THE MACRO-ECONOMIC & SECTORAL IMPACTS OF HIV AND AIDS IN INDIA

A CGE STUDY

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The Macro-Economic and Sectoral Impacts of HIV and AIDS in India

A CGE Analysis

Vijay P. Ojha
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सत्यमेव जयते
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Foreword

The study on the Socio-Economic Impact of HIV and AIDS which was conducted in the six high-prevalence states of India, is an important initiative to assess the impact of HIV and AIDS on households and make projections at the macro and sectoral level. The National AIDS Control Organisation (NACO) commissioned this study to address the need for concrete evidence on the social and economic consequences of HIV and AIDS in India.

A unique feature of this study is the scale of the research. It is noteworthy for its detailed analysis of the phenomenon of stigma and discrimination and of the impact of HIV and AIDS on households, on people living with HIV and AIDS (PLWHA) and their family members.

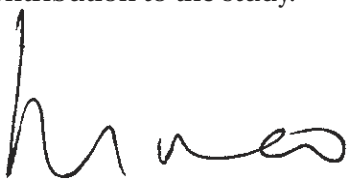
There are many issues of concern highlighted in this study. The additional financial burden imposed on households with PLWHA is forcing them further into poverty. An important indicator is the reduction in the aggregate income of the PLWHA households surveyed by around nine percent. This has a devastating impact considering that most of the sample households were from the low income group.

There are various factors that bring about a fall in income levels. One reason for lower income levels is the higher prevalence of HIV and AIDS among working people. Also, on an average, the per capita medical expenses of HIV households were four times higher than those of the non-HIV households. To meet this expense, almost 43 percent of the households had either borrowed or sold assets. As a result of lower savings and expenditure, dependants in the households such as children, spouses, caregivers and the elderly were also affected. For example, in Andhra Pradesh the number of children from HIV households who had to absent themselves from school due to their parents' illness was four times higher as compared to non-HIV households.

The study is timely for NACO and State AIDS Control Societies (SACS), particularly now as we are finalising the National AIDS Programme Phase III (NACP III) and the state level Programme Implementation Plans (PIPs). I have no doubt that the study will be invaluable in guiding us on the road ahead. The States AIDS Control Societies (SACS), district and block level officers will also be able to tap state and district level findings to advocate for better decentralised cooperation.

The macro-model prepared in this study suggests that the long-term impact of HIV and AIDS is likely to be severe, on both aggregate and per capita GDP. NACO will use these findings to mobilise actors such as the private sector, media and non-health government ministries and to add momentum to ongoing efforts. Clearly HIV is not just a health issue and its impact has both social and economic ramifications. To overcome the challenges posed by HIV and AIDS we must ensure greater synergy between the efforts of several sectors as well as urgent action.

I would like to congratulate the National Council of Applied Economic Research (NCAER), the United Nations Development Programme (UNDP), PLWHA networks, state level bodies, SACS and Voluntary Counselling and Testing Centre (VCTC) counsellors for their excellent contribution to the study.



(K. Sujatha Rao)
Additional Secretary and Director-General
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Message

The multi-dimensional nature of vulnerabilities that result from HIV and AIDS are at first glance difficult to comprehend and measure. At the global level, research is increasingly focusing on the relationship between HIV and AIDS and other socio-economic issues.

In India, the impact of HIV and AIDS is not very visible due to the low prevalence rate and large population size. In such a scenario, it is even more important to document both human and economic dimensions of HIV and AIDS . Research studies conducted till date in India have measured the impact of HIV and AIDS on stigma and discrimination and income but their limitations lie in their small sample size. It was therefore, thought necessary to conduct this study on a more comprehensive scale.

The study brings out the negative impact HIV is likely to have over the next decade on economic growth and livelihoods of people, particularly the poor, if current trends are not heeded. A case in point is the study finding that highlights that Persons Living with HIV and AIDS who have minimum social security, such as unskilled wage labourers, are even more at risk. This was substantiated by the sectoral study which revealed that HIV and AIDS hit those sectors harder that use unskilled labour intensively. Work in several African countries has highlighted that high-prevalence rate of HIV infection can lead to a reduction of the Gross Domestic Product. Not surprisingly, when such a trend sets in, it is the poor that are most affected.

The pervasiveness of stigma and discrimination is another cause for concern, making a strong case for mainstreaming HIV in the work of non-health sectors. In Maharashtra, for example, 56 percent of those surveyed had not disclosed their status in the community and 79 percent had not disclosed their status to the employer.

In the case of women, the discrimination was much higher than against men. These findings clearly underline the urgent need for women-centric components within the HIV and AIDS programmes. This reiterates UNDP's position that a stronger focus on women is necessary to empower them and make them less vulnerable to HIV and AIDS .

UNDP is happy to have supported NACO in this study and hopes that the findings will be useful to strengthen evidence based planning for a more comprehensive response to HIV and AIDS in India. We hope this study will contribute to enhancing our collective understanding of the impact of HIV and AIDS beyond the health sector. Finally, I would like to congratulate the research team at NCAER under the leadership of Dr. Suman Bery for making this study possible.

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Message

The first AIDS case in India was detected in 1986 and since then the HIV epidemic has emerged as a serious public health problem in India. As in 2005, an estimated 5.206 million persons were living with HIV and till 31 July 2005, 1,11,608 AIDS cases have been reported in the country. HIV and AIDS are more than a health problem and its impact reaches far beyond the health sector with severe economic and social consequences. HIV and AIDS affect the individual, the family and the community at the micro-level and the various sectors of the economy at the macro-level.

While the companion report focuses on the socio-economic impact of HIV and AIDS on the affected individuals and their households in the six HIV high prevalence states of India, this report is concerned with the economy-wide and sectoral impacts of HIV and AIDS in India.

The study is based on a five-sector computable general equilibrium model of the Indian economy. In assessing the macro-economic and sectoral impacts of HIV and AIDS in India through the sophisticated methodology of computable general equilibrium modelling, this study is the first of its kind. Further, in part II of the study, an extended 28-sector CGE model of the Indian economy is used to enable a more detailed analysis of the sectoral impact of the HIV epidemic – particularly the impact of AIDS on the Indian industry.

The study takes into account the various modes of transmission of the adverse impact of HIV and AIDS on the national economy. All major effects of HIV and AIDS – decline in total factor productivity resulting from the increased mortality and morbidity, change in the skill composition of the labour force due to unequal incidence of AIDS among different grades of labour, fall in savings due to increase in medical expenditure, and drop in the growth rate of the economically active population, because of deaths caused to young adults – are incorporated in the analysis, thanks to the computable general equilibrium modelling methodology.

The study clearly brings out how economic growth of the Indian economy would slow down because of HIV and AIDS. The slowdown in economic growth is manifested in a decline in both real aggregate GDP and per capita GDP. In sectoral terms, the HIV epidemic hits harder the sectors that use unskilled labour intensively, such as, tourism and manufacturing.

We are grateful to the National AIDS Control Organisation for entrusting this important and sensitive study to NCAER and to the UNDP for funding the project.

We hope that the findings of this study would be helpful to NACO and other organisations working in this field for designing and implementing various programmes for the welfare of the people living with HIV and AIDS.

I would like to thank Dr. Basanta Pradhan and his team for the successful completion of this pioneering and sensitive study.

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Abbreviations

AIDS	Acquired Immuno-Deficiency Syndrome
Cam-CGE	Cameroon CGE
CET	Constant Elasticity Transformation
CGE	Computable General Equilibrium
GDP	Gross Domestic Product
GES	General Equilibrium Solution
LES	Linear Expenditure System
NACO	National AIDS Control Organisation
NCAER	National Council of Applied Economic Research
PLWHA	People Living with HIV and AIDS
RAL	Rural Agricultural Labour
RASE	Rural Agricultural Self-Employed
RNASE	Rural Non-Agricultural Self-Employed
RNAL	Rural Non-Agricultural Labour
ROH	Rural Other Households
SA-CGE	South African CGE
SAM	Social Accounting Matrix
TFP	Total Factor Productivity
USE	Urban Self-Employed
USH	Urban Salaried Households
UCL	Urban Casual Labour
UOH	Urban Other Households
UNAIDS	Joint United Nations Programme on HIV and AIDS
UNDP	United Nations Development Programme
WHO	World Health Organisation

Executive Summary

The adverse economic impact of HIV and AIDS occurs at three levels: the individual/household, sector, and national or macro-levels. In the early phase of the epidemic, the impacts at the sector and macro-levels are rather mild and, hence, not easily measurable or quantifiable. So far in India, given the low overall prevalence, the focus has been on the effects at the level of the individual and the household.

The enlisted study, by Pradhan, Sundar and Singh (2006)[1] also focuses on the impact of HIV and AIDS on affected households, which it finds to be seriously adverse, and, therefore, a matter of acute concern. At the same time, the study underplays the adverse economy-wide impact of AIDS. Given the current prevalence rate, the extrapolation of the household-level impact to the level of the state or the national economy does not reveal a large macro-economic impact. But, this is because the survey, on which the study is based, captures the snapshot of the economy at a given point of time, while the question of the macro-economic impact of AIDS is essentially a dynamic one.

As the HIV epidemic unfolds, its impacts are bound to be deeply compounded. These impacts cannot be assessed in their totality by a mere extrapolation of the household level impact. Furthermore, in 2005, the number of HIV-infected persons exceeds 5 million, and this number is expected to quintuple to between 20 million and 25 million by 2010. With that kind of a jump in the number of HIV cases in the next 5-10 years, there is bound to be a visible impact on the national economy.

At present, little or nothing is known about the potential macro-economic impact of HIV and AIDS on the Indian economy. The rough-and-ready estimates of the macro-economic costs of AIDS that are available are of no help in guiding and accelerating the response of the Government of India to the potential threat to the economy imposed by this epidemic. A quantitative assessment of the macro-economic impact of AIDS on the Indian economy, therefore, needs to be undertaken urgently to assist the policy makers.

Keeping this in mind, the study analyses the macro-economic and sectoral impacts of HIV and AIDS in India, using a five-sector computable general equilibrium (CGE) model.

Why the CGE model?

Empirical models on the macro-economic impact of HIV and AIDS are

[1] Pradhan, B.K, Ramamani Sundar, Shalabh K. Singh (2006): 'Socio-Economic Impact of HIV and AIDS in India' , jointly published by National AIDS Control Organisation, United Nations Development Programme and National Council of Applied Economic Research, New Delhi.

essentially of the following three types : (i) Macro-econometric models, (ii) Macro-simulation models, and (iii) Computable general equilibrium (CGE) models.

Macro-econometric models

Macro-econometric models are about econometrically estimating the impact of HIV and AIDS on the rate of growth of real Gross Domestic Product (GDP) per capita. However, these models are based on cross-country macro-level regressions, which can neither reflect the mechanism through which the adverse impact of HIV and AIDS work themselves out, nor can they capture the sectoral readjustments that take place in the economy that is coping with the epidemic.

Macro-simulation models

On the other hand, macro-simulation models, which are simulation exercises based on the one-sector neo-classical growth model, successfully capture the various channels through which AIDS impedes economic growth. The various channels through which AIDS affects economic growth are as follows: (i) a decline in total factor productivity resulting from the increased mortality and morbidity associated with AIDS, (ii) a change in the skill composition of the labour force due to unequal incidence of AIDS among different grades of labour, (iii) decline in public and private savings due to increase in medical expenditure caused by AIDS, and (iv) a decline in the growth rate of the economically active population, because of deaths caused to young adults suffering from AIDS.

In general, the macro-simulation models are successful in highlighting the considerable deceleration in the growth rate of GDP that may result from an AIDS epidemic, but show only a marginal negative impact of the epidemic on the growth rate of per capita GDP. This is not surprising. Indeed, theoretically it is conceivable that, the per capita real GDP rises with the decline in population more than compensating the fall in real GDP, thereby, pointing towards the conclusion that the survivors of the epidemic are "indifferent" or "better-off". However, that is merely a corollary of the fact that the population is declining in an economy afflicted by AIDS. And a population which is declining due to the increased mortality associated with AIDS can hardly be seen as a favourable occurrence offsetting the slowdown in GDP growth. More importantly, to infer from this that the survivors of the epidemic are "better-off" is not only trivial but also perverse.

Finally, it must be noted that, a major limitation of the macro-simulation models arises from the fact that they are aggregate growth models. Accordingly, they cannot capture the sectoral readjustments which serve to mitigate the loss in aggregate output resulting from an AIDS epidemic. To the extent that this mitigation effect is ignored in the macro-simulation models, the latter type models tend to overestimate the loss in aggregate output.

CGE models

CGE models, although resembling the one-sector neo-classical growth model in its dynamic structure, typically include a larger number of sectors. CGE models, therefore, are not only useful for assessing the aggregate economic impact of HIV and AIDS (i.e., the effect on the growth of real GDP per capita and other real macro-variables), but also allow a detailed insight into the happenings of the various sectors of the economy.

A characteristic feature of any economy is the existence of sectors that are not identical. Among other things, the

CGE models are not only useful for assessing the aggregate economic impact of HIV and AIDS but also allow a detailed insight into the happenings of the various sectors of the economy

relative use of different types of labour in combination with other factors – capital and land – will differ across sectors. Hence, when the labour supply declines due to AIDS-related deaths, there will be a differential impact across sectors. Typically, there will be a mildly negative impact on the outputs of sectors that use more of capital and less of labour, but sharp reductions in outputs will occur in the labour-intensive sectors. The latter sectors, in turn, will substitute relatively cheaper factors of production for labour inputs, and, thereby, regain some of the output loss. The net loss in (aggregate) output will, therefore, be smaller than what is usually estimated through the aggregate growth models. In other words, the latter type models are incapable of capturing the intra-sectoral and the inter-sectoral substitutions that necessarily take place to absorb the shock caused to an economy by an AIDS epidemic and, therefore, overestimate its impact.

The model used in this study is a multi-sectoral, neo-classical type price-driven CGE model

On the other hand, a multi-sectoral CGE model is ideally suited for assessing the impact of HIV and AIDS, as it takes into account the various intra-sectoral and inter-sectoral substitutions that take place in production, consumption and distribution in response to price changes. Moreover, because a CGE model simulates the workings of a market economy in which prices fluctuate to equate demand and supply for all goods and factors, it successfully captures the feedback between labour markets and the rest of the economy, which is ignored in the one-sector macro-simulation models. Typically, therefore, a CGE model provides a realistic estimate, rather than an overestimate, of the net loss in output resulting from a reduction in labour supply caused by increased mortality due to AIDS, which is generally the case in single-sector neoclassical growth models.

Furthermore, a CGE model is an ideal tool for capturing other impacts of the AIDS epidemic: (i) fall in total factor productivity (TFP) due to higher hiring and training costs, necessitated by increased absenteeism of HIV-positive workers and due to slower technological adaptation, (ii) lower efficiency (productivity) of workers with HIV, and (iii) shifts in the household and government spending patterns towards healthcare.

Finally, an additional virtue of the CGE model is that it also brings out the sectoral impact of the epidemic.

CGE model for India

The model used in this study is a multi-sectoral, neo-classical type price-driven CGE model. The overall structure of the model is similar to the one presented in Arndt, C and Lewis, J. D. (2001)[2]. However, in formulating the details of the model, an eclectic approach has been followed keeping in mind the institutional features peculiar to the Indian economy.

The model has five production sectors: agriculture, tourism, manufacturing, services and health care, and three factors of production: land, capital and composite labour, which in turn, is a nested constant elasticity of substitution (CES) aggregation of non-educated (unskilled), secondary-educated (semi-skilled) and higher-educated (skilled) labour[3].

[2] Arndt, C and Lewis, J D (2001): "The HIV/AIDS Pandemic in South Africa : Sectoral Impacts and Unemployment", Journal of International Development, 13, 427-449, (2001).

[3] In our classification of three types of labour in India, 'secondary educated' includes all those from class 1 pass to class 12 pass – i.e., 'elementary' + 'secondary' + 'higher secondary' educated, and 'higher educated' includes 'graduates ' + 'higher-than-graduates'.

At the beginning of a period, the economy is endowed with a certain level of physical and human capital, in the form of stocks of different types of labour. In any given period, the allocation of capital across production sectors is fixed, but labour is inter-sectorally mobile.

Producers act as profit-maximisers in perfectly competitive markets, i.e., they take factor and output prices (inclusive of any taxes) as given and generate demands for factors so as to minimise unit costs of output. The factors of production include intermediates and the primary inputs – capital, land and different types of labour.

For households, the initial factor endowments are fixed. They, therefore, supply factors inelastically. Their commodity-wise demands are expressed, for given income and market prices, through the Stone-Geary linear expenditure system (LES). Also, households save and pay taxes to the government. Furthermore, households are classified into five rural and four urban categories.

The government is not assumed to be an optimising agent. Instead, government consumption, transfers and tax rates are exogenous policy instruments.

The rest of the world supplies goods to the economy which are imperfect substitutes for domestic output, makes transfer payments and demands exports. The standard small-country assumption is made, which implies that, India is a price-taker in import markets and can import as much as it wants. However, because the imported goods are differentiated from the domestically produced goods, the two varieties are aggregated using a CES function, based on the Armington assumption. As a result, the imports of a given good depends on the relation between the prices of the imported and the domestically produced varieties of that good. For exports, a downward sloping world demand curve is assumed. Furthermore, a constant elasticity of transformation (CET) function is used to define the output of a given sector as a revenue-maximising aggregate of goods for the domestic market and goods for the foreign markets. This implies that the response of the domestic supply of goods in favour or against exports depends upon the price of those goods in the foreign markets vis-à-vis their prices in the domestic markets, given the elasticity of transformation between goods for the two types of markets. The model is Walrasian in character. Markets for all commodities and non-fixed factors - capital stocks are fixed and inter-sectorally immobile - clear through adjustment in prices. However, thanks to the Walras' law, the model determines only relative prices.

The exchange rate is chosen as the numeraire, and is, therefore, normalised to unity. In the external closure of the model, foreign savings are fixed exogenously. Finally, the model follows a savings-driven macro-closure, in which aggregate investment is the endogenous sum of the separate savings components – household savings, government savings and foreign savings.

Inter-temporally, the model adjusts through changes in the stock of physical capital and the stock of human capital. Physical capital is increased by investment, which is determined by domestic and foreign savings. Human capital (i.e., the stocks of the three types of labour) is augmented by the new supplies of labour of three skill types, which are exogenously given.

Inter-temporally, the model adjusts through changes in the stock of physical capital and the stock of human capital

The 'no-AIDS' and 'with-AIDS' scenarios

The five-sector CGE model of the Indian economy is used to generate a 'no-AIDS' reference scenario and a 'with-AIDS' scenario for the 14-year period, 2002-03 to 2015-16, wherein a comparison of the latter with respect to the former yields an estimate of the macro-economic and sectoral impacts of the HIV epidemic in India.

In the 'with-AIDS' scenario, the following impacts of AIDS on the key exogenous variables are incorporated : (i) slower growth in population and supply of labour by the skill categories, resulting from the AIDS-related deaths, (ii) lower labour productivity of workers with HIV reflected in a lower effective labour input, (iii) declines in sectoral TFP growth rates, initially, i.e., from 2002-03 to 2011-12, to 0.8 times the 'no-AIDS' growth rate, and, finally, during the height of the epidemic, i.e., from 2012-13 to 2015-16, to 0.7 times the 'no-AIDS' growth rate, (iv) the share of health services spending of the HIV households, is augmented by an additional 10 percent of total consumption expenditure, at the expense of other non-food expenditures, (v) an increase in the health expenditure of the government by 10 percent from 2002-03 to 2011-12, and by 15 percent from 2012-13 to 2015-16.

The macro-economic impact of AIDS

The growth rates of supplies of labour of all the three skill types decline in the 'with-AIDS' scenario. The decline is maximum for the unskilled labour, followed by that of semi-skilled and skilled labour (Table 1).

The increase in health expenditure of the households and the government results in a fall in their savings, which

Table 1

Macro-economic impact of AIDS

	Average annual growth rates for 2002-03 to 2015–16 (in percent)		Diff. from 'no-AIDS' scenario in percentage points
	'with-AIDS' scenario	'no-AIDS' reference scenario	'with-AIDS' scenario
Labour supply	**1.70**	**2.01**	**-0.31**
Unskilled labour	0.69	1.03	-0.34
Semi-skilled labour	3.18	3.49	-0.31
Skilled labour	4.46	4.68	-0.22
Wage rate (real)	**5.07**	**5.17**	**-0.10**
Unskilled labour	4.21	4.28	-0.07
Semi-skilled labour	3.82	3.86	-0.05
Skilled labour	3.60	3.63	-0.03
Real GDP	**7.34**	**8.21**	**-0.86**
Real GDP per capita	**6.13**	***6.68***	**-0.55**
Government saving (percent of GDP)	-2.26	-1.59	-0.67
Household saving (percent of GDP)	27.86	29.01	-1.15
Investment (percent of GDP)	27.95	29.11	-1.16

then crowds out investment. This fall in investment causes growth to slow down, and, hence, labour demand to shrink. The fall in labour demand outstrips the AIDS-induced fall in labour supply in case of all the three skill types of labour, and all the wage rates, therefore, decline, though unequally (Table 1).

The slowdown in economic growth is manifested in a decline in the growth of real aggregate GDP as well as in the growth of per capita GDP (Fig. 1 and 2). The former decreased, on an average, by 0.86 percentage points, while the latter declined, on an average, by 0.55 percentage points in the 'with-AIDS' scenario compared to the 'no-AIDS' scenario. Hence, the survivors of the epidemic are not "indifferent" or "better-off". They are in fact "worse-off", as the lower per capita incomes show (Table 1).

Household income growth rates for all the groups decline, though unequally.

Fig 1

Real GDP

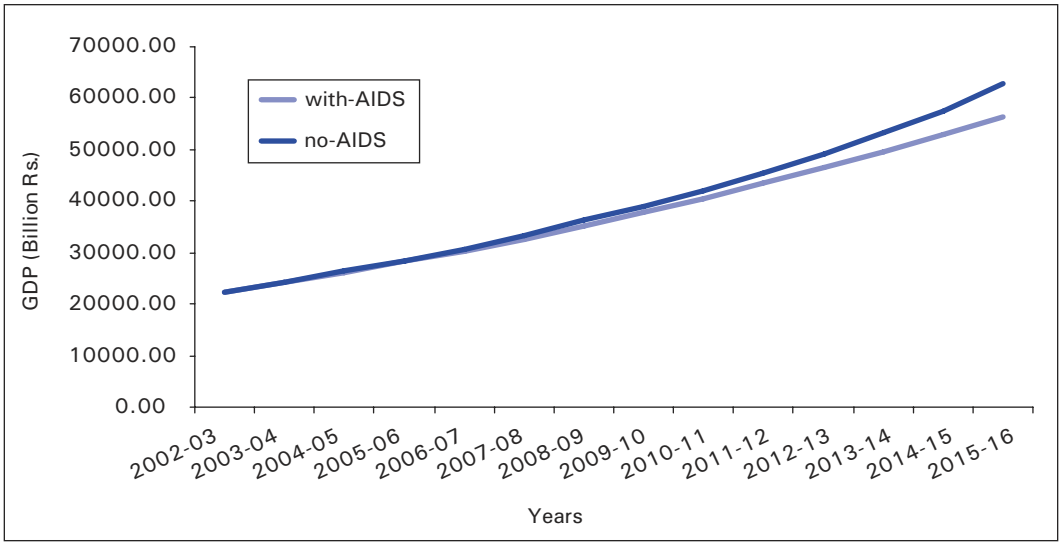
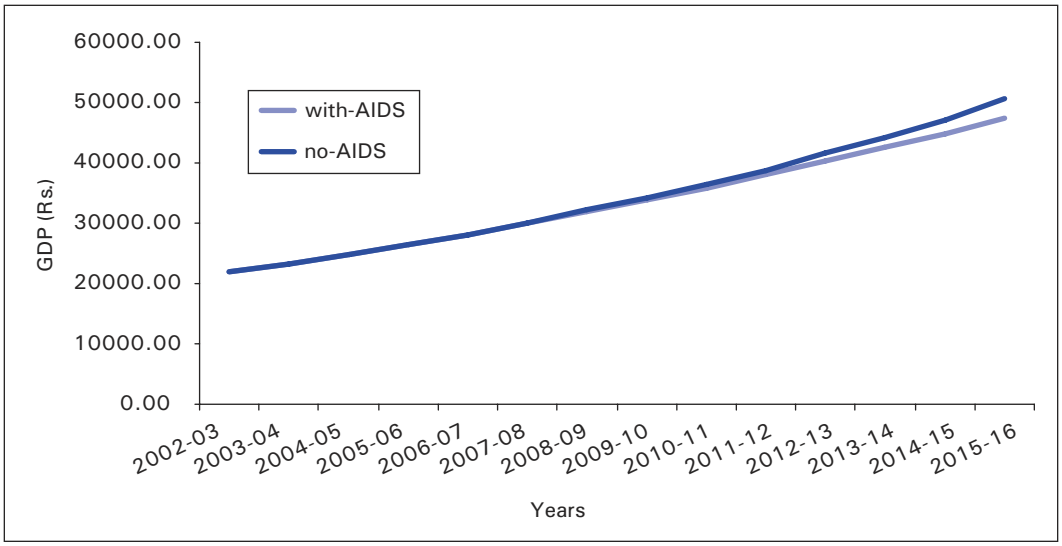


Fig 2

Real GDP per capita



In sectoral terms, the AIDS epidemic hits harder the sectors that use unskilled labour intensively

The decline in the household income growth rate is steepest for rural non-agricultural self employed, followed by that of rural agricultural labour, rural non-agricultural labour rural agricultural self employed and urban casual labour. These household groups are the ones which derive their incomes mainly from unskilled labour, which, among the three labour types, is affected most adversely by the HIV epidemic.

The sectoral impact of AIDS

In sectoral terms, the HIV epidemic hits harder the sectors that use unskilled labour intensively. For example, 'tourism', which is the second-most unskilled labour-intensive sector, suffers the maximum loss of 18 percent in value-added terms in the 'with-AIDS' scenario in the final year 2015-16. It is followed by the 'manufacturing' or 'industry' sector, occupying the third position in the unskilled labour intensity ranking, and having a value-added which is 12 percent smaller in the 'with-AIDS' scenario as compared to the 'no-AIDS' scenario. On the other end of the scale, is the healthcare sector, which is least unskilled labour-intensive, and, hence, experiences a minor 2 percent loss in its value-added. The other reason for this obviously, is that the demand for health care by workers with HIV increases relatively. Overall, the sectoral pattern of production changes in favour of 'healthcare' and 'services' – i.e. sectors having relatively lower unskilled labour intensity - at the cost of 'tourism' and 'manufacturing' – i.e., sectors with relatively higher unskilled labour intensity (Table 2).

In part II of the study, an extended 28-sector CGE model of the Indian economy has been used to do a detailed analysis of the sectoral impact of the HIV epidemic – particularly the impact of AIDS on the Indian industry. The 28 sectors include agriculture, 16 industrial sectors and 11 service-providing sectors. For

Table 2
Sectoral impact of AIDS

	For the year 2015-16		Computed from the base-year (2002-03) values				
	'with-AIDS'/ 'no-AIDS' value-added ratio (in percent)	Loss in value-added due to AIDS (in percent)	Share in GDP (in percent)	Share of unskilled labour in total sectoral labour value-added (in percent)	Share of unskilled labour in total sectoral value-added (in percent)	Ranking (descending order) as per cols. 5 & 6	Ranking (descending order) as per col. 3
Agriculture	90.92	9.08	22.98	70.04	37.65	1st	4th
Tourism	81.69	18.31	00.03	37.45	21.82	2nd	1st
Manufacturing (Industry)	87.52	12.48	22.40	36.31	20.77	3rd	2nd
Services	89.87	10.13	53.20	21.26	10.71	4th	3rd
Healthcare	98.07	1.93	01.39	08.07	05.55	5th	5th
Simple Average	89.61	10.31	20.00	34.63	19.30		
Real GDP	**90.11**	**9.89**	**100.00**	**36.86**	**20.51**		

agriculture and industry, as an aggregate, and services or tertiary sector, also as an aggregate, the adverse impact generated through the extended CGE model is virtually the same as that obtained from our five-sector CGE model of part I. However, within industry, it is possible able to identify the sectors which are major contributors to the overall loss in industrial GDP as a result of AIDS. These sectors are: Construction, Chemicals, Mining and Quarrying, Capital Goods and Textiles. Within industry, a weakly positive relationship between the sectoral unskilled labour intensity and the sectoral loss in value-added as a result of AIDS is found to hold. As far as the macro-economic impact of AIDS is concerned, the extended CGE model more or less replicates that of the five-sector CGE model.

