3% of GDP, which is unlikely to present a major problem. Alternatively, such spending could be funded by an increase in taxes of 0.3% of GDP, approximately a 3.5% increase in total taxation.

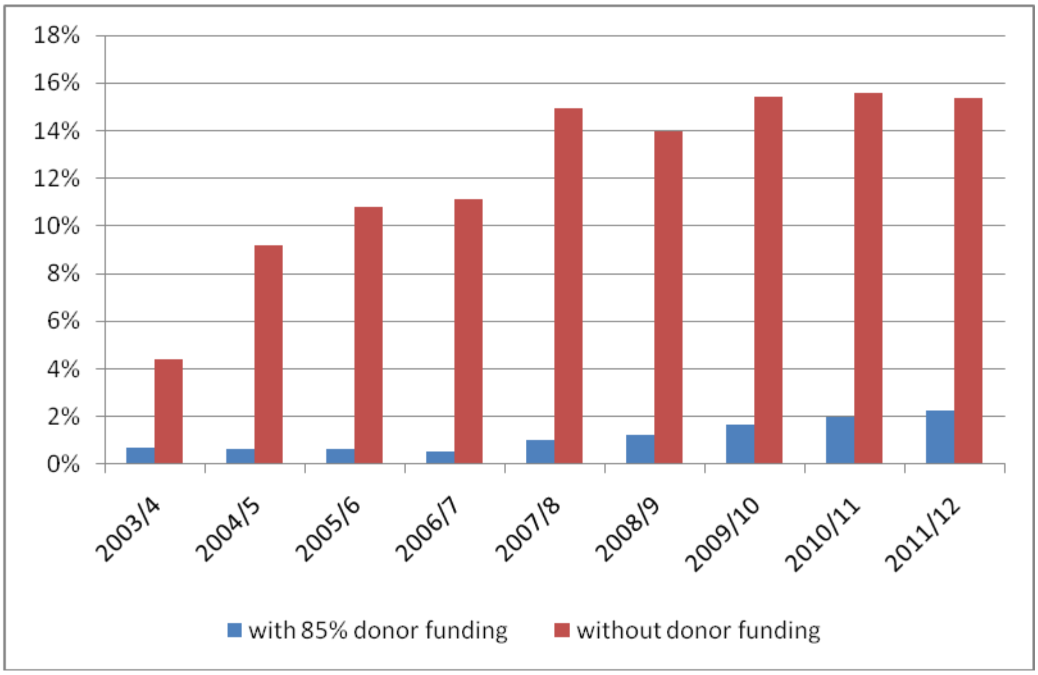
However, this comes at a time of other fiscal pressures (extending health and education services, road infrastructure etc.). For instance, the 2008/09 Budget envisages an increase in development spending from 3% to 5.5% of GDP, much larger than the anticipated GoU spending on HIV/AIDS programmes. In practice, increased domestic spending on HIV/AIDS would require some tradeoffs, with reduced expenditure in other areas.

The above refers to the domestically-financed portion of GoU spending on HIV/AIDS programmes. Of course total spending is much larger, and concerns have been raised about the donor-financed portion of GoU spending, and the impact that increased GoU spending would have on budget ceilings. Increasingly, however, spending on HIV/AIDS programmes is being conducted through non-government agencies, so this issue is less relevant. Data on government spending on HIV/AIDS programmes is not readily available as a distinct category, as it is spread across a number of ministerial budgets. If we assume, however, that one-third of total HIV/AIDS spending goes through the GoU, then this would approximately double the impact on the budget, taking spending from 0.2% to 0.8% of GDP between 2003/4 and 2011/12 – still a relatively small amount.

Even though HIV/AIDS programmes would have a relatively small impact on the budget, the spending through non-government agencies would still have a macroeconomic impact, and this is discussed below.

The major impact on the government budget would come if donor funding were not available but expenditure was kept at the same level. This would take total spending to around 15% of domestic revenues – a level that would be extremely difficult to sustain as it would require either sharp cutbacks in other important spending areas, tax increases, or unsustainable deficit funding and public borrowing.

Figure 6: GoU Spending on HIV/AIDS Programmes (as % of domestic revenues)



Source: own calculations

Monetary and Exchange Rate Impact.

Concerns about the monetary and exchange rate of HIV/AIDS spending impact stem primarily from the magnitude of donor currency flows, the impact on the exchange rate and competitiveness, and the required policy responses. Under the NSP projections, HIV/AIDS-related donor funding would increase from 18% of ODA in 2004/05 to an estimated 50% in 2011/12, assuming that non-HIV/AIDS ODA remains static in real USD terms[5].

Exchange Rate

If the intended proportions of financing from the GoU are met, HIV/AIDS-related donor inflows will increase from $32m in 2003/04 to $436mn in 2011/12. On the face of it, this would represent a significant addition to foreign exchange receipts. Estimated donor flows amounted to 4.6% of non-HIV current account receipts in 2006/7, rising to an estimated 7.2% in 2011/12[6]. Donor funds would represent an increase of 50% in transfers (excluding remittances) to government and the private

[5] Non-HIV/AIDS-related ODA has been steady at around USD400m in recent years.

[6] This assumes that the ratio of current account receipts to GDP stays the same – in fact it is likely to increase, which would make impact of donor funds less in relative terms.

sector from 2006/07 levels, and these additional inflows could put upward pressure on the currency, causing appreciation and a loss of competitiveness.

However, the net inflows are likely to be much smaller. It is estimated that that 60% of HIV/AIDS programme expenditure goes on imports (see Phase II report). Taking this into account, while gross donor flows would rise from $162mn in 2006/7 to $436m in 2011/12, net flows would only rise from $68m to $200m over the same period. The magnitude of the relative impact on the balance of payments and the currency would therefore be much smaller.

However, we can also compare the net inflows to the overall balance of payments (BoP), as this arguably is best indicator of likely currency pressures. Over the period 2001/02 to 2006/7, the overall balance on the BoP averaged 2% of GDP. Taking this as the average going forward, the net flows from HIV/AIDS programmes would rise from 11% of the overall balance in 2003/4 to 60% in 2011/12. Clearly the impact on the foreign exchange market would be substantial; as the value of the currency is determined by the balance between inflows and outflows, and even taking account of major import component of HIV spending, the remainder would add considerably to net foreign exchange inflows and hence change the balance, causing upward currency pressures.

Net inflows have already risen from 11% of the BoP in 2003/4 to 30% in 2006/07, and this may have contributed to currency appreciation pressures, which would increase further.

Figure 7: Net HIV/AIDS flows as % of BoP

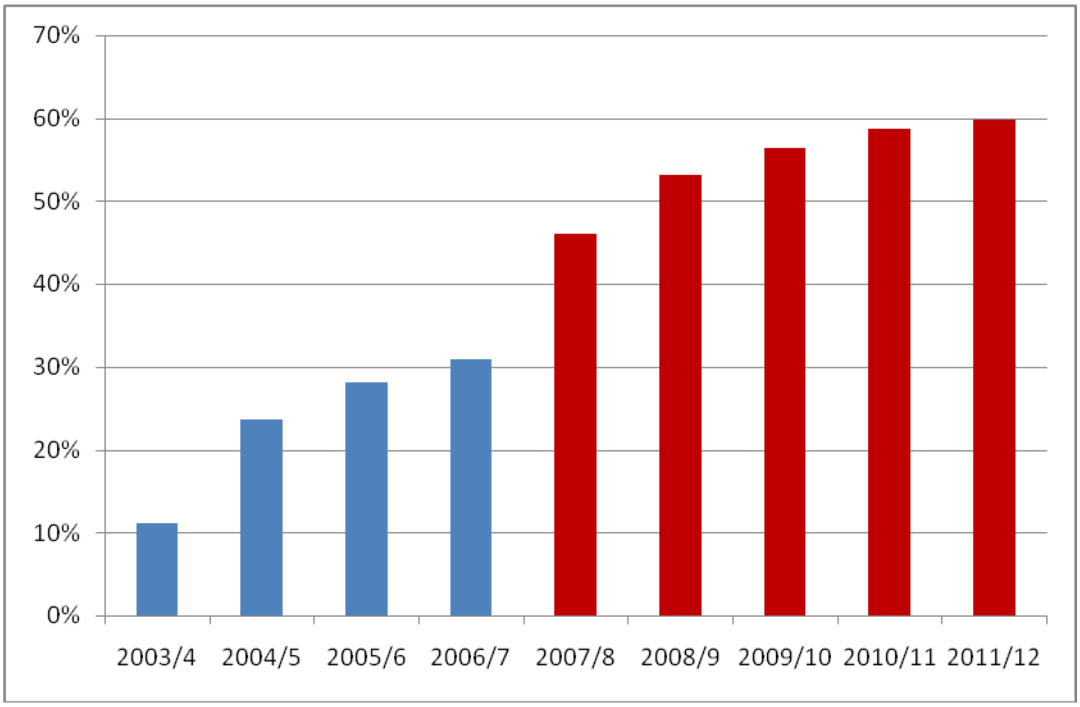


Table 1: Macroeconomic Data Summary:

		2003/4	2004/5	2005/6	2006/7	2007/8	2008/9	2009/10	2010/11	2011/12
Total HIV/AIDS spending	USDmn	38	103	134	170	276	347	402	458	511
Total HIV/AIDS spending	Ushs bn	74	179	249	314	511	642	744	847	946
Total HIV/AIDS spending	% GDP	0.6%	1.2%	1.4%	1.5%	2.3%	2.7%	2.8%	2.9%	3.0%
GDP (est.)	USDmn	6,817	8,726	9,507	11,001	11,983	13,053	14,235	15,590	17,070
GDP (est.)	Ushs bn	13,190	15,165	17,351	19,583	21,653	21,642	24,185	27,127	30,453
Exchange rate	Ush/US$	1,935	1,738	1,825	1,780	1,807	1,658	1,699	1,740	1,784
Funding of HIV/AIDS spending										
Donors	USDmn	32	96	126	162	257	317	359	400	436
GoU	USDmn	6	7	8	8	19	30	43	58	75
GoU-funded spending on HIV/AIDS										
% total HIV/AIDS spending		15.5%	6.8%	6.1%	4.8%	6.8%	8.8%	10.8%	12.8%	14.8%
% domestic revenues		0.7%	0.6%	0.7%	0.5%	1.0%	1.2%	1.7%	2.0%	2.3%
% of GDP		0.1%	0.1%	0.1%	0.1%	0.2%	0.2%	0.3%	0.4%	0.4%
% of GDP (incl. donor-funded portion)		0.2%	0.2%	0.2%	0.2%	0.3%	0.5%	0.7%	0.8%	1.0%
Govt revenue (USDmn)		863	1,121	1,242	1,529	1,846	2,480	2,610	2,940	3,329
Overall balance of payments	US$m	136	175	190	220	240	261	285	312	341
HIV/AIDS FX inflows (net)	US$m	15	41	54	68	110	139	161	183	204
HIV/AIDS FX inflows (net)	% of BoP	11%	24%	28%	31%	46%	53%	56%	59%	60%
HIV/AIDS FX inflows (net)	Ushs bn	-	-	98	121	199	230	273	319	365

Monetary Impact

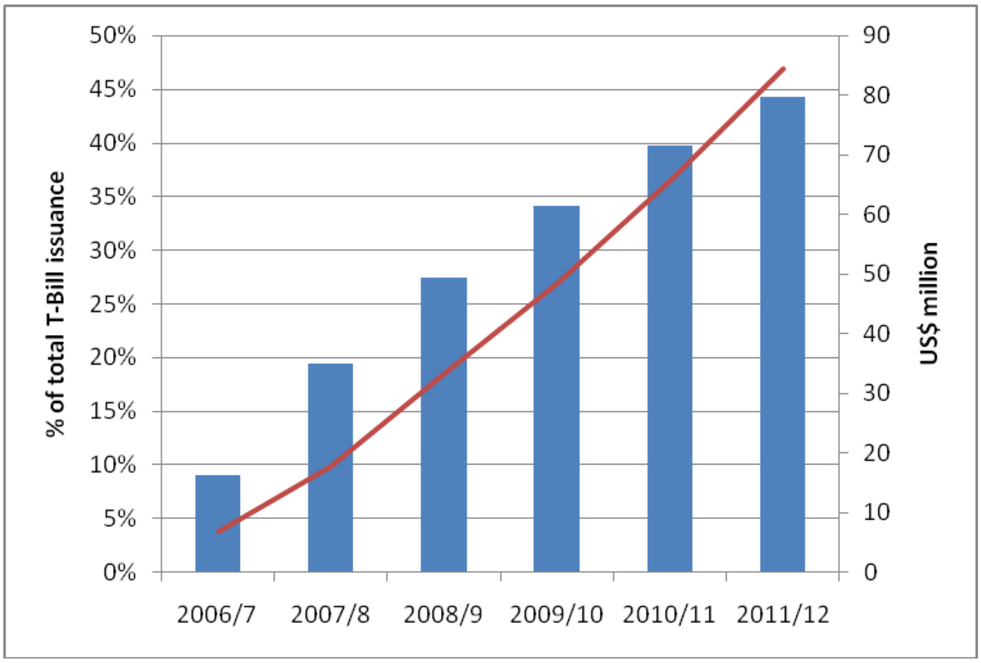
The monetary impact of donor inflows depends on the policy response adopted. Donor inflows of foreign currency may be purchased by the central bank to offset currency pressures, but in this case there will be a monetary expansion, which may in turn be offset by monetary sterilisation operations in order to prevent inflation. This will be discussed further below in the context of options regarding the absorption and spending of donor inflows. The Phase II report of this study noted that aid flows had not led to inflation, because additional inflows resulting from purchase of donor foreign exchange by the Bank of Uganda (BoU) – resulting in creation of local currency - had been sterilised by monetary operations.

Looking forward, if the entire additional net foreign exchange inflows resulting from donor funds are purchased by the BoU, this would result in money creation that would have to be sterilised and offset by the sale of an equivalent volume of BoU/GoU bills. At projected exchange rates, this would result in sterilisation rising from UGX 121bn in 2006/07 to UGX 365 bn in 2011/12. This compares with a total issuance of UGX1340bn in Treasury Bills in June 2007. However, as the sterilisation would be cumulative, the total would rise quickly. The additional issues required would represent an estimated 44% of total T-Bill issuance in 2011/12, compared to an estimated 9% in 2006/07.

The additional cost to government of this T-Bill issuance, at a 10% interest rate, would be substantial, amounting to approximately US$85mn a year. This would be larger than the cost of the Government's share of HIV/AIDS programmes. Furthermore, it is likely that the impact on interest rates would be large, leading to a crowding -out effect on private investment.

However it is important to note that sterilisation would only be necessary to the extent that the GoU/BoU decided not to absorb the additional foreign currency inflows, but to use them to add to foreign exchange reserves. This is a policy option that is discussed further below.

Figure 8: Cumulative net inflows relative to total T-Bill issuance



4. Policy Choices

Before considering the policy options relating to dealing with foreign exchange inflows, it is important to note that the macroeconomic implications depend on both the scale of inflows and also how those aid inflows are used; to the extent that inflows are used to purchase imported inputs of goods & services, the magnitude of the impact will be reduced, i.e. there will be less currency appreciation and/or crowding out of the private sector through higher real interest rates.

Absorption and Spending

The policy choices for dealing with donor foreign exchange inflows can be conveniently conceptualised in the Absorption and Spending framework[7].

Absorption is the extent to which aid flows from external donors result in additional imports and a widening of the (non-aid) current account deficit. Absorption captures both direct and indirect increases in imports financed by aid, which represent the real transfer of resources financed by aid. It reflects the aggregate impact of the macroeconomic policy response to higher aid inflows, including the impact of monetary, exchange rate and fiscal policies. To the extent that aid inflows are *not* absorbed, and do not result in additional imports, they are added to the country's foreign exchange reserves.

Spending – in the context of aid flows accruing to government - refers to the extent to which the non-aid fiscal deficit increases as a result of the aid. Aid can be used by government to increase spending or reduce taxation. Aid is fully spent if total spending increases by the same amount as the aid received; with the incremental spending financed by aid, the non-aid fiscal deficit is increased.

The macroeconomic effects of aid inflows vary depending on which combination of absorption and spending is adopted.

Table 2 lays out the four possible absorption/spending combinations (in practice of course there an infinite number of intermediate solutions possible, with different degrees of absorption and spending).

Table 2: Absorption/Spending Combinations

	Spend	**Don't Spend**
Absorb	Additional imports/No accumulation of reserves Additional govt spending + higher fiscal deficit	Additional imports/No accumulation of reserves No net new govt spending/fiscal deficit unchanged
Don't Absorb	Accumulation of reserves/No additional imports Additional govt spending + higher fiscal deficit	Accumulation of reserves/No additional imports No net new govt spending/fiscal deficit unchanged

Table 3 lays out the implications for economic impacts and policy responses for the various combinations[8].

[7] For further details, see IMF (2005)
[8] Much of this discussion is taken from IMF (2005).

Table 3: Absorption/Spending Combinations - Economic Impacts[9]

	Spend	**Don't Spend**
Absorb	Real transfer of resources from RoW Nominal (and real) exchange rate appreciation (Dutch Disease) Reduced competitiveness and exports, leading to reduced aggregate demand Additional govt spending/higher fiscal deficit, leading to higher aggregate demand Output and growth may be positively or negatively affected. Long-term effects may be more favourable if govt. spending leads to relieving capacity constraints Inflation if scale-up too rapid *Appropriate in most circumstances. However, shifts resources from private to public sector*	Real transfer of resources from RoW Nominal (and real) exchange rate appreciation (Dutch Disease) Reduced competitiveness and exports, leading to reduced aggregate demand No net new govt spending/fiscal deficit unchanged Growth negatively affected *Rarely appropriate*
Don't Absorb	No transfer of resources from RoW Nominal exchange rate unchanged Money supply expansion resulting from foreign exchange purchases and fiscal deficit **Either***:* inflation, real exchange rate appreciation and reduced competitiveness **Or**: sterilisation of money supply expansion and higher interest rates, leading to crowding out and switch from private investment to govt. consumption/investment Additional govt. spending/fiscal deficit is financed domestically, not by aid *Least appropriate option. Shifts resources from private to public sector and does not allow benefits of real transfer of aid-financed resources*	No transfer of resources from RoW Nominal exchange rate unchanged Govt. balances at central bank increased (proceeds of aid inflows) which sterilises increased money supply from foreign exchange purchases No pressure exchange rate or prices *Appropriate in short-term if foreign exchange reserves are very low and/or aid flows are volatile. Not appropriate in long-term unless Dutch Disease concerns are very serious and fully outweigh the benefits of absorption of aid inflows*

9 Assumes floating exchange rate.

With respect to absorption, if the additional foreign exchange inflows are absorbed, this means that there is a net transfer of resources from abroad, manifested in a widening current account deficit (excluding aid transfers). The central bank will sell the foreign exchange received to the private sector, which will use it to finance additional imports. This in turn will put downward pressure on the price of foreign exchange, hence representing an appreciation of the domestic currency, and potential competitiveness and Dutch Disease problems.

If the additional flows are not absorbed, the foreign exchange receipts are retained by the central bank and added to foreign exchange reserves. However, this leads to domestic money creation, which is potentially inflationary, which would lead to real exchange rate appreciation (but through inflation rather than appreciation of the nominal exchange rate). This monetary impact can be offset by sterilisation through sale of T-Bills by the central bank, but this has a fiscal cost, and pushes up nominal and real interest rates.

So, there will be a negative economic impact of donor foreign exchange inflows, whether exchange rate appreciation, higher inflation or real interest rates. However, the key question is to what extent this can be offset by growth-enhancing measures through expenditure on removing constraints to growth (including HIV/AIDS itself).

With respect to spending, if the aid is absorbed but not spent, there are no growth benefits. If aid is not absorbed, but spent, this is equivalent to domestic financing of the increased spending, which is likely to be inflationary, making monetary policy response even tighter (with a higher real interest rate). If aid is not absorbed and not spent, then there is no transfer of resources to the economy and no additional spending (on consumption and investment), just an accumulation of foreign exchange reserves and government balances at the central bank. If aid is both absorbed and spent, then there is a real transfer of resources to economy, plus additional domestic demand, so aid has a real economic impact, although there are also offsetting costs (from reduced competitiveness).

The conclusions drawn by the IMF and other commentators on the basis of this analysis are that the most appropriate combination of absorption and spending depends on many factors, including the level of official reserves, the existing debt burden, the level of inflation and the degree of aid volatility. However, in normal circumstances – where there are no major problems relating to the four factors above – the most appropriate response would be to both absorb and spend the aid. Only if inflation was a major problem and reserves were precariously low, or aid likely to be very volatile, would other approaches be optimal. However, it is also important to note that when aid receipts are spent, this should be done in a way that is growth-enhancing, and addresses constraints to growth.

Impact on IMF targets

Uganda is no longer dependent upon meeting IMF conditions to access loan finance, as it was previously under the Poverty Reduction and Growth Facility (PRGF). However, it does have a Policy Support instrument (PSI) in place, which includes a set of targets agreed between the GoU and the IMF.

The key macroeconomic targets under the PSI (IMF 2008) relate to the following:

A1 Net Foreign Assets (NFA) of the Bank of Uganda
A2 Net Domestic Assets (NDA) of the Bank of Uganda
B Monetary Base (MB)(=NFA+NDA)
C Net Claims on Central Government by the Banking System (NCG)
D Net International Reserves (NIR) of the Bank of Uganda (closely related to A1, NFA)

These target variables may be affected by donor inflows related to HIV/AIDS. The impact of additional donor funds on NIR, NDA and MB under different absorption and spending scenarios are shown in Table 3 (taken from IMF, 2005, Box 1). These show that the only problematic case would be under the "Spend but Don't Absorb" scenario, where the monetary base would expand, possibly threatening the agreed target, and requiring sterilisation operations if the monetary base is not to increase.

Table 4: Example of Impact of $100 in additional donor funds on programme targets

	Spend	**Don't Spend**
Absorb	Central Bank Balance Sheet NIR 0 — MB 0 NDA 0 Fiscal Accounts Ext. fin 0 — Deficit 0 Dom. fin. 0	Central Bank Balance Sheet NIR 0 — MB -100 NDA -100 Fiscal Accounts Ext. fin +100 — Deficit 0 Dom. fin.-100
Don't Absorb	Central Bank Balance Sheet NIR +100 — MB +100 NDA 0 Fiscal Accounts Ext. fin +100 — Deficit+100 Dom. fin. 0	Central Bank Balance Sheet NIR +100 — MB 0 NDA -100 Fiscal Accounts Ext. fin +100 — Deficit 0 Dom. fin.-100

Source: IMF, 2008

5. Modelling the Macroeconomic Impact of HIV/AIDS

The Phase I report of this study reviewed various different approaches to evaluating and modelling the macroeconomic impact of HIV and AIDS, and their application across a range of different African countries[10]. The modelling approaches used in these studies can be classified into various categories:

(i) econometric estimation, where HIV/AIDS is one of a range of factors hypothesised to determine economic growth rates, and the relative impact and significance of these different factors is estimated econometrically (statistically) in a conventional growth model;

[10] Outside of Africa, overall HIV prevalence rates are too low to have a macroeconomic impact.

(ii) aggregate macroeconomic equilibrium growth models, where a simple simulation model is constructed and calibrated to a particular economy, and the growth path of an economy is simulated under different scenarios (e.g. "with AIDS" and no-AIDS);
(iii) computable general equilibrium (CGE) models; these are like aggregate growth models in that they simulate the equilibrium behaviour of an economy under different scenarios, but are more disaggregated and can take into account labour, capital and commodity markets;
(iv) large scale macroeconomic models, where an economy is represented by a number of econometrically estimated equations that can be used to forecast economic trends, and which can incorporate HIV/AIDS-related factors (e.g. impact on productivity growth) into model-based forecasts;
(v) overlapping generations models, which focus on the impact of HIV/AIDS on long-term human capital formation. Whereas other models have generally had a time horizon of up to one generation (15-25 years), the OLG focuses on the impact of HIV-related deaths of parents on the ability of children to participate in education and accumulate human capital.

These approaches have various advantages and disadvantages, which are also reviewed in the Phase I report. This review has several implications for the methodology to be employed in the current study to assess the macroeconomic impact of HIV/AIDS. First, the aggregate growth function approach is an accepted one in the literature, and indeed is probably the most widely used approach to modelling the macroeconomic impact of HIV and AIDS. It has relatively modest data requirements, which can be satisfied even in countries with limited data availability, and does not require any specialised software or programming skills[11].

A second implication of the review is that, if CGE modelling is feasible, it can provide a broader and richer range of outputs, in that it can more thoroughly trace the impact of HIV/AIDS and ART provision through the economy, and permit a more detailed analysis of the impact on different production, labour market and household sectors. It should be noted that the CGE approach is not fundamentally different to the growth function approach – in that a similar production function is central to the CGE model – it is just much more disaggregated in terms of economic sectors and markets, and labour and household categories. However, the data requirements of CGE modelling are much more demanding than that of an aggregated growth function approach; besides requiring a (recent) Social Accounting Matrix (SAM), it requires suitably disaggregated data on national accounts, the labour market, and the government budget, as well as information on HIV prevalence across labour market categories.

Finally, while the macro-econometric modelling approach has been used successfully in South Africa, this is dependent upon the use of an existing macro-econometric model. There is no such model currently in existence for Uganda, and the task of producing one is beyond the scope of this study. Hence this approach was not pursued in this study, but both the aggregate growth model and the CGE approaches were used. The outputs of both were used for the final economic impact projections.

The results of the various studies reviewed in the Phase I report are summarised in Table 5 below.

