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HIV/AIDS AND LABOR MARKETS IN TANZANIA

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Abstract

We analyze the implications of the HIV/AIDS pandemic in Tanzania for labor markets and human capital accumulation. Three analyses are undertaken. First, we examine the 2000/01 Labor Force Survey and compare it with the 1990/91 Labor Force Survey. Since these two surveys encompass a period where accumulated AIDS deaths increased dramatically, their comparison provides an opportunity to make inferences about the impact of HIV/AIDS over that period. Second, we study rates of human capital accumulation, proxied by educational attainment, for the period 1991 to 2000. While the most obvious impact of HIV/AIDS on human capital comes about through the deaths of skilled people, this might not be the greatest concern in terms of long run economic impact. In poor countries with low levels of human capital, implications for rates of human capital accumulation might be of greater concern. We estimate education transition matrices to assess human capital accumulation over the 1990s and assess the trends in transition probabilities and regional variations in these trends. Finally, we analyze the implications of skills upgrading using a computable general equilibrium (CGE) model of Tanzania. We find that the age structure of the labor force is changing with 10-14 year olds and juveniles comprising a significantly larger share and prime age adults aged 20-35 a smaller share compared with 1990/91. The growth in the child and juvenile labor force is matched by a trend towards an increased tendency to exit primary school and an overall lower share of children aged 5-14 enrolled in primary school. We conclude that workforce experience and rates of human capital accumulation are declining with HIV/AIDS being a prime factor underlying these trends. The CGE analysis indicates that skills upgrading of the population has particularly large first order (segmented rural and urban labor markets) impacts on the agricultural sector since the large majority of the population is rural. If migration is permitted, the enhanced productivity of a more skilled rural labor force permits substantial growth in agricultural and non-agricultural output generating a development pattern similar to those advocated by Mellor (1976) and Adelman et al. (1989). Reduced rates of skills upgrading would slow these trends.

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Introduction

Tanzania has a mature HIV/AIDS pandemic of medium severity (relative to other countries in the southern and eastern Africa region). While certainly not positive for Tanzania, these characteristics make Tanzania a potentially good candidate for evaluation of the economic implications of the pandemic. In particular, the maturity of the pandemic indicates that sufficient time has passed for significant numbers of HIV positive individuals to develop AIDS. AIDS effects, not just high prevalence rates, can thus be observed. Also, the overall HIV prevalence rate, at about 8% of the adult population, is sufficiently high to warrant real concern about economic impacts in general and labor market impacts in particular (UNAIDS 2000).

Given the severity and duration of the pandemic, the economics of the AIDS pandemic in Tanzania has been the topic of some study. For example, the early macroeconomic work of Cuddington (1993) focused on Tanzania. In addition, a detailed survey of the Kagera region undertaken by the World Bank from 1990-1994 has served as the base for a series of analyses (Lundberg, Over, and Mujinja 2001 is a recent example). Nevertheless, the knowledge base regarding the implications of HIV/AIDS is surprisingly thin both for Tanzania and for the highly afflicted regions of Africa in general.

At least two general conclusions do emerge from the analyses conducted to date. First, when taking a static view of the pandemic with a focus on AIDS deaths, the impact of AIDS deaths, ceteris paribus, can often imply an increase in *per capita* GDP since fewer people implies more capital and land per person. This effect was demonstrated by Kambou, Devarajan, and Over (1993). However, the AIDS pandemic is by nature very slow moving taking place over long periods of time. The duration of the pandemic calls for analysis within a dynamic framework. Using a simple dynamic framework, Arndt and Lewis (2000) show that even small impacts on rates of accumulation of critical economic factors like the physical capital stock and technical change can cumulate over time to generate large economic impacts.

In this dynamic view of the pandemic, potential implications for labor markets and human capital accumulation have come increasingly into focus (for example, see Hamoudi and Birdsall 2002; Arndt 2002; Arndt and Lewis 2001). However, much of the work available to date on the interactions between HIV/AIDS, labor markets, and human capital accumulation has been done in projection mode with a relatively thin empirical base.

The following paper examines what has happened in Tanzania over the past decade with the goal of sharpening understanding of the implications of the pandemic for labor markets and human capital accumulation. Three main analyses are performed. First, the recent 2000/01 Integrated Labor Force Survey is examined in detail and the results are compared with results from the 1990/91 Labor Force Survey. Since these two surveys happen to encompass a period where accumulated AIDS deaths went from a relatively small number to a relatively large number, the surveys potentially provide an opportunity to make inferences about the impact of AIDS over that period.

Second, rates of human capital accumulation (proxied by educational attainment) are analyzed for the period 1991 to 2000. While the most obvious impact of HIV/AIDS on human capital comes about through the deaths of skilled people, this might not be the area of greatest concern in terms of long run economic impact. In poor countries with very low levels of human capital such as Tanzania, greater concern might legitimately be centered on implications for rates of human capital accumulation. Since human capital stocks are small, growth in the stock is crucial. If HIV/AIDS causes rates of human capital accumulation to be lower for prolonged periods, the long run impacts could be profound. To assess human capital accumulation over the 1990s, education transition matrices are estimated. Trends in transition probabilities and regional variations in these trends are assessed.

Third, a general equilibrium analysis of skills upgrading is undertaken. A computable general equilibrium model of Tanzania, with substantial labor market detail, is undertaken. Simulations of the implications of skills upgrading are developed, motivated by the results obtained in the two preceding sections.

The paper is structured as follows. Section 2 provides background on human capital formation, productivity, and AIDS. Section 3 provides a review of the performance of the Tanzanian economy in the 1990s and then goes on to examine the 2000/01 Labor Force Survey in detail and to compare results with the 1990/91 survey. Section 4 introduces the transition matrix estimation procedure. Section 5 presents results from transition matrix estimation. Section 6 introduces the CGE model and underlying social accounting matrix employed and presents results from the analysis of skills upgrading. Finally, Section 7 concludes.

1. Human Capital Formation, Productivity and AIDS

1.1 Education and Productivity

Evidence continues to mount for a strong positive association between education levels and productivity growth in both agricultural and non-agricultural sectors in developing countries. An early review of 18 studies focused on agricultural productivity conducted by Lockheed, Jamison, and Lau (1980) concluded that education had a significant and positive impact on agricultural productivity. However, the authors qualified their results by stating that the effect of education was likely to be much stronger in "modernizing agricultural environments than in traditional ones" (p. 61). More than two decades later, this qualification still excludes much of Africa including Tanzania.

However, a series of recent microeconomic analyses tends to find a strong association between education and agricultural productivity even in traditional African contexts (including Tanzania). Positive returns were found by Weir and Knight (2000a and 2000b) for Ethiopia, Pinckney (1997) for Kenya and Tanzania, and Appleton and Balihuta (1996) for Uganda. Furthermore, these studies point to significant education externalities. Put simply, the illiterate neighbors of more educated farmers, who tend to be more innovative, benefit by simply watching and copying.

In non-agricultural sectors, Psacharopolous (1994) provides a review of microeconomic studies. He finds positive returns to education with particularly high returns to primary schooling. Bloom, Canning and Sevilla (2001) employ macroeconomic panel data to examine the issues of health, human capital and economic growth. They find, consistent with the microeconomic evidence, a positive association between schooling and aggregate economic output.

Generally, the weight of evidence has placed significant investments in human capital as a centerpiece of development strategy.

1.2 Education and HIV/AIDS

The AIDS pandemic poses obvious problems to the education sector in Tanzania. The dearth of qualified teachers, particularly teachers with experience, is a real concern. AIDS worsens the supply constraint. There is little reason to believe that HIV prevalence rates amongst teachers and other critical personnel in the education sector should be any lower than the average prevalence rates in the adult population. Indeed, there is some reason to fear that the rate might be higher. As stated by Badcock-Walters and Whiteside (2000), "the comparatively high incomes, often remote postings and social mobility of …[educators]… has long suggested that they may be of far greater risk than the population they serve" (p. 2).[1] This fear is confirmed in Zambia where, in 1998, the AIDS death rate among educators was 70% higher than that of the 15-49 age group in the general population (Badcock-Walters and Whiteside 2000).

Concerns also exist on the demand side. Akabayashi and Psacharopoulos (1999) explore the trade-offs between child labor and human capital formation for Tanzania. Consistent with expectations, they find that hours of work by children are negatively correlated with reading and mathematical skills. As parents stricken with AIDS fall ill and die, the need for children to work clearly becomes more pressing. In a review of the literature, UNAIDS (1999) lists taking children out of school as one of the four most common household responses to stresses induced by the AIDS pandemic.

In addition, with the large volume of orphaning that is occurring, one can expect large numbers of children to be living with friends and relatives. An analysis of data from the Kagera region of Tanzania indicates that orphaning reduces the demand for education, particularly when the effected families are poor (World Bank 1997). This analysis is supported by a recent probit analysis of national level household data from Mozambique, which indicates that children who are not the direct biological descendant of the household head are significantly less likely to attend school. The tendency is present in both rural and urban areas (Arndt 2002). As the number of children living with friends and relatives increases, one would certainly not expect this effect to be reduced. More

[1] Also see Gregson, Waddell, and Chandiwana (2001).

likely, the tendency to keep children of relatives and friends at home to work will become more pronounced.

In sum, AIDS can be expected to lower the school age population, reduce the share of the school age population that seeks to attend school, and impair the capacity of the education system to deliver on its mandate. All of these factors point to a reduced rate of human capital accumulation. It is possible that the education system could function reasonably well at a reduced rate. With reduced supply and reduced demand, supply might be adequate to cope with current demand. However, this is unlikely. It is much more likely that demand constraints bind in some areas and supply constraints in others leaving the system to operate well below potential capacity. Nimble management of the sector could help substantially; however, managerial capacity is already thin and not immune to AIDS. For example, Badcock-Walters and Whiteside (2000), while concerned about deaths amongst teachers, worry even more about a "catastrophic" erosion of the stock of education sector managers in the southern Africa region.

1.3 AIDS and Workforce Experience

If adults are dying and children are quitting school to join the workforce, then a decline in overall workforce experience should be expected. The microeconomic evidence on workforce and experience is reasonably clear: more experienced workers tend to be paid more. For example, Bils and Klenow (1998) report a fairly strong positive association between experience and wages. If labor markets are reasonably efficient, then workers pay should be closely related to their value of marginal product. As a result, the positive association between wages and experience would suggest a positive relationship between experience and productivity. Unfortunately, the available macroeconomic evidence fails to support a clear link between worker experience and productivity. For example, Bloom, Canning, and Sevilla (2001) find no relationship between average workforce experience and aggregate output. However, failure to find a link in aggregate data does not rule out the existence of a link. Given the relatively rapid and strong impact on workforce experience that might occur due to HIV/AIDS and the available microeconomic evidence, workforce experience remains a factor worth considering.

2. Economic and Labor Force Trends

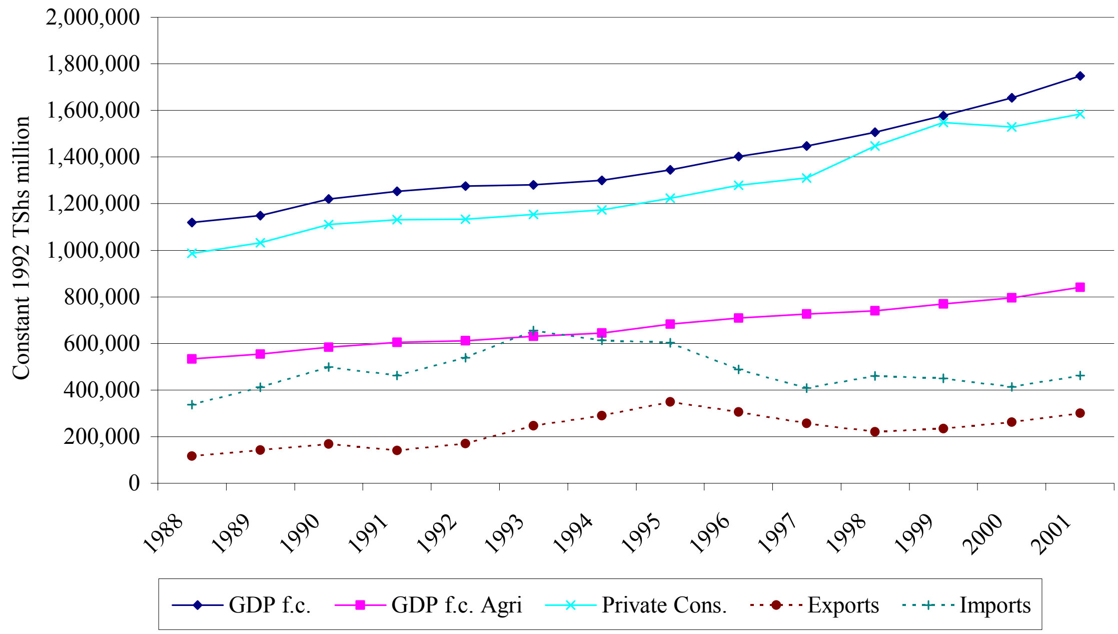
2.1 General Economic Trends in the 1990s

With an estimated population growth rate of about 2.8%, Tanzania's population grows by around 840,000 people annually (World Bank 2002). During the 10-year period 1990/91 until 2000/01, total population grew from about 25.0 million to about 32.9 million. The population pyramid remains, like many African countries, very wide at the base. About 46% of the population is under 15 years old. As a result, the passage of a decade brings about rapid growth in the labor force as the bulk of the population under 15 in 1990 matures and enters the labor force by the year 2000. Given the relatively rapid growth in population and labor force, real GDP must of course grow even faster in order to increase per capita income and output per worker.

Graph 3.1 illustrates GDP (as well as some selected components of GDP) at constant 1992 prices. The Graph illustrates a few important features of the economy such as:

a) the heavy predominance of private consumption in GDP,
b) the importance of production agriculture in overall GDP, and
c) the generally large gap between imports and exports.