Conclusion and policy implication

The humanitarian case for taking action to prevent the spread of HIV and AIDS is in itself a compelling one. However, it does not suffice for the economic policy-maker. For the latter, there are many problems which demand attention on humanitarian grounds. Not all such problems can be attended to the same extent in a resource-constrained environment. With many problems competing for public sector budgets, AIDS is likely to be accorded high priority only if the potential economic costs of AIDS can be shown as high. In other words, the humanitarian cause of combating AIDS will be greatly helped by building an economic case for policy action for containing AIDS.

The very severe adverse economic and social impact of the HIV epidemic at the household level has been clearly shown by the companion study by Pradhan, Sundar and Singh (2006).

In addition, the present study shows that the adverse macro-economic and sectoral impacts which the HIV epidemic is likely to impinge on the Indian economy in the coming decade, is by no means insignificant. Rather, it is very much real and sizable, and reinforces the already compelling humanitarian reason for urgent and effective policy action to control HIV and AIDS.

In the absence of remedial policy action, the HIV epidemic in India is likely to bring down the average annual GDP growth rate during 2002-03 to 2015-16 by about 1 percent. Conversely speaking – i.e., assuming that the 'with-AIDS' scenario is the business-as-usual scenario, and the 'no-AIDS' scenario is the counter-factual policy scenario – it is possible to argue that in the next decade the annual GDP growth rate can be increased by upto 1 percent, if AIDS is effectively countered. It is time, therefore, to begin to see policy action against AIDS as a growth-enhancing policy endeavour, and, first and foremost, dedicate adequate resources for this purpose. However, allocating plentiful resources by itself will not suffice for successfully responding to AIDS. Availability of financial resources fulfill only the necessary conditions for effective HIV and AIDS-control programmes. For sufficient conditions to hold as well, new ideas, innovative institutions, and bold implementation must follow suit.

It is time to begin to see policy action against AIDS as a growth-enhancing policy endeavour, and, first and foremost, dedicate adequate resources for this purpose

Chapter 1

Introduction

It is now accepted that India is facing a formidable challenge of containing an HIV epidemic. Till recently, HIV and AIDS were regarded as having a minor presence in India. The first HIV case in India was reported in 1986. About two decades later, the prevalence rate in the adult population (15-49 age group) stands at 0.80 percent. Going by this prevalence rate, India is still a low HIV-prevalence country. But a low HIV-prevalence rate in a highly populated country can be deceptive. It tends to undermine the gravity of the epidemic, which is unfortunate. In reality, a low HIV-prevalence rate can translate into a large absolute number of HIV cases when the population is high. In India, the number of PLWHA has now (2005) become 5.21 million, according to recent estimates of National AIDS Control Organisation (NACO). That puts India second, trailing behind only South Africa, in a classification of countries according to the highest number of HIV cases. Moreover, what is more disturbing is that an increase in the prevalence rate of 0.1 percent in future will imply 0.5 million new infections. In other words, judging from the trend in the past two decades, the HIV infection is spreading very rapidly in India, and, hence, the possibility of a very grim scenario in the next few decades is a real one.

In the vast geographical area of India, the spread of HIV is neither uniform nor sporadic. Rather, it is concentrated in ten out of thirty-one states of India. These 10 states – Maharashtra, Tamil Nadu, Karnataka, Andhra Pradesh, Manipur, Nagaland, Kerala, Gujarat, Goa, Pondicherry – account for 96 percent of total reported AIDS cases (UNAIDS and WHO, 2002). The first six of these 10 states belong to the highest prevalence group having generalised epidemics in a classification of India's states on the basis of prevalence rate and the stage of epidemic prepared by the National Sentinel Surveillance. The last four states are in the moderate prevalence group experiencing localised epidemics. However, the nature of the epidemic is unique for each state. That is to say, each state has its own distinctive vulnerability, dominant mode of transmission and scale of impact. The HIV epidemic in India, therefore, is best seen as an aggregation of regional micro-epidemics.

In India, as in the rest of the world, HIV has spread mainly through unprotected sexual activity. Over 85 percent of HIV cases in India can be traced to heterosexual relationships, which is reflected in the high-prevalence rate for sex workers as a group. The other major groups with high prevalence rates are

the intravenous drug users and men having sex with men. Infected blood as a source of fresh HIV infection is not yet common. Vertical transmission from mother to newborn is also quite restricted as the number of sero-positive pregnant women is not very high. In other words, the HIV infection is largely confined to groups designated by the National AIDS Control Organisation as engaging in high-risk behaviour. That said, it needs to be stressed that more recent developments portend to reverse this conclusion. The infection is already showing signs of being transmitted to the general population through bridge populations such as truck drivers. HIV has also begun to affect adolescents. In states with generalised epidemics, data shows an increasing prevalence among married women in monogamous relationships.

The adverse economic impact of HIV and AIDS occurs at three levels : the individual/ household, sector and national or macro-levels

The humanitarian case for taking action to prevent the spread of HIV and AIDS are a compelling one. However, it does not suffice for the economic policy maker. For the latter, there are many problems which demand attention on humanitarian grounds. Not all such problems can be attended to the same extent in a resource constrained-environment. With many problems competing for public sector budgets, AIDS is likely to be accorded high priority only if the potential economic costs of AIDS can be shown as high. In other words, the humanitarian cause of combating AIDS will be greatly helped by building an economic case for policy action for containing AIDS.

1.1 The economic impact of HIV and AIDS

The adverse economic impact of HIV and AIDS occurs at three levels : the individual/household, sector and national or macro-levels. In India, given the low overall prevalence, the most visible effects are at the level of the individual and in the household. In the early phase of the epidemic, the impacts at the sector and macro-levels are rather mild and, hence, not easily measurable or quantifiable (Mahal, 2004). Not surprisingly, studies concerned with the economic impact of AIDS in India are mostly focussed on the measurable effects at the micro-level, i.e., the level of infected individuals or households. However, as the epidemic evolves, the effects at the sector and the national or macro-levels will become discernible. Hence, it would be worthwhile and timely to study the macro-economic impact of HIV and AIDS in India.

1.1.1 Household economic impact

At the household level, the most obvious impact of HIV and AIDS is the increased spending on treatment and care. The ratio of treatment costs to per capita income is estimated to be 2.2 in India (Bloom and Mahal, 1996 and Bloom and Glied, 1993). It must be noted that the treatment costs in these studies did not include the costs of anti-retroviral (ARV) drugs. With the phasing out of the drug price control system and the strengthening of the Intellectual Property Rights, there would most probably be a rise in drug prices. Hence, taking into account the costs of ARVs would further escalate the HIV treatment costs. Secondly, since HIV and AIDS mostly affect individuals in their most productive years, there is a substantial loss of earnings and incomes of households with HIV-positive adult members. Under very conservative assumptions of working life span and discount rates, the loss in lifetime earnings are estimated to be three-and a-half times the annual costs of treatment of AIDS (Bloom and Mahal, 1996). Income losses arise on various accounts:

(i) premature death of an AIDS affected earning member of the household, (ii) reduced earnings due to disability or reduced ability to work because of the infection, (iii) loss of worktime of the non-infected members due to the caretaking responsibilities imposed on them by the infected members, and (iv) reduced employability due to the stigma associated with the infection. Thirdly, lost earnings and increased expenditures have long-term adverse impacts on household savings and asset-holdings for a majority of the households as they are not covered by social security or health and life insurance. Fourthly, members of HIV-affected households will typically have lower long-term accumulations of human capital, measured in terms of health and education. The extent of the long-term adverse economic impact varies according to the initial economic status of the household – with the richer households having greater resilience in absorbing the adverse economic shock of AIDS than the poorer ones (Basu, Gupta and Krishna, 1997). Finally, the stigma and discrimination on account of AIDS are particularly severe in India leading often to denial of healthcare to individuals infected with HIV and ostracism of the concerned households.

The accompanying study by Pradhan, Sundar and Singh (2006) confirms these adverse household economic impacts for the six high-prevalence states - Maharashtra, Tamil Nadu, Karnataka, Andhra Pradesh, Manipur, Nagaland – of India. In addition, it points out that there is higher workforce participation rate among children and the elderly in the HIV-positive households, as compared to non-HIV households. The female members of the HIV households are more vulnerable than their male counterparts. Gender inequality is thus further accentuated by AIDS.

1.1.2 Sectoral impact

HIV and AIDS also have a visible impact on certain sectors. These sectors are the following : health, tourism, agriculture, transportation and industry. The impact on the health sector is obvious. There will be higher budgetary allocations for the health sector, most likely at the cost of some other sectors, as the prospect of squeezing expenditure on prevention and treatment of infections other than HIV and AIDS is usually bleak. Already, in many countries a large share of the public health expenditure is being accounted for by HIV and AIDS. For example, in Thailand, more than 5 percent of all public sector health expenditure in the mid-1990's was on HIV and AIDS. Over and above the increase in public sector health expenditure, there is a large increase in private health spending. This is expected, as Barnett et al (2001), have shown, for Rwanda, and other countries are not likely to be too different, that more than 90 percent of all spending on treatment and prevention of HIV and AIDS comes from private expenditure by households. Arndt and Lewis (2001) use a 14-sector CGE model to assess the economic impact of HIV in South Africa. With their CGE model, they work out a 'no-AIDS' scenario and a 'with-AIDS' scenario for the period 1997-2010, and, thus, estimate the ratio of real value-added by sector between 'no-AIDS' and 'with-AIDS' scenario. All sectors, in 2010, have ratios of value-added less than one, and 'medical services' has the second-highest ratio of 0.90. This means that value-added in 'medical services' in 2010 in the 'with-AIDS' scenario is only 10 percent less than that in the 'no-AIDS' scenario. All other sectors suffer a larger loss of value-added of more than 18 percent. There is some impact of HIV and AIDS on the private health insurance sector as well, even if persons living with HIV and AIDS

HIV and AIDS also have a visible impact on certain sectors. These sectors are the following : health, tourism, agriculture, transportation and industry

(PLWHA) are largely excluded from the pool of insurable individuals (Bloom et al, 2004). This is because treatment costs for opportunistic infections are easily passed on to insurance companies without disclosure of the patient's HIV status.

In high-prevalence countries, tourism is likely to be adversely affected if potential foreign tourists are scared away by the risk of HIV infection. However, a typical visitor is not one who is likely to indulge in high-risk activities, such as, unprotected sex, sharing of injecting equipment and the like. In other words, the number of tourists who undertake high-risk activities is unlikely to be large. On the whole, therefore, the impact of HIV on tourism might well be insignificant. In fact, that turns out to be to be the finding in an empirical study. In a cross-country analysis of 31 countries, Bloom et al (1997) found no association between AIDS and tourism. Not surprisingly, in India, which is a low-prevalence country, the tourism sector is yet to experience a negative impact from HIV.

In high-prevalence countries, tourism is likely to be adversely affected if potential foreign tourists are scared away by the risk of HIV infection

Because HIV affects mostly young adults, it is likely to negatively impact labour intensive sectors such as the agricultural sector. The AIDS epidemic can result in an acute labour shortage which, in turn, could lead to a severe decline in farm labour inputs. For example, a study for Rwanda estimated that the loss of a female adult member of an agricultural household translated into an almost 50 percent decline in its farm labour inputs (Gillespie, 1989). With low labour-capital substitutability, that would result in a substantial decline in farm output. Other consequences of the labour shortage caused by the AIDS epidemic appear to have been declines in area cultivated, a shift away from more labour-intensive activities such as, food crops cultivation and animal husbandry to less labour-intensive activities such as, cultivation of cash crops (Barnett and Blaikie 1992, Guinness and Alban, 2000). It may be noted that the actual decline in area cultivated may not turn out to be much after all, as land can easily be transferred/ sold from AIDS-affected households to households not affected by AIDS, who will then work overtime to increase production. The net impact of HIV and AIDS on agriculture, however, may be a substantial decline in the sector's output. The only sector level estimates available are from CGE model-based simulations undertaken by Arndt and Lewis (2001) for South Africa. According to their estimates, value-added in agriculture in South Africa in 2010 would be 17 percent lower under a simulated AIDS scenario as compared to that in a 'no-AIDS' scenario.

Another sector that is considered vulnerable in the context of HIV and AIDS epidemic is the transport sector. Several analysts have regarded the trucking industry as a catalyst in the spread of HIV (Bloom and Mahal, 1996 and Giraud, 1993). In Zimbabwe, the profits of a major bus company were down by 7 percent, and in the National Railways of Zimbabwe absenteeism rate was as high as 15 percent , all due to AIDS (Bollinger et al, 1999). The CGE analysis of Arndt and Lewis (2001) estimates the value-added in South Africa in 2010 to be 20 percent lower under a simulated AIDS scenario relative to a 'no-AIDS' scenario. There are as yet no studies for India dealing with the impact of HIV on the transport sector. However, absenteeism and high-risk behaviour among truck drivers is reported to be common (Mahal, 2004). In other words, cost escalation and profit squeeze may have already become a reality in the trucking industry in India.

HIV and AIDS have two major effects on the industry. First, there is an effect

on the workforce through an increase in absenteeism, recruitment and training costs, burial and funeral costs, lost knowledge, and damaged morale. In a study based on a survey of about one thousand firms in sub-Saharan Africa, Biggs and Shah (1997) found that, although the impact of AIDS on staff turnover was minimal, replacing a professional staff member, who, say, died of AIDS, was many times more difficult than replacing a less skilled member of the staff who met with the same fate. Precisely, it took firms 24 weeks to replace a highly skilled staffer as compared to 2-3 weeks required for the replacement of a low-skilled worker. Secondly, there is a reduction in the consumer's base or the size of the market of the firms. It must be noted that young adults of working age – the most vulnerable group as far as AIDS is concerned – constitute a major source of demand for goods and services. As this group of consumers diverts its expenditure towards healthcare and away from other sectors to tackle AIDS, there results a reallocation of demand in favour of healthcare and against almost all other sectors. However, noticeable erosion of consumer base for products of sectors other than health is likely to occur in regions with very high-prevalence of HIV and AIDS. In India, where HIV prevalence is still low, there is as yet no visible decline in consumer base. Nor does the problem of labour shortage seem to be very acute. If the epidemic continues to spread, however, there may be a perceptible negative impact on the private industry directly through shortage as well as indirectly through reallocation of demand. The efforts of Confederation of Indian Industry (CII) and some individual firms notwithstanding, there seems to be very little concern about the impact of HIV on private industry in India (Bloom et al, 2004). This needs to change urgently.

1.1.3 Macro-level impact

The macro-impact of HIV and AIDS arises mainly on account of the following factors (i) productivity losses that come from increased absenteeism, which necessitates higher recruitment and training costs of new workers, from debilitation in the last stage of AIDS, and from the erosion of human capital that results from a diminished ability and incentive to invest in human capital – i.e., schooling and training of children – for HIV-infected adults of parenting age, (ii) changes in the skill composition of the workforce in case HIV and AIDS show any skill bias as it spreads across the population, (iii) a decline in the aggregate saving rate resulting from the reduced ability to save because of increase in medical expenditure, on one hand, and decrease in the earnings, on the other hand, for all those households having one or more members infected by HIV and (iv) a decline in the working-age population growth rate due to increased mortality caused by AIDS.

The macro-economic impact of HIV and AIDS in the medium and long term is best analysable in the framework of the neo-classical growth model

The macro-economic impact of HIV and AIDS in the medium and long term is, therefore, best analysable in the framework of the neo-classical growth model. Using a one-sector neo-classical growth model, Haacker (2004) brings out the various channels through which HIV and AIDS can affect GDP per capita. In this model, output (Y) is a function of the levels of capital (K) and labour (L), where the latter is disaggregated into highly skilled and unskilled labour :

$$Y = A^{\alpha} (e_H p_H L)^{\beta} (e_U p_U L)^{\gamma} \qquad (1)$$

where, A : total factor productivity, e_H : efficiency of highly skilled labour ; e_U : efficiency of unskilled labour ; p_H : proportion of highly skilled labourers in the workforce ; $p_U = (1- p_H)$ is the proportion of unskilled labourers in

the workforce ; $\alpha + \beta + \gamma = 1$. Further, assuming that gross investment is equal to domestic saving, we get :

$$K = sY - \delta K \qquad (2)$$

where, K : rate of growth of capital stock over time., s : rate of saving, and δ : rate of depreciation. Further, assuming that supply of skilled as well as unskilled labour grow at rate 'n', and rewriting (2) in per capita terms, we get :

$$k = sy - (\delta + n)\, k \qquad (3)$$

where, $y = Y/K$ and $k = K/L$. That is, equation (3) defines a steady-state growth in which both the capital-labour ratio and the output per capita are equal to $sy-(\delta+n)k$.

Next, solving for the steady-state capital-labour ratio, k, and per capita output, y, yields

$$k^* = \left\{ \frac{sA}{\delta + n} \right\}^{1/(\beta+\gamma)} (e_H\, p_H)^{\beta/(\beta+\gamma)} \; (e_U\, p_U)^{\gamma/(\beta+\gamma)} \qquad (4)$$

$$y^* = A\,(k^*)^{\alpha}\,(e_H\, p_H)^{\beta}\;(e_U\, p_U)^{\gamma} \qquad (5)$$

Substituting (4) into (5), we get,

$$y^* = A^{1/(\beta+\gamma)} \left\{ \frac{s}{\delta + n} \right\}^{\alpha/(\beta+\gamma)} (e_H\, p_H)^{\beta/(\beta+\gamma)} \; (e_U\, p_U)^{\gamma/(\beta+\gamma)} \qquad (6)$$

Equations (4)-(6) establish a framework which is extremely helpful in elucidating the various modes through which HIV and AIDS impact GDP per capita in the medium and long-term.

In terms of the above framework, overall productivity losses arising due to the additional costs incurred in hiring and training new workers required to compensate for the increased absenteeism of the workers with HIV induce a decline in total factor productivity, A, which, in turn, leads to a reduced capital-labour ratio, *k*, and output per capita, *y*. On the other hand, labour productivity losses occuring because of debility and erosion of human capital are reflected in a decline in the efficiencies of the skilled and unskilled labour, i.e. in e_H and e_U. These declines in the efficiencies of labour, like the decline in total factor productivity, result in a fall in capital-labour ratio and per capita output.

HIV prevalence may be uneven across different grades of labour, and that may change the skill composition of the workforce. If, for example, HIV prevalence is higher among the unskilled, the workforce share of the skilled (p_H) will rise, and that, according to equation (6), will lead to a rise in per capita output. On the other hand, if HIV prevalence is higher among the skilled workers, the result may be a decline in per capita output.

As noted in section 1.1.1, dealing with the household impact of HIV and AIDS, most HIV-affected households suffer a decline in their savings. This observed decline in household savings will translate into a decline in aggregate saving unless and until the overall HIV prevalence is very low. The fall in the aggregate saving rate, s, will then bring down the capital-labour ratio and the output per capita (equations 4 and 6).

HIV and AIDS bring about a decline in population growth, initially due to increased mortality but subsequently also because of a fall in birth rates. A decline in the growth rate of the working-age population results, however, in an

increase in the capital-labour ratio and thus of the per capita output.

On the other hand, the decline in the rate of growth of the working-age population induced by the AIDS epidemic may well lower the per capita GDP through a process that has been described as a 'reverse demographic gift' by Mahal (2004). Bloom and Williamson (1998) have detailed the process by which health improvements raise the per capita incomes in the long-term and called it the 'demographic dividend'. According to them, health improving activities lead, initially, to a decline in infant mortality, and, later, also to a decline in fertility. The former leads to a bulge in the very young ages of the age-distribution of the population. Hence, in the initial phase of the demographic transition initiated by the health improving activities, there is an increase in the dependency ratio (i.e. the ratio of non-working-age population to working-age population) which helps to bring down per capita incomes. However, over time, the 'bulge' shifts to the prime working ages of the age-distribution of the population, leading to a decline in the dependency ratio, which, seen the other way round, is a rise in the ratio of the number of people contributing to production to the number of those incapable of contributing to production. A dramatic rise in this ratio in an economy is usually associated with a notable rise in per capita income, and the concerned economy is said to reap a 'demographic dividend'. The prime examples of economies reaping the 'demographic dividend' are, as pointed out by Bloom and Williamson (1998), the high performance East Asian economies. On the other hand, an adverse health shock, such as, the spread of an AIDS epidemic, because of the morbidity and mortality it causes among people in their prime working ages, leads to a rise in the dependency ratio, or, what is the same thing, to a fall in the ratio of the productive people to the non-productive people (i.e., retirees and children), and that depresses the per capita income. In other words, an AIDS epidemic confers, what has been called, a 'reverse demographic gift' on the economy it afflicts.

What emerges from the above analysis based on the steady-state growth framework, is that the effect of increased mortality and morbidity caused by HIV and AIDS on output per capita is uncertain. On one hand, there is a decline in total factor productivity, in the efficiencies of skilled and unskilled labour, and in the aggregate saving – all leading to a fall in capital-labour ratio and per capita output. On the other hand, there is a decline in population growth, and also, probably, a rise in the workforce share of the skilled workers (if the unskilled workers are relatively harder hit by HIV and AIDS), both leading to a rise in capital-labour ratio and, hence, in per capita output. In other words, although HIV and AIDS can reduce overall output, it also reduces population, so per capita output may in fact rise. What is the net impact of HIV and AIDS on per capita GDP, is, therefore, essentially an empirical question, and the answer to it varies from case to case (country to country). Nonetheless, the framework of the neo-classical growth model is amenable to generalised application. It has, in fact, been used in many empirical studies for assessing the macro-economic impact of HIV and AIDS (Joint United Nations Programme on HIV/AIDS, 2004).

What is the net impact of HIV and AIDS on per capita GDP, is essentially an empirical question, and the answer to it varies from country to country

However, the above steady-state growth framework has its limitations in assessing the macro-economic impact of HIV and AIDS. In this closed economy framework, investment is necessarily equal to domestic saving, and the rise in the

capital-labour ratio as a consequence of the decline in population growth offsets to a great extent the otherwise negative impact of HIV and AIDS on per capita output. It may be noted that, the rate of return to capital declines as the capital-labour ratio increases, but that has no effect on investment, which adjusts passively to changes in domestic saving.

In the open-economy version of the neo-classical growth model, investment is sensitive to rate of return on capital (Haacker, 2002). Hence, if the rate of return to capital falls because of the productivity losses in an AIDS-affected economy, domestic and foreign investors would switch investment from the affected economy to the rest of the world. This would result in a decline in the capital-labour ratio, which, in turn, will reinforce, rather than counter, the downward impact of HIV and AIDS on per capita output. In other words, the fall in per capita output, in case of an open economy, will most likely be greater than that in case of a closed economy. On the other hand, while the output per capita and income per capita fall to the same extent, because they are one and the same thing in a closed economy; in an open economy the income per capita, as distinct from output per capita, falls to a lesser extent. This is because in an open economy, larger (net) capital outflows in response to the productivity shock caused by the AIDS epidemic generate additional investment income for domestic residents, and this increase in repatriated income cushions the fall in per capita income.

An expanded response to HIV and AIDS often includes an increase in inflows of external grants

In an open economy, the larger capital outflows and/or a decline in foreign domestic investment will create some disequilibrium in the balance of payments as well. As is well known, the balance of payments consists of two parts – the current account and the capital account. The former comprises payments for goods and services, and transfers including external grants; while the latter incorporates the capital flows. Hence, an increase in net capital outflow would lead to a decline in the capital account balance. What is important to know, however, is, how serious the deterioration in the capital account balance turns out to be in quantitative terms. According to an estimate based on a numerical example in Haacker (2002), the accumulated decline in the capital account balance in the long-term is fairly large (about 20% of GDP) but, the annual declines are much smaller.

An expanded response to HIV and AIDS often includes an increase in inflows of external grants. The latter would lead to an improvement in the current account balance, which, in turn, can cause the domestic currency to appreciate, thus, reducing the competitiveness of domestic industry. On the other hand, the improvement in the current account balance, and the deterioration in the capital account balance mentioned above tend to offset each other. However, the net effect should not be seen as a mere addition of the two effects. In reality, they are interdependent. The grant inflows, if productively invested in prevention and cure of AIDS, would gradually restore the productivity and competitiveness of the afflicted economy, and, thus facilitate the sterilisation of the foreign currency inflows. The restoration of the health of the economy would arrest the capital outflows, and, also, attract more foreign investment, particularly, in the health sector. In short, an expanded response to HIV and AIDS, financed through external grants, would in the long-term, neutralise many of the adverse effects of HIV and AIDS on demographics, productivity and competitiveness.

1.2 Empirical models on the macro-economic impact of HIV and AIDS

Empirical models on the macro-economic impact of HIV and AIDS are essentially of the following three types : (i) Macro-econometric models, (ii) Macro-simulation models, and (iii) Computable General Equilibrium (CGE) models. Macro-econometric models are about econometrically estimating the impact of HIV and AIDS on the rate of growth of real GDP per capita. On the other hand, macro-simulation models are simulation exercises based on the one-sector neoclassical growth model, conducted to examine the impact of HIV and AIDS on economic growth. Finally, CGE models, although resembling the one-sector neo-classical growth model in its dynamic structure, typically include a larger number of sectors. CGE models, therefore, are not only useful for assessing the aggregate economic impact of HIV and AIDS (i.e., the effect on the growth of real GDP per capita and other real macro-variables), but also allow a detailed insight into the happenings of the various sectors of the economy.

1.2.1 Macro-econometric models

The earliest macro-econometric study on the impact of HIV and AIDS on the national economic performance is that of Bloom and Mahal (1997). Using cross-country data for 51 countries and standard empirical equations of the type used by Barro (1991) and Mankiw, Romer and Weil (1992), Bloom and Mahal (1997) measure the statistical significance of the association between the prevalence of HIV and AIDS and the growth rate of real GDP per capita. Their main finding is that the AIDS epidemic has had a statistically insignificant effect on the growth of real income per capita, with no evidence of reverse causality during the period 1980-1992. There have been reservations expressed about the findings of Bloom and Mahal (1997), because, first, their study is concerned with a period in which HIV prevalence rates were too low to have any noticeable effect on the national economic performance, and, secondly, their regression specification does not 'correct' for factors that are capable of distorting the relationship between HIV and AIDS prevalence and the growth of real income per capita (Bonnel, 2000)

Bonnel (2000) examines the relationship between the rate of growth of real income per capita and a quadratic term in HIV prevalence, which controls for factors that could possibly confound this relationship for Africa during 1990-97. His central conclusion is that the AIDS epidemic lowered the growth rate of real per capita income in Africa by about 0.7 percentage points during 1990-97. There are two obvious criticisms of Bonnel's work – one is the relatively short time period of the study, the other is the possibility of the coefficients of the HIV variables not being robust under different specifications of the growth equation (Mahal, 2004).

There are three more serious methodological objections, that have been raised against the 'single-period' cross-country regressions of both Bloom and Mahal (1997) and Bonnel (2000). The first objection is against the use of lagged GDP per capita as an exogenously given explanatory variable, as it is not really exogenous. Second, the country-specific non-observable factors, such as, cultural practices and non-quantifiable policy measures that can affect the association between HIV prevalence and economic growth uniquely in each country have not been taken into account in these regressions.

Empirical models on the macro-economic impact of HIV and AIDS are essentially of the following three types: (i) Macro-econometric models, (ii) Macro-simulation models, and (iii) Computable General Equilibrium models

Third, the theoretical foundation of these regressions has not been made explicit.

The theoretical foundation of these regression equations is clarified by Bloom and Williamson (1998). The Bloom and Williamson (1998) specification, which is similar to but not the same as the Bloom and Mahal (1997) specification[4], is based on the Solow-Swan growth model (Barro and Sala-i-Martin, 1995). In fact, the specifications used in all the three cross-country regressions - Bloom and Mahal (1997), Bloom and Williamson (1998) and Bonnel (2000) – can be shown to follow from the Solow-Swan growth model provided the countries in question are assumed to be close to their steady states. As far as the first and the second methodological objections to these single-period cross-country regressions are concerned, the solution lies in shifting to panel data estimation methods, provided time-series data (for sufficiently large number of time points) for the relevant variables for the concerned countries are available.