[11] The model can be built using a spreadsheet programme

Table 5: Studies Evaluating the Macroeconomic Impact of HIV/AIDS

Authors	Country	Method	Period Covered	Impact on Growth Rates	
				GDP	GDP per cap.
Over (1992)	30 sub-Saharan African countries	Econometric estimation & simulation	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)	Cameroun	CGE	1987-91	-1.9%	n/a
Bloom & Mahal (1995)	51 countries	Econometric estimation	1980-92	-ve but small	
Cuddington (1993a,b)	Tanzania	Aggregate growth model	1985-2010	-0.6% to -1.1%	0.0% to -0.5%
Cuddington & Hancock (1994a,b)	Malawi	Aggregate growth model	1985-2010	-0.1% to -1.5%	-0.1% to -0.3%
BIDPA (Jefferis, Greener & Siphambe) (2000)	Botswana	Aggregate growth model	1996-2021	-0.8% to -1.9%	+0.4% to -0.5%
Bonnel (2000)	70 developing countries	Econometric estimation	1990-97	up to -2.8%	up to -1.4%
Quatteck/Ing Barings (2000)	South Africa	Macro-econometric model	2001-2015	-0.3%	+ve
Arndt & Lewis (2000)	South Africa	CGE	2001-2010	-1.6%	– 0.8%
MacFarlan & Sgherri (2001)	Botswana	Aggregate growth model	1999-2010	-3.5% to -4.5%	0% to -1%
Laubscher et al/BER (2001)	South Africa	Macro-econometric model	2001-2015	-0.33% to -0.63%	+0.7% to +1.0%
Zerfu (2002)	Ethiopia	Macro-econometric model	1981-1999	-2% total	n/a
Haacker (2002)	Nine southern African countries	Aggregate growth model	10-15 years	n/a	-10% to +4% (total, not p.a.)
Bell, Devarajan & Gersbach (2004)	South Africa	Overlapping-generations model	1990-2080	n/a	-0.2% to -2.5% (†)
Lofgren, Thurlow & Robinson (2004)	Zambia	CGE	2001-2015	-0.4% to -0.9%	+0.2%
Masha, I (2004)	Botswana	Aggregate growth model	1991 – 2016	-0.8% to 2%	n/a
BER (2006)	South Africa	Macro-econometric model	2000-2020	-0.4% to -0.6%	+0.3% to +0.4%

Jefferis, Kinghorn, Siphambe & Thurlow / Econsult (2007)	Botswana	Aggregate growth model CGE Household simulation model	2001-2021	-1.2% to -2.0%	-0.4% to -0.9%

Source: updated from Table 4 in BER (2006)
Notes: † real income per family, derived from figures in paper

6. Conclusion

This overview indicates that the financial flows associated with HIV/AIDS are likely to be large relative to key macroeconomic aggregates in Uganda, and that there are potential concerns regarding large donor-funded inflows. In principle, however, the absorption-spending framework suggests that the "absorb and spend" approach is preferable. However, if the likelihood is of a rapid scale up of inflows, then this may have to be countered with a partial "don't absorb and don't spend" approach.

The following two chapters show the results of the analysis of the macroeconomic impact of HIV/AIDS using the Aggregate Growth Model and CGE Modelling approaches. These provide some quantification of the macroeconomic magnitudes involved. However, it is important to realise that these cannot quantify all of the macroeconomic impacts, especially those that occur through social rather than directly economic processes (such as the impact of HIV/AIDS on the coherence and stability of households), or which impact on economic processes that are not captured in the national accounts (such as household labour). Hence these models may underestimate the overall macroeconomic impact of HIV and AIDS.

Chapter 2: Aggregate Growth Model Results

1. Introduction

The aim of this chapter is to develop projections for the macroeconomic impact of AIDS in Uganda, focusing in particular on GDP growth and per capita real incomes. It simulates the growth path of the economy over a 20-year period (2001-2021) under three scenarios: "no-AIDS"; "AIDS-with-ART" and "AIDS-without-ART", and makes projections for key economic variables under each scenario, enabling comparisons between them. It also permits the variation of key parameters in the with-AIDS scenarios, which enables the projections to identify areas where policy interventions might best help to minimise the impact of AIDS on the economy.

The modelling approach is well established and essentially replicates that followed in studies on Tanzania (Cuddington 1993a,b), Malawi (Cuddington & Hancock, 1994a,b) and Botswana (BIDPA, 2000; MacFarlan & Sgherri, 2001; Masha, 2004; Jefferis *et al*, 2007), and is described in more detail below.

The results show that while HIV/AIDS is likely to have (and has already had) a significant negative impact on GDP growth, reducing the economic growth rate as compared to the no-AIDS scenario, as well as a negative impact on per capita incomes. The economy is likely to remain more agricultural under both of the with-AIDS scenarios than in the no-AIDS scenario. The results are of course sensitive to the assumptions made about various key parameters, especially about the rate of investment in the AIDS-with-ART and AIDS-without-ART scenarios.

2. The Macroeconomic Simulation Model

Model Structure

At the centre of the model is a production function, which enables output (GDP) to be calculated as a function of inputs (labour and capital) and productivity changes. If the inputs of the different factors of production can be projected (projections which will differ under the AIDS and no-AIDS scenarios), then GDP can also be projected.

The model goes beyond a simple, single production function by introducing the following innovations:

- the economy is divided into non-agricultural and agricultural sectors, with each modelled separately;
- labour is divided into skilled and unskilled categories

The model therefore has three labour markets: skilled non-agricultural sector, unskilled non-agricultural sector, and unskilled agricultural (it is assumed that all skilled workers are employed in the non-agricultural sector[12]). These labour markets behave differently.

- in the skilled, non-agricultural sector, it is assumed that market forces work, and that wages adjust to equate demand and supply;
- in the unskilled, non-agricultural sector, it is assumed that even if there is no formal minimum wage, wages are sticky and do not adjust readily in response to demand and supply. As a result, the non-agricultural sector market for unskilled labour does not clear, and there is (non-agricultural sector) unemployment;
- unskilled workers who are not employed in the non-agricultural sector make up the supply of labour in the agricultural sector, where wages (or incomes for the self-employed) adjust to clear the market and equate demand and supply.

The model therefore incorporates skilled and unskilled labour separately, along with unemployment and dual labour markets.

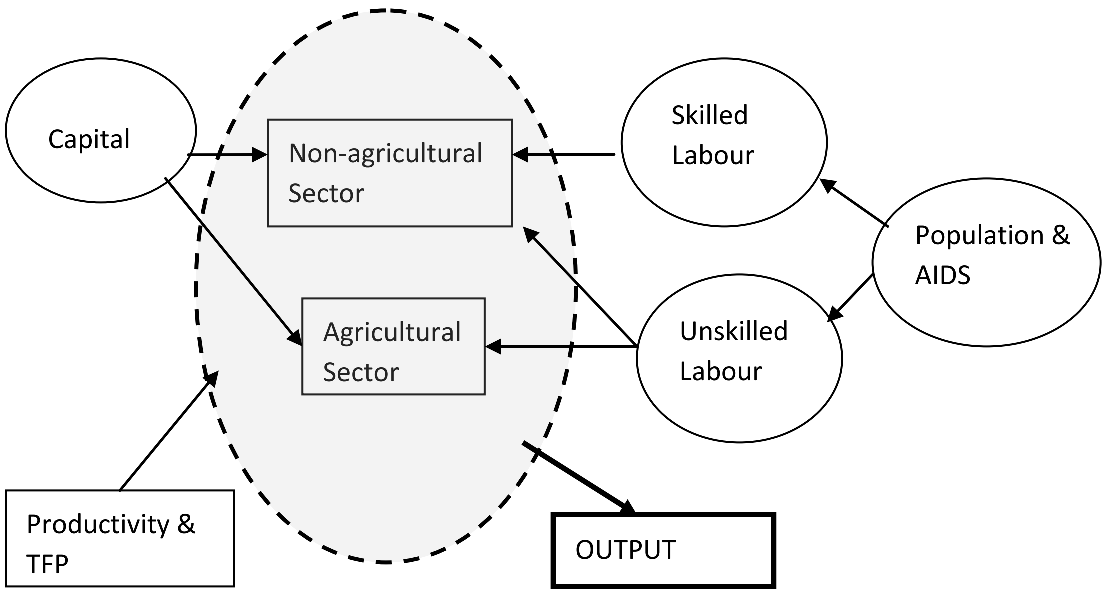
The advantages of this approach, and the reasons for choosing it are as follows:

- the production function approach allows forecasts of output to be made according to the factor inputs (capital and labour) available, and hence forecasts of economic growth rates with different amounts of inputs;
- it permits modelling of labour markets and consequently determination of the quantity of labour employed, and its wage rate;
- the division into the non-agricultural and agricultural sectors reflects the structure of sub-Saharan African economies in general, and the Uganda economy in particular;
- labour and capital inputs can be changed to reflect the impact of AIDS, as can various other parameters;
- the incorporation of a sticky wage for unskilled labour in the non-agricultural sector, and market determination of wages in the agricultural sector, reflects the institutional structure of wage determination; and
- the model is appropriate to the particular economic structure of Uganda (in particular the persistent shortage of skilled labour).

The model is shown diagrammatically below.

[12] While there may be some skilled workers employed in the agricultural sector, the numbers are considered small enough (in terms of the classification of skilled and unskilled workers used here) not to make any significant impact on the results, and hence they are not included in the model.

Figure 9: Structure of Aggregate Macroeconomic Impact Model



The production function takes the Cobb-Douglas form (this relates to the manner in which inputs are combined to produce output). In the non-agricultural sector, this is as follows:

$$Yf_t = \alpha f . \gamma f^{\,t} Lfs_t^{\beta_s} Lfu_t^{\beta_u} Kf^{\,\rho f} \qquad [1.]$$

where L*fs* and L*fu* represent labour supplies of skilled and unskilled labour respectively, and *Kf* is the capital stock. The shares of output attributable to each factor are β_s and β_u, and $\rho f=1-\beta_s-\beta_u$. γf^t represents an exogenous technological trend, while the constant αf is a scale factor, which is used to calibrate the model in the base year (2002), so that it fits the actual data from that year. It should be noted that all projections are in real terms (in constant 2002 prices).

Assumptions in the model

Like all models, this one makes certain assumptions regarding the behaviour of the economy. The assumptions that are explicitly or implicitly made here are as follows:

- markets will clear (prices adjust to equate supply and demand) (except for the non-agricultural sector market for unskilled labour);
- the economy responds to changes in factor prices, by substituting cheaper factors of production for more expensive ones, e.g., if a shortage of skilled labour causes skilled wages to rise relative to cost of unskilled labour and capital, the economy will substitute unskilled labour and capital for skilled labour;
- the rate of factor substitution is fixed and determined by the production function;
- there are constant returns to scale and the price of capital is fixed.

The assumption that factor substitution takes place in response to changes in relative prices is probably reasonable one over a long period of time on an economy wide basis. It assumes that firms behave rationally and that natural selection will help the firm sector as a whole to adjust the relative price changes. What is less satisfactory is that the value of the rate of substitution is fixed – and on the basis of our present knowledge of the economy, we have no way of knowing whether that fixed value is correct.

This raises a more general point that the model depends upon a variety of parameter values, many of which are unknown and cannot be determined from empirical data. Where possible, the projections deal with this through sensitivity analysis - varying these parameters and determining the impact of this variation on the results.

In order to apply the model, it is necessary to calibrate it so that its projections match the actual (known) values of relevant economic variables in some base period. In this case, 2002 is chosen as the base year, as it is the year of the most recent Social Accounting Matrix (SAM).

Investment and Capital Stock

The production function requires information regarding the capital stock (K) in order that output can be calculated; hence capital stock projections have to be made for the simulation period. This is a difficult task, although it can be achieved by projecting investment rates and making an assumption about depreciation. However, it is not accurate about the exact level of the capital stock that is essential, but modelling the impact of AIDS on the likely path of the capital stock (i.e., it is the *impact of AIDS on investment* that is important, rather than the absolute level of investment).

There are two main channels through which AIDS can impact on investment: availability of finance (savings), and investment intentions. Assessments of the economic impact of HIV/AIDS generally focus mainly on the first impact, i.e., reduced availability of savings. In this case we assume the following:

- investment is financed from a combination of domestic savings and foreign savings (the latter equivalent to the current account deficit of the balance of payments);
- domestic savings are equal to the difference between income and consumption;
- the additional expenditures related to HIV and AIDS will be financed by a reduction in domestic investment spending (this may not be entirely accurate, as some may be financed by reducing other consumption spending, but it illustrates the maximum potential impact of HIV/AIDS;
- the main impact of HIV/AIDS on household spending (and hence on savings) comes through additional expenditures related to healthcare (broadly interpreted, e.g. to include transport costs) and funerals (note that the income effect is taken care of at a macroeconomic level)
- the main impact on firms comes through additional spending on healthcare, sick-pay, recruitment etc.;
- the main impact on government comes from the additional healthcare spending required; in the with-ART scenario, this relates mainly to the costs of treatment, while in the no-ART this relates mainly to the costs of treating opportunistic infections and AIDS. In the with-ART scenario, it is assumed that 85% of the costs would be met by external donors, while in the non-ART scenario donors would only meet 70% of the (much lower) costs.

Details of the relevant calculations are given in Appendix 2 of this chapter. The overall conclusion is that there will be additional expenditure (relative to the no-AIDS scenario) as follows:

Table 6: Summary of Impact of HIV/AIDS on Expenditure (% of GDP)

	No ART			ART		
	Agric	**Non-agric**	**Total**	**Agric**	**Non-agric**	**Total**
Households	1.9%	1.1%	1.8%	1.3%	0.8%	1.2%
Firms	1.5%	1.2%	1.3%	1.0%	0.8%	0.9%
Government	0.3%	0.3%	0.3%	0.4%	0.4%	0.4%
Total	**3.7%**	**2.6%**	**3.4%**	**2.7%**	**2.0%**	**2.5%**

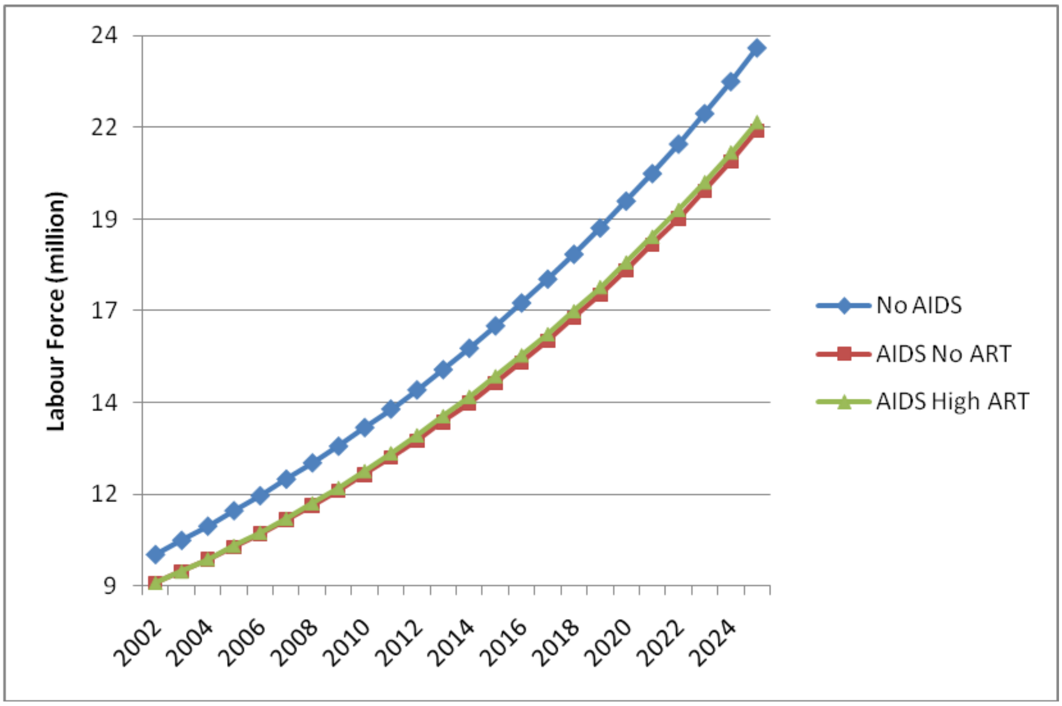
Impact of HIV/AIDS on the Labour Force

Size of the Labour Force

It is important to incorporate the impact of HIV/AIDS on the labour force (age 15-59), as this is one of the main channels through which the economic impact of HIV/AIDS occurs.

The demographic projections produced in Phase II of this project have been used to project the growth of the total labour force over the period to 2025. If we assume (for simplicity) that the labour force participation rate remains unchanged, then the growth of the labour force will be as shown in Figure 10. This shows that under both of the “with AIDS” scenarios, the labour force will be smaller in 2025 with AIDS than it would have been without AIDS. In the no-AIDS scenario the labour force in 2025 would total 25.8 million, whereas in the “AIDS-with-high ART” scenario it would total 24.6 million and in the “AIDS-without-ART” scenario it would only total 24.3 million. However, the growth of the labour force over the two decades between 2005 and 2025 is similar in each case, at around 113%, indicating that the main population losses were incurred prior to 2005 rather than going forward. The average age of the labour force is slightly younger in the with-AIDS scenarios.

Figure 10: Labour Force Projections



Labour Force Skill Classification

For the purposes of the model, the labour force is divided into skilled and unskilled categories. This is done in terms of occupational classifications, as below. The percentage distribution of the labour force across occupational categories is primarily derived from the Labour Force Report from the 2002/03 UNHS.

Table 7: Classification of Workers into Skilled and Unskilled, by Occupation

Occupation	% of labour force	Category
Legislators, managers, technical & professionals	4.1	Skilled non-agric
Clerical	0.6	Skilled non-agric
Sales & service	11.8	Unskilled non-agric
Skilled manual/plant & machine operators	6.6	Skilled non-agric
Unskilled manual/elementary occupations	7.0	Unskilled non-agric
Domestic service	0.9	Unskilled non-agric
Agricultural workers	69.5	Agriculture

Model Assumptions

Model Parameters

The model can now be used to derive equilibrium solutions for various time periods for the three scenarios (i.e. No-AIDS, AIDS-with-ART and AIDS-without-ART). The model is solved using the labour force and capital stock projections from 2002 (the base year) to 2025 under the three scenarios. This provides outcomes for wages and employment in each of the three labour markets, and real output (GDP) in the agricultural and non-agricultural sectors. Key results are presented in the accompanying graphs and tables.

The model allows key parameters to be varied. In many cases the true values of these parameters are not known, and hence a sensitivity analysis can be carried out to see which variables the model results are most sensitive to.

The following parameters can be changed:

Labour force HIV/AIDS prevalence rate (as percent of overall prevalence rate). This can be varied if there is reason to believe that the labour force has a higher or lower HIV prevalence rate than the general population in the same age cohorts.

Skilled labour force HIV/AIDS prevalence rate (as percent of overall labour force prevalence rate): this can be varied if there is reason to believe that there is a higher or lower HIV prevalence rate amongst skilled workers than amongst the labour force as a whole.

Growth rate of skilled and unskilled labour forces (relative to overall growth rate of labour force) this reflects the results of education and training and the evolution of the labour force;

Productivity loss of workers with AIDS (percent of worker-equivalent per year): workers with HIV and AIDS may be less productive than other workers, although the degree of reduced productivity will depend on many factors, including the stage of the disease, the type of treatment undertaken and its effectiveness.

Investment rate (Gross Fixed Capital Formation (GFCF), as a percent of GDP, with AIDS and without AIDS, for the total economy and for the agricultural sector). This is likely to vary between the no-AIDS and with-AIDS scenarios, as discussed further below.

Annual growth rate in total factor productivity (TFP), with and without AIDS. This is one of the most important potential impacts of HIV/AIDS. TFP refers to efficiency changes that are not attributable directly to either the capital or labour inputs to production, but to the manner in which they are combined in production. Arndt & Lewis (2000) identify four reasons why TFP growth rates are likely to decline as a result of HIV/AIDS: (i) the resources directed towards various aspects of the epidemic, which have an opportunity cost; (ii) the disruption to production from worker illness and absenteeism, resulting in some idling of capital equipment; (iii) higher transactions costs in enforcing contracts (for instance, HIV positive borrowers may have less incentive to repay debts); and (iv) the greater likelihood of illness and death amongst the workforce is likely to reduce the incentive to develop and implement process improvements. To these reasons may be added the negative impact of raised crime levels, and the resources devoted to associated counter-measures, that are likely in a society with a high level of HIV/AIDS and the alienation of some people from society as a whole.

Parameter Value Assumptions

Assumptions need to be made as to the numerical values of the above parameters in order to generate projections. The initial results are reported for a Base Case with “neutral” parameter assumptions that do not vary significantly across the three scenarios, in order to initially identify the economic impact of HIV/AIDS through the changes in the size of the labour force. The Base Case is not the most likely scenario, but rather a starting point for more complex simulations.

Productivity loss of workers with AIDS (percent of worker-equivalent per year): there are only a few empirical estimates of the negative labour productivity impact of AIDS, and most analyses try to make reasonable assumptions regarding this important parameter. Arndt & Lewis (2000, p.10) assume that “AIDS-afflicted workers are half a productive as remaining workers” (i.e. the fall in productivity is 50 percent), while BER (2006, p.50) assumes “a 40 percent reduction in the productivity of both skilled and unskilled workers who are sick with AIDS”. In both cases this refers to productivity in the case of the untreated disease, and only to workers who have reached the later stages of the disease (i.e. in WHO stages 4-6) and not those who are HIV positive but asymptomatic. In this study, we take the lower estimate (40 percent). Where ART is available, workers taking ART will be much healthier, but some will experience illness due to treatment lapses or adverse reaction to treatment, and time will also be lost due to the need to collect medication (at present this is done on a monthly basis, on according to some reports can take a whole day). Furthermore, even in the AIDS-with-ART scenario, some eligible adults will not enrol in the ART programme. In line with other authors, we assume that the productivity impact of being on ART is equal to 25 percent of that associated with untreated HIV/AIDS. These factors combined make the average productivity loss in the AIDS-with-ART scenario equal to 15 percent.

Productivity estimates: formal estimates of total factor productivity growth for Uganda were not available. We therefore took an estimate of 1.0% a year TFP growth in the no-AIDS scenario for the non-agricultural sector, a figure that would be typical of a reasonably fast-growing developing country. In the agricultural sector, TFP growth was assumed to be half of this level, at 0.5% a year.

We take continued productivity growth at this rate as the base case across the three scenarios (this will be varied in the alternative case below).

Gross fixed investment was set at 28 percent of GDP in the non-agricultural sector, and in the agricultural sector at 10 percent of income.

Skilled labour force growth: continued investment in education and training is likely to result in faster growth of the skilled labour cohort of the labour force, and a rising proportion of skilled workers in the labour force. It is assumed that the skilled cohort grows on average 0.75 percent a year faster than the unskilled component. This would result in the skilled proportion of the labour force rising by around 20 percent (from the current level of 11 percent to around 13 percent) over a twenty year period.

The parameter values used in the Base Case scenarios are summarised in the table below:

Table 8: Base Case Parameters

Parameter	No AIDS	AIDS – with ART	AIDS – No ART
Labour force HIV/AIDS prevalence rate (as % of overall prevalence rate)		100%	100%
Skilled labour force HIV/AIDS prevalence rate (as % of overall LF prevalence rate).		100%	100%
Growth rate of skilled labour force (relative to overall growth rate of unskilled labour force).	0.75%	0.75%	0.75%
Productivity loss of workers with AIDS (% of worker-equivalent per year).		15%	40%
Investment rate non-agricultural sector (% of GDP)	28%	28%	28%
Investment rate – agricultural sector (% of income)	10%	10%	10%
Annual growth rate in total factor productivity (TFP), with and without AIDS, in the non-agricultural sector	1.0%	1.0%	1.0%
Annual growth rate in total factor productivity (TFP), with and without AIDS, in the non-agricultural sector	0.5%	0.5%	0.5%

The results under the Base Case scenario are laid below (see Figure 11 - Figure 13).

3. Model Results

Base Case - No AIDS

Output: GDP grows at an average annual rate of 6.5 percent between 2005 and 2025. With population growth averaging 3.7 percent a year, however, GDP per capita grows more slowly than GDP, at 2.7 percent a year. Economic growth in the non-agricultural sector (7.1 percent p.a.) is faster than in the agricultural sector, which grows on average by 3.9 percent a year.

Labour Market: relatively fast economic growth and increasing demand for labour in the non-agricultural sector pushes up real skilled wages slightly (2.3 percent a year). Increased availability of skilled labour causes overall employment in the non-agricultural sector to increase faster (4.7 percent a year) than the growth of the labour force (3.9 percent a year), and hence employment in the agricultural sector declines as a proportion of the labour force (indicating falling un-/under-employment). Average real wages rise by 2.1 percent a year.