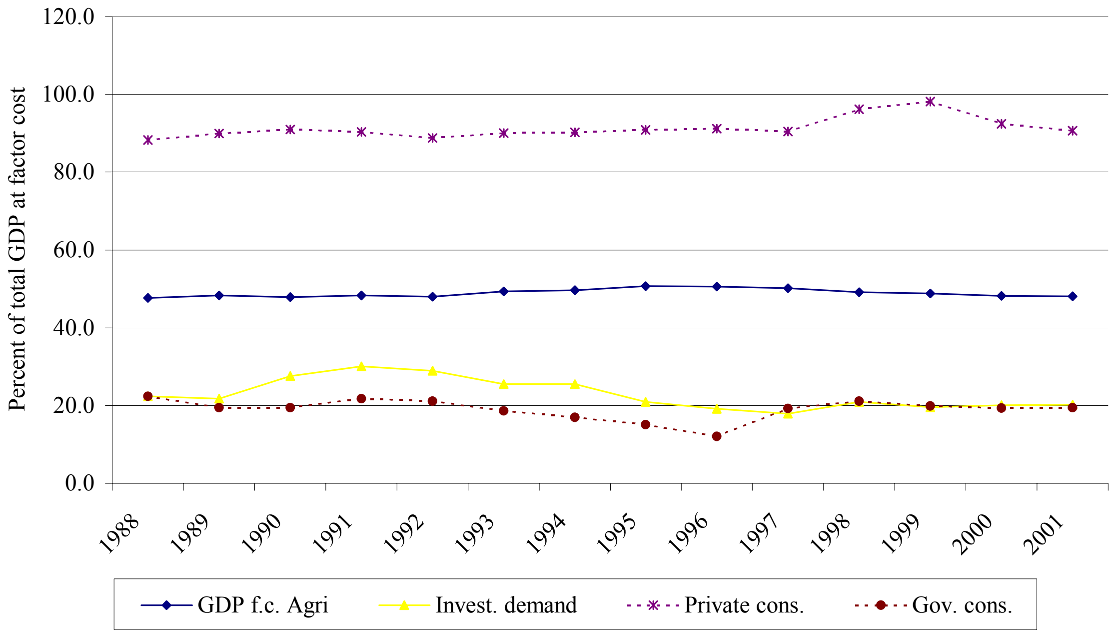
Graph 3.1
Development of some economic indicators (const. 1992 prices)



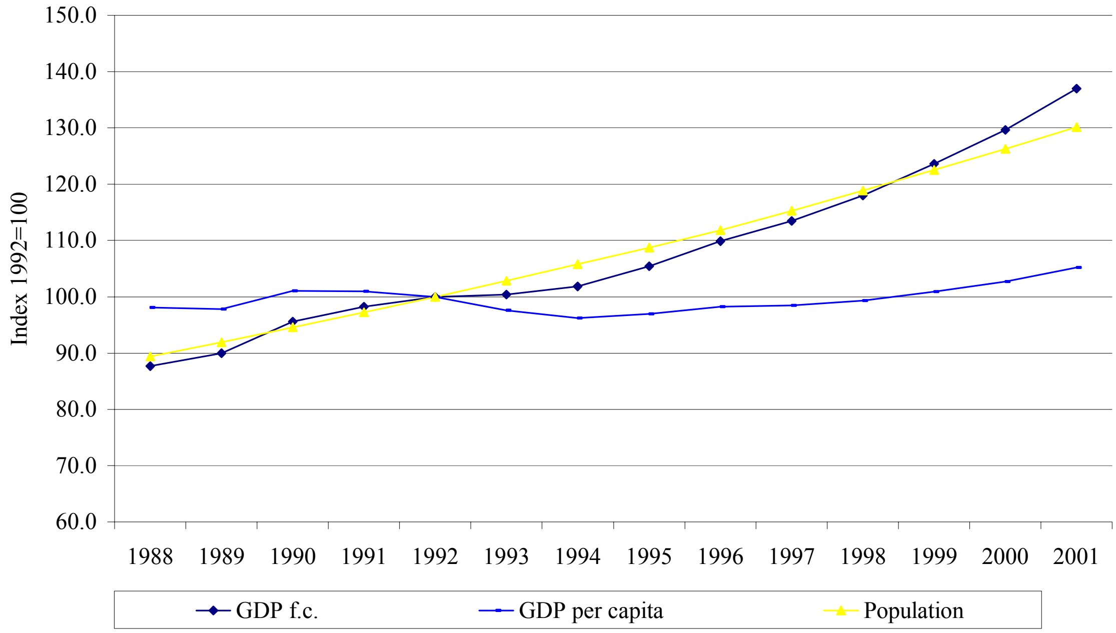
Selected shares of GDP at factor cost are presented in Graph 3.2. This graph confirms the large and stable share of agricultural GDP at factor cost for the entire period 1988-2001 as well as a stable share of private consumption. Investment demand as a share of total GDP at factor cost decreases in accordance with the decrease in government consumption between 1991 and 1997, reflecting the privatization process of parastatals and the lack in private investment to substitute for reduced government investments. While investment has remained at around 20% of GDP since 1996, government demand recovered to previous levels mainly due to increased spending on health and education services that were covered by increased revenue collection.

Graph 3.1 shows that real GDP in 2000 is approximately one third larger than GDP in 1990 (note that the end points of the graph are 1988 and 2001). However, this growth in GDP is essentially equivalent to the cumulative population growth over the same period indicated above. Per capita GDP growth has thus been essentially flat. Trends in per capita GDP are shown more formally in Graph 3.3. The lowest real GDP per capita as compared to 1992 is reached in 1994 with 3.7% below 1992 levels and even lower than levels of the late 1980s. Since 1994, economic performance has improved registering positive, but unspectacular, real per capita GDP growth over the period.

Graph 3.2
Some economic indicators as share of total GDP f.c.



Graph 3.3
Indices of population and GDP f.c. (Base 1992)



2.2 The Labor Force in 2000

Data collection for the 2000/01 Integrated Labor Force Survey (LFS) of Tanzania was carried out between May 2000 and April 2001 by the National Bureau of Statistics (NBS) and the survey data became available in January 2002.[2] The new LFS 2000/01 provides the opportunity to analyze the structure of Tanzania's workforce at the turn of the century. The NBS put a particular emphasis on making the LFS 2000/01 comparable to an earlier LFS that had been conducted in 1990/91 by following the same basic structure in sampling, sequence of interviews, and questions asked in the different parts of the two surveys.[3] Despite all efforts made, we find some irregularities across the two surveys that are pointed out below and should be kept in mind when interpreting the relative comparison of the surveys. At this time, no published analysis has documented the structure of the Tanzanian workforce in 2000/01 and the changes in comparison to the 1990/91 structure using the 2000/01 LFS database.

[2] The LFS 2000/01 is called the "Integrated" LFS as it combines the previous 1990/91 LFS with a previously separate informal sector survey, and a previously separate survey on child labor. However, the relevant parts of the LFS 2000/01 with respect to total labor force composition we are using in this analysis are the same as in the LFS 1990/91, while informal and child labor issues are also addressed in more detail in separate sections (an questionnaires) of the LFS 2000/01.
[3] Refer to Appendix D for a brief overview on the differences in sampling and data collection methodologies between the 1990/91 and 2000/01 LFS.

The analysis of the 2000/01 survey and comparison with the 1990/91 survey is obviously of strong interest for Tanzania. However, the interest is potentially more general. Even in Africa, there are relatively few countries that have endured a sufficiently large number of AIDS deaths for a sufficient period of time to allow for reasonable expectations of significant demographic impacts from the AIDS pandemic. Fewer still have comparable surveys that coincide roughly with the period just prior to the true onset of the pandemic (e.g., significant AIDS deaths) and a recent period 10 years hence.

Unfortunately, a close examination of the results from the two surveys indicates that the degree of comparability actually attained is not as large as originally hoped. The four largest issues of comparability are:

1) The 1990/91 survey estimate of total population is about 1.2 million below the official population estimate for Tanzania Mainland in 1990 (URT 2002). Data from the 1988 census indicate that the underestimation is particularly pronounced in the age range 0-9, which appears to be underestimated by about 800,000 people. Nevertheless, even with this increment to the 1990/91 cohort aged 0-9, the estimated size of this cohort in LFS 2000/01 (who would then be in the age range 10-19) exceeds the 1990/91 estimate by 700,000 people (or about 9%). This is clearly inconsistent—the size of the cohort cannot grow and should shrink due to deaths. The raw data from the 2000/01 labor force survey might overestimate the size of the 10-19 cohort, and indeed, the published population estimates for 2000 adjust the size of this cohort downward by about 500,000 individuals (URT 2002).

2) More to the heart of labor force issues, the population of the male cohort aged 20-29 appears to be underestimated in 2000/01 (The 10-19 population estimated in 1990/91 corresponds reasonably well with the 1988 census). The raw data for the two labor force surveys indicate a death rate of 29% of the male cohort aged 10-19 over the space of a decade. While AIDS quite likely contributed to a reduction in the size of this cohort, this reduction is very dramatic. If AIDS were the primary culprit, then one would expect females of the same age cohort to experience a similar or even more pronounced decline since HIV prevalence is widely believed to be higher among female young adults than their male counterparts. However, the corresponding death rate for females of the same age cohort is a much smaller (but still considerable) 9%.

3) While the implied death rates for the female cohort moving from their teens to their twenties are fairly high (9%), death rates for female cohorts moving from their twenties to their thirties and from their thirties to their forties are too low. For these cohorts, death rates are zero. The 1988 census indicates that the 1990/91 LFS survey undercounts females in their twenties and thirties (by about 6% and 2% respectively).

4) Discrepancies also exist in older age categories particularly at fine levels of disaggregation. For example, the 2000 survey estimates the population of females aged 50-54 to be 13% larger than the 1990 estimate of the population of females aged 40-44. Clearly, the greater standard deviation of results for small survey subsets plays

a role. Perhaps more importantly, since more than half the population is characterized by a low level of education, it is quite possible that a significant number of adults do not know their own age exactly. Comparing the results between the surveys across wider age intervals helps to eliminate some, but not all, inconsistencies.

These and other discrepancies not listed indicate that fine comparisons between the 1990/91 and 2000/01 survey should be interpreted with care. Nevertheless, the 2000/01 survey does provide the best available source of information on the current structure of the Tanzanian workforce. The survey also forms the basis for the official population estimate for 2000. The following Tables and Graphs present the structure of the workforce for Tanzania based on the raw data from 2000/01 survey. Comparisons with estimates from 1990/91 are also provided though these comparisons should be interpreted with caution. This section concludes with a discussion of the more robust comparisons between 1990/91 and 2000/01.

Table 3.1 presents the main structure of the total workforce of about 16.9 million in 2000/01 with respect to agriculture *versus* non-agriculture, urban *versus* rural, and male *versus* female workers. It is a comprehensive table that conveys a lot of information at once, providing the composition of Tanzania's workforce in 2000/01 and its changes since 1990/91 in a nutshell. The two bold numbers in each "Total" row add up to 100%, the two numbers in italics in the "Total" column add up to 100%, and the non-bold and non-italic numbers of each sub-section and each column add up to 100% vertically. Numbers in parenthesis provide percentage point changes for each of the labor force categories with respect to the LFS 1990/91, which we will discuss below.

The 2000/01 LFS reveals that still 81% of the workforce is engaged in agriculture, while 19% of all employees in the formal and informal sector are working in non-agriculture. These shares differ slightly for male and female employees (78.2% and 21.8% for male and 83.6% and 16.4% for female), but differ substantially between urban and rural areas. In rural areas, 90.2% of the workforce is engaged in agricultural activities. This share is much less in urban areas where only 36.9% of the workforce engages in agriculture; however, Tanzania's shares of urban agricultural employment are notably high even in an African context.[4] Overall the shares for male and female employees in urban and rural areas show that women are more likely to engage in agriculture than men, both in urban and rural areas (41.3% *versus* 32.6% in urban areas and 92.3% *versus* 88.0% in rural areas for female and male respectively). In total, female employees constitute 50.6% of Tanzania's workforce, indicating a high involvement of women in all formal and informal sectors of the economy.

[4] Note that Tanzania throughout the structural adjustment period since 1986 maintained an agricultural share of total GDP at factor cost of around 50%—ranging between 48.0% and 50.7% during 1992 and 2000 in 1992 prices considering monetary and non-monetary GDP (BoT 2001, Table 1.7, p.25).

Table 3.1
2000/01 labor force by sector, area, and gender in percentage shares[1)]

	Total		Urban		Rural	
Total			**17.3**	(+1.7)	**82.7**	(-1.7)
Agriculture	81.0	(-3.2)	36.9	(-1.0)	90.2	(-2.5)
Non-agriculture	19.0	(+3.2)	63.1	(+1.0)	9.8	(+2.5)
Male						
Total	*49.4*	(-0.7)	**17.6**	(-0.6)	**82.4**	(+0.6)
Agriculture	78.2	(+0.3)	32.6	(+5.7)	88.0	(-1.3)
Non-agriculture	21.8	(-0.3)	67.4	(-5.7)	12.0	(+1.3)
Female						
Total	*50.6*	(+0.7)	**17.0**	(+4.0)	**83.0**	(-4.0)
Agriculture	83.6	(-6.7)	41.3	(-12.1)	92.3	(-3.6)
Non-agriculture	16.4	(+6.7)	58.7	(+12.1)	7.7	(+3.6)

Source: Calculations from LFS 2000/01.
Note: 1) Bold numbers horizontally add up to 100, non-bold/non-italics numbers vertically add up to 100, and italic numbers add up to 100. Numbers in parenthesis show percentage point changes to LFS 1990/91.

Numbers in parenthesis in Table 3.1 indicate the percentage point (pp) change of the shares in LFS 2000/01 with respect to shares in LFS 1990/91 and hence give a good approximation of sectoral and societal shifts during this period of structural adjustment. Between 1990/91 and 2000/01, the labor force increased by 55.3%, in particular reflecting the large number of children and juveniles joining the workforce at over-proportionate rates as described in the following paragraphs. In general, we observe a shift from agricultural to non-agricultural employment of 3.2 pp, which is particularly dominant for women (6.7 pp) although more pronounced in urban (12.1 pp) as compared to rural (3.6 pp) areas. Notably, men in urban areas *increased* their relative engagement in agricultural activities by 5.7 pp. Overall, urban employment increased by 1.7 pp throughout the 1990s reflecting the comparatively slow process of urbanization in Tanzania.

A comparison of the 2000/01 and 1990/91 surveys with respect to their breakdown of total employed labor force by nine occupational categories and two geographic regions (rural and urban) shows only relatively small changes in workforce structure based on these criteria. The structure of occupation is consistent for the total labor force, male and female, urban and rural, as well as any combination of urban/rural and male/female (see Table A1 of the Appendix A). This provides some empirical support for the consistent survey methodology applied by the NBS to both surveys with respect to the actual workforce.

In terms of education levels, the 2000/01 survey data show a shift from "low" to "medium" and "high" education. The share of employees with low education decreases by 2.8 percentage point, while the shares of employees with medium and high education increase by 1.5 and 1.2 percentage points respectively.[5] For the high education category this translates to a relative increase of its share in total workforce by 50.1% from 2.4% in 1990/91 to 3.7% in 2000/01. Given the relatively small initial share of the high education group in the 1990/91 labor force this relatively large increase seems reasonable. It also accords well with the estimates of trends in secondary school transition probabilities reported in Section 5. The overall decrease in the low education labor category reflects the relatively large decrease of low education workers in the agricultural sector (-4.6 pp), while the non-agricultural sector increases its low education category by 1.8 pp (see Table 3.2).

Table 3.2
Composition of 2000/01 labor force and percentage point deviation from 1990/91

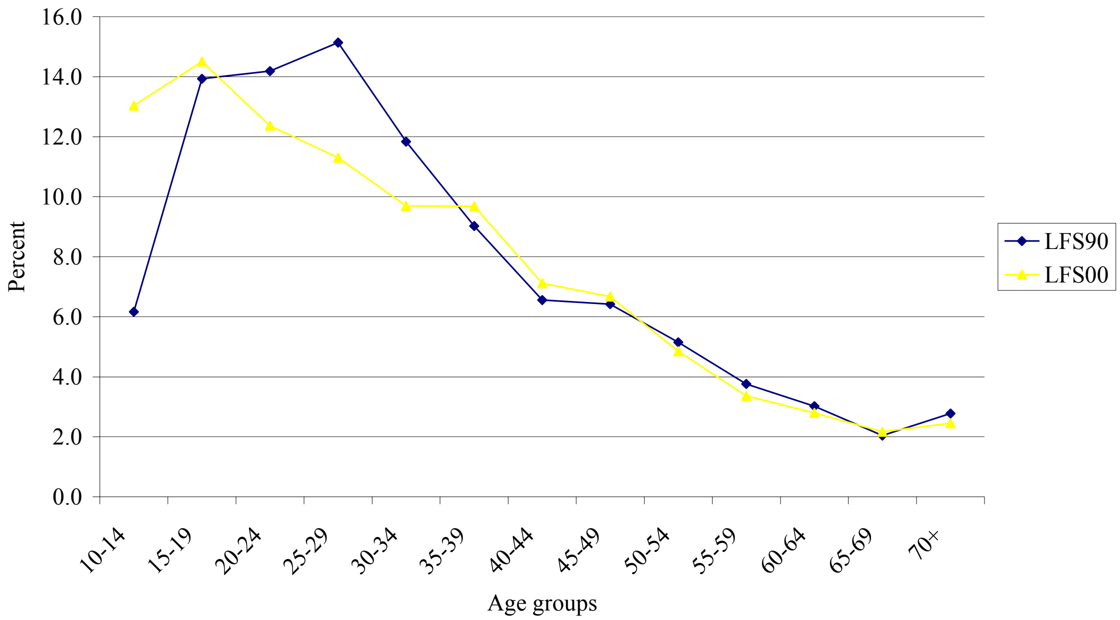
	2000/01 LFS			Percentage point change		
Educational Level	**Total**	**Agri.**	**Non-Agri.**	**Total**	**Agri.**	**Non-Agri.**
Total	100.0	81.0	19.0	0.0	-2.7	2.7
Low	51.3	45.1	6.2	-2.8	-4.6	1.8
Med	45.1	34.9	10.2	1.5	1.2	0.4
High	3.7	1.0	2.6	1.2	0.7	0.5

Source: Computations using 2000/01 LFS.