HIV prevalence is found to have a significantly negative effect on life expectancy, while the latter has a significantly positive effect on growth of real income per capita

McDonald and Roberts (2001) have used panel data methods to estimate the impact of HIV and AIDS on economic growth. They have extended the model of Mankiw, Romer and Weil (1992), which itself is an empirical extension of the neo-classical growth model. In McDonald and Roberts (2001), HIV and AIDS do not enter directly into the econometric growth equation. Instead, HIV and AIDS impact the health capital terms among the explanatory variables of the econometric growth equation. The full model, therefore, consists of a system of two equations, a structural growth equation based on the Solow-Swan growth framework, and a reduced form health equation used to estimate the effect of HIV on a chosen measure of health capital, such as, life expectancy. In this model, HIV prevalence is found to have a significantly negative effect on life expectancy, while the latter has a significantly positive effect on growth of real income per capita. However, as pointed out by Bloom and Mahal (2004), the model of McDonald and Roberts (2001) has three serious limitations. First, the sources of time-series data for HIV prevalence for more than 100 countries have not been made clear. Second, apart from the impact of HIV on economic growth via life expectancy, there are other channels of influence of HIV and AIDS on economic growth, such as, decline in public savings due to high treatment costs of AIDS and fall in productivity due to increased mortality and morbidity associated with AIDS, which their model does not take into account. Third, the regression coefficients in their model appear to be highly unstable over different specifications. Finally, it must be noted that, the limitations of their model notwithstanding, the highlighting of the role played by HIV and AIDS in influencing growth of real income per capita through life expectancy, is a valuable contribution to empirical analysis of the linkage between HIV and AIDS and economic growth.

[4] The major difference (apart from other minor differences) between the Bloom and Mahal (1997) specification and the Bloom and Williamson (1998) specification for the empirical equation that has the rate of growth of real income per capita as the dependent variable, is that, the latter does not include a term for HIV and AIDS prevalence among the explanatory variables. This is because the Bloom and Williamson (1998) study is not concerned with the impact of HIV and AIDS prevalence on economic growth *per se*, but with the effects of growth in the economically active population and the total population on the growth rate of real GDP per capita, with a view to bring out the relationship between changes in the dependency ratio (ratio of economically active population to the economically inactive population) that occur during demographic transitions in economies and economic growth.

In the light of the new developments of the last few years, Mahal (2004) has re-examined the relationship between HIV and AIDS and economic growth. The new developments are basically three. First, the AIDS epidemic is now entering into the third decade since its inception. Hence, its effects on national economic performance are likely to be stronger and, therefore, probably noticeable. Second, data today, as compared to a decade ago, is available for a larger number of countries, and is also more reliable. Third, there is a realisation that the AIDS cases data, rather than HIV prevalence data, should be used in an analysis of the linkage between the AIDS epidemic and economic growth. This is because the adverse effects of HIV and AIDS – premature death and morbidity leading to a quantitative and qualitative loss of labour for the economy, loss of human capital due to reduced incentive and ability to invest in education and skill development of children of HIV-positive parent(s), increase in medical expenditure by the private sector households and the government leading to a decline in aggregate saving in the economy– mostly materialise at the AIDS stage of the epidemic. However, the number of AIDS case are, in all likelihood, underestimated in the developing countries, because of the latter's poor record-keeping systems. Hence, estimates of the number of AIDS cases derived from HIV prevalence data through modeling exercises are often used.

In the re-examination of the impact of HIV and AIDS on economic growth, Mahal (2004) re-estimates two empirical equations for the rate of growth of real GDP per capita[5] – one of them is the same as that in Bloom and Mahal (1997 : 112), and, the other one is the equation in Bloom and Williamson (1998 : 431) with a term for AIDS prevalence added – with new data for the period 1980-98. Once again it is a 'single-period' cross-country regression in case of both these equations – the Bloom and Mahal (BM) one, and the Bloom and Williamson (BW) one. The number of countries considered, however, differ in the two cases. It is 66 in case of the BM equation, and 57 in case of the BW equation. Furthermore, because the AIDS epidemic is known to have increased its severity 1990 onwards, both these equations have been estimated separately for the truncated time period 1990-98. This was done in view of the expectation that the impact of AIDS on economic growth would most likely be more significant during this truncated eight-year period than whatever it would be for the longer eighteen-year period, 1980-98.

There is a realisation that the AIDS cases data, rather than HIV prevalence data, should be used in an analysis of the linkage between the AIDS epidemic and economic growth

The main findings of the above re-estimation exercise are as follows : (i) for the period, 1980-98, the coefficient of the AIDS variable was statistically insignificant under both the BM and BW specifications, (ii) for the period, 1990-98, the AIDS coefficient was statistically significant under both the specifications, (iii) the estimated specification for the 1990-98 period provided a much poorer fit to the data under both the BM and BW specifications, relative to 1980-98 period (iv) the specification tests undertaken did not provide any evidence of reverse causality for either of the two specifications under either of the two periods.

It follows then, that econometric evidence for the claim that AIDS impedes national

[5] In both the equations, the dependent variable is the rate of growth of real GDP per capita, and the explanatory variables include a host of variables that influence economic growth *plus* a variable, AIDS, which captures the prevalence rate of AIDS.

economic growth is rather weak. But does that imply that AIDS does not matter as far as the macro-economy is concerned? Most probably not. Much depends upon how the econometric evidence is interpreted. For example, MacFarlan and Sgherri (2001) forecast that between 2000 and 2010, the impact of the AIDS epidemic in Botswana would be to lower the rate of growth of real GDP by 3 to 4 percentage points below its trend growth rate of 5.5 percent per year. On the other hand, if the forecast is reworked with the AIDS case projections of MacFarlan and Sgherri (2001) and the re-estimated AIDS coefficients of Mahal (2004), then the AIDS epidemic in Botswana brings down its annual average rate of growth of real GDP by 2.7 percent to 7.1 percent points during 2000-2010. In other words, the 'small' re-estimated coefficients of AIDS actually result in 'large' declines in the rate of growth of real GDP, if the rate of growth of cumulative AIDS prevalence is high, as in Botswana.

The macro-econometric models are based on cross-country macro-level regressions, which cannot reflect the mechanism through which the adverse impact of HIV and AIDS work themselves out

Finally, a caveat is in order. That is, the macro-econometric models, it must be noted, are based on cross-country macro-level regressions, which can neither reflect the mechanism through which the adverse impact of HIV and AIDS work themselves out, nor can they capture the sectoral readjustments that take place in the economy that is coping with the epidemic.

1.2.2 Macro-simulation models

The macro-simulation models meant to assess the macro-economic impact of HIV and AIDS are almost all the time modified versions of the one-sector neo-classical growth model. The various channels through which AIDS affects economic growth have already been outlined in section 1.1.3. To recapitulate, they are as follows : (i) a decline in total factor productivity resulting from the increased mortality and morbidity associated with AIDS, (ii) a change in the skill composition of the labour force due to unequal incidence of AIDS among different grades of labour, (iii) decline in public and private savings due to increase in medical expenditure caused by AIDS, and (iv) a decline in the growth rate of the economically active population, because of deaths caused to young adults affected by AIDS.

Cuddington (1993a) uses a macro-simulation model to analyse the macro-economic impact of HIV and AIDS in Tanzania during 1985-2010. No precise estimates for two key parameters of Cuddington's model – x, the fraction of the annual AIDS-related medical costs that comes out of reduced saving[6], and z, fraction of work year lost per AIDS-stricken worker as a result of absence or reduced productivity on the job – are available. Hence, simulations of the AIDS scenario were run using alternative values – 0, 0.5, 1.0 and 2.0 – for these two parameters. Each of the 16 AIDS scenarios thus generated for each of the 16 combinations of (x, z) was then compared to the 'no-AIDS' reference scenario. The AIDS simulations are different from those of the 'no-AIDS' scenario in three important respects. First, the prevalence of AIDS among adults, a_t, increases from 0.09 percent in 1985 to 3.15 percent in 2010, whereas a_t is, by definition, always zero in the 'no-AIDS' scenario. Second, population size in the AIDS-scenarios, relative to the 'no-AIDS' scenario, is smaller because of higher mortality rates. Third, the age structure in the AIDS scenarios, in comparison to the 'no-AIDS' scenario, is tilted towards younger age cohorts in a lower average age of the workforce.

[6] The remaining portion (1-*x*) is financed through a reduction of other current expenditures.

Considering, for example, the most likely AIDS scenario in which the productivity of those suffering form AIDS reduced by half (i.e. z = 0.5) and the fraction of medical expenditure that comes out of reduced domestic saving is also half (i.e. x = 0.5), Cuddington (1993a) finds that real GDP grows at an average rate of approximately 3.2 percent per year, as against 3.9 percent per year of the 'no-AIDS' reference scenario, and, hence, the level of real GDP (in constant 1980 Tanzanian Shillings) in 2010 is 16 percent lower than that in the 'no-AIDS' scenario. However, per capita GDP, under the AIDS scenario, continues to grow at almost the same rate as the one which prevails in 'no-AIDS' scenario. Precisely, per capita GDP grows at 0.6 percent per annum in the AIDS scenario, compared with 0.7 percent per annum in the 'no-AIDS' scenario. Hence, the level of per capita GDP in 2010 in the AIDS scenario is only 2.7 percent lower than that in the 'no-AIDS' scenario. Typically and expectedly (as explained in section 1.1.3) the adverse impact of HIV and AIDS on per capita GDP, as compared to that on the overall GDP, is smaller.

The single-sector model of Cuddington (1993a) is based on the assumption that labour and capital are always efficiently allocated throughout the economy. That is, there are no market failures or policy-induced distortions that lead can result in a misallocation of resources. The simulations based on such a single-sector, full-employment growth model, therefore, effectively trace the impact of AIDS on the economy's potential (rather than actual) growth path. In reality, particularly in developing countries, workers who die of AIDS can easily be replaced by otherwise unemployed or underemployed workers, leaving overall GDP virtually unaffected, and the per capita income possibly higher than before.

Cuddington (1993b), therefore, generalises and extends the above analysis of Cuddington (1993a) by allowing for the possibility of under-employment and the existence of dual labour-markets – two features that are especially relevant in examining the impact of AIDS in developing countries. The dual-economy simulations of Cuddington (1993b), once again using Tanzanian data, suggest that the macro-economic consequences of AIDS epidemic are of the same order of magnitude as those found in the single-sector full employment of Cuddington (1993a). That is, GDP is about 15 to 25 percent smaller, and per capita GDP is 0 to 10 percent smaller than what these would have been if there was no AIDS. The dual economy simulations also suggest that more rapid labour market adjustment induced by economic reform policies could yield substantial real income gains, which, interestingly, could recover some or all of the macro-economic losses brought about by AIDS. Further research is required to determine precisely the extent to which labour market adjustment policies can offset the negative economic effects of the AIDS epidemic.

Further research is required to determine precisely the extent to which labour market adjustment policies can offset the negative economic effects of the AIDS epidemic

The modified neo-classical growth model has also been used for analysing the macro-economic impact of AIDS in Botswana by MacFarlan and Sgherri (2001). The modifications introduced by MacFarlan and Sgherri (2001) allow for two sectors – formal and informal– and two categories of labour – skilled and unskilled. All skilled labourers are assumed to be employed in the formal sector, which is also the sector with higher capital intensity. The model thus consists of three labour markets : skilled labour in the formal sector, unskilled labour in the formal sector, and unskilled labour in the informal sector; in the first and the last labour market, wages

adjust to equate demand and supply of labour, while in the second one there is a fixed minimum wage. The model (MacFarlan and Sgherri (2001)) is then used to generate various 'with-AIDS' and 'no-AIDS' scenarios for Botswana during 1999-2020. A comparison of the different scenarios suggest : (i) the rate of growth of real GDP falls from 5.5 percent a year in the 'no-AIDS' scenario to between 1.5 and 2.5 percent a year in the 'with-AIDS' scenarios, (ii) the level of real GDP in 2010 in the 'with-AIDS' scenarios consequently is 33 to 40 percent lower than what it is in the 'no-AIDS' scenario, (iii) public expenditures rises by over five percent of GDP as a result of higher healthcare spending, leading to a marked deterioration in the fiscal situation, (iii) while the informal sector, a labour-intensive sector, experiences lower growth because of the contraction in the labour supply caused by increased mortality associated with AIDS, the formal sector, a capital intensive sector, also suffers slower growth as a result of slower capital accumulation, and (iv) the main sectoral impact on income distribution arises from the shortage of skilled labour, from a shift of unskilled labour from the informal to the formal sector, and from a reduction in the unskilled wage differential between the two sectors.

The macro-simulation models are successful in highlighting the considerable deceleration in the growth rate of GDP that may result from an AIDS epidemic, but show only a marginal negative impact of the epidemic on the growth rate of per capita GDP

In general, the macro-simulation models are successful in highlighting the considerable deceleration in the growth rate of GDP that may result from an AIDS epidemic, but show only a marginal negative impact of the epidemic on the growth rate of per capita GDP. This is not surprising. Indeed, theoretically, it is conceivable that the per capita real GDP rises with the decline in population more than compensating the fall in real GDP, thereby, pointing towards the conclusion that the survivors of the epidemic are "indifferent" or "better-off". However, that is merely a corollary of the fact that the population is declining in an economy afflicted by AIDS. And a population which is declining due to the increased mortality associated with AIDS can hardly be seen as a favourable occurrence offsetting the slowdown in GDP growth. More importantly, to infer from this that the survivors of the epidemic are "better-off" is not only trivial but also perverse.

Finally, it must be noted that, a major limitation of the macro-simulation models arise from the fact that they are aggregate growth models. Accordingly, they cannot capture the sectoral readjustments which serve to mitigate the loss in aggregate output resulting from an AIDS epidemic. To the extent that this "mitigation effect" is ignored in the macro-simulation models, the latter type models tend to overestimate the loss in aggregate output.

1.2.3 Computable general equilibrium models

A characteristic feature of any economy is the existence of sectors that are not identical. Among other things, the relative use of different types of labour in combination with other factors (capital and land) will differ across sectors. The reduced labour supply resulting from the increased mortality associated with AIDS will, therefore, have a differential impact across sectors. Typically, there will be a mildly negative impact on the outputs of sectors that use more of capital and less of labour, but sharp reductions in outputs will occur in the labour-intensive sectors. The latter sectors, in turn, will substitute relatively cheaper factors of production for labour inputs, and, thereby, regain some of the output loss. The net loss in (aggregate) output will, therefore, be smaller than what is usually estimated

through the aggregate growth models. In other words, the latter type models are incapable of capturing the intra-sectoral and the inter-sectoral substitutions that necessarily take place to absorb the shock caused to an economy by an AIDS epidemic and, therefore, overestimate its impact.

This limitation of the aggregate growth models is overcome in the computable general equilibrium (CGE) models. The CGE models embody the interactions between various sectors that make up the domestic economy. Moreover, these models allow for a variety of substitution mechanisms including substitution in production, consumption and trade occuring in response to price changes. Finally, CGE models simulate the workings of a market economy in which prices fluctuate to equate demand and supply for all goods and factors. It is obvious that the feedback between labour markets and the rest of the economy, which is overlooked in the aggregate growth models, can be easily captured in a CGE model. In these models, therefore, the net loss in output resulting from a reduction in labour supply caused by increased mortality due to AIDS, will be realistically estimated rather than overestimated as is likely in the case of aggregate growth models.

Kambou, Devarajan and Over (1992) use a CGE model of Cameroon to evaluate the impact of an AIDS-induced reduction in labour supply on the economy of Cameroon. The Cameroon CGE model is a variant of the standard CGE model for developing countries built by Dervis, de Melo and Robinson (1982). The Cameroon model has 11 sectors divided into three agricultural, five manufacturing and three service sectors. Each sector produces a single composite good using three different skill categories of labour, capital and intermediate inputs. In production, intermediate inputs are used according to fixed input-output coefficients but, capital and labour are used according to a nested Cobb-Douglas or CES production function. Production decisions are guided by profit maximising behaviour of producers. However, capital stocks are sector specific and exogenously fixed in a given period. The three types of labour – rural (unskilled), urban-unskilled and urban-skilled - are not sector-specific, though their overall supplies are fixed. (That is, the supply curves of all the three kinds of labour are vertical.) In any given period, therefore, profit-maximising producers hire each type of labour until wages equal marginal revenue products. The labour market for each skill category clears when the total demand for labour, obtained as the summation of the sectoral demands of labour, equals the exogenously fixed supply of labour.

The limitation of the aggregate growth models is overcome in the computable general equilibrium (CGE) models

In the Cameroon model, the foreign trade sector interacts with the rest of the economy in a particular way. On the import side, it is assumed that imported goods and domestically produced goods are imperfect substitutes in each sector. And, in each sector, therefore, consumers demand a composite good defined as a CES aggregation of imported and domestic goods, where the elasticity of substitution reflects the relative ease of substituting one for the other in response to changes in relative prices (Armington, 1969). Because consumers are assumed to minimise the cost of acquiring the composite goods, their chosen combination of imported and domestic goods is a function of the ratio of their prices and of the elasticity of substitution. Moreover, the small country assumption is made to keep the world prices of imports fixed and the supply of imports to Cameroon infinitely elastic at these prices.

On the export side, the model deviates from the small country assumption that the world price of exports is fixed by world market conditions. This is because exports are differentiated by country of origin, and, given world prices, Cameroon exporters can increase their world market share by increasing their international competitiveness (by lowering their supply prices). They, therefore, face a downward sloping world demand curve for their products. Furthermore, the model assumes that goods produced for domestic sales and exports are imperfect substitutes. Hence, a constant elasticity of substitution (CES) function is used to define the output of each sector as a revenue-maximising aggregate of goods for the domestic market and goods for the foreign markets. An increase in the price of exports relative to domestic sales, therefore, induces domestic producers to increase the share of exports and decrease the share of domestic sales in total output.

There is no inter-temporal optimisation in the Cameroon CGE model. The model is only quasi-dynamic

The production of goods and services for domestic and foreign consumption generates a flow of income whose main recipients are households and the government. This flow of income, in turn, generates demands for goods. There is a single representative household whose total income is given by the sum of factor earnings. With its total income, the household pays income tax, saves a fraction of disposable income, and spends the rest on goods and services according to fixed expenditure shares. The latter follow from the assumption that households maximise a Cobb-Douglas utility function over commodities subject to the budget constraint.

The main sources of government revenue are import tariffs, export duties, indirect and income taxes, and foreign borrowings. The government uses its revenues to purchase goods and services and to finance investment. Government saving is determined residually by deducting total expenditures from total revenues.

Total saving is equal to the sum of government saving, household saving and foreign saving, which is given exogenously. Investment is then set equal to total saving. Because saving determines the level of investment, the model is said to be saving-driven. And that, in fact, defines the model closure. Investment demands by sectors of origin are determined according to exogenously given fixed shares. Investment by sectors of destination are also determined by fixed shares in accordance with the structure of capital stock.

Aggregate demand for the composite output in each sector is the sum of household demand, government demand, investment demand and intermediate demand for that sector. On the other hand, the supply of the composite goods in a sector is, as mentioned before, a CES aggregation of domestic production and imports. For a general equilibrium solution, excess demands in all sectors must be equal to zero. However, from Walras' law, only (n-1) out of the n excess demand equations are independent (where n is the total number of sectors, which is 11 in the Cameroon model). That is, the CGE model is homogeneous of degree zero in prices and, can, therefore, determine only relative prices. A price normalisation rule is required to anchor the price level. This is done by normalising the nominal exchange rate to unity.

The model runs from the base-year, 1985-86 to the terminal year, 1990-91. There is no inter-temporal optimisation in this model. The model is only quasi-dynamic.

That is, it runs as a series of static equilibria. The description given above is that of the single-period static model. Obviously, the quasi-dynamic CGE model encompasses the static model. It takes as given the equilibrium solution provided by the static model, and updates over time some exogenous variables by using the available time series data, and some others by using behavioural equations in a 'between-period' model. To give an example of the latter, the investments by sector of destination determined endogenously in the general equilibrium solution (GES) for period *t* are added in the 'between-period' model to the sectoral capital stocks of period t to arrive at the sectoral capital stocks for period *t+1*, which, in turn, are used to generate the GES for period *t+1*. This process goes on till the GES for period *t+n*, the terminal year of the model, is obtained. From the series of static equilibria thus generated, certain variables are culled out, and their growth paths are then drawn for the period covered by the model, 1985-86 to 1990-91.

These growth paths of the selected variables define what is known as the base-line or reference scenario, or, base or reference run, or, base or reference case. The reference scenario in the model of Kambou, Devarajan and Over (1992) simulates the working of the Cameroonian economy during the period 1985-86 to 1990-91 in the absence of AIDS. The 'no-AIDS' reference scenario, thus generated serves as a benchmark against which the effects of an adverse supply shock, such as, a fall in the supply of labour caused by an AIDS epidemic, are measured. Subsequently, to simulate the impact of a fall in the supply of labour caused by an AIDS epidemic, the model is rerun in the manner described above after admitting this shock (i.e. after making suitable changes in the relevant exogenous variables), and, thus, a 'with-AIDS' scenario is generated. A comparison of this 'with-AIDS' scenario with the 'no-AIDS' reference scenario then provides an assessment of the impact of an AIDS-induced labour shortage.

Kambou, Devarajan and Over (1992) generate four 'with-AIDS' scenarios. In their first 'with-AIDS' scenario the effects of a general labour shortage caused by AIDS are simulated. In this scenario, the AIDS epidemic manifests as an annual reduction of 30,000 workers from the total supply of labour, with the reduction being equally distributed across the three skill categories of labour. The consequences of this general labour shortage turn out to be seriously adverse. By every account, the economy is worse off in comparison to the 'no-AIDS' reference scenario. GDP growth rate is almost halved, and, growth rate of investment is reduced to almost one-fourth of what it was in the 'no-AIDS' reference case. There is a sharp decline for growth in exports and imports as well. On the growth in consumption and private savings, however, there is only a marginal adverse impact. Government revenues grow much more slowly, because of significantly lower growth in all economic activities. There is consequently a steep fall in the growth rate of government saving (the average annual rate of growth of government saving falls from 10.2 percent in the 'no-AIDS' scenario to –25.2 percent in this 'with-AIDS' scenario), and, it is that which is responsible for the fall in the growth rate of investment.

The Cameroon CGE model shows adverse consequences of the general labour shortage caused by AIDS

In the second 'with-AIDS' scenario, the effects of a reduction in the quantity of rural workers only is simulated. In this simulation, the number of rural workers is assumed to decrease each year throughout the simulation period by 10,000, which represents 0.40 percent

and 0.30 percent of the rural and entire labour force, respectively. As a result, the labour force growth slows down but remains positive. The net effect of this slowdown in the labour force growth rate on the economy is mildly negative. There is a marginal decline, *vis-à-vis* the 'no-AIDS' reference case, in the growth rates consumption and government saving. However, in case of other macro-variables – GDP, investment, exports imports, and private saving– the growth rates remain more or less the same.

In the third 'with-AIDS' scenario, an annual reduction of 10,000 urban-unskilled workers only is assumed. The effect of this annual loss of 10,000 urban-unskilled workers is approximately the same as that for an annual loss of 10,000 rural (unskilled) workers in the previous 'with-AIDS' scenario. All the macro-variables except government saving in this scenario have growth rates which are almost the same as in the previous scenario. Government saving grows at a rate which is visibly lower than that in the second 'with-AIDS' scenario. That is, in comparison to the latter, the decline in government saving, with respect to the reference case, is more pronounced in this scenario.

The impact on real output of an AIDS-induced labour shortage is directly related to the share of labour in production, and inversely related to the elasticity of susbstitution among labour of different skill categories and between the latter and other factors of production

In the fourth 'with-AIDS' scenario, it is assumed that deaths caused by AIDS lead to an annual decline of the supply of urban-skilled workers by 10,000, which represents 6 percent of the urban-skilled labour force. The impact on the economy is seriously adverse like in the first 'with-AIDS' scenario of a general labour shortage caused by AIDS. There is a 40 percent decline in the GDP growth rate, and a 66 percent fall in the investment growth rate. There is a major decline in the growth rate of exports and imports also. The sharpest decline, however, is in the growth of government saving; the average annual rate of growth of government saving falls from 10.20 percent in the 'no-AIDS' reference scenario to –20.60 percent in this 'with-AIDS' scenario. For the growth in consumption and private saving, there is only a minor deceleration. In short, like in the first 'with-AIDS' scenario, setback to the economy in this simulation is caused by a steep fall in government saving.

Some general points emerge from the simulation exercises described above. First, the impact on real output of an AIDS-induced labour shortage is directly related to the share of labour in production, and inversely related to the elasticity of susbstitution among labour of different skill categories and between the latter and other factors of production. Second, the reduced supply of labour means that wages and, thereby, the prices rise. The wage-push inflation then results in higher domestic costs of production, which, in turn, causes the real exchange rate to appreciate. The end result is a decline in exports, production and foreign exchange. Third, the fall in production and exports lowers government revenues, thus, causing the government saving to decline. Lower government saving, in the absence of a compensating increase in private saving, results in a decrease in overall saving in the economy. Lower saving translates into lower investment, causing thus a slowdown in economic growth. It must be pointed out here that, the decline in government saving (which is rather steep in the first and fourth 'with-AIDS' scenarios) observed in the four simulations described above, is occuring despite the assumption that the government is not undertaking any policy measure, i.e., it is not incurring any expenditure, to tackle the AIDS epidemic. In other words, if this unrealistic assumption is not made, and the government has to incur additional

expenditure for the prevention and treatment of AIDS, which is what is likely to be the case in real life, then the fall in saving and, thereby, in investment will be even more, leading ultimately to an even slower economic growth. Fourth, the adverse impact on economic growth is greater in case of unequal incidence of AIDS among labour of different skill categories, with the prevalence of AIDS being higher among the more skilled categories, and lower among the less skilled categories of labour. This is amply demonstrated by the fourth 'with-AIDS' scenario.

A major limitation of the Kambou, Devarajan and Over's model is that it considers only one effect of the AIDS epidemic, namely, the decline in labour supply as a consequence of the increased mortality associated with AIDS. Other very significant effects of AIDS – labour productivity losses due to debility and erosion of human capital, overall productivity declines arising from additional costs of hiring and training new workers needed to offset the loss in labour input because of increased absenteeism of AIDS-affected workers, and declines in household and government savings because of additional expenditure incurred on healthcare – have not been taken into account in the modeling exercise of Kambou, Devarajan and Over (1992). Therefore, in all probability, they provide an underestimate of the impact of AIDS.

This limitation is largely overcome in the CGE model of Arndt and Lewis (2001). The Arndt and Lewis' CGE model has been built for the South African economy with a view to analyse the impact of the AIDS epidemic in South Africa on its unemployment rates. Unemployment has been a perennial problem in South Africa, especially for the unskilled and semi-skilled labourers. Since the mid-seventies, unemployment rates of unskilled and semi-skilled labourers have been increasing steadily, and in 1995 crossed the intolerably high level of 50 percent. For skilled labourers, the unemployment rate has been very low till 1990, after which they start rising rapidly, and reach the considerably high level of 10 percent. On the other hand, unemployment rate for highly skilled labourers has been almost zero throughout the 30-year period, 1970-2000. Interestingly, a comparison of these unemployment trends in the three skill categories of labour with the trends in their respective wages during this 30-year period suggests a clear positive relationship between growth in unemployment rates and growth in wages. That is to say, wage rates for unskilled and semi-skilled labourers have grown rather fast, inducing, evidently, a rapid decline in employment (i.e., a rise in unemployment) for this category of the workforce. On the other hand, for the highly skilled labourers, wages have not grown at all in the 30-year period; in fact, there has been a marginal decline in their wages, and so unemployment for this category of the workforce has remained negligible throughout. It would seem that in South Africa, institutional factors, such as, labour unions, wage bargaining councils, and labour legislation have all served to make rigid the wages for unskilled and semi-skilled workers at levels well above the market-clearing levels.

The Arndt and Lewis' CGE model has been built for the South African economy with a view to analyse the impact of the AIDS epidemic in South Africa on its unemployment rates

Both the Cameroon CGE (Cam-CGE) model of Kambou, Devarajan and Over (1992) and the South African CGE (SA-CGE) model of Arndt and Lewis (2001) are based on the standard CGE model of Dervis, de Melo and Robinson (1982), but there are some important differences between the two.

The SA-CGE contains 14 sectors, which include three sectors especially relevant in an analysis of HIV and AIDS : medical and health services, social services and government services. There are five primary factors of production : capital and four types of labour – professional, skilled, unskilled and informal, and five household categories representing income distribution quintiles.

Sectoral production in this model is determined according to a translog production function. First, capital and labour inputs are combined to generate a value-added aggregate. Second, the value-added aggregate is combined with intermediate inputs to produce output according to a fixed-coefficients technology.