Figure 11: Base Case - Real GDP

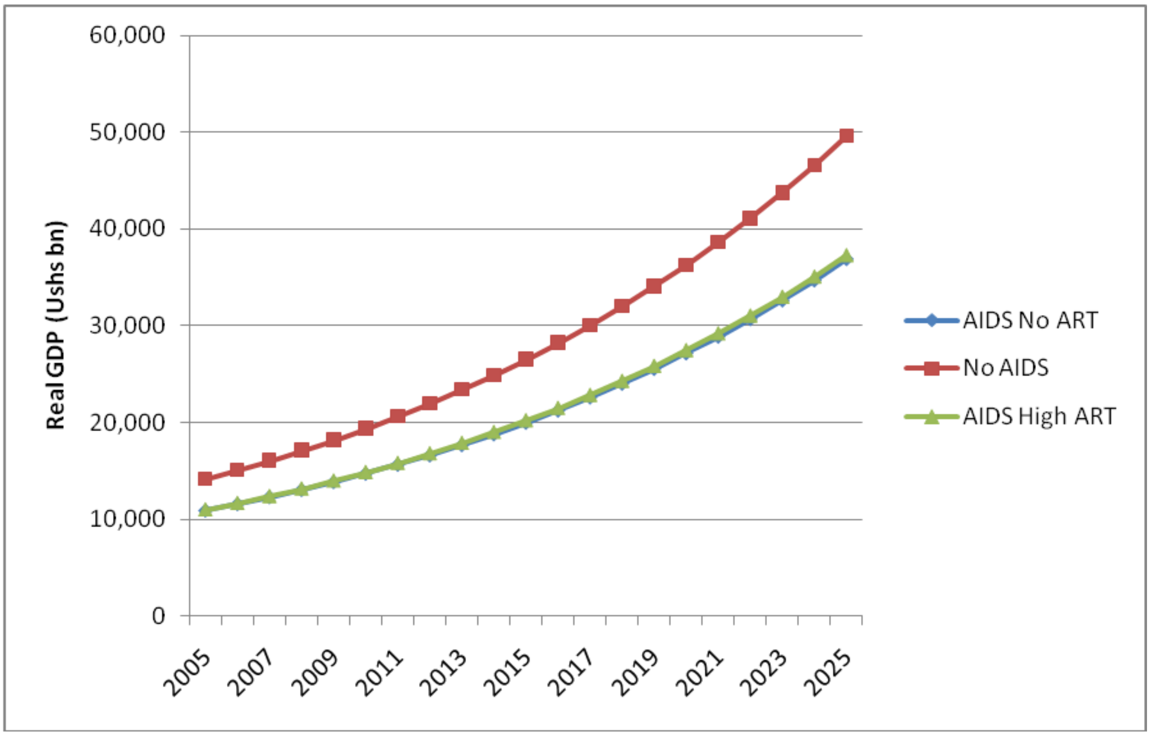
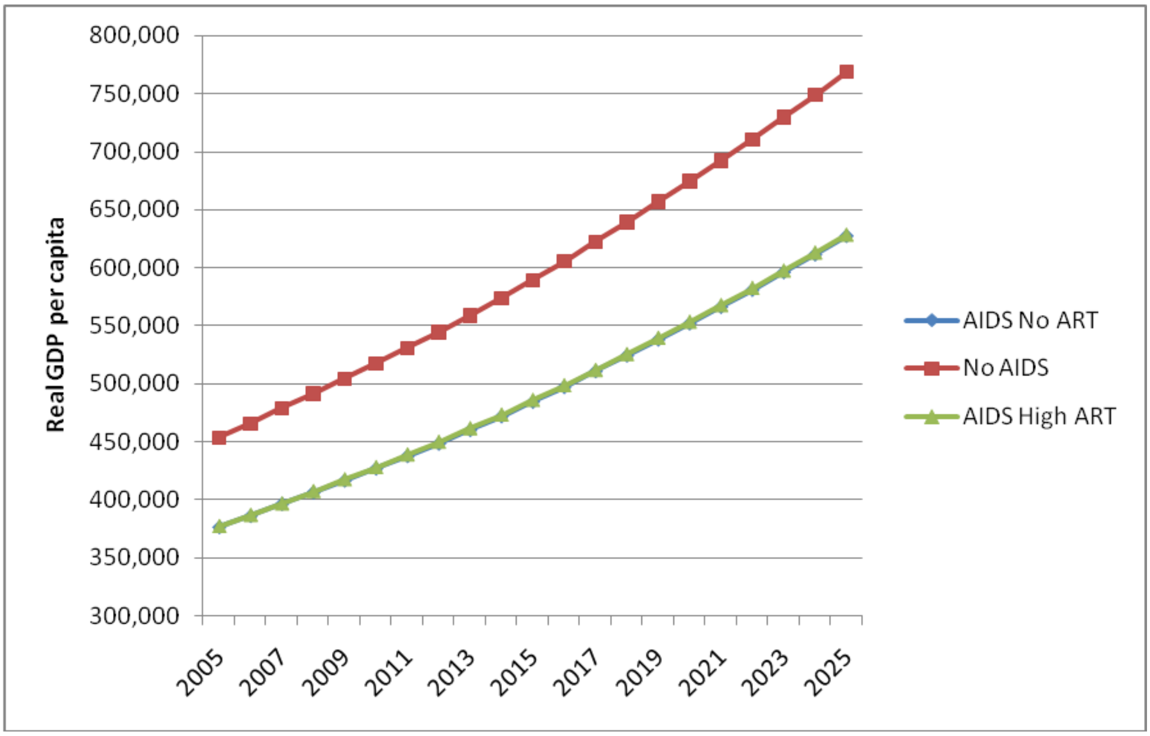


Figure 12:Base Case - Real GDP per Capita



Base Case - AIDS without ART

Output: average GDP growth is lower with AIDS, at 6.3 percent - this is to be expected, given the slower growth rate of the labour force. Average GDP per capita growth is also slightly lower, at 2.6 percent a year. The lower rate of GDP growth means that in 2025, GDP is 25.6 percent smaller with AIDS than it would have been without AIDS, while the population is 8.7 percent smaller, and as a result GDP per capita is 18.4 percent lower. However, most of the deficit is incurred prior to 2005, as GDP is already 22.7% smaller by that year than it would have been without HIV/AIDS.

Figure 13:Base Case - Real GDP Growth

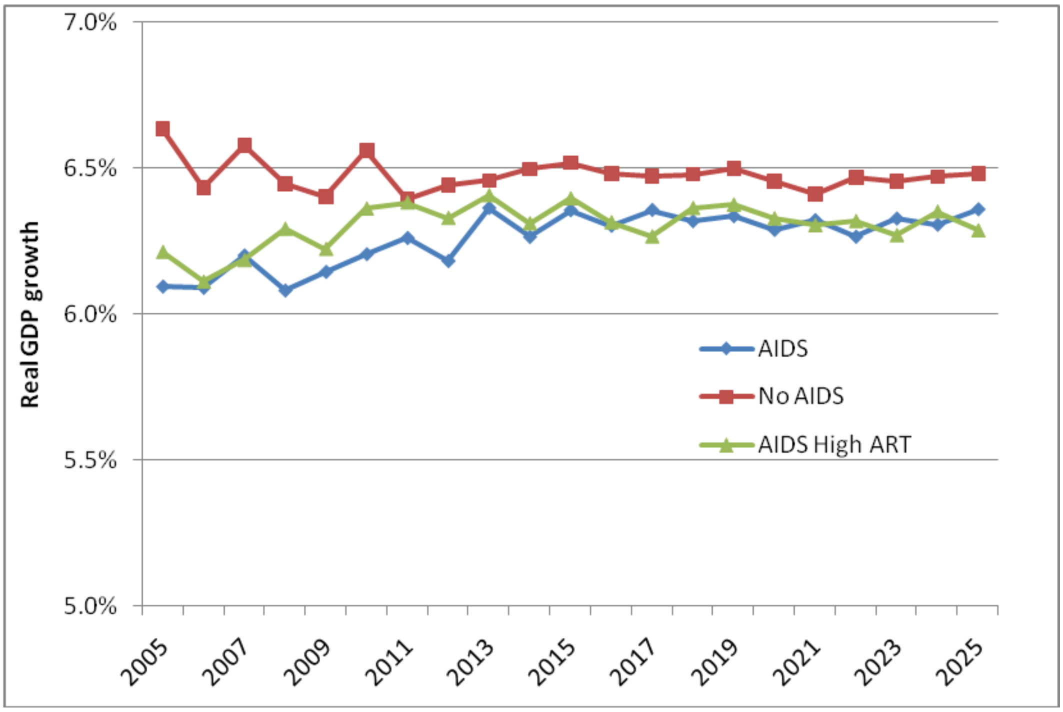
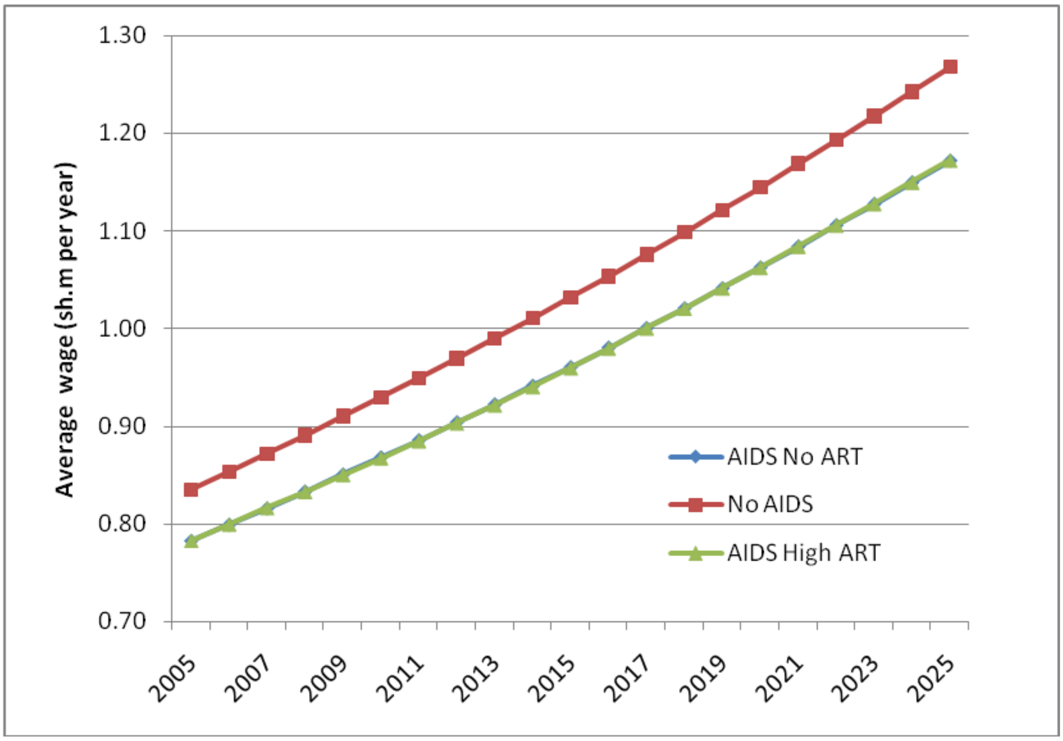


Figure 14: Base Case – Average Wage



Labour Market: given the lower rate of labour force growth with AIDS, non-agricultural sector employment only grows at 5.5 percent a year. The impact of HIV/AIDS on population growth and the labour force intensifies supply-side pressure in the labour market, although this is offset by reduced demand growth. Overall, the influence of reduced demand dominates, so the non-agricultural sector employs less labour in the AIDS-without-ART scenario, and agricultural employment grows faster. As a result, average wages grow more slowly in this scenario.

Base Case - AIDS with ART

Output: average GDP growth is lower than in the "without-AIDS" scenario, at 6.3 percent, but marginally higher than in the "AIDS-without-ART" scenario. This largely reflects the positive impact the size of the labour force of providing ART. Although GDP growth is higher, population growth is also higher, and hence GDP per capita is no higher under the "with-ART" scenario than under the "without-ART" scenario. The lower rate of GDP growth means that in 2025, GDP is 24.8 percent smaller with AIDS and ART than it would have been without AIDS, while the population is 8.0 percent smaller, and as a result GDP per capita is 18.3 percent lower.

Labour Market: employment trends are similar to those under the "without ART" scenario; non-agricultural sector employment grows faster than the labour force, and hence the size of the agricultural sector declines, but not as fast as under the "No AIDS" scenario. Wage levels are similar with and without ART.

The Base Case scenarios indicate that HIV/AIDS, through its impact on population and the labour force, will reduce economic growth and per capita incomes; furthermore, real wages would be lower, and employment in the non-agricultural sector lower, with AIDS. ART raises the economic growth rate somewhat compared to the no-ART scenario, but not by much.

Alternative Case – Full Impact

As noted above, the Base Case identifies the fundamental impact of HIV/AIDS on the economy through changes in the size of the labour force, and some of the negative productivity impact of HIV/AIDS. However, it does not include a number of likely effects that will change, and perhaps exacerbate, the negative economic impact of HIV/AIDS. These are considered in the Alternative Case scenario below, reflecting the following effects.

Variations in HIV/AIDS prevalence across skill categories: the results of national sero-prevalence survey indicate that HIV prevalence varies across different categories of the population. First, HIV prevalence is higher for employed adults than for non-working adults. This indicates that HIV prevalence in the labour force is 17% higher than in the adult population as a whole. Second, HIV prevalence varies by level of wealth. If we use wealth as a proxy for skill levels, and take the upper two wealth quintiles as representing skilled workers, and the lower three quintiles for unskilled workers, then the HIV prevalence rate of skilled workers is 19% higher than in the labour force as a whole.

Investment rates: the Base Case assumes that gross investment rates are unaffected by HIV/AIDS; as discussed earlier, however, this is unlikely. The costs associated with HIV/AIDS are likely to reduce investment by causing diversion of expenditure. The additional expenditures associated with HIV for households, firms and government are shown in Table 6 above. These expenditures could be met by reducing investment, or other consumption spending, or a combination of both. The largest impact on growth will be felt if HIV/AIDS-related spending is financed by reducing other investment, and that is what is modelled here. It is hypothesised that additional expenditures (and the consequent reduction in investment) are larger in the case of the agricultural sector (as additional household expenditures are higher in the rural areas) and furthermore that additional expenditures are lower when ART is provided (because people are healthier and donors meet a greater proportion of the costs).

The hypothesised investment rates are:

Table 9: Investment Rates

Non-agric sector, % GDP	
No AIDS	28.0%
AIDS ART	26.0%
AIDS No ART	25.4%
Agric. sector, % income	
No AIDS	10.0%
AIDS ART	7.3%
AIDS No ART	6.3%

Impact on productivity (TFP) growth: as noted earlier, various studies suggest that overall productivity growth is likely to be negatively affected by HIV/AIDS, although much more in the case of no-ART than in the with-ART case. Arndt & Lewis (2000) assume that South African TFP growth will be halved in the with-AIDS (and without ART) scenario relative to the no-AIDS scenario. BER (2006) assume that TFP growth is reduced by a slightly smaller amount, by 37 percent in the AIDS-without-ART scenario and 31 percent in the AIDS-with-ART scenario. In this study, we use a 20 percent reduction in TFP growth in the AIDS-without-ART scenario (given that HIV prevalence is lower in Uganda than in South Africa), and a 10 percent reduction in TFP growth in the AIDS-with-ART scenario.

Impact on Skilled Labour Force Growth: the impact of HIV/AIDS on skilled labour is difficult to predict; certainly the existing shortage of skilled labour will be intensified, and public sector resources available for investment in education and training may be constrained. In the private sector, reduced life expectancy and higher absenteeism will reduce the returns to training and hence discourage firm-specific investment in human capital. Furthermore, the higher HIV prevalence rate for skilled labour will tend to reduce the growth rate of skilled labour. On balance, we assume lower growth rates of the skilled labour force in the two with-AIDS scenarios, at 0.5 percent with-ART and 0.25 percent without-ART, compared to 0.75 percent in the Base Case.

The combination of these changes to key parameters is summarised in the table below:

Table 10: Alternative Case Parameters

Parameter	No AIDS	AIDS – with ART	AIDS – No ART
Labour force HIV/AIDS prevalence rate (as % of overall prevalence rate)		117%	117%
Skilled labour force HIV/AIDS prevalence rate (as percent of overall LF prevalence rate).		119%	119%
Growth rate of skilled and unskilled labour forces (relative to overall growth rate of labour force).	0.75%	0.5%	0.25%
Productivity loss of workers with AIDS (percent of worker-equivalent per year).		15%	40%
Investment rate non-agricultural sector (percent of GDP)	28.0%	26.0%	25.4%
Investment rate – agricultural sector (percent of income)	10.0%	7.3%	6.3%

Annual growth rate in total factor productivity (TFP).	1.0%	0.9%	0.8%

The results of this scenario are as follows (see Figure 15 -Figure 17). When there is No AIDS, the results are the same as in the Base Case, above.

Alternative Case - AIDS without ART

Output: average GDP growth is significantly lower with AIDS, at 5.3 percent. This is due to the lower growth rate of the labour force, reduced investment, and reduced productivity growth. Average GDP per capita growth is also lower, at 1.7 percent a year. The lower rate of GDP growth means that in 2025, GDP is 38.7 percent smaller with AIDS and without ART than it would have been without AIDS, while the population is 8.8 percent smaller, and as a result GDP per capita is 32.8 percent lower. Most of this negative impact has already been incurred however, and the impact of HIV/AIDS is smaller between 2005 and 2025 than it was prior to 2005.

Labour Market: given the lower rate of labour force growth with AIDS, non-agricultural sector employment only grows at 4.6 percent a year. This is, however, only marginally faster than labour force growth, and hence the non-agricultural sector only grows slightly in size (in relative terms). The agricultural sector stays much larger – accounting for 68% of the labour force - than it would have been without HIV/AIDS (59%). This reflects lower investment and lower employment growth in the non-agricultural sector, forcing more people to remain in agriculture. Wage growth is also slower.

Figure 15: Alternative Case - Real GDP

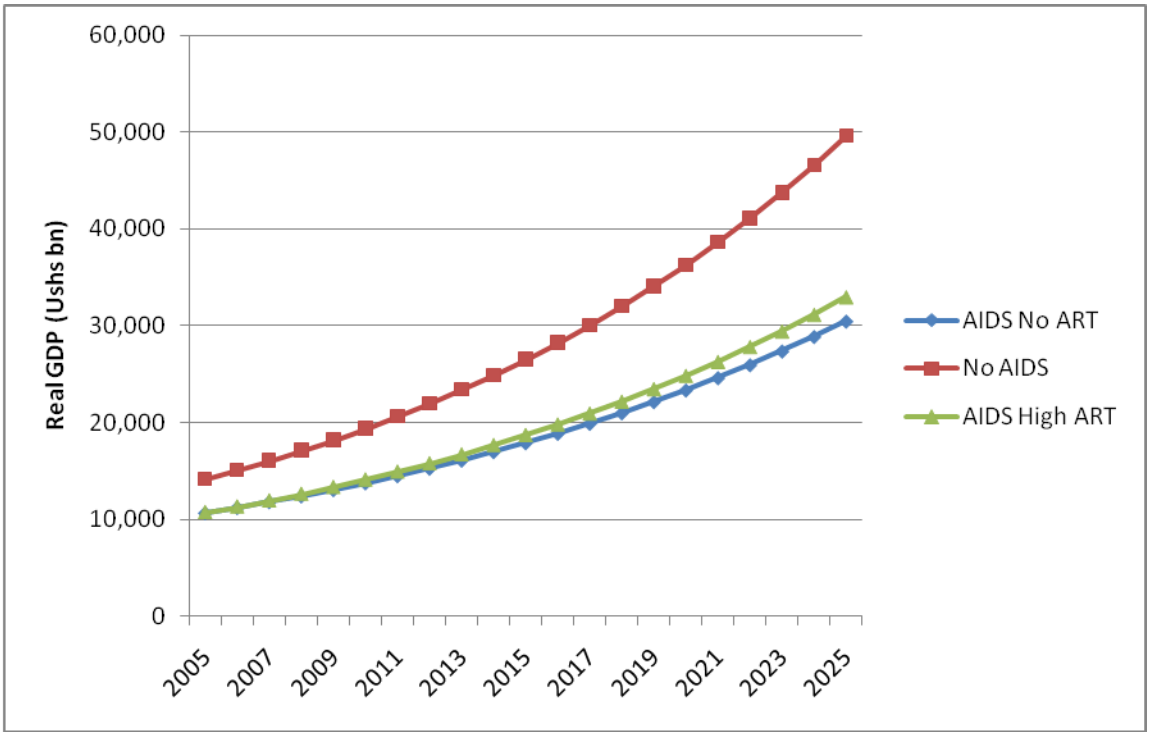


Figure 16:Alternative Case - Real GDP per capita

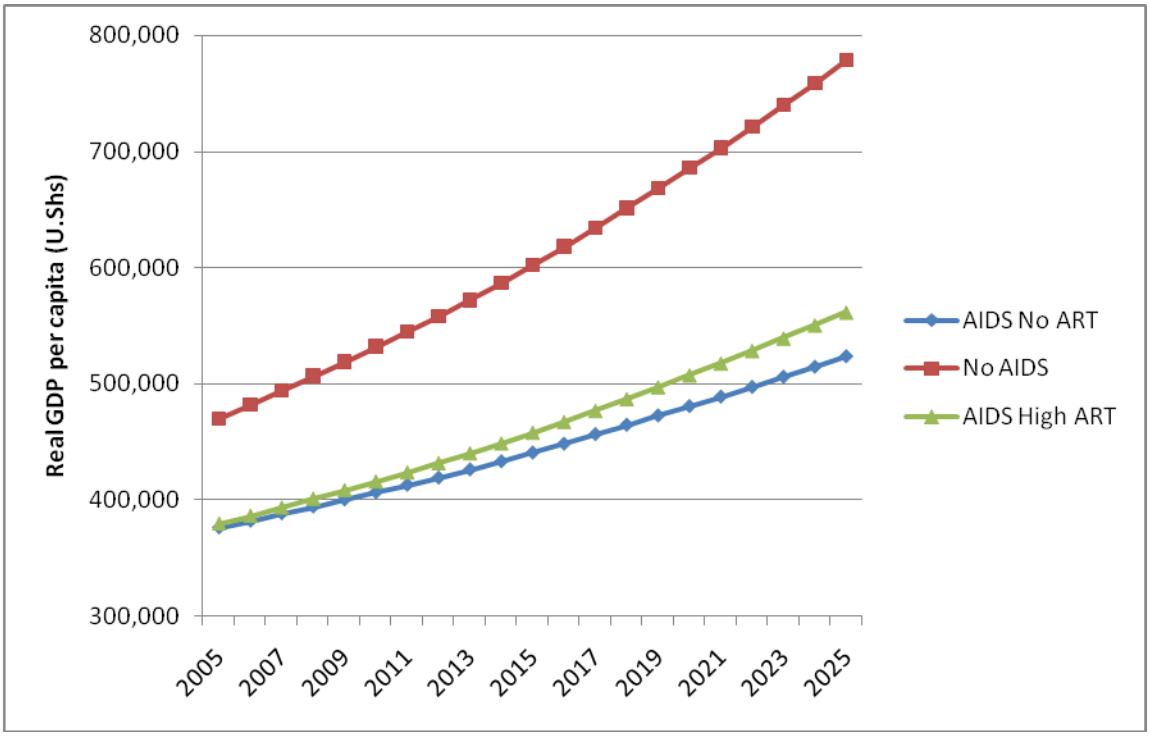


Figure 17: Alternative Case - Real GDP Growth

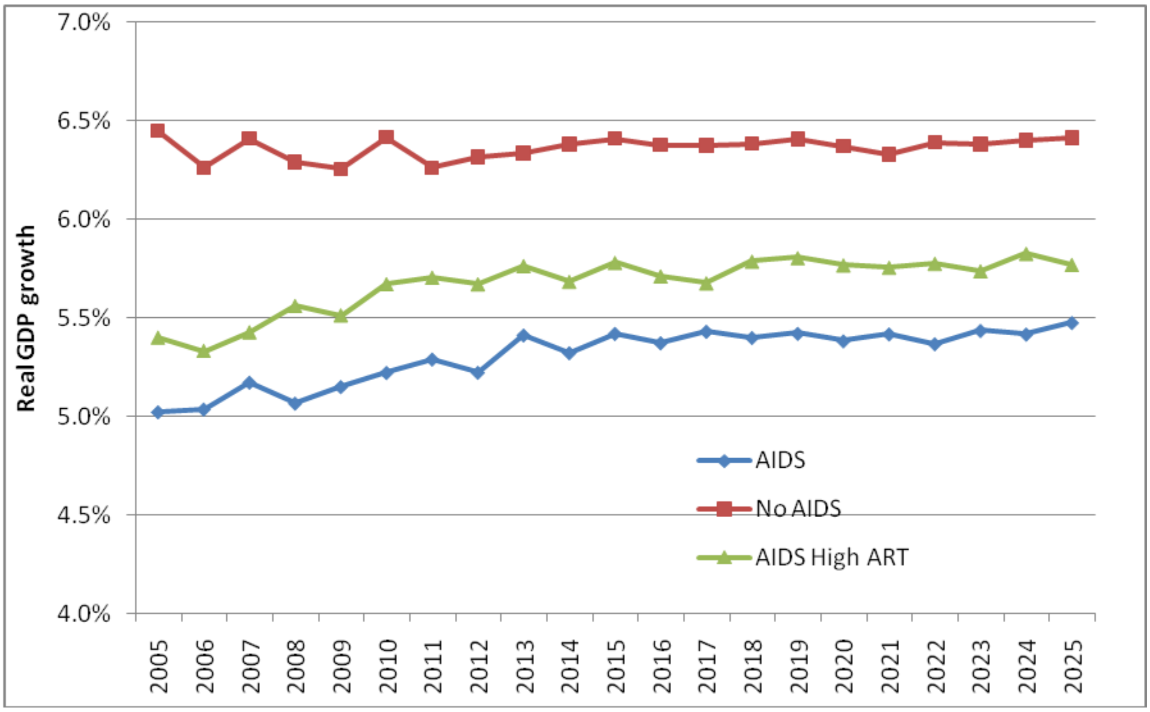
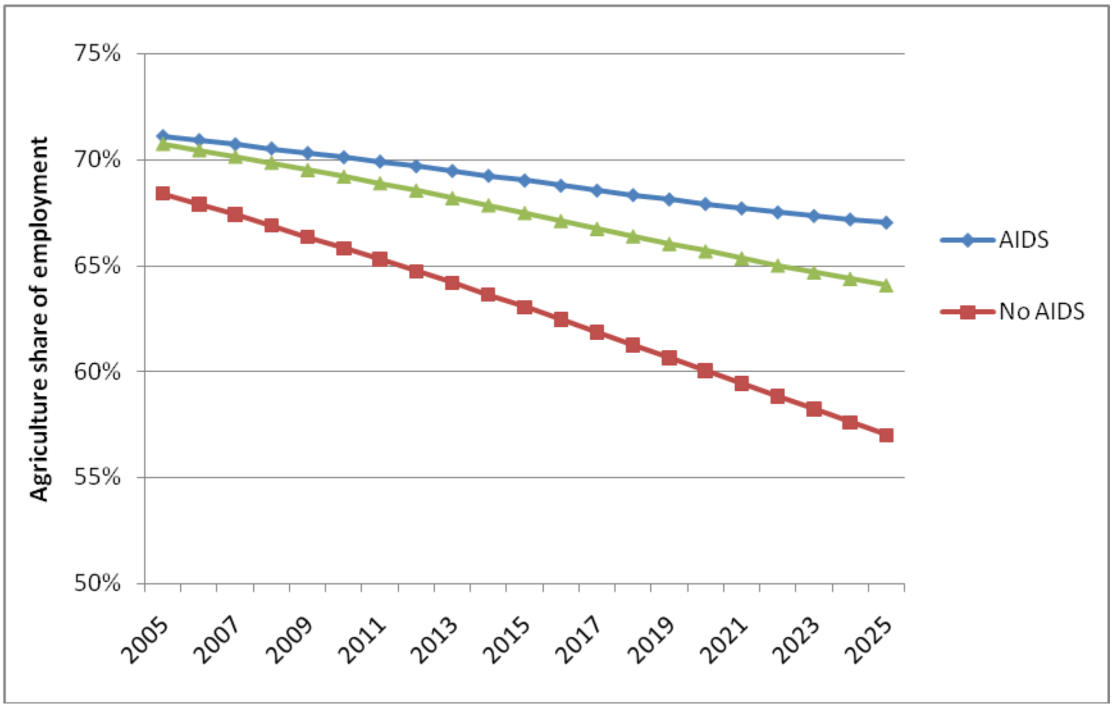


Figure 18: Alternative Case – Agriculture Share of Employment



AIDS-with-ART

Output: average GDP growth is lower than in the "without-AIDS" scenario, at 5.7 percent, but higher than in the "AIDS-without-ART" scenario. This largely reflects the positive impacts of providing ART on the size of the labour force, productivity and investment. Although GDP growth is higher, population growth is also higher; nevertheless, GDP per capita is higher under the "with-ART" scenario than under the "without-ART" scenario. The lower rate of GDP growth means that in 2025, GDP is 32.8 percent smaller with AIDS and ART than it would have been without AIDS, while the population is 8.0 percent smaller, and as a result GDP per capita is 26.9 percent lower.