While the occupation structure is relatively static, labor force by age group in 2000/01 as compared to 1990/91 shows a dramatic change in structure as can be seen from Graph 3.4.a. Care must be taken in interpreting these graphs as discussed above. The basic result that emerges is that the numbers of the medium age group employees (20-34 years) decline in relative terms, the younger age groups increase their relative share in the workforce.

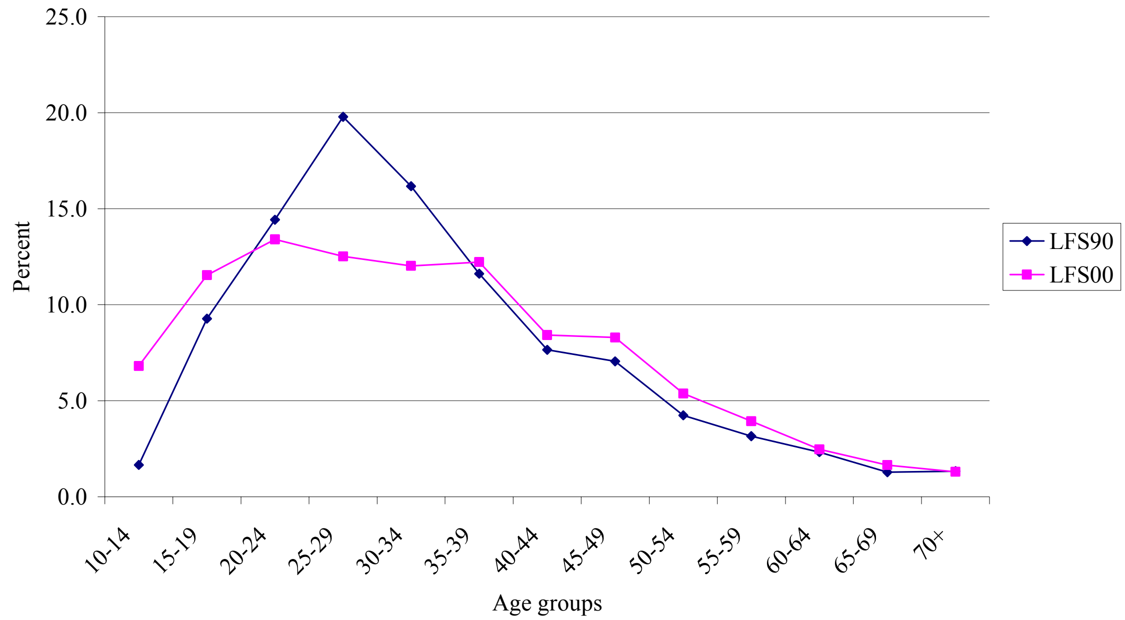
[5] Low education = not finished primary school; Medium education = completed primary school, but not form 4; High education = form 4 and higher. Data on national and regional statistics on education are obtained from the Ministry of Education (MoE various years).

Graph 3.4.a
Composition of work force by age group 1990/91 vs 2000/01

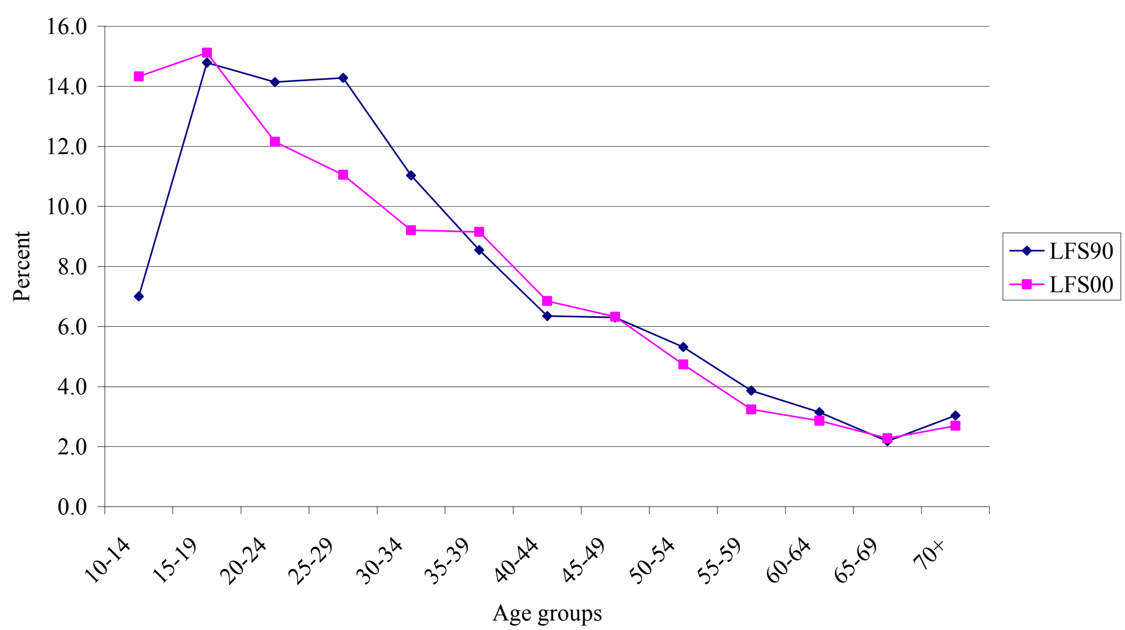


This phenomenon could result from a potential sampling problem in the 2000/01 LFS, which might have neglected increased migration of mid-age population groups from rural to urban areas. Increased migration could have changed the relative size of rural to urban population, which might not have been taken completely into account in the new survey sampling. The many more mid-age people in urban areas might have been observed correctly in the 2000/01 survey, but weighted incorrectly using the 1990/01 LFS weights. Consequently, urban mid-age population would be substantially underestimated. However, looking at the breakdown of the total work force by age groups into urban and rural components confirms the phenomenon for both geographical areas (Graphs 3.4.b and 3.4.c).

Graph 3.4.b
Composition of urban work force by age group 1990/91 vs 2000/01



Graph 3.4.c
Composition of rural work force by age group 1990/01 vs 2000/01



The already large group of 15-19 years old that represented 13.9% of the total workforce in 1990/91 increases its share to 14.5% in 2000/01, representing a relative increase in their group's contribution to the total work force of 4.1% since 1990/91. Children between 10 and 14 years who constituted only 6.2% of the total workforce in 1990/91 more than double their share to 13.0%.

From the point of data collection and preparation we have to consider the possibility of an anomaly. There is one particular issue that requires highlighting. Fetching water and firewood are included in economic activities in 2000 but not in 1990. At first blush, this appears to be a substantial difference in methodology that could generate, on its own, the observed increase in labor force participation by 10-14 year olds. However, to be excluded from the work force in 1990 while counted in 2000 would require that the 10-14 year old engage solely in fetching water and firewood and no other economic activity. Since the raw data for 1990 are not available, we cannot check this exact number. However, in 2000, only a small number of children 10-14 indicated fetching water and firewood as their sole economic activity. So, while this difference in methodology does generate some upward, it does not appear to be particularly large.[6]

Other more general possibilities for error should also be admitted. Because the 2000/01 LFS has fully integrated informal and child labor issues, the general part of the survey may have also paid more careful attention to these issues than the LFS 1990/91. The same may hold for women with mainly domestic (but also economic) responsibilities, as well as some informal sector activities that may have been neglected in the 1990/91 survey. However, these considerations remain speculative.

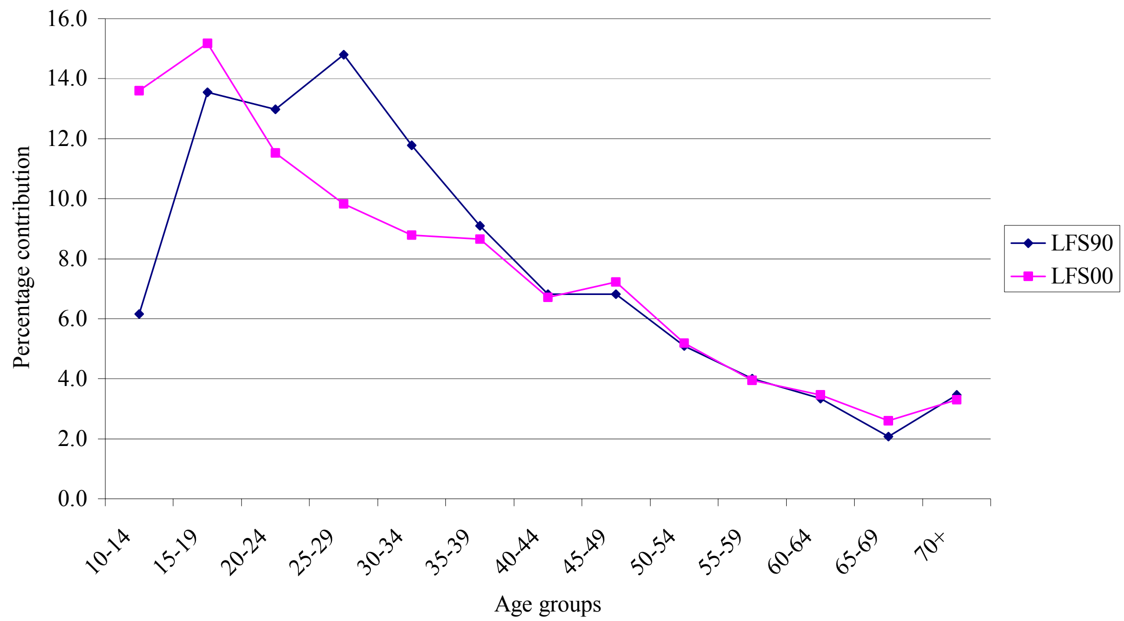
The trends in labor force composition by age presented in Figure 3.1 are broadly but not completely consistent with substantial AIDS deaths among the working age population. In the first instance, the workforce actually declines in prime working age categories. Second, the drastic increase in the share of child labor in the total labor force is consistent with common understanding of how the HIV/AIDS epidemic affects education both on the demand and supply sides. For afflicted population groups (the demand side), especially for poor families, the easiest coping strategy if an adult suffers from or died of HIV/AIDS is to take one or more children out of school in order to take over responsibilities in domestic affairs, work on family-owned fields, or earn some supplementary income through formal or informal work in agriculture or off-farm. On the supply side, the deaths of teachers and critical administrative personnel might force children from non-afflicted families into the work force through the reduction or outright foreclosure of education opportunities.

Overall children and juveniles substitute for the loss in prime-aged workforce and the more moderately declining older age groups. Since children under 15 years old represent almost half of the population (the median age in Tanzania is 16.4 years), significant movement of children into the workforce can have large impacts on the age structure of the workforce (REPOA 1998).

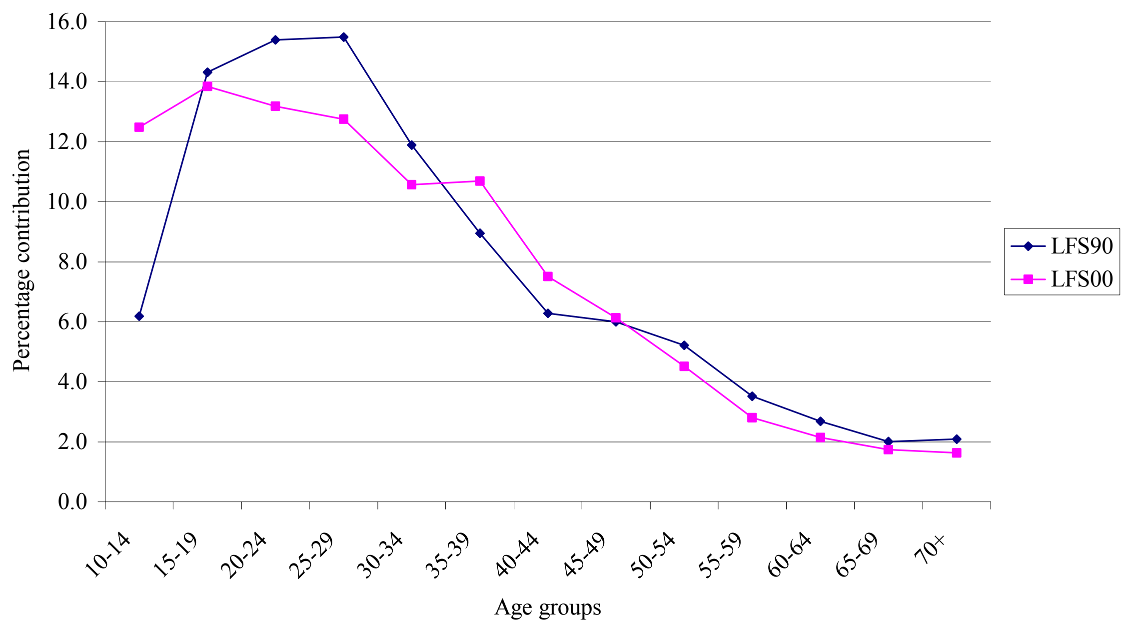
[6] Survey methods are explained in Appendix D.

Graphs 3.5 and 3.6 show relative changes in the workforce by age group for male and female employees respectively, and the change in compositional shares of different age groups between 1990/91 and 2000/01 is shown in Graph 3.7. The basic changes in the total labor force are reflected by both males and females.

Graph 3.5
Composition of male work force by age group 1990/91 vs 2000/01



Graph 3.6
Composition of female work force by age group 1990/91 vs 2000/01



Graph 3.7
Change in relative contribution to the work force by age and gender

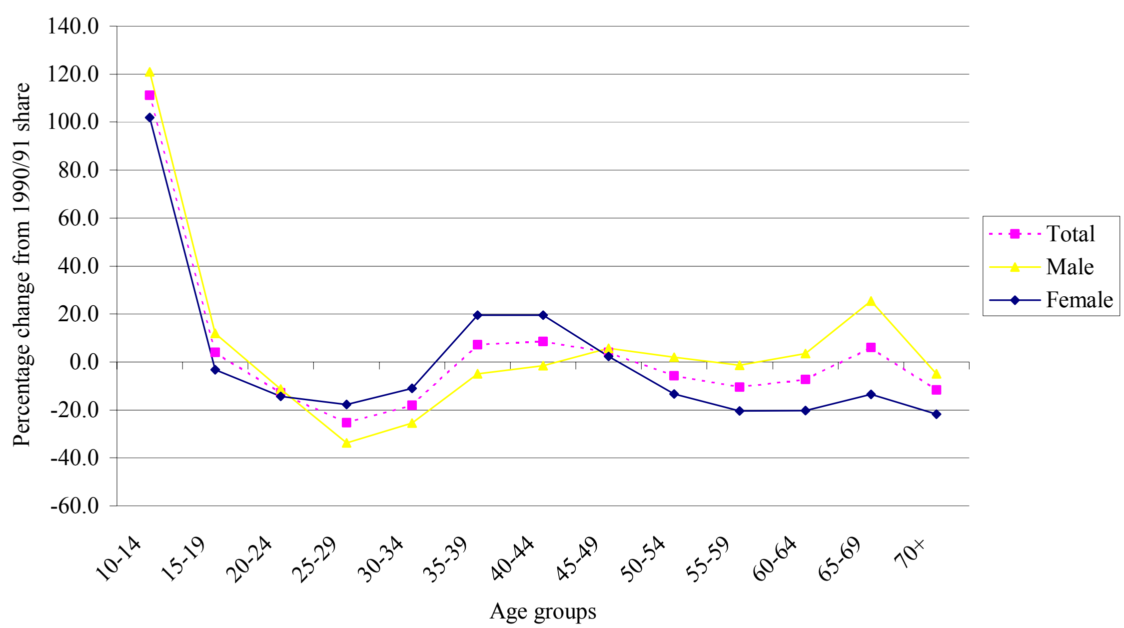


Table 3.3 presents the change in the relative contribution of different age groups to the total workforce in 2000/01 and 1990/91, as well as the percentage point changes of each

male and female age group within the 10-year period. Women constituted the majority of all age groups between 15 and 29 years in 1990/91 (bold numbers in the table indicate a larger share in total workforce for either men or women), while the contribution of male and female to the 30-34 years age group was equal. By 2000/01, men became the larger share of the15-19 year-old group while women remain the larger share of workers in the remaining age categories.[7]

The relative shares in total labor force of all male and female age groups in the range of 20-34 years decline substantially. However, the percentage point declines of the relative shares for females are more even across the three age groups, while the declines for males are particularly pronounced for the older age groups. Interestingly, while male juveniles between 15 and 19 years old increase their relative contribution to the work force by 0.7%, the corresponding female group remains almost constant (-0.1%). This could reflect that females at this age are not only less likely to proceed with secondary school, but also less likely to engage in formal or informal work, carrying out non-economic domestic activities instead.

