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Poverty and malnutrition in Tanzania:
New approaches for examining trends and spatial patterns

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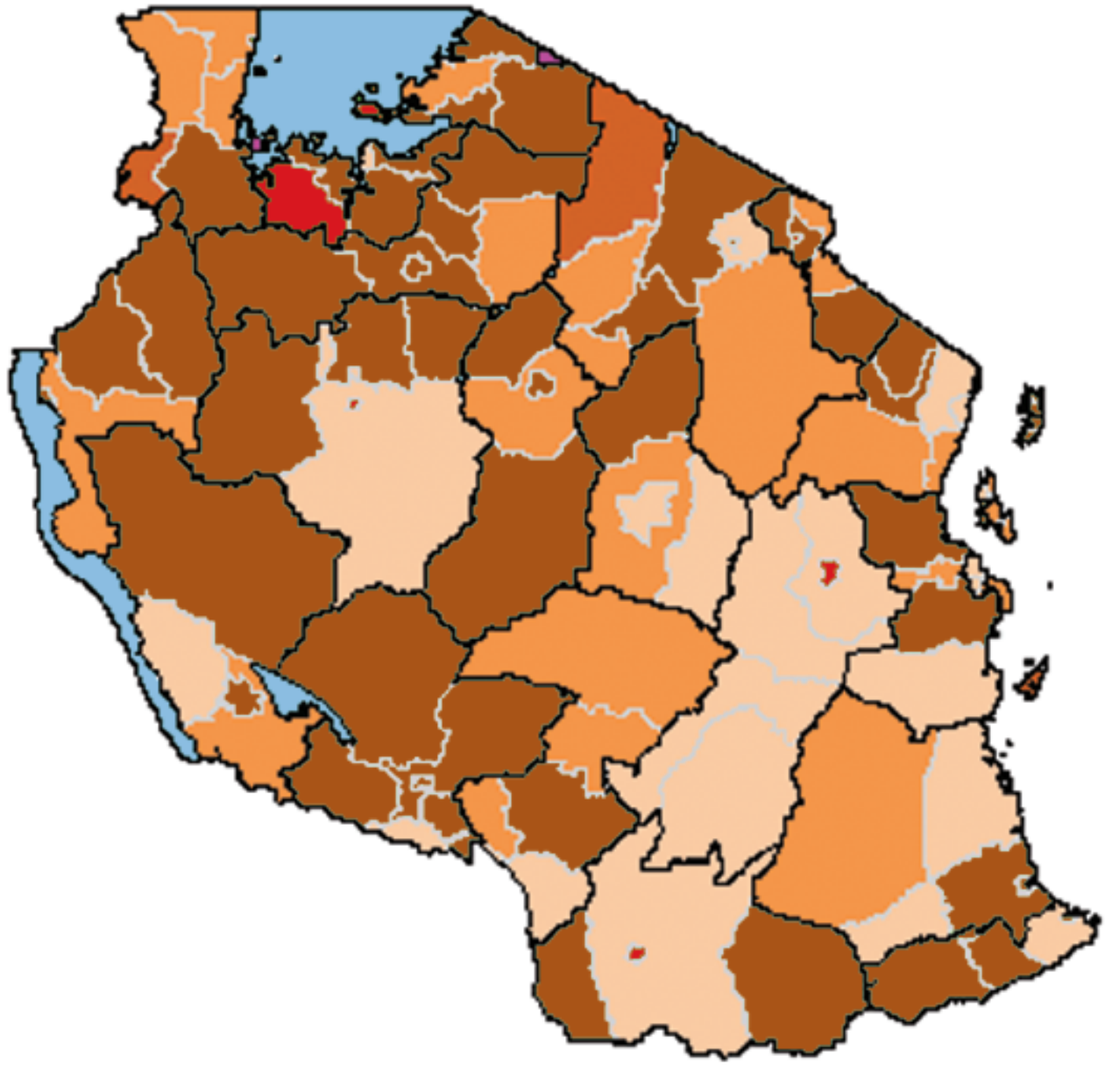

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Poverty and malnutrition in Tanzania: New approaches for examining trends and spatial patterns

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Preface

Starting in 1986, Tanzania embarked on a program of economic reforms to stabilize the macro economy, liberalize domestic markets and trade, and reduce state involvement in direct production and marketing activities. Agricultural markets were liberalized, subsidies on fertilizer and other goods were removed, state enterprises were closed or privatized, and the exchange rate was devalued and then allowed to float. Until the late 1990s, the focus of these policy reforms was to improve macroeconomic performance. To some degree, they succeeded: by the end of the 1990s, inflation was brought down to less then 10 percent, the annual growth in gross domestic product (GDP) was increased to about 4 percent, and foreign direct investment increased five-fold as a percentage of GDP.

But there were persistent questions as to whether the economic growth was being translated into concrete benefits for Tanzanian households, particularly the rural poor. In the late 1990s, government policy began to focus more attention on poverty reduction with the National Poverty Eradication Strategy in 1998 and the Poverty Reduction Strategy Paper (PRSP) in 2000 (URT, 1998 and URT, 2000). Further attention was drawn to the importance of poverty reduction by the United Nations Millennium Summit in September 2000, which established the Millennium Development Goals. The first of the eight goals is to halve the number of poor and hungry people between 1990 and 2015. As a result of these events, there is even greater demand for information on the patterns and trends in poverty and malnutrition.

This project was funded by the Rockefeller Foundation and implemented by the International Food Policy Research Institute in collaboration with researchers from REPOA, the Economic Research Bureau and the National Statistics Bureau. It responded to the demand for better information on poverty and malnutrition in three ways. First, the project included a capacity building component in which IFPRI researchers offered three one-week training courses on survey analysis, geographic information systems, and poverty mapping. Second, it demonstrated the potential of relatively new approaches to monitoring poverty trends over time and to evaluating spatial patterns of malnutrition. These methods are variations of small-area estimation methods, also known as poverty mapping. Third, using this new approach, this study generated new estimates of the patterns and trends in poverty and nutrition in Tanzania during the 1990s,

The results of this study challenge conventional wisdom in two ways. First, although a comparison of the 1991/92 Household Budget Survey and the 2000/01 Household Budget Survey suggests only modest progress in poverty reduction over the 1990s, this analysis indicates that the headcount poverty rate may have fallen about 9 percentage points over 1991-2003. Second, the conventional wisdom is that urban households and rural household with good market access have gained more from the economic growth associated with the market reforms, this analysis suggests that urban and rural households experienced similar poverty reduction and that remote rural households may have gained as much as other rural households over this period.

The third result confirms other studies that show that there is a sharp difference between the prevalence of child malnutrition in urban and rural areas, as well as a variation in the prevalence of child malnutrition within rural areas.

Because a different methodology has been used to arrive at results that challenge conventional wisdom, and to a large extent, public opinion, it is important that there is further discussion on this new methodology. As we continue to reflect on this methodology we should make use of the results of this study, especially in the areas that strengthen our understanding of poverty and nutrition developments in the country.

Professor Joseph Semboja, Executive Director
Research on Poverty Alleviation (REPOA)
September 2005

Acknowledgements

This project would not have been possible without the support and collaboration of a wide range of individuals and institutions. First, we wish to express our appreciation to the Rockefeller Foundation who provided the funding for the project. In particular, John Lynam, former project manager at Rockefeller Foundation, provided excellent support in terms of encouragement and guidance, including the suggestion to incorporate a nutrition mapping component.

Research in Poverty Alleviation (REPOA) has served the project well as an institutional "home" for the project in Tanzania. Professor Joseph Semboja, Executive Director of REPOA, has been generous with his time and ideas, including valuable contributions at the various workshops in which preliminary and final results were presented. Blandina Kilama, Researcher with REPOA, in addition to being a co-author of this report, assisted in various coordination tasks including organizing the final workshop and supervising the printing and distribution of the report. Sonja Tiscenko, Communications Officer with REPOA, was very helpful in organizing earlier workshops and in guiding the dissemination efforts.

The Research and Analysis Technical Working Group (R&AWG) served as an informal steering committee for the project, providing valuable feed-back and guidance at several stages during the implementation of the project. We are thankful for this support.

We are grateful to the National Bureau of Statistics for giving us access to various databases used in the analysis, including the 1988 Population Census, the 1991/92 Household Budget Survey, and the 2000/01 Household Budget Survey.

We would also like to thank Livia Montana of the Measure DHS program of Macro International, Inc. for assistance in accessing the four DHS data sets for Tanzania and answering numerous question during the analysis of these data. She was also very helpful in supplying us with the geo-reference codes for the DHS surveys, necessary for the GIS analysis in Chapter 2.

The University Computing Centre (UCC) of the University of Dar es Salaam provided their well-equipped computer laboratory for the three training courses carried out by the project. The staff of the UCC provided efficient, professional services at a reasonable price.

We appreciate the assistance of Patti Kristjanson and John Owuor of the International Livestock Research Institute and Richard Bakubiye of the National Bureau of Statistics in completing the digitized ward-level map of Tanzania, used in the nutrition mapping analysis in Chapter 6.

Jordan Chamberlin with the Development Strategy and Governance Division of IFPRI provided key assistance in generating the travel-time market access variables that were used in the poverty trends analysis in Chapter 2.

Tigist Defabachew, Joy Fabela, and Shirley Raymundo of the Marketing, Trade, and Institutions Division of IFPRI provided excellent administrative support to the project, processing numerous research agreements, budget amendments, and other project documents.

We hope that this report will make a constructive contribution to the development of research methods and policies to reduce poverty and malnutrition in Tanzania, and we look forward to further opportunities to collaborate on similar topics.

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Table of Contents

List of Tables

List of Figures

1 Introduction

1.1 Background

Since the late 1980s, Tanzania has embarked on a series of wide-ranging reforms to allow markets to play a larger role in the economy. The impact of economic reforms, particularly agricultural market liberalization, on rural areas has been widely debated. Some argue that market liberalization has created new opportunities for farmers, particularly cash-crop growers. Others claim that the reforms have increased unemployment, widened the gap between the poor and the rich, and disadvantaged farmers by removing input subsidies. An intermediate position is that the reforms have benefited well-endowed households, but left behind others, particularly those in remote rural areas. The debate has suffered from a lack of comparable information regarding the trends and spatial patterns in poverty, inequality, and malnutrition.

Various institutions in Tanzania, particularly the National Bureau of Statistics (NBS), have carried out a number of nationally-representative surveys to study the patterns in poverty and malnutrition. As discussed in more depth later, the NBS carried out a Household Budget Survey in 1991 and again in 2000/01. This provides information on the incidence of poverty at the beginning and the end of the decade, but comparable estimates during the decade are not available. Furthermore, in order to compare poverty rates from two household surveys, it is necessary to address the difficult issue of adjusting the poverty line and income/expenditure estimates for changes in prices. Finally, these household data have not been used to examine whether there are differences in poverty trends between remote, isolated rural areas and those rural areas with relatively good market access.

With regard to nutrition data, Macro International and the NBS have carried out nationally representative Demographic and Health Surveys (DHS) in 1991, 1996, 1999, and 2003. Although these provide valuable information on nutritional patterns and trends since 1991, the sample sizes of the DHSs (around 4000 to 8000) do not allow estimates of malnutrition below the zone or region level. A more detailed map of nutritional patterns would make it easier to target nutritional programs and could shed light on some of the causes of malnutrition.

1.2 Objectives

In order to help fill this gap in the knowledge base, the International Food Policy Research Institute (IFPRI), with funding from the Rockefeller Foundation, carried out a project to examine patterns and trends in poverty and malnutrition over the 1990s and differences between rural areas with good and poor market access. In order to implement the project, IFPRI established a collaborative relationship with Research on Poverty Alleviation (REPOA), as well as with researchers with the Economic Research Bureau of the University of Dar es Salaam and the National Bureau of Statistics.

The project had five objectives:

- to estimate changes in poverty since 1990,
- to examine the impact of market access and agro-climactic variables on poverty in Tanzania,
- to estimate and map the spatial distribution of child malnutrition in Tanzania,
- to strengthen the capacity of Tanzanian institutions to use poverty mapping methods, and
- to disseminate the methods and results among analysts and policymakers in Tanzania.

One premise of the project is that additional information can be extracted from existing survey data. In particular, both the poverty trend analysis and the nutrition mapping analysis make use of a relatively new method called "small area estimation" or more commonly "poverty mapping." This study does not involve a traditional poverty mapping analysis, in which household budget data are combined with census data to generate estimates of poverty and inequality for small administrative units (such as wards). Rather, this study uses poverty mapping methods in new ways, as discussed below.

1.3 Project activities

The project was divided into four activities: collection of secondary data, capacity strengthening, data analysis, and dissemination of the results. Each is described below

Collection of secondary data: The project was designed to make better use of existing survey data rather than to collect new data. Thus, the project obtained and re-analyzed three household budget surveys, four Demographic and Health Surveys (DHSs), the 1988 Population Census, and GIS data on topography, rainfall, temperature, land cover, and various measures of market access.

Capacity strengthening: The project carried out three one-week training courses for 10-15 Tanzanian analysts from the University of Dar es Salaam, the National Bureau of Statistics, Research on Poverty Alleviation (REPOA), the Economic and Social Research Foundation (ESRF), Sokoine University of Agriculture, and other institutions. All three courses were given at the University Computing Centre of the University of Dar es Salaam and involved hands-on computer applications and exercises.

The first training course was on "The Use of Geographic Information Systems (GIS) for Economic Research in Tanzania." The course was given by Todd Benson and Michael Epprecht of IFPRI over 1-5 September, 2003.

The second course was "Using Stata for Survey Data Analysis in Tanzania." It was carried out 20-24 October 2003 and was given by Nicholas Minot and Ken Simler from IFPRI.

The third module was "Introduction to Poverty Mapping Methods with Applications to Tanzania." It was given by Nicholas Minot and Ken Simler over 19-23 January 2004.

Data analysis: The project involved two types of analysis. First, household budget survey data were combined with the results of four Demographic and Health Surveys (DHSs) to examine the trends in poverty and inequality between 1991 and 2003. We also explore the sensitivity of these results to changes in methods and assumptions. In addition, we looked at whether geographic variables such as market access help to explain patterns and trends in poverty.

Second, the 1991 DHS and the 1988 Census data were combined to explore the feasibility of "nutrition mapping," that is, generating a spatially disaggregated map of the prevalence of child malnutrition. These results are compared to the findings of other nutrition studies. Geographic variables are used to help predict child malnutrition.

Dissemination activities: The methods and results of this analysis have been disseminated in various ways. As mentioned above, the project carried out three one-week training courses to develop local capacity in the methods. Two workshops have been held to explain the methods and present preliminary results of the analysis, and a final workshop was held on 21 July 2005. This report and an accompanying policy brief represent the final outputs of the project.

1.4 Data and methods

The poverty trend analysis starts by using regression analysis on the 1991/92 Household Budget Survey to estimate per capita expenditure as a function of various household characteristics, including household size and composition, education, housing type, water source, and ownership of assets. Then, the estimated regression equation is applied to the same household characteristics in four Demographic and Health Surveys (DHSs), generating estimates of poverty and inequality for 1991, 1996, 1999, and 2003. These results are broken down by urban/rural, region, education level, and sex of head of household. Using GIS analysis, we also examine whether the level or the changes in poverty are related to the degree of market access, trying six different definitions of market access.

The nutrition mapping analysis follows a similar procedure. In this instance the outcome variable of interest in child nutritional status, as measured by children's height-for-age and weight-for-age. Regression analysis is applied to the 1991/92 DHS to estimate child malnutrition as a function of individual, household, and community characteristics. Next, the estimated regression equation is applied to the same individual and household characteristics in the 1988 Population Census to estimate the prevalence of child malnutrition at the sub-district-level. GIS variables are used in both the first and second stages to improve the predictive power of the model. The results are mapped at the district and sub-district level.

1.5 Summary of findings

The poverty trend analysis indicates that poverty has declined from 47 percent in 1991 to 38 percent in 2003. The poverty rate is lowest in Dar es Salaam, intermediate in other urban areas, and highest in the rural areas. The analysis suggests that Kigoma and Rukwa are the poorest regions, while Dar es Salaam, Arusha, and Kilimanjaro are the least poor. Mtwara, Morogoro, and Mwanza have seen the greatest improvement in poverty rates, while Dodoma is the only region where poverty appears to have increased between 1991 and 2003. Using other household surveys to estimate the prediction equation changes the regional ranking somewhat, but does not change the finding that poverty has declined over the 1990s.

The analysis is also used to examine trends in poverty across different types of households. Although poverty rates in male- and female-headed households have declined, the rates for male-headed households have declined more rapidly, leading to a widening gap between them. Further research is needed to explore the reasons for this, but the rising incidence of HIV/AIDS may be a factor.

In examining the relationship between poverty and market access, the results confirms the widespread view that households in more remote rural areas are poorer than those with better market access, at least according to some definitions of market access. Households farther from regional centers tend to be poorer, but there is no relationship between poverty and distance to road or distance to Dar es Salaam. On the other hand, the results of the analysis contradict the common view that remote rural areas have fallen behind in the process of market-led agricultural development. Remote rural households have enjoyed the same degree of poverty reduction as rural households with good market access (however defined). Furthermore, the gains in rural areas are similar to those in urban areas.

The nutrition mapping analysis generates estimates of the prevalence of child malnutrition at the level of the region, district, sub-district, and ward, a significant improvement over analysis of the DHS data which only supports disaggregation of results by rural/urban area of residence. The analysis shows that the difference in malnutrition rates between regions is relatively small compared to the differences in rates between areas within the same region. In particular, child malnutrition

rates tend to be much lower in urban areas—even fairly small urban areas—than in rural areas. This is found for both stunting (low height-for-age) and underweight (low weight-for-age). That said, it is also important to note that even though malnutrition rates are much lower in urban areas, the absolute number of malnourished in urban areas is still large, because of the higher population density.

1.6 Organization of the report

The report is organized into seven chapters. Chapter 2 describes the analysis of poverty trends, including a more detailed description of the data and methods, a review of poverty trends for different types of households, and an analysis of the relationship between market access and poverty. Chapter 3 carries out a sensitivity analysis on the poverty trends analysis, using a different household budget survey to estimate the relationship between per capita expenditure and household characteristics and comparing the results with those in Chapter 2. Chapter 4 examines the links between the agricultural sector and poverty, with the goal of providing a context for interpreting the results in Chapters 2 and 3. Chapter 5 provides a review of existing studies on patterns and trends in child malnutrition in Tanzania. Chapter 6 describes the methods and results of the nutrition mapping analysis, which combines DHS and census data to generate a high-resolution map of child malnutrition. Finally, Chapter 7 summarizes the main findings of the study and draws some implications for policy and further research.

