The Macroeconomic Impact of HIV/AIDS in Ethiopia

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Abstract

In this paper, a small macroeconometric model of Ethiopia is used to simulate the macroeconomic impact of HIV/AIDS in Ethiopia. The model is set up in aggregate demand and supply framework and the individual equations in the model are estimated in an ECM format using the Johansen approach in view of the time series properties of the macro-time series variables. The simulation result shows that the prevalence of HIV/AIDS has a negative impact on the overall economy through lowering the active labour force. The decline in the labour force has a direct negative impact on both the output of the agricultural and non-agricultural sectors that would lead to the fall in private consumption, investment, exports and government tax revenue. The slow down of the economy would also be strengthened with the fall in imports due to the decline in exports and hence the shrinking down of the importing capacity.

Key Words: *HIV/AIDS, Macroeconometric Model, Simulation*

I. Introduction

HIV/AIDS is becoming the threat of this century especially for the low-income developing countries. The growth process of developing countries is constrained by many such as exogenous shocks like availability of rainfall, terms of trade deterioration and movement in oil price apart from the availability of the basic factors of production. These factors were the main explanatory variables in most of cross-country growth models. Nowadays, the impact of HIV/ADIS has come to the forefront to be one of the explanatory factors for the slow growth performance of developing world.

According to the UNAIDS (2000) report, 10% of African youths are infected by HIV; and in Ethiopia 280,000 working age population (14 –49years) died because of AIDS in 1999. AIDS deaths are mainly concentrated in the 20 – 50 age groups. This indicates that the economically active population- i.e. the labour force- is affected disproportionally more than the overall population.

The direct economic impact of HIV can be observed due to a reduction in labor force as a result of AIDS. Apart from such labor force reduction, the medication cost and the related opportunity costs and switching of expenditure to meet a higher medication cost also entail another adverse impact to the economy. This will, in turn, affect the saving and the steady state path of the economy.

Cuddington (1993) identified some of the mechanisms through which the AIDS epidemics affect the macro economy. Cuddington tried to establish the link between growth, saving and investment and also tried to show the loop through which a one time effect would

produce a dynamic outcome. He posits that savings would be reduced not only as a result of a higher medical cost but also through the loop channel that reduces labor force and hence growth which is positively related with savings. In addition, the increase in the dependency ratio as a result of HIV related death also reduces savings. Such a decline in the gross domestic savings will, in turn, reduce capital formation and long term growth.

From the demand side, the demand for education may also be reduced as children are forced to leave school earlier to support ill parents (Cuddington, 1993). In addition, households may switch their expenditure from education and other welfare enhancing expenditures to the financing of funeral services. This, in effect, reduces the human capital accumulation in the long run, which is associated with efficiency loss. The efficiency loss would be aggravated as AIDS shifts the composition of the labour force towards young and less-experienced workers (Cuddington, 1993).

The impact of HIV/AIDS would be transmitted from the micro units to the macro economy through different channels. A decline in the labour supply of the micro units due to the infection leads to a lower labour force in the economy which in effect contributes for a low level of output through a direct relationship between labour force and level of output as explained by a simple production function. In addition to this, output would also decline due to a lower productivity of the workers as a result of sickness and skiving. The decline in output would, in turn, affect the level of consumption, private investment, government revenue, and export while the latter also leads to a decline in consumer goods and intermediate goods imports. Moreover, the general price level might also be affected as a result of the fall in output given that the fall in supply dominates the fall in demand. The slow down of the economy may also be accompanied by the shortage of imported raw materials that would make the fall in output worse. Apart from the output and the resultant effect of HIV, it also leads to lower labour income, increase in demand for health services and a squeezed level of domestic savings which could set a potential vicious spiral circle (Quatteck, 2000).

To analyse the economic impact of HIV/AIDS in a systematic way, three different approaches are used in this study. The first one is to quantify the output lost due to the epidemics by using the average productivity of labour in the country level. In this case, the output loss can be easily, but crudely, estimated by multiplying the average productivity of labour by the lost labour force due to the epidemics. The second approach is to compute the direct medication cost of HIV using an average medication cost per adult AIDS patient over the duration of the patient's illness. The final approach, and the main focus of this study, is to use a counterfactual analysis using a macroeconometric model of Ethiopia constructed by Daniel (2001). In the counterfactual analysis, we tried to compare the HIV scenario with no HIV scenario in order to see the real impact of HIV by introducing 'a what if' type of analysis. However, all the above methods do not exhaust all the possible effects of HIV. Thus, our focus will be on output lost, medication cost and other macroeconomic variables as will be shown in the counterfactual analysis.

The rest of the paper is organized as follows. The second section contains the discussion on the cost of HIV/AIDS measured by the output lost and medication cost. Section three lays

out the outline of the macroeconometric model. The counterfactual analysis based on the outlined model is also contained in section three. The final section concludes the paper.