The South Africa CGE contains 14 sectors, which include three sectors especially relevant in an analysis of HIV and AIDS : medical and health services, social services and government services

The SA-CGE is specially designed to handle unemployment. Of the four skill types of labour – professional, skilled, unskilled and informal – only the first one has a market-clearing wage rate; the remaining three types have institutionally fixed wages. Specifically, wages for these three types are fixed relative to the overall price index. Total supplies for all the four types of labour are, however, fixed, i.e., all the labour supply curves are vertical. Sectoral demands for labour are determined by profit-maximising producers, who equate marginal product of labour to the real wage rate. Total demand (employment) of each type of labour is then determined as the sum of the sectoral demands. For the professional labour, the wage rate adjusts to equilibriate total demand and supply. On the other hand, for each of the other three types of labour having exogenously fixed wage rates, total demand is not equated to total supply; instead, the difference between the latter and the former is defined to be the unemployment.

The rest of the single-period static SA-CGE model is very similar to the single-period static Cam-CGE model. Moreover, the dynamic features of the two models are also the same. Like the Cam-CGE model, the SA-CGE model is recursively dynamic (quasi-dynamic). That is, the SA-CGE model includes a 'between-period' model containing a set of dynamic equations, which update certain parameters and exogenous variables from one year to next. Sectoral capital stocks are adjusted each year based on investment, net of depreciation, and investment is assumed to respond to differential sectoral profit rates so as to maintain the rental rate differentials observed in the base-year data. Sectoral total factor productivities (TFP), total supplies of all the four types of labour, and the institutionally fixed wages for the informal, unskilled and skilled labour groups are scaled upwards each year by their respective exogenously given growth rates.

The SA-CGE model has been calibrated to the benchmark equilibrium data set obtained from a Social Accounting Matrix (SAM) for South Africa for the year 1997. The model is then run from the base-year, 1997, to the terminal year, 2010, under two sets of assumptions to generate two basic scenarios – a 'no-AIDS' reference scenario and a 'with-AIDS' scenario.

In the 'no-AIDS' reference scenario, it is assumed that the prevalence of AIDS is so low as to have no impact on the economy. It must be noted that, the 'no-AIDS' scenario is a hypothetical scenario– and not an actual or a business-as-usual scenario– that is generated to serve as a standard against which the 'with-AIDS' scenario is evaluated.

On the other hand, in the 'with-AIDS' scenario, the prevailing incidence of AIDS is assumed to have precise impacts[7] on key exogenous variables. These precise impacts are as follows : (i) slower growth in population and supply of labour by the skill categories, resulting from AIDS-related deaths as forecasted in ING Barings (2000), (ii) lower labour productivity of HIV workers reflected in a lower effective labour input in proportion to the AIDS-related deaths projected by ING Barings (2000), (iii) declines in sectoral TFP growth rates, initially to about 0.6 times the 'no-AIDS' growth rate, and, finally, at the height of the epidemic, to about half of the 'no-AIDS' growth rate, (iv) an increase in the share of health services spending by 10-15 percent, depending on the quintile, of the HIV households, at the expense of other non-food expenditures, (v) an increase in the health share of the total government spending from 15 percent in 1997 to 26 percent in 2010, resulting in a fall in government saving (which then crowds out investment).

In the 'no-AIDS' scenario, the real GDP growth rate accelerates slowly and steadily from 2.3 percent in 1998 to 3.7 percent in 2010, mainly on account of capital deepening and projected increase in the rate of growth of professional and skilled labour. In the 'with-AIDS' scenario, real GDP growth rate starts from 2.0 percent in 1998, and decelerates to 1.3 percent in 2010. However, the difference in the real GDP growth rates between the two scenarios is not uniform over the 13-year period, 1997-2010. This difference, which is about 0.3 percent initially, reaches a maximum of 2.6 percent in 2008, but, declines slightly, thereafter, to about 2.4 percent in 2010. It is obvious that, the divergence between the two growth paths widens over time as the epidemic increases in its severity.

Comparing the real GDP in absolute terms in the two scenarios, it turns out that the real GDP is progressively lower in the 'with-AIDS' scenario 1998 onwards, ending up in 2010 at a level which is 20 percent lower compared to the 'no-AIDS' scenario. The per capita real GDP in the 'with-AIDS' scenario also dips below the level of per capita real GDP in the 'no-AIDS' scenario as early as 1999 – though by only 0.5 percent – after that it falls progressively below the latter, and, in 2010, reaches a level that is 8 percent lower relative to the 'no-AIDS' scenario. In other words, the fall in real GDP is so large as not to be offset by the decline in population. Hence, the survivors of the epidemic are not "indifferent" or "better-off". They are in fact "worse-off", as the lower per capita incomes show.

The 'with-AIDS' scenario of South Africa CGE model shows a large reduction in GDP

The 'with-AIDS' scenario of SA-CGE model captures not only the impact of a fall in the supply of labour as a consequence of the premature deaths caused by the AIDS epidemic, but also other equally important impacts of the latter – reduced labour productivities as well as total factor productivities, and increased spending on health services by households and the government. The combined effect of all these adverse impacts is, not surprisingly, a large reduction in GDP.

As far as unemployment is concerned, the a *priori* expectation is that slower growth in the supply labour because of AIDS-related deaths will cause unemployment rates to fall. However, this is not borne

[7] These precise impacts themselves are based on empirical observations and/or projections from other (demographic) models, such as, ING Barings (2000).

out in the 'with-AIDS' scenario. There is considerably slower growth in the supply of labour in the 'with-AIDS' scenario; so much so that by 2010, the pool of labour is 17 percent smaller relative to the 'no-AIDS' scenario. At the same time, overall economic growth slows down. As a result, demand for labour falls. The latter, in fact, falls proportionately more than the fall in supply of labour. This happens because the changed sectoral pattern of growth in the 'with-AIDS' scenario is skewed in favour of sectors that are capital intensive rather than labour intensive. To put it another way, sectors that use labour more intensively are hit relatively harder by the AIDS epidemic compared to the sectors that are capital intensive in nature. Sectoral impact of the epidemic is, therefore, important, and we now turn to that.

All the 14 sectors of the South Africa CGE model have smaller value-addeds in the 'with-AIDS' scenario compared to the 'no-AIDS' scenario. However, the loss of value-added is not uniform across sectors

All the 14 sectors have smaller value-addeds in the 'with-AIDS' scenario compared to the 'no-AIDS' scenario. However, the loss of value-added is not uniform across sectors. There is, for example, in the final year, 2010, considerable variation in the ratio of real value-added by sector between the 'with-AIDS' and 'no-AIDS' scenarios. This ratio is lowest for the construction sector followed by that for the equipment sector; it is 0.65 and 0.69 respectively. These two sectors are hit hardest by the AIDS epidemic. They are followed by four other sectors – Mines, Consumption goods, Intermediates, Trade and Electricity and Gas – which have their vaue-added ratios in the range, 0.70 – 0.79. All other sectors, including Transport, Agriculture, Business Services, have ratios which are equal to or more than 0.80. The overall real GDP ratio between the 'with-AIDS' scenario and the 'no-AIDS' scenario is 0.80.

Investment demand forms 62 percent and 34 percent of the total demand in case of the Construction and Equipment sectors respectively. These two sectors with their high shares of investment demand are particularly affected by the decline in investment consequent to the fall in government and household savings brought on by the epidemic. It must be noted that the decline in investment itself is a large one : in 2010, investment in 'with-AIDS' scenario is 39 percent less compared to the 'no-AIDS' scenario.

Between the sectoral with-AIDS/no-AIDS value-added ratio and sectoral unskilled labour use as a share of total employment of unskilled labour a negative relationship is found. In other words, the adverse impact of the epidemic on value-added is greater for sectors that are large demanders of unskilled labour. It may be noted, however, that the strength of the negative relationship between the sectoral value-added ratios and the unskilled labour use shares, is very sensitive to the degree of sectoral disaggregation. That is to say, the higher the level of sectoral disaggregation, the higher most likely will be the magnitude of the negative slope coefficient of the estimated line of regression, in which the sectoral value-added ratio is the dependent variable and the sectoral unskilled labour use share is the independent variable. On the other hand, by adopting a lower level of sectoral disaggregation – i.e. by aggregating more and more sectors whose value-addeds are weakly affected by the labour shortage resulting from the epidemic, into a single sector constituting, by virtue of its sheer size, a large share of total unskilled labour demand – the observed negative relationship between the sectoral with-AIDS/no-AIDS value-added ratio and the sectoral share of unskilled labour use can be considerably weakened or even eliminated. It must be stressed that for the 'reasonable' degree of sectoral disaggregation adopted in the SA-CGE

model, there is a well-defined negative relationship between the sectoral with-AIDS/no-AIDS value-added ratio and the sectoral share of unskilled labour use. The inference that the epidemic impacts more severely the sectors that are large demanders of unskilled labour is thus justified.

In addition, the estimated slope coefficient of the line of regression, where the share of unskilled labour value-added in total sectoral value-added is the independent variable and the sectoral with-AIDS/no-AIDS value-added ratio is the dependent variable, turns out to be negative. This implies that the larger the intensity of unskilled labour use relative to other factors, the higher is the loss in value-added due to AIDS.

It is important to see the adjustment mechanism at work in the SA-CGE model. A major shock delivered to the economy by the AIDS epidemic, apart from the decline in the supply of labour which it causes, is the increase in health expenditure of the households and the government. Consequently, both household and government savings decline. So, in turn, does the investment in the economy. The decline in investment demand then induces a cutback in labour demand, and the latter effect is reinforced in the labour intensive sectors. Overall, the fall in labour demand outstrips the AIDS-induced fall in labour supply, and the unemployment rates, therefore, either increase or remain the same.

The larger the intensity of unskilled labour use relative to other factors, the higher is the loss in value-added due to AIDS

Part I

The Macro-economic Impact of HIV and AIDS in India

Chapter 2

The Macro-economic Impact of HIV and AIDS in India

The survey in the accompanying study by Pradhan, Sundar and Singh (2006) underplays the adverse macro-economic impact of HIV and AIDS. Given the current prevalence rate, the extrapolation of the household level impact to the level of the state or the national economy does not reveal a large economy-wide impact. But, this is because the survey captures the snapshot of the economy at a given point of time, while the question of the macro-economic impact of HIV and AIDS is essentially a dynamic one. As the HIV epidemic unfolds, its impacts are bound to be deeply compounded. These impacts cannot be assessed in their totality by a mere extrapolation of the household level impact.

Moreover, because India has been a low HIV prevalence country so far, the macro-economic impact of HIV and AIDS till date could not have been significant. However, in 2005, the number of PLWHA has exceeded 5 million. HIV infections in India are also expected to quintuple to between 20 million and 25 million by 2010 (National Intelligence Council, 2002). That would mean India would be having the maximum number of PLWHA by 2010. With that kind of a spurt in the number of HIV cases in the next 5-10 years, there is bound to be a noticeable impact on the macro-economy.

At present, little or nothing is known about the potential macro-economic impact of HIV and AIDS on the Indian economy. The rough-and-ready estimates of the macro-economic costs of AIDS that are available are of no help in guiding and accelerating the response of the Government of India to the potential threat to the economy imposed by this epidemic. Though policy response has been gathering momentum recently, its effectiveness is far from certain. Precise knowledge of the macro-economic impact of HIV and AIDS will both add impetus to policy action and enhance its effectiveness by enabling the government to make sustainable and cost-effective choices among the available policy options. In short, a quantitative assessment of the macro-economic impact of HIV and AIDS needs to be undertaken urgently for the Indian economy to assist the policy makers.

The present study attempts to do precisely that, using a recursively dynamic multi-sectoral CGE model for the Indian economy. This model has been formulated on the lines of Arndt and Lewis (2001) model to capture the impact of HIV and AIDS on aggregate and per capita GDP, sectoral GDPs, and distribution of income across four rural and five urban household groups.

As has been done in the Arndt and Lewis (2001) study, first a 'no-AIDS' reference scenario is generated, and then a 'with-AIDS' scenario is stimulated. Subsequently, the two scenarios are compared to arrive at an assessment of the macro-economic impact of HIV and AIDS on the Indian economy.

The rest of the paper is organised as follows. Section two presents the overall structure of the CGE model. In Section three, the main macro-economic features are described, such as, GDP growth and growth of per capita income, household income distribution, of the 'no-AIDS' reference scenario are reported. In Section four, the results of the 'with-AIDS' scenario in comparison with 'no-AIDS' reference scenario are reported. Part II deals with the impact of HIV and AIDS on the Indian industry. In Section five, the industrial and the residual are described - i.e., the non-industrial - sectors of the Indian economy. In Section six, the results on the sectoral impact of the epidemic obtained from our 28-sector CGE model are presented. Section seven summarises and concludes. In Appendix 1, the five-sector Social Accounting Matrix (SAM) for 2002-03 are presented, which provides the benchmark equilibrium data set for the five-sector CGE model of part I. The 28-sector SAM for 2002-03 which has been used in the 28-sector CGE model of part II, has been presented in Appendix 2. In Appendix 3, the equations of the CGE model are given.

The model used in this study is a multi-sectoral, neo-classical type price driven CGE model

2.1 CGE model structure

This model is a multi-sectoral, neo-classical type price driven CGE model. The overall structure of this model is similar to the one presented in Arndt and Lewis (2001). However, in formulating the details of the model, an eclectic approach keeping in mind the institutional features peculiar to the Indian economy have been followed.

The model has five production sectors and three factors of production - land, capital and composite labour, which in turn, is a nested CES aggregation of non-educated (unskilled), secondary-educated (semi-skilled) and higher-educated (skilled) labour[8]. At the beginning of a period, the economy is endowed with a certain level of physical capital and human capital, in the form of stocks of different types of labour. In any given period the allocation of capital across production sectors is fixed, but labour is inter-sectorally mobile. Producers act as profit maximisers in perfectly competitive markets, i.e., they take factor and output prices (inclusive of any taxes) as given and generate demands for factors so as to minimise unit costs of output. The factors of production include intermediates and the primary inputs – capital, land and different types of labour. For households, the initial factor endowments are fixed. They, therefore, supply factors inelastically. Their commodity-wise demands are expressed, for given income and market prices, through the Stone-Geary linear expenditure system (LES). Also, households save and pay taxes to the government. Furthermore, households are classified into four rural and five urban categories. The government is not assumed to be an optimising agent. Instead, government consumption, transfers and tax rates are exogenous policy instruments. The rest of the world supplies goods to the

[8] In our classification of three types of labour in India, 'secondary educated' includes all those from 1st pass to 12th pass – i.e., 'elementary' + 'secondary' + 'higher secondary' educated, and 'higher educated' includes 'graduates ' + 'higher-than-graduates'.

economy which are imperfect substitutes for domestic output, makes transfer payments and demands exports. The standard small-country assumption is made, which implies that India is a price-taker in import markets and can import as much as it wants. However, because the imported goods are differentiated from the domestically produced goods, the two varieties are aggregated using a constant elasticity of substitution (CES) function, based on the Armington assumption. As a result, the imports of a given good depends on the relation between the prices of the imported and the domestically produced varieties of that good. For exports, a downward sloping world demand curve is assumed. Furthermore, a constant elasticity of transformation (CET) function is used to define the output of a given sector as a revenue-maximising aggregate of goods for the domestic market and goods for the foreign markets. This implies that the response of the domestic supply of goods in favour or against exports depends upon the price of those goods in the foreign markets *vis-à-vis* their prices in the domestic markets, given the elasticity of transformation between goods for the two types of markets. The model is Walrasian in character. Markets for all commodities and non-fixed factors – capital stocks are fixed and inter-sectorally immobile – clear through adjustment in prices. However, thanks to the Walras' law, the model determines only *relative* prices. The exchange rate is chosen as the numeraire, and is, therefore, normalised to unity. In the external closure of the model, foreign savings are fixed exogenously. Finally, the model follows a savings-driven macro-closure, in which aggregate investment is the endogenous sum of the separate savings components – household savings, government savings and foreign savings.

Inter-temporally, the model adjusts through changes in the stock of physical capital and the stock of human capital. Physical capital is increased by investment, which is determined by domestic and foreign savings. Human capital (i.e. the stocks of the three types of labour) is augmented by the new supplies of labour of three skill types, which are exogenously given.

2.1.1 Sectoral disaggregation

Our model is based on a five-sector disaggregation of the Indian economy :

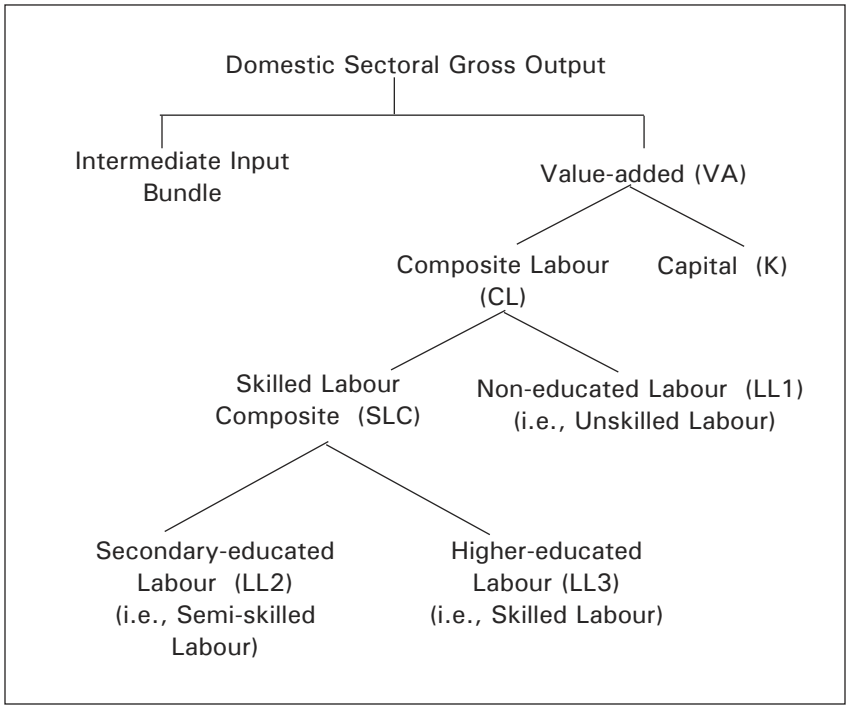
(i) Agriculture,
(ii) Manufacturing (Industry)
(iii) Services
(iv) Healthcare
(v) Tourism

Production technologies for all sectors are defined using nested CES functions

2.1.2 The production structure

Production technologies for all sectors are defined using nested CES functions as shown below :

Figure 3
The production structure



Note that vertical lines in the nesting diagram represent Leontief combinations, while the slanting lines represent CES combinations of the inputs involved. For agriculture, there is an additional branch in the nesting structure. In the agricultural sector, a Cobb-Douglas aggregation of land and capital produces composite capital, which in turn, is combined with composite labour to produce value-added. At each level of the nested production function, the assumption of constant elasticity of substitution (CES) and constant returns to scale (CRS) is made. For every level, the producer's problem is to minimise cost (or maximise profit) given the factor and output prices and express demands for inputs. It follows that for every level, the following three relationships hold : the CES function relating output to inputs, the first order conditions, and the product exhaustion theorem. For all the levels taken together, the production system thus determines the gross domestic output, the input demands, value-added as well as the demands for the various types of labour. (The capital stock in a particular period is given, so the first-order condition effectively determines the sectoral return on capital.)

Labour is inter-sectorally mobile. Wages are flexible and adjust to equilibriate the demand and supply for each of the three types of labour – unskilled labour, semi-skilled labour and skilled labour

2.1.3 Investment

There are fixed share parameters for distributing the aggregate investment across sectors of origin. However, the allocation mechanism for sectors of destination is different. The allocation ratios are given in a particular period, but are revised from period to period on the basis of the sectoral relative return on capital. The relative return on capital in any sector is given by the normalisation of the implicit price of capital in that sector to the economy-wide returns. This rule does not imply full-factor price equalisation, but only a sluggish reallocation of investment from sectors where rate of return is low to ones having higher rates of return.

2.1.4 Factor markets

Labour is inter-sectorally mobile. Wages are flexible and adjust to equilibriate the demand and supply for each of the three types of labour – unskilled labour, semi-skilled labour and skilled labour. There is no unemployment for any of the three types of labour. Cropping land in the agricultural sector is also fully utilised at the equilibrium rent. However, capital stocks are fixed sector-wise. The optimising behaviour of producers therefore, determines sector specific return on capital.

2.1.5 Household income and consumption demand

There are nine household groups in the model – rural agricultural self-employed (RASE), rural non-agricultural self-employed (RNASE), rural non-agricultural labour (RNAL), rural agricultural labour (RAL), rural other households (ROH), urban self-employed (USE), urban salaried households (USH), urban casual labour (UCL), and urban other households (UOH). The factor endowments for each household group are given. Households derive their income by selling the factors they own – land, labour (of three types) and capital. From these incomes, taxes are netted out and transfer payments by government and rest of the world are added to arrive at the household disposable incomes. The households are assumed to save a fixed fraction of their disposable incomes. The rest of it is spent on the consumption of goods. The consumption functions of the households are estimated by the most suitable Stone and Geary linear expenditure system (LES), which is widely used in India. Private corporate and public sectors do not have any consumption expenditure. They receive income from the rental values of

non-land capital. Private corporate sector gets additional income from rental value of land and government transfer payments including interest payments.

2.1.6 Private corporate and public sector income

Private corporate sector income consists of its earnings from factor incomes and transfers from government, which is equal to its savings. On the other hand, public sector income is defined as income from entrepreneurship (factor income from capital) that goes as transfers to government.

2.1.7 Household savings

The average propensity to save out of their disposable incomes is exogenously given for each of the four rural and five urban households. Households thus, save a fixed part of their incomes. Total household savings in the economy is obtained by summing up the savings of all the nine household groups.

2.1.8 Government savings

Government revenue originates from the following five sources : excise tax on production, sales tax on goods, import duties from imported goods and income tax from households. All the tax rates are exogenously given. Government income also includes the capital income and land rent from ownership of these, factor income from abroad and public sector income. Government expenditure takes place on account of government consumption and transfers to households and firms, and public sector investment, all of which are exogenously fixed. Government savings are obtained as the difference between government income and expenditure.

2.1.9 Foreign savings

Foreign savings in dollar terms is expressed in the model as the excess of payments for total imports over the sum of export earnings, net current transfers and factor income from abroad. The latter two, it may be noted., are exogenously given values in the model.

2.1.10 Market equilibrium and macro-economic closure

Market clearing equilibrium in the commodity markets is ensured by the condition that sectoral domestic supply must equal demand faced by that sector. The sectoral domestic supply, (i.e., domestic gross output) of a commodity is determined through the nested CES function in the production structure of the model. On the other hand, sectoral demand is a combination of domestic demand and export demand, based on a CET transformation function. In turn, the aggregate demand for a commodity – i.e. the sum of consumption, investment and government and intermediate demands – is equated to the demand for a composite commodity defined as an Armington type CES aggregation of domestic demand and imports.

In the model the Walras' law holds. It is, therefore, homogeneous of degree zero in prices determining only relative prices. The exchange rate serves as the numeraire, and is, therefore, fixed at one

The model is Walrasian in spirit with the sectoral prices being the equilibrating variables for the market-clearing equations. The Walras' law holds and the model is, therefore, homogeneous of degree zero in prices determining only relative prices. The exchange rate serves as the numeraire, and is, therefore, fixed at one.

Finally, the model is neo-classical in nature, and follows a savings-driven macro-closure in which aggregate investment is determined endogenously as the sum of household savings, government savings and foreign savings.

2.1.11 Inter-temporal adjustments

In the interim-period sub-model, the physical and human capital stocks are

updated. Sectoral capital stocks are exogenously given at the beginning of a particular period. However, the model is recursively dynamic, which means that it is run for many periods (years) as a sequence of equilibria. Between two years, there will be additions to capital stocks in each sector because of the investment undertaken in that sector in the previous year. More precisely, sectoral capital stocks for any year t+1 are arrived at by adding the investments by sectors of destination, net of depreciation, in year t to the sectoral capital stocks at the beginning of the year t.

Between two years, there will also be additions to human capital stocks. These yearly 'additions' to labour stocks of different skill types are, however, exogenously given.

Chapter 3

The 'No-AIDS' Reference Scenario

The CGE model has been calibrated to the benchmark equilibrium data set represented in a SAM for the Indian economy for the year 2002-03. Using the benchmark data set for the year 2002-03, the CGE model is first solved for the base-year, and, subsequently, using a time series of the exogenous variables of the model, is generated a sequence of equilibria for the period from 2002-03 to 2015-16, under the assumption that AIDS is having no impact on the economy as its prevalence is too low. From the sequence of equilibria thus generated, the growth paths of selected (macro) variables of the economy are outlined to describe the 'no-AIDS' reference scenario.

3.1 Benchmark parameters

After having obtained the basic data set from the SAM, the CGE model is subjected to benchmark calibration. Calibration involves a deterministic approach to specifying parameter values in such a manner that the model solution replicates the base-year data (Shoven and Whalley 1992). Calibration of the 'shift' and 'share' parameters of the production functions, CES aggregation function for imports and CET function for imports, however, require the elasticity parameters of these functions to be given. The elasticity parameters have been taken from different sources and are given below in Table 1. Note that different types of labour are combined in two stages in the production structure to reflect different degrees of substitutability. The skilled labour composite and unskilled labour are combined within a CES type Armington aggregation that has a small elasticity of substitution equal to 0.5 to yield composite labour. In turn, skilled labour composite is a CES Armington aggregation of semi-skilled and skilled labour based on a larger elasticity of substitution equal to 0.8. The higher wage income for the skilled labourers results in higher share parameters for such workers in the calibration. Skilled workers thereby contribute more to the composite labour.

In Table 4, the endowments of human capital across the nine household groups are presented. It is interesting to note that most of the semi-skilled and skilled labour belong to the urban salaried and urban self-employed groups. Almost 85 percent of skilled and 42 percent of semi-skilled workers come from these two groups. However, semi-skilled workers are more evenly spread over the urban and rural groups. Urban groups have 48.5 percent of the semi-skilled workers,

while rural groups have the remaining 51.5 percent of these workers. (It may be noted that, in this classification, semi-skilled workers is an all inclusive category for those who are elementary, secondary or higher-secondary educated.)

Table 3

Elasticity parameters

		ρ_1	ρ_2	ρ_3	ρ_a	ρ_c	ε_{ex}
s1	Agriculture	0.7800	0.5000	1.5000	1.1387	0.9200	0.8400
s2	Manufacturing	1.0101	0.5000	1.5000	2.2011	1.1818	1.0880
s3	Services	1.6500	0.5000	1.5000	2.1450	0.9200	1.3600
s4	Healthcare	1.0800	0.5000	1.5000	0.7150	0.3067	0.6667
s5	Tourism	1.4500	0.5000	1.5000	2.1450	0.9200	1.3200

Note : ρ_1 : elasticity of substitution between composite labour and capital.
ρ_2 : elasticity of substitution between skilled labour, composite labour and uneducated labour.
ρ_3 : elasticity of substitution between secondary-educated labour and higher-educated labour.
ρ_a : elasticity of substitution between domestic demand and imports.
ρ_a : elasticity of substitution between domestic sales and exports.
ε_{ex} : export demand elasticity
Source : *Jung and Thorbecke (2003) and Chadha et al (1998).*

Table 4

Resource endowment shares

(in percentages)

	Unskilled Labour	Semi-skilled labour	Skilled labour	Physical capital
RASE	20.34	13.98	2.65	27.34
RNASE	10.46	3.89	0.63	9.73
RNAL	9.09	0.43	0.00	0.34
RAL	31.02	11.59	0.31	0.33
ROH	14.69	21.68	9.45	2.61
USE	3.96	9.36	8.79	15.16
USH	6.64	33.30	75.73	6.18
UCL	3.25	5.02	0.90	1.53
UOH	0.55	0.75	1.54	3.64
	100	100	100	66.86

Note : RASE : Rural agricultural self-employed ; RAL : Rural agricultural labourer ;
RNASE: Rural non-agricultural self-employed ; RNAL : Rural non-agricultural labour
ROH : Rural other households ; USE : Urban self-employed ;
USH: Urban salaried households ; UCL : Urban casual labourer ; UOH : Urban other households.
Physical capital endowment includes that of land. Capital column sums upto only 66.86 percent because the remaining 33.14 percent accrues to private enterprise, public enterprise, government and the rest of world.
Source : Calculations from Pradhan and Roy (2003)

3.2 Labour supply and wage levels

In the 'no-AIDS' reference scenario, labour supply grows annually at the rate of 2.01 percent (Table 5). Among the three types of labour, the supply of skilled workers grows fastest at the rate of 4.68 percent, followed by semi-skilled workers' supply which increase at the rate 3.49 percent. The supply of unskilled labour grows by only 1.03 percent annually.