The authorship of the chapters in this report are as follows:

Chapter	Authorship
2. Poverty trends in Tanzania: An alternative approach	Nicholas Minot (IFPRI)
3. Sensitivity analysis of poverty trends	Ahmed Makbel (NBS)
4. Link between agriculture and poverty	Eliab Luvanda (ERB)
5. Patterns and trends in child malnutrition	Blandina Kilama (REPOA)
6. Nutrition mapping: An exploratory analysis	Ken Simler (IFPRI)

In addition, Todd Benson provided essential GIS support, particularly for Chapters 2 and 6, as well as assisting with the data analysis in Chapters 3 and 5.

2 Poverty trends in Tanzania: An alternative approach[1]

2.1 Introduction

In the late 1980s, the government of Tanzania launched a program of reforms to reduce the role of the state in managing the economy and promote a greater role for the decisions of individual farmers, entrepreneurs, and consumers. The government removed extensive controls on consumer prices, liberalized agricultural markets, devalued the exchange rate (eventually allowing it to float), removed many import restrictions, lowered import tariffs, and closed or privatized a large majority of the state enterprises, which had been established in almost every sector of the economy.

In macroeconomic terms, the reforms have been relatively successful. After stagnation in the 1980s, the Tanzanian economy grew at 4-5 percent per year in the second half of the 1990s and 5-6 percent over the past few years. Budget deficits have been brought under control, and inflation has been reduced to less than 5 percent.

The impact of the economic reforms on standards of living remains controversial. Some observers, particularly economists, argue that market liberalization has created new opportunities for farmers, particularly in high-value agriculture for sale to the cities or for export. Another view, more common among ordinary Tanzanians, is that the reforms have increased unemployment, widened the gap between the poor and the rich, and hurt farmers by removing price guarantees and input subsidies. Even many of those that believe the economic reforms have had a generally positive impact on Tanzanian standards of living doubt that the benefits have reached less-well endowed rural households in remote areas. Anecdotal evidence, as well as a plausible economic argument, support the widespread view that households in remote rural areas have been "left behind" by economic growth. However, there is no solid quantitative evidence of this pattern in Tanzania to our knowledge.

These issues are important because they affect the design and implementation of the Poverty Reduction Strategy Programme (PRSP), as well as the rural development strategy more generally. Better information on trends in poverty would help government agencies and international organizations understand and guide the impact of policy reforms. More accurate data on the spatial patterns in poverty would help efforts to target assistance to the poorest areas.

The objective of this chapter is to examine the trends in poverty and inequality over the 1990s. In particular, we address the following questions:

- Has poverty increased or decreased during the 1990s, a period of extensive market liberalization?
- What types of households have gained or lost as a result of these changes?
- Have households in poor, remote areas been "left behind" other rural areas in terms of growth?

1 *This chapter was prepared by Nicholas Minot, Senior Research Fellow, International Food Policy Research Institute. Todd Benson (IFPRI) and Jordan Chamberlin (IFPRI) assisted in generating the GIS variables to measure market access.*

Figure 2.1

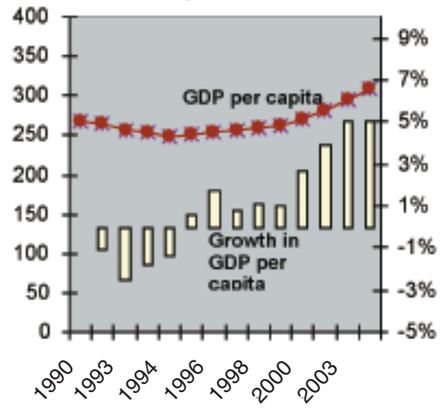


Figure 2.1. Trends in GDP per capita in Tanzania

Source: World Bank Development Indicators

This chapter develops a new approach for measuring medium-term trends in poverty and inequality, drawing from both the small-area estimation method (Hentschel et al, 2000 and Elbers et al, 2003) and the asset index method (Filmer and Pritchet, 1998). We use the 1991/92 Tanzanian Household Budget Survey (HBS) to estimate the relationship between per capita expenditure and various household characteristics. This relationship is then applied to the same household characteristics in the Tanzanian Demographic and Health Surveys, carried out in 1991/92, 1996, 1999, and 2003 to estimate the incidence of poverty and level of inequality in each of those years[2]. We then use GIS analysis to compare levels and trends in poverty and inequality between urban areas, rural areas with good market access, and remote rural areas.

2.2 Background

At least four approaches have been used for measuring trends in poverty in developing countries. One approach is to infer changes in the incidence of poverty directly from changes in income or gross domestic product (GDP) per capita. This relationship is sometimes described in terms of the elasticity of poverty with respect to growth in per capita income or GDP. One study used survey data from 88 countries and estimated a poverty elasticity of -2.39, meaning that a one percent increase in per capita income was associated with a 2.39 percent reduction in the incidence of poverty. The elasticity for sub-Saharan Africa was 1.67 (Chen and Ravallion, 2001). A more recent study using GDP data from 14 developing countries found an elasticity of -1.7 (AFD, BMZ, DfID, and World Bank,2005).

Figure 2.1 shows the level and growth rates of real GDP per capita in Tanzania over 1990-2003. GDP per capita declined in the early 1990s but has grown since 1995, accelerating to 5 percent per year recently. The average annual growth in GDP per capita between 1991/92 and 2003 was 1.47 percent. Using a poverty elasticity of -1.7, we would expect the incidence of poverty to have fallen about 12 percentage points over this period[3]. Using GDP per capita measured at purchasing power parity instead would imply a reduction in poverty of about 10 percentage points.

A second approach is to compare the results of household budget surveys carried out in different years. Typically, this involves a comparison of some welfare measure, such as income or expenditure,

2 *The 1999 survey wqs called the Reproductive and Child Health Survey and the 2003 survey was called the Tanzania HIV/AIDS Indicator Survey, but all four surveys were carried out under the technical supervision of Macro International, the sampling is quite similar, and the variables we used are based on identical questions. For convenience, we refer to all four as DHS surveys.*

3 *The growth in GDP per capita is 1.47 percent per year, so decline in poverty would be 1.7 x 1.47 = 2.50 percent per year. Over 11 years, this implies a decrease by a factor of $(1-.0.25)^{11} = 0.75$. Starting from a poverty rate of 48 percent, this would be a reduction to 48*0.75 = 0.36 or 12 percentage points.*

Figure 2.2

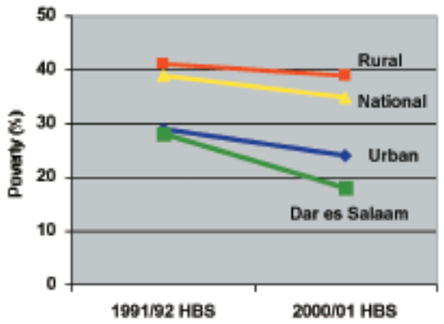


Figure 2.3

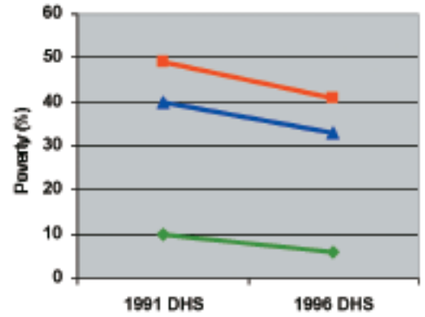


Figure 2.2. Incidence of poverty in Tanzania according to the Household Budget Surveys

Source: NBS (2002)

Figure 2.3. Incidence of poverty in Tanzania according to an asset index

Source: Stifel et al, 1999

adjusted for household size and changes in the cost of living between the two surveys. But survey results are often difficult to compare in developing countries due to changes in the questionnaire and sampling method, as well as problems adjusting for inflation. Eele et al (2000) reports that seven household surveys were carried out in Tanzania between 1983 and 1999. They note that "comparison between surveys, however, is complicated by differing methodologies, definitions, and populations covered" (p 69). They also list the problems of the valuation of non-marketed food production, small sample sizes, the lack of an official poverty line, and inflation, which resulted 40-fold increase in poverty lines from 1983 to 1998. Sarris and Tinios (1994) show that estimates of the change in poverty between two household surveys are very sensitive to seemingly arbitrary decisions regarding how to adjust for inflation.

Many of these problems were addressed with the implementation of the 2000/01 Household Budget Survey (HBS). A comparison of the 1991/92 and 2000/01 HBSs, including re-analysis of the earlier HBS to improve comparability, found that poverty declined from 38.6 percent in 1991/92 to 35.7 percent in 2000/01 (NBS, 2002). This study found that poverty declined the most in Dar es Salaam and the least in rural areas. It should be noted that the re-analysis of the 1991/92 HBS resulted in a rural poverty rate that was 16 percentage points lower than in the original analysis and an urban poverty rate that was 22 percentage points higher (see NBS, 2002 and Table 3.1). The re-analysis undoubtedly gives a better comparison, but the large change in the results highlights the sensitivity of poverty estimates to the methods used to define the poverty line.

A third approach is to construct an asset index based on household surveys that do not collect income or expenditure data. The asset index combines information about housing characteristics, source of water, sanitation, and ownership of consumer durables into an index using weights that are generated from principal component analysis (Filmer and Pritchit, 1998) or cluster analysis (Stifel et al, 2003). The asset index approach is typically based on data from the Demographic and Health Surveys (DHS), that have been carried out 2-3 times in many developing countries. Although the results are robust to alternative specifications, it is difficult to evaluate the accuracy of the asset index as a measure of income or expenditure. In addition, these analyses do not use a poverty line so poverty is defined in relative terms. Usually, the bottom 40 percent of the population in the first DHS is defined as poor. Figure 2.3 shows the estimates of relative poverty for Tanzania based on the 1991 and 1996 DHSs (Stifel et al, 1999). According to this analysis, if poverty is defined to be 40 percent in 1991, the change in the asset index implies a decrease in poverty to 33 percent in 1999.

A fourth approach is to develop an index based on available measures of health, education, and nutrition. Sometimes called basic needs indicators, these measures often give equal weight to each indicator or attach subjective weights based on the perceived importance of each indicator. The Human Development Index (HDI), developed and monitored by the United Nations Development Programme, falls into this category. It is based on life expectancy, adult literacy, and GDP per capita. Figure 2.4 gives the value of the HDI for Tanzania for selected years since 1990. The index declines

Figure 2.4

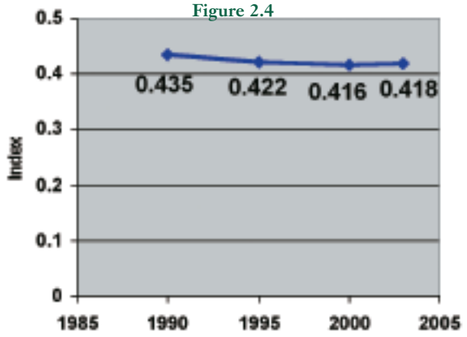


Figure 2.4. Human Development Index for Tanzania

Source: UNDP , 2005.

over the 1990s, implying worsening conditions, but increases slightly between 2000 and 2003. The HDI can be used at the sub-national level as well (see REPOA, 2003). The main disadvantage of the HDI and other basic needs indicators is that the choice of indicators and the weights attached to each are somewhat arbitrary.

2.3 Data and methods

In the last five years, a new approach has been developed to estimate poverty for small areas (such as districts) by combining data from a household expenditure survey and a census (Minot, 2000; Hentschel et al, 2000; Elbers et al, 2003). The idea is to use the household survey to estimate the relationship between poverty and a set of household characteristics, and then apply this relationship to the same household characteristics in the census data. This method has been applied in a growing number of countries (Henninger and Snel, 2003). However, census data are typically available only every ten years, making it difficult to use this approach to describe medium-term trends. Although often called "poverty mapping", this approach can be used to generate small-area estimates for any variable that can be predicted using household characteristics.

This chapter uses a new method for estimating trends in poverty in the medium term that draws from both the asset index approach and small-area estimation methods. To implement this method, we select household characteristics that are available in both a household budget survey and the Demographic and Health Surveys for that country. Typically, these variables include the size and composition of the household, the education of household members, the sex and ethnicity of the head of household, housing characteristics (type of roof, floor, and walls), source of water, type of toilet, whether or not the house has electricity, and ownership of consumer durables such as radios, bicycles, and motor vehicles.

The next step (called "Stage 1" in the small-area estimation literature) is to use the household budget survey to estimate per capita expenditure (y_i) as a function of these household characteristics (X_i). In order to reduce heteroskedasticity and ensure that the residuals in the regression approximate a normal distribution, we follow the convention of using a semi-log functional form:

(1) $$\ln(y_i) = X_i\beta + e_i$$

In Stage 2 of the standard small-area-estimation method, the regression coefficients from Stage 1 would be applied to the same household characteristics from census data to generate spatially disaggregated estimates of poverty. In this chapter, we apply the regression coefficients to the same household characteristics from Demographic and Health Surveys (DHS). Hentschel et al. (2000) show that the expected value of the probability that household i is poor (Pi) can be described as follows:

(2) $$E\left(P_i \mid X_i^C, \beta, \sigma\right) = \Phi\left[\frac{\ln(z) - X_i^{DHS}\beta}{\sigma}\right]$$

and that a consistent estimate of the incidence of poverty for a set of households is simply the average of these household probabilities[4]. Although we lose the spatial resolution available from the census data, we gain a temporal dimensions from the fact that DHS surveys have been carried out several times in many developing countries (four times in Tanzania). The similarity of the questionnaires and sampling method, as well as the generally high quality of the data generated, make the DHS surveys a useful tool in measuring trends over time.

An important assumption of this approach is that the model for predicting income based on household characteristics is valid over the range of years covered by the DHS surveys. In other words, we assume that the regression coefficients (β) are constant over the 1990s and that any changes in poverty are reflected in changes in the household characteristics (X_i). Although this assumption is standard in the asset index literature, in Chapter 3 we report on the results of sensitivity analysis to test this assumption.

We apply this method in Tanzania by using the 1991/92 Household Budget Survey (HBS) for the regression analysis in Stage 1. The 1991/92 HBS covered 4750 households in mainland Tanzania, using a stratified random cluster sample[5]. The survey collected data on income, expenditure, the characteristics of household members, ownership of assets, and housing characteristics. Stage 2 of the analysis uses four Demographic and Health Surveys carried out in Tanzania in 1991/92, 1996, 1999, and 2003. The surveys employed almost identical questionnaires and sampling methods. The 1991/92 and 1996 surveys had samples of 8,327 and 7,969 households, respectively, selected from the same 357 clusters (see Figure 1). The 1999 survey was smaller, using a sample of 3,615 households selected from 176 clusters that were a subset of the original clusters. And the 2003 survey had a sample of 6,499 households selected from 345 clusters. The DHS surveys collect information on characteristics of household members, ownership of a few assets, and housing characteristics, as well as a wide range of health and nutrition variables.

In what could be called Stage 3 of the analysis, the results from Stage 2 are then combined with geographic information system (GIS) data to explore the relationship between rural poverty and market access in Tanzania and whether this relationship changed over the 1990s. We use six definitions of market access: straight-line distance to the nearest road, straight-line distance to the nearest regional center[6], and travel time to cities and towns in four size-categories. To link the DHS poverty data and the GIS market access data, we identified the geographic coordinates of the DHS clusters. This was possible for 329 of the 357 clusters in the first two DHS surveys[7], and all of the 1999 DHS clusters. At the time this analysis was carried out, the geographic coordinates of the clusters in the 2003 DHS were not available, so the Stage 3 analysis is limited to the first three DHS surveys.

The straight-line distance from these clusters to the nearest roads and regional centers was calculated using the software ArcView. The four travel-time measures were generated with a raster analysis that measured the distance along the road network, with weights for each type of road to convert distance into travel time. This analysis, carried out with ArcInfo, created a country-wide "surface" for each of the four travel-time market access variables, from which the values corresponding to each DHS cluster were selected (Figure 2.1 shows the values of travel time to a secondary town on a map of Tanzania). The final result is a database with poverty estimates at the household level and GIS variables at the cluster level[8].

4 *Typically, the poverty rate is calculated as a weighted average, taking into account the sampling weights of the census (if any) and the size of the households. This results in an estimate of the proportion of people below the poverty line rather than the percentage of households below the line.*

5 *Asset data are missing for 14 households in the HBS, so the sample that we used for the regression analysis included 4,736 households.*

6 *During the 1990s, mainland Tanzania was divided in to twenty administrative regions, each with an administrative center. Recently, an additional region was created*

7 *Twenty eight clusters in the 1996 and 1999 DHS surveys could not be found in GIS databases of places in Tanzania, nor on paper maps of the country.*

8 *Macro International, the Research firm that conducts the Demographic and Health Surveys, kindly provided the geo-coordinates for the 176 clusters in the 1999 survey. Todd Benson geo-coded another 156 clusters, compiled GIS variables, and calculated some of the market access indicators. Jordan Chamberlin calculated the travel-time measures of market access.*

2.4 Results

The results of the analysis are divided into three sections. First, we describe the regression analysis used to predict per capita expenditure as a function of household characteristics, using household survey data from Tanzania. Then, we present estimates of Tanzanian poverty between 1991 and 2003 derived from applying the regression models to the household characteristics in the four DHSs. Finally, these poverty estimates are used to analyze econometrically the relationship between poverty and various definitions of market access.

2.4.1 Predictors of household welfare

In this section, data from the 1991/92 Household Budget Survey (HBS) are used to estimate the logarithm of per capita expenditure as a function of household characteristics, as shown in equation (1). Although the HBS collected information on many more variables that could be used to "predict" per capita expenditure, we are limited to those that are also available in the four Demographic and Health Surveys (DHS) carried out in Tanzania.