II. The Cost of HIV/AIDS: Output Lost and Medication Cost

2.1. Output Loss

As outlined above, the output loss can be estimated using average productivity at a country level. Tables 1 and 2 present the computation of average productivity and output loss, respectively.

Table 1: Computing Average Productivity

Year	Labour force (L)*	Output (Y)**	Y/L
1992	24.1	11799.5	489.4
1993	23.5	11999.5	511.7
1994	24.2	12646.0	523.6
1995	24.9	13987.1	562.3
1996	25.6	14713.6	574.2
1997	25.7	14512.8	564.9
1998	26.3	15413.5	585.1
1999	26.4	16218.1	615.0
Average productivity (1992 - 1999)			***553.3 Birr***

** Source: World Development Indicators, 2000 WB CD ROMS* ***Source: MEDaC*

Table 2: Potential Output Loss

Average Productivity	AIDS Death in 1999		Potential Output Loss in 1999		
	High Estimate	Low Estimate	High Estimate	Low Estimate	Average
553.3 Birr	280000	140000	154.9 mill Birr	77.5 mill Birr	116.2 mill Birr
			0.96 (% of GDP)	0.48 (% of GDP)	0.72 (% of GDP)

**Source: UNAIDS Report, www.unaids.org/epidemic_update/report*

The above tables show the average productivity of labour in the country and the possible loss of output as a result of HIV death. The potential output loss is calculated as a multiplication of the average productivity of labour and the number of adults (15-49) in the labour force died due to AIDS in 1999. According to the UNAIDS estimates the highest estimated death is 280,000 adults while the lowest is 140,000 adults. Using this data we can get the lowest and the highest estimates of output loss. The high estimate of the output loss is about 154.9 million Birr worth of output, which is around 1% of 1999/00 real GDP while the low estimate is 77.5 million Birr or around 0.5% of 1999/00 real GPD and the average estimated loss is 116.2 million Birr – i.e. 0.7% of real GDP. This implies that a proportional per capita income growth is also scarified.

2.2. Medication Cost

Apart from the output lost due to the epidemics, the treatment cost is also a significant loss to the economy for no avail. To estimate the medication cost, we need to have information about the average cost per adult AIDS patient over the duration of the patient's illness. However, such type of information in the case of Ethiopia is not accessible if not completely unavailable. As a result, we need to resort to a better proxy of the medication cost- i.e. the medication cost in other developing and comparable countries. Thus, for analytical purpose I

took the average medication cost of Tanzania (computed by Pallangyo and Laing, 1990, as quoted in Cuddington, 1993), which is 257 USD (2185 Birr) for adults, and 176.3 USD (1495.5 Birr) for children.

Table 3: Medication Cost

Infected Adult Medication Cost (1999)				Medication cost related to HIV death (1999)		
Average cost per adult	Infected Adult	Medication Cost		HIV Death	Medication Cost	
		Scenario 1*	Scenario 2*		Scenario 1*	Scenario 2*
2185 Birr	2.9 million	3.17 billion	1.58 billion	0.28 million	305.9 million	153.0 million
		5.9 (% GDP)	2.9 (% GDP)		0.6 (% GDP)	0.3(% GDP)

** Scenario 1, assuming 50% of the HIV infected adult get medication.*
**Scenario 2, assuming only 25% of the HIV infected adult get medication.*

Table 3 above shows the estimated cost of medication in relation with HIV. Since actual data on treatment of the epidemics is not available, two scenarios are considered. The first scenario is '50% of the HIV infected adult may get medication during his/her illness period' and the second scenario is 'only 25% of the HIV infected adults may get medication during the illness period'. However, it is not only the infected adults who would get medication but also those who died may incur some medication cost. So the above two scenarios are also applied to such category.

The medication cost of those who are infected, estimated under the first scenario, is around 3.2 billion Birr, which is 5.9% of GDP, while under the second scenario it is around 1.6 billion Birr – i.e. 2.9% of GDP in 1999/00. On the other hand, the estimated medication cost of those who died is around 305 million Birr –i.e. 0.6% of GDP and 153 million- i.e. 0.3%, under the first and the second scenario, respectively. Thus, the total estimated cost ranges from 1.7 billion Birr to 3.5 billion Birr, which is from 3.2 % of GDP to 6.4% of GDP.

III. The Macroeconomic Impact of HIV

In order to examine the macroeconomic impact of HIV/AIDS, a small macroeconometric model is specified in aggregate demand and aggregate supply framework. The model is developed considering the supply-constrained nature of the economy. On the supply side, total output in the economy is disaggregated into agricultural sector and non-agricultural sector, both depending on labour input, among others. In addition, since the economy is characterized by a general capacity under utilization, the capacity utilization rate of the economy is also specified. On the demand side, the private and public consumption expenditures and private investment expenditure functions are specified. The government investment is assumed to be exogenous. In addition to the public and private expenditure components, the domestic demand for imports (disaggregated into consumption goods import and intermediate goods import) and foreign demand for export is included on the demand side. The monetary sector contains a behavioural money demand and money supply equations. The money supply equation is endogenous to the model to capture the

monetization of the deficit. The price and the real exchange equations are also specified and hence they are determined endogenously.