Table 3.3
Change in relative contribution of mid-age groups to workforce[1)]

	— 2000/01 —		**— 1990/91 —**		**— Change[2)] —**	
Age	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
15-19	**7.5**	7.0	6.8	**7.1**	0.7	-0.1
20-24	5.7	**6.7**	6.5	**7.7**	-0.8	-1.0
25-29	4.8	**6.5**	7.4	**7.7**	-2.6	-1.3
30-34	4.3	**5.4**	5.9	5.9	-1.6	-0.6

Source: NBS (1993) and computations from LFS 2000/01.
Note: 1) Bold numbers indicate the dominating gender group in each age group. 2) In percentage points.

In sum, Tanzania's workforce in 2000/01, when compared to 1990/91, appears to be much younger and much less experienced than ten years ago. The share of 20-34 year-old male and female employees dropped substantially between 1990/91 and 2000/01. Apparently, as a substitute for lost prime-aged labor, 10-14 year-old children and 15-19 year-old juveniles are joining the workforce and thereby increasing the share of inexperienced workers dramatically. We also observe an increase in relative contribution to the total work force of medium age women, while the contribution of the respective male age groups are more stable. Detailed relative changes of all age groups by gender are provided in Table A2 in Appendix A.

We now consider trends in the education sector.

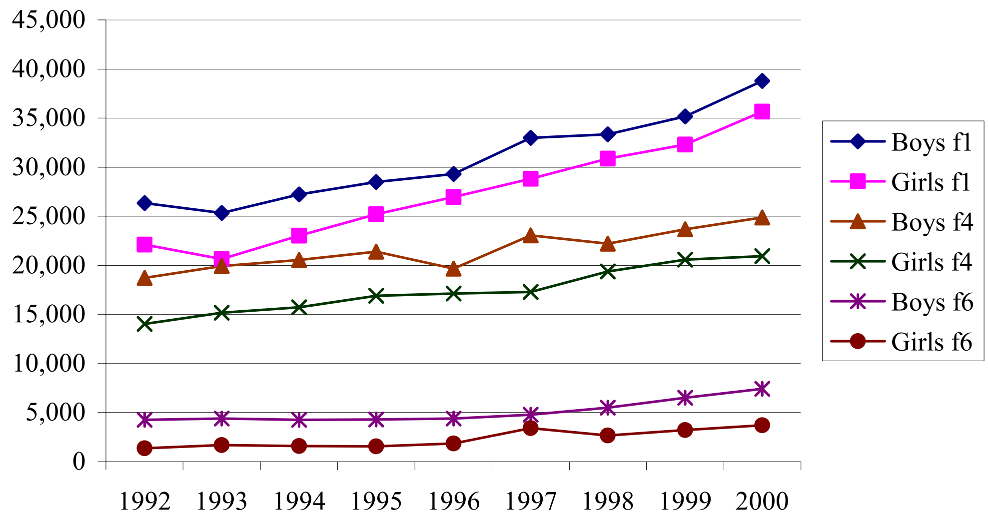
7 While the delays between infection and death render comparison somewhat difficult, it is worth noting that females aged 15-19 are three times more likely to be HIV positive than males of the same age (MoH 2000).

3. Education Trends and Estimation of an Education Transition Matrix

3.1 Education Trends

Graphs 4.1 and 4.2 illustrate the trends in secondary and primary enrollment for the period 1991-2000 based on enrollment data. Consistent with a rapidly increasing share of the skilled labor force, enrollment trends in secondary school appear to be essentially positive (Graph 4.1). The definitional break between medium and high education occurs at successful completion of form 4 where the enrollment level has been increasing steadily.[8]

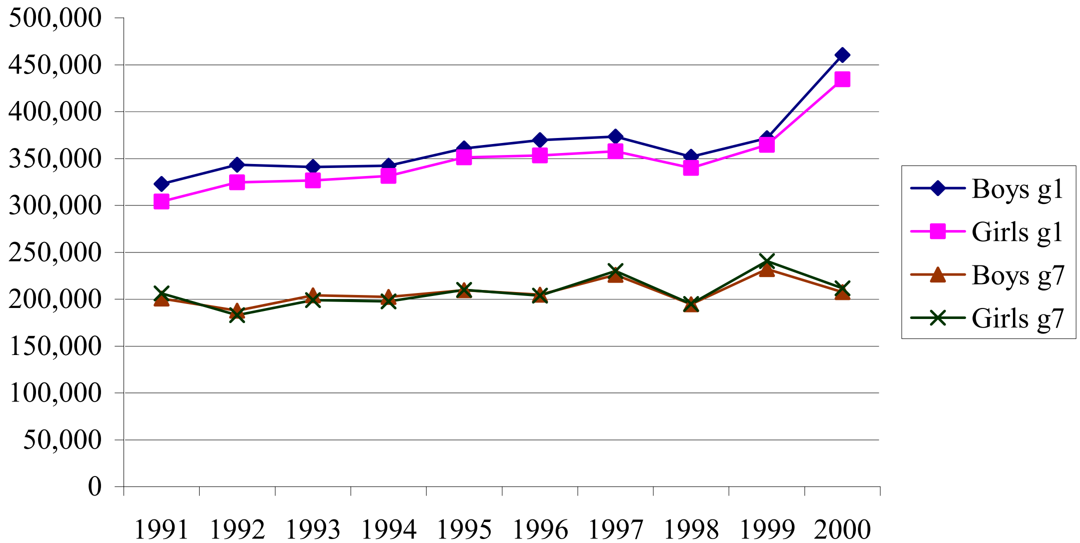
Graph 4.1
Secondary enrollments form 1, 4, and 6 (1992-2000)



However, the real action in total enrollments is in primary school. Despite successful efforts to substantially increase secondary school enrollment, secondary enrollment was still at a mere 10% of primary enrollment in 2000. Information from primary school enrollment confirms the trend that, despite increasing enrollments in grade 1, the number of pupils who stay throughout the school system is not necessarily increasing. Overall, primary enrollment numbers for boys and girls are very similar over time (Graph 4.2). However, girls show substantially lower numbers in secondary enrollment than boys (Graph 4.1).

[8] Note that these are enrollment figures for form 6 and *not* graduates

Graph 4.2
Primary enrollments grade 1 and 7 (1991-2000)

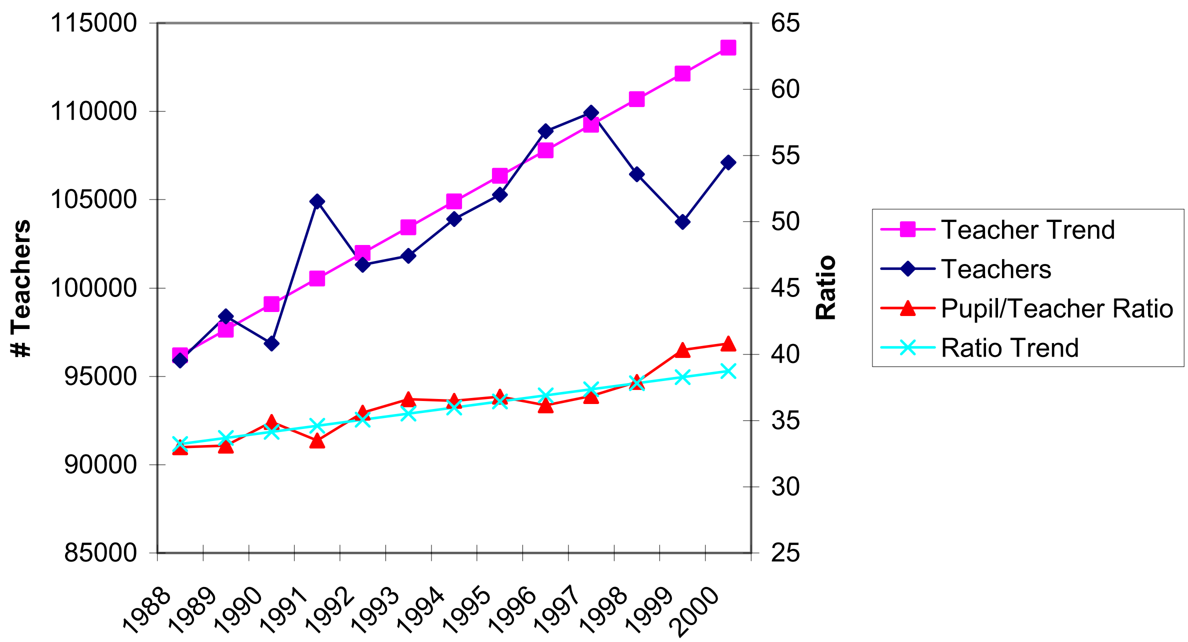


Enrollments in primary school have not kept pace with growth in the population aged 5-14. In 1991, about 50% of the population 5-14 was enrolled in primary school. By 2000, this proportion had fallen to about 46%. Since the proportion of the population 5-14 in total population is relatively large (nearly 30%), the decline in the share enrolled represents a significant number of people. If 50% of the population aged 5-14 had been enrolled in primary school as in 1991, primary school enrollment would have been higher by about 400,000 students (or about 9% larger). If these 400,000 children no longer in school are all working rather than attending school, then this would account for about one third of the growth in the child labor force as a share of the total labor force shown in Graphs 3.5 and 3.6. The remainder would be working and attending school (and thus counted as part of the labor force) rather than uniquely attending school. Simultaneously working and attending school is a common phenomena (Akabayash and Psacharopoulous 1999).

Trends in the number of teachers also provide some insight into the functioning of the educational system. Graph 4.3 shows the primary school pupil to teacher ratio and trends in the absolute number of primary school teachers from 1988 to 2000. The ratio of pupils to teachers has been climbing essentially throughout the 1990s. For most of the period, the growth in the pupil to teacher ratio was due to growth in primary school enrollments outpacing growth in the number of primary school teachers. As shown in the Graph, the number of primary school teachers was on a reasonably steady upwards trend from 1988 to 1997. However, this trend broke in 1998 and 1999, when the number of primary school teachers declined. The number of teachers grew again in 2000; however, this number remains below the absolute number of 1997 as well as below the pre 1998 trend contributing to more rapid growth in the pupil to teacher ratio in the late 1990s. Lastly, since AIDS deaths amongst teachers were almost surely occurring well before the decline in the number of teachers was registered, average teacher experience has almost surely been declining throughout the period.

Changes in expenditures on education do not appear to be associated with the decline in numbers of teachers observed in the late 1990s. Real expenditures on education grew substantially throughout the 1990s both in absolute terms (60%) and as a share of GDP (15%).

Graph 4.3
Primary school teachers and pupil/teacher ratio (1988 – 2000)



Note: The teacher and ratio trends are calculated for the period 1988 to 1997 and then projected for the remaining three periods.

While graphical analysis is useful for viewing general tendencies, more formal analysis helps to specify trends more precisely. We turn now to a method for more formally defining enrollment trends with particular focus on completion of primary school.

3.2 Estimation of an Education Transition Matrix

Estimation focuses on school enrollment. Data was collected on primary school enrollment, by province, from 1991-2000 and on secondary school enrollment, by province, for the period 1992-2000. Both data sets track enrollments of boys and girls. Primary school contains grades 1 to 7 (g1 to g7) and secondary school contains forms 1 to 6 (f1 to f6).

We are particularly interested in the way that school children move through the educational system. For a child enrolled at a given education level, there are essentially three possibilities for the following year with respect to enrollment:

a) the child progresses to the next educational level,
b) the child repeats the same educational level (far from uncommon), or
c) the child exits the educational system (and presumably enters the labor force).

By assumption, children who exit the school system will not re-enroll at a later date.

The probabilities associated with each of these outcomes for each grade level are of interest. In order to estimate these probabilities, one can postulate a transition matrix, T, giving probabilities associated with each possible outcome from period t to period t+1. All blank elements in the matrix are assumed to have value zero.

$$T = \begin{bmatrix} T_{g1g1} & T_{g1g2} & & & & & & & T_{g1exit} \\ & T_{g2g2} & T_{g2g3} & & & & & & T_{g2exit} \\ & & T_{g3g3} & T_{g3g4} & & & & & T_{g3exit} \\ & & & T_{g4g4} & T_{g4g5} & & & & T_{g4exit} \\ & & & & \cdots\cdots & \cdots\cdots & & & \cdots\cdots \\ & & & & & T_{f4f4} & T_{f4f5} & & T_{f4exit} \\ & & & & & & T_{f5f5} & T_{f5f6} & T_{f5exit} \\ & & & & & & & T_{f6f6} & T_{f6exit} \end{bmatrix}$$

The rows of the transition matrix T sum to one. This implies that the entire enrollment at each scholastic level must be accounted for. Consider row 2, which corresponds to children enrolled in grade 2. According to row 2, children at this scholastic level could repeat the same level next year (T_{g2g2}), enroll in grade 3 (T_{g2g3}), or exit the school system with no probability of return (T_{g2exit}). By assumption, children enrolled in grade 2 cannot leap to grade 4 or higher and will not fall back to grade 1. The remaining rows can be similarly interpreted.

Once the transition matrix has been estimated, the evolution of enrollments proceeds as follows. Let E_t be a thirteen element column vector (seven grades in primary school plus six forms in secondary school) with enrollment in grade 1 in year t in the first element and zeros elsewhere. The number of individuals at each scholastic level in period t+1 is then $S_{t+1} = T'S_t + E_t$. Note that, since enrollments in grade 1 (rather than new entrants to grade 1) are supplied exogenously, the transition probability T_{g1g1} (the probability of repeating grade 1) must be set equal to zero.

T matrices were estimated for each province, for the nation as a whole, and for various groupings of provinces. At the provincial level, secondary enrollment is small, particularly by sex. For example, enrollment of girls in form 6 in the year 2000 was less than 100 students in 12 regions (of 20) and was equal to zero in two regions. Secondary school enrollment data also tends to be quite variable in relative terms making estimation difficult and less precise. As a result, estimation at the provincial level focused only on primary school enrollments. The full transition matrix was estimated at the national level and for other regional aggregates.

Given the relatively short time series, a minimum cross entropy approach, similar to the approach of Karantininis (2002), was employed. The approach relies upon information theory and is well-suited to problems where data series are short and/or incomplete (Golan, Judge, and Miller 1996). The philosophy of the minimum cross entropy approach (and its cousin, maximum entropy) is to use all available information, but do not assume any information you do not have. Consistent with this philosophy, the minimum cross entropy approach also permits use of prior information on transition probabilities. [9] While the approach permits hypothesis testing (see, for example, Golan and Vogel 2000 or Karantininis 2002), the power of these tests is weak and/or their small sample properties are unknown. The accent in the minimum cross entropy approach is placed on robust parameter estimation when sample size is small.