Regarding wage levels, there is maximum improvement in the unskilled workers' wage rate which increases by 4.28 percent annually. The spread of education benefits the unskilled (non-educated) labour indirectly, by inducing a relative decrease in its supply. Semi-skilled (secondary-educated) workers' wage rate also grows fast at 3.86 percent. The wage rate of skilled (higher-educated) workers increases at only 3.63 percent per annum. The wage rates of semi-skilled and skilled workers rise despite the increase in

their supplies because the techniques of production become more skill intensive as the economy grows over time (Table 5).

The higher rate of growth of the unskilled worker's wage notwithstanding, the wage inequality across the three types of labour – particularly between unskilled and skilled labour - remains acute at the end of the fourteen-year period (Table 6). This is mainly because the distribution of wages of the three types of labour is highly unequal to begin with in 2002-03.

3.3 GDP and household income

Real GDP in the base-run ('no-AIDS' scenario) grows at 8.21 percent per annum, with investment in physical capital being on an average 29.11 percent of GDP. Investment is financed by household savings, government savings and foreign savings[9], of which the last is given exogenously. Government savings contribute negatively towards investment, which, hence, is largely dependent upon household savings. Household savings constitute, on an average, 29.01 percent of GDP in the base-run (table 7). Finally, it must be noted that real GDP per capita grows at 6.68 percent in the 'no-AIDS' scenario.

Household income as a whole grows at 7.68 percent per annum. But the rates of growth of incomes vary widely across the various household groups (Table 7). The rate of growth of incomes of the urban salaried class is, expectedly, the highest – i.e., 9.26 percent. Urban salaried households are the greatest beneficiaries from the spread of education. These households account for 75.75 percent of the skilled and 33.30 percent of the semi-skilled labour (Table 4). Urban self-employed improve their incomes at the rate of 7.06 percent per annum. This class also depends largely for its income on semi-skilled and skilled labour. Another group, not so expected, which benefits from the spread of education is rural other households. This group is endowed with 21.68 percent of the semi-skilled workforce and 9.45 percent of the skilled workforce. However, the non-beneficiaries of education – i.e., those having mainly unskilled labour as a source of their income – are also significantly better-off, thanks to the rise in the wage rate of unskilled labour. For example, household incomes of the rural agricultural labourers grow at 7.26 percent per annum. Urban casual labourers, who are to a large extent though not mainly dependent on unskilled labour, also increase their incomes by 7.47 percent per annum[10].

Real GDP in the base-run ('no-AIDS' scenario) grows at 8.21 percent per annum. Real GDP per capita grows at 6.68 percent in the 'no-AIDS' scenario

[9] Corporate sector savings is an insignificant part of total savings, and remains more or less constant in proportionate terms throughout the period of the model.

[10] Note that wage income is allocated to each household group on the basis of the base-year endowment shares for all the years. That is, the flow of new labour types is distributed across household groups in the same way as the whole labour stock.

Chapter 4

The 'with-AIDS' Scenario

In the 'with-AIDS' scenario, the prevailing incidence of AIDS is assumed to have precise impacts on key exogenous variables. These precise impacts are as follows : (i) slower growth in population and supply of labour by the skill categories, resulting from the AIDS-related deaths, (ii) lower labour productivity of AIDS-afflicted workers reflected in a lower effective labour input, (iii) declines in sectoral TFP growth rates, initially, i.e., from 2002-03 to 2011-12, to 0.8 times the 'no-AIDS' growth rate, and, finally, during the height of the epidemic, i.e., from 2012-13 to 2015-16, to 0.7 times the 'no-AIDS' growth rate, (iv) the share of health services spending of the AIDS-afflicted households, is augmented by an additional 10 percent of total consumption expenditure, at the expense of other non-food expenditures, (v) an increase in the health expenditure of the government by 10 percent from 2002-03 to 2011-12, and by 15 percent from 2012-13 to 2015-16.

With regard to (iv) it must be mentioned that, with the share of health services of the AIDS-affected households being augmented by an additional 10 percent of total consumption expenditure, the latter end up spending around 11.4 percent of their total consumption expenditure on healthcare . This is almost the same as the figure, 10.8 percent, obtained in the companion study of Pradhan, Sundar and Singh (2006) for the AIDS-afflicted households.

4.1 Impact on labour supply and wages

In the 'with-AIDS' scenario, growth rates of supplies of labour of all the three skill types decline. The decline is maximum for the unskilled labour, followed by that of semi-skilled and skilled labour (fig. 4). However, the decline in growth rates of labour supplies does not result in a rise in the growth of the wage rates. Instead, the growth in wages of the three labour types suffers a decline (Table 5).

This happens because (in our general equilibrium framework), while the supply of labour falls due to deaths associated with the AIDS epidemic, the demand for labour falls proportionately more as a result of a slower overall economic growth accompanied by a changed sectoral pattern of growth in favour of sectors with relatively lower intensity of unskilled labour-use relative to other factors (as shall be seen later). The slowdown in economic growth occurs because of a decline in investment. The AIDS epidemic, it must be noted, induces an increase in health expenditure of the households and the government resulting in a fall in their savings, which

Table 5

Labour supply and wage rates

	Average annual growth rates for 2002-03 to 2015–16 (in percent)		Difference from 'no-AIDS' reference scenario in percentage points
	'with-AIDS' scenario	'no-AIDS' reference scenario	'with-AIDS' scenario
Labour supply	**1.70**	**2.01**	**-0.31**
Unskilled labour	0.69	1.03	-0.34
Semi-skilled labour	3.18	3.49	-0.31
Skilled labour	4.46	4.68	-0.22
Wage rate (real)	**5.07**	**5.17**	**-0.10**
Unskilled labour	4.21	4.28	-0.07
Semi-skilled labour	3.82	3.86	-0.05
Skilled labour	3.60	3.63	-0.03

Table 6

Wage rate indexes

	Wage rate as a multiple of unskilled labour's wage rate in 2015-16	
	'with-AIDS' scenario	'no-AIDS' reference scenario
Wage rate (real)		
Unskilled labour	1.00	1.00
Semi-skilled labour	1.80	1.78
Skilled labour	6.79	6.76

then crowds out investment. The decline in investment demand in turn induces a cutback in labour demand, and the latter effect is reinforced in the unskilled labour-intensive sectors. All in all, the fall in labour demand outstrips the AIDS-induced fall in labour supply, and the wage rates, therefore, decrease, rather than increase (fig. 5).

The decline in the wage rates, however, is not uniform across the three types of labour. The decline is largest for unskilled labour, followed by that of semi-skilled and skilled labour (Table 3). The result is a marginal increase in wage inequality, with the semi-skilled and skilled workers earning wages which are respectively 1.80 and 6.79 times the wage of unskilled workers (Table 6).

4.2 Impact on GDP and household incomes

Real GDP in the 'with-AIDS' scenario grows at 7.34 percent per annum, which is 0.86 percentage point less than the annual GDP growth rate of the 'no-AIDS' scenario (Table 7). The fall in GDP growth is not "offset", as is sometimes believed, by the decline in population

Fig 4

With AIDS/No-AIDS wage ratio

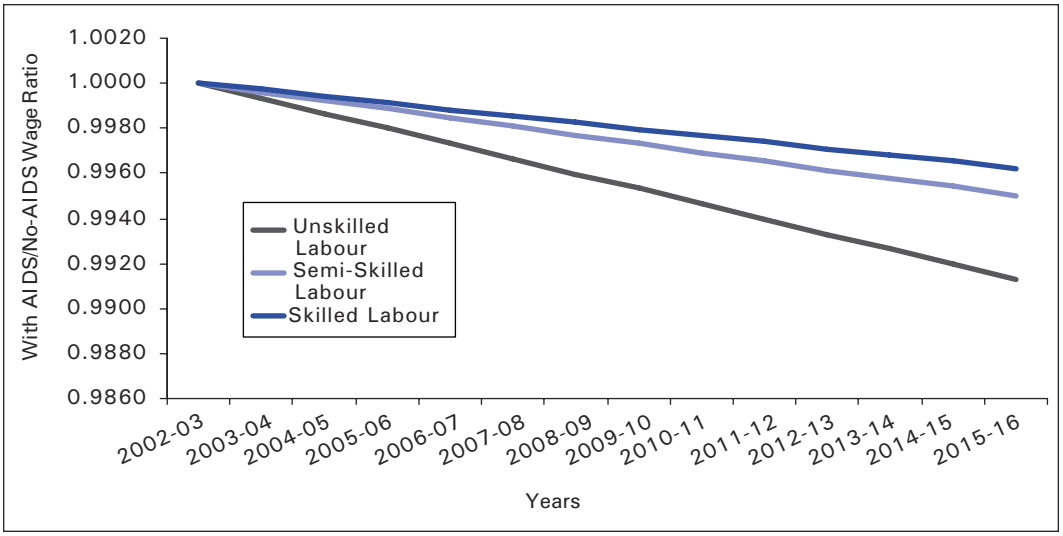
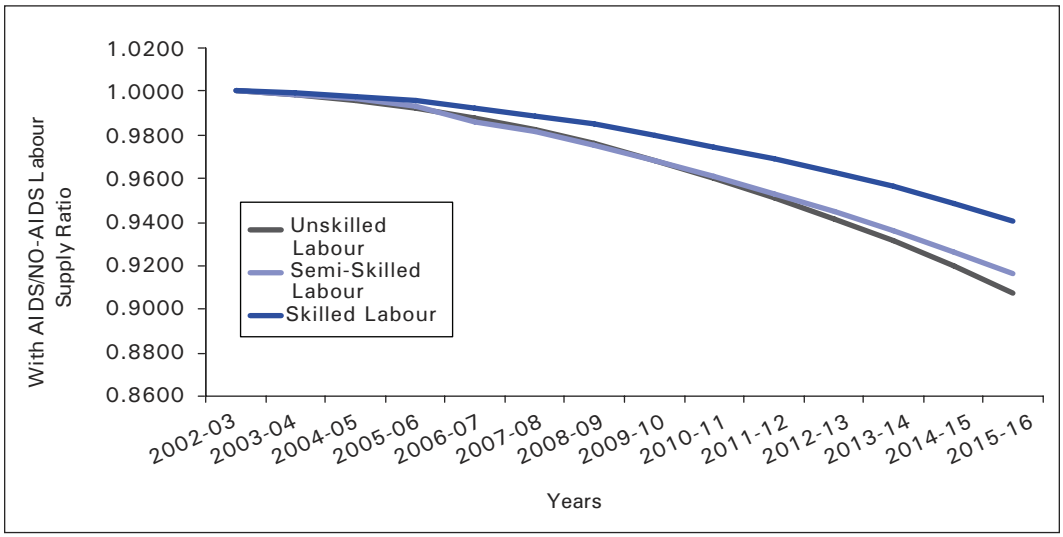


Fig 5

With AIDS/No-AIDS labour supply ratio



growth caused by the AIDS epidemic. This is obvious from the fact that growth of real GDP per capita also declines by 0.55 percentage points in the 'with-AIDS' scenario (fig. 6).

The crowding out of investment in the 'with-AIDS' scenario is clearly shown by a 1.16 percentage point decline in the investment/GDP ratio. It is the result of a fall in both household and government

Table 7

GDP and household income

	Average annual growth rates for 2002-03 to 2015-16 (in percent) 'with-AIDS' scenario	Average annual growth rates for 2002-03 to 2015-16 (in percent) 'no-AIDS' reference scenario	Difference from 'no-AIDS' reference scenario in percentage points 'with-AIDS' scenario
Real GDP	**7.34**	**8.21**	**-0.86**
Real GDP per capita	**6.13**	**6.68**	**-0.55**
Government saving (% of GDP)	-2.26	-1.59	-0.67
Household saving (% of GDP)	27.86	29.01	-1.15
Investment (% of GDP)	27.95	29.11	-1.16
Household income (real)	**7.22**	**7.68**	**-0.46**
Rural agricultural self-employed	**6.08**	**6.55**	**-0.47**
Rural non-agricultural self-employed	**5.64**	**6.49**	**-0.84**
Rural non-agricultural labour	**6.56**	**7.03**	**-0.47**
Rural agricultural labour	**6.48**	**7.26**	**-0.78**
Rural other households	7.84	8.03	-0.18
Urban self-employed	6.91	7.06	-0.15
Urban salaried households	**9.14**	**9.26**	**-0.12**
Urban casual labour	7.09	7.47	-0.39
Urban other households	6.20	6.44	-0.24

Fig 6

Real GDP per capita

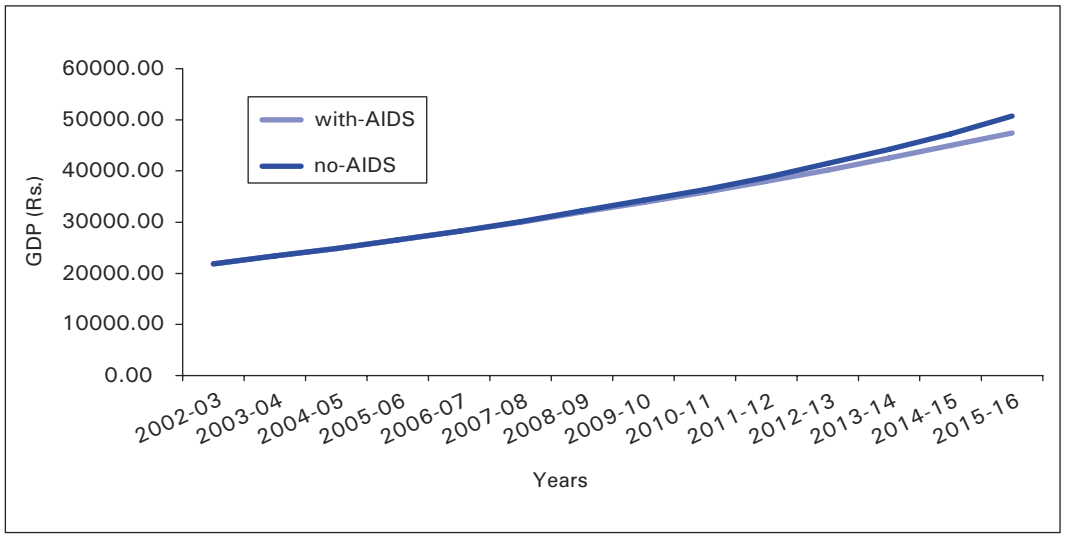
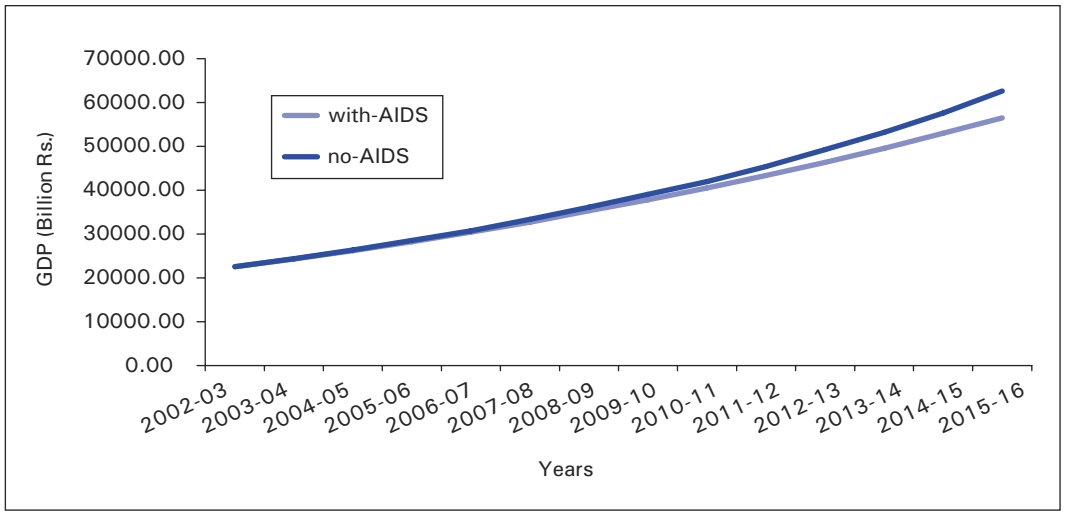


Fig 7

Real GDP



savings. The ratios of household and government savings to GDP decline respectively by 1.15 and 0.67 percentage points respectively (Table 7).

Growth in household income as a whole also suffers a decline of 0.46 percentage points. Furthermore, an inter-group comparison of the household income growth rates reveals that all groups experience a slower growth in their incomes. The extent of slowdown in the income growth rates, however, varies widely across the household groups. The household groups for whom the declines in their income growth rates are relatively sharper are the following : rural non-agricultural self-employed, rural agricultural labour, rural non-agricultural labour, rural agricultural self-employed and urban casual labour (in that order) (see Table 7). These household

groups are the ones which derive their livelihood predominantly from unskilled labour. And it is the unskilled labour which is relatively harder hit by the AIDS epidemic.

4.3 Sectoral impact of the HIV epidemic

Turning now to the sectoral impact of the AIDS epidemic, with the exception of 'agriculture', its adverse impact on value-added is greater for sectors that use unskilled labour intensively. For example, 'tourism', which is the second-most unskilled labour-intensive sector, suffers the maximum loss of 18.31 percent in value-added terms in the 'with-AIDS' scenario in the final year 2015-16. It is followed by the 'manufacturing' sector, occupying third position in the unskilled labour intensity ranking, and having a value-added which is 12.48 percent smaller in the 'with-AIDS' scenario as compared to the 'no-AIDS' scenario. Next comes the 'services' sector, which is placed fourth in the unskilled labour intensity ranking. The value-added in this sector declines by 10.13 percent. The value-added in 'agriculture', which is the most unskilled labour-intensive sector, however, declines by only 9.08 percent. Finally, there is the 'healthcare', the least unskilled labour-intensive sector, suffering a minor 1.93 percent loss in its value-added (Table 8). It follows that, the sectoral pattern of production changes in favour of 'healthcare' and 'services' – i.e., sectors having relatively lower unskilled labour intensity – at the cost of 'tourism' and 'manufacturing' – i.e., sectors with relatively higher unskilled labour intensity.

The adverse impact of AIDS on value-added is greater for sectors that use unskilled labour intensively

4.4 The healthcare sector under the HIV epidemic

As seen above in section 4.3, the healthcare sector undergoes a small decline of 1.93 percent in value-added terms. Because the

Table 8

Sectoral impact of the HIV epidemic

	For the year 2015-16		Computed from the base-year (2002-03) values				
	'with-AIDS'/ 'no-AIDS' value-added ratio (in percent)	Loss in value-added due to AIDS (in percent)	Share in GDP (in percent)	Share of unskilled labour in total sectoral labour value-added (in percent)	Share of unskilled labour in total sectoral value-added (in percent)	Ranking (descending order) as per cols. 5 & 6	Ranking (descending order) as per col. 3
Agriculture	90.92	9.08	22.98	70.04	37.65	1st	4th
Tourism	81.69	18.31	00.03	37.45	21.82	2nd	1st
Manufacturing (Industry)	87.52	12.48	22.40	36.31	20.77	3rd	2nd
Services	89.87	10.13	53.20	21.26	10.71	4th	3rd
Healthcare	98.07	1.93	01.39	08.07	05.55	5th	5th
Simple average	89.61	10.31	20.00	34.63	19.30		
Real GDP	90.11	9.89	100.00	36.86	20.51		

health sector uses relatively less unskilled labour, it suffers a minimal impact from the supply side. On the demand side, the health sector is impacted in two diametrically opposite ways during the course of an AIDS epidemic. On one hand, the increase in AIDS-related expenditure by the government and the AIDS-affected households stimulates increased activity in this sector. On the other hand, the decline in saving and thereby investment, results in a slowdown of economic growth causing incomes to fall across all household groups. The non-AIDS-affected households – which form the majority – then reduce their spending on healthcare. This reduction in the health expenditure of a majority of the households exerts a downward pressure on the activity in the health sector. It is obvious that the latter effect predominates and, hence, the net result is a fall in the level of economic activity for the healthcare sector.

In other words, the increase in the health expenditure of the government does boost the healthcare sector, but it fails to reverse the decline in healthcare activities brought about due to the reduced health expenditure of the households experiencing a fall in their incomes.

Part II

The Impact of HIV and AIDS on Indian Industry

Chapter 5

The Impact of HIV and AIDS on Indian Industry

In Part I, section 4.3, we have seen that the 'industry' or the manufacturing sector, which occupies the third position in the unskilled labour intensity ranking – in descending order – of the five sectors (Agriculture, Tourism, Manufacturing, Services, Healthcare) of the Indian economy, experiences the second-highest loss of 21 percent in its value-added in the 'with-AIDS' scenario as compared to 'no-AIDS' scenario.

In part II, we work out our CGE model with a higher level of sectoral disaggregation, with a view to gain insight into the impact of AIDS on the various sectors which actually constitute the Indian industry. Such an extended CGE model will allow a more realistic assessment of the impact of the epidemic on the industrial sectors of the Indian economy.

Precisely, we work with a 28-sector CGE model in this part of the study. Except for having a larger number of sectors, the CGE model that we use here is identical to the one employed in part I. Hence, as before, production activity in each of the sectors is organised with the help of the following five factors of production : land, capital, and three types of labour – i.e., unskilled labour, semi-skilled labour and skilled labour. Moreover, it may be recalled that, the AIDS-related death rate is highest for unskilled labour, followed by that of semi-skilled labour and skilled labour, in that order. Hence, a priori, an inverse relationship between the sectoral unskilled labour intensity and the sectoral with-AIDS/no-AIDS value-added ratio is likely to hold. In other words, overall we can expect that, the higher the intensity of unskilled labour use relative to other factors in a sector, the larger is the loss in value-added due to AIDS in that sector.

5.1 The sectors of the Indian economy

In our extended CGE model, the Indian industry is disaggregated into 16 constituent sectors. Over and above, we have the agricultural sector and 11 other sectors covering all the services. In other words, the economy is made of 28 producing sectors, 16 of which comprise its industrial activities. These 28 sectors are as follows :

It must be noted that, each of these 28 sectors are themselves an aggregation

Agriculture

1) Agriculture

Industry

2 Mining and quarrying	(Min. and Qua.)
3) Food and beverages	(Food & Bev.)
4) Textiles	
5) Wood & wood products	(Wd. & Wd. Prods.)
6) Paper and printing	(Paper & Print.)
7) Leather & leather products	(Lr. & Lr. Prods.)
8) Petroleum products	(Pet. Prods.)
9) Chemicals	
10) Non-metallic products	(Non-met. Prods.)
11) Basic metals	
12) Metal products	
13) Capital goods	
14) Other manufacturing	(Other Manuf.)
15) Construction	
16) Electricity	
17) Gas & water supply	(Gas & Water Su.)

Services

18) Rail transport service	(Rail Transport)
19) Other transport service	(Other Transport)
20) Storage	
21) Communications	
22) Trade	
23) Hotels and restaurants	(Hotels & Res.)
24) Finance and ownership of dwellings	(Fin. & O of D.)
25) Education & research	(Ed. & Rsch.)
26) Healthcare	
27) Public administration & Other Services	(Public Ad. & Other Services)
28) Tourism	

of many sectors for which the inter-sectoral flows are covered in the 115-sector Central Statistical Organisation, Input-Output Transactions 1989-90 Table (CSO, 1997). In other words, we could in fact have worked with an even more disaggregated structure of the Indian economy, but then the results obtained from a model with too many sectors would not be easy to interpret. A far more sensible thing to do is to work with a model having a manageable number of sectors, and keep in mind the broad list of economic activities subsumed under them while interpreting the results of the model.

It would be useful then, to broadly cover the producing activities included in each of our 28 sectors, and also outline other key features of a sector such as, share in GDP, and labour and capital intensities of production.

5.1.1 Agriculture

Agriculture, in our sectoral classification, is very broadly defined to include all the food, cash and plantation crops, animal husbandry, forestry and logging, and fishing. Thus defined, agriculture produces 22 percent of India's GDP. In a three-sector division of the Indian economy – agriculture (primary sector), industry (secondary sector) and services (tertiary sector) – agriculture has the highest unskilled labour intensity, defined as the share of unskilled labour in total sectoral labour value-added. The share of unskilled labour in total sectoral value-added is also the maximum in case of agriculture. However, agriculture has the lowest intensities for semi-skilled labour, skilled labour and capital (Tables 7 & 8)

5.1.2 Industry

In terms of share in GDP, industry is an equal of agriculture. Industry produces 23 percent of India's GDP. The unskilled labour intensity in industry is lower in comparison to agriculture, but higher as compared to services. The semi-skilled labour intensity in industry is highest among the three sectors. As far as skilled labour intensity is concerned, industry occupies an intermediate position between agriculture and services. The capital intensity in both industry and services is around 50 percent – which is about 6 percent higher than that in agriculture.

In Tables 9 and 10, we have arranged the 16 industrial sectors according to their ranks, in descending order, of their unskilled labour intensities (i.e. share of unskilled labour in total sectoral labour value-added). In this arrangement, we would refer to the first five sectors – Non-metallic products, Wood and Wood Products, Construction, Food and Beverage and Textiles – as the high unskilled labour intensity (HULI) sectors; the second set of four sectors – Leather and Leather Products, Other Manufacturing, Metal Products, and Mining and Quarrying – as the medium unskilled labour intensity (MULI) industries; the third set of seven sectors – Chemicals, Capital Goods, Paper and Printing, Basic Metals, Gas and Water Supply, Petroleum Products, Electricity - as the low unskilled labour intensity (LULI) industries. It is obvious that, in characterising the sectors above we are employing the following sectoral classification:

Non-metallic products

The non-metallic products include structural clay products, cement and other non-metallic mineral products, such as glass and glass products, earthenware, pottery, sanitaryware, porcelainware, insulators, lime and plaster, mica products, graphite etc. This sector produces 3.24 percent of industrial GDP, which is 0.74 percent of national GDP. This sector is highly unskilled labour-intensive. In this sector, the share of unskilled labour in total sectoral labour value-added is 68.22 percent – the highest among all the industrial sectors (Tables 9 and 10).

Wood and wood products

This sector consists of wooden, bamboo and cane furniture and fixtures, and repair of such furniture, manufacture of veneer, plywood and their products, sawing and planing of wood, structural wooden goods, wooden industrial goods, cork and cork products, and other miscellaneous wood, bamboo and cane products. This sector produces only 1.31 percent of industrial GDP – i.e., 0.30 percent of the country's GDP. Among the industrial sectors, its rank in terms of its share in GDP is 10 out of 16. This sector is a HULI sector - in fact, it is the second-most unskilled labour intensive sector within industry (Table 9).

Construction

The construction sector subsumes all activities concerned with construction and maintenance of buildings, aerodromes, roads, railways, bridges, pipelines, ports, harbours, runways, etc. This is the largest sector in industry in terms of relative value-added. Within industry, its rank with respect to its share in GDP is one out of 16. It accounts for 22.65 percent of industrial GDP or 5.17 percent national GDP. Construction, a HULI sector, is the third-most unskilled

(i)	Share of unskilled labour in total sectoral labour value-added	upto 30 %	Low unskilled labour intensity (LULI) sectors
(ii)	Share of unskilled labour in total sectoral labour value-added	above 30 % to 50 %	Medium unskilled labour intensity (MULI) sectors
(iii)	Share of unskilled labour in total sectoral labour value-added	above 50 % to 80 %	High unskilled labour intensity (HULI) sectors

labour intensive sector within industry (Table 9).

Food and beverages

The food and beverage sector covers the following: manufacture and refining of sugar, boora, candy and khandsari, hydrogenated oils, vanaspati ghee, edible oils other than vanaspati, tea and coffee processing, miscellaneous food products, beverages, and tobacco products. Its contribution to industrial GDP is 2.17 percent, and to national GDP it is 9.15 percent. In value-added terms, it is the fourth largest sector within industry (Table 9). It is also a HULI sector.

Textiles

The textiles sector includes khadi and cotton textiles, silk textiles, art silk and synthetic fibre textiles, jute, hemp and mesta textiles, readymade garments, and miscellaneous textile products. It is the seventh largest sector within industry. It contributes 6.66 percent of industrial GDP and 1.52 percent of national GDP (Table 9). It is a HULI sector.

Leather and leather products

This sector subsumes tanning, curing, finishing, embossing and japanning of leather, manufacture of wearing apparel, manufacture and repair of leather-cum-rubber footwear and various other leather-related activities. In terms of relative value-added, this is the smallest sector within industry. It produces only 0.66 percent of industrial GDP, which is 0.15 percent of national GDP (Table 9). It is a MULI sector.

Other manufacturing

Other manufacturing is actually a residual sector. Whatever does not belong to any one of the other 15 sectors is included here. It is also referred to as miscellaneous manufacturing. It covers the following economic activities: manufacture and repair of watches, clocks and time pieces, manufacture of surgical, medical, laboratory, scientific and mathematical instruments, such as water meters, electricity meters, photographic and optical goods, jewellery and related articles, sports and athletic goods, toys, manufacture of aircraft and parts and repair of enterprises not elsewhere classified. Its contribution to industrial GDP is 3.11 percent, and to national GDP it is 0.71 percent (Table 9). It is a MULI sector.