3.1. The Model

Aggregate Demand

Aggregate demand for domestic output is the sum of domestic absorption and the trade balance.

$$Y = A + (X-Z)$$

Where A is domestic absorption and X and Z are export and import, respectively.
Domestic absorption is in turn the sum of private consumption (C), investment (I) and government expenditure on domestic goods (G).

Private Consumption

The consumption function is specified in the traditional way in which consumption level is a function of income and price level. The function is given as

$$\text{Log } RC_{pt} = \beta_{10} + \beta_{11} P_t + \beta_{12} \log RC_{t-1} + \beta_{13} \log RY_t + \beta_{14} \log RY_{t-1} \quad \ldots\ldots\ldots(1)$$

where RC_{pt} is real private consumption, P_t is the price level and RY is real income.

Private Investment

The private investment function is specified based on FitzGerald et. al (1992). The model is basically an accelerator model but it is extended to capture the external constraints to private investment.

The private investment (Ip) function is defined in the simple accelerator model to show the adjustment of capital stock (K*) to its desired level (K_{pt-1}).

$$I_{pt} = \lambda(K^*_{pt} - K_{pt-1}) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2.1)$$

Where λ is the adjustment coefficient.

The desired capital stock for the current year (K^*_{pt}) is given as

$$K^*_{pt} = b_1 RY_t + b_2 kg_{t-1} + b_3 DG_t + b_4 Z_t + b_5 J \ldots\ldots\ldots\ldots (2.2)$$

$$b_1 > 0; \qquad b_2 > 0; \quad b_3 < 0; \; b_4 > 0; \; b_5 < 0$$

where DG_t is level of public debt

Z_t is the level of imports; and J is capital flight

Substituting (2.2) into (2.1) and first differencing to circumvent the capital stock problem we yield

$$I_{pt} = \beta_{20} \Delta RY_t + \beta_{21} I_{gt} + \beta_{22} Z_t + \beta_{23} \Delta J_t + \beta_{24} PB_t$$

Taking the log of the above expression we have

$$LogI_{pt} = \beta_{20}\Delta LogRY_t + \beta_{21} LogI_{gt} + \beta_{22} LogZ_t + \beta_{23}\Delta LogJ_t + \beta_{24} LogPB_t \quad \ldots\ldots\ldots(2.3)$$

Where PB is first difference of DG and implies public current borrowing; and I_{gt} is the first difference of government capital stock implying the government investment expenditure. Since the measurement of capital flight is controversial and may not also be important factor in Ethiopian context, ΔJ will not be used in the estimation process.

Government Sector

The government sector is modelled from both the revenue and expenditure sides. From the government revenue side, tax revenue is modelled to be a function of total output and foreign financial flows and the non-tax revenue is assumed to be exogenous. The expenditure function is also explicitly specified rather than being assumed to be exogenous policy variable[1]. Assuming expenditure as exogenous is not realistic so long as the economy is open for external shocks such as increase in foreign inflation rate and/or foreign interest rate, and an increase or decrease in foreign financial flows.

The specification of the government sector is basically based on Alemayehu (2002) with some extensions to allow for the effects of foreign inflation on the government expenditure.

Tax Revenue

Tax revenue is defined to be a function of economic activity proxied by GDP (Y), level of foreign trade and foreign capital flow (F). This is given as

$$Log\ TR = \beta_{30} + \beta_{31} logRY_t + \beta_{32} log\ (x+Z) + \beta_{33} logF_t \quad \ldots\ldots\ldots\ldots\ldots\ldots(3)$$

Where $\beta_{3i} > 0$ and $i = 1\ldots3$

Government Expenditure

The government current expenditure (G) is assumed to be positively related to total revenue (T) and foreign inflow (F). Foreign inflation rate proxied by import price (p^m) is also included in the specification and expected to be related positively to G. The lagged value of G is also introduced to show the persistence of previous patterns of expenditure

$$Log\ G_t = \beta_{50} + \beta_{51} logTR_t + \beta_{52} logF_t + \beta_{53} logP^m + \beta_{54} logG_{t-1} \quad \ldots\ldots\ldots\ldots..(4)$$

where $\beta_{5i} > 0$ for $i = 1\ldots4$

Foreign capital inflow is included in the above specifications to allow for the possible effect of foreign capital inflow on revenue and expenditure following the 'fiscal response to foreign financial flow' literature which argues that foreign financial inflows reduce government effort in collecting tax (see Heller, 1975, Mosely et. al, 1987, White, 1993 and 1994, and Gang and Khan, 1991).

[1] For instance, Feltensten (1985) treated expenditure as exogenous policy variable.