Labour Market: employment trends are more favourable than those under the "without ART" scenario; non-agricultural sector employment grows faster and the size of the agricultural sector is smaller. Overall real wages grow by 1.5 percent a year, but are lower than under the "No-AIDS" scenario (reflecting reduced investment and productivity growth); however, they are higher than under the "without-ART" scenario, despite the more severe shortage of skilled labour under that scenario.

Capital-Labour Ratios: there are different trends in the capital-intensity of the economy in the no-AIDS and the two with-AIDS scenarios. In the former, capital stock grows much faster than the labour force and hence the capital-labour ratio (combined across the non-agricultural and agricultural sectors) is grows steadily over the period as a whole. In the two with-AIDS scenarios, however, capital stock rises more slowly, because of lower investment rates, and hence the capital-labour ratio rises only slowly. Relative to the no-AIDS scenario, the economy is more labour intensive in the with-AIDS scenarios. This illustrates one of the core economic problems arising from HIV/AIDS: due to slower labour force growth, overall economic growth rates can only be maintained if investment rises (hence more capital and a higher K/L ratio would compensate for fewer workers); but if investment falls, as appears likely, the lower growth arising from slower labour force growth is compounded by reduced investment (as well as reduced productivity growth).

This scenario indicates that HIV/AIDS, through its impact on investment and productivity, as well as on population and the labour force, has reduced economic growth significantly, and will also reduce per capita incomes relative to the no-AIDS scenario. Both real wages and non-agricultural employment would be lower, with AIDS. However, ART raises the economic growth rate and per capita incomes somewhat compared to the no-ART scenario.

Summary of Macroeconomic Results

We can summarise these results as follows:

- AIDS will have a negative impact on the rate of economic growth in Uganda; if investment is strongly negatively affected, the rate of GDP growth will fall from a projected 6.5 percent a year without AIDS to an estimated 5.8 percent under the "AIDS-with-ART" scenario, and by 2025 the economy will be 33 percent smaller than it would have been without AIDS;
- however, most of the negative economic impact of HIV/AIDS has already been incurred – of the 33 percent reduction in the size of the economy due to HIV/AIDS, the majority of this had been incurred prior to 2005;
- the impact on the growth of average real incomes (per capita GDP) is also negative, if investment is strongly affected, averaging 2.0 percent a year under the "AIDS-with-ART" scenario, compared to 2.7 percent a year without AIDS, and would be 27 percent lower by 2025 (this contrasts with the results of some other studies, which found that GDP per capita could plausibly rise as a result of HIV/AIDS, on the basis that the reduction in GDP growth could be smaller than the reduction in population growth);
- due to the sharp drop in investment (and hence weak demand for labour), wage growth is slower;
- the economy remains more agricultural as a result of HIV/AIDS; without AIDS, the agricultural sector would have accounted for 16 percent of GDP and 59 percent of employment in 2025, whereas under the AIDS-with-ART scenario, it accounts for 20 percent of GDP and 66 percent of employment at that time; this is because the reduced investment due to HIV/AIDS and lower economic growth and demand for labour in the non-agricultural sector as a result of HIV/AIDS forcers more people to remain in the agricultural sector;

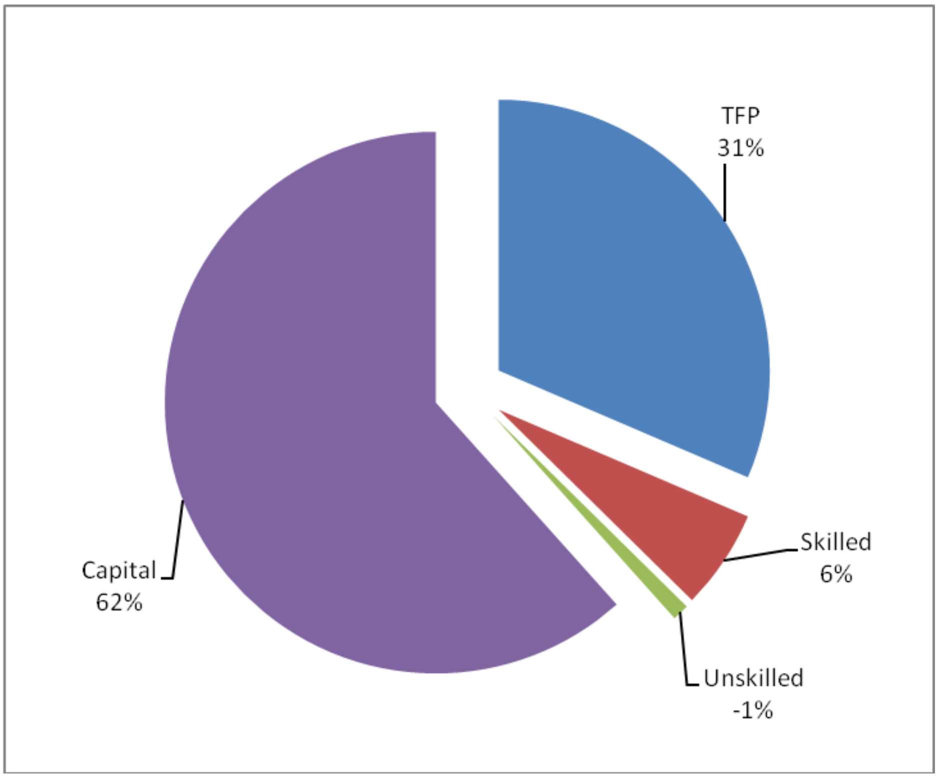
It is important to note that although both GDP and average income growth rates may fall as a result of AIDS, *they both remain positive*. In other words, in the scenarios chosen here, neither GDP nor average incomes will be lower in 2025 years than they are now - they may simply be lower than they would have been without AIDS.

Although all of the with-AIDS scenarios are less favourable than the without-AIDS scenario, the widespread provision of ART has a number of positive economic impacts (compared to the AIDS-without-ART scenario); in particular:

- economic growth is higher (averaging 5.7% rather than 5.3%);
- real per capita GDP growth is higher (averaging 2.0% rather than 1.7%)
- economic activity and employment is shifted towards the (more productive) non-agricultural sector
- average wages in the non-agricultural sector are higher

The reduction in growth in the non-agricultural sector as a result of HIV/AIDS can be decomposed into its various components, as in Figure 19 (which shows the with-ART case). The greatest impact is from reduced capital stock, which contributes 62 percent of the fall in growth, with reduced productivity (TFP) growth contributing 31 percent, reduced supply of skilled labour 6 percent, and reduced supply of unskilled labour 1 percent.

Figure 19: Contributions to GDP Growth (No AIDS vs. AIDS with ART)



In general, the results are highly sensitive to all three key parameters: the investment rate (reflecting the high productivity of capital in a capital-scarce economy); the rate of productivity growth (reflecting this as the key determinant of long-term economic growth rates); and the growth rate of the skilled labour force (reflecting this key binding constraint in the economy). Reductions in the investment rate and the productivity growth rate are likely; in the simulation they account for almost all of the reduction in economic growth, and more generally it is here that the greatest danger of a very adverse economic impact from HIV/AIDS lies.

Table 11: Macroeconomic Model Results Summary

	No AIDS		AIDS baseline		AIDS Full Impact		AIDS ART	
	2025	Avg. Growth 2002-2025	2025	Avg. Growth 2002-2025	2025	Avg. Growth 2002-2025	2025	Avg. Growth 2002-2025
Economy								
Real GDP (factor cost, Ushs bn)	49,558	6.5%	36,873	6.3%	30,772	5.3%	33,311	5.7%
Real GDP/capita	768,347	2.7%	626,877	2.6%	523,155	1.7%	561,642	2.0%
Population	64.50	3.7%	58.82	3.6%	58.82	3.6%	59.31	3.6%
Average wage	1.27	2.1%	1.17	2.0%	1.00	1.2%	1.06	1.5%
Non-agricultural sector								
Real GDP (factor cost, Ushs bn)	41,864	7.1%	30,086	7.0%	24,168	5.8%	26,900	6.3%
Skilled employment	2.90	4.7%	2.60	4.8%	2.31	4.3%	2.48	4.6%
Skilled wage	5.15	2.3%	4.67	2.0%	4.27	1.4%	4.41	1.6%
Unskilled employment	6.65	6.0%	5.41	5.9%	4.39	4.7%	4.87	5.2%
Unskilled wage	0.89	1.0%	0.89	1.0%	0.89	1.0%	0.89	1.0%
Total employment	9.55	5.6%	8.00	5.5%	6.70	4.6%	7.34	5.0%
Average wage	2.18	1.4%	2.12	1.4%	2.05	1.1%	2.08	1.2%
Agricultural Sector								
GDP	7,694	3.9%	6,787	4.0%	6,604	4.0%	6,411	3.9%
Employment	13.59	2.9%	12.82	3.0%	14.23	3.5%	13.72	3.4%
Income	0.57	1.0%	0.53	1.0%	0.46	0.5%	0.47	0.5%
% GDP	15.5%		18.4%		21.5%		19.2%	
% labour force	58.7%		61.6%		68.0%		65.1%	

Appendix 1: Model Specification

Introduction

The overall model consists of the following:

- three labour supply functions (skilled, unskilled non-agricultural, unskilled agricultural)
- three labour demand functions
- a capital stock supply function
- two aggregate production functions

Before we can solve the model we need to establish the exact form of these functions. Below we deal with (i) production functions; (i) labour supply functions; (iii) labour demand functions, and (iv) capital stock supply functions.

Production Function: Non-agricultural Sector

We assume that the production of aggregate output in the non-agricultural sector, *Yf*, can be represented by a Cobb-Douglas production function with constant returns to scale. There are three factors of production, skilled labour, unskilled labour, and capital.

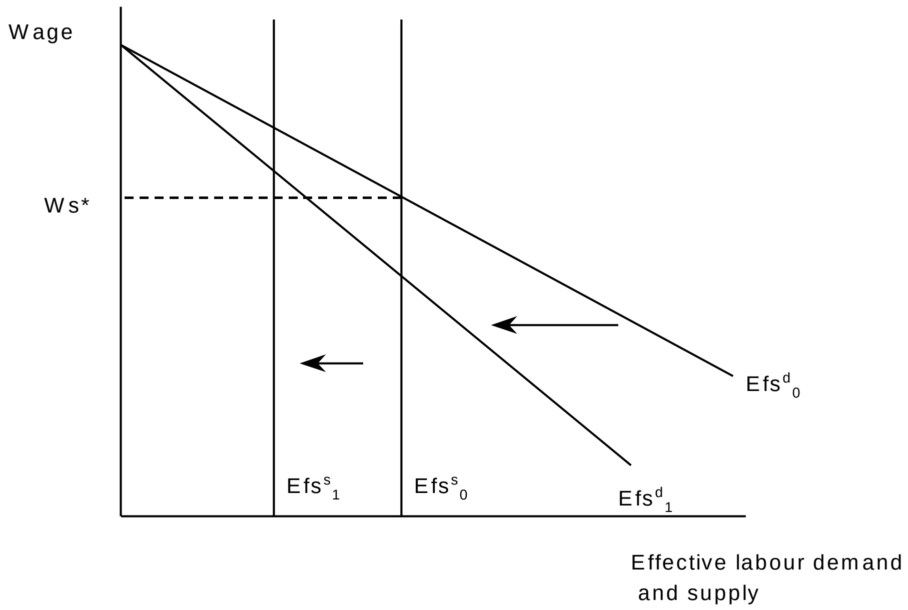
$$Yf_t = \alpha f . \gamma f^{\,t} Lfs_t^{\beta_s} Lfu_t^{\beta_u} Kf^{\,\rho f} \qquad [2.]$$

Where *Lfs* and *Lfu* represent effective labour supplies of skilled and unskilled labour respectively, and *Kf* is the capital stock. The shares of output attributable to each factor are β_s, β_u, and ρf=1-β_s-β_u. γf^t represents an exogenous technological trend, while the constant αf is a scale factor which is used to calibrate the model in the base year (2002), so that it fits the actual data from that year.

Labour Allocation

In this model it is assumed that the market for skilled labour clears, that is, the skilled wage adjusts so as to equate supply and demand (see Figure A20). The market for unskilled labour in the non-agricultural sector is different, however, and is characterised by the existence of a sticky wage that may lie above the market-clearing level (for unskilled labour); hence the non-agricultural sector unskilled labour market does not necessarily clear. In this case, unemployment (or underemployment) may result. In Figure A21, the "sticky" wage is set at Wfu_{min}, which is above the market-clearing level *Wfu**. Non-agricultural sector demand for unskilled labour at Wfu_{min} ($Efu^d{}_0$) is less than labour supply ($Efu^s{}_0$), leaving excess labour supply of Uf_0 (=Efu^s-Efu^d).

Figure A20: Skilled Labour, Non-agricultural sector



Rather than this excess labour supply resulting in unemployment, it is assumed that unskilled workers who cannot find employment in the non-agricultural sector turn instead to the agricultural; these workers may be considered to be under-employed, rather than unemployed. The supply of (unskilled) workers in the agricultural sector (Eiu^s_0) is therefore equal to unemployment in the non-agricultural sector (Uf_0). Wages (or income) in the agricultural sector adjusts to clear the agricultural sector labour market (see Figure A22) at Wi^*_0.

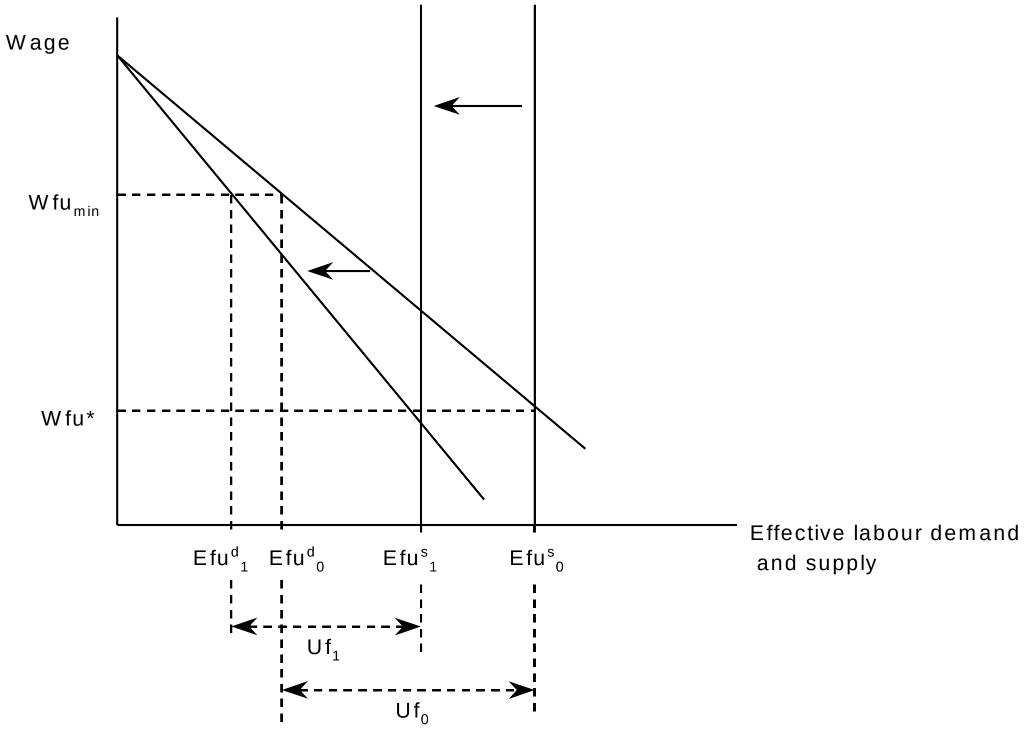
Agricultural Sector

The aggregate output of the agricultural sector (*Yi*) is modelled in the same way as the non-agricultural sector, but as skilled labour is not an input, there are only two factors of production (unskilled labour, *Eiu*, and capital, *Ki*):

$$Yi_t = \alpha i.\gamma i^t Eiu_t^{\beta_i} Ki_t^{(1-\beta i)} \quad [3.]$$

In the agricultural sector we assume that all enterprises are owner-operated, and we therefore include both returns to capital and labour in income; average income is therefore equal to output divided by employment.

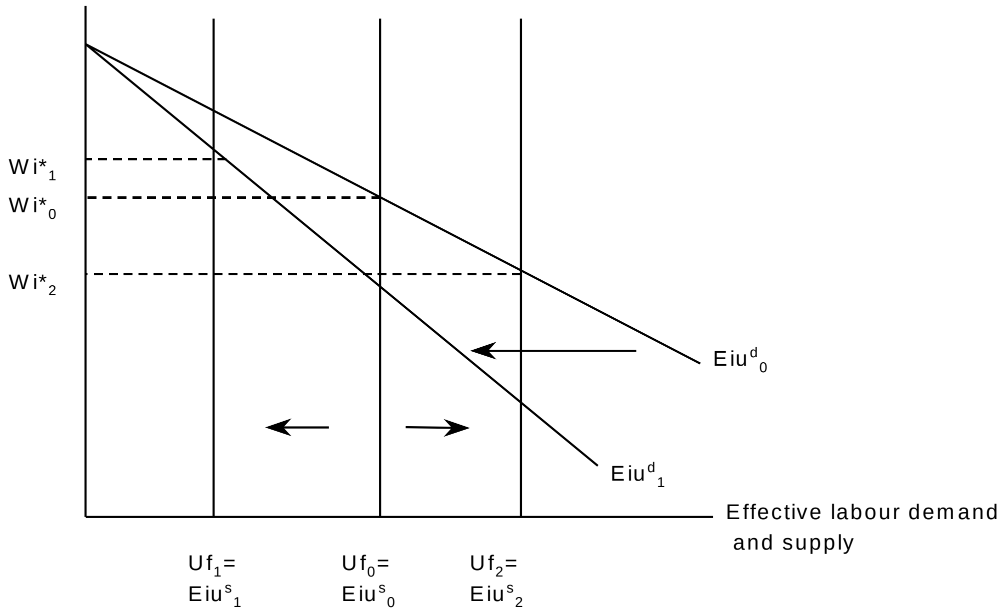
Figure A21: Unskilled Labour Non-agricultural Sector



Labour Supply Functions

It is assumed that in any time period the supply of skilled and unskilled labour is fixed. The overall supply of unskilled labour is divided between the agricultural and non-agricultural sectors, with the supply of unskilled labour in the agricultural sector depending upon the level of the non-agricultural sector sticky wage and hence the level of excess labour supply in the non-agricultural sector. Therefore, all labour supply functions are represented by the vertical schedules in Figure A20 - Figure A22.

Figure A22: Unskilled Labour, Agricultural Sector



Labour Demand Functions

The labour demand functions for the non-agricultural sector can be derived from the aggregate production function. The labour demand function for skilled labour is as follows:

$$Lfs^d = \phi fs.Kf \qquad \text{where :} \qquad \phi fs = (\alpha f.\gamma f^t)^{\frac{1}{1-\rho}} . \left(\frac{\beta_s}{wf_s}\right)^{1+\frac{\beta_s}{1-\rho}} . \left(\frac{\beta_u}{wf_u}\right)^{\frac{\beta_u}{1-\rho}} \qquad [4.]$$

A similar demand function can be derived for unskilled labour in the non-agricultural sector:

$$Lfu^d = \phi fu.Kf \qquad \text{where :} \qquad \phi fu = (\alpha f.\gamma f^t)^{\frac{1}{1-\rho}} . \left(\frac{\beta_u}{wf_u}\right)^{1+\frac{\beta_u}{1-\rho}} . \left(\frac{\beta_s}{wf_s}\right)^{\frac{\beta_s}{1-\rho}} \qquad [5.]$$

Labour demand for both skilled and unskilled labour is therefore an increasing function of capital stock and a decreasing function of the wage rates for both categories of labour.

Capital Stock

It is assumed that in each time period, both the supply of the capital stock and its price is fixed. Hence:

$$K_t = \overline{K}_t$$

In the longer term, the supply of capital is determined by a simple investment function, where gross fixed capital formation is a specified percentage of GDP. This percentage is dependent upon the availability of savings, and will change if other expenditure commitments affect the savings rate. Depreciation is a fixed proportion of fixed capital stock, and hence net fixed capital formation can be generated to provide a capital stock series. The same principle is applied to derive capital stock series for the agricultural and non- agricultural sectors, although with a lower investment rate in the agricultural sector.

Labour Market Equilibrium

Recall that in the skilled labour market, the wage level (*Wfs**) adjusts to ensure equilibrium between demand and supply (see Figure A20). The equilibrium level of the skilled non-agricultural sector wage can be solved as follows:

$$Lfs^{s} = Lfs^{d} = \overline{Lfs} \qquad [6.]$$

$$\overline{Lfs} = \phi fs.Kf = (\alpha f.\gamma f^{t})^{\frac{1}{1-\rho}}.\left(\frac{\beta_s}{wf_s}\right)^{1+\frac{\beta_s}{1-\rho}}.\left(\frac{\beta_u}{wf_u}\right)^{\frac{\beta_u}{1-\rho}} Kf \qquad [7.]$$

$$Wfs = \frac{\beta_s}{\left(\dfrac{Lfs}{\overline{Kf}.(\alpha f.\gamma f^{t})^{\frac{1}{1-\rho}}.\left(\dfrac{\beta_u}{Wuf}\right)^{\frac{\beta_u}{1-\rho}}}\right)^{\frac{1}{1+\frac{\beta_s}{1-\rho}}}} \qquad [8.]$$

Therefore, the equilibrium skilled wage (*Wsf*) is a function of the capital stock (*Kf*), the skilled labour supply (*Lfs*), and the unskilled wage (*Wuf*) and can be calculated for any point in time as long as the values of these variables are known. This is therefore straightforward as all of these values are exogenous.

In the unskilled labour market, the wage is fixed (at Wfu_{min}). Labour demand at Wfu_{min} does not equal labour supply, and hence there is unemployment. This level of unemployment (which equals the supply of labour to the agricultural sector) can be calculated as follows:

$$Uf = Efu^{s} - Efu^{d}(Wfu_{\min}) \qquad [9.]$$

In the agricultural sector, wages adjust to achieve equilibrium, hence:

$$Liu^{d} = \phi i.Ki \qquad \text{where :} \qquad \phi i = \left(\alpha i.\gamma i^{t}\,\frac{\beta_i}{Wi}\right)^{\frac{1}{1-\beta_i}} \qquad [10.]$$

$$wi = \frac{\beta.\alpha i.\gamma i^{t}}{\left(\dfrac{Eiu}{Ki}\right)^{1-\beta}} \qquad [11.]$$

Thus the labour market side of the model can be solved to give the equilibrium wage for skilled labour (*Wfs**), demand for unskilled labour in the non-agricultural sector at the sticky wage (*Lfu*), and the equilibrium wage in the agricultural sector (*Wi**). Together with variables that are exogenous to the model variables (quantity of skilled labour, capital stock), these solutions provide the necessary inputs to the aggregate production functions to determine output in the agricultural and non-agricultural sectors.

Impact of AIDS on the Labour Market

HIV/AIDS impacts on the labour market through various channels:

- reducing the productivity of labour
- reducing the size of the labour force

Both of these processes reduce the effective supply of labour. In Figure A20 and Figure A21, this causes the labour supply functions to shift to the left. At the same time, the labour demand curve also shifts inward, due to the lower productivity of labour. The wage rate for skilled labour may therefore rise or fall in the AIDS case relative to the no AIDS case, depending on the relative magnitude of the shifts in the two curves (Figure A20). In the non-agricultural sector market for unskilled labour (Figure A21) the wage remains set at Wfu_{min}. The excess supply of labour may rise or fall, depending on the magnitude of the shifts in the supply and demand schedules. In the agricultural sector (unskilled labour), the supply of labour may rise or fall, depending on what happens to excess labour supply in the non-agricultural sector (Figure A22). Again, the wage rate in the agricultural sector may rise or fall.

Appendix 2: Model Calibration

Labour and Capital Shares in Income

Before the model can be used for forecasting and simulation, it must be calibrated. This involves choosing values for the unknown parameters so that the model fits to actual data for the base year. In the present exercise 2002 is chosen as the base year, as this is when the most recent Social Accounting Matrix (SAM) was carried out, and there was also a National Household Survey, including labour force information, carried out in the same year. The relevant data are shown in Table A12: Data from SAM, 2002 (Ushs mn)

below.