Metal products

Metal products sector consists of hand tools, hardware, and miscellaneous metal products. This sector produces only 2.37 percent of industrial GDP or 0.54 percent of national GDP (Table 9). It is a MULI sector.

Mining and quarrying

Mining and quarrying includes coal and lignite mining, crude petroleum, natural gas, iron ore mining, manganese ore mining, bauxite mining, copper ore mining, other metallic minerals, limestone mining, mica mining and other non-metallic minerals. Mining and quarrying is the second largest industrial sector. It accounts for 10.11 percent of industrial GDP, which is 2.31 percent of national GDP (Table 9). Mining and quarrying is a MULI sector.

Chemicals

Chemicals sector has a very wide coverage. It includes inorganic heavy chemicals, organic heavy chemicals, fertilisers, pesticides, paints, varnishes and lacquers, drugs and medicines, soaps and cosmetics, synthetic fibres, resin and other chemicals. Within industry, chemicals is the third largest sector. It produces 9.98 percent of industrial GDP, which is 2.28 percent of national GDP (Table 9). Chemicals sector is a LULI sector.

Capital goods
Capital goods sector covers a wide variety of machineries, machine tools, equipments, appliances and consumer durables. This sector includes the following: industrial machinery for various industries, machine tools, tractors and other agricultural implements, office computing and accounting machinery, other non-electrical and electrical machinery, electrical industrial machinery, electrical cables, wires, batteries, electrical appliances, communication equipment, electronic equipment including television, ships and boats, rail equipment, motor vehicles, motor cycles and scooters, bicycles and cycle-rickshaws, and other transport equipment. Capital goods sector is the fifth largest industrial sector. It accounts for 8.94 percent of industrial GDP, which is 2.04 percent of national GDP (Table 9). It is a LULI sector.

Paper and printing
Paper and printing sector includes paper, paper products and newsprint, printing, publishing and allied activities. Paper and printing is a small industrial sector, accounting for only 2.10 percent of industrial GDP, and 0.48 percent of national GDP. It is a LULI sector.

Basic metals
Basic metals sector consists of manufacture of iron and steel ferro-alloys, iron and steel foundries, iron and steel casting and forging, non-ferrous basic metals and alloys. Basic metals is the eighth largest sector. It accounts for 5.52 percent of industrial GDP, which is 1.26 percent of national GDP. It is a LULI sector.

Gas and water supply
Gas and water supply sector includes manufacture of gas in gasworks, distribution through mains to household, industrial and commercial and other users, LPG and gobar gas, collection, purification and distribution of water. Gas and water supply is a very small sector, producing only 1.87 percent of industrial GDP, which is 0.43 percent of national GDP. This sector is a LULI sector.

Petroleum products
Petroleum products sector subsumes petroleum products rubber and plastic products, as well as coal tar products. Petroleum products contribute 5 percent of industrial GDP, which is 1.14 percent of national GDP. It is a LULI sector.

Electricity
Electricity sector includes generation and transmission of electric energy and its distribution to households, industrial, commercial and other users. Electricity is the sixth largest industrial sector, contributing 6.96 percent of industrial GDP, which is 1.59 percent of national GDP (Table 7). Electricity is, expectedly, a LULI sector.

5.1.3 Services

Among the three broad sectors of the Indian economy – agriculture, industry, and services – services is the largest contributor to GDP. The services or tertiary sector produces 54.29 percent of India's GDP. Among the three sectors, services has the lowest unskilled labour intensity. As far as semi-skilled labour intensity is concerned, services occupies an intermediate position between agriculture and industry. The skilled labour intensity in services is highest among the three sectors. The capital intensity in services is around 50 percent – the same as in industry.

In Tables 9 and 10, we have arranged the 11 service sectors according to their ranks, in descending order of their unskilled labour intensities (i.e. share of unskilled labour in total sectoral labour value-added). In this arrangement, we would refer to the

first five sectors – Hotels and restaurants, Other transport, Tourism, Storage, and Trade – as the medium unskilled labour intensity (MULI) sectors, and the second set of six sectors – Rail transport, Public administration and other services, Education and research, Finance and ownership of dwellings, Health and communications – as the low unskilled labour intensity (LULI) services.

Hotels and restaurants

Hotels and restaurants sector covers services rendered by hotels, boarding houses, eating houses, cafes, restaurants, canteen etc. This is a small sector contributing only 1.86 percent of tertiary sector's GDP, which amounts to 1.01 percent of national GDP. It is MULI sector.

Other transport

Other transport services include all transport services rendered by buses, tramways, trucks, taxis, auto-rickshaws, animals, anima-drawn carts, cycles, rickshaws, ships, boats, steamers, ferries, aircrafts etc. This sector is the fourth largest tertiary sector, producing 10.36 percent of the tertiary sector's GDP, which is 5.62 percent of national GDP. Other transport services is a MULI sector.

Tourism

Tourism is the smallest tertiary sector. It accounts for only 0.06 percent of tertiary sector's GDP, which is 0.03 percent of national GDP. It is MULI sector.

Storage

Storage sector includes cold storage, storage and warehousing. It is the second smallest tertiary sector, producing only 0.11 percent of tertiary sector's GDP, which amounts to 0.06 percent of national GDP. Storage sector is a MULI sector.

Trade

Trade sector incudes all wholesale and retail trade. It is the largest tertiary sector, contributing 26.85 percent of tertiary sector's GDP, which amounts to 14.57 percent of national GDP. It is a MULI sector.

Rail transport

Railway transport services sector includes all transport services rendered by government and private railways. It is the third smallest sector, producing 1.81 percent of tertiary sector's GDP, which is 0.98 percent of national GDP. It is a LULI sector.

Public administration and other services

Public Administration and Other Services cover public administration, defence and a whole lot of other services rendered by real estate, religious and legal institutions, information, broadcasting and entertainment companies, laundries, barber and beauty shops and other personal services. This sector is the second largest sector, accounting for 22.45 percent of tertiary sector's GDP, which amounts to 12.18 percent of national GDP. It is a LULI sector.

Education and research

Education and research sector includes all services rendered by education, scientific and research services. It is fifth largest sector, producing 22.04 percent of tertiary sector's GDP, i.e., 11.96 percent of national GDP. Education and research is a LULI sector. Expectedly, it is a highly skilled labour intensive sector.

Finance and ownership of dwellings

Finance and ownership of dwellings sector subsumes the services rendered by the commercial banks, banking department of RBI, other financial

Table 9

Sectors of the Indian economy I

Sector no.		For the year 2015-16			Computed from base-year (2002-03) values						
		'With-AIDS' / 'no-AIDS' value-added ratio	Loss in value-added due to AIDS		Share in GDP			Share of unskilled labour in total sectoral labour value-added		Share of unskilled labour in total sectoral value-added	
		(in %)	(in %)	Rank	Sectoral (in %)	National (in %)	Rank	(in %)	Rank	(in %)	Rank
	Agriculture	81.37	8.73		100.00	22.26		70.05		37.66	
1	Agriculture	81.37	8.73		100.00	22.26		70.05		37.66	
	Industry	88.19	11.81		100.00	22.82		36.84		21.55	
10	Non-met. prods.	84.85	15.15	2	3.24	0.74	10	68.22	1	27.69	4
5	Wd. & wd. prods.	87.29	12.71	3	1.31	0.30	15	66.67	2	42.90	2
15	Construction	76.92	23.08	1	22.65	5.17	1	63.26	3	49.22	1
3	Food and bev.	96.80	3.20	16	9.51	2.17	4	56.42	4	25.29	5
4	Textiles	91.84	8.16	12	6.66	1.52	7	52.02	5	28.76	3
7	Lr. & lr. prods.	90.14	9.86	6	0.66	0.15	16	41.49	6	23.67	6
14	Other manuf.	90.98	9.02	9	3.11	0.71	11	40.85	7	20.21	7
12	Metal products	89.59	10.41	4	2.37	0.54	12	35.37	8	15.10	8
2	Min. and qua.	90.24	9.76	7	10.11	2.31	2	33.12	9	10.43	10
9	Chemicals	89.84	10.16	5	9.98	2.28	3	23.58	10	6.50	13
13	Capital goods	90.39	9.61	8	8.94	2.04	5	22.81	11	10.76	9
6	Paper and print.	91.61	8.39	10	2.10	0.48	13	20.61	12	9.49	11
11	Basic metals	92.72	7.28	14	5.52	1.26	8	17.32	13	6.73	12
17	Gas & water su.	91.99	8.01	13	1.87	0.43	14	14.35	14	9.00	16
8	Pet. prods.	91.83	8.17	11	5.00	1.14	9	13.28	15	3.63	15
16	Electricity	93.00	7.00	15	6.96	1.59	6	13.26	16	4.69	14
	Services	90.98	9.02		100.00	54.29		24.14		12.05	
23	Hotels & res.	85.00	15.00	4	1.86	1.01	8	48.19	1	29.85	1
19	Other transport	83.15	16.85	3	10.36	5.62	4	42.28	2	26.54	2
28	Tourism	81.60	18.40	1	0.06	0.03	11	37.44	3	21.81	3
20	Storage	82.94	17.06	2	0.11	0.06	10	33.62	4	18.34	4
22	Trade	86.81	13.19	5	26.85	14.57	1	30.58	5	10.36	8
18	Rail transport	91.35	8.65	7	1.81	0.98	9	21.76	6	13.95	6
27	Public ad. & other services	97.88	2.12	10	22.45	12.18	2	21.26	7	16.45	5
25	Ed. & rsch.	97.63	2.37	9	8.97	4.87	5	16.49	8	12.89	7
24	Fin. & O. of D.	89.07	10.93	6	22.04	11.96	3	14.54	9	3.29	10
26	Healthcare	98.59	1.41	11	2.59	1.40	7	8.08	10	5.57	9
21	Communications	95.26	4.74	8	2.92	1.58	6	4.79	11	1.16	11

Note : The ranks in all the columns are in descending order.

Table 10

Sectors of the Indian Economy II

Sector no.		Computed from base-year (2002-03) values									
		Share of semi-skilled labour in total sectoral labour value-added		Share of semi-skilled labour in total sectoral value-added		Share of skilled labour in total sectoral labour value-added		Share of skilled labour in total sectoral value-added		Share of capital in total sectoral value-added	
		(in %)	Rank	(in %)	Rank	(in %)	Rank	(in %)	Rank	(in %)	Rank
	Agriculture	22.61		12.86		7.35		5.09		44.39	
1	Agriculture	22.61		12.86		7.35		5.09		44.39	
	Industry	35.27		16.22		27.89		11.73		50.51	
10	Non-met. prods.	22.62	16	9.18	14	9.16	15	3.72	16	59.41	6
5	Wd. & wd. prods.	26.12	13	16.81	7	7.21	16	4.64	15	35.66	15
15	Construction	25.59	15	19.91	3	11.15	14	8.68	12	22.19	16
3	Food and bev.	26.83	12	12.03	11	16.75	12	7.51	13	55.18	8
4	Textiles	35.09	7	19.40	4	12.90	13	7.13	14	44.72	12
7	Lr. & lr. prods.	39.68	3	22.64	2	18.83	11	10.74	10	42.95	13
14	Other manuf.	38.07	4	18.84	5	21.08	10	10.43	11	50.52	11
12	Metal products	37.75	5	16.11	10	26.87	9	11.47	8	57.32	7
2	Min. and qua.	31.34	10	9.86	13	35.54	7	11.19	9	68.52	3
9	Chemicals	25.87	14	7.13	16	50.55	3	13.93	7	72.45	2
13	Capital goods	37.08	6	17.49	6	40.10	5	18.92	3	52.83	10
6	Paper and print.	35.03	8	16.13	9	44.36	4	20.42	2	53.96	9
11	Basic metals	29.66	11	11.53	12	53.03	2	20.61	1	61.13	5
17	Gas & water su.	57.02	1	35.76	1	28.63	8	17.96	4	37.28	14
8	Pet. prods.	31.43	9	8.60	15	55.29	1	15.13	5	72.64	1
16	Electricity	46.71	2	16.53	8	40.03	6	14.17	6	64.61	4
	Services	29.92		14.94		45.94		22.94		50.07	
23	Hotels & res.	36.85	5	22.82	4	14.96	11	9.27	11	38.06	6
19	Other transport	42.17	3	26.47	2	15.55	10	9.76	10	37.23	7
28	Tourism	24.49	8	14.89	7	38.05	6	23.15	4	40.15	5
20	Storage	47.89	1	26.13	3	18.49	9	10.09	9	45.44	4
22	Trade	36.12	6	12.23	9	33.30	8	11.28	8	66.14	3
18	Rail transport	44.06	2	28.23	1	34.17	7	21.90	5	35.93	8
27	Public ad. & other services	29.26	7	22.65	5	49.49	5	38.30	3	22.60	10
25	Ed. & rsch.	17.45	11	13.63	8	66.05	2	51.60	1	21.88	11
24	Fin. & O. of D.	20.33	10	4.60	11	65.13	3	14.76	6	77.34	1
26	Healthcare	21.77	9	15.33	6	70.15	1	49.34	2	29.76	9
21	Communications	39.97	4	9.64	10	55.24	4	13.33	7	75.88	2

Note : The ranks in all the columns are in descending order.

companies, industrial development and financial corporations, post office saving banks, cumulative time deposit accounts, cooperative credit societies, life insurance corporation, postal life insurance, employees state insurance and non-life insurance and ownership of residential houses. Finance and ownership of dwellings is the third largest tertiary sector, accounting for 11.96 percent of tertiary sector's GDP and 22.45 percent of national GDP. This sector is a LULI sector. On the other hand, it is the most capital intensive sector.

Healthcare

Healthcare sector includes all the medical and health services. It accounts for only 2.59 percent of the tertiary sector's GDP, which is 1.40 percent of the country's GDP. Health sector is a low unskilled labour intensive sector, but is a highly skilled labour intensive sector.

Communications

Communications sector includes postal, telephonic and telegraphic services rendered by postal and telegraph department and overseas communication services. Communication services sector contributes 2.92 percent of the tertiary sector's GDP, which is 1.58 percent of national GDP. It is a LULI sector, but a highly capital intensive sector.

Chapter 6

The 'with-AIDS' Scenario with the 28-sector CGE Model

As in the case of the five-sector CGE model of part I, we generate first a 'no-AIDS' reference scenario with our 28-sector CGE model of the Indian economy, and, then simulate a 'with-AIDS' scenario with it. A comparison of the two scenarios gives an idea of the sectoral impact of AIDS – particularly, the impact of AIDS on the 16 industrial sectors.

For calibration of the 28-sector CGE model, we now use the 28-sector SAM of the Indian economy for the year 2002-03. The SAM has been prepared by Pradhan, Saluja and Singh (2005), and is given in Appendix 2. For the subsequent years, 2003-04 to 2015-16, we use the same time series of exogenous variables on which the 'no-AIDS' reference scenario of the five-sector CGE model was based. Hence, their differences in sectoral detail notwithstanding, the two versions of the CGE model depict broadly similar pictures of the macro-economy in their 'no-AIDS' scenarios. In fact (as we shall see below), the growth paths of macro-variables in the two 'no-AIDS' reference scenarios – as well as in the two 'with-AIDS' scenarios – are very much the same.

The 'with-AIDS' scenario of the extended 28-sector CGE model is generated after admitting the same "shock", which was given to the exogenous variables in case of the five-sector CGE model to engender the latter's 'with-AIDS' scenario. That is, the 'with-AIDS' scenario of the extended CGE model incorporates precisely the same impacts: slower growth in population and supply of labour by the skill categories, resulting from the AIDS-related deaths, lower labour productivity of workers with HIV resulting in a lower effective labour input, decline in sectoral TFP growth rates, initially to about 0.8 times the 'no-AIDS' growth rate, and finally during the height of the epidemic, i.e., from 2011-12 to 2015-16, to 0.7 times the 'no-AIDS' growth rate, a 10 percent increase in the share of health services spending of the HIV households, at the expense of other non-food expenditures, an increase in the health share of the total government spending from 10 percent in 2002-03 to 15 percent in 2015-16.

6.1 The macro-economic impact

The macro-economic impact of AIDS generated by our extended CGE model is virtually the same as that obtained from the five-sector CGE model of part I. This can be verified easily by comparing tables 7 and 11. Under the macro-economic impact of AIDS as determined by the extended CGE model the average annual growth rate of GDP declines by 0.89 percentage points

Table 11

The macro-economic impact of AIDS obtained from the extended CGE model

	Average annual growth rates for 2002-03 to 2015-16 (in percent) 'with-AIDS' scenario	Average annual growth rates for 2002-03 to 2015-16 (in percent) 'no-AIDS' reference scenario	Difference from 'no-AIDS' reference scenario in percentage points 'with-AIDS' scenario
Real GDP	**7.36**	**8.25**	**-0.89**
Real GDP per capita	**6.14**	**6.70**	**-0.56**
Government saving (percent of GDP)	-2.33	-1.62	-0.71
Household saving (percent of GDP)	27.82	28.96	-1.14
Investment (percent of GDP)	27.97	29.15	-1.18

(Table 11), while under the macro-economic impact of AIDS as worked out through the five-sector CGE model, the average annual GDP growth rate decreases by 0.86 percentage points (table 7). Likewise, the orders of magnitudes of the decreases in other macro-variables–per capita GDP, government saving, household saving, investment – under the two versions of our CGE model, are the same (Tables 7 and 11).

The loss in value-added due to AIDS in agriculture, in the year 2015-16, is 8.73 percent

6.2 The impact on agriculture

We have already seen the impact of AIDS on Indian agriculture in section 4.3, through our five-sector CGE model. The impact is more or less replicated here, when we use the extended CGE model. Table 9 shows the loss in value-added due to AIDS by sector for the year 2015-16. The loss in value-added due to AIDS in agriculture, in the year 2015-16, is 8.73 percent. (It was 9.08% as determined by the five-sector CGE model). Agriculture is a highly unskilled labour intensive sector. The share of unskilled labour in total sectoral labour value-added for agriculture is the highest – 70.05 percent; for industry it is 36.64 percent; and for services it is 24.14 percent. One should, therefore, expect the largest loss in value-added due to AIDS for agriculture. However, atypically, agriculture experiences a loss in value-added which is smaller than that for industry, and almost the same as that for services. This happens because, the demand for agricultural products is typically inelastic, and hence, the decline in production and incomes, as a consequence of AIDS, depresses the demand of other sectors' commodities but not (so much) of agricultural commodities, leading to a rise in relative prices for the latter. The consequent shift in the production pattern towards agriculture helps in minimising the loss in agricultural GDP.

6.3 The impact on industry

Industry as a whole is a medium unskilled labour intensity sector, and, on account of AIDS, it suffers a loss in value-added of

11.08 percent, which is the highest among the three broad sectors of the economy – agriculture, industry and services. What is worth noting, however, is the considerable variation – with the standard deviation being 4.20 - in the extent of value-added losses due to AIDS across the 16 industrial sectors (Table 9).

The heaviest AIDS-induced loss in value-added – i.e., of 23.08 percent - occurs in the construction sector, the third-most unskilled labour intensive sector (table 9). Moreover, construction sector's loss in value-added has the maximum weight in the overall loss to industrial GDP, as this sector commands the highest share in industrial GDP.

Other highly unskilled labour intensive sectors which suffer large losses – i.e., in the 12-16 percent range - in their value-addeds are Non-metallic Products and Wood and Wood Products. Both these sectors, however, are having very small weights in the overall industrial GDP.

The remaining two HULI sectors – Food and Beverages and Textiles – undergo relatively smaller losses – of 3.20 percent and 8.16 percent respectively – in their value-addeds. It may be noted that, like the Agricultural Products, Food and Beverages and Textiles face relatively inelastic demands. Hence, the adverse impact of AIDS on production gets moderated to a large extent in case of these sectors. As a result, these sectors turn out to be exceptions to the general rule that there is a positive relationship between the sectoral unskilled labour intensity and the sectoral loss in value-added as a consequence of AIDS.

Among the four MULI sectors, the sector which matters most is Mining and Quarrying, because this sector has the largest weight in the overall industrial GDP. Mining and Quarrying suffers a loss of 9.76 percent in its value-added. The other three MULI sectors – Leather and Leather Products, Other Manufacturing and Metal Products – also undergo substantial losses in their value-addeds in the range 9-11 percent. But their weights in the overall industrial GDP are very small. Hence, their contribution to the overall loss in industrial GDP would be much less than that of the mining and quarrying sector.

Among the seven LULI sectors, Chemicals has the largest weight in the overall industrial GDP. This sector is also a big – the fifth-largest – loser in value-added terms. Precisely, it loses 10.16 percent of its value-added due to AIDS. The LULI sector which has the second-largest weight in the overall industrial GDP is the Capital Goods sector. Capital Goods sector suffers a loss of 9.61 percent in its value-added. The next three LULI sectors, in order of their weights in the overall industrial GDP are: Electricity, Basic Metals, and Petroleum Products. These three sectors experience value-added losses in the range of 6.50-8.50 percent. Paper and Printing, and Gas and Water Supply have very small weights in the overall industrial GDP. Hence, their respective value-added losses of 8.39 percent and 8.01 percent contribute insignificantly to the overall loss in industrial GDP.

In industry, the heaviest AIDS-induced loss in value-added – 23.08 percent - occurs in the construction sector, the third-most unskilled labour intensive sector

It follows then that, the sectors which contribute principally to the overall loss in industrial GDP resulting from AIDS, are: Construction, Chemicals, Mining and Quarrying, Capital Goods and Textiles.

Finally, in figure 8, we plot the sectoral unskilled labour intensities on the X-axis, and the sectoral loss in value-added on the Y-axis, and fit a linear trendline through

the scatter. The resulting trendline is upward-sloping, and thereby, confirms the expected positive association between the sectoral unskilled labour intensity and the sectoral loss in value-added as a result of AIDS. However, the correlation coefficient between the two variables is only 0.5158. The estimated slope coefficient (0.1131) of the linear trendline is significantly different from zero at 1 percent level of significance.

The expected positive association between the sectoral unskilled labour intensity and the sectoral loss in value-added as a result of AIDS is confirmed for the industrial sector

6.4 The impact on services

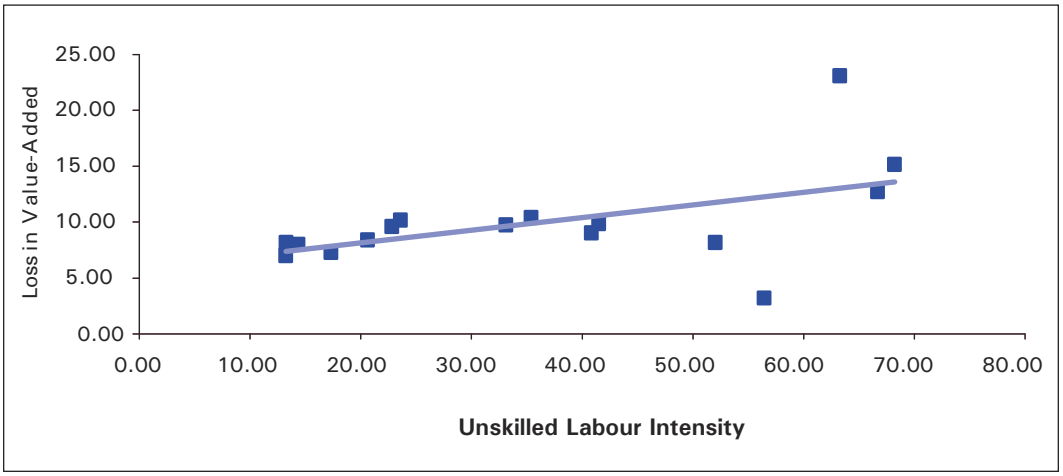
The services or tertiary sector, as a whole, is a low unskilled labour intensity sector. Its value-added declines by 9.02 percent (Table 9), which is lower than the value-added loss of industry. However, the variation across the value-added losses of the 11 tertiary sectors is higher than that in industry – the standard deviation in the case of services is 6.23 as compared to 4.23 of industry.

The largest value-added loss of 18.40 percent in the tertiary sector is experienced by the tourism sector, a MULI sector. However, tourism has a very small weight of 0.06 percent in the tertiary sector's GDP. Storage, another very small component of the services sector, undergoes a large value-added loss of 17.06 percent. The next big loser in value-added terms among the MULI sectors is the other transport sector. Its value-added loss is of 16.85 percent. It also has the fourth-largest weight in the tertiary sector's GDP. Hotels and Restaurants, also a MULI sector, suffers a decline in its value-added by 15 percent. Last, but the most important MULI sector, is trade. That is because it has the maximum weight in the tertiary sector's GDP. Trade experiences a value-added loss of 13.19 percent, but that, because of its large weight, accounts hugely for the overall value-added loss in the tertiary sector.

Among the LULI tertiary sectors, Finance and Ownership of Dwellings suffers the largest value-added loss of 10.93 percent. Following closely are Rail Transport – whose value-added loss is 8.65 percent, and Communications, suffering a decline in its value-added by 4.74 percent. Public Administration and Other Services is the second-largest tertiary sector, and suffers a small loss of 2.12 percent in its value-added. In Education and Research, value-added declines by only 2.37 percent. The healthcare sector is expectedly the

Fig 8

Loss in value-added vs. unskilled labour-intensity (Industry)

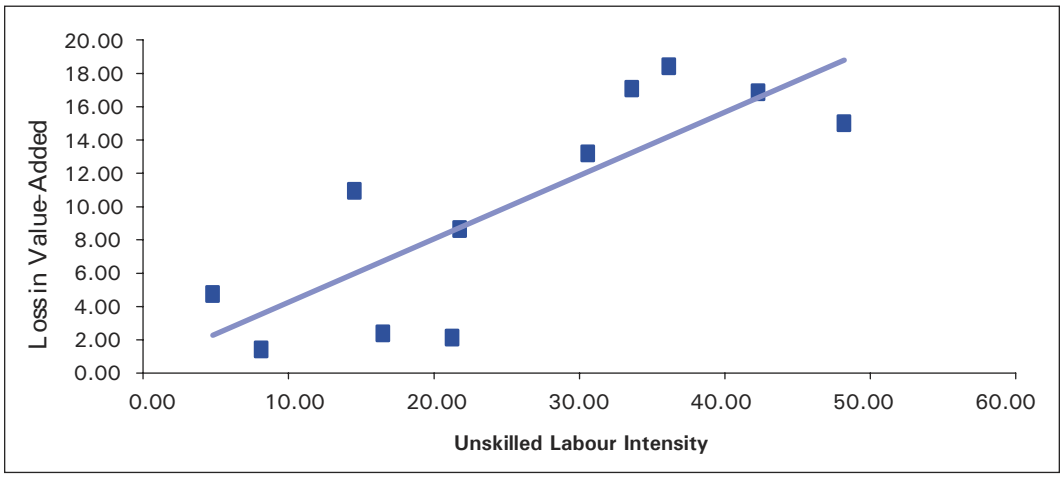


smallest loser in value-added terms. Its value-added declines by only 1.41 percent. Because of the increased medical expenditure by the households and the government, production pattern shifts in favour of this sector mitigating the decline in its value-added.

Finally, in figure 9, we plot the sectoral loss in value-added against the sectoral unskilled labour intensities and fit a linear trendline through the scatter. The trendline turns out to be upward-sloping, confirming the expected positive association between the sectoral unskilled labour intensity and the sectoral value-added loss due to AIDS. The correlation coefficient between the two variables also comes out to be high – i.e., 0.8156. The estimated slope coefficient of the linear trendline is 0.3801, which is significantly different from zero at 1 percent level of significance.

Fig 9

Loss in value-added vs. unskilled labour-intensity (Services)



Part III

Summary and Conclusion

Summary and Conclusion

The adverse economic impact of HIV and AIDS occurs at three levels: the individual/household, sector and national or macro-levels. In the early phase of the epidemic, the impacts at the sector and macro-levels are rather mild and hence, not easily measurable or quantifiable. So far in India, given the low overall prevalence, the focus has been on the effects at the level of the individual and the household. However, in 2005 the number of HIV-affected persons exceeds 5 million, and this number is expected to quintuple to between 20 million and 25 million by 2010. With that kind of a jump in the number of HIV cases in the next 5-10 years, there is bound to be a visible impact on the macro-economy.