Fiscal Closure

The fiscal stance of the government is closed by the public deficit and its given as

Total government revenue (TGR) = TR + other government revenue (OGR)

Total government expenditure (TGE) = G + Capital expenditure (CE)

Fiscal deficit (FD) = TGE - TGR

External Sector

Export

A single export supply function is estimated without desegregating the total exports into coffee and non-coffee like Asmerom and Kocklaeuner (1985) and Lemma (1993). This is fairly acceptable since the natures of the commodities exported are almost similar. The equation is, thus, given as

$$\text{Log } X_t = \beta_{60} + \beta_{61}\text{logRER}_t + \beta_{62}\,\text{logCUR}_t + \beta_{63}\text{logRY}_t$$

Where $\beta_{6i} > 0$ i = 1,2 & 3 ……(5)

Imports

The import function is disaggregated into two parts: consumers' good import and intermediate import. The specification is similar to that of Soludo (1995).

Consumers' Good Import

$$\log \text{Zcons}_t = \beta_{70} + \beta_{71}\log\text{RY}_t + \beta_{72}\text{logRER}_t + \beta_{73}\log\text{R}_{t-1} + \beta_{74}\text{logZcons}_{t-1} \quad \text{…….(6)}$$

where Zcons is import of consumers' good, RY_t is real income, RER is real exchange rate and R is total foreign exchange reserves.

Intermediate import

$$\log \text{ZRac}_t = \beta_{80} + \beta_{81}\log\text{RY}_t + \beta_{82}\text{logRER}_t + \beta_{83}\log\text{R}_{t-1} + \beta_{84}\text{logZRac}_{t-1}\text{……..(7)}$$

where ZRac is intermediate import, RY is real income , RER is real exchange rate and R is total foreign exchange reserves.

In both import equations lagged dependent variables appeared to show partial stock adjustment behaviour.

Total import (Z) will then be the summation of consumers' good import, intermediate import; and other imports.

$$Z = \text{Zcons} + \text{Zrac} + \text{Zother}$$

External Sector Closure

The external sector is closed by the reserve flows identity in which the accumulation or de-accumulation of reserves take place. Except the trade balance, the other components of the external sector are exogenous in the model

BOP = CA + Transfer payments + capital account balance + net errors and omissions

Change in Reserve = BOP + change in arrears + debt relief

$$\text{Reserve}_{(t)} = \text{Reserve}_{(t-1)} + \text{Change in reserve}_{(t)}$$

Where CA (current account) is given as the sum of trade balance + net services + net private transfer payments.

Aggregate Supply

Production

In modelling the production side, the production sectors are disaggregated into agricultural and non-agricultural. The agricultural and the non-agricultural production functions are distinguished and specified on the basis of the economic structure of the country.

Agricultural Production Function

The agricultural production function is assumed to be positively related with labour in the agricultural sector, rainfall, and relative price of agricultural products. The function is given as:

$$\text{Log Yagr} = \beta_{90} + \beta_{91}\log\text{Lagr}_t + \beta_{92}\log\text{RF}_{t-1} + \beta_{93}\log\left(\frac{P_{agr}}{P_{nagr}}\right)_t + \beta_{94}\log\text{Yagr}_{t-1} \quad \ldots\ldots(8)$$

Where Yagr is agricultural GDP, Lagr is labour force in agricultural sector, RF is rainfall, and P_{agr}/P_{nagr} is the ratio of agricultural GDP deflator to non agricultural GDP deflator. The data for labour force is adjusted using the capacity utilization rate in the agricultural sector to proxy employed labour force in the sector since the data for employed labour force is not available.

Non-Agricultural Production Function

The non-agricultural sector contains both manufacturing and service sectors. The non-agricultural production sector is determined by labour force in the sector, change in capital stock, intermediate import and capacity utilization in the economy. This production function is given as

$$\text{Log Ynagr} = \beta_{100} + \beta_{101}\log\text{Lnagr}_t + \beta_{102}\log\Delta K_t + \beta_{103}\log\text{Zrac}_t + \beta_{104}\log\text{CUR} \quad \ldots\ldots\ldots..(9)$$

Where Lnagr is labour force in non-agricultural sector, ΔK_t is change in capital stock, Zrac is intermediate imports, and CUR is capacity utilization rate in the economy. The data for

labour force is adjusted using the capacity utilization rate in the non-agricultural sector since the data for employed labour force is not readily available.

The total production will be given as

$$RY = Yagr + Ynagr$$

Capacity Utilization Rate

Capacity under utilization in the economy may come from both the agricultural sector and the non-agricultural sector. Under utilization of capacity in the agricultural sector can be mainly attributed to shortage of rainfall, among other things. In the non-agricultural sector the main cause of under utilization of capacity is shortage of imported inputs. Thus, capacity utilization in the economy is assumed to be dependent on the level of capital imports, total export earnings and rainfall.

$$\text{Log } CUR_t = \beta_{110} + \beta_{111}\log RF_{t-1} + \beta_{112}\log Zcap \qquad \text{.....(10)}$$

$\beta_i > 0$ where i = 1 & 2; RF is rain fall and Zcap is intermediate imports.