Following Karantininis (2002), stationary and non-stationary transition matrices were estimated. In the stationary matrix case, transition probabilities are constant through time. In the non-stationary case, transition probabilities are permitted to evolve through time. In the non-stationary estimations performed here, individual transition probabilities are permitted a linear trend through time. For example, a given element of the matrix T may start at a high (low) value in 1991 and then gradually decline (increase), in equal increments per year, towards a lower (higher) value by the year 2000. The transition matrix for each year is constrained to meet all the requirements of a transition matrix (e.g., rows sum to one and all elements fall within the [0,1] interval). More details on the estimation procedure are presented in Appendix B.

4. Results

The presentation of results is divided into three sections. In the first section, broad results on a national scale are presented with a focus on the stationary estimated transition matrices. This section provides a point of departure. In the second section, trends in national enrollments are discussed based on results from the non-stationary transition matrices. The idea is to estimate trends in enrollment probabilities during a decade characterized by an increasing number of AIDS deaths. Finally, in the third section, trends in regional primary school enrollments are examined with an eye toward

[9] For the estimation of the national transition matrix, simple priors were employed that convey to the estimator that, for most grade levels, the probability of transitioning to a higher level is greater than the probability of staying in level. Specifically, the probability of remaining at level, moving to the next level, and exiting were 2.5%, 95%, and 2.5% respectively for the entire matrix. For the estimation of all regional aggregates and provinces, the estimated national transition matrix (for girls, boys, and total) was employed as a prior.

correlations between below average enrollment trends and available information on AIDS prevalence by region.

4.1 National Results

Tables 5.1, 5.2, and 5.3 illustrate the estimated stationary transition matrices for girls, boys, and all students respectively at the national level. These matrices illustrate well a number of the salient features of the Tanzanian educational system. For most grade levels, the large majority of pupils transition to the next higher level. Remaining students either repeat the same grade level or exit the educational systems in (very) roughly equal proportions. Consider, for example, the row of the transition matrix for girls corresponding to grade 3. This row indicates that, if 1000 girls are enrolled in grade 3, 69 will repeat grade 3, 892 will proceed to grade 4 and 39 will exit.

For some grade levels, the associated transition probabilities differ very significantly from the pattern illustrated by grade 3. These differences are qualitatively very similar for girls and boys. For example, in grade 4 (the final year of lower primary school), the probability of repeating and exit are elevated while the probability of moving on to grade 5 (the first year of upper primary school) is reduced commensurately. This can be easily viewed in the data. One would expect that, due to population growth and attrition from the school system, enrollments in any given year should be declining across grade levels. The data confirm this with enrollments declining at higher scholastic levels for any given year of data. The major exception is grade 4. For example, at the national level in the year 2000, enrollment in grade 4 was 10% higher than enrollment in grade 3 indicating a large number of repeaters in grade 4. At the same time, a high probability of repeating combined with an elevated probability for exit implies much reduced throughput to grade 5. Using the stationary transition matrix for all students, the predicted enrollment in grade 5 in the year 2000 is about 82% of grade 4 enrollment.

The next row that differs very significantly from the grade 3 pattern is grade 7, which corresponds with the end of primary school. Few Tanzanians progress from primary school to secondary school. About 79% of girls enrolled in grade 7 exit the school system while only about 12% continue to form 1 in secondary school with the remainder repeating grade 7. As indicated earlier, the relatively small size of secondary school enrollment and the primacy of primary school is clear from the data.

Table 5.1
Estimated stationary transition matrix at the national level – girls.

	g2	g3	g4	g5	g6	g7	f1	f2	f3	f4	f5	f6	exit
g1	86.9												
g2	6.1	88.7											5.1
g3		6.9	89.2										3.9
g4			16.3	77.4									6.4
g5				7.5	86.5								6.0
g6					8.7	85.2							6.1
g7						8.2	12.4						79.4
f1							7.5	85.5					7.0
f2								13.6	74.4				12.0
f3									15.0	67.8			17.2
f4										27.5	14.1		58.4
f5											9.2	81.5	9.3
f6												7.9	92.1

Table 5.2
Estimated stationary transition matrix at the national level – boys.

	g2	g3	g4	g5	g6	g7	f1	f2	f3	f4	f5	f6	exit
g1	86.3												
g2	6.6	87.6											5.8
g3		7.1	88.0										4.9
g4			15.3	76.7									8.0
g5				6.6	86.8								6.5
g6					8.2	85.2							6.6
g7						8.5	14.3						77.2
f1							7.0	86.0					7.0
f2								10.7	79.5				9.8
f3									12.3	71.6			16.1
f4										22.6	25.7		51.8
f5											4.7	85.6	9.7
f6												6.4	93.6

Table 5.3:
Estimated stationary transition matrix at the national level – all students.

	g2	g3	g4	g5	g6	g7	f1	f2	f3	f4	f5	f6	exit
g1	86.6												
g2	6.4	88.2											5.5
g3		7.0	88.6										4.4
g4			15.8	77.1									7.2
g5				7.0	86.7								6.3
g6					8.5	85.2							6.4
g7						8.4	13.4						78.3
f1							7.3	85.7					7.0
f2								12.0	77.3				10.8
f3									13.1	70.2			16.8
f4										24.5	20.7		54.9
f5											5.6	85.0	9.4
f6												6.9	93.1

The final row to differ significantly from the pattern established in grade 3 is the form 4 row. Students completing form 4 receive a degree. They can either enter the labor force or enroll in technical school. At the national level for all students, slightly more than 50% of the students enrolled in form 4 exit the system in order to work or enroll in technical school. Of the remaining 50%, roughly half (26%) progress to form 5 with the remainder repeating form 4.

While the three transition matrices presented above are broadly quite similar and the focus has been on these similarities, there are some differences worth noting between the matrices for girls and boys. Close examination of probabilities of transition to higher grade levels and exit probabilities in Tables 5.1 and 5.2 indicates three stages. First, in grades 1 to 4, girls (once in school) tend to perform better than boys with higher probabilities of transition to the next grade and lower probabilities of exit. Second, in grades 5 to 7, performance of boys and girls is quite comparable. Third, in secondary school, boys' performance is almost uniformly better using the same criteria.

The implications of these transition probabilities are presented in Table 5.4. The Table shows predicted enrollments in 2000 for all scholastic levels for girls and boys using the estimated stationary matrices shown in Tables 5.1 and 5.2. The major breaks in enrollments at grade 5, form 1, and form 5 are easily spotted. Comparing girls with boys, one notes that fewer girls were enrolled in grade 1 than boys.[10] The differences in transition probabilities outlined above imply that girls' enrollment approaches and then

[10] Recall that grade 1 enrollments are exogenously set.

surpasses boys' enrollment by grade 5.[11] The tide turns in secondary school where enrollment of girls declines rapidly relative to enrollment of boys.

Table 5.4
Predicted national enrollments for 2000 (in thousands) using the stationary matrix

	Girls	Boys	Ratio
g1	434	461	0.94
g2	336	342	0.98
g3	302	309	0.98
g4	335	337	0.99
g5	276	272	1.01
g6	256	249	1.03
g7	227	224	1.01
f1	30	34	0.87
f2	29	32	0.89
f3	24	28	0.86
f4	22	25	0.86
f5	3	7	0.49
f6	3	6	0.47

4.2 National Trends

To consider trends in enrollments over the decade of the 1990s, we employ the non-stationary estimation approach. As indicated earlier, the non-stationary estimation approach permits transition probabilities to trend linearly with time over the estimation period. The estimated intercept coefficients (alpha) and slope coefficients (beta) are presented in Appendix C (see Appendix B for formal definitions of alpha and beta).

The addition of a trend for each estimated transition probability doubles the number of free parameters to be estimated. With more free parameters, the fit of the model should improve. Improvement of fit in the prediction of enrollments at each scholastic level can be captured through a pseudo R-squared measure.[12] Table 5.5 presents a pseudo R-squared measure for both the stationary and non-stationary (labeled "With Linear Trend") estimates.

[11] Note that, in years immediately prior to 2000, the ratio of girls' enrollment to boys' enrollment was closer to 0.97. So, some of the "catch-up" in the early grades reflects this difference in initial enrollments. However, enrollment in grade 1 of girls never exceeds enrollment of boys in the relevant period. The surpassing of boys' enrollment by grade 5 is due to differences in transition probabilities.

[12] Pseudo R-squared = 1 – ESS/TSS where ESS denotes error sum of squares and TSS denotes total sum of squares.

Table 5.5
Pseudo R-squared measure for national estimates

	Stationary			With Linear Trend		
	Girls	Boys	Total	Girls	Boys	Total
g2	0.956	0.950	0.961	0.959	0.962	0.969
g3	0.963	0.931	0.951	0.979	0.966	0.976
g4	0.837	0.805	0.828	0.844	0.845	0.848
g5	0.633	0.552	0.597	0.657	0.601	0.631
g6	0.669	0.543	0.618	0.698	0.629	0.668
g7	0.335	0.063	0.226	0.410	0.323	0.369
f1	0.913	0.951	0.937	0.999	0.993	0.997
f2	0.956	0.968	0.966	0.991	0.984	0.990
f3	0.968	0.983	0.980	0.992	0.988	0.992
f4	0.958	0.974	0.975	0.989	0.976	0.987
f5	0.850	0.869	0.875	0.964	0.988	0.983
f6	0.774	0.890	0.887	0.918	0.984	0.988

For both the stationary and non-stationary estimators, the fit is generally quite good with r-squared values frequently above 0.9. The scholastic level with the poorest fit is g7 (final year of primary school). When a linear trend is added, goodness of fit, as measured in Table 5.5, improves in every case. The improvement in fit is particularly strong for the latter years of primary and secondary school.[13]

Turning back to the estimated probabilities in Appendix C, the most salient features of the trends are a marked tendency for reduced repetition rates through time and a consistent tendency for the probability of moving to the next level to rise. These trends are present for both girls and boys at almost every scholastic level. The reduction in repeat probabilities and increase in higher level transition probabilities implies that students are moving more quickly through the system. Since the row sums of the transition matrix must be equal to one, the row sums of the beta matrices must be equal to zero. Consequently, the difference between the change in the repetition rate and the change in the next level transition probability determines the change in the exit probability. This change in the exit probability determines whether students move more quickly up to higher levels or out of the educational system.

[13] An entropy ratio statistic (similar to a likelihood ratio), comparing the objective values across the stationary and non-stationary formulations (see Golan and Vogel 2000), was calculated. This statistic is distributed Chi-square and measures the information content of new information. The interpretation of the statistic is somewhat nuanced. On the one hand, if the existing information base is poor and new information generates a large Chi-square value, then the new information could be viewed as highly informative. On the other hand, if the existing information base is reasonably credibly and new information generates a large Chi-square value, then the new information could be interpreted as being so informative as to question the validity of the new information. For the case here, Chi-square values were relatively small indicating some, but not an enormous, information gain.

Whether the trend of up (desirable) or out (undesirable) predominates is not clear from simple examination of the matrices in Appendix C. For example, the exit column in Table C6 shows the trend in exit probabilities across grade levels for all students. These exit probabilities are declining for grades 2 and 3 making trends at these grade levels uniformly positive. However, exit probabilities are increasing with time, sometimes very substantially, for grades 4 to 7. These exit probability trends are consistent, at least in direction, with the large increase in 10-14 year olds as a share of the labor force observed in Section 3. Nevertheless, given that the early primary exit probabilities are decreasing and that probabilities of transitioning to higher grade levels are increasing, the exact implications for enrollments at, for example, grade 7 are not entirely clear from simple inspection of the matrices. Similarly, shifts in secondary school exit probabilities are both positive and negative (though primarily negative).

Tables 5.6, 5.7, and 5.8 illustrate the net effect of these trends in transition probabilities. The Tables show projected enrollments at the national level in the year 2000 for girls, boys, and all students respectively under various estimators and scenarios. In addition, actual enrollments are also shown. The first column shows projected enrollments in the year 2000 using the stationary matrix described in the previous sub-section. The projections are made by starting with actual enrollments in 1992 (the first year for complete data on primary and secondary school enrollments). Enrollments in the next year (1993) are then projected using the estimated transition matrix. Actual enrollments are then inserted into the 1993 enrollment vector for grade 1 only. Enrollments in 1994 are then projected based upon the projected 1993 vector of enrollments (which includes actual data on enrollments in grade 1). Actual grade 1 enrollments are then inserted into the 1994 vector. This process is repeated for all of the projections shown in the three Tables with different transition matrices guiding the process.

Comparing the stationary and linear trend with the actual data confirms that the fit of the matrices to the data is relatively good. One can also note that, as expected, the fit of the linear trend model is typically better than the stationary matrix.

The two columns, labeled “Matrix 1991” and “Matrix 2000”, provide insight into enrollment trends. The “Matrix 1991” column contains projections of enrollments in 2000 based upon the 1991 estimated transition matrix from the non-stationary model. In other words, the column projects what would have happened to enrollments in 2000 if the 1991 estimated transition matrix had prevailed over the entire period. The “Matrix 2000” column is similarly constructed. This column projects what would have happened to enrollments in 2000 if the 2000 estimated transition matrix had prevailed over the entire period. Actual grade 1 enrollments are used for both cases. The final columns of Tables 5.6 to 5.8, labeled “Ratio 1991/2000”, give the ratio of projected enrollments for “Matrix 1991” divided by “Matrix 2000”.

Table 5.6
Enrollment projections for girls in 2000 using alternative transition matrices

	Stationary	Linear Trend	True Values (Data)	Matrix 1991	Matrix 2000	Ratio 1991/2000
g1	434	434	434	434	434	1.00
g2	336	344	335	332	346	0.96
g3	302	307	308	304	308	0.99
g4	335	329	334	342	330	1.04
g5	276	274	286	277	275	1.01
g6	256	249	256	258	251	1.03
g7	227	220	212	236	218	1.09
f1	30	35	36	24	37	0.66
f2	29	30	30	25	32	0.79
f3	24	25	26	20	27	0.73
f4	22	22	21	17	25	0.68
f5	3	4	4	2	6	0.31
f6	3	4	4	2	5	0.30

Table 5.7
Enrollment projections for boys in 2000 using alternative transition matrices

	Stationary	Linear Trend	True Values (Data)	Matrix 1991	Matrix 2000	Ratio 1991/2000
g1	461	461	461	461	461	1.00
g2	342	353	349	337	354	0.95
g3	309	316	319	311	318	0.98
g4	337	334	337	345	336	1.03
g5	272	272	284	274	275	1.00
g6	249	241	249	256	244	1.05
g7	224	212	207	240	209	1.15
f1	34	37	39	30	38	0.81
f2	32	33	33	30	34	0.87
f3	28	29	29	25	29	0.85
f4	25	26	25	20	27	0.75
f5	7	9	8	4	10	0.41
f6	6	7	7	4	9	0.42

Table 5.8
Enrollment projections for all students in 2000 using alternative transition matrices

	Stationary	Linear Trend	True Values (Data)	Matrix 1991	Matrix 2000	Ratio 1991/2000
g1	895	895	895	895	895	1.00
g2	678	697	684	670	700	0.96
g3	611	624	628	615	627	0.98
g4	671	662	671	687	665	1.03
g5	548	547	570	550	551	1.00
g6	505	491	504	514	496	1.04
g7	451	432	419	477	426	1.12
f1	64	73	74	55	75	0.74
f2	61	63	63	55	66	0.83
f3	52	54	55	45	56	0.79
f4	47	48	46	37	52	0.72
f5	10	13	13	6	16	0.38
f6	9	11	11	6	15	0.39

Notes on Tables 5.6-5.8:
1) Stationary and Linear Trend refer to the estimated values from the two approaches.
2) Matrix 1991 and Matrix 2000 are enrollment projections based upon the estimated 1991 and 2000 matrices from the non-stationary model.
3) All figures are in thousands of students.