Table A12: Data from SAM, 2002 (Ushs mn)

	Agriculture	Non-agriculture	Total
Gross Output	3,600,745	15,109,860	18,710,605
less Inputs	886,451	6,888,287	7,774,738
Value Added	2,714,294	8,221,573	10,935,867
of which:			
Mixed income	2,042,626	2,486,080	4,528,706
Operating surplus	32,813	2,110,469	2,143,282
Taxes	1,119	351,520	352,639
Capital	20,506	500,264	520,770
Wages	617,230	2,773,240	3,390,470
Distribution of Wage Payments			
Wages-unskilled	456,623	257,605	714,228
Wages-semi-skilled	73,501	160,174	233,675
Wages-skilled	60,926	600,456	661,382
Wages-high skilled	26,181	1,755,005	1,781,185
Wages-unskilled + semi	530,124	417,780	947,903
Wages-skilled + high	87,106	2,355,460	2,442,567
Wages & Mixed Income	2,659,856	5,259,320	7,919,176
GDP at Factor Cost			
Shs mn	**Agriculture**	**Non-agriculture**	**Total**
Mixed income	2,042,626	2,486,080	4,528,706
Operating surplus	32,813	2,110,469	2,143,282
Capital	20,506	500,264	520,770
Wages-unskilled	530,124	417,780	947,903
Wages-skilled	87,106	2,355,460	2,442,567
Total	2,713,175	7,870,053	10,583,228
Total net of depreciation	2,692,669	7,369,789	10,062,458

Using the above data, income for the various factors of production can be calculated. The challenge is dividing the category of “mixed income” between capital and labour. Mixed income is defined as:

> ..... the balancing item in the generation of income account for a sub-set of enterprises, i.e., unincorporated enterprises owned by members of households either individually or in

partnership with others in which the owners, or other members of their households, may work without receiving a wage or salary. Owners of such enterprises must be self-employed: those with paid employees are employers, while those without paid employees are own-account workers. In a few cases it may be possible to estimate the wage or salary element implicitly included within mixed income, but there is usually not enough information available about the number of hours worked or appropriate rates of remuneration for values to be imputed systematically. **Thus, mixed income contains an unknown element of remuneration for work done by the owner of the enterprise, or other members of the same household, as well as the surplus accruing from production.** The element of remuneration could be predominant in some cases[13].

Mixed income is important in Uganda, as it accounts for 41% of total value added in the economy, and 75% of value added in the agricultural sector, and it is necessary to divide mixed income between labour and capital (i.e., between remuneration for work and operating surplus). As shown in Table A13, mixed income has been allocated (somewhat arbitrarily) one third to capital (operating surplus) and two-thirds to labour.

Table A13: Derived Factor Income and Cost Shares (Ushs mn)

	Agriculture	Non-agriculture	Total
Total labour income	1,985,790	4,438,914	6,424,703
Share	73.7%	60.2%	63.8%
Total return to capital (incl. land)	727,385	3,431,139	4,158,525
Share (net of depreciation)	26.3%	39.8%	36.2%
Capital stock	2,909,542	17,155,697	
o/w land	2,318,793	2,743,805	
Capital-output ratio	1.07	2.09	
Assumptions			
Division of Mixed income			
Capital	*33%*	*33%*	*33%*
Skilled labour	*0%*	*33%*	*18%*
Unskilled labour	*67%*	*34%*	*49%*
Rate of return on capital	*25%*	*20%*	

Once the total return to capital has been derived (share of mixed income plus operating surplus), this can be used to derive the total capital stock in the agricultural and non-agricultural sectors (see below).

Calibrating the production functions (equations [2] and [3]) with these data gives values for α of 2.12 and 0.52 in the non-agricultural and agricultural sectors respectively. The derivation of cost share parameters is shown in Table A14 below. It should be noted that the cost share for capital (0.40) and labour (0.60) in the non-agricultural sector are almost the same as Cuddington's figures for the formal sector in Tanzania[14]. In the agricultural sector, the cost shares are 0.26 for capital and 0.74 for labour, which are also similar to Cuddington's figures for Tanzania.

[13] UN Statistics Division, 1993 SNA, Section VII.E, para 7.85 (http://unstats.un.org/unsd/sna1993/)

[14] Cuddington (1993b) uses cost shares of 0.6 for labour and 0.4 for capital in the formal sector, and 0.8 and 0.2 respectively for the informal sector.

Table A14: Calibration of Cost Shares

			Agricultural	Non-Agricultural
Skilled labour				
Wage rate	w_s	Ushs mn/yr		3.05
		Ushs '000/month		254.5
Labour input	L_s	No.		1,040,083
Cost		Ushs mn		3,175,867
Cost share	b_s			43.1%
Unskilled labour				
Wage rate	w_{uf}	Ushs mn/yr	0.01	0.72
		Ushs '000/month	0.4	59.7
Labour input	L_{uf}	No.	6,438,022	1,762,277
Cost		Ushs mn	32,813	1,263,047
Cost share	b_u		73.7%	17.1%
Capital				
Capital stock	K		2,909,542	17,155,697
Cost share	ρ		26.3%	39.8%
Output				
GDP	Y		2,692,669	7,369,789
alpha	α		0.52	2.12

Calculation of Capital Stock

The stock of fixed physical capital can be derived from the national accounts data on Gross Fixed Capital Formation (GFCF). Generating a capital stock series requires an assumption regarding the initial capital stock (the further back the starting year is, the less important is this assumption) and the rate of depreciation. The assumptions used in this case were an initial fixed capital of Shs 4 000 bn (in constant 1997/98 prices) and annual depreciation of 5%. This was used to generate an annual capital stock series, and the 2002 figure was converted to current prices using the deflator for current and constant price GFCF.

This gives a value of fixed physical capital, but capital stock also includes land. To estimate that value of land (as capital), we assumed rates of return on capital of 25% in the agricultural sector and 20% in the non-agricultural sector. Combining these with data on returns on capital (in Table A13 above), we can obtain a total value for capital stock; then subtracting the value of fixed capital, we can obtain the value of land as capital.

Table A15: Capital Stock and Investment

(Sh mn, constant 1997/98 prices)

	Opening K	GFCF	Depreciation	Closing K	Capital-output ratio	Deprec-iation/GDP	GFCF/GDP
1992	*2,000,000*	656,954	100,000	2,556,954	0.42	2.1%	14%
1993	2,556,954	711,701	127,848	3,140,807	0.50	2.5%	14%
1994	3,140,807	934,270	157,040	3,918,036	0.49	2.4%	15%
1995	3,918,036	1,199,150	195,902	4,921,284	0.60	3.0%	18%
1996	4,921,284	1,161,909	246,064	5,837,129	0.70	3.5%	17%
1997	5,837,129	1,225,160	291,856	6,770,433	0.79	3.9%	17%
1998	6,770,433	1,364,530	338,522	7,796,441	0.86	4.3%	17%
1999	7,796,441	1,442,162	389,822	8,848,781	0.91	4.6%	17%
2000	8,848,781	1,334,067	442,439	9,740,409	0.99	5.0%	15%
2001	9,740,409	1,432,229	487,020	10,685,617	1.04	5.2%	15%
2002	10,685,617	1,554,124	534,281	11,705,461	1.09	5.4%	16%
2003	11,705,461	1,758,639	585,273	12,878,827	1.12	5.6%	17%
2004	12,878,827	2,109,738	643,941	14,344,623	1.17	5.9%	19%
2005	14,344,623	2,351,529	717,231	15,978,921	1.24	6.2%	20%
2006	15,978,921	2,782,705	798,946	17,962,680	1.29	6.4%	22%

Assumed depreciation rate (% K stock) *5%*

Estimated Capital Stock & Investment in Base Year (2002) (Current prices)

Deflator	1.40	(derived from GFCF in current and constant prices)
Capital stock	15,002,641	
GFCF	2,181,995	

Derived Capital Stock

(Shs mn, 2002 prices)

	Fixed Capital	Land	Total
Agriculture	590,749	2,318,793	2,909,542
Non-agricultural	14,411,892	2,743,805	17,155,697
Total	15,002,641	5,062,598	20,065,239

Impact of HIV/AIDS on Expenditure and Savings

The impact of HIV/AIDS on savings is derived from its impact on expenditure; it is assumed that all of the additional expenditure is met by reduced savings and hence investment. The impact is calculated separately for households, firms and government.

Household expenditures are primarily on healthcare and funerals. Following earlier work (Phase II Study on the Poverty Impact of HIV/AIDS), these are estimated as follows:

- Healthcare: 25% of household expenditure for urban households; 50% for rural households
- Funerals: 4 months expenditure

On the assumption that, on average, people will survive for 10 years after becoming infected with HIV, and that they will require intensive healthcare treatment for one third of this time, we can calculate these additional expenses as a percentage of average annual expenditure. Taking account of the average household (not individual) HIV prevalence, the urban-rural distribution of the population, and the proportion of GDP accounted for by household consumption, we can calculate these expenses as a proportion of GDP.

Firms: following estimates in other studies (see Phase I Report – Literature Review), we allow HIV/AIDS to add an average of 2% to firms labour costs. Using the proportion of labour costs in value added in the agricultural and non-agricultural sectors, we can calculate the HIV/AIDS cost impact as a percentage of GDP.

For both firms and households, the impact is considered to be reduced by 1/3 if ART is available.

Government: from data on spending on HIV/AIDS programmes by GoU and donors (Lake & Mwijuka, 2006), government spending can be calculated as a proportion of GDP. In the No-ART case, it is assumed that total spending would be 2/3 lower, but that the GoU share would be higher.

Table A16: Impact of HIV/AIDS Spending

Household Impact (on consumption and savings)		
% of income (consumption)	**AIDS no ART**	**AIDS with ART**
Healthcare		
urban	8.3%	5.6%
rural	16.7%	11.1%
Funeral	3.3%	2.2%
Household HIV prevalence - national	12.1%	12.1%
Urban population (% of total)	15.0%	15.0%
Average Impact (% of consumption)		
- urban	1.4%	0.9%
- rural	2.4%	1.6%
- national	2.3%	1.5%
Private cons as % of GDP	80.0%	80.0%
Average Impact (% of GDP)		
- urban	1.1%	0.8%
- rural	1.9%	1.3%
- national	1.8%	1.2%

Firms Impact	**AIDS no ART**	**AIDS with ART**
% rural	33%	33%
% of labour costs	2.0%	1.3%
% of GDP		
agric	1.5%	1.0%
non-agric	1.2%	0.8%
total	1.3%	0.9%
Total Impact		
agric/rural	3.4%	2.3%
non-agric/urban	2.3%	1.6%

Government Impact		**AIDS no ART**	**AIDS with ART**
HIV/AIDS spending			
GoU share	% total	30%	15%
Total	% of GDP	0.9%	2.6%
GoU share	% of GDP	0.3%	0.4%

Summary		**No ART**			**ART**	
(% of GDP)	**Agric**	**Non-agric**	**Total**	**Agric**	**Non-agric**	**Total**
Households	1.9%	1.1%	1.8%	1.3%	0.8%	1.2%
Firms	1.5%	1.2%	1.3%	1.0%	0.8%	0.9%
Government	0.3%	0.3%	0.3%	0.4%	0.4%	0.4%
Total	**3.7%**	**2.6%**	**3.4%**	**2.7%**	**2.0%**	**2.5%**

Chapter 3: Computable General Equilibrium Model (CGE) Model Results

1. Introduction

The approach followed in the previous chapter deals with the economy at an aggregate level, and does not disaggregate the impact of HIV/AIDS by sector, or attempt to model the evolution of the economy on a sectoral level. It includes only a limited distinction between economic activities, through the model's division into formal and informal sector economic activities and skilled and unskilled labour. However, a richer analysis of the impact of HIV/AIDS on an economy can be obtained from a modelling approach that incorporates different sectors. In practice, the economic impact of HIV/AIDS will vary across sectors, depending on a number of factors such as the degree of labour/capital intensity in the production structure of each sector, and its use of skilled and unskilled labour. Given that HIV/AIDS has its impact through various different channels, including investment, labour availability and productivity, and public spending, the sectoral impacts may well vary.

Such a disaggregated approach can be modelled using a computable general equilibrium model (CGE). Arndt & Lewis, 2000, 2001 note that:

"CGE models have a number of features that make them suitable for examining "cross-cutting" issues such as the impact of HIV/AIDS.

- They simulate the functioning of a market economy, including markets for labour, capital and commodities, and provide a useful perspective on how changes in economic conditions will likely be mediated through prices and markets.
- Unlike many other partial equilibrium or aggregate macro approaches, they are based on a consistent and balanced set of economy-wide accounts (called a Social Accounting Matrix, or SAM), which requires (among other things) that key behavioural and accounting constraints (such as budget constraints and balance of payments equilibrium) are maintained, which in turn serves as an important check on the "reasonability" of the outcomes.
- Because they can be fairly disaggregated, CGE models can provide an economic "simulation laboratory" with which we can examine how different factors and channels of impact will affect the performance and structure of the economy, how they will interact, and which are (quantitatively) the most important" (Arndt & Lewis 2000, p.4)

CGE models therefore permit a disaggregation of the economy into various different productive sectors, each using a range of factors of production (e.g. skilled and unskilled labour, and capital), and incorporating different household types by income level and various government spending categories; they can also incorporate different HIV prevalence rates across skill categories. CGE modelling enables the consideration of distributional impacts, the impact on overall economic growth and sectoral growth, the impact on employment and wages in different segments of the labour market, as well as the impact on relative prices.

In this chapter a CGE model is used to simulate the impact of HIV/AIDS on the Uganda economy. We run various simulations based on the availability and access to Anti-Retroviral Therapy (ART), and comparing different financing options. The medium- and high-ART scenarios reflect the demographic projections prepared in Phase II[15]. Each of these scenarios is compared to the hypothetical simulation where we assume that there was no AIDS. We apply a Dynamic Computable General Equilibrium model based on a Social Accounting Matrix (SAM) which has 49 activities, 49 commodities, 32 household types, and 3 labour categories.

The various scenarios build on each other and shown in Table 17 below. The first set of scenarios build in the various impacts, including labour force effects, productivity effects, and the impact on household spending. The second set of scenarios incorporate all of these channels and consider various different financing options with different combinations of domestic and donor financing.

Table 17: Scenarios Modelled - CGE

Scenario	Effects Modelled
Base case	No HIV/AIDS
ART Provision and Impact Modelling	
AIDS – No ART	Labour force effects, No ART
AIDS – ART	Labour force effects, with (high) ART
TFP AIDS – No ART	Productivity and labour force effects, No ART
TFP AIDS –ART	Productivity and labour force effects, with (high) ART
HH Exp – No ART	Household spending, productivity and labour force effects, No ART
HH Exp –med ART	Household spending, productivity and labour force effects, with (medium) ART
HH Exp –ART	Household spending, productivity and labour force effects, with (high) ART
Modelling of Financing Options	
FF AIDS – No ART	Foreign financing, household spending, productivity and labour force effects, No ART
FF AIDS – No ART	Foreign financing, household spending, productivity and labour force effects, with (high) ART
Gov- ART	Domestic financing, household spending, productivity and labour force effects, with ART

They key results suggest that there AIDS/HIV is causing considerable output loss to Uganda, with an estimated 0.8 percent reduction in average annual economic growth over the period 2007-2015 owing to reductions in labour supply, population growth and loss in total factor productivity. Second, with the presence of ARTs, the loss in average output growth is reduced to only 0.4 percent as compared to the no-AIDS scenario. While there is an appreciation of the currency when HIV/AIDS is financed by donor-funded inflows from abroad, the overall impact on the economy remains positive due to the dominating effects of the increased population, productivity and labour force available. Increased consumption expenditure by households on health related expenses could also lead to lower savings and growth rates in the long run. Finally by the government targeting its health programs to low income earners this could result into the convergence of the growth rates of income for the various households.

[15] The Low-ART scenario was not included as the demographic outcome is similar to the No-ART scenario.

The rest of the chapter is organized as follows. Section 2 describes the SAM used as a basis for the baseline and our simulations. Section 3 presents results. The conclusion and policy implications are provided in section 4. A technical appendix provides more information on the SAM.

2. The Uganda Social Accounting Matrix (SAM) 2007

A Social Accounting Matrix (SAM) is a table which summarizes the economic activities of all agents in the economy. These agents typically include households, enterprises, government, and the rest of the world (RoW). The relationships included in the SAM include purchase of inputs (goods and services, imports, labour, land, capital etc.); production of commodities; payment of wages, interest rent and taxes; and savings and investment. Like other conventional SAMs, the Uganda SAM is based on a block of production activities, involving factors of production, households, government, stocks and the rest of the world.

The Uganda SAM is a 120 by 120 matrix. The various commodities (domestic production) supplied are purchased and used by households for final consumption (42 per cent of the total), but also a considerable proportion (34 per cent) is demanded and used by producers as intermediate inputs. Only 7 percent of domestic production is exported, while 11 per cent is used for investment and stocks and the remaining 7 percent is used by government for final consumption. Households derive 64 per cent of their income from factor income payments, while the rest accrues from government, inter-household transfers, corporations and the rest of the world. The government earns 32 percent of its income from import tariffs – a relatively high proportion, but a characteristic typical of developing countries. It derives 42 percent of its income from the ROW, which includes international aid and interest. The remainder of government's income is derived from taxes on products (14 percent), income taxes paid by households (6 percent) and corporate taxes (5 percent).

Investment finance is sourced more or less equally from government (26 per cent), domestic producers (27 per cent) and households (26 per cent), with enterprises providing only 21 per cent. Imports of goods and services account for 87 percent of total expenditure to the ROW. The rest is paid to ROW by domestic household sectors in form of remittances; wage labour from domestic production activity; domestic corporations payments of dividends; income transfers paid by government; and net lending and external debt related payments.

The extent of household dis-aggregation is very important for policy analysis, and involves representative household groups as opposed to individual households. Pyatt and Thorbecke (1976) argue persuasively for a household dis-aggregation that minimizes within-group heterogeneity. This is achieved in the Uganda SAM through the disaggregating of households by rural and urban, and whether households are involved in farming or non farming activities.

The Uganda SAM identifies three labour categories disaggregated by skilled, unskilled and self employed. Given the different HIV prevalence rates across labour categories, this classification provides the scope for a detailed analysis of the implications of the AIDS on the economy. Land and capital are distributed accordingly to the various household groups.

3. Results

For most of the recent studies using CGE models to assess the impact of AIDS on the economy, they typically consider two scenarios: *with AIDS* scenario and *without AIDS* scenario. However, for the case of Uganda, by 2007 when the SAM was constructed, AIDS had already been in place for about 25 years. Under the scenario of *with AIDS*, AIDS affects the economy through four main channels.

Population and labour supply

First, it reduces the total stock of the population and has differential effects on the labour supply. AIDS also tend to strike the most productive age groups in the range of 22-45 years of age. Based on the projected labour supply derived from the demographic model we run simulations of with and without ART over a period of 2007-15.

Labour Productivity

Aids also affect the productivity of individuals either through sickness, absenteeism from work, and the overall moral of the individual worker. We introduce a productivity parameter in the labour supply function to account for these effects.

Total Factor Productivity

Aids also reduce the overall productivity of firms. With high turnover of workers due to the illness, firms incur hiring costs, training adjustment costs and slower technological adaptation.

Household Spending Patterns

Households which have a sick patient would tend to incur higher health expenditures. This could result into either lower savings or a switch from spending on other commodities.

Government spending

With the incidence of AIDS, government would also be induced to spend more on health related services. This would either result into reallocation of spending from other activities or running a higher deficit.

We mainly focus on the macroeconomic implications of these simulations. We also assess the impact of these simulations on sectors, by identifying sectors that are affected most as a result of the pandemic. Lastly, we also assess the effects of these simulations on household's income and savings behaviour.

Population and Labour Supply Simulation

We make use of the demographic model produced in Phase II of the study to derive population growth rates which are then applied to the labour categories available in the SAM, thereby providing detailed labour profiles according to gender and labour type. We assume that the semiskilled and unskilled groups would exhibit similar labour growth rates under the different scenarios. With limited information, we also assume that the rural and urban skill types grow at the same rate.

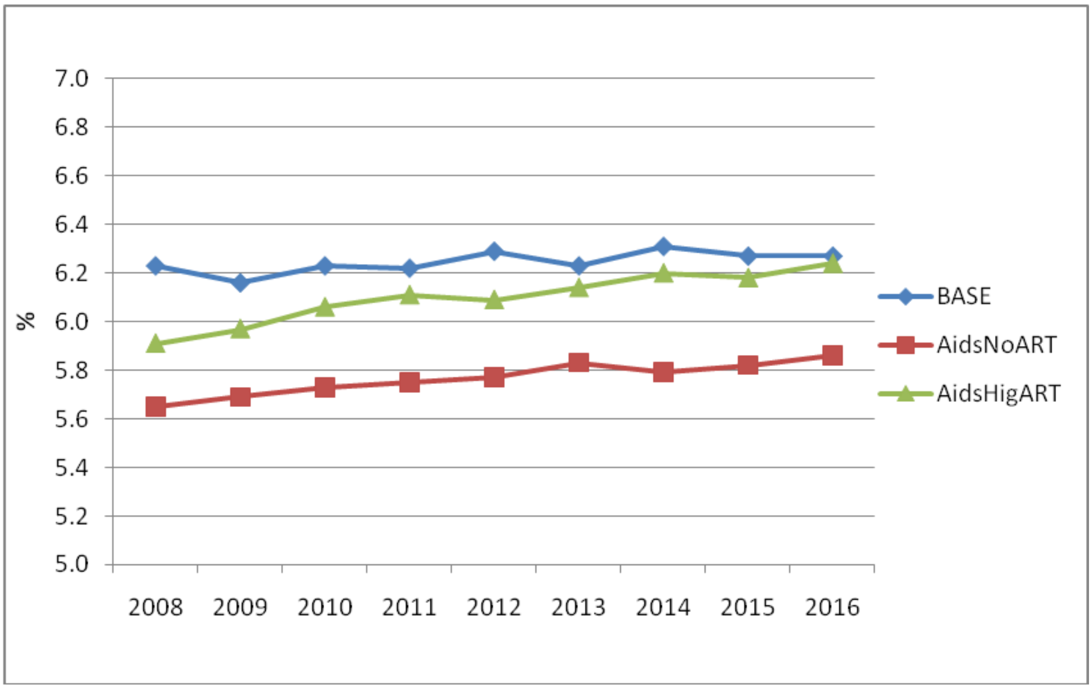
In this section we perform three simulations. First, we implement a hypothetical simulation where there was no AIDS. This simulation provides a basis of assessing the overall damage the pandemic has caused. In this case, the labour growth rates for all categories or workers are all higher than other scenarios. The second simulation is where we assume that AIDS was in place but with no ART. The third simulation is whereby AIDS existed but with ART treatment. In all cases the population figures are adjusted accordingly to reflect the No AIDS, AIDS No ART, and AIDS with ART scenarios.

Without AIDS

We use the *No AIDS* scenario as a benchmark to assess what would have happened if the pandemic was not in place. While this is hypothetical, it helps us to assess the lost output as a result of the disease. We also assume that total factor productivity growth is 1 percent. These assumptions are used through all other simulations except in the subsequent simulations where we assume that the productivity growth rate also changes.

The results of the "No AIDS" scenario show GDP growing at 6.2 percent annually during the period 2008-16 (see Figure 23). The "No AIDS" scenario shows a path that is relatively high and steadily increasing through the simulation period as a result of capital deepening and increased availability of skilled labour. From the expenditure side, the growth is mainly driven by investment and higher private consumption. The higher investment is a result of households earning higher incomes and thereby saving more. Likewise, the higher consumption is driven by the larger disposable income due to increased labour income. In addition, production tends to be more labour intensive as producers have access to abundant labour of various skill types.

Figure 23: Real Growth of GDP – Labour Force Effects



Turning to households, with increased labour supply, this leads to higher household incomes. In the simulations we assume that labour is fully employed, and that the semiskilled and unskilled labour categories are mobile between sectors while skilled labour is sector specific. As a result of increased labour supply, the equilibrium wage rates fall. However, the quantity of labour supplied increases, which on the overall increases labour income. In addition, given that households are also proprietors of the different production activities, the higher production due to more labour utilized would result into increased profit income. This leads to higher savings which encourage investments and subsequent capital accumulation for the following years.

With AIDS and No Treatment Scenario

The second set of simulations focuses on the scenario where we have the HIV/AIDS pandemic but without any government intervention in form of ART treatment. In this case we assume that the drugs may be available, but would be too expensive to be affordable by most households. Hence some patients who get the disease treat themselves privately without any government support programs, but the majority cannot afford to do so. This scenario could particularly reflect the early years of the pandemic where ARTs were hardly accessible. In this scenario we do not yet introduce any negative productivity growth effects, and hence assume that factor productivity growth remains at 1 percent, as in the baseline scenario. The difference between this simulation and the baseline is that labour grows at a lower rate for both skilled and unskilled categories, as does the population as a whole.

Under this scenario, we find that there are large negative effects on the aggregate economy. First, GDP in real terms would grow by 5.8 percent on annual basis. Compared to the "No AIDS" scenario, this would imply that every year we lose about 0.4 percent of GDP as a result of the pandemic. The growth rate path is relatively lower compared to the "No AIDS" scenario through the simulation period, as there is a significant reduction in production for all economic activities. Previous studies on Botswana suggest that producers would switch to more capital intensive technologies (Thurlow, 2007). However, for the case of Uganda where the bulk of the population is rural based, switching to capital intensive technologies for sectors like agriculture would not be a smooth adjustment. As a result, for most activities which are mainly labour intensive, there would be a marked decline in labour use and production. In addition, the equilibrium wages would be much higher hence reducing the profitability for these sectors.

From the expenditure side, we also note that there is substantial decline in both consumption and investment. The reduction in consumption is a result of reduced economic activity and income. With reduced earnings, savings are also reduced and hence less capital accumulation over the years.

With- AIDS Treatment Scenario

The third simulation is where AIDS exists and the government, NGOs and private sector embark on treatment programs including the purchase of ARTs and counselling programs. Use of ARTs slows the progression of HIV into full-blown AIDS and increases the age of the infected population. The cost of funding an AIDS treatment program is very high – estimated at around US$500 per person per year. However, for this simulation we do not (yet) consider alternative funding scenarios and productivity effects, simply the labour force effects, as with the availability of drugs we would have a higher stock of labour.[16]

The impact of the treatment scenario is an increase in the total of labour supply, as life expectancy of the infected population is increased. The availability of drugs and hence prolonged life expectancy would put the country on a higher growth path compared to the *No Treatment* scenario.

The provision of ART has beneficial effects in all sectors. Overall GDP growth is only reduced by 0.2%, compared to 0.4% in the No-ART scenario. The provision of ART eliminates around one half of the negative growth impact of HIV/AIDS. The more labour intensive growth path also results into higher incomes and savings by households. These projections suggest that the improved availability of labour when treatment is widely available of labour restores much of the output costs of HIV/AIDS under the *No Treatment* scenario.

However, these two scenarios (AIDS with and without treatment) only capture part of the impact of HIV/AIDS on economic growth, the channels operating through the size of the labour force. There

[16] We separately run simulations where we explicitly assume that the household meets the AIDS related health expenses.