Prices

The domestic price level is expected to be determined by the excess demand over the supply in the domestic economy (RED) excess money supply over the money demand (EMs) and import prices ($P^{m)}$. In addition to this, capacity utilization rate (CUR) is also related with the rate of inflation because it shows the nature of mark-up pricing. The mark-up (the profit margin) is assumed to be an increasing function of the capacity utilization rate (Soludo, 1995). Thus, the inflation equation is given as

$$P_t = \beta_{120} + \beta_{121}\,EMs + \beta_{122}\log RED_t + \beta_{123}\log CUR_t + \beta_{124}\log P^m \qquad \text{.....(11)}$$

Money Market

Money Supply

The money supply equation is specified in such a way that it is partly endogenous from the side of the balance of payments and the fiscal deficit. Following the flow of funds approach, the domestic money supply (Ms) in the economy can be given as

$$Ms = (TGR\text{-}TGE) - G^s_p + DC_p + \Delta R \qquad \text{.....(12)}$$

Where (TGR – TGE) is the budget deficit, G^s_p is net sales of government interest bearing assets to the non-bank private sector, DC_p is domestic credit to the private sector, ΔF is change in foreign financial flows, and ΔR is change in foreign exchange reserve.

Money Demand

The demand for real money balance (M/P) is positively related to income (RY) and negatively related with the opportunity cost of holding money. The demand for the real money is given as:

$$\text{Log } (M/P)_t = \beta_{140} + \beta_{141} \log RY_t - \beta_{142} r_t + \beta_{143} \pi_t + \beta_{144} \log(M/P)_{t-1} \ldots\ldots\ldots (13)$$

Where r and π are interest rate and inflation rate, respectively. And they are used to proxy opportunity cost of holding money.

Exchange Rate

Since the nominal exchange rate had been fixed for long period of time, the specification of the exchange rate will be based on the real exchange rate. The real exchange rate equation follows similar formulation as that of Ghura and Grennes (1993).

$$\text{Log RER} = \beta_{150} + \beta_{151} \log TOT_t - \beta_{152} \log(OPEN)_t + \beta_{153} \log F_t + \beta_{154} EMs \ldots\ldots\ldots (14)$$

Where RER is the real exchange rate, TOT is terms of trade,

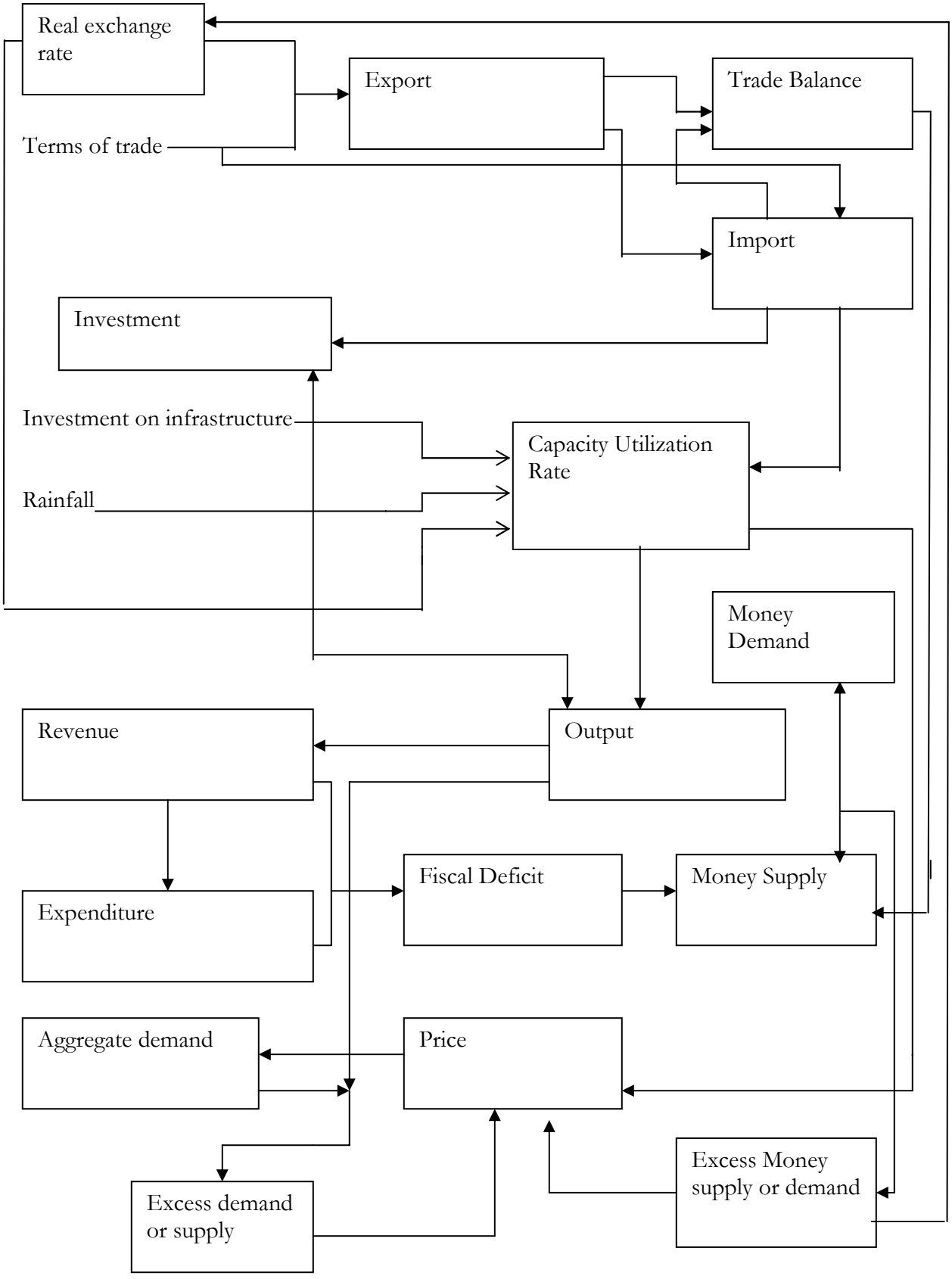
OPEN = [(X+Z)/ Y] is the ratio of GDP over the sum of imports (Z) and exports (X); F is foreign financial flows, and EMs is excess money supply, measured as the difference between money supply and money demand.