Consider the final column of Table 5.8, which focuses on all students. The ratios of enrollments in secondary school are all less than one with the ratios for forms 5 and 6 considerably less than one. This indicates that the trend in secondary school transition probabilities has been on net positive. However, as indicated earlier, secondary school contains relatively small enrollment numbers. The trends in primary school enrollments, where the large numbers reside, are considerably less positive. As noted earlier, transition probability trends for grades 2 and 3 are uniformly positive and the enrollment ratio for those grades reflect those positive trends. However, the positive trends reverse at grade 4. By grade 7, the transition probability trends are revealed to be strongly negative for primary school with enrollments that would have been 12% higher had the transition probabilities for 1992 prevailed throughout the decade. These results differ for boys and girls with the trends for boys being much more negative.

4.3 Regional Trends in Primary School Enrollment

The results presented so far are broadly consistent with the view that the implications of the HIV/AIDS pandemic on the experience and skills level of the workforce could be negative and profound. The growth of the "underage" labor force documented in Section 3 and the trends in exit transition probabilities for grades 4 to 7 presented in the previous sub-section are also mutually consistent, at least in terms of direction. Finally, the more pronounced tendency of boys to exit the school system is also broadly consistent with the labor force data.

While strongly indicative, the exact role of AIDS in these trends is unclear. Education transition probabilities could evolve positively or negatively for lots of reasons with AIDS being only one. A fair share of the observed growth in the labor force in the 10-14 year age bracket could reflect under-counting in that category in 1990/91 or some other trend rather than the impacts of HIV/AIDS. Of course, we will never be able to untangle the exact implications of AIDS. The true counter-factual is a parallel world without the AIDS pandemic, which, quite obviously, we will never observe.

In an effort to gain some comparative traction, transition matrices for primary school enrollments were estimated at the regional level. The primary purpose of these estimations was to attempt to take advantage of variations in prevalence rates across the 20 administrative regions comprising Tanzania. Evidence for variation in prevalence rates across regions during the early 1990s exists. For example, the prevalence rate in 1992 among ante-natal women in Kilimanjaro (from a rural observation post) was 6.4% while the observed rate from a rural observation post in Rukwa was 11.3%. Published data on HIV infection among blood donors also shows strong regional variation (MoH 2000 and 2001).

Based on these data, five regions were labeled as highly afflicted in the early 1990s. If highly afflicted by the early 1990s, significant AIDS deaths should have occurred before 2000—the final year of the estimation period. The regions labeled as highly afflicted were Dar Es Salaam, Iringa, Kagera, Mbeya, and Rukwa. Enrollments in these regions were aggregated to form a group labeled HIGHAFF. All other regions were aggregated into a group labeled LESSAFF. In addition, a final group, labeled HIGHXM, comprised of Dar Es Salaam, Kagera, and Rukwa was created.

With 20 regions, the national numbers, and the three groups, a large volume of information is generated. This information is summarized in Table 5.9 in a manner similar to the comparatives presented in Tables 5.6, 5.7, and 5.8. Specifically, for each region, predicted enrollments in grade 7 in the year 2000 are generated using the 1991 and 2000 matrices. As in Tables 5.6, 5.7, and 5.8, the projected enrollments from the 1991 matrix are divided by the projected enrollments from the 2000 matrix. The hope is that, by comparing trends through time across regions, the impacts of HIV can be more easily isolated and compared. The resulting ratios for girls, boys, and all students are presented in Table 5.9.

The most salient feature from Table 5.9 is that the negative trends in transition probabilities for primary school appear to be almost completely generalized across regions. Nearly all of the ratios are greater than one indicating that the 1991 transition probability matrix is preferred in terms of enrollments in grade 7. These results strongly support the declining enrollment trend result at the national level presented in the previous section. On the other hand, the attempt to gain insight from the variation in prevalence rates across regions gives counter-intuitive results. As indicated in the Table, the highly afflicted group (HIGHAFF) actually performs better than the less afflicted group (LESSAFF) for girls, boys, and all students.

Table 5.9
Ratios of projected enrollments in grade 7 in 2000
comparing beginning and end of decade trends

Province	Girls	Boys	All Students
NATION	1.086	1.151	1.120
HIGHAFF	1.078	1.119	1.098
HIGHXM	1.239	1.254	1.247
LESSAFF	1.084	1.169	1.126
ARUSHA	1.038	1.132	1.092
DSALAAM	1.129	1.318	1.215
DODOMA	1.060	1.315	1.195
IRINGA	1.053	0.947	0.993
KAGERA	1.298	1.215	1.265
KIGOMA	1.089	1.148	1.120
KNJARO	1.031	1.052	1.042
LINDI	NA	NA	NA
MARA	1.157	1.258	1.214
MBEYA	0.960	1.078	1.019
MOROGORO	0.944	1.059	1.004
MTWARA	1.290	1.428	1.353
MWANZA	1.067	1.101	1.082
PWANI	1.021	1.162	1.091
RUKWA	1.310	1.348	1.292
RUVUMA	0.932	1.082	1.005
SNYANGA	1.133	1.048	1.037
SINGIDA	0.971	1.068	1.017
TABORA	1.255	1.140	1.201
TANGA	1.187	1.212	1.178

Notes on Table 5.9:

1) The figures are the ratios of projected enrollments in grade 7 in 2000 based on the 1991 and 2000 transition matrices estimated by the non-stationary approach. The ratio is 1991/2000 so a number greater than one indicates a negative trend in enrollment transition probabilities.
2) All enrollment figures are in thousands of students.
3) The estimator for Lindi region failed to converge.
4) Regions characterized as high afflicted (HIGHAFF) are in italics.

Closer examination of the regional results indicates that Iringa and Mbeya, both members of the highly afflicted group, are performing relatively well (members of the highly afflicted group are *italicized* in the Table). Since prevalence rates in Iringa were measured in urban zones and at the roadside, it is possible that the published prevalence rates from the available observation posts substantially overstate the actual prevalence rate within the region. This is also possible for Mbeya though the evidence for a fairly generalized pandemic in that region by 1992 is far more complete. It is the case that, with Iringa and Mbeya dropped from the highly afflicted group as in HIGHXM, the results deteriorate dramatically conforming to the expectation of more severe effects in highly afflicted regions. However, it is always the case that the average becomes smaller if positive innovations are removed.

There are a series of potential explanations for the failure to pick up the influence of HIV/AIDS across regions. These include:

1) The implications of HIV/AIDS for the education system are, in fact, not that strong. Other factors caused the deteriorating performance of primary schools over the 1990s.
2) The regional groupings into highly afflicted and less afflicted are inaccurate. A more accurate grouping would indicate a stronger influence of HIV/AIDS.
3) Trends in primary school transition probabilities may have been quite different at the beginning of the estimation period. One must look at the change in the trend rather than the trend itself while controlling for other factors that might influence trends.
4) Supply side effects, driven primarily by the aggregate supply of teachers at the national level, are much stronger than demand side effects. Educational attainment in regions with low prevalence rates is negatively affected due to the paucity of teachers, particularly experienced teachers, nationwide. Also, prevalence rates amongst teachers might be only weakly correlated with the overall prevalence rate in the region where they are located.

In order to try to shed some additional light on these possibilities, relationships between the performance measure for all students given in Table 5.9 and other variables including numbers of primary school teachers, the pupil/teacher ratio, regional per capita GDP, and various transforms thereof. Significant relationships did not manifest themselves.

To end this section, some speculation on the results obtained and the relevance of the four explanations given above is presented. The failure to find a strong influence of HIV/AIDS in cross section does not provide substantial enough support to alleviate concerns about the implications of HIV/AIDS for educational attainment and human capital accumulation. The hypothesis is that HIV/AIDS tends to negatively affect trends in the education system. In the results obtained, there are no provinces that exhibit a substantial positive trend and many that exhibit fairly dramatic declines despite substantial increases in overall resources allocated to the educational sector. In addition, economic performance over the period, while far from good, was not particularly poor especially by African standards. HIV/AIDS still looms as a likely major contributing factor.

5. General Equilibrium Analysis of Skills Upgrading

In this section, the implications of skills upgrading (e.g., reducing the proportion of the work force with low skills and increasing the proportions of the workforce with medium and high skills) is analyzed using and economy-wide, general equilibrium approach. Computable general equilibrium (CGE) models are useful for examining "cross-cutting" issues, such as skills upgrading, where interactions across a large number of markets are important. In developing countries, this class of models has been frequently applied to issues of trade strategy, income distribution, and structural change.[14] Here, we focus on the implications of skills upgrading for the Tanzanian economy using a static general equilibrium model. The following three sub-sections present a review of CGE models, the Tanzania CGE model and then discuss the simulations performed with the model and the results obtained.

5.1 An Overview of Static CGE Models

Before describing the Tanzania CGE model specifically, it is perhaps worthwhile to review the basic characteristics of a standard static CGE model. The specific features of the Tanzania model can then be highlighted.

CGE models can be thought of as containing four basic elements:

a) behavioral specification,
b) accounting constraints,
c) treatment of imports and exports, and
d) market closure.

These elements are treated in turn.

6.1.1 Behavioral Specification

In any economic model, the behavior of the agents must be specified. For example, firms are often assumed to maximize profits subject to available technology and taking prices for inputs and outputs as given. Likewise, households are often assumed to maximize utility subject to a budget constraint. These are also the most common assumptions applied to CGE models. In addition, other agents are usually contained in a CGE. For example, government receives revenue through taxes and other sources and purchases commodities. Enterprises earn financial profits (returns to capital) and either distribute dividends or retain the earnings for investment purposes. Investors, through the purchase of commodities in order to form capital, determine the commodity composition of investment. Just as for firms and households, expenditure allocation rules must be specified for these additional agents. The rules can be simple or complex. For a simple example, all agents could allocate available funds across uses in constant budget shares. More complex rules that account for items such as risk, imperfect competition, or returns to scale can also be applied.

[14] The Tanzania model is a modified version of the IFPRI standard model (Löfgren et al. 2001). A thorough exposition of the properties of this class of models can be found in Dervis, de Melo, and Robinson (1982). See Robinson (1989) for a review of CGE model applications to developing countries.

6.1.2 Accounting Constraints

The behavioral specifications within CGE models rarely set them apart from other economic models. The accounting equations, on the other hand, are a major distinguishing feature from partial equilibrium models. CGE models contain a number of identities that enforce consistency. For example,

a) households must respect their budget constraint,
b) the domestic price of imports equals the CIF price multiplied by the exchange rate and the prevailing tariff rate plus any marketing margins or additional domestic sales taxes,
c) the value of imports cannot exceed the availability of foreign exchange,
d) supply of commodities must equal demand for commodities (with inventory accumulation counted as demand),
e) firms cannot use more of any factor than the total availability in the economy,
f) investment must be financed via foreign or domestic savings, and
g) government consumption must be financed through tax revenue, foreign grants (aid), or borrowing on domestic or foreign markets.

These propositions are essentially a matter of accounting; however, they serve to circumscribe the range of possible outcomes, sometimes surprisingly tightly. For example, skilled labor is often fully employed. This implies that, for a given stock of skilled labor, if an industry expands output and uses more skilled labor in the process, other industries must use less skilled labor. To achieve equilibrium in the various factor and product markets, prices adjust to simultaneously satisfy the decision rules and the accounting constraints.

6.1.3 Exports and Imports

As in most models with foreign trade, exports and imports receive special treatment.[15] While the ideal special treatment remains a matter of considerable debate, it is clearly incorrect to assume that that a domestic commodity and the same commodity being imported or exported are homogeneous (with the possible exception of trade in bulk commodities such as rice between similar countries). For the vast majority of traded commodities, the empirical evidence is overwhelming that imports, exports, and domestic goods are differentiated products. The exact form of differentiation and the degree of differentiation remains contentious.

The most common practice in CGE modeling is to adopt the "Armington assumption" whereby products are distinguished by country of origin (Armington 1969). Other assumptions are possible. For example, goods might be differentiated by firm. So, Honda automobiles might be considered the same wherever they are produced but they differ from Ford automobiles. In a single country CGE model employing the Armington

[15] Treatment of exports and imports really falls under the heading of behavioral specification. However, since the treatment of foreign trade is crucial to many applications, a separate section is devoted to this part of the model.

assumption, there are three goods associated with each commodity: imports, exports, and domestically produced goods for domestic consumption.

6.1.4 Closure

The final issue, closure, pertains to the macroeconomic characteristics of the economy in question. Is a fixed or flexible exchange rate regime pursued? Do taxes adjust to maintain an arbitrary alignment between government revenue and expenditures or does the government deficit adjust? Are factors of production fully employed and are they mobile across productive activities? Is investment driven by the available savings pool or do savings adjust somehow to accommodate an exogenous investment level? These questions are addressed through the choice of macroeconomic closure.

Results from CGE models are often sensitive to the choice of closure. This characteristic is sometimes cited as a weakness of CGE models. In fact, it is a strength. Economic outcomes do vary substantially depending upon macroeconomic conditions and policies. For example, if the defense build up pursued by the United States under President Ronald Reagan had been tax financed rather than deficit financed, the economic structure of the United States towards the end of the 1980s would arguably have been very different (see, for example, McKibbin 1992). Alternative closures permit the models to capture these alternative outcomes.

In summary, CGE models combine behavioral specifications for a large number of agents in the economy with accounting constraints and a view of the macroeconomic policy regime and the nature of product differentiation in international trade.

5.2 A Tanzania SAM and CGE Model

To render a CGE model operational, these modeling choices must be linked to a picture of the economy, usually at a point in time, in the form of a social accounting matrix (SAM). With current computing technology (both software and hardware), detailed SAMs, which break economic activity into large numbers of productive activities, commodities, households, and factors of production, can be constructed and used as a basis for modeling. While the modeling issues discussed above clearly influence results, the structure of the economy as depicted in a social accounting matrix is often a determining or the determining factor.

Since economic structure is observable, the ability to capture the implications of economic structure within a fully consistent economic modeling framework with a reasonable representation of behavior represents a major attraction for CGE models. At their best, CGE models provide an economic "simulation laboratory" with which one can examine how different events or policies will affect the performance and structure of the economy, how they will interact, and which are (quantitatively) the most important.

The Tanzania CGE model is a variant of the basic modeling structure fully described in Löfgren et al. (2000). The basic model is in many ways quite standard with firms maximizing profits under perfect competition subject to production technology that is CES in value added and Leontief intermediate inputs. Households maximize an LES utility function. The Armington assumption is adopted with CES aggregator functions, which combine, on a commodity by commodity basis, domestic production for sale on domestic markets with imports and CET disaggregator functions which allocate total domestic production of each good between domestic markets and exports. Investment and government spending is comprised of a fixed basket of goods. The quantity purchased of each good in the basket adjusts proportionately to equal the value of available funds at current prices.

A distinguishing feature of the Tanzania model is the detailed treatment of marketing margins and home consumption (see Arndt et al. 2000 for a detailed discussion). In many African countries, differences between producer (farm gate) and consumer prices are large particularly for agricultural commodities. Due to the presence of large wedges between producer and consumer prices, many households opt to produce primarily for own consumption rather than to produce for markets. For rural households in Tanzania, the value of home consumption amounts to about 22% of total consumption.

Consistent with recent macroeconomic policies in Tanzania, the exchange rate is flexible while sources of foreign savings are set exogenously. Investment is savings driven with fixed savings rates applied to households and enterprises. Total government spending is set at a constant share of total absorption. Changes in government revenues and expenditures are reflected in changes in the overall government budget deficit/surplus. Consistent with the labor surveys discussed above and past work in Tanzania, factors are considered fully employed and, with some exceptions, mobile.[16] The exceptions are as follows. Agricultural capital is confined to the agricultural sector but mobile across agricultural activities while non-agricultural capital is confined to the non-agricultural sector but mobile across non-agricultural activities. Labor mobility is scenario dependent. In some scenarios, labor is mobile across all activities (e.g., rural-urban migration permitted) while in other scenarios agricultural and non-agricultural labor are fixed in their respective sectors in the manner of agricultural and non-agricultural capital. Land is used only in agriculture and is mobile across activities.