The sample of the 1991/92 HBS is divided into four strata: Dar es Salaam, large towns, small towns, and rural areas. A Chow test indicates that the coefficients in the four strata are significantly different from each other, so separate regressions were run for each stratum. Ordinary least squares (OLS) models were used to carry out some diagnostic tests. The Breusch-Pagan test indicates the presence of multiplicative heteroskedasticity in two of the four models (Dar es Salaam and large towns). We address this problem by using the Huber/White/sandwich estimator of the standard errors, which is consistent under heteroskedasticity. The Ramsey RESET test, using powers of the predicted values, suggests the omission of variables in the same two models. In spite of adding squared terms and additional variables, we were not able to address this problem. The variance inflation factors (VIF) were calculated to test for multicollinearity. Two variables in the Dar es Salaam model had VIF values over 20, the conventional limit, are were removed.

Next, the four models were run using the *svyregrss* command in Stata which takes into account the stratification and clustering of the HBS sample and, as mentioned above, calculates Huber/White/ sandwich standard errors. Individual variables and sets of dummy variables were removed if they were not statistically significant at the p=0.20 level. Note that we are not concerned about likely endogeneity of some of the explanatory variables (e.g. ownership of consumer goods) in the models because we are only interested in generating a model to predict per capita expenditure.

Table 2.1 gives the results of the final models. Some coefficients were statistically significant in all four models: household size, household size squared, and ownership of a radio, refrigerator, and car. The sets of dummy variables representing the age-sex composition of the household, the education of the head of household, and the region are each jointly significant, based on the F-test. Somewhat surprisingly, the poverty rate does not vary significantly between male- and female-headed households, after controlling for other factors. The coefficients representing the education of the spouse were jointly significant only in the rural model. The signs of the coefficients are broadly consistent with expectations: the coefficients on ownership of consumer goods and electricity are uniformly positive, while the coefficient on earth floors is negative.

The overall fit of the four models is relatively good, with the value of R^2 ranging from 0.42 to 0.53. This is toward the upper range of similar prediction models carried out as part of poverty mapping analyses in other countries (see Henninger and Snel, 2003).

2.4.2 Poverty estimates for different types of households

The regression equations described in the previous section are then applied to the same household characteristics in the Tanzanian Demographic and Health Surveys (DHS) of 1991/92, 1996, 1999, and 2003. The result is an estimate of the per capita expenditure for each household in the four DHS surveys. This estimate is transformed into the probability that the household is poor using equation

Table 2.1. Regression models of per capita expenditure based on the 1991/92 HBS

	Dar es Salaam		Large towns		Small towns		Rural areas	
	N = 1107		N = 794		N = 664		N = 2171	
	R2 = 0.5034		R2 = 0.4279		R2 = 0.5268		R2 = 0.4178	
	Coefficient	**t-statistic**	**Coefficient**	**t-statistic**	**Coefficient**	**t-statistic**	**Coefficient**	**t-statistic**
Household size	-0.25492	-8.91 ***	-0.224030	-2.79 ***	-0.252674	-5.74 ***	-0.159395	-10.27 ***
Households size squared	0.00972	4.54 ***	0.011910	2.20 **	0.011629	4.38 ***	0.004886	6.59 ***
% males under 5 yrs	0.00539	3.30 ***	0.001294	0.32	0.002042	0.64	0.003574	1.91 *
% females under 5 yrs	0.00555	3.02 ***	0.000240	0.07	0.001382	0.33	0.001045	0.75
% males 5-15 yrs	-0.00012	-0.09	-0.012338	-1.73 *	-0.002905	-0.93	-0.001735	-1.23
% females 5-15 yrs	0.00028	0.25	-0.003835	-1.1	-0.005580	-2.38 **	-0.001598	-1.03
% males 16-30 yrs	-0.00059	-0.66	-0.002234	-1.18	-0.000363	-0.17	0.000734	0.71
% females 16-30 yrs	0.00092	1.26	-0.003077	-1.54	-0.002251	-1.14	0.000172	0.12
% females 31-55 yrs	-0.00030	-0.22	-0.002818	-2.67***	-0.002908	-1.23	-0.000399	-0.25
% males over 55 yrs	0.00243	1.15	-0.001686	-0.44	-0.005041	-2.15 **	0.003162	2.48 **
% females over 55 yrs	0.00233	1.24	-0.001034	-0.42	-0.001228	-0.36	0.000748	0.54
Female head								
Age of head	-0.00357	-2.61 **	-0.001256	-0.53				
Head has some primary schooling	0.01550	0.24	0.279551	2.34**	0.243244	2.69 ***	0.086257	2.39 **
Head finished primary school	-0.10593	-1.32	0.527486	3.57***	0.391461	3.04 ***	-0.012855	-0.18
Head has some second. Schooling	0.04493	0.57	0.237551	1.48	0.386034	3.87 ***	0.230773	1.93 *
Head finished upper sec school	0.19154	2.51 **	0.321873	2.24**	0.401873	3.32 ***	0.042039	0.65
Spouse has some primary schooling							0.052134	1.52
Spouse finished primary school							0.358541	2.64 ***
Spouse has some second. Schooling							0.177469	1.11
Spouse finished upper sec school							-0.019249	-0.33
Floor of house made of earth	-0.17159	-3.99 ***	-0.288577	-2.67***			-0.205615	-3.76 ***
Water from indoor pipe	0.28188	4.82 ***			0.193219	1.05		
Water from outdoor pipe					0.148876	1.44		
Water from well					-0.154783	-1.19		
Flush toilet					0.246282	1.44		
Latrine					0.240432	2.24 **		
House has electricity					0.121323	1.51		
Radio ownership	0.08130	1.87	0.127064	1.49	0.304930	2.90 **	0.293940	7.62 ***
Television ownership	0.23464	2.02 **	0.345648	1.22				
Refrigerator ownership	0.30908	5.88 ***	0.191551	1.80*	0.368204	2.57 **	0.426404	1.48
Motorbike ownership							0.149271	1.50
Car ownership	0.33038	2.75 ***	0.434943	2.45**	0.263515	1.66	0.240083	1.97 **
Constant	10.99431	85.61 ***	10.56714	38.72***	9.823588	29.81 ***	-0.34683	-1.81 *

Source: 1991 Tanzanian Household Budget Survey

** = significant at the 10 percent level, ** = significant at the 5 percent level, *** = significant at the 1 percent level*

Note: Dependent variable is log of per capita expenditure. Coefficients of regional dummy variables omitted to save space.

Figure 2.5

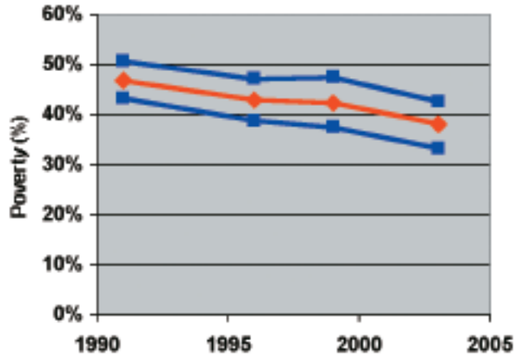


Figure 2.5. Poverty trends in mainland Tanzania (with 95% confidence intervals)

Source: See Table 2.2

(2) and averaged over groups of households to obtain estimates of the incidence of poverty. Throughout this chapter, the "poverty rate" refers to the estimated headcount poverty ratio, that is, the share or percentage of the population living in a household whose per capita expenditure is below the basic needs poverty line.

Mainland Tanzania

Table 2.2 presents the poverty estimates for each year of the DHS and for different household groups. The most notable finding is that the overall poverty rate in mainland Tanzania has fallen almost 9 percentage points, from almost 47 percent in 1991/92 to 38 percent in 2003 (see Figure 2.5). How credible is this result? We examine four possible questions regarding the plausibility of these findings.

First, are the estimated poverty rates for 1991/92 consistent with the measured poverty rates from the 1991/92 Household Budget Survey? Our poverty estimate for 1991/92 is 46.8 percent, which is less than half a percentage point from the basic needs poverty rate (47.1 percent) estimated directly from the 1991/92 Household Budget Survey (NBS and OPM, 2000). The 1991/92 poverty rate for Dar es Salaam is 3.6 percent, close to the HBS estimate of 3.1 percent, while the 1991/92 rural poverty rate is 52.9 percent, somewhat lower than the HBS estimate of 56.3 percent.

Second, is the change in poverty statistically significant or could it be due to imprecision in estimating expenditure or sampling errors in the DHS surveys? Using formulas developed by Hentschel et al (2000), we calculate that the standard errors of the poverty estimates (see Table 2.8). They imply that the 95% confidence interval around each estimate is ±4-5 percentage points (see Figure 2.5). Based on these standard errors, the change in overall poverty in mainland Tanzania between 1991/92 and 2003 is statistically significant at the 1% confidence level.

Third is the decline in poverty derived from improvements in a small number of household indicators or a broad set of indicators? The latter would be a more credible sign of improved living conditions. Table 2.3 shows that only one of the 20 indicators suggests deteriorating living conditions, three show no change, and 16 suggest improved living conditions. This means that our estimate of poverty reduction in Tanzania is based on improvement in a broad range of household indicators.

Fourth, are these results consistent with the findings of the two Household Budget Surveys (HBSs)? According to a comparison of the 1991/92 HBS and the 2000/01 HBS, the incidence of poverty declined just 2.9 percentage points over the 1990s (see NBS, 2002 and Section 3.2 of this report). However, unlike the HBS comparison, our analysis includes the 2000/01-2003 period, during which real GDP per capita grew 4.8 percent per year. If we limit ourselves to the period from 1991/92 to 1999, our analysis gives a 4.4 percentage point decline in poverty, still larger than the HBS estimate but much closer. Thus, our analysis does imply more progress in poverty reduction than the comparison of HBSs, but the discrepancy is less than it first appears.

Table 2. 2. Incidence of poverty by year and by household category

	Year				Change from
	1991/92	1996	1999	2003	1991-2 to 2003
Tanzania mainland	0.468	0.429	0.424	0.380	-0.088
Urban category					
Urban	0.247	0.199	0.188	0.175	-0.072
Rural	0.529	0.484	0.492	0.450	-0.079
Stratum					
Dar es Salaam	0.036	0.041	0.033	0.045	0.009
Large towns	0.184	0.165	0.118	0.173	-0.011
Small towns	0.345	0.305	0.296	0.302	-0.043
Rural areas	0.529	0.484	0.492	0.450	-0.079
Zone					
Coast	0.385	0.346	0.371	0.265	-0.120
Northern Highlands	0.284	0.304	0.261	0.219	-0.065
Lake Zone	0.498	0.440	0.477	0.411	-0.087
Central Zone	0.520	0.550	0.526	0.517	-0.003
Southern Highlands	0.590	0.528	0.508	0.471	-0.119
Southern Zone	0.513	0.460	0.438	0.400	-0.113
Sex of head of household					
Male	0.469	0.422	0.416	0.367	-0.102
Female	0.465	0.460	0.461	0.430	-0.035
Education of household head					
No schooling	0.576	0.547	0.555	0.536	-0.040
Some primary school	0.490	0.459	0.410	0.397	-0.093
Completed primary school	0.343	0.345	0.354	0.336	-0.007
Some secondary school	0.137	0.128	0.121	0.131	-0.006

Source: Based on analysis of the 1991/92 Household Budget Survey and the Demographic and Health Surveys of 1991/92, 1996, 1999, and 2003.

Note: Incidence of poverty refers to the proportion of the population living in households with per capita consumption expenditure below the poverty line.

Table 2.3. Trends in the household characteristics used to predict per capita expenditure

Household characteristic	1991/92	1996	1999	2003	Implication for living conditions
	Percent of households				
Urban households	18%	24%	33%	24%	↑
Radio ownership	33%	41%	43%	56%	↑
Television ownership	0%	1%	2%	5%	↑
House has electricity	7%	9%	8%	11%	↑
Bicycle ownership	21%	32%	32%	38%	↑
Motorbike ownership	1%	1%	1%	1%	=
Car ownership	1%	1%	1%	2%	↑
Water from indoor tap	11%	8%	3%	4%	↓
Water from outside tap	22%	28%	34%	30%	↑
Water from well	29%	29%	38%	36%	↑
Water from other source	38%	35%	25%	30%	↑
Flush toilet	1%	2%	1%	4%	↑
Latrine	85%	86%	87%	84%	=
Other toilet	14%	12%	12%	12%	↑
House has earth floor	80%	79%	79%	71%	↑
Head has no schooling	39%	34%	33%	27%	↑
Head has some primary schooling	25%	23%	23%	19%	↑
Head has completed primary	30%	36%	39%	46%	↑
Head has some secondary	5%	5%	5%	5%	=
Head has completed secondary	1%	2%	1%	3%	↑

Source: Calculated from the DHS surveys of 1991/92, 1996, 1999, and 2003.

Figure 2.6

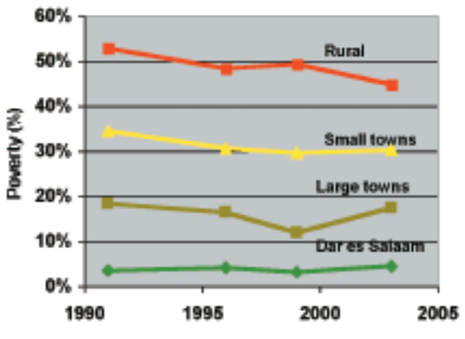


Figure 2.6. Poverty trends in urban and rural areas

Figure 2.7

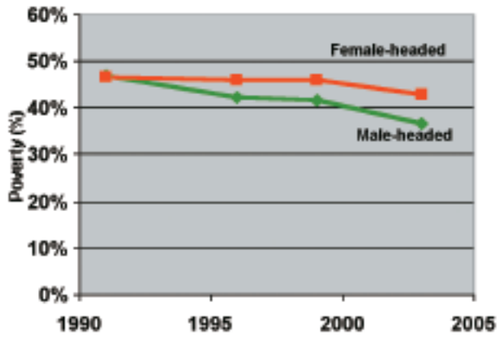


Figure 2.7. Poverty trends by sex of head of household

Source: See Table 2.2

Fifth, are these results consistent with the trends in GDP per capita over the same period? As discussed in Section 2.2, based on average relationship between income growth and poverty reduction in two cross-country studies, the growth in Tanzanian GDP between 1991/92 and 2003 should reduce poverty by 10-12 percentage points. Of course, individual countries differ from the average pattern, but our estimate of a 9 percentage point decline in poverty is certainly consistent with these international patterns. Looking at the trends within this period, our results show the greatest poverty reduction per year occurring between 1999 and 2003, which is also the period of fastest GDP growth since 1991. One area where our results are not consistent with GDP trends is in the first half of the 1990s: GDP per capita declined during this period, but our results show a decline in poverty over the same period.

Urban and rural areas

Table 2.2 also indicates that poverty declined 7.2 percentage points in urban areas and 7.9 percentage points in rural areas. This contradicts the widespread view that the benefits of growth have been concentrated in urban areas. The overall decline in poverty (9.9 percentage points) was greater than the decline in either urban or rural areas. The explanation for this apparent paradox is that the share of the population living in urban areas, where poverty is lower, increased from 18 percent in 1991/92 to 24 percent in 2003. Thus, the change in the composition of the population contributed to poverty reduction, in addition to changes within urban and rural areas[9].

Interestingly, the poverty reduction in urban areas does not come from gains in Dar es Salaam, where poverty was essentially unchanged over the period under consideration. Rather the urban poverty reduction is due to declines in poverty in small towns and, to a lesser degree, large towns, along with migration toward larger centers (see Figure 2.6). One hypothesis is that during the 1990s, economic reforms resulted in a more geographically decentralized pattern of growth, now that the public sector and state enterprises (most of which were based in Dar es Salaam) play a smaller role in economic decisions.

9 *The standard errors for these poverty estimates is generally between 0.02 and 0.04 (see Table 2.8 in the Annex). This implies a 95% confidence interval of ± 4-8 percentage points. The change in rural poverty between 1991/02 and 2003 is statistically significant at the 5% confidence level*

Figure 2.8

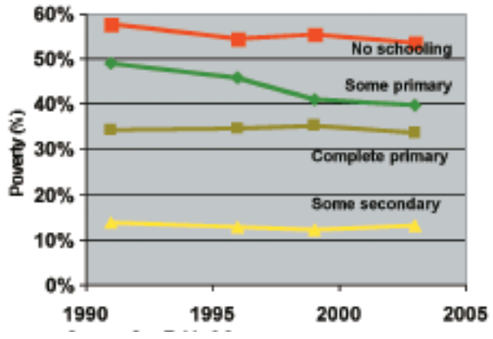


Figure 2.9

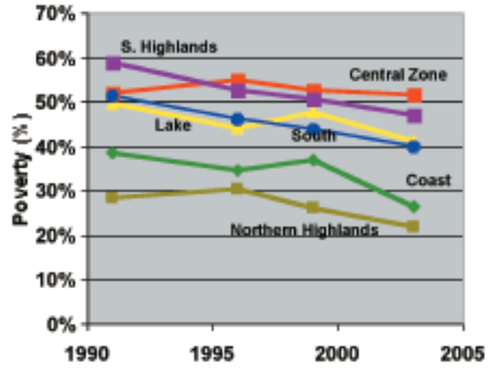


Figure 2.8. Poverty trends by education of head of household

Figure 2.9. Poverty trends by zone

Source: See Table 2.2

Sex of head of household

The poverty rate among female-headed households was roughly equal to that of male-headed households in 1991/92. Over the next 12-13 years, however, poverty among male-headed household appears to have declined substantially (about 10 percentage points), while that of female-headed households has declined much less (about 3.5 percentage points) (see Table 2.2 and Figure 2.7). This pattern is particularly strong in urban areas, where the poverty rate among female-headed household did not change over the decade. One hypothesis is that female-headed households have been less able to take advantage of new market opportunities provided by the economic reforms due to cultural norms, the demands of child care, or other factors. Alternatively, the growing problem of HIV/AIDS may mean that many of these female-headed households are AIDS widows, who would have faced costs associated with the illness and incapacity of their husbands. The DHS data indicate that the proportion of female-headed households has increased from 19 percent in 1991/92 to 23 percent in 2003.

Education of head of household

Figure 2.8 and Table 2.2 show the poverty trends by the educational level of the head of household. The results confirm the strong negative relationship between education and poverty. The incidence of poverty is more than four times greater among households in which the head has no education compared to those in which the head has at least some secondary education. The results also suggest that the gains in poverty reduction have been greater among less educated households. The poverty reduction among households with a head with no education or some primary was 4 and 9 percentage points, respectively. However, households in which the head had completed primary school had virtually unchanged poverty rates. This suggests that less educated households (typically poor households in rural areas) have gained at least as much as more educated households, suggesting that the benefits of economic growth have not been limited to a small elite.