Keeping this in mind, we have analysed the macro-economic and sectoral impacts of HIV and AIDS in India, using a five-sector CGE model. A multi-sectoral CGE model is ideally suited for this purpose, as it takes into account the various intra-sector and inter-sectoral substitutions that take place in production, consumption and trade in response to price changes. Moreover, because a CGE model simulates the workings of a market economy in which prices fluctuate to equate demand and supply for all goods and factors, it successfully captures the feedback between labour markets and the rest of the economy, which is ignored in the one-sector macro-simulation models. Typically, therefore, a CGE model provides a realistic estimate, rather than an overestimate, of the net loss in output resulting from a reduction in labour supply caused by increased mortality due to AIDS. This is generally, reflected in the case of single-sector neoclassical growth models. Finally, an additional virtue of the CGE model is that it also brings out the sectoral impact of the epidemic.

Our five-sector CGE model of the Indian economy is used to generate a 'no-AIDS' reference scenario and a 'with-AIDS' scenario for the 14-year period, 2002-03 to 2015-16, wherein a comparison of the latter with respect to the former yields an estimate of the macro-economic and the sectoral impact of the AIDS epidemic.

In the 'with-AIDS' scenario, the following impacts of AIDS on the key exogenous variables are incorporated : (i) slower growth in population and supply of labour by the skill categories, resulting from the AIDS-related deaths, (ii) lower labour productivity of workers with HIV reflected in a lower effective labour input, (iii) decline in sectoral TFP growth rates, initially, i.e., from 2002-03 to 2011-12, to 0.8 times the 'no-AIDS' growth rate, and finally, during the height of the epidemic, i.e., from 2012-13 to 2015-16, to 0.7 times the 'no-AIDS' growth rate,

(iv) the share of health services spending of the HIV households is augmented by an additional 10 percent of total consumption expenditure at the expense of other non-food expenditures, (v) an increase in the health expenditure of the government by 10 percent from 2002-03 to 2011-12, and by 15 percent from 2012-13 to 2015-16.

The increase in health expenditure of the households and the government results in a fall in their savings, which then crowds out investment. The fall in investment causes growth to slow down, and, hence, labour demand to shrink. The fall in labour demand, in fact, outstrips the AIDS-induced fall in labour supply in case of all the three skill types of labour, and all the wage rates, therefore, decline, though unequally.

The slowdown in economic growth due to AIDS is manifested in a decline in the growth of real aggregate GDP as well as in the growth of per capita GDP

The slowdown in economic growth is manifested in a decline in the growth of real aggregate GDP as well as in the growth of per capita GDP. The former decreased, on an average, by 0.86 percentage points, while the latter declined, on an average, by 0.55 percentage points in the 'with-AIDS' scenario compared to the 'no-AIDS' scenario. Hence, the survivors of the epidemic are not "indifferent" or "better-off". They are in fact "worse-off", as the lower per capita incomes show.

Household income growth rates for all the groups decline, though unequally. The decline in the household income growth rate is steepest for rural non-agricultural self-employed, followed by that of rural agricultural labour, rural non-agricultural labour, rural agricultural self-employed and urban casual labour, in that order. These household groups are the ones which derive their incomes mainly from unskilled labour, which, among the three labour types, is affected most adversely by the HIV epidemic.

In sectoral terms, the HIV epidemic hits the sectors that use unskilled labour intensively harder. For example, 'tourism', which is the second-most unskilled labour intensive sector, suffers the maximum loss of 18.31 percent in value-added terms in the 'with-AIDS' scenario in the final year 2015-16. It is followed by the 'manufacturing' or 'industry' sector, occupying the third position in the unskilled labour intensity ranking, and undergoing a value-added loss of 12.48 percent. On the other end of the scale, is the healthcare sector, which is least unskilled labour intensive, and hence, experiences a minor 1.93 percent loss in its value-added. Overall, the sectoral pattern of production changes in favour of 'healthcare' and 'services' – i.e. sectors having relatively lower unskilled labour intensity – at the cost of 'tourism' and 'manufacturing' – i.e. sectors with relatively higher unskilled labour intensity.

In part II of the study, an extended 28-sector CGE model of the Indian economy has been used to do a detailed analysis of the sectoral impact of the HIV epidemic – particularly the impact of AIDS on Indian industry. The 28 sectors include agriculture, 16 industrial sectors and 11 service providing sectors. For agriculture, industry, as an aggregate, and services or tertiary sector, also as an aggregate, the adverse impact generated through the extended CGE model is virtually the same as that obtained from our five-sector CGE model of part I. However, within industry, we are now able to identify the sectors which are major contributors to the overall loss in industrial GDP resulting from AIDS. These sectors are: Construction, Chemicals, Mining and Quarrying, Capital Goods and Textiles. Within industry, we also find a weakly positive relationship between the sectoral unskilled labour intensity and the sectoral

loss in value-added as a result of AIDS. As far as the macro-economic impact of HIV and AIDS is concerned, the extended CGE model more or less replicates that of the five-sector CGE model.

It follows that the adverse macro-economic impact which the HIV epidemic is likely to impinge on the Indian economy in the coming decade, is by no means insignificant. Rather, it is very much real and sizable, and reinforces the already compelling humanitarian reason for urgent and effective policy action to combat HIV and AIDS.

As observed, in the absence of remedial policy action, the HIV epidemic in India is likely to bring down the average annual GDP growth rate during 2002-03 to 2015-16 by about 1 percent. Conversely speaking - i.e., assuming that the 'with-AIDS' scenario is the business-as-usual scenario, and the 'no-AIDS' scenario is the counter-factual policy scenario – it is possible to argue that in the next decade the annual GDP growth rate can be increased by upto 1 percent, if AIDS is effectively countered. It is time, therefore, to begin to see policy action against AIDS as a growth-enhancing policy endeavour, and, first and foremost, dedicate adequate resources for this purpose. However, allocating plentiful resources by itself will not suffice for combating AIDS. Availability of financial resources fulfill only the necessary condition for successful HIV Prevention and Control programmes. For sufficient condition to hold as well, new ideas, innovative institutions, and bold implementation must follow suit.

Policy action against AIDS must be seen as a growth-enhancing policy endeavour

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Appendix

Appendix 1

Social Accounting Matrix 2002-03

	Agriculture	Manufacturing	Services	Healthcare	Tourism
Agriculture	81,52,404.65	1,38,61,443.58	36,78,792.81	46,441.11	9,722.02
Manufac-turing (Industry)	44,83,689.04	6,08,28,759.74	2,38,31,716.90	21,27,379.05	32,197.64
Services	34,33,850.67	3,38,84,829.43	3,10,46,753.46	40,06,980.62	27,203.64
Healthcare	19,383.61	3.58	43,959.32	0.00	186.07
Tourism	0.00	0.00	8,996.33	0.00	0.00
Lab1	200,03,649.65	74,41,060.44	1,31,72,530.20	1,57,312.01	10,172.45
Lab2	56,19,487.69	1,00,62,831.63	1,81,25,525.91	5,32,861.17	7,974.13
Lab3	24,97,269.69	87,80,415.69	2,79,58,896.31	12,55,015.52	8,727.13
Capital	2,22,06,628.20	2,59,50,454.05	6,14,90,883.58	8,22,372.26	18,102.38
RH1					
RH2					
RH3					
RH4					
RH5					
UH1					
UH2					
UH3					
UH4					
Priv. corp.					
Pub. enter.					
Govt.					
Ind. taxes	-11,39,951.04	68,97,033.41	45,70,468.01	3,18,230.11	5,843.31
Capital A/C	0.00	0.00	0.00	0.00	0.00
ROW	11,07,995.74	3,51,69,645.51	57,21,854.93	0.00	0.00
Total	**6,63,84,407.89**	**20,28,76,477.05**	**1,89,650,377.77**	**92,66,591.84**	**1,20,128.77**

	Lab1	Lab2	Lab3	Capital
Agriculture				
Manufacturing (Industry)				
Services				
Healthcare,				
Tourism				
Lab1				
Lab2				
Lab3				
Capital				
RH1	25,04,566.79	51,46,671.02	13,34,050.14	77,14,528.73
RH2	1,56,38,419.67	34,93,284.97	9,94,122.16	67,774.45
RH3	49,77,909.65	13,22,718.46	0.00	4,04,052.78
RH4	69,45,881.41	61,00,618.13	24,50,094.09	3,22,15,265.73
RH5	11,36,855.18	16,00,377.76	12,11,501.84	1,16,86,312.97
UH1	28,69,618.85	28,22,190.80	57,42,683.01	1,29,98,207.92
UH2	26,80,492.12	1,12,03,080.24	2,76,01,916.13	28,31,217.95
UH3	3,69,65,18.29	21,11,225.32	3,17,846.64	9,19,355.24
UH4	25,23,88.06	4,79,390.96	7,66,607.93	43,07,023.80
Priv. corp.				65,30,800.00
Pub. enter.				39,73,600.00
Govt.				24,61,200.00
Ind. taxes				
Capital A/C				2,32,95,200.00
ROW				
Total	**4,07,02,650.03**	**3,42,79,557.64**	**4,04,18,821.94**	**10,94,04,539.57**

	RH1	RH2	RH3	RH4	RH5
Agriculture	37,45,577.19	67,65,897.44	18,63,502.79	1,09,66,829.26	31,62,469.53
Manufacturing	31,13,319.50	52,25,690.47	16,68,324.44	91,91,195.54	31,08,928.71
Services	50,61,768.48	72,19,547.44	27,48,729.69	1,73,44,838.74	61,03,955.63
Healthcare,	4,50,832.07	10,97,272.41	2,97,964.88	17,75,373.19	9,89,860.05
Tourism	8,436.85	11,697.70	4,196.07	28,144.01	8,312.32
Lab1					
Lab2					
Lab3					
Capital					
RH1					
RH2					
RH3					
RH4					
RH5					
UH1					
UH2					
UH3					
UH4					
Priv. corp.					
Pub. enter.					
Govt.	1,53,300.00	0.00	0.00	17,86,712.07	6,12,230.79
Ind. taxes	4,30,940.75	7,07,335.07	2,29,141.88	13,68,240.02	4,65,527.31
Capital A/C	61,66,205.30	12,44,553.57	3,20,719.70	1,13,88,307.01	39,87,773.20
ROW					
Total	**1,91,30,380.15**	**2,22,71,994.11**	**71,32,579.45**	**5,38,49,639.83**	**1,84,39,057.54**

	UH1	UH2	UH3	UH4
Agriculture	47,55,087.77	53,87,698.68	12,22,153.62	8,62,309.52
Manufacturing	48,47,456.68	68,23,413.47	11,76,627.21	10,60,895.08
Services	1,12,89,775.82	2,07,58,639.34	24,25,253.18	37,08,558.35
Healthcare,	7,76,884.59	15,26,069.61	2,68,180.90	6,64,409.68
Tourism	16,307.90	26,474.53	3,396.95	4,166.93
Lab1				
Lab2				
Lab3				
Capital				
RH1				
RH2				
RH3				
RH4				
RH5				
UH1				
UH2				
UH3				
UH4				
Priv. corp.				
Pub. enter.				
Govt.		10,26,412.09	17,14,942.96	2,73,602.09
Ind. taxes	7,54,864.37	12,01,707.85	1,77,376.29	2,19,312.40
Capital A/C	73,46,456.26	1,38,11,556.71	4,10,928.16	14,91,099.09
ROW				
Total	**2,97,86,833.39**	**5,05,61,972.28**	**73,98,859.27**	**82,84,353.16**

	Priv. Corp.	Pub. Enter.	Govt.	Ind. Taxes	Capital A/C	ROW	Total
Agriculture			2,17,133.57		-3,23,564.27	20,10,508.63	6,63,84,407.89
Manufacturing			41,37,276.11		4,80,83,527.40	2,31,36,078.99	20,28,76,475.96
Services			2,33,46,253.41		41,98,337.61	1,30,45,100.70	18,96,50,376.23
Healthcare,			13,56,211.87		0.00	0.00	92,66,591.84
Tourism			0.00		0.00	0.00	1,20,129.60
Lab1						-82,074.72	4,07,02,650.03
Lab2						-69,122.89	3,42,79,557.64
Lab3						-81,502.39	4,04,18,821.94
Capital						-10,83,900.00	10,94,04,540.46
RH1			21,70,742.80			2,59,820.57	1,91,30,380.05
RH2			17,26,229.32			3,52,162.08	2,22,71,992.65
RH3			4,10,911.38			16,986.69	71,32,578.96
RH4			59,25,396.57			2,12,383.47	5,38,49,639.39
RH5			18,58,875.76			9,45,134.04	1,84,39,057.55
UH1			29,23,442.62			24,30,690.47	2,97,86,833.67
UH2			4,397,795.53			18,47,472.77	5,05,61,974.75
UH3			2,66,583.05			87,330.40	73,98,858.94
UH4			7,08,022.97			17,70,919.50	82,84,353.21
Priv. corp.			10,20,700.00				75,51,500.00
Pub. enter.							39,73,600.00
Govt.	44,02,600.00			2,08,43,600.00		-2,48,200.00	3,30,26,400.00
Ind. taxes			6,04,318.63		40,33,211.62		2,08,43,600.00
Capital A/C	31,48,900.00	39,73,600.00	-1,80,43,493.60			-25,50,292.14	5,59,91,513.26
ROW							4,19,99,496.18
Total	**75,51,500.00**	**39,73,600.00**	**3,30,26,399.99**	**2,08,43,600.00**	**5,59,91,512.35**	**4,19,99,496.18**	

Appendix 2

28-Sector Social Accounting Matrix (SAM) – 2002-03

	Agriculture	Mining and quarrying	Food and beverages	Textiles	Wood & wood products	Paper and printing	Leather & leather products
Agriculture	81,52,404.65	1,572.11	97,26,273.38	15,65,573.84	2,51,382.02	1,30,007.00	1,06,764.84
Mining and quarrying	1,664.23	69,803.07	1,62,578.22	66,293.94	2,832.91	1,08,138.54	1,264.91
Food and beverages	3,37,861.75	21.78	20,06,408.59	17,135.07	83.70	4,471.05	472.50
Textiles	1,88,574.99	115.11	97,627.13	26,63,010.97	5,825.39	37,351.26	16,572.48
Wood & wood products	13,737.58	25,403.75	1,18,035.36	20,803.63	92,135.52	54,381.99	5,733.36
Paper and printing	12,783.98	6,767.55	3,25,937.63	70,569.79	9,406.25	8,80,518.56	6,930.73
Leather & leather products	1,693.69	0.08	1,438.94	10,043.58	419.26	19.37	2,80,925.29
Petroleum products	4,06,211.81	1,06,453.01	3,85,929.93	1,54,551.72	36,976.89	27422.37	30,398.84
Chemicals	31,07,874.57	1,51,346.46	6,02,414.53	11,12,052.80	23,527.53	264970.17	90,647.76
Non-metallic products	485.76	23,635.64	1,46,405.80	6,295.30	2,724.85	10,326.55	1,473.23
Basic metals	6,978.23	344.36	59,619.73	37,312.27	11,258.38	32,760.83	4,026.83
Metal products	28,541.14	64,276.10	1,37,710.72	40,126.49	7,788.18	12,077.61	8,562.70
Capital goods	1,32,647.34	2,48,525.68	1,42,945.46	1,06,232.00	8,310.49	17,819.48	11,176.88
Other manufacturing	8,119.23	39,039.43	11,711.17	21,165.13	6,278.96	14,025.15	3,919.65
Construction	2,36,514.74	72,996.00	70,978.48	33,745.30	5,520.57	7,544.15	3,489.91
Electricity	2,02,776.59	1,88,487.64	2,03,094.48	7,51,344.11	42,507.23	1,21,037.23	16,745.03
Gas and water supply	499.06	1,598.30	10,429.67	12,332.72	107.89	6,090.56	204.97
Rail transport	1,12,005.09	30,841.17	95,236.62	30,023.33	3,052.08	43,161.11	4,096.50
Other transport	9,84,540.06	1,50,095.90	10,72,414.90	9,69,642.16	40,603.27	1,53,744.28	47,438.27
Storage	0.00	0.00	0.00	0.00	0.00	0.00	0.00

(Table Contd.....)

(Table Contd.....)

Communication	11,576.37	7,315.97	95,428.77	22,109.04	1,897.93	95,105.85	3,106.02
Trade	16,12,697.70	83,708.02	20,52,862.44	12,57,254.49	67,531.83	2,07,918.20	1,80,761.12
Hotels and restaurants	8,697.02	3,791.38	7.02	0.08	0.01	0.00	0.00
Finance and real estate	4,61,287.62	74,697.59	11,47,019.42	6,21,347.04	56,634.52	1,51,894.42	56,506.48
Education & research	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Health	19,383.61	0.00	0.00	0.00	0.00	0.00	0.00
Public admin. & other services	39,771.16	94,462.32	5,90,954.74	3,74,488.59	16,668.31	29,075.12	47,026.82
Tourism	0.00	0.00	0.00	0.00			
L1	2,00,93,302.10	6,50,838.90	12,97,405.76	10,89,252.06	2,88,843.62	1,03,528.66	82,369.60
L2	59,69,740.48	6,15,742.52	6,17,003.29	7,34,719.45	1,13,161.22	1,75,957.39	78,782.58
L3	20,57,364.44	6,98,422.59	3,85,128.53	2,70,108.49	31,225.21	2,22,785.92	37,393.14
Capital	2,22,06,628.20	42,77,724.00	28,30,715.22	16,93,920.62	2,40,069.29	5,88,745.91	1,49,471.79
RH1							
RH2							
RH3							
RH4							
RH5							
UH1							
UH2							
UH3							
UH4							
Priv. corp.							
Pub. enter.							
Govt							
Ind. tax	-11,39,951.04	1,58,292.83	3,61,562.39	3,90,517.27	29,951.10	1,51,779.38	31,142.66
Capital A/C							
ROW	11,07,995.74	1,06,56,777.70	4,96,875.00	92,79,06.94	24,818.32	11,74,000.57	90,025.07
Total	**6,63,84,407.89**	**1,85,03,096.97**	**2,52,52,153.34**	**1,50,69,878.20**	**14,21,542.71**	**48,26,658.65**	**13,97,429.98**

	Petroleum products	Chemicals	Non-metallic products	Basic metals	Metal products	Capital goods	Other manufacturing
Agriculture	1,93,697.74	9,43,750.44	19,252.54	2,507.64	2,060.08	3,857.93	99,082.97
Mining and quarrying	68,87,652.71	13,97,789.91	10,45,191.02	10,74,566.07	1,46,164.84	78,140.98	1,35,055.59
Food and beverages	206.95	53,848.07	336.75	620.46	26.26	318.20	219.70
Textiles	1,35,854.12	1,84,751.42	1,18,510.21	33,606.42	19,980.21	71,481.40	52,302.25
Wood & wood products	15,339.68	52,374.85	20,704.16	17,930.05	8,030.14	1,47,951.23	71,213.87
Paper and printing	30,535.85	3,94,929.73	8,318.00	15,181.35	11,400.83	92,823.57	49,178.51
Leather & leather products	9,779.55	358.39	178.92	345.65	768.68	5,598.23	4,340.13
Petroleum products	2,71,459.07	3,98,045.50	2,50,288.06	5,66,162.54	1,04,943.26	7,68,243.78	1,63,758.44
Chemicals	11,00,284.09	54,89,446.31	1,63,774.68	1,74,750.68	73,934.06	6,11,310.74	4,25,673.81
Non-metallic products	4,040.48	51,462.01	1,36,780.54	11,792.86	10,538.00	59,875.99	11,458.42
Basic metals	46,291.36	1,02,427.33	39,282.17	31,40,350.79	12,95,747.28	38,66,992.27	27,07,246.53
Metal products	52,032.43	1,19,162.18	24,815.15	4,36,640.68	1,41,653.56	4,60,702.37	34,300.16
Capital goods	22,692.33	84,906.28	30,675.57	70,038.53	50,639.30	22,97,385.54	56,560.68
Other manufacturing	5,752.45	96,912.31	39,863.55	24,103.27	13,529.26	1,91,182.88	67,457.54
Construction	14,748.04	43,208.66	15,092.63	18,742.93	7,047.97	46,190.03	13,669.97
Electricity	2,35,216.45	6,57,426.11	2,01,665.05	4,57,715.16	1,14,681.63	6,17,419.26	1,60,642.63
Gas and water supply	7,930.81	36,140.21	2,005.40	8,341.55	1,946.16	24,773.24	3,491.93
Rail transport	74,868.32	1,42,488.36	1,81,745.76	3,90,459.24	63,147.49	1,11,040.83	28,715.96
Other transport	3,02,950.33	6,93,783.94	2,73,474.36	3,24,937.06	95,371.72	4,35,740.43	1,40,603.36
Storage	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Communication	15,335.72	1,28,984.66	10,896.20	26,469.87	12,066.42	1,02,295.33	64,244.98
Trade	5,08,666.72	12,01,976.11	3,26,501.36	10,07,200.60	2,62,047.10	10,83,465.20	3,75,827.99
Hotels and restaurants	0.00	0.20	0.00	15.64	0.00	1,365.66	0.00
Finance and real estate	4,00,891.05	8,50,508.21	2,08,542.90	5,45,332.75	1,96,141.93	10,86,475.71	1,94,951.67
Education & research	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Health	0.00	0.00	0.00	0.00	0.00	3.57	0.01
Public admin. & other services	1,04,462.77	1,05,763.65	42,398.74	2,09,769.58	1,56,247.48	9,26,715.03	84,851.35
Tourism						0.00	
L1	93,286.44	3,78,314.71	4,62,363.06	2,07,504.34	1,83,716.83	5,20,928.35	3,26,451.92
L2	2,20,815.68	4,14,923.07	1,53,313.89	3,55,424.80	1,96,092.47	8,46,721.84	3,04,279.14
L3	3,88,456.76	8,10,844.19	62,092.75	6,35,441.90	1,39,584.50	9,15,740.60	1,68,427.68

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Capital	18,64,935.36	42,18,636.93	9,91,978.86	18,84,412.57	6,97,544.45	25,57,639.51	8,16,009.42
RH1						0.00	
RH2						0.00	
RH3						0.00	
RH4						0.00	
RH5						0.00	
UH1						0.00	
UH2						0.00	
UH3						0.00	
UH4						0.00	
Priv. corp.						0.00	
Pub. enter.						0.00	
Govt						0.00	
Ind. tax	7,44,117.59	8,07,851.50	1,53,550.22	5,59,248.36	2,09,387.16	13,72,404.33	4,85,442.05
Capital A/C							
ROW	20,27,252.43	32,45,482.87	7,18,137.43	35,11,119.69	1,82,274.45	86,53,632.27	34,61,342.78
Total	**1,57,79,553.28**	**2,31,06,498.11**	**57,01,729.94**	**1,57,10,733.02**	**43,96,713.51**	**2,79,58,416.31**	**1,05,06,801.41**

	Construction	Electricity	Gas and water supply	Rail transport	Other transport	Storage	Commu-nications
Agriculture	8,15,661.04	66.88	49,784.06	20.59	2,10,301.56	0.00	0.00
Mining and quarrying	15,81,905.63	13,96,933.42	496.08	5,302.33	2.00	0.00	0.25
Food and beverages	471.97	0.00	1.79	0.00	1,272.72	16.53	0.00
Textiles	64,054.85	1,152.66	61.99	404.32	41,013.94	2,209.76	753.06
Wood & wood products	8,25,143.19	3,830.55	139.21	2,547.97	9,817.36	2,634.69	1,712.15
Paper and printing	24,495.39	43,767.08	2,582.46	6,029.58	1,67,753.79	3,265.92	32,945.02
Leather & leather products	691.36	86.87	0.00	0.00	2,445.72	0.00	0.06
Petroleum products	11,78,943.18	2,94,436.60	2,425.67	1,07,073.98	53,72,624.74	3,321.66	31,026.76
Chemicals	7,32,033.58	30,027.15	6,470.23	175.11	71,793.53	1,223.91	2.11
Non-metallic products	28,76,068.63	12.69	1,306.64	215.34	22,775.93	128.18	0.11
Basic metals	20,13,135.51	0.81	1,678.86	154.02	494.72	330.97	10.81
Metal products	4,40,791.68	2942.59	872.21	347.76	1,28,834.75	312.52	3,064.26
Capital goods	3,41,098.45	5,67,714.73	3,879.24	4,29,479.10	8,55,696.34	3,697.05	2,49,974.10
Other manufacturing	59,112.41	73,127.57	1,517.31	1,795.55	1,78,300.83	1,575.36	3,063.55
Construction	1,82,522.98	77,112.17	2,09,700.01	2,24,541.07	3,25,139.64	3,668.53	1,76,170.76
Electricity	4,20,950.48	26,10,170.68	40,349.62	5,39,573.33	12,92,173.16	26,732.08	1,14,047.47
Gas and water supply	47,700.05	1,15,907.01	36,097.58	146.18	32,220.99	177.93	412.86
Rail transport	3,90,223.71	5,26,538.76	3,410.32	9,327.26	1,45,414.00	1,190.04	26,593.16
Other transport	16,56,819.78	4,54,132.88	13,581.64	19,939.68	9,52,678.77	5,008.95	42,019.61
Storage	0.00	0.00	0.00	0.00	304.54	421.76	0.00
Communication	1,56,936.97	72,087.73	9,151.46	11,012.26	3,34,846.67	2,519.81	35,679.80
Trade	18,81,027.84	6,20,782.20	7,514.32	31,747.68	9,71,101.51	2,516.70	52,658.59
Hotels and restaurants	3,361.08	24,878.32	2,107.21	7,107.19	5,75,610.83	793.03	17,868.22
Finance and real estate	13,40,130.51	5,05,341.28	4,632.76	3,39,203.94	7,93,079.99	10,185.79	24,677.51
Education & research	0.00	0.00	0.00	8,258.79	0.00	0.00	0.00
Health	0.00	0.00	0.00	41,025.91	0.00	0.00	2,933.25
Public admin. & other services	6,24,640.73	2,66,382.95	55,681.54	1,41,611.63	24,18,429.31	18,464.59	2,14,837.19
Tourism							
L1	69,62,950.60	1,88,669.84	87,702.50	3,08,587.48	30,45,187.27	25,151.81	41,310.45

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L2	28,16,424.43	6,64,782.87	3,48,452.82	6,24,741.46	30,36,841.41	35,827.59	3,44,638.16
L3	12,27,538.86	5,69,797.60	1,74,994.38	4,84,540.41	11,19,939.18	13,830.21	4,76,309.39
Capital	31,38,650.14	25,98,709.84	3,63,269.54	7,95,000.46	42,71,371.13	62,309.60	27,12,142.00
RH1							
RH2							
RH3							
RH4							
RH5							
UH1							
UH2							
UH3							
UH4							
Priv. Corp.							
Pub. enter.							
Govt							
Ind. tax	14,41,786.57	2,18,834.98	8,032.83	70,885.06	23,19,780.23	3,917.16	56,622.37
Capital A/C							
ROW					16,00,189.00	0.00	16,306.42
Total	**3,32,45,271.61**	**1,19,28,228.70**	**14,35,894.30**	**42,10,795.44**	**3,02,97,435.55**	**2,31,432.12**	**46,77,779.42**