3.2. The Working of the Model

The operation of the model is as follows (also see the chart below). The value of export together with foreign financial inflows (i.e. foreign exchange availability), terms of trade and real exchange rate determine the level of imports. Imports, in turn, affect the level of private investment and determine the capacity utilization rate of the economy along with the exogenously given weather condition and availability of infrastructure. The capacity utilization rate is assumed to have a direct impact on output which in turn affects government revenue and expenditure and hence the fiscal deficit. The fiscal deficit has a feed back effect on prices through its effect on money supply. The level of output also determined the aggregate demand. The excess demand over the total output is assumed to be financed by foreign financial flows. However, for a given level of foreign financial flows, the disequilibrium between aggregate demand and aggregate supply is assumed to spillover to the domestic price (note that the price equation includes excess demand as an argument) and market clearing will be achieved through adjustment in price.

3.3. Estimation Techniques

The individual equations in the model are estimated in an ECM format using the Johansen approach in view of the time series properties of the macro-time series variables for the period of 1965/66 – 1998/99 (see the appendix for the complete result of the estimated equations). The model has 30 equations of which 14 are behavioural and 16 are identities and technical relationships. The scenario that will be experimented is that what would have been the performance of the economy, had there been a 10% decline in the labour force since 1980/81 due to HIV. The scenario experimented hear is that what would have been the performance of the economy, had there been a 10% decline in the labour force since 1980/81 due to HIV. Thus, the result should be interpreted carefully with these caveats in mind.


Real exchange rate
Export
Trade Balance
Terms of trade
Import
Investment
Investment on infrastructure
Capacity Utilization Rate
Rainfall
Money Demand
Revenue
Output
Fiscal Deficit
Money Supply
Expenditure
Aggregate demand
Price
Excess Money supply or demand
Excess demand or supply

3.4. The Counterfactual Analysis

Following Quattek (2000:9), the channels in which the impact of HIV AIDS is reflected in the economy are

1. Lower labour force
2. Lower labour productivity through absenteeism and illness
3. Cost pressure for companies through higher benefit payments and replacement costs
4. Lower labour income, as employees bear some of the AIDS- related costs
5. Lower population translating into lower expenditure
6. Increased private sector demand for health services
7. Higher government expenditure on health services.

In this study, however, only one aspect of HIV –i.e. its impact on reducing labour force- is considered. This is because, as outlined in the introductory part, the decline in the labour force and the resultant consequences on the economy is diverse. In addition, in the context of Ethiopia the labour force impact of HIV is more important since the economy is based on agriculture, which contributes more than 50% of GDP and 85% export earning, and the agricultural sector mainly depends on labour force, among others.

As shown in the table below, the decline in the labour force would directly affect the production process in both the agricultural and non-agricultural sectors. According to the result, the agricultural and the non-agricultural output would decline by around 2% and 1.8% on average during the forecast period as compared to the base run. As a result of the fall in output, private consumption, investment, exports and government tax revenue would be lower by 1.9%, 2.4%, 3% and 8%, respectively. The decline in government revenue would in turn put a downward pressure on government expenditure and hence it would go down by 6.7% on average.