Geographic zone

The headcount poverty rates by geographic zone are presented in Table 2.2 and Figure 2.9. The poverty ranking of zones appears to be fairly stable over the decade. The lowest poverty rates are in the Northern Highlands, which benefits from horticultural production, tourism, and trade with Kenya. The Central Zone is among the poorest two zones in all four periods, probably reflecting the low and variable rainfall that affects this region.

The Coast, Southern Highlands, and Southern zones saw poverty decline by more than 10 percentage points between 1991/92 and 2003. The Coast probably benefited from population growth in

Dar es Salaam[10], while the South has gained from the dramatic growth in cashew nut production and exports (see Chapter 4). In 1998, Mtwara and Lindi accounted for 80 percent of Tanzanian cashew nut production (URT, 2000). The strong poverty reduction in the Southern Highlands is somewhat surprising because this zone (the main maize-surplus zone in Tanzania) is said to have been hurt more than other regions by market reforms that eliminated fertilizer subsidies and removed maize price supports. On the other hand, it is a region with good agricultural potential, so perhaps it has gained from market reforms and, in particular, from the gradual opening of cross-border trade with Zambia. The Northern Highlands and the Lake zones had significant but not dramatic reductions in poverty, but the Central Zone shows no poverty reduction over this period. The Central Zone is subject to low and variable rainfall and is vulnerable to periodic droughts.

Region

The estimated poverty rate for each region in Tanzania for each year the DHS was carried out is shown in Table 2.4. The regional poverty estimates should be interpreted with caution because the DHS sample size within each region is small, just 300 households on average for each year. The 95% confidence interval is typically ±11-12 percentage points for poverty estimates for 1991/92, 1996, and 2003 and 15 percentage points for 1999, whose DHS had a smaller sample (see Table 2.9). In comparing two typical regions in one year, the difference in poverty rates must generally be greater than 16 percentage points to be statistically significant at the 5% confidence level[11].

With these qualifications in mind, the region with the lowest poverty rate is, not surprisingly, Dar es Salaam (5 percent in 2003), followed by Kilimanjaro and Arusha (21 and 23 percent in 2003). These three regions keep their ranks of first, second, and third in every year except 1996 when Arusha slipped to 5th. Located in the Northern Highlands, Arusha and Kilimanjaro benefit from tourism, trade with Kenya, and good soils and rainfall which allow the production of horticultural and other high-value crops. Arusha is the second largest city in Tanzania after Dar es Salaam. Kagera and Mwanza, are consistently among the least poor regions, according to our analysis. These two Lake Zone regions benefit from the growing fishing industry on Lake Victoria (see Chapter 4), and Kagera is an important coffee-producing region.

Source: Based on analysis of the 1991/92 Household Budget Survey and the Demographic and Health Surveys of 1991/92, 1996, 1999, and 2003.

Note: Incidence of poverty refers to the proportion of the population living in households with per capita consumption expenditure below the poverty line.

Table 2.4. Incidence of poverty by year and by region

	Year								Change over
	1991/92		1996		1999		2003		1991-2003
	Rate	Rank	Rate	Rank	Rate	Rank	Rate	Rank	
Dodoma	0.50	11	0.56	18	0.53	16	0.54	18	0.04
Arusha	0.33	3	0.36	5	0.30	3	0.23	3	-0.10
Kilimanjaro	0.24	2	0.22	2	0.19	2	0.21	2	-0.03
Tanga	0.52	13	0.49	14	0.50	12	0.43	13	-0.09
Morogoro	0.50	12	0.47	12	0.45	9	0.36	8	-0.14
Coast	0.56	16	0.49	13	0.61	18	0.45	14	-0.11
Dar es Salaam	0.08	1	0.07	1	0.03	1	0.05	1	-0.03
Lindi	0.48	9	0.38	7	0.42	8	0.38	9	-0.09
Mtwara	0.58	17	0.54	15	0.51	13	0.42	12	-0.16
Ruvuma	0.47	7	0.42	10	0.33	4	0.40	11	-0.08
Iringa	0.61	18	0.54	15	0.53	15	0.49	17	-0.12
Mbeya	0.48	9	0.40	9	0.41	7	0.35	6	-0.12
Singida	0.56	15	0.55	17	0.52	14	0.48	15	-0.08
Tabora	0.46	6	0.37	6	0.47	10	0.36	7	-0.10
Rukwa	0.78	19	0.73	19	0.74	19	0.69	19	-0.09
Kigoma	0.78	20	0.76	20	0.75	20	0.72	20	-0.06
Shinyanga	0.53	14	0.47	11	0.55	17	0.49	16	-0.04
Kagera	0.39	4	0.36	4	0.40	6	0.30	5	-0.09
Mwanza	0.42	5	0.34	3	0.36	5	0.29	4	-0.13
Mara	0.47	8	0.39	8	0.48	11	0.39	10	-0.08
Mainland	0.47		0.43		0.42		0.38		-0.09

10 *Although our results indicate that the poverty rate in Dar es Salaam did not decline over the 1990s, the share of the population living in Dar es Salaam has increased. An increase in the share of the population living in Dar es Salaam (located in the Coast Zone) would reduce the poverty rate of the zone.*

11 *These "typical" results are based on the median standard errors in Table 2.9.*

The poorest regions, according to our analysis, are Kigoma and Rukwa, with poverty rates of around 70 percent in 2003. This is not surprising given that they are both remote, largely rural regions on the western border of Tanzania. Most of the population in these two regions derives their living from semi-subsistence production of maize, cassava, and bananas. Dodoma, and Singida, in the semi-arid Central Zone of Tanzania, are generally among the poorest regions in each year. Figure 2.10 through Figure 2.13 are maps showing the estimated poverty rates by region for 1991/92, 1996, 1999, and 2003, respectively. They show that the incidence of poverty tends to be higher on the western border (Kigoma and Rukwa), in the center (Dodoma and Singida), and the southeast (Mtwara).

REPOA (2003) compares regional rankings according to various economic and social indicators. For example, according to the regional Human Development Index (HDI), the least deprived regions are Dar es Salaam, Kilimanjaro, Mbeya, and Arusha, while the most deprived regions are Rukwa, Shinyanga, Lindi, and Mwanza.

Table 2.4 and Figure 2.14 show the changes in regional poverty rates over the period 1991/92-2003. It appears that Mtwara has made the most progress, reducing the incidence of poverty by 16 percentage points. Also showing substantial progress in reducing poverty are Morogoro, Mwanza, Iringa, and Mbeya. The change in poverty between 1991/92 and 2003 is statistically significant at the 5% confidence level for Mtwara and Morogoro and at the 10% confidence level for Mwanza[12]. In the case of Mtwara, some of the poverty reduction is presumably related to the rapid growth in cashew nut exports since the early 1990s. Over the 1990s, Tanzanian cashew-nut production expanded four-fold and the value of exports six-fold. Mtwara produces roughly three-quarters of the cashew nuts in Tanzania. Morogoro benefits from good market access, being relatively close to Dar es Salaam and lying along the main highway from Dar es Salaam to the Southern Highlands. The improvement of the Morogoro-Dar es Salaam road and the removal of pan-territorial pricing have presumably stimulated poverty reduction in Morogoro. Iringa and Mbeya, in the Southern Highlands, have good agricultural potential and low population density, allowing them to take advantage of opportunities opened up by liberalized markets.

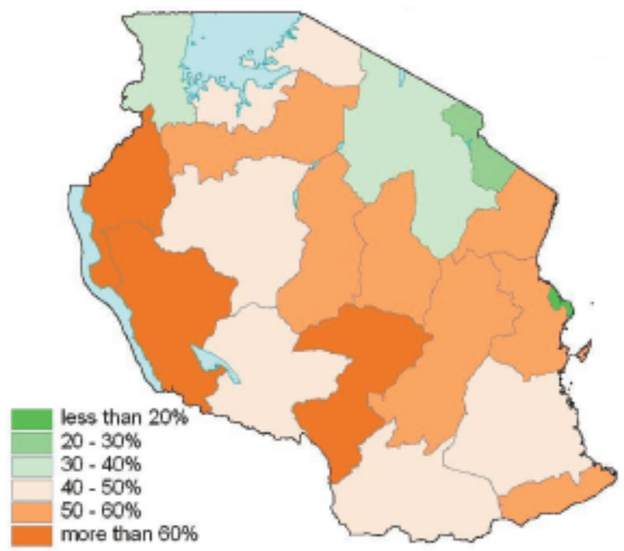


Figure 2.10. Estimated incidence of poverty by region in 1991

Source: See Table 2.3.

12 *These calculations of statistical significance are based on simple comparisons of two estimates (1991/92 and 2003) and do not include estimates for 1996 and 1999. If data from all four surveys were taken in to account , other regions might show a statistically significant downward trend.*

Figure 2.11

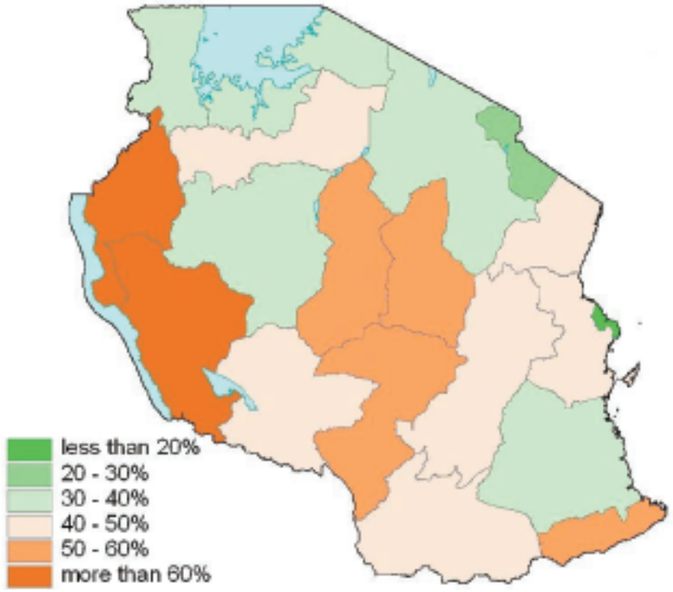


Figure 2.11.
Estimated incidence of poverty by region in 1996

Source: See Table 2.3.

Figure 2.12

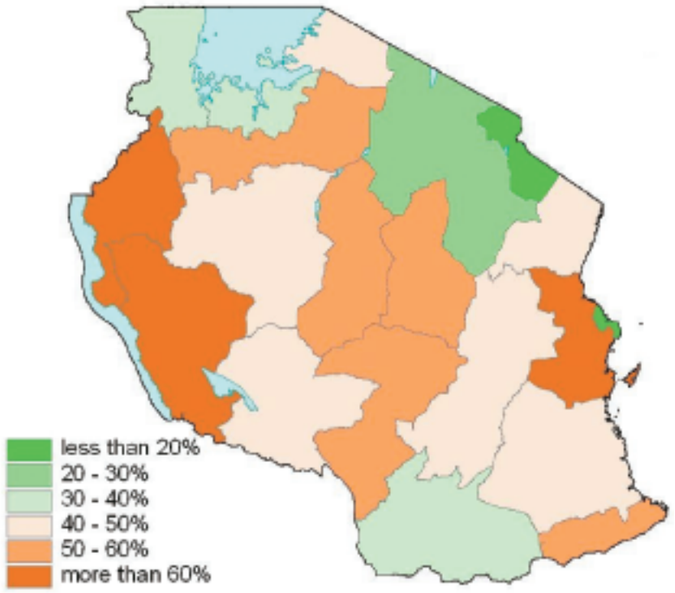


Figure 2.12.
Estimated incidence of poverty by region in 1999

Source: See Table 2.3.

Figure 2.13

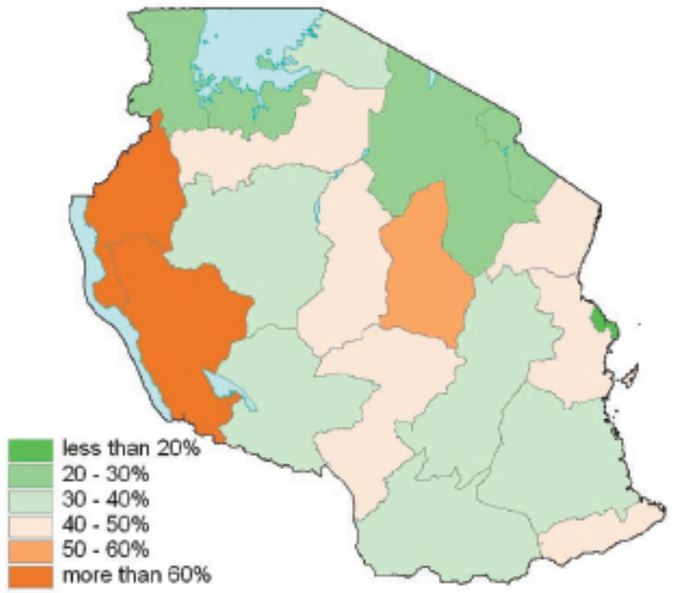


Figure 2.13.
Estimated incidence of poverty by region in 2003

Source: See Table 2.3.

Figure 2.14

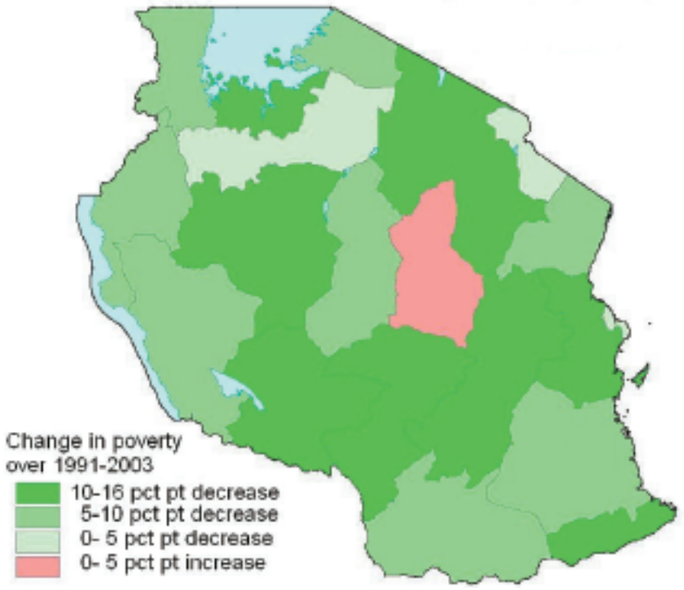


Figure 2.14.
Estimated change in poverty between 1991 and 2003

Source: See Table 2.3.

2.4.3 Relationship between market access and poverty

Are remote rural households left behind by economic growth? In order to answer this question, we need to define "remote" and link this geographic variable to the DHS data that we use to estimate poverty trends. Conceptually, we define "remote" in terms of market access, that is distance or travel time to roads or urban centers. The focus is on rural poverty because urban areas have, almost by definition, good market access, and we do not want the large urban-rural income differences to affect our results. This analysis is limited to the DHS surveys in 1991/92, 1996, and 1999 because the geo-reference data for 2003 survey were not available at the time of the analysis. We use six measures of market access:

- Straight-line distance to a primary or secondary road
- Straight-line distance to a regional center
- Travel time to Dar es Salaam
- Travel time to the closest of eight large towns[13]
- Travel time to the closest of 11 secondary towns[14]
- Travel time to the closest of 22 tertiary towns[15]

As an example of the patterns formed by these variables, Figure 2.15 shows the travel time to the closest secondary town.

Somewhat surprisingly, the different measures of market access are not very closely correlated with each other. Of the 15 combinations of market access indicators, most pairs have correlation coefficients (r) between 0.4 and 0.6, and only one is above 0.65.

Table 2.5 presents the estimates of rural poverty by year and by degree of market access using the six definitions given above. The average poverty rate for rural areas, in the first row, is almost identical to the rural poverty rates reported in Table 2.2, the slight differences being due to the omission of clusters that could not be geo-coded. The relationship between poverty and market access varies across different measures of market access. Rural poverty is most closely related to distance to a

Figure 2.15

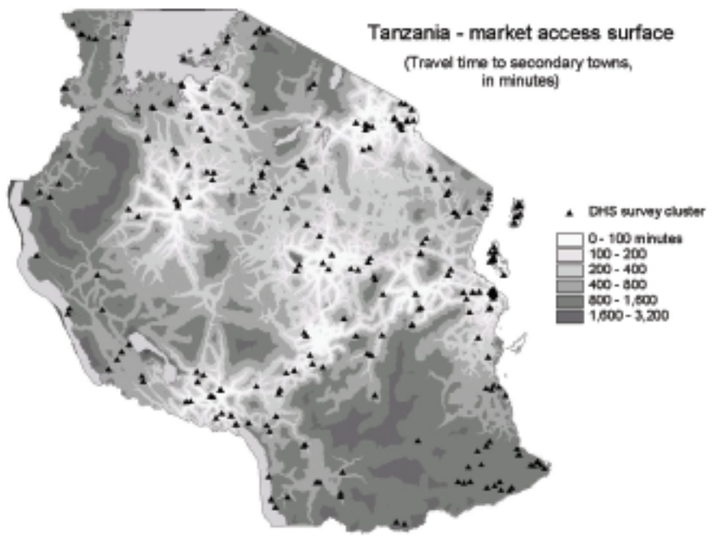


Figure 2.15. Map of Tanzania with travel time to secondary towns

Source: Generated from GIS data on roads and population centers.