	Trade	Hotels and restaurants	Finance and real estate	Education & research	Health	Public admin. & other services	Tourism
Agriculture	1,24,465.17	23,37,407.50	0.05	57,427.67	46,441.11	8,99,319.33	9,722.02
Mining and quarrying	72,484.28	18,590.17	0.00	0.00	2.25	8,08,721.53	2,734.45
Food and beverages	11,661.55	9,12,687.37	2,235.15	0.00	0.00	1,10,469.66	3,036.48
Textiles	82,992.98	11,769.12	5,953.71	5,692.52	6,774.16	5,82,755.91	2,702.00
Wood & wood products	92,096.92	11,033.97	9,242.98	27,122.61	19,548.02	1,71,350.71	192.91
Paper and printing	1,14,349.00	3,761.54	2,25,812.39	62,417.00	28,555.21	3,35,603.48	710.01
Leather & leather products	14,046.90	0.00	0.11	0.03	0.05	45,382.59	630.73
Petroleum products	5,04,732.26	52,973.49	81,463.71	22,206.71	14,401.24	3,25,781.65	10,090.29
Chemicals	2,46,056.58	5,200.87	0.34	58,364.58	19,90,706.75	10,61,550.12	3,215.85
Non-metallic products	5,991.71	4,425.92	4.77	0.72	0.98	45,968.11	112.01
Basic metals	1,88,024.99	0.02	0.00	0.00	0.72	10,44,508.72	2,187.06
Metal products	2,72,463.14	173.13	16,609.65	2,937.30	3,495.05	1,99,767.11	379.83
Capital goods	75,883.54	20,319.18	74,038.04	6,245.48	7,430.71	6,36,887.52	3,673.40
Other manufacturing	2,60,005.96	12,928.99	82,896.83	32,684.88	17,690.88	19,86,895.02	675.71
Construction	82,809.51	66,495.61	9,98,682.52	1,18,158.33	38,773.01	2,99,928.90	1,856.91
electricity	3,32,482.08	1,14,084.52	2,41,483.74	7,052.31	19,178.06	4,94,830.00	5,661.30
Gas and water supply	2,256.55	44,297.03	3,066.42	285.94	340.22	9195.11	212.11
Rail transport	82,950.56	13,222.37	35,440.30	31,927.43	17,811.36	1,35,441.73	459.86
Other transport	13,91,174.37	2,41,426.32	1,67,696.78	2,57,061.26	2,09,418.28	6,30,938.91	3,594.99
Storage	2,28,023.58	0.00	0.00	0.00	0.00	0.00	0.50
Communication	1,54,281.00	14,525.62	4,31,988.90	29,608.00	21,180.94	2,17,464.04	810.90
Trade	2,85,503.96	5,05,898.67	62,282.36	35,495.64	4,74,680.73	11,84,244.76	5,645.70
Hotels and restaurants	20,106.25	1,173.68	2,37,895.11	1,60,019.05	50,415.09	39,173.81	988.05
Finance and real estate	16,20,051.97	9,563.41	12,64,745.57	2,58,241.16	64,473.59	11,28,444.69	4,138.89
Education & research	0.00	0.00	0.00	51,073.95	457.99	0.00	37.46
Health	0.00	0.00	0.00	0.00	0.00	0.16	186.07
Public admin. & other services	15,19,297.48	1,42,740.95	13,45,815.96	3,32,065.05	31,49,024.36	9,41,374.07	5,653.88
Tourism	8,996.33		0.00			0.00	0.00
L1	32,70,774.35	6,83,331.24	8,68,807.72	14,19,321.70	1,58,036.18	44,57,732.93	9,718.39
L2	38,63,172.07	5,22,474.27	12,14,309.67	15,01,766.02	4,23,171.74	61,36,267.38	6,741.38

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L3	35,61,778.75	2,12,200.31	38,91,328.10	56,83,875.94	13,63,980.78	1,03,78,507.14	10,413.94
Capital	2,08,88,566.95	8,71,226.83	2,03,95,748.05	24,10,093.95	8,22,372.26	61,22,445.23	18,102.38
RH1							
RH2							
RH3							
RH4							
RH5							
UH1							
UH2							
UH3							
UH4							
Priv. corp.							
Pub. enter.							
Govt							
Ind. tax	5,32,728.67	1,13,353.89	2,04,083.63	50,701.55	3,18,230.11	9,91,527.64	5,843.31
Capital A/C							
ROW	0.00	3,82,294.46	3,62,330.00			33,60,735.05	
Total	**3,99,10,209.41**	**73,29,580.43**	**3,22,23,962.59**	**1,26,21,846.79**	**92,66,591.84**	**4,47,83,213.02**	**1,20,128.77**

	L1	L2	L3	Capital
Agriculture	0.00	0.00	0.00	0.00
Mining and quarrying	0.00	0.00	0.00	0.00
Food and beverages	0.00	0.00	0.00	0.00
Textiles	0.00	0.00	0.00	0.00
Wood & wood products				
Paper and printing				
Leather & leather products				
Petroleum products				
Chemicals				
Non-metallic products				
Basic metals				
Metal products				
Capital goods	0.00	0.00	0.00	0.00
Other manufacturing				
Construction				
Electricity				
Gas and water supply				
Rail transport				
Other transport				
Storage				
Communication				
Trade				
Hotels and restaurants				
Finance and real estate	0.00	0.00	0.00	0.00
Education & research				
Health				
Public admin. & other services	0.00	0.00	0.00	0.00
Tourism				
L1				
L2				
L3				
Capital				
RH1	36,76,874.30	25,12,367.38	27,96,046.37	77,14,528.73
RH2	82,35,700.43	56,27,362.66	62,62,765.16	67,774.45
RH3	25,78,283.44	17,61,712.45	19,60,632.72	4,04,052.78
RH4	63,41,369.15	43,32,987.13	48,22,237.78	3,22,15,265.73
RH5	16,15,863.77	11,04,101.77	12,28,769.23	1,16,86,312.97
UH1	46,79,114.45	31,97,186.95	35,58,190.98	1,29,98,207.92
UH2	1,69,76,296.86	1,15,99,715.16	1,29,09,474.00	28,31,217.95

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UH3	25,06,656.04	17,12,770.24	19,06,164.30	9,19,355.24
UH4	613,155.66	4,18,962.46	4,66,268.77	43,07,023.80
Priv. corp.				65,30,800.00
Pub. enter.				39,73,600.00
Govt				24,61,200.00
Ind. tax				
Capital A/C				2,32,95,200.00
ROW				
Total	**4,72,23,314.09**	**3,22,67,166.21**	**3,59,10,549.31**	**10,94,04,539.57**

	RH1	RH2	RH3	RH4	RH5
Agriculture	37,45,577.19	67,65,897.44	18,63,502.79	1,09,66,829.26	31,62,469.53
Mining and quarrying	5,678.04	10,556.83	3,049.08	15,356.61	4,991.24
Food and beverages	16,89,841.68	31,01,890.58	9,16,141.30	47,38,283.57	15,11,224.66
Textiles	5,80,274.31	10,05,184.73	2,84,823.69	17,33,171.53	5,41,589.43
Wood & wood products	18,681.90	18,167.59	9,906.89	60,379.48	19,669.23
Paper and printing	95,298.74	1,25,971.54	46,651.27	3,28,017.93	89,819.19
Leather & leather products	35,537.14	48,138.51	17,918.19	1,10,974.37	52,566.47
Petroleum products	2,19,063.32	3,62,965.67	1,50,794.45	7,07,555.11	4,08,522.61
Chemicals	1,60,021.18	2,11,525.51	78,334.64	5,50,792.36	1,50,820.18
Non-metallic products	11,831.44	9,873.54	6,111.84	39,562.09	10,819.62
Basic metals	0.00	0.00	0.00	0.00	0.00
Metal products	62,803.89	61,074.89	33,304.48	2,02,980.74	66,123.04
Capital goods	1,38,813.19	1,34,991.64	73,611.70	4,48,641.05	1,46,149.39
Other manufacturing	95,474.69	1,35,349.43	47,676.91	2,55,480.70	1,06,633.64
Construction	0.00	0.00	0.00	0.00	0.00
Electricity	1,35,042.14	2,51,075.75	72,517.14	3,65,229.95	1,18,707.89
Gas and water supply	46,538.45	86,526.14	24,990.98	1,25,866.15	40,909.31
Rail transport	82,748.95	1,09,382.49	40,507.82	2,84,821.62	77,991.00
Other transport	10,28,315.86	1359289.09	5,03,388.06	35,39,459.79	9,69,189.13
Storage	0.00	0.00	0.00	0.00	0.00
Communication	1,51,571.84	200356.67	74,198.46	5,21,709.76	1,42,856.67
Trade	12,09,639.73	1598973.77	5,92,150.93	41,63,575.93	11,40,087.12
Hotels and restaurants	4,00,922.77	529963.57	1,96,262.39	13,79,974.84	3,77,870.27
Finance and real estate	8,96,955.78	1524913.11	6,93,345.13	30,76,190.20	17,63,984.63
Education & research	2,90,919.62	476314.09	1,50,390.94	10,67,319.47	7,00,344.16
Health	4,50,832.07	1097272.41	2,97,964.88	17,75,373.19	9,89,860.05
Public admin. & other services	8,19,113.34	1082752.75	4,00,977.84	28,20,691.05	7,72,015.46
Tourism	8,436.85	11697.70	4,196.07	28,144.01	8,312.32
L1					
L2					
L3					
Capital					
RH1					
RH2					
RH3					
RH4					
RH5					
UH1					
UH2					
UH3					
UH4					

(Table Contd.....)

(Table Contd.....)

Priv. corp.					
Pub. enter.					
Govt	1,53,300.00			17,86,712.07	6,12,230.79
Ind. tax	4,30,940.75	7,07,335.07	2,29,141.88	13,68,240.02	4,65,527.31
Capital A/C	61,66,205.30	12,44,553.57	3,20,719.70	1,13,88,307.01	39,87,773.20
ROW					
Total	1,91,30,380.15	2,22,71,994.11	71,32,579.45	5,38,49,639.83	1,84,39,057.54

	UH1	UH2	UH3	UH4
Agriculture	47,55,087.77	53,87,698.68	12,22,153.62	8,62,309.52
Mining and quarrying	8,651.28	9,827.04	3,888.56	1,738.82
Food and beverages	23,06,905.05	27,45,944.43	6,45,988.71	4,72,801.73
Textiles	8,21,744.22	9,93,670.58	1,80,236.07	1,67,202.99
Wood & wood products	38,397.55	52,027.25	4,990.98	7,467.30
Paper and printing	1,89,816.84	3,14,857.64	39,160.15	49,826.23
Leather & leather products	63,399.51	78,932.76	11,151.11	12,705.22
Petroleum products	4,54,151.54	12,06,341.09	1,32,482.96	1,28,968.39
Chemicals	3,18,731.56	5,28,694.21	65,755.90	83,665.87
Non-metallic products	13,611.51	31,649.74	2,808.12	4,137.98
Basic metals	0.00	0.00	0.00	0.00
Metal products	1,29,082.99	1,74,902.64	16,778.42	25,103.20
Capital goods	2,85,307.50	3,86,581.03	37,084.74	55,484.71
Other manufacturing	2,17,657.15	2,99,985.04	36,301.49	51,792.63
Construction	0.00	0.00	0.00	0.00
Electricity	2,05,755.44	2,33,719.04	92,482.61	41,354.76
Gas and water supply	70,907.78	80,544.65	31,871.51	14,251.75
Rail transport	1,64,820.07	2,73,394.39	34,003.20	43,264.67
Other transport	20,48,208.37	33,97,454.35	4,22,555.52	5,37,647.25
Storage	0.00	0.00	0.00	0.00
Communication	3,01,902.09	5,00,778.42	62,283.89	79,248.20
Trade	24,09,370.80	39,96,530.55	4,97,065.11	6,32,451.07
Hotels and restaurants	7,98,561.41	13,24,609.35	1,64,747.17	2,09,619.47
Finance and real estate	26,87,704.15	55,69,793.45	5,85,999.74	14,52,867.16
Education & research	9,71,028.73	26,75,545.32	1,97,654.40	2,69,586.75
Health	7,76,884.59	15,26,069.61	2,68,180.90	6,64,409.68
Public admin. & other services	16,31,516.99	27,06,269.82	3,36,590.02	4,28,267.27
Tourism	16,307.90	26,474.53	3,396.95	4,166.93
L1				
L2				
L3				
Capital				
RH1				
RH2				
RH3				
RH4				
RH5				
UH1				
UH2				

(Table Contd.....)

(Table Contd.....)

UH3				
UH4				
Priv. corp.				
Pub. enter.				
Govt		10,26,412.09	17,14,942.96	2,73,602.09
Ind. tax	7,54,864.37	12,01,707.85	1,77,376.29	2,19,312.40
Capital A/C	73,46,456.26	1,38,11,556.71	4,10,928.16	14,91,099.09
ROW				
Total	**2,97,86,833.39**	**5,05,61,972.28**	**73,98,859.27**	**82,84,353.16**

	Priv. corp.	Pub. enter.	Govt	Ind. tax	Capital A/C	ROW	Total
Agriculture	0.00	0.00	2,17,133.57	0.00	-3,23,564.27	20,10,508.63	6,63,84,407.89
Mining and quarrying	0.00	0.00	10,619.31	0.00	29,73,978.33	3,90,451.42	1,85,03,095.88
Food and beverages	0.00	0.00	93,878.05	0.00	26,76,042.91	8,89,326.65	2,52,52,153.34
Textiles	0.00	0.00	5,139.35	0.00	2,31,385.14	40,91,601.82	1,50,69,878.20
Wood & wood products			20,230.37		-7,15,864.60	47,300.37	14,21,542.71
Paper and printing			2,82,690.92		-4,51,479.87	7,48,697.88	48,26,658.65
Leather & leather products			0.23		-3,394.93	5,90,307.23	13,97,429.98
Petroleum products			2,94,936.10		-18,54,015.81	18,95,440.70	1,57,79,553.28
Chemicals			2,31,312.27		-7,544.65	31,35,560.16	2,31,06,498.11
Non-metallic products			9.35		-16,05,030.98	37,42,038.53	57,01,729.94
Basic metals			8.83		3,035.59	11,06,523.02	1,57,10,733.02
Metal products			12,280.33		4,36,615.78	5,34,282.64	43,96,713.51
Capital goods	0.00	0.00	5,71,025.34	0.00	1,62,80,668.56	28,43,485.00	2,79,58,416.31
Other manufacturing			12,42,254.48		16,41,800.83	31,21,063.57	1,05,06,801.41
Construction			13,72,891.18		2,84,77,331.10	0.00	3,32,45,271.61
Electricity			1,82,816.54		0.00	0.00	1,19,28,228.70
Gas and water supply			5,05,279.12		0.00	0.00	14,35,894.30
Rail transport			86,607.61		97,924.18	184496.74	42,10,795.44
Other transport			5,99,665.92		8,61,204.50	3300225.47	3,02,97,435.55
Storage			2,681.36		0.38	0.00	2,31,432.12
Communication			5,28,374.29		0.53	25,570.91	46,77,778.92
Trade			3,51,225.36		24,68,500.93	45,01,118.14	3,99,10,208.94
Hotels and restaurants			1,33,626.52		0.00	6,58,048.74	73,29,580.43
Finance and real estate	0.00	0.00	3,94,580.47	0.00	0.00	1,58,486.00	3,22,23,962.20
Education & research			57,62,914.93		0.00	0.00	1,26,21,846.60
Health			13,56,211.87		0.00	0.00	92,66,591.84
Public admin. & other services	0.00	0.00	1,47,98,481.30	0.00	7,70,707.09	42,17,154.71	4,47,83,213.02
Tourism							1,20,129.60
L1						-82,074.72	4,72,23,314.09

(Table Contd.....)

(Table Contd.....)

L2						-69,122.89	3,22,67,166.21
L3						-81,502.39	3,59,10,549.31
Capital						-10,83,900.00	10,94,04,540.46
RH1			21,70,742.80			2,59,820.57	1,91,30,380.15
RH2			17,26,229.32			3,52,162.08	2,22,71,994.11
RH3			4,10,911.38			16,986.69	71,32,579.45
RH4			59,25,396.57			2,12,383.47	5,38,49,639.83
RH5			18,58,875.76			9,45,134.04	1,84,39,057.54
UH1			29,23,442.62			24,30,690.47	2,97,86,833.39
UH2			43,97,795.53			18,47,472.77	5,05,61,972.28
UH3			2,66,583.05			87,330.40	73,98,859.27
UH4			7,08,022.97			17,70,919.50	82,84,353.16
Priv. corp.			10,20,700.00				75,51,500.00
Pub. enter.							39,73,600.00
Govt	44,02,600.00			2,08,43,600.00		-2,48,200.00	3,30,26,400.00
Ind. tax			6,04,318.63		40,33,211.62		2,08,43,600.00
Capital A/C	3,14,89,00.00	39,73,600.00	-1,80,43,493.60			-2,5,50,292.14	5,59,91,513.26
ROW							4,19,99,496.18
Total	**7,55,15,00.00**	**39,73,600.00**	**3,30,26,399.99**	**2,08,43,600.00**	**5,59,91,512.35**	**4,19,99,496.18**	

Appendix 3

Equations of the Model

Production structure

$$X_i = as_i \left[\lambda_i CL_i^{\rho 1_i} + (1-\lambda_i)\overline{K}_i^{\rho 1_i}\right]^{1/\rho 1_i} \quad (1)$$

$$CL_i = \overline{K}_i \left[\left(\frac{WK_i}{WCL_i} \right) \left(\frac{\lambda_i}{1-\lambda_i} \right) \right]^{1/(1-\rho 1_i)} \quad (2)$$

$$PX_i * X_i * (1-exct_i) = WLL1 * LL1_i + WLL2 * LL2_i + WLL3 * LL3_i + WK_i * \overline{K}_i + \sum_j PC_j * a_{ji} * X_i \quad (3)$$

$$CL_i = as_{2i} \left[\lambda_{2_i} LL1_i^{\rho 2_i} + (1-\lambda_{2_i})SLC_i^{\rho 2_i}\right]^{1/\rho 2_i} \quad (4)$$

$$LL1_i = SLC_i \left[\left(\frac{WSLC_i}{WLL1} \right) \left(\frac{\lambda_{2i}}{1-\lambda_{2i}} \right) \right]^{1/(1-\rho 2_i)} \quad (5)$$

$$WCL_i * CL_i = WLL1 * LL1_i + WSLC_i * SLC_i \quad (6)$$

$$SLC_i = as_{3i} \left[\lambda_{3_i} LL2_i^{\rho 3_i} + (1-\lambda_{3_i})LL3_i^{\rho 3_i}\right]^{1/\rho 3_i} \quad (7)$$

$$LL2_i = LL3_i \left[\left(\frac{WLL3}{WLL2} \right) \left(\frac{\lambda_{3i}}{1-\lambda_{3i}} \right) \right]^{1/(1-\rho 3_i)} \quad (8)$$

$$WSLC_i * SLC_i = WLL2 * LL2_i + WLL3 * LL3_i \quad (9)$$

$$XD_i = cet_i \left[\lambda c_i EXP_i^{\rho c_i} + (1-\lambda c_i)ADD_i^{\rho c_i}\right]^{1/\rho c_i} \quad (10)$$

$$EXP_i = ADD_i \left[\left(\frac{PEX_i}{PD_i} \right) \left(\frac{\lambda c_i}{1-\lambda c_i} \right) \right]^{1/(1-\rho c_i)} \quad (11)$$

$$PX_i * XD_i = PEX_i * EXP_i + PD_i * ADD_I \quad (12)$$

$$PEX_i = PWE_i * ER \quad (13)$$

$$EXP_i = exs_i * (pwes_i / PWE_i)^{\varepsilon I} \quad (14)$$

$$AD_i = arm_i \left[\lambda a_i IMP_i^{\rho a_i} + (1-\lambda a_i) ADD_i^{\rho a_i} \right]^{1/\rho a_i} \quad (15)$$

$$IMP_i = ADD_i \left[\left(\frac{PM_i}{PD_i (1+salt_i)} \right) \left(\frac{\lambda a_i}{1-\lambda a_i} \right) \right]^{1/(1-\rho a_i)} \quad (16)$$

$$PC_i * AD_i = PM_i * IMP_i + PD_i * (1+ salt_i) * ADD_i \quad (17)$$

$$PM_i = pwm_i * (1 + tarf_i) * ER \quad (18)$$

Labour markets

$$\sum_i LL1 = LS_1 \quad (19)$$

$$\sum_i LL2 = LS_2 \quad (20)$$

$$\sum_i LL3 = LS_3 \quad (21)$$

Commodity markets

$$XD_i = X_i \quad (22)$$

Incomes

$$Y_h = WLL3 * end_{h,LL3} + WLL2 * end_{h,LL2} + WLL2 * end_{h,LL2} + WLND * end_{h,LND} \quad fk_h * \sum_i (WK_i * \overline{K}\, i) \quad (23)$$

$$YD_h = Y_h - inct_h * (Y_h - WLND * end_{h,LND}) + fg_h * trnfg * PINDEX + trnfw_h * ER \quad (24)$$

$$HS_h = sav_h * YD_h \quad (25)$$

$$CORPDI = (1- corpt) * [WLND * end_{corp,LND} + fk_{corp} * \sum_i (WK_i * \overline{K}\, i)] + fg_{corp} * trnfg * PINDEX \quad (26)$$

$$CORPSAV = CORPDI \quad (27)$$

$$PUBDI = fk_{pub} * \sum_i (WK_i * \overline{K}\, i) \quad (28)$$

$$\begin{aligned} TAXREV = \; & inct_h * (Y_h - WLND * end_{h,LND}) \\ & + corpt * [WLND * end_{corp,LND} + fk_{corp} * \sum_i (WK_i * \overline{K}\, i)] \\ & + \sum_i PX_i * X_i * exct_i + \sum_i PD_i * ADD_i * salt_i \\ & + \sum_i IMP_i * pwm_i * ER * tarf_i \end{aligned} \quad (29)$$

$$\begin{aligned} GREV = \; & TAXREV + WLND * end_{gov,\,LND} + fk_{gov} * \sum_i (WK_i * \overline{K}\, i) \\ & + trnfw_{gov} * ER \end{aligned} \quad (30)$$

Expenditures

$$C_{h,i} = minc_{h,i} + (\gamma_{h,i} / PC_i) * [(YD_h - HS_h) - (\sum_i PC_i * minc_{h,i})] \quad (31)$$

$$INVDT_i = rkv_i * INVAGG \quad (32)$$

$$ID_i = ad_i * INVAGG \quad (33)$$

$$AD_i = \sum_h C_{h,i} + ID_i + cg_i + \sum_j a_{ij} * X_j \quad (34)$$

$$GEXP = trnfg * PINDEX + \sum_i PC_i * cg_I \quad (35)$$

Savings and investment

$$GS = GREV + PUBDI - GEXP \quad (36)$$

$$\begin{aligned} fsd = \; & \sum_i (pwm_i * IMP_i) + [fk_{row} * \sum_i (WK_i * \overline{K}\, i)] / ER \\ & - \sum_i (pwe_i * EXP_i) - \sum_h trnfw_h + trnfw_{gov} \end{aligned} \quad (37)$$

$$TS = \sum_{h} HS_h + CORPSAV + GS + fsd * ER \quad (38)$$

$$TS = \sum_{i} PC_i * ID_i \quad (39)$$

$$PVA_i = PX_i * (1\text{-}exct_i) - \sum_{j} PC_j * a_{ji} \quad (40)$$

$$PINDEX = \sum_{i} \alpha_i * PC_i \quad (41)$$

$$RGDP = [\sum_{i} PVA_i * X_i] / PINDEX \quad (42)$$

Intertemporal adjustments

$$\overline{K}_{i,(t+1)} = \overline{K}_{i,t} * (1\text{-}dp_i) + INVDT_i \quad (43)$$

$$LS_{l\,(t+1)} = LS_{l\,t} \left(1 - dh_l - dth\,(aids)_{l\,t}\right) + nls_{l\,t} \;;\; \text{for } l = 1,2,3. \quad (44)$$

Notations

Endogenous variables

AD_i	aggregate demand
ADD_i	aggregate domestic demand
$Ch,_i$	consumption demand of commodity 'i' by household group 'h'
CORPDI	private corporate sector disposable income
CORPSAV	private corporate sector savings
CL_i	composite labour
EXP_i	exports
ER	exchange rate
GED_l	government education expenditure at education level 'l'
GREV	government (total) revenue
GEXP	government (total) expenditure
GS	government savings
G	growth rate of the economy (GDP)
HSh	household savings by household group h
INVAGG	real aggregate investment
ID_i	real investment demand by sector of origin
$INVDT_i$	real investment by sector of destination
IMP_i	imports
LL1	demand for labour level 1 (unskilled labour)
LL2	demand for labour level 2 (semi-skilled labour)
LL3	demand for labour level 3 (skilled labour)
LS_l	labour supply of skill level 'l' , l = 1,2,3.
PC_i	price of composite good for domestic demand
PD_i	price of domestic sales
PEX_i	export price in rupees
PWE_i	export price in dollars
PM_i	import price in rupees (inclusive of tariffs)
PX_i	producer's price
PINDEX	overall price index
PVA_i	value-added price
PUBDI	public sector disposable income
RGDP	real GDP
SLC_i	skilled labour composite

TAXREV	tax revenue of the government
WLL1	wage for labour of skill level 1 (unskilled labour)
WLL2	wage for labour of skill level 2 (semi-skilled labour)
WLL3	wage for labour of skill level 3 (skilled labour)
$WSLC_i$	wage for skilled labour composite
WCL_i	wage for composite labour
WLND	price of land
WK_i	price of capital
X_i	domestic output
XD_i	demand for domestic output
Yh	income of household group h
YD_h	disposable income of household group h

Exogenous variables and parameters

as_i	shift parameter in production function for domestic output
$as2_i$	shift parameter in aggregation function for composite labour
$as3_i$	shift parameter in aggregation function for skilled labour composite
arm_i	shift parameter in Armington function for imports and domestic demand
a_{ij}	input-output coefficient
α_i	weight in the price index (share of value added of product i)
cet_i	shift parameter in CET function for export demand and domestic demand
cg_i	real government consumption
corpt	corporate tax rate
ad_i	share of real aggregate investment by sector of origin
dr_i	retirement rate of labour stock of skill level 'l'
$dth\ (aids)_l$	AIDS - related death rate of labour of skill level 'l'
dp_i	depreciation rate of physical capital
$end_{h,LLl}$	household 'h' endowment of labour level l , l = 1,2,3
$end_{h,LND}$	household 'h' endowment of land
$end_{gov,LND}$	government's endowment of land
$end_{corp,LND}$	corporate sector's endowment of land
$exct_i$	excise tax rate
exs_i	scale factor in the export demand function

ε_i	export demand elasticity
fg_h	share of government transfer to household group 'h'
fg_{corp}	share of government transfer to the corporate sector
fk_h	share of capital income to household group h
fk_{corp}	share of capital income to corporate sector
fk_{pub}	share of capital income to public sector
fk_{gov}	share of capital income to government
fk_{row}	share of capital income to rest of world (row)
fsd	foreign savings in dollars
$\gamma_{h,i}$	marginal budget share of good 'i' for household group 'h'
$inct_h$	income tax rate for household group 'h'
λ_i	factor share parameter in production function for domestic output
λ_{2i}	factor share parameter in aggregation function for composite labour
λ_{3i}	factor share parameter in aggregation function for skilled labour composite
λa_i	share parameter in Armington function for imports and domestic demand
λc_i	share parameter in CET function for export demand and domestic demand
$minc_{h,i}$	minimum real consumption parameter for household group 'h'
n	labour participation rate
P	population
nls_l	new labour supply of skill level 'l' , l= 1,2,3.
pwm_i	world price of imports in dollars
$pwes_i$	world price of export substitutes (in dollars)
rkv_i	share of real aggregate investment by sector of destination
r	discount rate
ρ_{1i}	substitutability parameter in production function for domestic output
ρ_{2i}	substitutability parameter in aggregation function for composite labour
ρ_{3i}	substitutability parameter in aggregation function for skilled labour composite
ρ_{ai}	substitutability parameter in Armington function for imports and domestic demand

ρ_{ci}	substitutability parameter in CET function for export demand and domestic demand
$salt_i$	sales tax rate
sav_h	savings-income ratio of household group 'h'
$tarf_i$	import tariff rate
trnfg	real transfer from government
$trnfw_h$	transfer from rest of the world to household group 'h' in dollars
$trnfw_{gov}$	transfer from rest of the world to government in dollars

National AIDS Control Organisation (NACO) in the Ministry of Health & Family Welfare, Government of India, directs and co-ordinates the National HIV/AIDS Prevention and Control Programme across the country. NACO is the nodal organisation for formulation of policy and implementation of programmes for prevention and control of HIV and AIDS so as to ensure a need-based, demand-driven, and people-centered response.

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S. Akram

In 2005, the number of HIV-infected persons in India exceeded 5 million, and is expected to increase in the next 5-10 years which is bound to have a visible impact on India.

So far in India, studies have analysed the household level impact but the macro and sectoral level have not been studied in detail due to the low prevalence of HIV. With increasing number of infections and AIDS related deaths, it has become imperative to make a quantitative assessment of the macro impact to provide further impetus to defining policy for the national response.

This study analyses the macro-economic and sectoral impacts of HIV and AIDS in India, using a five-sector Computable General Equilibrium (CGE) model. The multi-sectoral CGE model is ideally suited for this purpose, as it takes into account the various intra-sector and inter-sectoral substitutions that take place in production, consumption and distribution in response to price changes.

The findings indicate that there will be a slowdown in the growth of real aggregate GDP as well as per capita GDP by the turn of the next decade. As the lower per capita income shows, even those who are not infected by HIV will be "worse-off" in the long term.

This report also presents a detailed analysis of the sectoral impact of the AIDS epidemic – particularly of the impact of AIDS on Indian industry. Overall, in sectoral terms, the AIDS epidemic hits harder the sectors that use unskilled labour intensively.

The study provides ample proof that the adverse macro-economic and sectoral impact of the HIV and AIDS epidemic is likely to impinge on the Indian economy in the coming decade. The findings issue a wake up call for urgent and effective policy action to combat HIV and AIDS.

The Report has been prepared by NCAER in collaboration with NACO and UNDP.

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