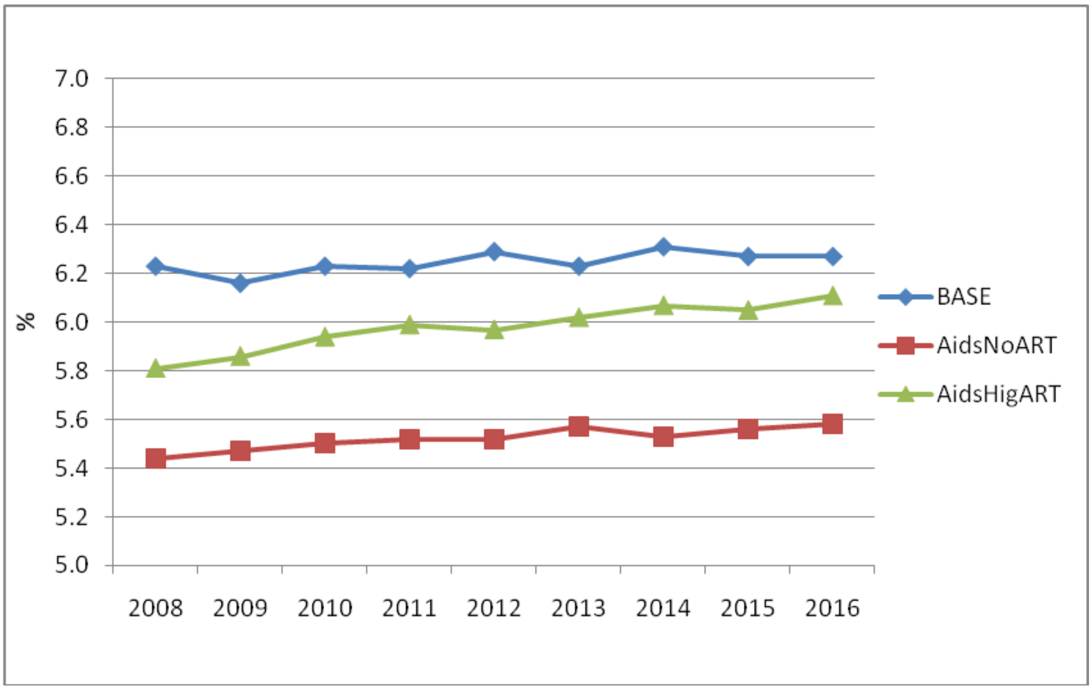
are other important channels of impact that need to be incorporated into the projections, including the impact on total factor productivity and the impact of alternative means of financing HIV/AIDS programmes. These are discussed below.

Negative Factor Productivity Impact

The second channel through which AIDS affects the economy is the change in total factor productivity (TFP) growth. This change is mainly as a result of reduced productivity owing to absenteeism of sick workers, general loss of morale to work with AIDS or even the weaker effort as a result weakness of the affected worker. It also reflects the reduced efficiency with which all factors of production are combined in the production process, and the reduced pace of technical progress. We run this simulation by focusing on the productivity losses for the specific sectors.

In the baseline we assumed that TFP growth is about 1 percent. In the first simulation we assume that TFP growth in each sector falls by 0.2 percent under the *No ART* scenario. We also assume the same growth path for the labour force and the population under *No ART* scenario as previously. In the second simulation we assume that TFP growth only falls by 0.1 percent, as a result of the beneficial impact of the availability of drugs. This scenario also assumes similar growth paths of labour and population growth used in the earlier simulations with ART in place[17]. The reduction in productivity is assumed to be equal across all years of the simulation.

Figure 24: Real Growth of GDP – Labour Force and TFP Effects



The implications of this adjustment are as expected where under the *No Treatment* scenario, there would be even higher output losses relative to the earlier simulation. The decline in growth is mainly driven by the substantial reduction in output for all the sectors. As shown in Figure 24, compared to the *No Aids* scenario, overall GDP would grow less, by 0.7 percentage points. Industry and

[17] The rationale for choosing these figures for the TFP simulations is discussed in Chapter 2 of this report. It should be emphasized that the estimated TFP effects used are hypothetical since there is very little empirical information on TFP by sectors and the implications of AIDS for overall factor productivity growth rates.

agriculture would be the worst hit sectors, with growth reduced by 0.79 percentage points and 0.77 percentage points respectively compared to the *No AIDS* scenario. Growth in the services sector falls by 0.68 percentage points (see Table 18). Proportionately (relative to base scenario growth rates), the greatest impact is felt in the agricultural sector, where growth falls by 21%.

In addition we also realize a significant reduction in incomes for all households and reduced aggregate consumption. The reduced income is due to the income lost due to low effective labour units supplied. This also translates into lower savings and investments for the subsequent years.

We also consider simulation where we assume that there is reduction of TFP growth, but in this case we assume that there is some treatment using ARTs. The results are very similar to the previous simulations of providing ARTs, where we note a higher growth path of the economy.

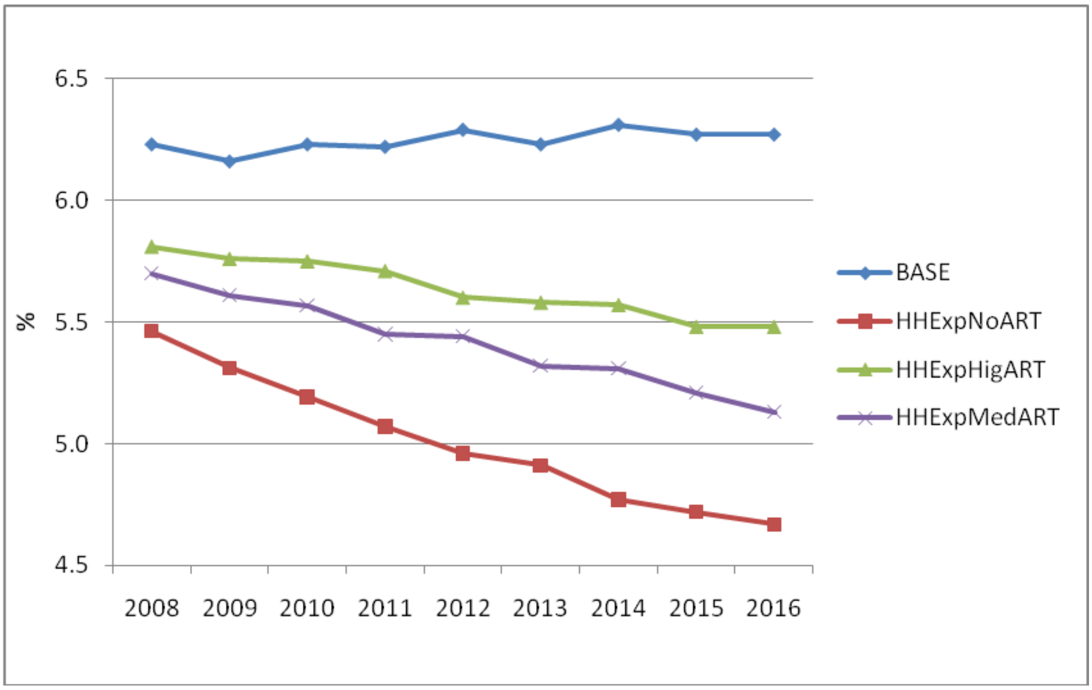
In addition the number of people leaving below the poverty line reduces under the ART treatment programs. The key question is then who pays for this treatment. In the subsequent simulations we look at two cases where households privately meet the expenses. The alternative is to have foreign donors sponsoring the AIDS programs including provision of ARTs or government mobilizing domestic resources and reallocating more spending for AIDS related programs.

Additional Household Costs with HIV+ Member

HIV/AIDS is associated with additional expenses incurred by households. These expenses are incurred as a result of a patient in the household requiring special medical attention, having special dietary needs, or when death occurs within the family. We run two simulations where we assume that all the medical expenses are met by the household. In the first simulation we also assume that there is no ART treatment and we adopt a similar labour supply path and population growth rates used in the earlier simulations of no ART.

In this case the household mainly spends on AIDS-related illnesses and opportunistic infections like tuberculosis. We assume that the household reallocates its expenditures from other items to health-related spending, and also increases total spending. This therefore affects (reduces) household savings, and the resources available for investment.

Figure 25: Real Growth of GDP – Labour Force, TFP and Household Effects



For the first scenario as expected, the marginal propensity to save declines as a result of increased spending on health. We note that investment declines by 0.6 percent of GDP. Rather than saving for the future, households are spending on health care. The lower investment levels results into a much lower growth path where average growth would be less than the hypothetical baseline by 1.2 percent. Furthermore, the growth trend is downwards, reflecting the impact on savings, investment and long-term growth.

The second simulation (with high-ART) however has two opposing effects. First the increase in spending by households on medical care results into lower savings for future investment. However, household spending is less than under the No-ART scenario, so the negative effects are less. Furthermore, given that there is increased labour supply and productivity under this scenario, we observe higher growth rates as a result of increased income received by households. Therefore there are two opposing effects (growth reducing and growth-enhancing). The average growth rate under this scenario is only 0.6% lower than the baseline, however, and hence the growth-enhancing effects of treatment dominate. A third scenario, which has a medium-ART provision (reaching two-thirds of those in need), lies between the No-ART and High-ART scenarios.

Sectoral Impacts

At the sectoral level, we note that forecast growth rates vary considerably between sectors in the base case (“No AIDS”) scenario. Of particular interest is the agricultural sector, which employs nearly 70 percent of Uganda’s labour force. Agriculture is mainly dominated by less-skilled labour, and in addition is a largely manual activity with very little capital equipment being used. With labour abundantly available for this sector, we note that the agricultural sector growth without HIV/AIDS is projected to average 3.7 percent. Growth is particularly high for horticulture, forestry and fishing activities. However, although growth is positive, it is lower than in other sectors and hence the share of agriculture in GDP is forecast to decline. Industry (manufacturing) and particularly services are where much more rapid growth is forecast to occur. The rapid growth in industry and services reflects the impact of skilled labour availability, and of investment and capital accumulation in those sectors, which are more important than in agriculture.

The channels of impact of HIV/AIDS vary somewhat across the sectors. In agriculture, HIV/AIDS mostly affects the supply of unskilled labour, and the fact that HIV/AIDS tends to cause a labour shortage, and so growth is projected to fall by 0.6 percentage points a year (a reduction in growth of around 16%). In the industry sector, the reduction in growth as a result of HIV/AIDS is much greater (2.2 percentage points), with a proportionate reduction in growth of 34%. This reflects the high dependence of industry on investment (which is affected by reduced savings) and skilled labour. In services, the impact is intermediate – a reduction in growth of 1.0 percentage points.

Figure 26: Real Growth of Agricultural sector (at factor cost)

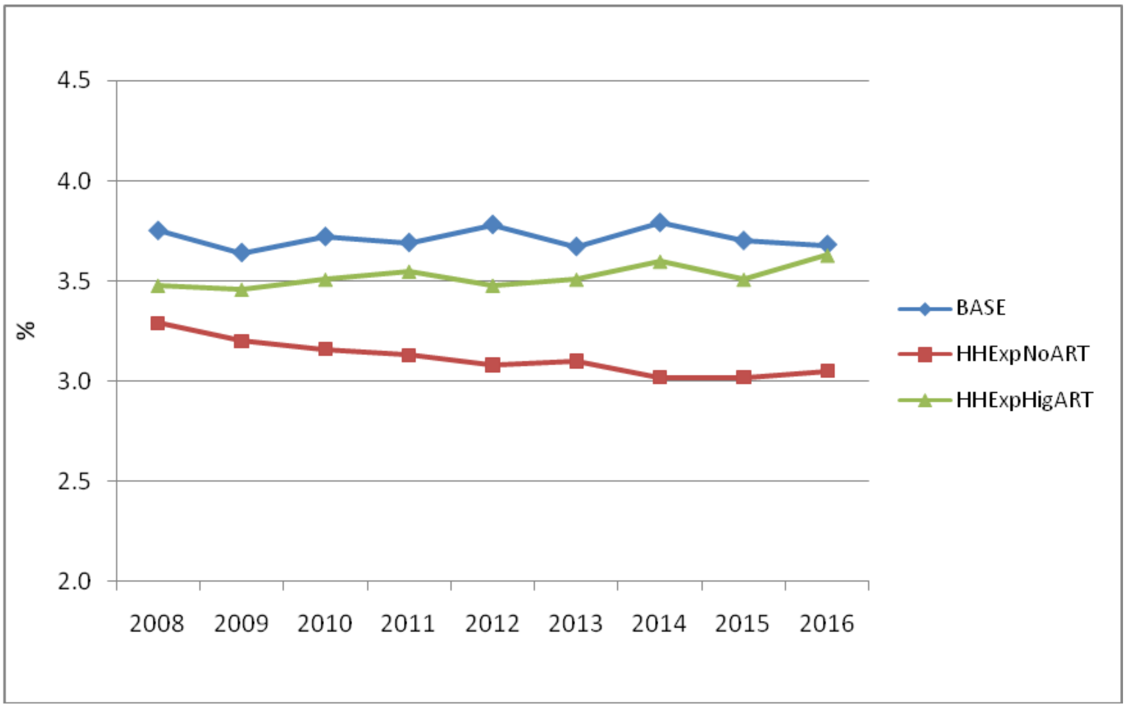


Figure 27: Real Growth of Industry sector (at factor cost)

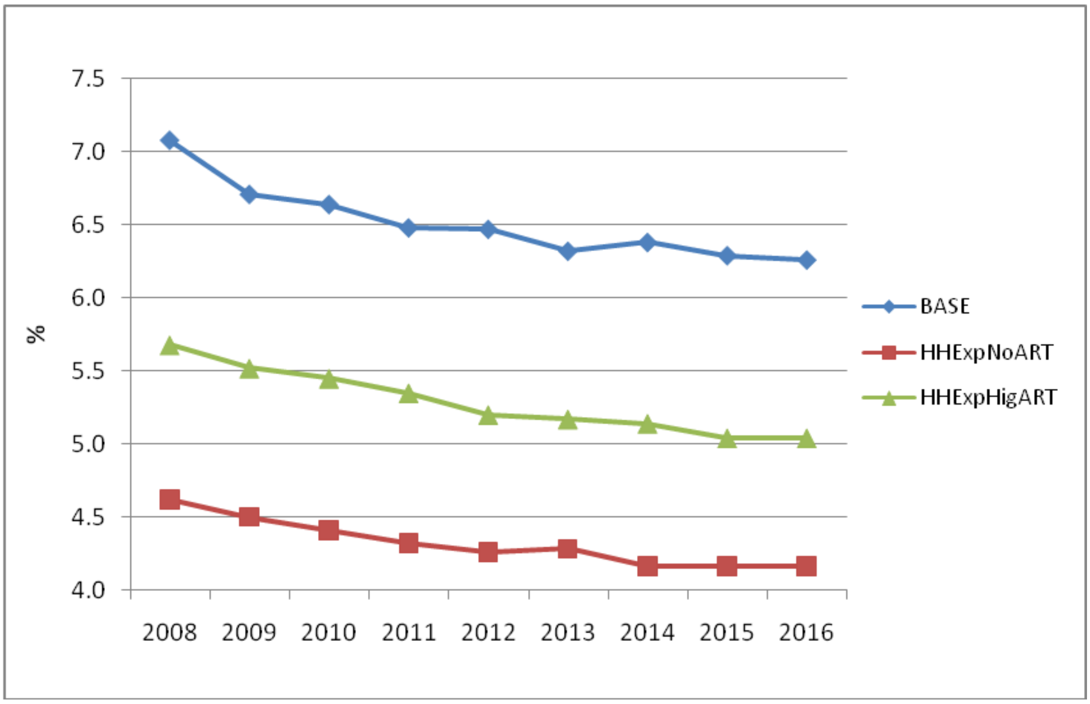
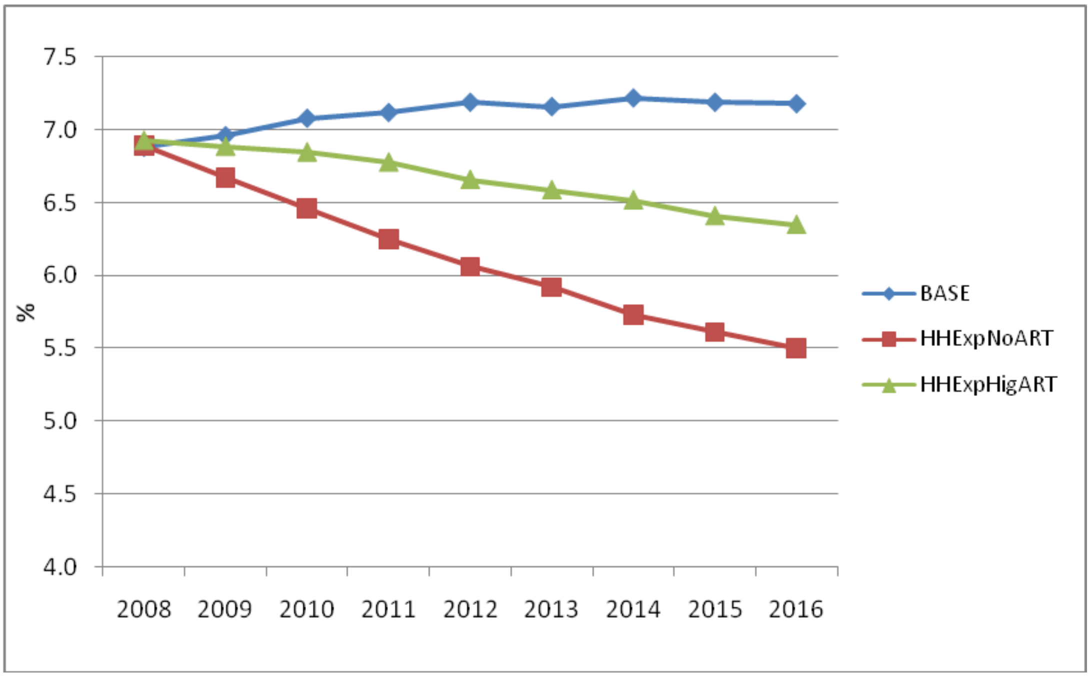


Figure 28: Real Growth of Service sector (at factor cost)



Financing Options

We now simulate the economic effects of different options for financing for HIV/AIDS programmes; these options include different proportions of foreign (donor) and domestic (tax/borrowing) finance. The effects of financing could depend on several factors. If the funds come in as foreign currency and are converted to local currency, this could have appreciation effects on the shilling, causing appreciation of the real exchange rate and a loss of competitiveness, which would in turn affect the export sector. There may also be knock effects of reduced tax revenue, increased budget deficit and reduced investment. However, if financing is sourced domestically, this will lead to some combination of higher taxes, or increased government borrowing leading to “crowding out” and higher interest rates. This is likely to particularly impact on sectors that are heavily dependent upon bank financing or that where profits, output and investment are sensitive to tax rates. Whichever domestic financing option is adopted, the impact on the economy (of that financing) will be negative. However, these negative impacts could be counteracted by other effects. As we have seen earlier, the provision of ART has a positive impact on labour supply, productivity and investment. The overall macroeconomic growth impact depends on the complex balance of all of these various channels.

We model a number of financing options as laid out in Table 17. These include variations in the level of ART provision (None-Medium-High) and of the proportion of the total cost funded by donors and government. One financing scenario mimics the intended funding in the NSP, comprising 85% donor funding and 15% domestic funding. At the other extreme, a hypothetical scenario entails donor funding being run down to zero during the NSP (hence leading to 100% government funding). An intermediate scenario entails an equal (50-50) split of incremental expenditure requirements between 2008 and 2016.

Growth Impacts

As Figure 29 and Figure 30 compares average economic growth rates over 2008-2016 with the “No AIDS” (Base Case). This illustrates the beneficial impact on growth of ART provision. It also shows that donor funding of ART in both the Medium and High ART scenarios leads to improved economic growth, even if funding is only partial.

Figure 30 show, the way in which HIV/AIDS programmes are financed has a major impact on the growth impact of HIV/AIDS. Essentially, the provision of ART and the availability of donor financing provide positive support to growth, so that the highest growth scenario is that with donor-funded high-ART provision. By contrast, the lowest growth scenario is the government-funded No-ART scenario. These results show that financing options have potentially an even greater negative impact on the economy than do the other impacts of HIV/AIDS (labour supply, productivity and household expenditure).

Figure 29: Annual GDP Growth Rates - Financing Scenarios

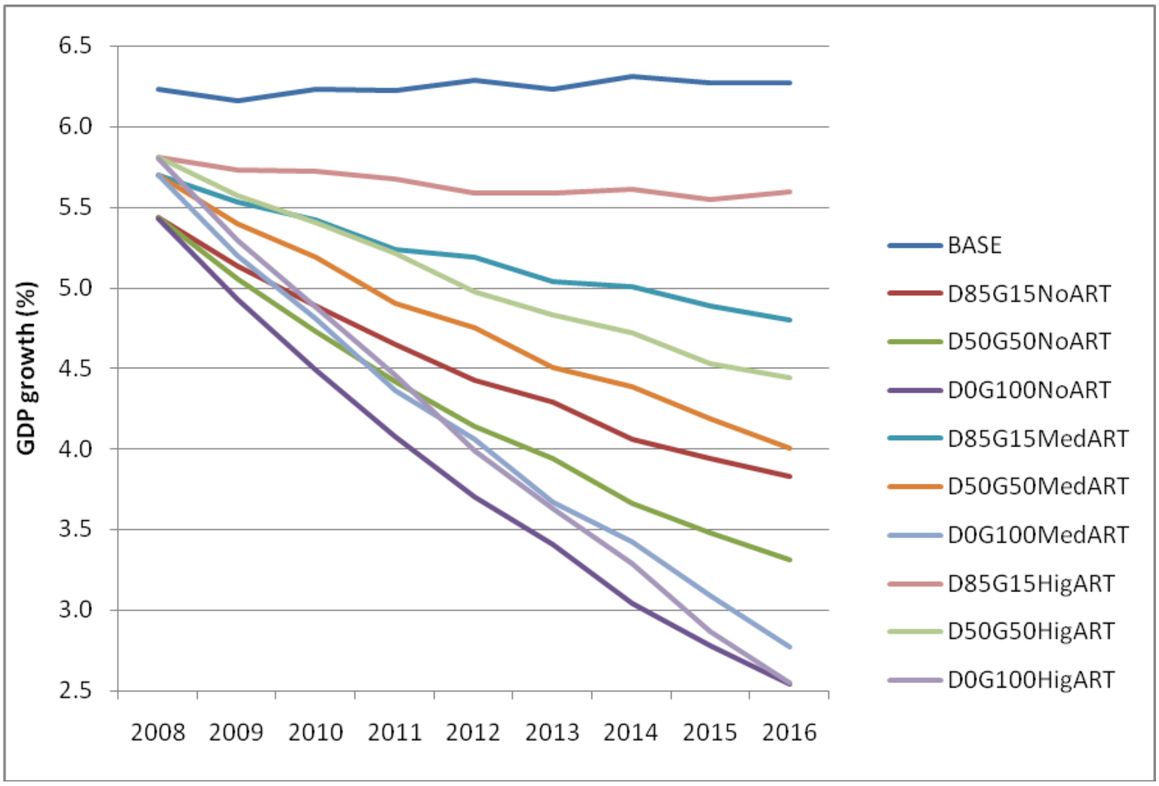
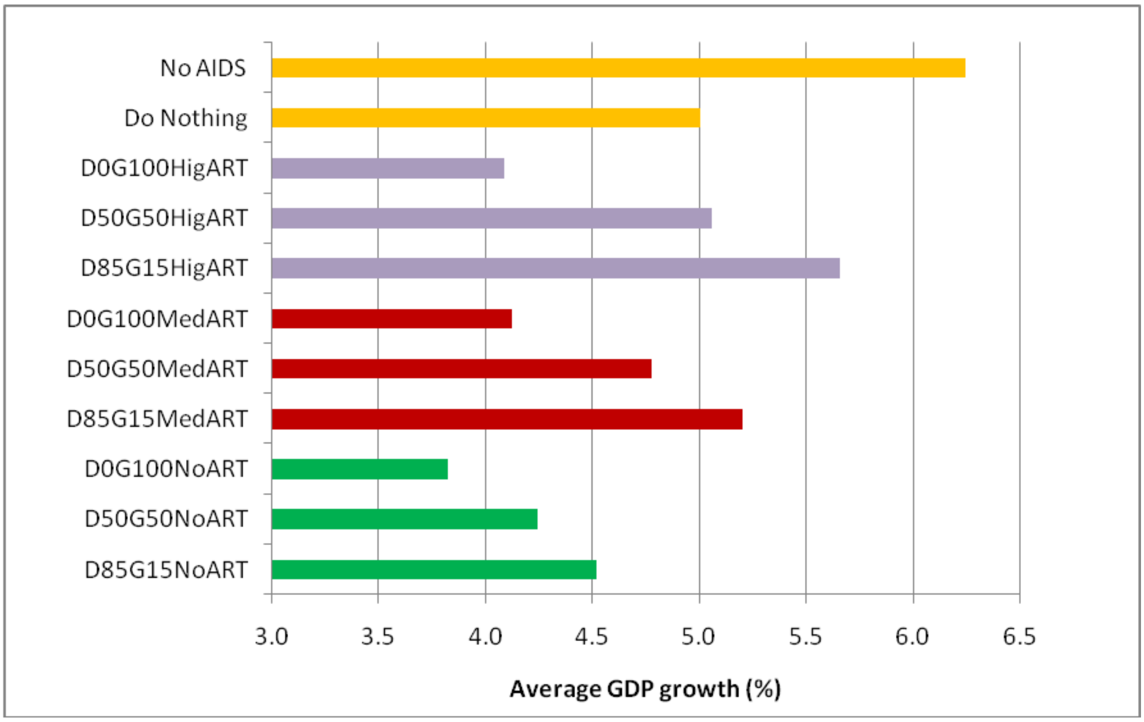


Figure 30 compares average economic growth rates over 2008-2016 with the "No AIDS" (Base Case). This illustrates the beneficial impact on growth of ART provision. It also shows that donor funding of ART in both the Medium and High ART scenarios leads to improved economic growth, even if funding is only partial.