13 *Large towns are those given the status of "municipality" in Tanzania and compromise Arusha, Dodoma, Iringa, Mbeya, Morogoro, Moshi, Mwanza, and Tabora.*

14 *Bagamoyo, Bukoba, Chake Chake, Kigoma, Lindi, Mtwara, Musoma, Shinyanga, Singida, and Songea*

15 *Babati, Ifakari, Kahama, Kilosa, Kondoa, Korogwe, Makambako, Manyoni, Masasi, Mpanda, Mpwapwa, Newala, Njombe, Nzga, Same, Sengerama, Sumbawanga, Tukuyu, Tunduru, Urambo, and Wete.*

Table 2.5. Incidence of rural poverty by year and by measures of market access1

	Year			Change from
	1991-2	1996	1999	1991-2 to 1999
Tanzania rural areas	0.531	0.484	0.491	-0.040
Distance to road				
On road	0.595	0.536	0.565	-0.030
Less than 2 km	0.468	0.467	0.461	-0.007
2-5 km	0.503	0.439	0.49	-0.013
More than 5 km	0.546	0.487	0.482	-0.064
Distance to regional center				
Less than 10 km	0.335	0.292	0.364	0.029
10-50 km	0.515	0.485	0.457	-0.058
50-100 km	0.54	0.481	0.503	-0.037
More than 100 km	0.561	0.517	0.523	-0.038
Quartile of travel time to Dar es Salaam				
Closest	0.534	0.499	0.534	0.000
2	0.499	0.457	0.419	-0.080
3	0.544	0.478	0.488	-0.056
Farthest	0.543	0.500	0.519	-0.024
Quartile of travel time to a primary town				
Closest	0.480	0.448	0.448	-0.032
2	0.550	0.484	0.505	-0.045
3	0.570	0.504	0.545	-0.025
Farthest	0.515	0.498	0.469	-0.046
Quartile of travel time to a secondary town				
Closest	0.486	0.456	0.450	-0.036
2	0.540	0.472	0.504	-0.036
3	0.531	0.494	0.490	-0.041
Farthest	0.565	0.509	0.522	-0.043
Quartile of travel time to a tertiary town				
Closest	0.515	0.469	0.495	-0.020
2	0.536	0.507	0.482	-0.054
3	0.552	0.478	0.472	-0.080
Farthest	0.523	0.482	0.517	-0.006

Source: Based on analysis of the 1991/92 Household Budget Survey, the Demographic and Health Surveys of 1991/92, 1996 and 1999, and GIS analysis.

(1) Incidence of poverty refers to the proportion of the population living in households with per capita consumption expenditure below the poverty line.

regional center and, to a lesser degree, travel time to primary, secondary, and tertiary towns. On the other hand, distance to a road and travel time to Dar es Salaam do not seem to be related to the incidence of poverty at all. The latter result is partly explained by the fact that the coastal area near Dar es Salaam is dry and has a low agricultural potential.

In order to get a more detailed picture of the bivariate relationship between poverty and market access, we use non-parametric regression analysis[16]. Figure 2.16 through Figure 2.21 give the results of regressing rural poverty (or more precisely, the household-level probability of poverty) as a function of each of the six measures of market access. In each case, the first panel (a) gives the result for 1991/92 and the second (b) for 1999. Figure 2.16 shows an unexpected, possibly U-shaped, relationship between rural poverty and distance from a road, particularly beyond 75 kilometers. It should be noted that fewer than 10 percent of the households live this far from the road[17], so the result is being driven by a relatively small number of observations. Figure 2.17 shows a positive relationship between rural poverty and distance to a regional center in 1991/92, but the relationship appears weaker in 1999. A similar pattern occurs in Figure 2.18 with travel time to Dar es Salaam. In Figure 2.19, 2.19, and 2.20, the shapes are similar in 1991/92 and 1999. In all six graphs, there is a downward shift from (a) to (b), reflecting the overall reduction in rural poverty. More importantly, none of the graphs show an increase in the slope from (a) to (b), which would indicate that remote rural areas have gained less or lost more than rural areas with better market access.

16 *To implement the non parametric regression analysis, we use the kernreg command in Stata and adopt a half-bandwith of 40 percent of the range of the independent variable, an Epanechnikov kernel, and 30 points where the regression analysis is carried out. The confidence intervals are estimated by bootstrapping with 100 replications.*

17 *In 1992, 424 households in 17 clusters lived more than 75 km from a road, while in 1999, 153 households in eight clusters lived this far.*

Figure 2.16. Non-parametric regression of rural poverty as a function of distance to road

Figure 2.16a
a. 1991/92

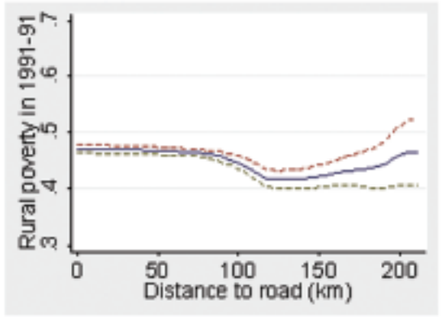


Figure 2.16b
b. 1999

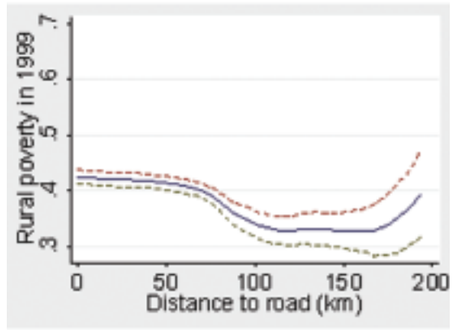


Figure 2.17. Non-parametric regression of rural poverty as a function of distance to regional center

Figure 2.17a
a. 1991/92

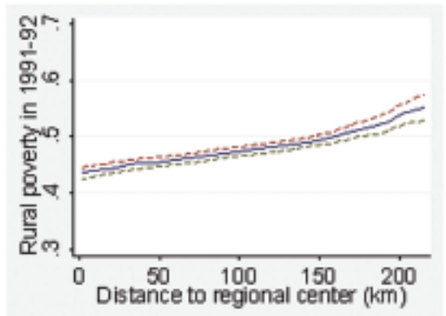


Figure 2.17b
b. 1999

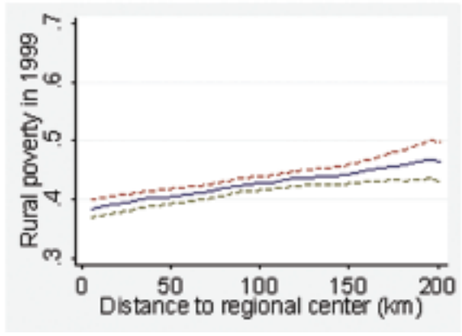


Figure 2.18a
a. 1991/92

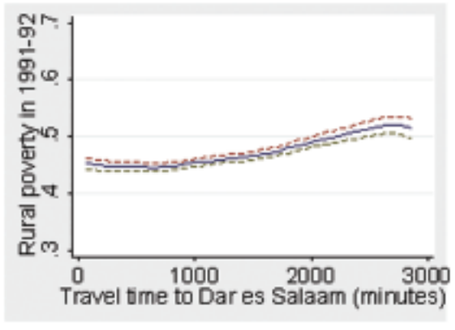


Figure 2.18b
b. 1999

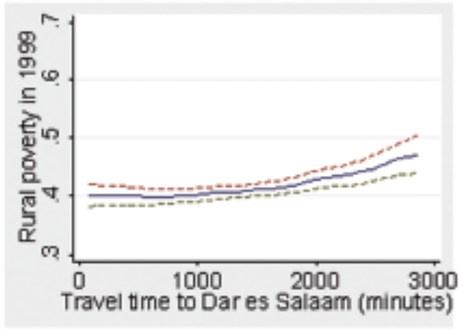


Figure 2.18. Non-parametric regression of rural poverty as a function of travel time to Dar es Salaam

Figure 2.19a
a. 1991/92

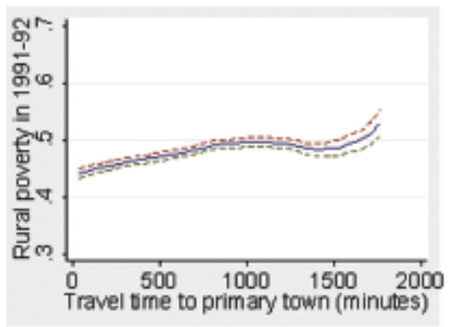


Figure 2.19b
b. 1999

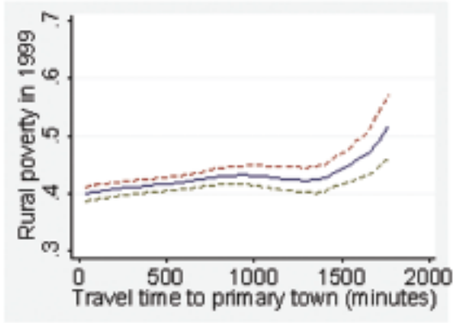


Figure 2.19. Non-parametric regression of rural poverty as a function of travel time to primary town

Figure 2.20a
a. 1991/92

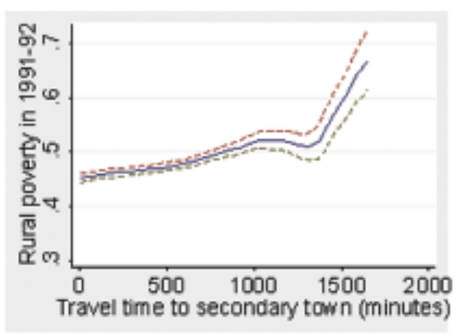


Figure 2.20b
b. 1999

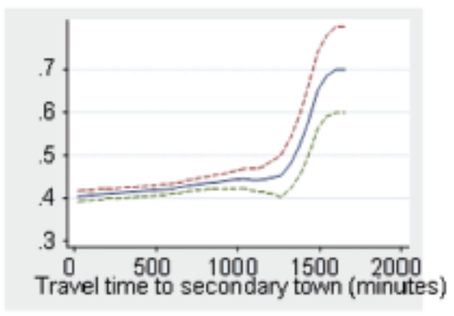


Figure 2.20. Non-parametric regression of rural poverty as a function of travel time to secondary town

Figure 2.21a
a. 1991/92

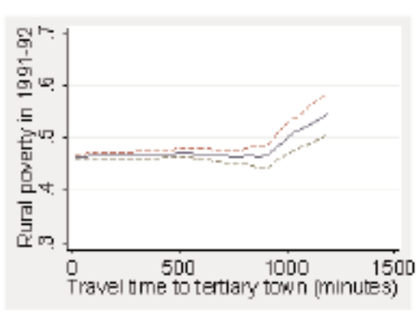


Figure 2.21b
b. 1999

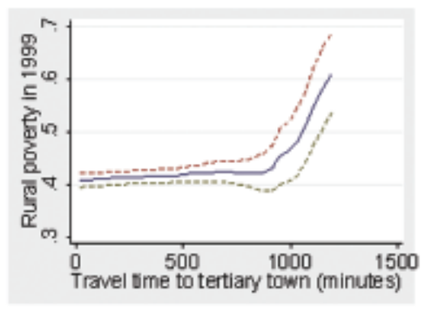


Figure 2.21. Non-parametric regression of rural poverty as a function of travel time to tertiary town

These bivariate relationships can also be examined with traditional parametric regression analysis. We run a seemingly unrelated regression (SUR) model for 1991/92 and 1999, which allows us to test the statistical significance of any changes in the market access coefficient between 1991/92 and 1999[18]. The conventional wisdom that poverty rises with remoteness would be reflected in a positive coefficient on the distance variables, while the view that over time remote rural areas have lost more (or gained less) than rural areas with better market access would be reflected in a statistically significant increase in the coefficient between 1991/92 and 1999.

Table 2.6 shows the results of this analysis, with each column representing the results from a regression model using one market access explanatory variable and data from both years. The coefficients (along the diagonal) are positive and statistically significant at least at the 10 percent level in most cases[19], indicating that poverty is higher in more remote areas. But the market access variables explain a very small proportion (1-2 percent) of the variation in rural poverty. The measure that performs best is travel time to a secondary town (Model 5). As shown in the last two rows of Table 2.6, the difference between the 1991/92 coefficient and the 1999 coefficient is not statistically significant at the 5 percent level for any of the six measures of market access (in one case, it is significant at the 10 percent level but the coefficient decreased over the period). These results do not support the idea that remote rural households have gained less or lost more than rural households with good market access over the 1990s.

An analysis (not shown) comparing the 1991/92 and 1996 data produced very similar results. Seven of the twelve coefficients are statistically significant at the 5 percent level, but none of the coefficients changes significantly between 1991/92 and 1996.

Table 2.6. Relationship between rural poverty and different measures of market access

	Year	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	1991/92	N = 5668	N = 5668	N = 5668	N = 5668	N = 5668	N = 5668
		R^2 = 0.002	R^2 =0.023	R^2 = 0.008	R^2 = 0.017	R^2 = 0.023	R^2 = 0.002
	1999	N = 1813	N = 1813	N = 1813	N = 1813	N = 1813	N = 1813
		R^2 = 0.012	R^2 =0.018	R^2 =0.007	R^2 =0.014	R^2 =0.023	R^2 =0.008
Constant	1991/92	.47347 ***	.40451***	.41783***	.42057***	.41822***	.45270***
	1999 .	.43104***	.35920***	.36697***	.37534 ***	.36543***	.38554***
Distance to nearest road	1991/92	-.00033					
	1999	-.00089**					
Distance to nearest regional center	1991/92		.00080***				
	1999		.00070*				
Travel time to Dar es Salaam	1991/92			.00004**			
	1999			.00004			
Travel time to primary town	19991/92				.00009***		
	1999				.00001*		
Travel time to secondary town	1991/92					.00016	
	1999					.00015***	
Travel time to tertiary town	1991/92						.00006
	1999						.00012
Test of hypothesis that β 1991/92 = β 1996	F-stat Prob	F = 3.05 p = 0.0819	F = 0.08 p = 0.7795	F = 0.01 p = 0.9185	F = 0.07 p = 0.7852	F = 0.00 p = 0.9745	F = 0.61 p = 0.4340

Source: Seemingly unrelated regression analysis of poverty rates as a function of indicators of market access.

18 *This procedure is implemented with the suest command in Stata, which calculates Huber/White/sandwich estimates of the standard errors, which are heteroskedasticity consistent and take into account the stratification and clustering in the data.*

19 *Of the twelve coefficients, six are significant at the 5 percent level and two more at the 10 percent level.*

The market access results presented thus far have been based on bivariate relationships. It is worth asking whether the findings would differ if we controlled for other geographic variables such as land use category, elevation, and climate. Table 2.7 shows the results of a model estimating rural poverty as a function of five of the six market access indicators[20] and other geographic factors. Again, we use SUR models to test for changes in the poverty-market access relationship between 1991/92 and 1999. A significant increase in the market access coefficient would confirm the conventional wisdom that remote rural areas have gained less or lost more than other rural areas. As shown in Table 2.7, two of the market access measures show no significant change between 1991/92 and 1999, while two others reveal a significant *decrease* in the coefficient. Only one market access indicator, travel time to a primary town, has a coefficient that increases significantly over the period. A separate SUR model (not shown) comparing 1991/92 and 1996 showed no changes significant at the 5 percent level.

Table 2.7. Relationship between rural poverty and all measures of market access controlling for agro-climactic characteristics

	1991/92		1999	
	N = 5668		N = 1813	
	R^2 = 0.1195		R^2 = 0.1128	
Variable name	**Coefficient**		**Coefficient**	
% of land in cropland	-0.0059		-0.0307	
% of land in deciduous forest	-0.01202		0.018389	
% of land in dry	0.002491		-0.00553	
% of land in coniferous forest	-0.11951	*	(dropped)	
% of land in grassland	0.021981		-0.00204	
% of land in mixed forest	0.047575		-0.12655	
% of land in savanna	0.001542		-0.01489	
% of land in shrub land	-0.04326		0.021543	
Mean elevation	3.13E-05		9.71E-05	
Rainfall in growing season	8.99E-05		0.000204	
Evapotranspiration rate	-0.00141	***	0.000506	**
Average max daily temperature	0.029348	**	0.014917	
Distance to road	-0.00183	***	-0.0031	*
Distance to regional center	0.000928	***	0.000788	***
Travel time to Dar es Salaam	2.95E-05		-5.7E-05	
Travel time to primary town	4.79E-05		0.000173	
Travel time to secondary town	5.96E-05		0.000123	***
Constant	0.276426		-0.59789	*
Test of hypothesis that coefficients for distance to road are equal for 1991/92 and 1999	F=4.94		Prob =0.0273	β 1991/92> β 1999
Test of hypothesis that coefficients for distance to regional center are equal for 1991/92 and 1999	F=0.13		Prob =0.7191	
Test of hypothesis that coefficients for travel time to Dar are equal for 1991/92 and 1999	F=4.64		Prob =0.0322	β 1991/92> β 1999
Test of hypothesis that coefficients for travel time to primary town are equal for 1991/92 and 1999	F=4.51		Prob =0.0348	β 1991/92< β 1999
Test of hypothesis that coefficients for travel time to secondary town are equal for 1991/92 and 1999	F=0.86		Prob =0.3549	
Test of hypothesis that all coefficients are equal for 1991/92 and 1999	F=1.72		Prob =0.0308	

Source: Seemingly unrelated regression analysis of rural poverty rates as a function of cluster-level GIS variables including six measures of market

20 *One market access indicator, travel time to tertiary towns, is dropped because it is not significant and it is closely correlated with travel time to secondary towns.*

2.5 Conclusions

In Tanzania, as in many other developing countries, the conventional wisdom is that economic reforms may have stimulated economic growth, but the benefits of this growth have been uneven, favoring urban households and farmers with good market access. This idea, although quite plausible, has rarely been tested. In this paper, we develop a new approach to measuring trends in poverty and apply it to Tanzania in order to explore the distributional aspects of economic growth and the relationship between rural poverty and market access. First, we use the 1991/92 Household Budget Survey to estimate the relationship between per capita expenditure and numerous household characteristics, including family size and composition, education, housing, water source, electrification, and ownership of various consumer durables. Then, we apply this relationship to the same characteristics in four Demographic and Health Surveys carried out between 1991/92 and 2003.

The key findings to come out of this analysis are as follows:

- Between 1991/92 and 2003, the overall incidence of headcount poverty fell by almost 9 percentage points, greater than measured by the Household Budget Surveys. The 9 percentage point decline is, however, statistically significant, it is supported by improvement in a broad range of indicators of living conditions, and it is roughly what would be expected based on GDP growth and international patterns.

- Our analysis suggests that the degree of poverty reduction was similar between rural and urban areas (7- 8 percentage points), though some poverty reduction was due to migration from rural to urban areas. Poverty did not decline in Dar es Salaam, so all of the gains were due to poverty reduction in other urban areas and in rural areas (and migration).

- Poverty reduction was greater among male-headed households (10 percentage points) than among female-headed households (3.5 percentage points), particularly in urban areas. This may be related to differential ability to take advantage of opportunities created by market liberalization or to the impact of HIV/AIDS.