The Tanzania SAM is based on data for 1998 and an earlier version of a SAM for Tanzania (Wobst 2001). It contains 12 activities (four agricultural), 12 commodities, nine factors of production, and 12 households. Labor factors are distinguished across three education levels for both the agricultural and non-agricultural classifications (six labor categories in total). Six rural and six urban households are distinguished across the income spectrum.

[16] Rural unemployment is very low. There is some urban unemployment. However, a large share of the urban unemployed are workers aged 10-19 who are likely just entering the workforce and undergoing search costs. The other large group of urban unemployed are women in their twenties and early thirties. Despite being officially unemployed, it is highly likely that unemployed women in this age group are occupied with considerable domestic responsibilities. These factors indicate that urban labor supply is roughly equivalent to urban labor demand.

As indicated in Section 3, agriculture is very important in the economy representing close to 50% of GDP at factor cost. As indicated in Table 3.2, agriculture is even more important in terms of employment with more than 80% of the working population engaged in agriculture. Also shown in Table 3.2, the largest group of workers is classified with low education (did not complete primary school). Nevertheless, the share of workers with a medium education level (at least completed primary school but less than form 4) is relatively high for both agricultural and non-agricultural sectors while the share of workers with a high education level (completed form 4 or more) is small.

However, since wages differ, the weight of the labor classes with skills in value added (e.g., the economic weight) is considerably higher. The wage for the high skill class is approximately four times the wage for the low skill class and twice the wage for the medium skill class for both the agricultural and non-agricultural labor classes. Wages also differ considerably between agricultural and non-agricultural labor classes. Non-agricultural labor wages are approximately seven times agricultural labor wages for each skill class. Shares in agricultural and non-agricultural labor value added by labor class are presented in Table 6.1.

Table 6.1
Shares in agricultural and non-agricultural labor value added.

	Ag	Non-Ag
Low	33.3%	28.4%
Medium	51.9%	53.1%
High	14.7%	18.5%

The relative sizes of the various labor classes, the wage differentials, and the associated shares in labor value added are important to the skills upgrading simulations described below.

5.3 Skills Upgrading Simulations and Results

The analyses of the labor force surveys and enrollment data point towards a slowdown in the rate of skills upgrading during the 1990s. HIV/AIDS is a likely contributor to this slowdown. The purpose of this section is to quantify the implications and benefits of skills upgrading. The results provide an indication of opportunity lost due to the slowdown (regardless of its source). Since the exact magnitude of the slowdown cannot be determined,[17] fairly simple simulations are conducted. To simulate skills upgrading, workers are shifted across skill categories while the total number of workers in the agricultural and non-agricultural sectors is kept constant. In particular, for both agricultural and non-agricultural labor categories, 2% of workers in the low skilled

[17] As indicated earlier, we do not know and cannot know what educational and labor force trends would have prevailed in the absence of the pandemic. In educational attainment, for example, enrollment trends might have been positive rather than negative causing a much wider gap than a "no trend" versus "observed trend" analysis would indicate.

category are shifted to the medium skilled category and 1% of the original number of workers in the medium skilled category are shifted to the high skilled category.

This experiment is conducted under two labor market scenarios. In the first, migration is permitted between rural and urban zones. In this scenario, agricultural labor in any skill class can migrate and become non-agricultural labor in the same skill class (and vice versa). The quantity of migration is determined by the ratio of non-agricultural/agricultural wages in each labor category. In the migration scenario, these ratios are assumed to remain constant. Labor flows between the two categories to maintain the ratio. In the second, migration is not permitted and agricultural and non-agricultural labor are fixed in their respective zones.

The implications of this skills upgrading experiment for the total number of workers by category are illustrated in Table 6.2.

Table 6.2
Percent change in the work force by scenario

	Migration		No Migration	
	Ag	Non-Ag	Ag	Non-Ag
Low	-2.1%	-1.4%	-2.0%	-2.0%
Medium	1.4%	2.0%	1.5%	1.3%
High	6.5%	7.2%	6.9%	5.0%

As one would expect, the low skilled labor force declines by exactly 2% in both agricultural and non-agricultural categories when migration is not allowed. Growth in medium and high skilled categories without migration depends upon the relative sizes of the labor categories. In the agricultural category, the size of the low skilled category compared with the medium skilled category is much greater. Consequently, the number of workers incoming to the medium skilled agricultural category from low skilled agricultural category is much higher than the number of workers outgoing to the high skilled agricultural category. As a result, the relative growth of the medium skilled labor force in agriculture is greater at 1.5% than in non-agriculture at 1.3%. By the same token, the relatively large share of high skilled workers in non-agriculture explains the relatively smaller growth (5%) in that category compared with agriculture (6.9%).

When migration is permitted, workers flow from agricultural categories to non-agricultural categories due to a combination of low elasticities of demand for agricultural products and greater opportunities for workers with skills in the non-agricultural sectors. Table 6.2 indicates that the flow from agriculture to non-agriculture occurs in all labor categories as the percentage change in the "Migration Ag" column are uniformly smaller than in the "No Migration" scenario while the reverse is true for the "Non-Ag" column.

The implications of this skills upgrading for real GDP are presented in Table 6.3. The gain of GDP of 0.35% under the "No Migration" scenario is actually fairly large for this class of model. Recall that 0.35% is the static gain. Gains in that same range will also likely be reaped in future years along with any other dynamic gains, such as technical advance, that might be reaped from a more highly skilled workforce.

Table 6.3
Implications of skills upgrading for real GDP

	Migration	No Migration
GDP	0.42%	0.35%
Ag GDP	0.40%	0.46%
Non-Ag GDP	0.43%	0.28%

A number of simple and logical propositions follow from Table 6.3. First, overall GDP growth is greater when migration is permitted. This follows from the wage (productivity) differentials between agricultural and non-agricultural labor. As observed in many developing countries and as discussed above, non-agricultural labor in Tanzania tends to be more productive and earns a higher wage. Under the assumptions present in the model, skills upgrading under migration earns a double benefit: (a) workers move to higher skill categories where they are more productive and (b) agricultural labor, particularly those with skills, tends to migrate to more productive non-agricultural occupations.

Second, without migration, skills upgrading is a strong stimulant to the agricultural sector. This follows from the enhanced productivity of more skilled agricultural labor (see the discussion in Section 2) and the large numbers of workers involved. Even if only a small fraction of the low skilled labor pool had in fact obtained medium level skills, a large number of workers move into the medium skilled category. Since the large majority of the population is rural and engaged in agriculture, the impetus to agricultural GDP is large when skills upgrading occurs and this more skilled labor does not migrate to non-agricultural sectors.

Third, with migration, labor flows out of the agricultural sector. However, the cost to agricultural GDP of this resource outflow is relatively small. While the percentages in Table 6.3 are indicative, the story is most easily told using absolute values. With skills upgrading and without migration, agricultural GDP increases by about 10 billion 1998 Tanzanian shillings (about US$15 million). When migration is permitted, the labor outflow reduces Ag GDP by only slightly more than 1 billion shillings. At the same time, non-agricultural GDP increases by about 4.5 billion shillings. This reflects both the productivity differentials between the agricultural and non-agricultural sector that have already been mentioned and the difficulties encountered by the agricultural sector in absorbing the increase in highly skilled labor under the "No Migration" scenario.

Table 6.4 shows the changes in wages (deflated by the consumer price index, which is the numeraire for all scenarios) for each scenario. Note that the wage for highly skilled labor in agriculture declines significantly when migration is not permitted. This reflects the relatively small demand for highly skilled labor within the agricultural sector and the fairly strong reductions in the marginal product of highly skilled labor brought about through the increase in the size of the highly skilled agricultural labor pool. When migration is permitted, highly skilled labor exhibits the highest propensity to migrate. Also, note that, consistent with migration, agricultural wages in the "No Migration" scenario decline relative to non-agricultural wages.

Table 6.4
Changes in wages

	Migration		No Migration	
	Ag	Non-Ag	Ag	Non-Ag
Low	1.8%	1.8%	-2.9%	5.2%
Medium	-1.0%	-1.0%	-5.6%	2.5%
High	-4.8%	-4.8%	-9.4%	-0.3%

6. Conclusions and Suggestions for Future Research

While the exact impact of the HIV/AIDS pandemic is extremely difficult or impossible to ascertain, the weight of evidence indicates that the pandemic is having a potentially strong effect on the Tanzanian labor force. Based on data from the 2000/01 Labor Force Survey, the age structure of the labor force is becoming younger with 10-14 year olds and juveniles, aged 15-19, comprising a significantly larger share compared with 1990/91. Rapid growth in workers aged 10-14 as a share of the total workforce stands out. The growth in the child and juvenile labor force is matched by a trend towards an increased tendency to exit primary school and an overall lower share of children aged 5-14 enrolled in primary school. Finally, the ranks of experienced workers appear to be thinning.

A CGE analysis examined the implications of skills upgrading. Since around 80% of the population is rural, economy-wide skills upgrading must include the rural sector. The analysis of a hypothetical skills upgrading achievement under migration and no migration scenarios indicates that skills upgrading generates patterns of development consistent with the development strategies favored by Mellor (1976) and Adelman et al. (1989). Under these strategies, stimulus to agriculture increases demand from the bulk of the population for non-agricultural products and permits resources (labor) to flow from agricultural to non-agricultural sectors without negatively affecting agricultural production. The slow down in skills upgrading identified in section 5 would dampen this positive process.

Overall, these results give additional weight to concerns about the macroeconomic impact of the pandemic. If inexperienced workers (e.g., children) are less productive and less innovative than more experienced workers, the strong shifts in the age structure of the workforce will have negative productivity effects. This is likely both at a point in time, due to the reduced productivity of inexperienced workers, and through time, due to the lower propensity of inexperienced workers to innovate. In addition, as children migrate out of school and into the workforce, future human capital (as well as the future innovations that this unrealized human capital might have realized) is sacrificed. Reductions in the growth of human capital might be most profound at the medium educational level (finished elementary school but did not complete form 4), which is where the large numbers are. Secondary schools appear to be less affected (though we do not know what would have happened in the absence of AIDS). Productivity and human capital are two of the three major channels through which the major macroeconomic impacts of HIV/AIDS are expected to occur (Arndt and Lewis 2000; Arndt 2002) and these channels appear to be operating in Tanzania.[18]

The agenda for future work is quite full. For example, a more complete explanation of differences in regional trends in educational attainment would be valuable both in terms of understanding the implications of HIV/AIDS more completely and in developing policy alternatives for countering negative impacts. More generally, a focus on constructive policy options is now merited.

7. References

Adelman, I., Bourniaux, J. M. and Waelbroeck, J. (1989) ´Agricultural Development-Led Industrialisation in a Global Perspective´ reprinted as chapter 15 in *Institutions and Development Strategies - The selected essays of Irma Adelman*. Volume 1. Aldershot, U.K.: Elgar, 1995.

Akabayash, Hideo and George Psacharopoulous (1999). "The Trade-off Between Child Labour and Human Capital Formation: A Tanzanian Case Study." *The Journal of Development Studies*, Vol. 35, No. 5, June 1999, pp. 120-140.

Appleton, Simon and Arsene Balihuta (1996). "Education and Agricultural Productivity: Evidence from Uganda." *Journal of International Development.* Vol. 8, No. 3, pp. 415-444.

Armington, Paul (1969). "A Theory of Demand for Products Distinguished by Place of Production." *IMF Staff Papers*. Vol. 16, no. 1 (July), pp. 159-178.

Arndt, Channing (2002). "HIV/AIDS and Macroeconomic Prospects for Mozambique: An Initial Assessment." The World Bank, Africa Region Discussing Paper, January 2001.

Arndt, Channing, Henning Tarp Jensen, Sherman Robinson and Finn Tarp. "Agricultural Technology and Marketing Margins in Mozambique." *Journal of Development Studies.* 37(October 2000):121-137.

[18] The third channel is physical capital accumulation.

Arndt, C. and J. D. Lewis. 2000. "The Macro Implications of the HIV/AIDS Epidemic: A Preliminary Assessment." *South African Journal of Economics.* 68:5(December 2000):1-32.

Arndt, Channing and Jeffrey D. Lewis (2001). "The HIV/AIDS Pandemic in South Africa: Sectoral Impacts and Unemployment." *Journal of International Development*. 13: 427-49.

Badcock-Walters, Peter and Alan Whiteside (2000). "HIV/AIDS and Development in the Education Sector." Unpublished paper. Health Economics and HIV/AIDS Research Division, University of Natal.

Bank of Tanzania (BoT) (2001). *Economic Bulletin*. For the Quarter Ended June 30, 2001. Vol.XXXI No.2. Bank of Tanzania: Dar es Salaam.

Bils, M. and P. Klenow (2000). "Does Schooling Cause Growth?" *American Economic Review.* Vol. 90, pp. 1160-1183.

Bloom, David E., David Canning, and Jaypee Sevilla (2001). "Health, Human Capital, and Economic Growth." Commission on Macroeconomics and Health. World Health Organization. *Working paper* no. WG1: 8.

Cuddington, John T. (1993). "Modeling the Macroeconomic Effects of AIDS with an Application to Tanzania." *World Bank Economic Review*. 7(2): 173-89.

Dervis, Kemal, Jaime de Melo, and Sherman Robinson (1982). *General Equilibrium Models for Development Policy*. Cambridge: Cambridge University Press.

Golan, Amos, George Judge and Douglas Miller (1996). *Maximum Entropy Econometrics: Robust Estimation with Limited Data.* New York: John Wiley & Sons.

Golan, Amos and Stephen J. Vogel (2000). Estimation of Non-Stationary Social Accounting Matrix Coefficients with Supply-Side Information. *Economic Systems Research*. December 2000, pp. 447-471.

Gregson, Simon, Heather Waddell, and Stephen Chandiwana (2001). "School Education and HIV Control in Sub-Saharan Africa: From Discord to Harmony?" *Journal of International Development*. Vol. 13, pp. 467-485.

Hamoudi, Amar and Nancy Birdsall (2002). "HIV/AID and the Accumulation and Utilization of Human Capital in Africa." Center for Global Development, Working Paper Number 2. Washington D.C. (www.cgdev.org).

Kambou, Gerard, Shantayanan Devarajan, and Mead Over (1993). "The Economic Impact of AIDS in an African Country: Simulations with a General Equilibrium Model of Cameroon." *Journal of African Economies.* Vol. 1, no. 1, pp. 103-30.

Karantininis, Kostas (2002). “Information-based Estimators for the Non-Stationary Transition Probability Matrix: An Application to the Danish Pork Industry.” *Journal of Econometrics*, Vol. 107, pp. 275-290.

Lockheed, Marlaine E., Dean T. Jamison, and Lawrence J. Lau (1980). “Farmer Education and Farm Efficiency: A Survey.” *Economic Development and Cultural Change.* pp. 37-76.

Löfgren, Hans, Rebecca Lee Harris, and Sherman Robinson (2001). “A Standard Computable General Equilibrium Model in GAMS.” Trade and Macroeconomics Division discussion paper 75. International Food Policy Research Institute, Washington D.C.

Lundberg, Matthias, Mead Over, and Phare Mujinja (2001). “Sources of Financial Assistance for Households Suffering an Adult Death in Kagera, Tanzania.” www.worldbank.org/aids-econ.

McKibbin, Warwick J (1992). “Short-Run Implications of Long-Run Shocks: Lessons from the 1980s and 1990s.” in *Macroeconomic modelling of the long-run*.” Hargreaves, Colin P., ed. Aldershot, U.K.

Mellor, J. W. (1976) *´The New Economics of Growth: A Strategy for India and the Developing World´* Cornell University Press: Ithaca and London.

Ministry of Education (MoE) (Various years). Basic Statistics in Education: Regional Data. Various issues, Ministry of Education: Dar es Salaam.

Ministry of Education (MoE) (Various years). Basic Education Statistics in Tanzania. Various issues, Ministry of Education: Dar es Salaam.