As described above, exports would decline by 3% in the simulation period. This would have a direct repercussion on imports through lowering the availability of foreign exchange. The result shows that consumers' imports and capital and raw material imports would on average fall by 3.9% and 2%, respectively, in the alternative scenario. The fall in capital and raw material imports would diminish the capacity utilization rate by 0.6%, on average.

Table 4 The Impact of HIV/AIDS due to a shock in the labour force: Deviation from the base run (in Percentage)

Year	Agricultural output	Non-agricultural output	Investment	Consumption	Price	Consumers import	Intermediate goods import	Capacity utilization rate	Tax Revenue	Govt Expenditure	Export	Output
1980/81	-1.9	-1.2	-12.5	-1.0	-3.6	-3.2	-1.6	-0.5	-7.3	-5.9	-2.5	-1.4
1981/82	-1.9	-1.3	-1.7	-1.3	-3.3	-3.4	-1.7	-0.5	-7.5	-6.1	-2.6	-1.5
1982/83	-1.9	-1.4	-2.0	-1.5	-4.0	-3.5	-1.7	-0.6	-7.9	-6.4	-2.6	-1.5
1983/84	-1.9	-1.5	-1.8	-1.6	-2.7	-3.6	-1.8	-0.6	-7.9	-6.5	-2.7	-1.6
1984/85	-2.0	-1.5	-1.6	-1.7	-2.2	-3.8	-1.7	-0.6	-8.3	-6.7	-3.2	-1.6
1985/86	-2.0	-1.6	-1.8	-1.8	-2.0	-3.7	-1.8	-0.6	-8.2	-6.7	-2.9	-1.6
1986/87	-2.0	-1.7	-1.8	-1.8	-2.9	-3.7	-1.8	-0.6	-8.0	-6.6	-3.0	-1.7
1987/88	-2.0	-1.7	-1.9	-1.9	-2.4	-3.9	-1.9	-0.6	-8.1	-6.7	-3.0	-1.7
1988/89	-2.0	-1.8	-2.0	-1.9	-2.4	-3.9	-1.9	-0.6	-8.2	-6.8	-3.2	-1.8
1989/90	-2.0	-1.9	-2.1	-2.0	-2.1	-4.0	-2.0	-0.7	-8.3	-6.9	-3.2	-1.8
1990/91	-2.0	-1.9	-2.0	-2.0	-1.5	-4.2	-2.0	-0.7	-8.2	-6.9	-3.3	-1.8
1991/92	-2.0	-2.0	-1.9	-2.0	-1.0	-4.2	-2.1	-0.7	-8.3	-7.0	-3.3	-1.9
1992/93	-2.1	-2.0	-2.0	-2.1	-1.8	-4.2	-2.1	-0.7	-8.3	-7.1	-3.4	-1.9
1993/94	-1.9	-2.1	-1.0	-2.1	-1.2	-4.1	-2.1	-0.7	-8.3	-6.9	-3.3	-1.9
1994/95	-2.1	-2.1	-2.9	-2.1	-1.2	-4.3	-2.3	-0.7	-8.9	-7.4	-3.3	-2.0
1995/96	-2.1	-2.1	-1.6	-2.2	0.8	-4.1	-1.8	-0.7	-8.2	-6.9	-3.2	-2.0
1996/97	-2.1	-2.1	-1.6	-2.2	2.6	-4.0	-1.9	-0.7	-7.6	-6.5	-3.1	-2.0
1997/98	-2.1	-2.1	-1.8	-2.2	5.5	-4.1	-1.9	-0.7	-7.3	-6.3	-3.1	-2.0
1998/99	-2.1	-2.1	-2.1	-2.2	7.0	-3.9	-2.0	-0.7	-7.2	-6.2	-2.9	-2.0
Average	***-2.0***	***-1.8***	***-2.4***	***-1.9***	***-1.0***	***-3.9***	***-1.9***	***-0.6***	***-8.0***	***-6.7***	***-3.0***	***-1.8***

IV. Conclusion

HIV/AIDS has a diverse impact in the economy as it affects the labour force and hence output, government expenditure and revenue apart from the social chaos that it creates. In this study, attempt is made to quantify the economic impact of HIV in the Ethiopian economy. To do so, three approaches are used. The first one is to use the direct method of average productivity to estimate output lost. The second one is to estimate medication cost using average cost per AIDS patient. The third one is a counterfactual simulation analysis using a macroeconometric method.

The result shows that output loss to be in the range of 0.5% to 1% while the medication cost ranges from 3.2% to 6.4% of GDP in 1999/00. From the counterfactual analysis it can be discerned that the prevalence of HIV/AIDS has a negative impact on the overall economy through lowering the active labour force. The decline in the labour force has a direct negative impact on both the output of the agricultural and non-agricultural sectors that would lead to the fall in private consumption, investment, exports and government tax revenue. The slow down of the economy would also be strengthened with the fall in imports due to the decline in exports and hence the shrinking down of the importing capacity.