- The gains in poverty reduction were greater among less educated households than among more educated households. This suggests that economic growth has not favored the educated elite over others.

- The Coast, the Southern Highlands, and the South zones have gained the most in terms of poverty reduction. All three regions have seen the incidence of headcount poverty, as estimated in this study, fall by at least 10 percentage points. The Central Zone is the only one not to show any progress in poverty reduction.

In order to look at the relationship between poverty and remoteness, we use GIS analysis to define six measures of market access. The relationship is examined using non-parametric regression analysis, simple regression analysis, and multiple regression analysis. The results are as follows:

- Rural poverty is associated with remoteness, but the relationship is surprisingly weak and it varies depending on the definition used.

- Rural poverty is more closely related to access to regional centers than distance to roads or to Dar es Salaam.

- Although poverty is somewhat higher in more remote rural areas, we find no evidence that remote areas are being "left behind" in the sense of gaining less from economic growth than other areas.

Overall, the results suggest that economic growth in Tanzania since 1991 has reduced poverty more than previously thought. Furthermore, more educated, urban households and rural households with good market access do not seem to have gained at the expense of less educated households and rural households in remote areas. The results do, however, suggest that female-headed households have not gained as much as male-headed households, a finding which calls for more study into the reasons and possible remedies.

Annex: Standard Errors of the Poverty Estimates

Table 2.8. Standard errors of poverty estimates (P_0) by year and by strata

Year	Place	Sample size (N)	Headcount poverty ratio (P_0)	Standard error of P_0
1991/92	Mainland Tanzania	7,691	0.468	0.019
1996	Mainland Tanzania	7,248	0.429	0.022
1999	Mainland Tanzania	2,728	0.424	0.024
2003	Mainland Tanzania	6,472	0.380	0.024
1991/92	Dar es Salaam	422	0.036	0.015
1991/92	Large towns	324	0.184	0.033
1991/92	Small towns	667	0.345	0.038
1991/92	Rural areas	6,278	0.529	0.023
1996	Dar es Salaam	582	0.041	0.013
1996	Large towns	308	0.165	0.038
1996	Small towns	818	0.305	0.034
1996	Rural areas	5,540	0.484	0.026
1999	Dar es Salaam	270	0.033	0.017
1999	Large towns	219	0.118	0.033
1999	Small towns	407	0.296	0.045
1999	Rural areas	1,832	0.492	0.031
2003	Dar es Salaam	420	0.045	0.016
2003	Large towns	565	0.173	0.027
2003	Small towns	587	0.302	0.041
2003	Rural areas	4,900	0.450	0.031

Source: Estimated using the equations given by Hentschel et al (2000) with an additional component to represent the DHS sampling error.

Note: The 95 percent confidence interval is ±(1.96)SE, where SE is the standard error.

Table 2.9. Descriptive statistics for the standard errors of regional poverty estimates (P_0)

Year	Minimum	25th percentile	Median	75th percentile	Maximum
1991/92	0.018	0.047	0.056	0.067	0.120
1996	0.017	0.050	0.056	0.069	0.128
1999	0.017	0.055	0.076	0.084	0.151
2003	0.016	0.047	0.061	0.072	0.0123

Source: Estimated using the equations given by Henstschel et al (2000) with an additional component to represent the DHS sampling error

Note: the 95 percent confidence interval is ±(1.96)SE, where SE is the standard error.

3 Sensitivity analysis of poverty trends[1]

3.1 Introduction

The economic reforms instituted by the Government of Tanzania in the late 1980s have resulted into both positive and negative results at the micro level despite having a general positive impact at the macro level. Consequently, programmes to measure and address social dimensions of adjustment were initiated in mid 1990s followed by the poverty reduction strategies in late 1990s and early 2000s driven partly by the highly indebted poor countries (HIPC) initiative. As a partial condition for qualifying in the debt relief initiative, the government was required to establish a poverty baseline for Mainland Tanzania that could be monitored during the implementation of the strategy. Therefore, during late 1999 and early 2000, the National Bureau of Statistics (NBS) with technical assistance from Oxford Policy Management Limited (OPM) of United Kingdom, further analysed data from the 1991/92 Household Budget Survey (HBS) to come up with poverty measures that prevailed in the year 1992. These measures were later updated using the 2000/01 Household Budget Survey conducted by NBS.

In the meantime, the NBS and the Macro International of the United States (US) have conducted four Demographic and Health Surveys (DHS): 1991/92, 1996 and 1999, and 20032. These surveys provided a potential source of data for measuring medium term trends in poverty and inequality in the 1990s using an approach proposed in Chapter 2 based on the small area estimation method of Henstchel et al. (2000) and Elbers et al. (2003) and the asset index method by Filmer and Pritchett (1998).

Chapter 2 uses the 1991/92 HBS data to estimate the relationship between per capita expenditure and various household characteristics. This relationship is then applied to the same household characteristics in the Tanzania's DHSs of 1991/92, 1996 and 1999 to estimate the incidence of poverty for each of the four survey years and for different types of households. In this chapter, we use the same approach except that we use the 2000/01 HBS data instead of the 1991-92 HBS data in order to test the sensitivity of the poverty trends to the use of a different household survey carried out ten years later.

There are two consequences of using a different household survey. First, the estimated relationship between per capita expenditure and household characteristics will be different. Second, we will be using a different poverty line to estimate the incidence of poverty. Because of the difficulties in constructing comparable poverty lines ten years apart, we devote some time to describing and comparing the methods used to construct poverty lines for each HBS.

Thus, the objectives of this chapter are following:

- Compare the methods used to construct poverty lines for the 1991 and 2000/01 Household Budget Surveys.
- Estimate the patterns and trends in poverty in Mainland Tanzania using the 2000/01 HBS and the DHS data for 1991/92, 1996, 1999, and 2003.
- Compare the results obtained above with those derived when using the 1991/92 HBS data in Chapter 2.

1 This chapter was prepared by Ahmed Makbel of the National Bureau of Statistics.

2 The 1999 survey was called the Reproductive and Child Health Survey and the 2003 survey was called the HIV/AIDS Indicator Survey. but all four surveys were carried out with technical assistance from Macro International, the sampling is quite similar, and the variables we used are based on identical questions. For convenience, we refer to all four as DHS surveys.

We begin by discussing the methods used to construct the poverty lines for the two Household Budget Surveys and then proceed with the sensitivity analysis.

3.2 Background on the HBS poverty lines

A poverty line is a monetary measure expressed as a minimum amount of money needed for satisfying food and/or some other basic needs. The households whose per capita expenditures fall below this line are then classified as poor. Two types of poverty lines were constructed from the Household Budget Surveys (HBSs): 1) the food poverty line that takes into account food consumption and 2) the basic needs poverty line, which adds the consumption of non-food items such as clothing and housing. The basic assumption in calculating the poverty lines is that food is an inescapable commodity needed for human survival.

In both the HBSs, it was first important to compute the total household consumption expenditure, also known as the consumption aggregate. This was done after determining which consumption items from different parts of the questionnaire should be included. The main sources of expenditure data from both surveys were the recall schedule and the diary. The housing schedule also provided some data on house rents. The construction of poverty lines for Mainland Tanzania was done in three stages in both the 1991/92 and the 2000/01 HBSs as outlined below:

- Determining items for inclusion in the consumption aggregate and the food basket to be used in defining the poverty line.
- Standardizing or adjusting the aggregates to represent expenditure over 28 days, to take into account inflation and spatial price differences, and to reflect the age-sex composition of the household.
- Calculating the cost of the basic food basket.

In the following sub-sections we describe how the measure of the average household per capita expenditure and the poverty lines for the two HBSs were arrived at.

3.2.1 1991/92 Household Budget Survey

The consumption aggregate was determined after careful assessment of the data from the annual recall schedule, the monthly diary and the housing schedule. Ultimately, the following consumption items with their sources were included in the consumption aggregate as depicted in NBS and OPM (2000):

- Food (monetary and non-monetary) and other non-durables expenditures excluding house rent were drawn from the monthly diary. For each item, the sum of values of purchased, home produced, in-kind wages and gifts was computed.
- Education, health and durables expenditures were extracted from the annual recall schedule.
- House rent was taken from the normal monthly rent in the housing schedule.

The measures taken to standardize the expenditures among households with different demographics and from different reference periods include:

- Adjusting for the reference period of 28 days, that is, multiplying monthly and annual expenditures by 20/30.4 and 28/365 respectively.
- Adjusting for inflation (using the consumer price indices) between the time the transaction was reported to have taken place and December 1994.
- Adjusting for age-sex composition of household members by using the adult equivalence scales and calculating consumption expenditure per adult equivalent.

The total household expenditure was computed as a sum of standardized individual expenditure transactions for items included in the consumption aggregate. The per capita expenditure was calculated by dividing the total household expenditure by the sum of household's adult equivalents. To determine whether a household is poor or not, this expenditure is compared with the poverty lines.

To construct the poverty lines, a food basket that meets minimum calorific requirements for an adult to survive, that is 2200 calories per day, was constructed using a low-cost realistic minimum diet approach used by Wagao (1993) in the preliminary poverty analysis for Tanzania. The food basket included maize meal (56 percent of the calories), beans (5 percent), fats and oils (12 percent), sugar (7 percent), fruits and vegetables (4 percent), milk (5 percent), meat (4 percent), and nuts (7 percent). The cost of this food basket was calculated using prices from the Base Price Survey (BPS) of 1994. Besides the overall cost of the food basket for Mainland Tanzania, different costs were calculated for the Dar es Salaam, other urban and rural sub-samples.

The food poverty line was defined as the cost of this food basket, without allowance for non-food spending. The basic needs poverty line was obtained by multiplying the food poverty line by a reciprocal of the proportion of total expenditure spent on food for the poorest 25 percent of the population in the stratum. Details on the construction of the poverty lines can be found in the report by NBS and OPM (2000). The poverty lines are shown in Table 3.1 below.

3.2.2 2000/01 Household Budget Survey

The approach used to calculate the consumption aggregate for the 2000/01 HBS was similar to that used for 1991/92 HBS. Three measures were examined in deciding which sources of expenditure data were suitable for the aggregate. The measures included the proportion of households reporting consumption of that item in the annual recall; the ratio of the number of households reporting expenses in the annual reports to the number reporting expenses in the diary; and the ratio of the reported amount spent in the annual recall over the multiple of 12 of amount reported in the diary (NBS, 2002).

In the standardization of the 2000/01 HBS consumption data, the consumer price index was not used to adjust for temporal and spatial price variations, and instead a Fisher Index was applied. Other standardization measures were the same as those done for the 1991/92 HBS.

The method used to calculate the food poverty line was different. Instead of using the low- cost realistic minimum diet approach, it was decided to cost all food items consumed by the poorest 50 percent of the population and adjust the food quantities proportionately to achieve 2200 calories per adult per day. The procedure for calculating non-food requirements for the basic needs poverty line was similar to the one used in 1991/92 HBS. Likewise, different poverty lines were constructed for different sub-samples of the survey population.

3.2.3 Re-analysis of 1991/92 Household Budget Survey

In order to compare the results of the two HBSs, the data from the 1991/92 HBS were re-analysed to make the methods similar to those used in processing the 2000/01 HBS. As described in NBS (2002), the re-analysis of the 1991/92 HBS differs from the original analysis in the following ways:

- A number of items were excluded from the consumption aggregate in order to get a measure that is more comparable to the 2000/01 measure.

- The consumption data for 1991/92 HBS was subjected to the same consistency checking and cleaning procedures as the 2000/01 HBS data.

- The consumption measure was adjusted using the Fisher Index instead of the consumer price index (CPI) due to the fact that the existing CPI was not representative of the whole urban and rural population of Mainland Tanzania.

- A new poverty line was defined using a full year of data and all food items rather than a basic food basket that meets minimum calorific requirements of an adult per day.

- The sampling weights were adjusted to ensure that the rural population was represented in proportion to its population.

The different food and basic needs poverty lines for the studied strata in the two HBSs are depicted in Table 3.1 below.

Table 3.1. Poverty lines and poverty incidences for 1991/92 and 2000/01 HBSs

	Dar es Salaam			Other Urban			Rural			Mainland Tanzania		
	Old HBS 91/92	New HBS 91/92	HBS 00/01	Old HBS 91/92	New HBS 91/92	HBS 00/01	Old HBS 91/92	New HBS 91/92	HBS 00/01	Old HBS 91/92	New HBS 91/92	HBS 00/01
Food Poverty Line (TShs.)	5711	3031	6719	5940	2387	5607	5075	1958	5107	5113	2083	5295
Basic Needs Poverty Line (TShs.)	8325	3841	9203	8659	3088	7680	7398	2603	6996	7453	2777	7253
Food Poverty Incidence (percent)	1.7	13.6	7.5	19.6	15.0	13.2	31.8	23.1	20.4	26.6	21.6	18.7
Basic Needs Poverty Incidence (percent)	5.6	28.1	17.6	41.1	28.7	25.8	57.0	40.8	38.7	48.4	38.6	35.7

Source: NBS and OPM (2000), & NBS (2002)

NBS (2002) also present the results obtained from using three consumer price indices (Dar es Salaam, other urban, and rural) for both surveys instead of using the Fisher index. It is asserted that the results would show that poverty declined by a smaller amount as depicted in Table 3.2 below.

Table 3.2. Poverty incidences using price indices for 1991/92 and 2000/01 HBSs

	Dar es Salaam		Other Urban		Rural		Mainland Tanzania	
	91/92	00/01	91/92	00/01	91/92	00/01	91/92	00/01
Food Poverty Incidence (percent)	13.6	7.5	15.0	12.3	23.1	21.6	21.6	19.5
Basic Needs Poverty Incidence (percent)	28.1	17.6	28.7	25.3	40.8	40.5	38.6	37.1

Source: NBS (2002)

Table 3.1 reveals that the poverty lines derived from the earlier analysis of 1991/92 HBS data were higher than those obtained during the re-analysis. As a result of the use of different data correction procedures, the Fisher Index, and a different approach to constructing the food basket, the poverty line fell from 48.4 percent in the original analysis of the 1991/92 HBS to 38.6 percent in the re-analysis of the same survey. These results illustrate the sensitivity of poverty estimates to the methods used in constructing the poverty line, highlighting some of the challenges of using household budget surveys to measure changes in poverty over time. They also help to interpret the results obtained later in this chapter.

3.3 Methods

In Chapter 2, small-area estimation methods were used to combine household budget data and data on household characteristics at several points in time to identify trends in poverty in Tanzania over the period 1991-2003. As described in Chapter 2, the procedure can be divided into three steps.

- Stage 0 involves identifying and harmonizing[3] common household characteristics that exist in both the 1991 Household Budget Survey (HBS) and the four Demographic and Health Surveys carried out in Tanzania. These include variables such as size and age-sex composition of house hold; age, sex and education of household head; housing characteristics (floor, wall and roof);

3 *Harmonizing the definition of the variable and the categories used in responses*

household amenities (water and toilet); and ownership of assets (radio, television, refrigerator, bicycle, motorcycle and car). Dummy variables for categories of these characteristics are then created ready for inclusion in an equation that compares them with the household per capita expenditure.

- Stage 2 entails expressing the per capita expenditure (y_i) in the HBS data as a function of the household characteristics (X_i). To reduce heteroskedasticity and getting normally distributed residuals, the following semi-log function form is used:

(1) $$\ln(y_i^{HBS}) = X_i^{HBS}\beta + e_i^{HBS}$$

- Finally, in Stage 3 the regression coefficients (β) obtained above are applied to the same household characteristics in the DHS data in order to estimate the probability that a household is poor.

(2) $$\ln(\hat{y}_i^{DHS}) = X_i^{DHS}\beta + e_i^{DHS}$$

- Hentshel et al. (2000) shows that the expected value of the probability that household is poor (P_i) can be described as follows:

(3) $$E(P_i \mid X_i^{DHS}, \beta, \sigma) = \Phi\left[\frac{\ln(z) - X_i^{DHS}\beta}{\sigma}\right]$$

The estimate of the incidence of poverty for a set of households is then obtained by computing the average of these household probabilities for a given group of households defined spatially (e.g. a region) or by household characteristics (e.g. female-headed households).

By using the DHS data, we lose the spatial resolution of the census data but we gain a temporal dimension from the fact that DHSs have been carried out two or three times in many developing countries during the 1990s (see Chapter 2). The similarity of questionnaires and sampling method as well as the high quality of data make the DHSs a useful tool in measuring trends over time.

A major assumption in the approach used in Chapter 2 is that the regression coefficients (β) were constant over the 1990s. Thus, any changes in poverty over time are assumed to be reflected in changes in household characteristics (X_i). Hence, this chapter examines the validity of this assumption, which is standard in asset index literature.

The method described above was applied to Tanzania using the 2000/01 HBS in Stage 1. In this survey, a representative sample of 22,178 households was interviewed based on a module of the National Master Sample (NMS), which provides estimates at regional level both for urban and rural areas (NBS, 2002). The survey gathered information on income; expenditure; demographic, social and economic characteristics of household members; housing structure and materials; ownership of assets; food security; and access to social and economic facilities by the household.

In stage 1, the average household per capita expenditure from the HBS was regressed against a set of household characteristics to come up with the coefficients that were later applied to the DHS data in stage 2. The 1991/92 and 1996 surveys selected samples of 8,327 and 7,969 households respectively from the same 357 clusters. The 1999 survey drew a sample of 3,615 households from 176 clusters that were a sub-sample of the original 357 clusters. The surveys gathered information on characteristics of household members; ownership of assets; housing characteristics; and a number of health and nutritional variables. The results of the application of the coefficients from the HBS on the DHSs are discussed in the subsequent sections.

3.4 Results

In the following sections we shall present and discuss the results from this study. The first section provides description of the regression models used to show the relationship of the household per capita expenditure and the household characteristics using the 2000/01 HBS data. A comparison of the characteristics of these models against those that used the 1991/92 HBS data is also given. In the next section, we present estimates of poverty and inequality for the three DHS years, followed by some discussion on the measures compared to those obtained when using the 1991/92 HBS data.

3.4.1 Predictors of household welfare

As mentioned earlier, the sample for 1991/92 Household Budget Survey (HBS) was divided into four strata namely city of Dar es Salaam, large towns, small towns and rural areas. In the 2000/01 HBS, the sample was designed to yield regional estimates for both urban and rural. This means that the sample could be stratified into three strata namely the city of Dar es Salaam, other urban and rural as there were no rural clusters for Dar es Salaam. Thus, in order to compare the two HBSs, the results for the large and small towns from the 1991/92 HBS are combined to represent the other urban stratum.