Ministry of Health (MoH) (2000). HIV/AIDS/STI Surveillance: Report No.14 December, 2000. National AIDS Control Programme: Dar es Salaam.

Ministry of Health (MoH) (2001). HIV/AIDS/STI Surveillance: Report No.15 December, 2000. National AIDS Control Programme: Dar es Salaam.

National Bureau of Statistics (NBS) (1993). The Labour Force Survey 1990/91. Bureau of Statistics and Labour Department: Dar es Salaam.

Psacharopoulos, George (1994). “Returns to Investment in Education: A Global Update.” *World Development.* Vol. 22, No. 9, pp. 1325-1343.

Pinckney, Thomas C. (1997). “Does Education Increase Agricultural Productivity in Africa?” in *Proceedings of the International Association of Agricultural Economists Meeting: 1997.* pp. 345-353.

Research on Poverty Alleviation (REPOA) (1998). Economic Policy Changes and Rural Poverty: Survey Data. REPOA: Dar es Salaam.

Robinson, Sherman. (1989). "Multisectoral Models," in *Handbook of Development Economics,* Vol II. Hollis Chenery and T.N.Srinivasan, eds. North Holland.

UNAIDS (1999). "A Review of Household and Community Responses to the HIV/AIDS Epidemic in the Rural Areas of sub-Saharan Africa." Electronically published at www.unaids.org.

UNAIDS (2000). "United Republic of Tanzania: Epidemiological fact sheet on HIV/AIDS and sexually transmitted infections." www.unaids.org.

URT. 2002. Tanzania Population Projection (1989-2025). Tanzania Population and Development Wesite at http://www.tanzania.go.tz/population (accessed October 1, 2002). United Republic of Tanzania: Dar es Salaam.

Weir, Sharada and John Knight (2001a). "Adoption and Diffusion of Agricultural Innovations in Ethiopia: The Role of Education." Center for the Study of African Economies, WPS2000-5, Oxford.

Weir, Sharada and John Knight (2001b). "Education Externalities in Rural Ethiopia: Evidence from Average and Stochastic Frontier Production Functions." Center for the Study of African Economies, WPS2000-4, Oxford.

Wobst, P. 2001. *Structural Adjustment and Intersectoral Shifts in Tanzania: A Computable General Equilibrium Analysis*. Research Report 117. Washington, D.C.: International Food Policy Research Institute.

World Bank (1997). *Confronting AIDS: Public Priorities in a Global Pandemic*. New York: Oxford University Press.

World Bank (2002). "Tanzania at the Turn of the Century: Background Papers and Statistics." A World Bank Country Study, Washington, D.C.

8. Appendix A: Labor Force Tables

Table A1
Percentage distribution of total labor force in 2000/01 and 1990/91
by occupation, geographic area, and gender

	Total		Urban		Rural	
	2000/01	1990/91	2000/01	1990/91	2000/01	1990/91
Total	100.0	100.0	17.3	15.6	82.7	84.4
Administration/Managers	2.2	2.0	1.4	1.2	0.9	0.7
Professionals	0.3	0.2	0.2	0.1	0.1	0.0
Associate Professionals	1.9	1.6	0.9	0.8	1.0	0.8
Clerks	0.4	0.9	0.3	0.7	0.1	0.1
Service/Shops	4.3	2.5	3.1	1.6	1.2	0.9
Agriculture	81.3	83.7	6.5	5.8	74.8	77.9
Craft workers etc.	2.4	3.4	1.6	1.8	0.8	1.6
Machine operators	0.7	1.1	0.5	0.9	0.2	0.3
Sales & laborers	6.3	4.7	2.7	2.6	3.6	2.0
Male						
Total	49.4	50.1	8.7	9.1	40.7	41.0
Administration/Managers	1.1	1.6	0.7	0.9	0.5	0.6
Professionals	0.2	0.1	0.2	0.1	0.0	0.0
Associate Professionals	1.3	1.1	0.5	0.6	0.8	0.6
Clerks	0.2	0.5	0.1	0.4	0.0	0.1
Service/Shops	2.1	1.4	1.4	0.9	0.7	0.5
Agriculture	38.9	38.7	2.9	2.4	36.0	36.3
Craft workers etc.	1.9	3.1	1.3	1.7	0.6	1.4
Machine operators	0.7	1.0	0.5	0.8	0.2	0.2
Sales & laborers	2.9	2.7	1.0	1.4	1.9	1.3
Female						
Total	50.6	49.9	8.6	6.5	42.0	43.4
Administration/Managers	1.1	0.4	0.7	0.3	0.4	0.1
Professionals	0.1	0.0	0.1	0.0	0.0	0.0
Associate Professionals	0.7	0.5	0.4	0.3	0.3	0.2
Clerks	0.2	0.4	0.2	0.4	0.0	0.0
Service/Shops	2.2	1.1	1.7	0.7	0.6	0.4
Agriculture	42.4	45.0	3.6	3.4	38.8	41.6
Craft workers etc.	0.5	0.3	0.3	0.2	0.2	0.2
Machine operators	0.1	0.1	0.0	0.1	0.0	0.0
Sales & laborers	3.4	2.0	1.7	1.2	1.7	0.7

Source: Calculations from NBS (1993) and LFS 2000/01 survey data.

Table A2
Change in labor force between 2000/01 and 1990/91 by age group

	2000/01	**1990/91**	**% change**
Total	100.0	100.0	
10-14	13.0	6.2	111.3
15-19	14.5	13.9	4.1
20-24	12.4	14.2	-12.8
25-29	11.3	15.1	-25.3
30-34	9.7	11.8	-18.1
35-39	9.7	9.0	7.3
40-44	7.1	6.6	8.6
45-49	6.7	6.4	4.0
50-54	4.9	5.1	-5.8
55-59	3.4	3.8	-10.5
60-64	2.8	3.0	-7.3
65-69	2.2	2.0	6.0
70+	2.5	2.8	-11.6
Male			
Total	49.4	50.1	-1.5
10-14	**6.7**	3.1	117.7
15-19	**7.5**	6.8	10.4
20-24	5.7	6.5	-12.5
25-29	4.8	7.4	-34.6
30-34	4.3	5.9	-26.5
35-39	4.3	**4.6**	-6.4
40-44	3.3	**3.4**	-3.0
45-49	**3.6**	**3.4**	4.3
50-54	**2.6**	2.5	0.5
55-59	**1.9**	**2.0**	-2.8
60-64	**1.7**	**1.7**	2.1
65-69	**1.3**	1.0	23.7
70+	**1.6**	**1.7**	-6.2
Female			
Total	50.6	49.9	1.5
10-14	6.3	3.1	104.8
15-19	7.0	**7.1**	-1.8
20-24	**6.7**	**7.7**	-13.1
25-29	**6.5**	**7.7**	-16.4
30-34	**5.4**	5.9	-9.7
35-39	**5.4**	4.5	21.2
40-44	**3.8**	3.1	21.2
45-49	3.1	3.0	3.8
50-54	2.3	**2.6**	-12.1
55-59	1.4	1.8	-19.3
60-64	1.1	1.3	-19.1
65-69	0.9	1.0	-12.2
70+	0.8	1.0	-20.5

Source: NBS (1993) and calculations from LFS 2000/01.

9. Appendix B: Estimation Procedure

Sets /set elements/:

t and te /1991*2000/ (contains T elements)	Time periods used in estimation
d /upper, middle, lower/	Discrete distribution points
p and pp / g1*g7, f1*f6, exit /	All categories
pe(p) / g2*g7, f1*f6 /	All categories in set p but g1 and exit

Parameters:

$q_{p,pp}$	Prior probability values
val_{pt}	Data for estimations
v_{dpt}	Prior bounds on estimated values
$g1tot_{pt}$	Students in grade 1

Variables:

Z	Objective value
$r_{t,p,pp}$	Posterior probabilities for transition matrix
$rbar_{,p,pp}$	Average of r over t
s_{dpt}	Posterior probabilities for error terms
$estval_{pt}$	Estimated values
$ehat_{pt}$	Error term on known items
$alpha_{p,pp}$	Posterior probability intercept term
$beta_{p,pp}$	Posterior probability trend term

Equations:

Minimize Z subject to:	Description
$Z = \sum_{pe}\sum_{pp} rbar_{pe,pp} * \ln(rbar_{pe,pp} / q_{pe,pp}) + \sum_{d}\sum_{pe}\sum_{te} s_{d,k,te} * \ln(s_{d,pe,te})$	Objective
$estval_{p,te+1} = g1tot_{p,te} + \sum_{pp} estval_{pp,te} * r_{te,pp,p}$	Transition Equation
$val_{p,te} = estval_{p,te} + ehat_{p,te}$	Defining the error 1
$ehat_{p,te} = \sum_{d} s_{d,p,te} * v_{d,p,te}$	Defining the error 2
$\sum_{pp} r_{t,pe,pp} = 1$	Moment zero r
$\sum_{d} s_{d,pe,te} = 1$	Moment zero s
$r_{t,p,pp} = alpha_{p,pp} + beta_{p,pp} * t$	Define r
$rbar_{p,pp} = \sum_{t} r_{t,pe,pp} / T$	Define rbar

Notes:

1) To estimate stationary transition matrices, one sets $beta_{p,pp}$ =0.
2) The formulation listed above is non-linear in the transition equation. To make the problem linear, one can substitute $val_{pp,te}$ for $estval_{pp,te}$ on the right hand side of the equation.
3) Results from the non-linear and linear formulations are quite similar. The non-linear results are presented.
4) All transition probability estimates are bounded to lie in the interval [0,1].

10. Appendix C: Non-Stationary Matrix Estimates for the Nation

Table C1
Alpha Values for Girls
(Corresponds to the 1991 Transition Matrix)

	g2	g3	g4	g5	g6	g7	f1	f2	f3	f4	f5	f6	exit
g1	80.3												
g2	12.6	81.6											5.7
g3		15.1	76.6										8.3
g4			29.9	70.1									0.0
g5				15.1	80.4								4.5
g6					16.4	83.6							0.0
g7						11.9	10.1						78.0
f1							3.4	80.6					15.9
f2								25.2	60.2				14.6
f3									26.4	45.9			27.7
f4										49.1	9.7		41.2
f5											10.7	77.4	12.0
f6												14.1	85.9

Table C2
Beta Values for Girls

	g2	g3	g4	g5	g6	g7	f1	f2	f3	f4	f5	f6	exit
g1	1.6												
g2	-1.4	1.5											-0.1
g3		-1.7	2.6										-0.9
g4			-3.1	1.6									1.5
g5				-1.7	1.3								0.4
g6					-1.8	0.3							1.5
g7						-0.6	0.6						0.1
f1							1.0	0.8					-1.8
f2								-2.8	3.4				-0.6
f3									-2.9	5.2			-2.3
f4										-5.5	1.5		4.0
f5											-1.2	2.1	-0.9
f6												-1.6	1.6

Notes: To obtain the estimated transition matrix for any year, t, of the estimation period (1991-2000), employ the formula: alpha + beta*(t-1991) where alpha and beta are the conformable matrices given above and t is a scalar in the interval [1991,2000].

Table C3
Alpha Values for Boys
(Corresponds to the 1991 Transition Matrix)

	g2	g3	g4	g5	g6	g7	f1	f2	f3	f4	f5	f6	exit
g1	79.1												
g2	13.3	80.6											6.0
g3		15.5	75.1										9.4
g4			30.0	70.0									0.0
g5				14.0	86.0								0.0
g6					10.9	79.7							9.5
g7						17.3	12.8						69.9
f1							0.0	85.0					15.0
f2								14.8	66.0				19.1
f3									24.5	47.6			27.9
f4										44.9	21.3		33.8
f5											0.0	81.9	18.1
f6												14.4	85.6

Table C4
Beta Values for Boys

	g2	g3	g4	g5	g6	g7	f1	f2	f3	f4	f5	f6	exit
g1	1.8												
g2	-1.5	1.6											-0.1
g3		-1.7	2.7										-1.0
g4			-3.3	1.4									1.9
g5				-1.6	0.0								1.5
g6					-0.6	1.2							-0.5
g7						-1.9	0.3						1.6
f1							1.6	0.0					-1.7
f2								-0.9	2.9				-2.0
f3									-2.7	5.2			-2.5
f4										-5.0	1.5		3.5
f5											1.0	1.0	-2.0
f6												-1.6	1.6

Note: To obtain the estimated transition matrix for any year, t, of the estimation period (1991-2000), employ the formula: alpha + beta*(t-1991) where alpha and beta are the conformable matrices given above and t is a scalar in the interval [1991,2000].

Table C5
Alpha Values for All Students
(Corresponds to the 1991 Transition Matrix)

	g2	g3	g4	g5	g6	g7	f1	f2	f3	f4	f5	f6	exit
g1	79.8												
g2	12.9	81.2											5.9
g3		15.2	75.8										9.0
g4			30.1	69.9									0.0
g5				14.7	80.6								4.7
g6					16.4	83.6							0.0
g7						12.6	11.7						75.7
f1							0.0	84.5					15.5
f2								17.9	63.4				18.7
f3									25.0	47.0			28.1
f4										46.9	15.2		37.9
f5											9.2	80.6	10.2
f6												14.7	85.3

Table C6
Beta Values for All Students

	g2	g3	g4	g5	g6	g7	f1	f2	f3	f4	f5	f6	exit
g1	1.7												
g2	-1.4	1.6											-0.1
g3		-1.7	2.7										-1.0
g4			-3.3	1.5									1.8
g5				-1.6	1.2								0.4
g6					-1.8	0.3							1.5
g7						-0.8	0.4						0.4
f1							1.6	0.1					-1.7
f2								-1.4	3.1				-1.7
f3									-2.8	5.2			-2.4
f4										-5.2	1.7		3.5
f5											-1.0	1.4	-0.4
f6												-1.6	1.6

Note: To obtain the estimated transition matrix for any year, t, of the estimation period (1991-2000), employ the formula: alpha + beta*(t-1991) where alpha and beta are the conformable matrices given above and t is a scalar in the interval [1991,2000].

11. Appendix D: Methodologies of the 1990/91 and 2000/01 Labor Force Surveys[19]

Major methodological differences between the 1990/91 and 2000/02 LFS in Tanzania

	1990/91 LFS	2000/01 LFS
1	Rural sample: 50 villages (app. 4,000 households covered)	Rural sample: 100 villages (app. 8,000 households covered)
2	Urban sample: 122 enumeration areas (app. 3,660 households covered)	Urban sample: 122 enumeration areas (app. 3,660 households covered)
3	Fetching water and firewood for home consumption regarded as non-economic activity	Fetching water and firewood for home consumption regarded as economic activity
4	Surveyed population: individuals aged 10 years and above	Surveyed population: individuals aged 5 years and above
5		Addition of 10 questions on informal sector module
6		Weighting for DSM and Other Urban was done and it is possible to get separate employment figures on them
7		Addition of child labor module

Concept used for the LFS 2000/01 adopted from the 12th International Conference of Labour Statistician (ICLS).

Definitions

(a) Economically active population

This is a key definition for the survey and, in general, it was decided to adopt the widest definition internationally recommended. Economically active persons are those who supply labor for the production of goods and services for the market, barter, or for home consumption as defined by the SNA. The production boundary is very wide under this system and includes paid employment and a wide range of self-employed activities, but excludes unpaid domestic activities such as minding children, cooking food for own family, etc.

(b) Employed persons

Are persons who did some work in the reference period (one week) either for payment in cash or kind (paid employees) and those who were in self-employment for profit or family gain, plus temporarily absent from these activities, but definitely going to return to them, e.g. on leave or sick.

[19] All information in Appendix D was obtained from NBS staff in Dar es Salaam.

(c) Unemployed persons

Are persons who were not employed as defined in (b) above and who stated that they were available for work.

(d) Not economically active (not in the labor force)

This category includes persons who were neither employed or unemployed in the reference period. This includes persons doing solely unpaid work in their own house, studying or persons not working because they were sick, retired, or too young to work.

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