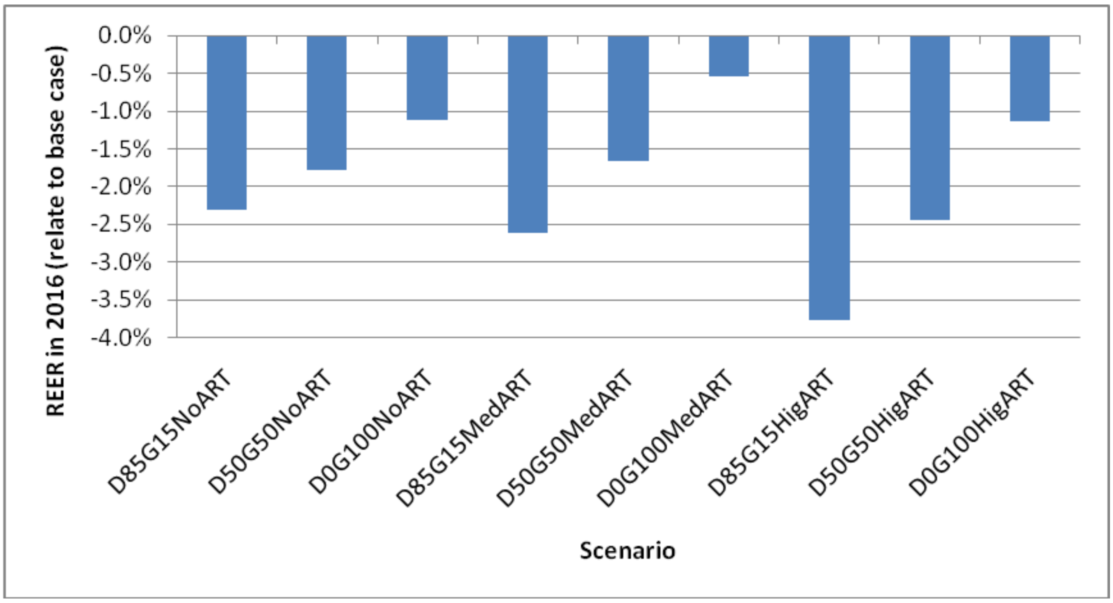
Figure 30: Average GDP Growth Rates 2008 to 2016 - Financing Scenarios



Real Exchange Rate

As noted earlier, concerns have been expressed that the inflows of donor financing of HIV/AIDS programmes would cause the real exchange rate to appreciate, thus hindering economic growth and diversification. This channel is accommodated within the CGE model. As shown in the figure below, the shilling does appreciate in value. As a result, exports grow at a slower rate than in the earlier simulations. However the extent of the appreciation varies considerably across the various scenarios. Furthermore, the overall degree of REER appreciation is small. As a result, the negative impact of REER appreciation on growth is smaller than the positive impact of ART provision and the real transfer of resources from the Rest of the World that results from donor financing. In addition, the negative impact of domestic financing is greater than the negative impact of donor financing. Therefore the arguments that increased HIV/AIDS-related inflows could hurt the economy are not supported by this simulation.

Figure 31: Real Exchange Rate in 2016 (relative to Base Scenario)



Poverty Impacts

The poverty analysis results in the CGE model are consistent with those produced in Phase II of this project. Without ART, HIV/AIDS has a negative impact on poverty, because of its effect on household spending for medical care, funerals etc., and on leading to reduced economic growth. Without ART, and without taking account macroeconomic financing implications, HIV/AIDS would lead to a poverty rate around 1% higher than the base case without HIV/AIDS (see Figure 33). However, the provision of ART offsets much of this negative impact, by leading to higher growth rates and a reduced burden on household spending, offsets this negative impact of HIV/AIDS on poverty.

However, these estimates do not take into account the impact of different financing options on poverty rates. Once financing is introduced, it can be seen that this can have an even greater impact on poverty rates than the provision (or not) of ART. Consistent with the earlier analysis, relying on domestic financing will reduce economic growth such that poverty rates will be higher, even in the high-ART scenario. Much lower poverty rates are projected where there is a high proportion of donor financing, because the adverse effects of domestic financing through higher taxes or crowding out of private sector borrowing are much reduced.

It should be noted that the main driver of poverty reduction is the real economic growth occurs over the simulation period, rather the impact of HIV/AIDS and ART provision.

Figure 32: Poverty Rates - all scenarios

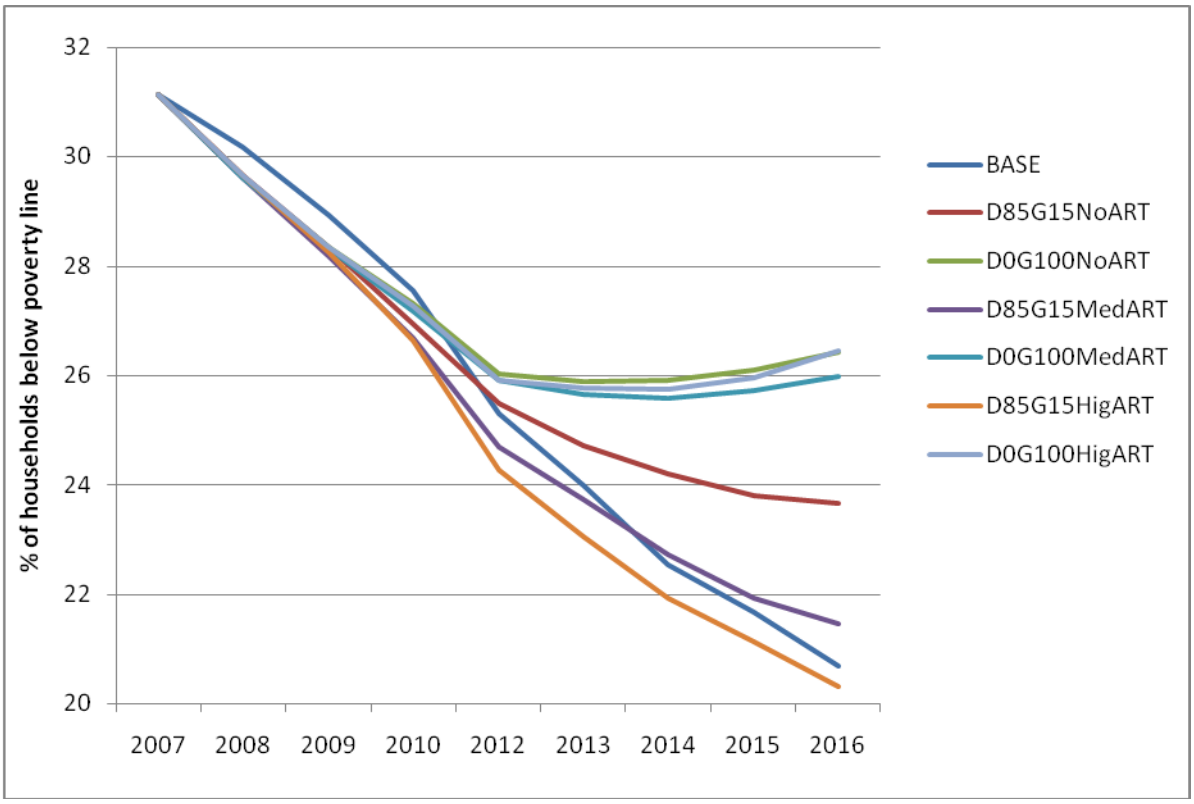
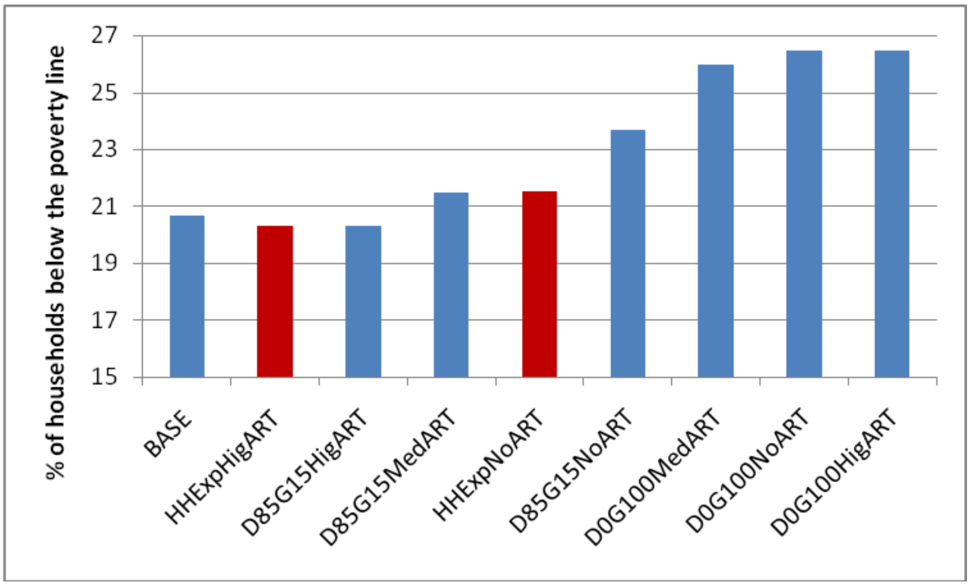


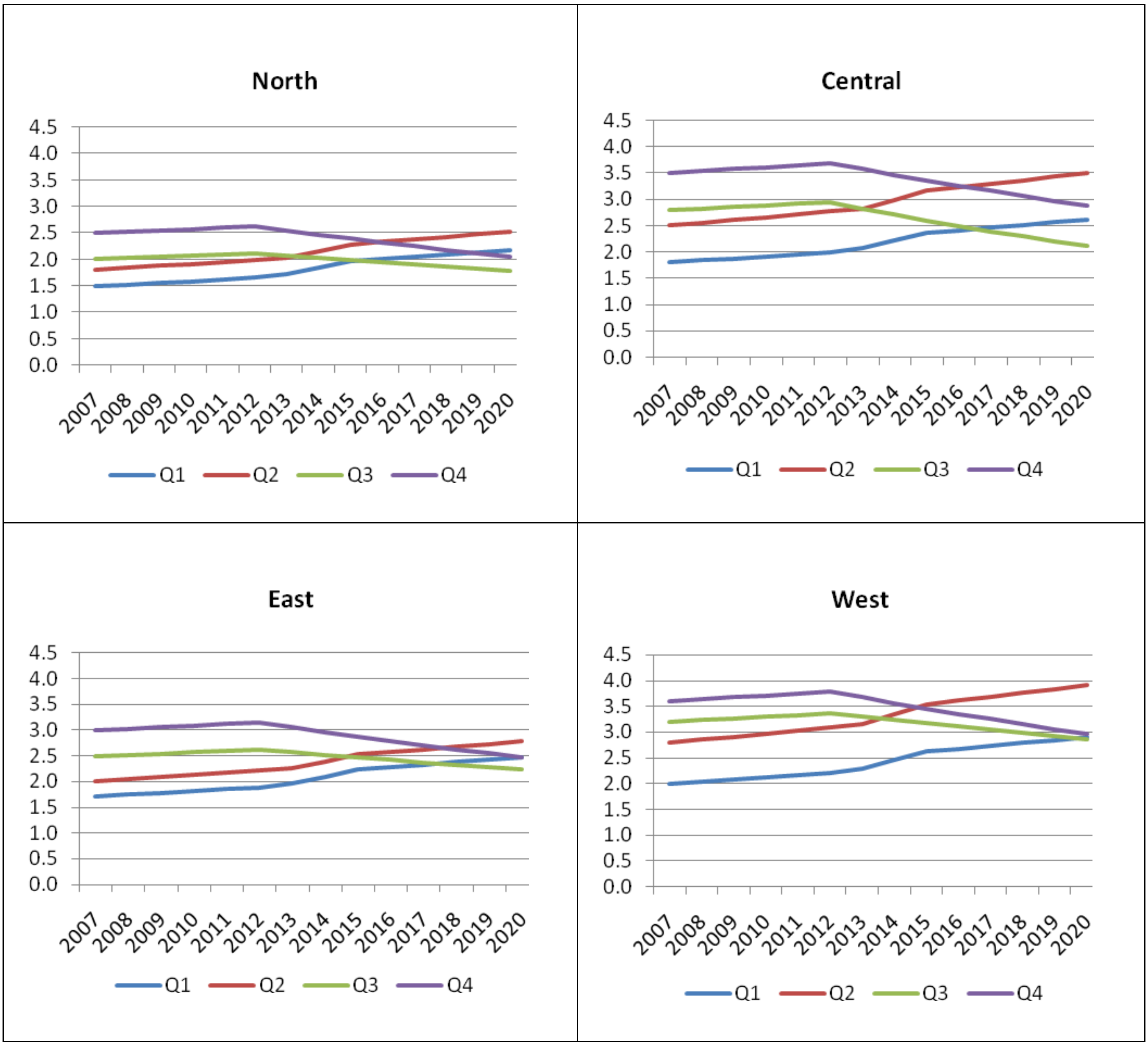
Figure 33: Poverty Rates in 2016



Targeted ART Programs

For practical policy implementation, running a fully blown universal provision of ARTs to all households would require considerable resources. Nevertheless the government could run more targeted campaigns based on income levels of households or severity and incidence of the disease in a particular region. For instance, the government could decide to only provide ART's to all households in the first two quintiles (Q1 and Q2). Alternatively, it could provide ARTs to households in specific regions for example rural areas. We run an experiment where the government is only targeting households in the first two quintiles. In this case it is assumed that for the households in the Q3 and Q4 category, they can afford the drugs without government help. As shown in the figures below, we observe that with a targeted program there would be a convergence in the growth rates of income between the poor and the rich. The AIDS treatment programs are therefore 'pro-poor' since all households tend to benefit and if well targeted they could also reduce inequality (Ravallion and Chen, 2003).

Figure 34: Regional Poverty Rates with Targeted ART



4. Conclusions and Policy Implications

AIDS has had significant effects on Uganda's growth rate. On average, the loss in growth over the period 2008 – 2016 is estimated to be a reduction in GDP growth of about 1.2 percentage points where there is no treatment, as compared to the hypothetical no AIDS scenario. Besides reduced labour supply, the pandemic has affected the economy through the reduction in productivity of labour. This is as a result of general weakness and absenteeism from work due to the disease. In addition, households that are affected by the disease tend to spend more on health related activities. This results in lower savings and therefore the available resources for future investment are also reduced. The contributors to reduced growth, without treatment, include reduction in the population and available labour force (-0.4%), productivity effects (-0.3%) and reduced savings and investment (-0.5%).

With these clear negative channels through which the disease affects the economy, it is reasonable to suggest that government to a certain extent should intervene to provide medical care for AIDS patients. This could be done by implementing a universal health program where every patient gets free ARTs. This would free up the high medical expenses sometimes incurred by households. However, while this is desirable, the cost of implementing such a program could be very high. Alternatively, the government could target certain income groups or regions for example rural areas.

It is also found that with ART availability, the reduction in growth could be much less. With medium ART provision (2/3 of those in need), the reduction in growth would be around 0.8%, and with high ART provision the reduction would be only 0.6%. Hence a full ART rollout could cut the negative growth impact of HIV/AIDS by around half.

Nevertheless the type of financing arrangements used for HIV/AIDS programmes can have considerable additional effects on growth. Foreign (donor) funding can cause real exchange rate appreciation and in turn retard exports and growth, although this may be offset by the transfer of resources from the rest of the world that leads to higher real incomes. Domestic financing leads to higher taxes or borrowing, which also have a negative impact on growth.

There have been concerns that huge AIDS-related inflows of donor funding could hurt the economy by appreciating the shilling and thereby reducing the competitiveness of exports. While there is some merit in this argument, where some exportable goods reduce and imports increase thereby resulting into a higher trade deficit, the overall macroeconomic effect still remains positive. This is due to the fact that the increased labour supply and productivity of the population dominates the negative implications of the appreciation of the shilling.

The conclusion of the CGE analysis is that the beneficial impact of ART provision can be greatly offset by the negative impacts of programme financing, especially if it has to be financed domestically. For instance, whereas an average growth rate over 2008-2016 of 5.4% is projected under the medium ART scenario before financing is considered, this is reduced to 4.1% if it is entirely domestically funded. However, if donors largely financed the programme (85%), then the projected growth rate is largely unchanged at 5.2%. Hence if the benefits of ART provision are to be maintained, it is important that the programme be predominantly donor financed.

Hence looking further ahead to the time when donor funding may not be available to fund the majority of HIV/AIDS programmes, the burden of domestic financing would be substantial. The results of funding HIV/AIDS programmes through the government budget or higher taxation would be to impose a considerable growth burden.

Table 18: Average real GDP Growth Rates by Sector (2008-2016)

Scenario	Overall GDP	Agriculture	Industry	Services
BASE	6.2	3.7	6.5	7.1
HIV/AIDS Impacts				
AidsNoART	5.8	3.2	6.0	6.7
AidsMedART	6.0	3.4	6.3	6.9
AidsHigART	6.1	3.5	6.4	7.0
TFPNoART	5.5	2.9	5.7	6.4
TFPMedART	5.8	3.3	6.1	6.7
TFPHigART	6.0	3.4	6.2	6.9
HHExpNoART	5.0	3.1	4.3	6.1
HHExpMedART	5.4	3.4	4.9	6.5
HHExpHigART	5.6	3.5	5.3	6.7
Financing Impacts				
D85G15NoART	4.5	3.0	2.6	6.0
D50G50NoART	4.2	3.0	1.6	6.0
D0G100NoART	3.8	3.0	(0.1)	5.9
D85G15MedART	5.2	3.3	4.2	6.5
D50G50MedART	4.8	3.3	2.6	6.4
D0G100MedART	4.1	3.3	(0.0)	6.3
D85G15HigART	5.7	3.4	5.4	6.7
D50G50HigART	5.1	3.4	3.1	6.6
D0G100HigART	4.1	3.4	(0.9)	6.4

Table 19: Macroeconomic Indicators (average growth rates, 2008-16)

	INITIAL	BASE	Aids NoART	Aids MedART	Aids HigART	TFP NoART	TFP MedART	TFP HigART	HHExp NoART	HHExp MedART	HHExp HigART
Absorption											
Consumption	26445.52	5.53	5.10	5.34	5.40	4.88	5.17	5.29	4.42	4.79	4.98
Investment	18742.54	5.95	5.52	5.75	5.82	5.28	5.57	5.69	5.44	5.71	5.82
Exports	5014.03	6.32	5.73	6.07	6.15	5.51	5.92	6.05	2.29	3.24	3.93
Imports	3334.56	10.59	10.15	10.39	10.45	9.80	10.13	10.27	8.86	9.37	9.68
Real exchange rate	9189.84	6.18	5.80	6.01	6.06	5.57	5.83	5.94	5.01	5.38	5.59
Nominal exchange rate	66.36	-1.02	-1.12	-1.05	-1.04	-1.11	-1.05	-1.03	-1.14	-1.10	-1.09
Investment to GDP	100	-1.02	-1.13	-1.06	-1.04	-1.13	-1.05	-1.04	-1.16	-1.11	-1.09
Foreign Savings to GDP	21.79	0.00	-0.08	-0.03	-0.02	-0.07	-0.02	-0.01	-0.57	-0.45	-0.36
Trade Deficit to GDP	9.74	-0.45	-0.43	-0.44	-0.44	-0.42	-0.43	-0.44	-0.39	-0.41	-0.42
Government Savings GDP	25.45	-0.71	-0.72	-0.72	-0.72	-0.70	-0.70	-0.71	-0.65	-0.66	-0.67

	INITIAL	D85G15 NoART	D50G50 NoART	D0G100 NoART	D85G15 MedART	D50G50 MedART	D0G100 MedART	D85G15 HigART	D50G50 HigART	D0G100 HigART
Absorption										
Consumption	26445.52	3.99	3.60	3.03	4.83	4.21	3.30	5.48	4.59	3.27
Investment	18742.54	5.08	4.86	4.53	5.59	5.22	4.69	5.93	5.42	4.70
Exports	5014.03	-1.41	-4.08	-9.34	1.75	-1.85	-9.96	4.15	-0.61	-14.54
Imports	3334.56	7.76	7.69	7.49	7.91	7.90	7.62	7.68	7.78	7.36
Real exchange rate	9189.84	4.35	3.85	3.11	5.24	4.44	3.25	5.98	4.84	3.09
Nominal exchange rate	66.36	-1.23	-1.16	-1.09	-1.27	-1.16	-1.03	-1.40	-1.24	-1.08
Investment to GDP	100	-1.28	-1.22	-1.15	-1.31	-1.21	-1.08	-1.44	-1.29	-1.15
Foreign Savings to GDP	21.79	-1.06	-1.34	-1.75	-0.70	-1.13	-1.80	-0.39	-1.02	-2.04
Trade Deficit to GDP	9.74	-0.37	-0.49	-0.66	-0.19	-0.40	-0.66	0.03	-0.28	-0.67
Government Savings GDP	25.45	-0.66	-0.78	-0.95	-0.47	-0.68	-0.95	-0.27	-0.58	-0.99

Table 20: Poverty Indicators

	Base	HHExp NoART	HHExp MedART	HHExp HigART	D85G15 NoART	D0G100 NoART	D85G15 MedART	D0G100 MedART	D85G15 HigART	D0G100 HigART
Poverty P0										
2007	31.14	31.14	31.14	31.14	31.14	31.14	31.14	31.14	31.14	31.14
2008	30.17	29.67	29.68	29.73	29.66	29.65	29.62	29.62	29.66	29.65
2009	28.93	28.22	28.19	28.25	28.34	28.34	28.19	28.32	28.26	28.35
2010	27.55	26.76	26.60	26.64	26.94	27.33	26.69	27.16	26.65	27.26
2012	25.31	24.82	24.24	24.21	25.50	26.04	24.68	25.89	24.26	25.91
2013	23.99	23.81	23.14	23.10	24.71	25.89	23.73	25.63	23.05	25.76
2014	22.54	22.79	22.14	22.06	24.20	25.92	22.71	25.57	21.92	25.74
2015	21.66	22.11	21.25	21.08	23.80	26.10	21.92	25.71	21.13	25.96
2016	20.68	21.54	20.58	20.30	23.66	26.44	21.45	25.96	20.31	26.44
Poverty P1										
2007	8.84	8.84	8.84	8.84	8.84	8.84	8.84	8.84	8.84	8.84
2008	8.41	8.25	8.26	8.28	8.24	8.23	8.23	8.22	8.25	8.24
2009	7.99	7.74	7.74	7.76	7.74	7.76	7.72	7.75	7.73	7.77
2010	7.57	7.31	7.26	7.28	7.35	7.42	7.26	7.38	7.25	7.40
2012	6.74	6.58	6.44	6.44	6.76	7.03	6.52	6.93	6.41	6.97
2013	6.34	6.26	6.10	6.06	6.55	6.95	6.22	6.84	6.05	6.89
2014	5.95	6.00	5.77	5.72	6.39	6.96	5.95	6.81	5.71	6.88
2015	5.59	5.77	5.49	5.41	6.28	7.03	5.72	6.86	5.40	6.97
2016	5.25	5.57	5.24	5.13	6.22	7.19	5.52	6.99	5.13	7.15

Appendix: Salient Features of the CGE Model

The CGE model used in the present study is based on a standard CGE model developed by Lofgren, Harris, and Robinson (2002). This is a real model without the financial or banking system. It cannot be used to forecast inflation. The CGE model is calibrated to the 2007 SAM. GAMS software is used to calibrate the model and perform the simulations.

Productions and commodities

For all activities, producers maximize profits given their technology and the prices of inputs and output. The production technology is a two-step nested structure. At the bottom level, primary inputs are combined to produce value-added using a CES (constant elasticity of substitution) function. At the top level, aggregated value added is then combined with intermediate input within a fixed coefficient (Leontief) function to give the output. The profit maximization gives the demand for intermediate goods, labour and capital demand. The detailed disaggregation of production activities captures the changing structure of growth due to the pandemic.

The allocation of domestic output between exports and domestic sales is determined using the assumption that domestic producers maximize profits subject to imperfect transformability between these two alternatives. The production possibility frontier of the economy is defined by a constant elasticity of transformation (CET) function between domestic supply and export.

On the demand side, a composite commodity is made up of domestic demand and final imports and it is consumed by households, enterprises, and government. The Armington assumption is used here to distinguish between domestically produced goods and imports. For each good, the model assumes imperfect substitutability (CES function) between imports and the corresponding composite domestic goods. The parameter for CET and CES elasticity used to calibrate the functions used in the CGE model are exogenously determined.

Factor of production

There are 6 primary inputs: 3 labour types, capital, cattle and land. Wages and returns to capital are assumed to adjust so as to clear all the factor markets. Unskilled and self-employed labor are mobile across sectors while capital is assumed to be sector-specific.

Institutions

There are three institutions in the model:, households, enterprises and government. Households receive their income from primary factor payments. They also receive transfers from government and the rest of the world. Households pay income taxes and these are proportional to their incomes. Savings and total consumption are assumed to be a fixed proportion of household's disposable income (income after income taxes). Consumption demand is determined by a Linear Expenditure System (LES) function. Firms received their income from remuneration of capital; transfers from government and the rest of the world; and net capital transfers from households. Firms pay corporate tax to government and these are proportional to their incomes.

Government revenue is composed of direct taxes collected from households and firms, indirect taxes on domestic activities, domestic value added tax, tariff revenue on imports, factor income to the government, and transfers from the rest of the world. The government also saves and consumes.

Macro closure

Equilibrium in a CGE model is captured by a set of macro closures in a model. Aside from the supply-demand balances in product and factor markets, three macroeconomic balances are specified in the model: (i) fiscal balance, (ii) the external trade balance, and (iii) savings-investment balance. For fiscal balance, government savings is assumed to adjust to equate the different between government revenue and spending. For external balance, foreign savings are fixed with exchange rate adjustment to clear foreign exchange markets. For savings-investment balance, the model assumes that savings are investment driven and adjust through flexible saving rate for firms. Alternative closures, described later, are used in a subset of the model simulations.

Recursive Dynamics

To appropriately capture the dynamic aspects of AIDS/HIV on the economy, this model is extended by building some recursive dynamics by adopting the methodology used in previous studies on Botswana and South Africa (Thurlow 2007 and Arndt and Lewis 2001). The dynamics is captured by assuming that investments in the current period are used to build on the new capital stock for the next period. The new capital is allocated across sectors according to the profitability of the various sectors. The labour supply path under different policy scenarios is exogenously provided from a demographic model. In addition, total factor productivity is also exogenously provided according to the assumed impact of AIDS. The model is initially solved to replicate the SAM of 2007.