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Appendix

Estimation Result of the Individual Equations

Consumption function

LReal_Cp = 2.175 + 0.6787LogrY - 0.1647LogPrice + 0.03211strDmy
LR- Prob values (0.0007) (0.0227) (0.0170)

Investment function
Log Ip=6.536 –0.2094logPBr+7.780Δlog rY+0.63591logZcap–0.5667LogIg
LR prob. (0.0786) (0.0000) (0.0012) (0.0130)

Tax revenue function
LTR = -28.02 + 1.016Lyreal - 0.2514LF_{t-1}
LR prob. (0.0436) (0.0160)

Expenditure function
LG = -0.2309 + 0.8666 LTR + 0.3941 LPf
LR prob (0.0412) (0.0990)

Export function
Log X = -8.488 + 0.4035 logTOT + 1.248Log Y + 1.378log RER
LR prob (0.0494) (0.0000) (0.0001)

Consumers import
LogZcons = -0.3761 + 0.981Log X - 1.222 Log RER
LR prob (0.0108) (0.0023)

Capital and Raw Material Intermediate Imports Function

LogZcap = 4.366 - 1.584LogRER +0.7521 Log X + 1.719 s1992
LR prob (0.0005) (0.0529) (0.0000)

Agricultural Production Function (2sls Estimates)

LYagr = 5.756 +0.2996 $LYagr_{t-1}$ + 0.08686 LPa/Pna_{t-1} + 0.7589 LLFagr +0.1879 LRF_{t-1} - 0.0329Dmy
Prob (0.0322) (0.0120) (0.0000) (0.0010) (0.1317)

Non Agricultural Production Function

LYnagr = 5.411 + 0.8728 LLFnagr+ 0.07497 LMcap - 0.2018 s1991
Prob (0.0000) (0.1984) (0.0007)

Price Equation

LCPI= -3.450 + 0.3558EM_s + 0.3875LED + 0.08635LPm + 0.2637 Dmyotlier
LR prob (0.0002) (0.0000) (0.1165) (0.0000)

Capacity utilization rate equation

$$LCUR = 2.550 + 0.1929LRF_{t-1} + 0.07606Lzcap - 0.07861Dmyoutlier$$
$$(0.0316) \quad (0.0000) \quad (0.0003)$$

Money demand equation

$$LM/P = -5.735 + 0.9961LrY + 14.67INF + 0.1465RIR - 0.478Dmy$$
$$(0.0305) \quad (0.0000) \quad (0.0000) \quad (0.2294)$$

Real exchange rate equation

$$LRER = 9.592 - 1.066LTOT + 0.8301LOPEN - 0.3467LFF - 0.2727LEXCR - 0.0928Dmy$$
$$(0.0026) \quad (0.0186) \quad (0.0016) \quad (0.0061) \quad (0.0735)$$

DIAGNOSTIC TESTS

Parameter Consistency Forecast Test (χ^2 Test)

Equation	*Ignoring parameter uncertainty and intercorrelation between the forecast errors at different time period*	*With parameter uncertainty but ignoring intercorrelation between the forecast errors at different time period*	*With both parameter uncertainty and intercorrelation between the forecast errors at different time period*
Consumption	*2.2097 (0.6973)*	*1.666(0.7969)*	*2.0187(0.7323)*
Investment	*17. 326(0.0675)*	*9.94(0.4458)*	*8.7408(0.5569)*
Tax Revenue	*1.6218(0.08049)*	*1.1011(0.8941)*	*1.0297(0.9053)*
Government Exp.	*6.7966(0.1470)*	*4.1666(0.3839)*	*4.086(0.3945)*
Export	*21.94(0.0250)**	*12.397(0.1344)*	*14.245(0.756)*
Consumers' Import	*4.6981(0.7893)*	*2.4373(0.9646)*	*2.9505(0.9374)*
Intermediate import	*6.7669(0.5620)*	*2.9848(0.9353)*	*2.943(0.9379)*
Agricultural Production fn.	*5.1864(0.2687)*	*3.1032(0.5407)*	*2.8145(0.5893)*
Non-agricultural production fn.	*19.577(0.0033)***	*12.249(0.0566)*	*10.474(0.1060)*
Price	*8.2268(0.4116)*	*5.9334(0.6547)*	*5.8914(0.6594)*
Capacity Utilization	*8.331(0.2148)*	*4.2635(0.6411)*	*4.3009(0.6360)*
Money Demand	*12.084(0.0601)*	*8.7336(0.1891)*	*8.8466(0.1824)*
Real exchange rate	*36.341(0.0001)***	*19.253(0.0372)**	*19.297(0.366)**
	*F- test version 3.6341(0.0084)***	*F- test version 1.9253(0.1088)*	*F- test version 1.9297(0.1080)*

Values in parenthesis are probability values.

**and ** imply reject the null at 5% and 1% level of significance, respectively.*

The null hypothesis: the forecast is accurate.