Table 3.3 shows the results from the Stage 1 regression analysis. The values of R^2 for the regression models based on the 2000/01 HBS range from 0.39 to 0.45 (see Table 3.3), compared to the range of 0.42 to 0.50 obtained using the 1991/92 HBS (see Chapter 2). This implies that there is a decline in the predicting power of the models used to estimate household welfare. There has also been a change in the prediction power of the independent variables used in the models. Some of them are increasing while others are decreasing or diminishing altogether differently among the three strata (Dar es Salaam, other urban, and rural). These changes among the three strata are depicted below and are described below for each stratum.

Dar es Salaam

In general, there has been a decline in the prediction power of the variables as witnessed by lower values of the coefficients. However, all the signs of the coefficients are in the expected directions. The variables that are found to be highly statistical significant in both surveys are household size, household size squared, age of head, earth floor, indoor piped water, refrigerator and car ownership.

On the other hand, variables that were found to be more significant in 2000/01 compared to 1991/92 include ownership of radio and television, head finishing primary school and percent of males over 55 years (which was not significant in 1991/92 altogether). There were also two variables that their significance diminished in 2000/01 namely the proportions of males and females less than 5 years.

The rising in significance of the two owned household goods (radio and television) is not surprising taking into consideration the rapid opening up of the country into the market economy through trade liberalization during the 1990s.

Table 3.3. Regression models of per capita expenditure using 2000/01 HBS

	Dar es Salaam N=1204 R2=0.4502		Other Urban N=13266 R2=0.4478		Rural N=7537 R2=0.3880	
	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic
Household Size	-0.2444711	-6.74 ***	-0.2299742	-16.58 ***	-0.2316991	-13.47 ***
Household size squared	0.0120947	4.84 ***	0.0112819	10.85 ***	0.0112813	8.97 ***
% males under 5 yrs	0.0009108	0.4	0.0019262	2.13 **	0.0017867	1.84 *
% females under 5 yrs	-0.0007388	-0.32	0.0007519	0.86	0.0007382	0.8
% males 5-15 years	0.0008228	0.4	-0.0022472	-2.02 **	-0.0021129	-2.41 **
% females 5-15 years	-0.0009608	-0.43	-0.0012118	-1.83 *	-0.0025839	-2.75 ***
% males 16-30 years	-0.0001823	-0.12	-0.0015123	-3.38 ***	-0.0010045	-1.33
% females 16-30 years	0.0007957	0.45	0.0006165	0.84	0.0002298	0.3
% females 31-55 years	-0.0000934	-0.05	0.0007962	1.25	0.0000902	0.11
% males over 55 years	-0.0041312	-1.78 *	-0.0000696	-0.11	-0.0019996	-2.24 **
% females over 55 years	-0.0004426	-0.14	-0.0004565	-0.77	-0.0002423	-0.31
Age of Head	-0.0082062	-2.09 **	-0.0025185	-3.27 ***		
Head has some primary school	-0.0224949	-0.36	0.0126439	0.4	0.0811771	3.27 ***
Head finished primary school	0.1501739	1.73 *	0.0137585	0.26	0.1881009	3.01 ***
Head has some secondary school	0.0215135	0.27	0.1601284	3.96 ***	0.3640328	5.16 ***
Head finished upper sec. school	0.1747013	1.94 *	0.1159792	1.6	0.409492	3.92 ***
Spouse has some primary school	-0.0048087	-0.19				
Spouse finished primary school	-0.1667386	-1.9 *				
Spouse has some sec. school	0.1924271	1.65 *				
Spouse finished upper sec. school	-0.1002528	-0.57				
Floor of house made of earth	-0.297105	-2.83 ***	-0.1448655	-3.93 ***	-0.2324172	-6.27 ***
Water from indoor pipe	0.2097402	4.12 ***	0.1515632	2.49 **		
Water from outdoor pipe	0.0655215	1.14				
Water from well	-0.039821	-0.75				
Flush toilet	0.1692257	3.16 ***				
Latrine	0.0188323	0.37				
House has electricity	-0.0248023	-0.51				
Radio ownership	0.1369608	2.05 **	0.2850594	10.74 ***	0.2199831	8.33 ***
Television ownership	0.2077159	3.69 ***	0.3326632	5.72 ***		
Refrigerator ownership	0.2722434	5.43 ***	0.1838083	4.92 ***	0.5071337	2.48 **
Motorbike ownership	0.2815292	3.06 ***				
Car ownership	0.3446115	5.04 ***	0.3103516	6.47 ***	0.3534618	2.93 ***
Constant	10.83618	46.06 ***	9.899796	92.02 ***	9.977589	66.46 ***

Source: The 2000/01 Tanzanian Household Budget Survey.
**** = significant at 1 percent level;*
*** = significant at 5 percent level;*
** = significant at 10 percent level.*

Note: Dependent variable is log of per capita expenditure. Regional dummy variables omitted to save space.

Other urban areas

Unlike Dar es Salaam, there has been a general increase in the prediction power of the variables in terms of the level of significance and the values of the coefficients. The signs of the coefficients are also in the expected directions. One would then assume that the conditions that existed ten years ago in Dar es Salaam has now trickled down and more forcefully into other urban centres in the country with greater impact in reflecting people's incomes. As mentioned earlier, in this analysis the results for the large and small towns will be looked together and compared to the results of the other urban strata of the 2000/01 HBS.

The variables that have remained statistically significant in both surveys include household size, household size squared, percents of males and females 5-15 years, head has some secondary schooling, earth floor, radio and refrigerator ownership. On the other hand, variables that were not statistically significant in 1991/92 but became so in 2000/01 are percent of males less than 5 years, percent of males 16-30 years, age of head, indoor piped water, flush toilet, television and car ownership. Variables that lost their significance in 2000/01 include percent of males over 55 years, head has some primary schooling, head finished primary schooling, head finished upper secondary school, and [pit] latrine.

The increase in significance of the ownership of household goods and housing conditions in predicting household welfare is in line with the changing economy of the country mentioned earlier when explaining the changes in Dar es Salaam.

Rural areas

Similar to the other urban areas, there has also been a general increase in the number, level and values of significant variables that predict household welfare in the rural stratum. The significant variables which are found in both HBSs include household size, household size squared, percent of males under 5 years, percent of males over 55 years, head has some primary schooling, head has some secondary schooling, spouse finished primary school, earth floor, radio and car ownership.

There are more new variables that have become significant during the 2000/01 HBS. These are percents of males and females 5-15 years, percent of males over 55 years, head finished primary school, head finished secondary school, spouse has some secondary schooling, refrigerator and motorbike ownership.

However, the variable spouse finished primary school has changed sign from positive to negative between 1991/92 and 2000/01. This implies that finishing primary school for spouses is no longer associated with an increase in household welfare, rather it declines compared to the one with spouse who has some secondary schooling.

3.4.2 Trends and patterns in poverty

The regression equations used to predict per capita expenditure based on household characteristics in the 2000/01 HBS were applied to the same household characteristics from the four DHS surveys. The equations were used to estimate the incidence of basic needs poverty for different types of households in each of the four years. The results are given in Table 3.4 below.

When the regression model is based on the 2000/01 HBS, the estimated poverty rates in the four DHS years are found to be lower by 2.4 to 5.9 percentage points (see Table 3.4) compared to estimates using the 1991/92 HBS for the regression model (see Chapter 2). In other words, for a given set of assets (education, type of housing, consumer durables, etc.), the regression model based on the 2000/01 HBS yields a lower poverty rate than the model based on the 1991/92 HBS. This is partly a reflection of the different methods used to construct the construct the poverty line for the two HBSs. As discussed in Section 3.2, the methods used for the 2000/01 HBS result in a lower poverty line compared to the methods used for the 1991/92 HBS. This is demonstrated by the fact that the poverty line the 1991/92 HBS fell when it was re-analysed using the methods used for the 2000/01 HBS (see Table 3.1). There are probably also changes in the relationship between real income and asset ownership over the decade.

Although the level of poverty is lower in this analysis, many of the trends are similar. Like the analysis in Chapter 2, these results show a steadily declining rate of basic needs poverty, although the change is less in this analysis. In this analysis, the poverty rate declines by 5.3 percentage points compared to 8.8 percentage points in Chapter 2.

Both analyses show poverty reduction in both rural and urban areas, but the analysis in Chapter 2 (using the 1991/92 HBS) showed equal poverty reduction in urban and rural areas, while this analysis (using the 2000/01 HBS) shows more poverty reduction in the urban areas. Both analyses agree that poverty has essentially not changed in Dar es Salaam and that all the gains in urban poverty reduction have been in other urban areas.

Regarding poverty in different zones, both analyses agree that the Northern Highlands and Coast are the least poor zones, while the Central Zone is the poorest. They also agree that poverty reduction has been greatest on the Coast and in the Southern Highlands, but poverty reduction has been below average in the Central Zone. The biggest difference in the two analyses is on the progress in poverty

reduction in the Southern Zone. Using the 1991/92 HBS, the Southern Zone showed strong improvement (see Table 2.2), while this analysis, using the 2000/01 HBS, shows only modest gains in poverty reduction (see Table 3.4).

Table 3.4. Incidence of poverty by year and by household category [1]

	Year				Change from 1991/2 to 2003
	1991/2	1996	1999	2003	
Mainland Tanzania	0.409	0.390	0.371	0.356	-0.053
Urban Category					
Urban	0.272	0.199	0.185	0.183	-0.089
Rural	0.447	0.436	0.425	0.416	-0.031
Stratum					
Dar es Salaam	0.061	0.066	0.063	0.059	-0.002
Other Urban	0.154	0.103	0.111	0.138	-0.016
Rural	0.438	0.423	0.406	0.405	-0.033
Geographic Zone					
Coast	0.298	0.279	0.262	0.202	-0.096
Northern	0.296	0.303	0.292	0.250	-0.046
Lake	0.461	0.462	0.450	0.431	-0.030
Central	0.553	0.534	0.517	0.515	-0.038
Southern Highlands	0.385	0.350	0.336	0.320	-0.065
Southern	0.435	0.408	0.377	0.412	-0.023
Sex of Household Head					
Male	0.415	0.397	0.373	0.358	-0.057
Female	0.375	0.357	0.365	0.348	-0.027
Education of Household Head					
No schooling	0.484	0.482	0.455	0.488	0.004
Some primary school	0.448	0.433	0.408	0.396	-0.052
Completed primary school	0.308	0.321	0.308	0.322	0.014
Some secondary school	0.118	0.112	0.098	0.102	-0.016

Source: Based on the analysis of the 2000/01 Tanzanian Household Budget Survey and the Demographic and Health Surveys of 1991/92, 1996, 1999, and 2003.

(1) Incidence of poverty refers to the proportion of the population living in households with per capita consumption expenditure below the poverty line.

With regard to gender, both analyses agree that the poverty rate has fallen faster among male-headed households than among female-headed households. In the original analysis, the two groups had similar poverty rates in 1991/92, but male-headed households have seen more poverty reduction. In the analysis presented in this chapter, however, male-headed households were poorer than female-headed households in 1991/92, but that difference had largely disappeared by 2003.

Finally, with regard to the education level of the head of household, the two analyses agree that there is a strong negative relationship between education and poverty. Furthermore, they agree that the strongest gains in poverty reduction occurred among households whose head had some primary school but had not completed it. And they also agree that households in the upper two educational categories had showed little change in the poverty rate. The main difference is that in the original analysis (using the 1991/92 HBS) households whose head had no education saw a reduction in poverty, while the poverty rate for this group remained constant in the analysis presented in this chapter (using the 2000/01 HBS).

From the results above, the poverty estimates obtained using the 2000/01 HBS are slightly lower than those originating from the 1991/92 HBS. However, the rates are not very far from those obtained directly from the 2000/01 HBS. The poverty rates estimated from the 1999 DHS and the 2003 DHS are similar to those calculated directly from the HBS data, as shown in Table 3.5.

It can be seen in Table 3.5 above that the HBS poverty rates for Mainland Tanzania, Dar as Salaam, and the rural areas are within one percentage point of those obtained from the 2003 DHS and within 2.5 percentage points of those calculated from the 1999 DHS. The largest discrepancies are in the estimates of the urban areas outside of Dar es Salaam, for which the HBS estimate is significantly greater than the estimates obtained from the two DHSs.

Source: Based on the analysis of the 2000/01 HBS and the DHSs of 1999 and 2003.

Table 3.5. Poverty incidence in different types of households

Household group	Incidence of basic needs poverty		
	1999 DHS (imputed)	2000/01 HBS (measured)	2003 DHS (imputed)
Mainland Tanzania	0.371	0.347	0.356
Dar es Salaam	0.063	0.060	0.059
Other urban	0.111	0.185	0.138
Rural	0.406	0.396	0.405

3.5 Summary

This chapter tests the sensitivity of the poverty trends analysis presented in Chapter 2 to the use of a different household budget survey for the Stage 1 regression analysis. The sensitivity analysis is complicated by the difference in the way the poverty lines were calculated. The original analysis of the 1991/92 HBS yielded a national poverty rate of 48 percent; re-analysis using the poverty line methods of the new HBS yielded a poverty rate of 39 percent from the same survey data.

If we use the 2000/01 HBS instead of 1991/92 HBS to carry out the poverty trends analysis presented in Chapter 2, the predictive power of the regression model falls somewhat. In addition, the estimated poverty rates for each year are about 2-6 percentage points lower, probably because of differences between the two surveys in the way the poverty line is constructed. However, many of the basic patterns and trends are similar. Specifically, the results show that:

- The overall basic needs poverty rate in mainland Tanzania declines steadily across the four periods: 1991-92, 1996, 1999, and 2003.
- Poverty declines more in the rural areas and other urban areas than in Dar es Salaam.
- Poverty declines more among male-headed households than female-headed households.
- Poverty rates are lowest in the Northern Highlands and Coast zones and highest in the Central Zone.
- Poverty reduction is greatest in the Coast and Southern Highlands and below average in the Central Zone.
- Poverty is essentially unchanged among households whose head has completed primary school; almost all the gains in poverty reduction are among households whose head did not complete primary school.

Thus, this analysis supports the findings in Chapter 2 that poverty reduction has not occurred evenly, favoring some types of households and some regions, but it does not seem to have left behind households with less education or those living in rural areas.

4 Link between agriculture and poverty[1]

4.1 Introduction

Poverty is a very serious problem in Tanzania. According to the 2000/01 Household Budget Survey, the poverty rate is 37 percent, implying that more than one-third of the population cannot afford basic needs. The food poverty rate is about 11 percent, meaning that about one-tenth of the population cannot afford basic food requirements. The problem is more serious in rural areas where it is estimated that about 39 percent of the people earn incomes that are not sufficient to afford basic needs. Realizing the seriousness of the problem the government in the1990s formulated a long term development strategy, Vision 2025. The major objective of the strategy is to accelerate economic development, with the major thrust being on poverty reduction. The government set the target of reducing poverty by half by 2015, and completely eradicating it by 2025.

To realize the objectives, strategies and policies such as the National Poverty Eradication Strategy (NPES), and Poverty Reduction Strategy (PRS) were formulated and implemented. Assessment of achievements so far indicates that very little, in terms of reducing poverty and moving towards the target, has been achieved. Specifically, the pace of reducing poverty in rural areas, where more than 80 percent of people live, has been quite slow. The proportion of people who are poor has decreased by only 2 percentage points over a decade, from about 41 percent in 1991 to 39 percent in 2000.

Agriculture has a strategic role to play in reducing poverty and eventually achieving the targets that have been set. The strategic role of the sector is based on the fact that it provides employment to more than 70 percent of the population, contributes about 50 percent to GDP, and supplies one of the basic needs ? food. The performance of the agricultural sector, thus, has a profound impact on the course and pace of poverty reduction in Tanzania.

This study, which examines the link between agriculture and poverty in rural areas, is divided into four sections. While Section 4.2 assesses the impact of agricultural policies during the 1990s and early 2000s. Section 4.3 assesses the magnitude of the problem of rural poverty in Tanzania. In Section 4.5, we use regression analysis and the 2000/01 Household Budget Survey to examine the determinants of poverty in the rural areas. Concluding remarks are presented in Section 4.6.

4.2 Impact of economic reforms on the agricultural sector

During the 1990's the government focused more of its efforts on macroeconomic stabilization policies, paying less attention to sectoral policies, in the belief that a stable macroeconomic environment was a necessary condition for promoting investment and restoring growth in output which stagnated in the early 1980's. It was only towards the end of 1990s and early 2000s when the government formulated strategies and programs such as the Rural Development Strategy (RDS) and Agricultural Sector Development Strategy (ASDS), and Agricultural Sector Development Program (ASDP). These strategies and programs are intended to bring fundamental changes in rural areas by raising productivity in the agricultural sector, raising incomes, and reducing poverty in rural areas.

One of the reforms which aimed at reducing budget deficit and ensuring efficiency in resource allocation was the removal of agricultural input subsidies. This measure resulted into rising input

1 *This chapter was prepared by Eliab Luvanda, Economic Research Bureau, University of Dar es Salaam.*

prices and reduced application of the inputs (Putterma, 1995, and Kherallah et al. 2002). Another policy measure that had similar effect was the devaluation of the local currency. Trade liberalization policy was also implemented in the 1990's in order to raise output. This policy measure had the impact of increasing product prices in the short run. The prices, however, later on stabilized at market clearing levels. While removal of pan-territorial pricing of agricultural products, as a trade liberalization measure, resulted into reduction of welfare of remote farmers, it benefited the urban poor in terms of being able to purchase food at lower prices.

Generally the policies in 1990's did not have significant impact on the agricultural sector performances. A number of reasons to explain this unsatisfactory response of the agricultural sector performance can be identified. These include, first, poor infrastructure that has hampered agricultural sector performance by raising transport cost in the rural areas. The private sector participation in the development of the agricultural sector has also been hindered poor infrastructure. The second reason has been the poor state of technology in the agricultural sector.

Poor dissemination of knowledge from research centers to farmers is another reason that explains the poor performance of the agricultural sector in spite of economic reforms. The fourth reason is the farmers' erratic access to extension services. This problem has been compounded by the recent decentralization of management of extension services to the local government. Food crops, cotton and coffee, which are usually grown by holder farmers have been most affected by erratic access to extension services.