Chapter 4: Summary and Conclusions

1. Introduction

The macroeconomic modelling exercises described in detail in chapters two and three of this report provide extensive analysis and projections of the likely impact of HIV/AIDS on the Ugandan economy, and of the economic impact of interventions, specifically the provision of Anti-retroviral Therapy (ART). This chapter contains a summary of these results, and the associated policy recommendations.

2. Results of Macroeconomic Modelling and Analysis

The purpose of the two macroeconomic modelling exercises was to quantify some of the macroeconomic impacts described in Chapter 1 of this report, and to provide analytical support for important policy decisions. In particular, it addressed the extent to which HIV/AIDS has had and is likely to have an impact on Uganda's economic growth, and the extent to which expenditure on HIV/AIDS programmes is likely to boost growth through alleviating some of the negative impacts.

Impact of HIV/AIDS on Economic Growth

Analysis of the effect of HIV/AIDS on economic growth was addressed in two different ways: (i) through an aggregate growth model (AGM), and (ii) through a Computable General Equilibrium (CGE) model.

Aggregate Growth Model

The AGM analyses the impact of HIV/AIDS on growth, incomes and employment over the twenty years from 2005 to 2025. The economy is considered at a high level, with a division only into agricultural and non-agricultural sectors. It analyses the impact of HIV/AIDS only (through labour and capital cannels), but not at other, indirect macroeconomic impacts such as exchange rate effects.

The results of the AGM modelling exercise show that[18]:

- AIDS will have a negative impact on the rate of economic growth in Uganda; if investment is strongly negatively affected, the rate of GDP growth will fall from a projected 6.5 percent a year without AIDS to an estimated 5.3 percent under the "AIDS-without-ART" scenario, and by 2025 the economy will be 39 percent smaller than it would have been without AIDS;
- however, most of the negative economic impact of HIV/AIDS has already been incurred – of the 39 percent reduction in the size of the economy by 2025 due to HIV/AIDS, the majority of this had been incurred prior to 2005;
- the impact on the growth of average real incomes (per capita GDP) is also negative, if investment is strongly affected, averaging 1.7 percent a year under the "AIDS-without-ART" scenario, compared to 2.7 percent a year without AIDS, and would be 33 percent lower by 2025 (this contrasts with the results of some other studies, which found that GDP per capita could plausibly rise as a result of HIV/AIDS, on the basis that the reduction in GDP growth could be smaller than the reduction in population growth);

[18] For full details see Chapter 2.

- due to the sharp drop in investment (and hence weak demand for labour), wage growth is slower;
- the economy remains more agricultural as a result of HIV/AIDS; without AIDS, the agricultural sector would have accounted for 16 percent of GDP and 59 percent of employment in 2025, whereas under the AIDS-without-ART scenario, it accounts for 22 percent of GDP and 68 percent of employment at that time; this is because the reduced investment due to HIV/AIDS and lower economic growth and demand for labour in the non-agricultural sector as a result of HIV/AIDS forces more people to remain in the agricultural sector;

It is important to note that although both GDP and average income growth rates may fall as a result of AIDS, *they both remain positive*. In other words, in the scenarios chosen here, neither GDP nor average incomes will be lower in 2025 years than they are now - they may simply be lower than they would have been without AIDS.

While HIV/AIDS has had and will continue to have a negative impact on the economy as a result of slower growth, much of this has already been incurred and it is too late to avoid it. However, the extent of provision of HIV/AIDS is a policy decision that is current, and the model also analyses the impact of ART provision on economic growth. The results show that although all of the with-AIDS scenarios are less favourable than the without-AIDS scenario, the widespread provision of ART has a number of positive economic impacts (compared to the AIDS-without-ART scenario); in particular:

- economic growth is higher (averaging 5.7% rather than 5.3%);
- real per capita GDP growth is higher (averaging 2.0% rather than 1.7%)
- economic activity and employment is shifted towards the (more productive) non-agricultural sector
- average wages in the non-agricultural sector are higher.

The negative economic effects of HIV/AIDS are therefore considerably offset by the provision of ART.

Macroeconomic Analysis: Results of Phase II

The macro-econometric study component of Phase II considered some of the broader macroeconomic impacts related to HIV/AIDS, which are not directly considered in the AGM. In particular, the study considered:

- the determinants of Uganda's exports, with a focus on the role of the real exchange rate, so as to shed light on the potential dangers of real exchange rate appreciation resulting from inflows of donor funds;
- the linkages between aid flows and inflation in Uganda, so as to shed light on whether, historically, the monetisation of aid flows has had an inflationary impact.

Real Exchange Rate and Exports: the study considered the impact of the real effective exchange rate (REER) on total exports and six major Ugandan exports (coffee, tea, cotton, fish, maize and flowers) over the period 1994-2006. The findings did not indicate a relationship between the REER and total exports. However, the study did find that the REER would affect specific exports, namely, fish, flowers and cotton, which account for nearly a quarter of total exports. Thus, for fish, flowers and cotton, the findings indicate a possible Dutch Disease effect. Since a possible Dutch effect would reduce some exports, it could have negative implications for poverty reduction in the long run. The impact of the REER was largest for flowers, where a 1% appreciation in the REER was associated with a 2.9% decrease in exports, and for fish (2.7%); the impact of the REER on cotton exports was much smaller at 0.04%.

These results suggest that even if there is some REER appreciation (as e.g. in the "Absorb and Spend" scenario, it would not have a major impact on overall exports, although it would have an effect in certain sectors.

Aid Flows, the Exchange Rate and Inflation: the study finds that an increase in aid flows is associated a long-term increase in the money supply, as expected. However, this does not lead to any long-term increase in prices or to real exchange rate appreciation, which suggests that the Bank of Uganda's monetary policy and sterilisation strategy has been successful. In the short run, an increase in aid is associated with greater volatility in both prices and the REER, though the impact is small. This could be damaging to private sector investment. Moreover, aid dependence led to high transactions costs (interest costs) through sales of securities by the monetary authorities. This would have negative implications for medium-term fiscal sustainability and domestic debt sustainability. One of the key conclusions arising from these results is the need to ensure stability and predictability in aid flows.

CGE Model[19]

The various different channels of impact are combined in the modelling carried out using the CGE model. This combines both the growth impacts of HIV/AIDS under the "with ART" and "without ART" scenarios, as well as some of the broader macroeconomic impacts. The CGE model, for instance, captures the effects of real exchange rate appreciation (although it cannot capture the effects of monetary impacts, interest rates or inflation). It is also highly disaggregated, and enables the impact on different sectors of the economy to be traced.

The results of the CGE model are consistent with those of the aggregate growth model. The CGE results indicate that HIV/AIDS will reduce average growth from 6.2% a year to 5.0% a year over the period 2008 – 2016, a reduction of 1.2% a year (the AGM had growth falling by the same amount, from 6.5% a year to 5.3%, although over a longer period). The CGE model also simulates the impact of ART provision, which boosts growth by 0.6% (compared to 0.4% in the AGM). The CGE therefore gives a somewhat larger positive impact of ART provision (it compensates for 50% of the negative growth impact of HIV/AIDS, compared to around 30% in the AGM).

At a sectoral level, manufacturing registers the largest reduction in output. Part of the reason is that while the manufacturing sector is capital intensive, the labour input required for this sector tends to be more skilled. Loss of this labour is costly to manufacturing firms given retraining costs and advertising expenses and could lead to large output losses. Although the output losses in agriculture are lower in absolute terms, in proportionate terms they are larger as agriculture is generally slow growing. Hence the relative impact on the agricultural sector is larger.

The CGE model goes beyond the AGM by incorporating the impact of alternative financing macroeconomic mechanisms for HIV/AIDS programmes, i.e. assuming that the costs are not just met privately by households and firms.

One particularly important aspect of the CGE is that it includes the negative growth impacts of REER appreciation as well as the positive growth impacts of ART provision. Where foreign aid is used to fund ART provision, there is REER appreciation which may negatively affect exports. Similarly, when domestic financing is used, funded additional taxes or government borrowing, the CGE can incorporate the impact of this on the domestic economy.

[19] For full details, see Chapter 3.

The results in Chapter 3 show that financing mechanisms are crucial, and that in general foreign financing is far preferable to domestic financing. The analysis concludes that the positive effects of donor financing outweigh the negative effects. In particular, the positive aspects of the productivity effects as a result of treatment and the increased labour supply dominate the negative effects that are associated with the appreciation of the shilling due to the development assistance for AIDS programs. By contrast, the negative effects of higher taxation or borrowing are much greater than the negative effects of REER appreciation.

While the CGE results from different scenarios are not directly applicable to the absorb-spend scenarios outlined in chapter 1 (in that CGE modelling cannot incorporate monetary and inflation effects), they can be broadly approximated, as follows.

- Absorb & spend – accept foreign assistance and spend on ART and other HIV/AIDS programmes
- Absorb & don't spend – accept foreign assistance but don't spend on ART
- Don't absorb, but spend – use domestic funds to finance ART provision, take foreign exchange inflows (ODA) into reserves
- Don't absorb & don't spend - take foreign exchange inflows into reserves, don't provide ART

The CGE simulations provide estimated growth rates under each of these scenarios (see Table 21). Under the spend scenarios, both medium and high ART provision are reported. There is considerable variation in growth, and the relative impact of the different scenarios is instructive. Clearly, the donor-funded High-ART scenario has the highest growth rate, whereas the domestically-funded No-ART scenario has the worst.

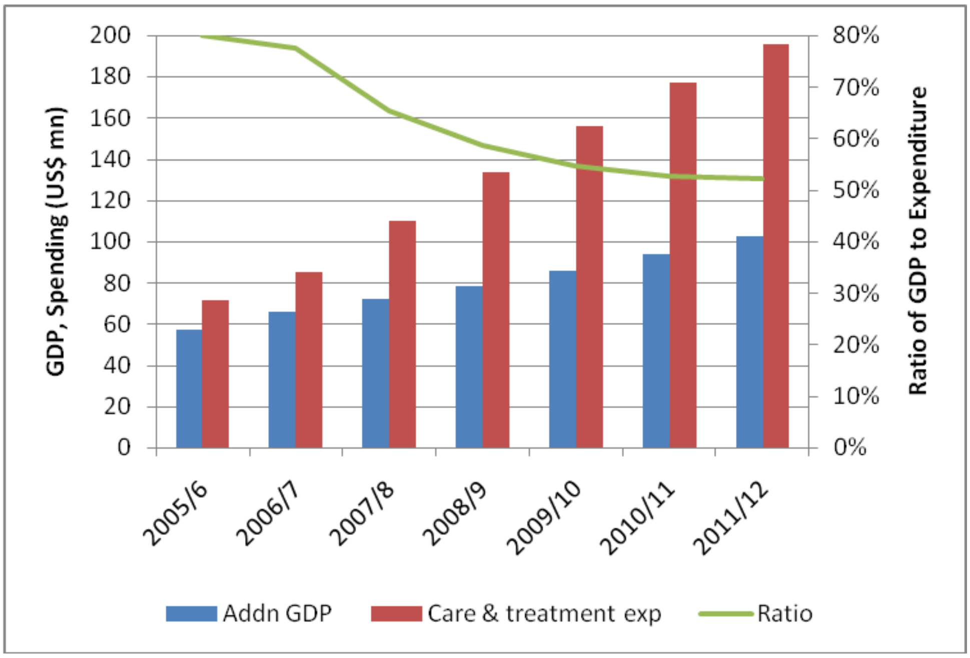
Table 21: Growth rates in Absorb/Spend scenarios (average, 2008-2016)

	Spend		Don't spend
Absorb	D85G15-HighART 5.7%	D85G15-Med ART 5.2%	D85G15-No ART 4.5%
Don't absorb	D0G100-HIghART 4.1%	D0G100-Med ART 4.1%	D0G100-No ART 3.8%

Economic Returns to Investment in ART

The economic modelling projections show that the provision of ART has a beneficial effect on the economy. However, they do not directly answer the question of whether expenditure on ART represents a good economic investment. As the modelling results show, the provision of ART should add around 0.6% a year to GDP growth; with total GDP of approximately $11 billion in 2006/07, this represents an additional $66 million of GDP, rising to an estimated $102 million in 2011/12. However, the expenditure required to achieve this extra GDP would be in excess of this amount; taking the "care and treatment" component of the NSP budget only (which relates mainly to ART provision), this amounted to $85 million in 2006/07, rising to $196 million in 2011/12. The analysis in this study suggests that the additional GDP generated by ART provision is only equivalent to around 50 percent of the cost of that provision (see Figure 35). However, the fact that the cost of ART is largely donor funded means that there is still a net economic benefit for Uganda.

Figure 35: Spending on ART and additional GDP – High ART



Error! Not a valid bookmark self-reference. shows a similar comparison for a lower level of ART provision (the medium ART scenario), which would add an estimated 0.4% to GDP growth, and involve a lower level of spending. He broad conclusion – that the additional GDP created would be significantly less than the expenditure required – remains unchanged. The results (in value terms) are presented in below.

Figure 36: Spending on ART and additional GDP – Medium ART

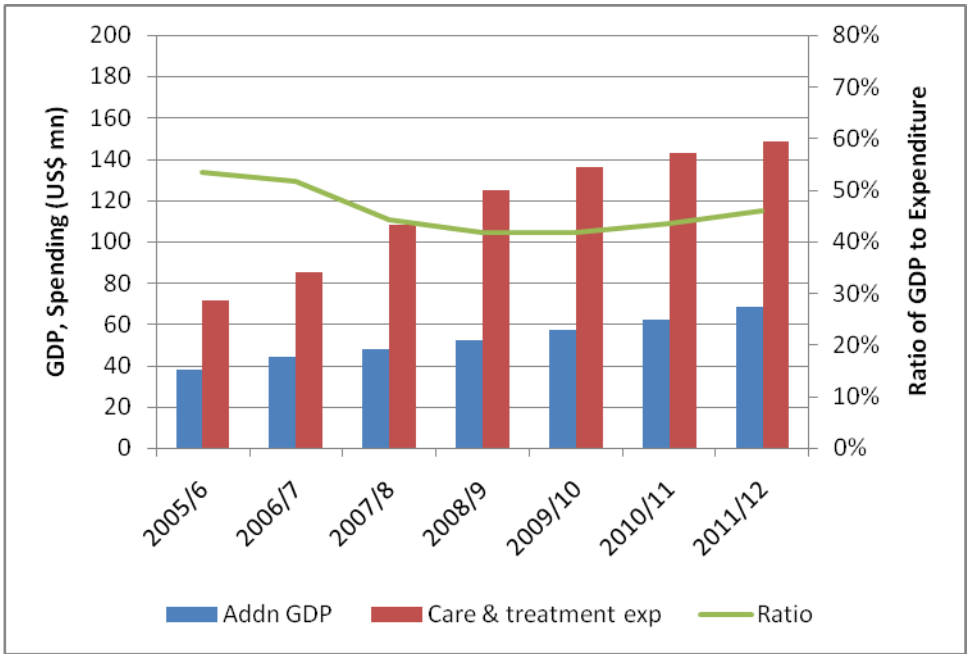


Table 22: ART Spending and Additional GDP (Annual Average, 2007/08 – 2011/12)

Scenario	Spending ($m)	Addn. GDP ($m)	Ratio (GDP/Exp.)
High ART	155	86	56%
Medium ART	132	58	44%

Expenditure Choices: Treatment vs Prevention

The relatively poor economic return to spending on ART raises the question as to whether other forms of spending on HIV/AIDS programmes, such as prevention, might be more efficient in economic terms[20]. At a broad level, it is difficult to make comparisons between the efficiency of spending on prevention and treatment – treatment may still be justified once people are infected, even if it would have been better to prevent them from becoming infected in the first place. However, some comments on the relative prioritisation of limited resources for HIV/AIDS programmes may be justified.

This study has not made any estimates of the cost-effectiveness of prevention programmes. However, some information is provided in Stover, Mukobe and Muwonge (2007). This paper[21] notes that:

- The WHO considers health interventions to be very cost-effective if the cost per disability-adjusted life year (DALY) is less than Gross National Income per capita, and cost-effective if less than three times GNI per capita;
- Prevention spending in Uganda costs around $1275-$1500 per infection averted, resulting in a cost of approximately $50 per DALY gained;
- The total discounted cost (NPV) to treat a new infection is about $5900. Therefore, expenditure on prevention is extremely cost-effective.
- Treatment costs for ART drugs alone amount to amount to $1031 per patient per year for first-line therapy (anticipated to decline to $500) and $1897 for second-line therapy (anticipated to decline to $600).

From these and other data it can be concluded that:

- Prevention expenditure is very cost effective (comparing a cost of $50 per DALY with GDP per capita of around $400)
- Treatment is probably not cost-effective (using the 3xGNI per capita benchmark) at current cost levels, especially once additional (non-drug) costs are taken into account, but could become cost effective once anticipated cost reductions are achieved
- To the extent that a a choice had to be made between expenditure on prevention and on treatment, prevention is far more cost-effective.

However, the choice between "prevention" and "treatment" is becoming somewhat blurred. Given the failures of efforts to date to find an effective vaccine for HIV, attention is turning to the preventative benefits of widespread ART treatment. This is because ART reduces viral loads in HIV-positive individuals, and hence makes them less likely to transmit the virus. In the long-term, it may

[20] Prevention programmes are wide-ranging, and include condom distribution, male circumcision, prevention of mother to child transmission (PMTCT) as well as information, education and communication.

[21] Supplemented by communications with John Stover

be that having a large proportion of HIV+ people on ART may be an effective means of preventing transmission, and thus play a crucial role in containing the epidemic. Evaluation of the effectiveness of ART treatment as a form of prevention is at an early stage, and has not been quantitatively established. But if it does turn out to be effective, then the benefits of ART treatment will be greater than the narrow economic effects considered in this study.

Scaling-up Issues

One important issue that it is not possible to address through the modelling process is that of how fast HIV/AIDS programmes can be scaled up. This is because the models used in Chapters 2 and 3 compare the economy at different points in time, but cannot address the dynamics of moving between those two points. The macroeconomic analysis does not deal with the optimal speed of scale-up in ART provision; it simply deals with the economic impacts once large-scale ART rollout is achieved. Nevertheless, there will be challenges relating to the speed of scale-up; the faster programmes are scaled-up, the more likely it is that the economy will face absorptive capacity constraints which will lead to inflation, reduce the effectiveness of expenditure, and reduce value-for-money in donor-financed spending. The speed of scale-up is important, because bottlenecks may arise that limit the ability to roll out new or expanded programmes quickly. This is a particularly important issue in Uganda. As discussed earlier, the country already spends a high proportion of GDP on HIV / AIDS programme, relative to HIV prevalence levels, and considerable further scale-up is envisaged.

In order to prevent such bottlenecks from reducing aid effectiveness, it will be necessary to assess resource needs and plan effectively for their provision (see ODI (2005) for how this was done in Botswana). In other words ART rollout is not just about ensuring sufficient funding, it is equally about ensuring that sufficient human resources (doctors, nurses, pharmacists, counsellors), physical resources (health and related facilities) and health information systems (for tracking and monitoring diagnoses, prescriptions, treatment adherence, drug resistance etc.) are in place. This in turn depends on a variety of factors, including the quality of health sector management, low level of corruption etc.

Botswana's experience does show that rapid scale up of HIV/AIDS programmes is feasible. As Figure 37 shows, Botswana increased real spending on HIV/AIDS programmes between 2003 and 2007. Uganda's "High Funding" scenario in the NSP envisages a similar speed of scale-up. However, it is questionable as to whether such a rapid scale-up is feasible. Uganda fares much worse than Botswana on international assessments of public sector capacity, governance, competitiveness and corruption (see Table 23). This suggests that bottlenecks would be encountered at an earlier stage of rollout of HIV/AIDS programmes, and that a more modest rate of scale-up, such as that in the alternative "medium funding" NSP scenario might be more cost-effective and less wasteful. Furthermore, it will be important to ensure that resources are devoted to growth-enhancing projects and interventions (which includes the provision of ART) and that the focus should be on removing implementation bottlenecks.

Figure 37: Projected Scale-up of HIV/AIDS spending in Uganda and Botswana

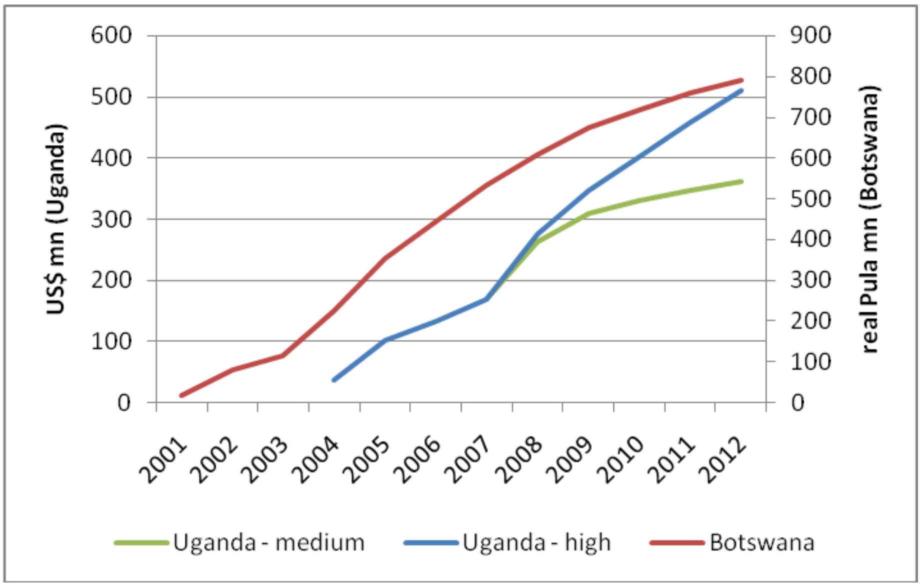


Table 23: Botswana and Uganda scores on international assessments (ranking)

	Botswana	Uganda
Mo Ibrahim Index of African Governance (/48)	4	19
Transparency International Corruption Perceptions Index (/180)	36	126
WEF Global Competitiveness Index (/137)	56	128

Mo Ibrahim Index, 2006 (percentile rankings)

Country	Security	Rule of Law	Participation and Rights	Economic Opportunity	Human Development	Overall
Botswana	75.0	81.6	87.4	58.2	68.0	74.0
Uganda	75.1	55.8	61.0	42.2	57.4	58.3

A related issue concerns the sustainability of donor funding for a scaled-up HIV/AIDS programmes. Even though there are economic benefits for a scaled-up HIV/AIDS programme, this does not deal with long-term sustainability issues. The treatment of HIV/AIDS requires a long-term commitment of resources, which would pose an unsustainable burden on the Uganda economy for the foreseeable future. Hence credible long-term donor funding commitments are necessary for the programme to be sustainable.

In this context, a policy that incorporates a combined "Absorb and Spend" and "Don't Absorb and Don't Spend" response may be the most rational. First, it mitigates some of the negative impacts that may result from a too-rapid scale up of spending, or from volatility in flows of donor funding. It therefore supports a slower scale-up, which may be more effective in the long run. Second, it enables the accumulation of resources (in the form of foreign exchange reserves and government financial balances) that can be used to finance future resource needs when donor inflows decline (whether temporarily or permanently). Third, a partial "Don't Absorb and Don't Spend" approach minimises the monetary sterilisation costs that would arise from an "Absorb but Don't Spend" approach.

Ideally donor funds should be used to create a capital (financial) asset that could be used to draw a permanent (annuity) income for financing HIV/AIDS programmes, rather than being used to finance immediate spending. This would contribute to the long-term sustainability of HIV/AIDS programmes. Governance issues for such a fund would be important, although there are various ways in which it could be managed to ensure that income is only drawn down at a sustainable rate and for the purposes intended.

3. Conclusions

The macroeconomic analysis in Phase III has concluded that HIV/AIDS has had a considerable negative macroeconomic impact on Uganda, and will continue to do so for the foreseeable future. The main conclusions and policy implications are that:

- In terms of economic growth and incomes, this negative impact can be partially – but not completely – offset through the provision of appropriate treatment (ART);
- While there are high levels of expenditure associated with the provision of ART, these are likely to be largely funded by external donors;
- The bulk of the donor funds received –an estimated 60% - would quickly flow out of Uganda, thereby partially mitigating any potential adverse effects;
- On balance, the potential negative impacts from a scaled up treatment programme stemming from real exchange rate appreciation are more than offset by the potential positive impacts on productivity and economic growth;
- The economic benefits of ART provision are largely dependent on the programme being donor funded, and if not donor-funded the programme offers questionable economic returns and may not be sustainable in the long term at current costs. The need to fund ART provision from domestic resources would most likely have major negative effects on the domestic economy.
- Given that the overall economic returns to investing in ART are limited (in terms of additional GDP relative to costs), ART provision is justified in human and social terms, rather than only in economic terms;
- Amongst the social justifications for ART include the positive impact that ART provision will have on poverty (and the fact that ART goes some way towards mitigating the negative impact of AIDS on poverty);
- In economic terms, investment in prevention programmes probably yields greater long-term benefits. However, it is increasingly acknowledged that ART provision may play an important role in preventing the spread of HIV as well as treating it, and if this effect can be established, it would provide further justification for the provision of ART.
- ART provision requires a long-term commitment of resources that donors may be unable or unwilling to provide. One way of ensuring greater predictability and sustainability of ODA flows for HIV/AIDS programmes would be for donors to finance a capital fund, which could be drawn down on an annuity basis (primarily financed by income earned on the fund).

- The “high funding“ scenario in the NSP entails a very rapid scale-up of ART provision that may not be optimal due to bottlenecks that are likely to be encountered in health infrastructure, governance, personnel and organisational requirements, which could undermine the effectiveness of the programme. The “medium funding” scenario may be more realistic in terms of long-term availability of donor funds as well as feasibility of scale-up.

It should be noted, however, that HIV/AIDS is only one among a range of factors that can affect long-term economic growth rates, real income and poverty levels. These include macroeconomic stability, structural reforms, and growth in regional and international economies, all of which can have a larger impact than HIV/AIDS. Indeed, it is important to make progress in areas where domestic policies can have an impact so that the negative impact of HIV/AIDS can be ameliorated.

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