As shown in Table 4.1, growth in gross domestic product (GDP) and agricultural GDP has been somewhat erratic. Over the period the average annual growth rate of the agricultural GDP has been about 3.6%. This rate is to a large extent influenced by the growth rate in the crops sub- sector (3.7%), which contributes about 74 percent to agricultural GDP. It appears that the agricultural growth rate has been somewhat higher since 2000 than it was during the 1990s, particularly the early 1990s.

Table 4.1
Source: URT (2004)

Table 4.1. GDP and agricultural GDP growth rates

Year	GDP growth	Agricultural GDP growth
1990	6.2	5.5
1991	2.8	3.6
1992	1.8	1.2
1993	0.4	3.1
1994	1.4	2.1
1995	3.6	5.8
1996	4.2	3.9
1997	3.3	2.5
1998	4	1.9
1999	4.8	4.1
2000	4.9	3.4
2001	5.7	5.5
2002	6.2	5
2003	5.7	4
2004	6.7	6

The performance of the agricultural sub-sectors over the past 15 years has been quite variable as a result of the fact that it is largely dependent on rainfall (see Figure 4.1). Over the past 15 years, the growth rate of output in the fishing subsector has increased fairly substantially, rising from less than 3 percent in early 1990s to about 4 per in mid 1990s and eventually to about 7 percent in early 2000s. Improvement in the performance of the fishing industry could be attributed to increase in the exports of fish from Lake Victoria in Mwanza to the European Union. The impact of growth in this subsector on overall agricultural growth has been modest because the subsector contributes only 6 percent to the total output of the sector.

Figure 4.1

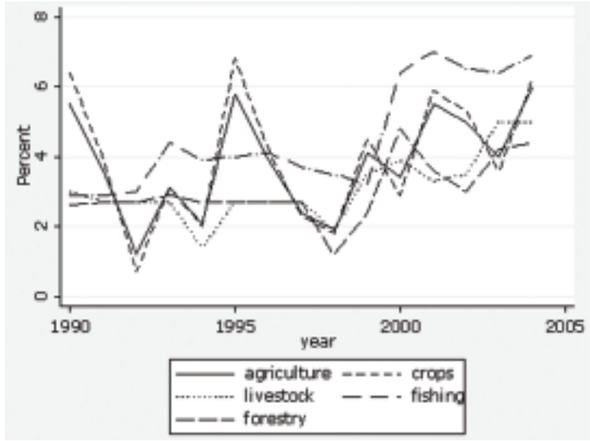


Figure 4.1.
Growth of agricultural sub-sectors since 1990

Source: URT (various issues)

Another subsector which has shown moderate persistent growth, especially since mid 1990s, is livestock. Growth in this sector has risen from about 3 percent in mid 1990s to 5 percent in early 2000s. The growth rate of output in the crops subsector, which contributes about 70 percent of output of the sector, has been fairly erratic, but recent growth rates have been in the 4-6 percent range, which is respectable.

Growth trends for major food and cash crops have been quite mixed. As Table 4.2 and Figure 4.2 show, the output of traditional staple food crops has been stagnant or declining. Maize production was stagnant over the 1990s, while sorghum and millet production have contracted quite rapidly (17 and 10 percent per year, respectively). On the other hand, pulses and paddy have shown impressive growth rates over the decade, rising 10 percent and 6 percent per year over the period. Paddy output has benefited from currency devaluation in the early 1990s which made imported rice more expensive. Since it is a "luxury" grain, domestic consumption has probably also expanded with urbanization and rising incomes.

Table 4.2. Growth trends of major crops over 1991-2000

Crop	Growth rate	
Food Crops		
Maize	-0.4 %	
Paddy	6.0 %	**
Sorghum	-16.7 %	
Millet	-9.6 %	**
Wheat	-0.1 %	
Pulses	9.7 %	**
Cash Crops		
Coffee	0.7 %	
Cotton	-6.0 %	*
Cashew nuts	13.0 %	***
Tea	2.1 %	**
Tobacco	7.0 %	*
Sisal	-5.0 %	***

Table 4.2
Note: The growth rates are based on the coefficients in a regression of the volume of production on time.
**** Significant at 1% level*
*** Significant at 5% level*
** Significant at 10% level*

Figure 4.2

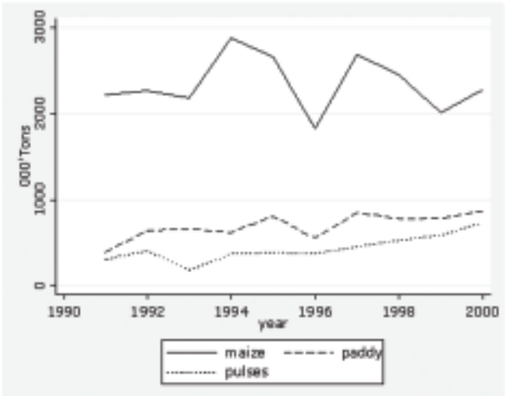


Figure 4.2
Production of the major food crops in the 1990s

Source: URT (2000)

Figure 4.3

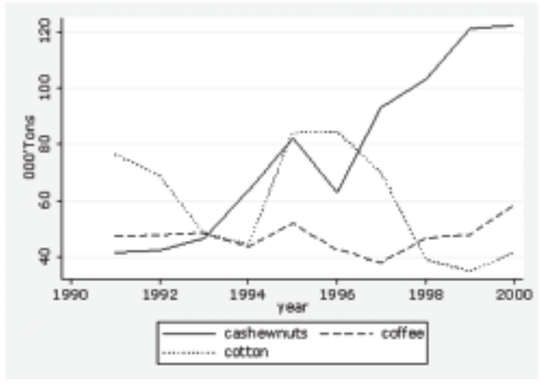


Figure 4.3 Production of major cash crops in the 1990s.

Figure 4.4

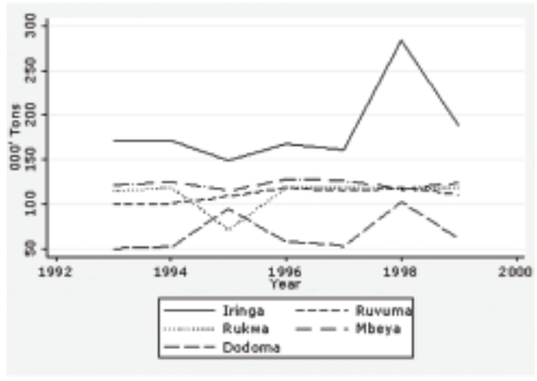


Figure 4.4 Maize production by major producing regions

Source: URT (2000).

Among cash crops, cashew nut production grew fastest over the decade (figure 4.3), average 13 percent growth annually. Much of Tanzanian cashew production is exported to India, so this growth reflects income growth in South Asia, as well as investment in the sector. Tobacco has also performed well, expanding at an average rate of 7 percent per year. Tea production has expanded more modestly, just 2 percent annually, while coffee output shows no growth over the period. The worst performance is registered by sisal and cotton, both of which declined by at least 5 percent per year. In the case of sisal, international demand has been declining for some time as a result of competition with synthetics. In the case of cotton, international prices declined in the second half of the 1990s, but the decline in production was accelerated by problems of cotton quality and farm credit.

Looking at the regional maize production patterns in Figure 4.4, there does not appear to be any trend upward or downward, nor much reallocation among regions. This is somewhat surprising because the economic reforms removed pan-territorial pricing in maize and fertilizer, which implied lower maize prices and higher fertilizer prices for the southern highlands, traditionally the maize surplus region of Tanzania. One would expect that these reforms would reduce maize production in the southern highlands and shift production to areas closer to Dar as Salaam such as Morogoro.

A major reason for the lack of growth in maize production is that there has been little or no improvement in tech-nology, as indicated by stagnant yields. Maize yields increased just 0.3 percent per year over the 1990s. Paddy yields have actually declined at about 3.1 percent per year while production has expanded. Pulses, on the other hand, show a fairly strong growth in yield (6 percent annually), although some of this may be due to changes in the composition of pulse production over this time period.

Based on the observation of performance of the agricultural sector over time, two main points can be raised. First, stagnant productivity and constant trends in the output of crops suggest that the fundamental factors, such as application of inputs and technology, which are necessary for sustained growth in output, have not been adequately addressed. Transitory increases in, and fluctuations of, output that characterizes the past and current performance of the agricultural sector are mainly due to erratic factors, such as weather, which are not fundamental in permanently improving the performance of the agricultural sector. Second, stagnant and low levels of agricultural productivity levels of income in the rural areas, which are very low, have remained stagnant. In addition, low levels of incomes and output of food crops do not permit adequate nutrition. In such circumstances, it is very difficult to imagine having a scenario in which poverty in rural areas can decline.

4.3 Poverty in rural areas

4.3.1 Defining and measuring poverty

In the previous section, it was observed that the performance of the agricultural sector in the 1990's has not been satisfactory. The sector has been characterized by low productivity. As a result incomes in the rural areas are still very low; and therefore poverty is still serious problem in the rural areas. In this section we attempt to assess the magnitude of the problem of poverty in the rural areas. Most of people in Tanzania depend on agriculture for their livelihood. In rural areas, more than 80 percent of the population is engaged in agriculture. As Table 4.3 below shows, about 85 percent of the rural population has farming as the main economic activity.

Table 4.3. Distribution of rural population by main economic activity

Main Occupation	Percent
Work on own farm	85.3
Unpaid family helper	9.4
Employee-central government	1.0
Employee-parastatal organization	0.1
Employee-cooperative	0.1
Employee-NGO/religious organization	0.3
Employee-private sector	1.2
Self-employed in business with employees	0.2
Self-employed in business without employees	2.0
Other	0.4
Total	100.0

Source: Computed from the 2002 Integrated Labor Force Survey

Including those who have agriculture as their secondary economic activity, almost the entire rural population depends on agriculture for the livelihood. Thus, the performance of agriculture is closely linked with the welfare of the rural population in the sense that rising agricultural incomes is a necessary condition to reducing poverty. This study uses the 2000/01 Household Budget Survey, which is representative at the regional level to examine the magnitude of the problem of poverty in rural areas. To take into account nutritional requirement of an individual based on age and gender, the study uses the adult equivalent scales developed by Latham (1965). The scales are presented in Table 4.4. The basic needs poverty line developed by the National Bureau of Statistics (2002) is used in this study to measure poverty in rural areas. According to NBS the basic needs poverty line is Tshs. 7258 per 28 days month.

Table 4.4. Adult equivalence scales

Age groups (years)	Male	Female
0-2	0.4	0.4
3-4	0.48	0.48
5-6	0.56	0.56
7-8	0.64	0.64
9-10	0.76	0.76
11-12	0.8	0.88
13-14	1	1
15-18	1.2	1
19-59	1	0.88
Over 60	0.88	0.72

Note: Adult equivalence scales are in index of caloric requirements by age and sex. These adult equivalence scales are based on data from East Africa.

Source: Collier et al (1990).

In this analysis, we measure rural poverty in Tanzania using the income/expenditure method, and the most common measures of poverty: the head count index (P_0), poverty gap index (P_1), and squared poverty gap index (P_2).

This index measures the population with per capita income or adult equivalent expenditure lower than the poverty line. It is the percentage of the population that is counted to be poor. The head count index is given by the following formula:

$$P_0 = \frac{1}{N}\sum_{i=1}^{N} I(y_i \le z) = \frac{N_p}{N}$$

Where N is the total population and I(.) is an indicator function, taking on a value of 1if the expression in the bracket is true, 0 otherwise. Thus if expenditure y_i is less than the poverty line z, I(.) is equal to 1 and the household is counted as poor. N_p is the total number of the poor.

The main and perhaps the only advantage of the head count index is its simplicity in computation and interpretation. Its main flaw is that it does not take into account poverty intensity. It simply gives the proportion of the population below the poverty line, without showing how far the poor are below the poverty line. The poverty gap index overcomes this limitation.

The poverty gap index, P_1, overcomes the weakness which is inherent in the head count ratio in the sense that it shows on average, how from the poverty line are the incomes of the individuals. This index gives a rough picture of the amount of effort needed to bring incomes of the poor to the level of the poverty line. The poverty gap index can be calculated using the following formula

$$P_1 = \frac{1}{N}\sum_{i=1}^{N}\frac{G_n}{z}$$

where $G_n = (z - y_i)I(.)$ is the poverty gap, z is the poverty line, y_i is the actual income or expenditure of individual i.

This measure can be thought of as the cost of eradicating poverty relative to the poverty line. It shows the magnitude of resources needed to be transferred to the poor to raise their incomes to the poverty line.

Poverty severity index, normally denoted by P_2, gives some indication of the distribution of poverty. Sometimes this measure, which sometimes is called the squared poverty gap index, gives more weight to individuals who are further away from the poverty line. The formula for the index is as follows:

$$P_2 = \frac{1}{N}\sum_{i=1}^{N}\left(\frac{G_n}{z}\right)^2$$

4.3.2 Estimates of rural poverty

Table 4.5 presents poverty indices by regions. According to the results, about 40 per cent of individuals in the rural areas are poor. This rate is higher than the rate of poverty in urban areas. For example, poverty rates in Dar-es-Salaam and other urban areas are 17.6 percent and 25.8 percent, respectively. Regional headcount estimates indicate that Mbeya has the lowest percentage of individuals who are poor, 2.3 percent. Dar-es-Salaam, which has the lowest headcount ratio, when calculations are based on the aggregate of urban and rural, is not among the 10 regions having the lowest poverty rates. The headcount ratio for Dar es Salaam rural is 44 percent.

Lindi has the highest percentage of individuals living in rural areas who are poor is one (59 percent). This region is one of the two regions with the highest headcount ratio, when calculations are based on the aggregate of urban and rural areas (see Table 4.5). Poverty gap and poverty severity indices suggest that poor individuals in Mbeya, Tabora, Iringa and Kilimanjaro have incomes that are closer to the poverty line. Incomes of poor individual in Mara are very far below the poverty line. Other regions in which more serious efforts are need to raise incomes of the poor to bring them closer to the poverty line are Lindi, Singida and Mwanza.

Table 4.5. Poverty indices in rural areas by region

	P_0			P_1			P_2		
Region	**Estimate**	**Std. Error**	**Rank**	**Estimate**	**Std. Error**	**Rank**	**Estimate**	**Std. Error**	**Rank**
Dodoma	0.37	0.066	8	0.083	0.015	8	0.031	0.006	8
Arusha	0.43	0.078	12	0.151	0.045	14	0.071	0.028	15
Kilimanjaro	0.32	0.071	5	0.071	0.018	4	0.022	0.006	1
Tanga	0.39	0.060	10	0.076	0.019	6	0.026	0.008	6
Morogoro	0.32	0.034	6	0.080	0.012	7	0.028	0.006	7
Pwani	0.48	0.102	17	0.159	0.047	15	0.067	0.022	14
Dar es Salaam	0.44	0.116	13	0.169	0.076	16	0.082	0.045	16
Lindi	0.59	0.157	20	0.187	0.058	18	0.083	0.025	18
Mtwara	0.40	0.053	11	0.109	0.021	10	0.044	0.012	10
Ruvuma	0.44	0.096	14	0.132	0.028	13	0.051	0.012	11
Iringa	0.30	0.059	4	0.070	0.015	3	0.024	0.006	3
Mbeya	0.23	0.067	1	0.061	0.019	1	0.023	0.008	2
Singida	0.58	0.049	19	0.193	0.029	19	0.090	0.019	19
Tabora	0.28	0.042	2	0.068	0.013	2	0.026	0.007	5
Rukwa	0.33	0.046	7	0.073	0.008	5	0.024	0.004	4
Kigoma	0.39	0.043	9	0.117	0.023	11	0.051	0.012	12
Shinyanga	0.44	0.070	15	0.128	0.028	12	0.051	0.013	13
Kagera	0.30	0.094	3	0.087	0.037	9	0.034	0.016	9
Mwanza	0.49	0.075	18	0.177	0.034	17	0.082	0.019	17
Mara	0.48	0.104	16	0.218	0.050	20	0.123	0.029	20
All rural	**0.39**	**0.02**	**-**	**0.117**	**0.008**	**-**	**0.05**	**0.004**	**-**

Source: 2000/01 Household Budget Survey.

Poverty indices based on different agricultural ecological zones have also been calculated in order to see roughly if there is correlation between agricultural ecological factors and poverty. Rural areas have been divided into six major zones: Northern highlands, Central, Lake regions, Southern highlands, Coast and Southern zone. Average annual rainfall and soil fertility have been used to determine the zone categories. For example, the Northern and Southern highland regions on average receive good amount of rainfall that as suitable for agriculture. These regions also have relatively fertile soils. Regions in the Central zone are arid.

Table 4.6 below shows that the Southern highland regions have the lowest head count, poverty gap and poverty severity indices. The Central zone has the highest head count ratio. Using the poverty gap and poverty severity indices, the Northern highlands and the Coastal zones rank second to the Southern highlands zone. Generally it an be argued that these results roughly suggest that there is correlation between agricultural ecological factors and poverty in rural areas.

Table 4.6. Poverty indices in rural areas by zone

	P_0			P_1			P_2		
Zone	**Estimate**	**Std. error**	**Rank**	**Estimate**	**Std. error**	**Rank**	**Estimate**	**Std. error**	**Rank**
Northern Highlands	0.388	0.042	4	0.105	0.021	2	0.043	0.013	3
Central	0.458	0.049	6	0.130	0.020	5	0.056	0.011	5
Lake Region	0.423	0.043	5	0.145	0.019	6	0.067	0.010	6
Southern Highlands	0.310	0.037	1	0.079	0.010	1	0.029	0.004	1
Coast	0.376	0.043	2	0.108	0.020	3	0.042	0.010	2
Southern Zone	0.386	0.045	3	0.111	0.017	4	0.046	0.008	4

Source: 2000/01 Household Budget Survey.

4.4 Income inequality in rural areas

Poverty indices that have been discussed in the previous section simply give a summary of welfare of individuals whose incomes or expenditures are below the poverty line. They do not convey any information about the position of poor individuals/households relative to those whose incomes are above the poverty line. Income inequality measures, such as the Gini coefficient, give a summary measure of the welfare of poor individuals relative to those individuals who are not poor. Another reason for the importance of a measure of income inequality is that it can inform the process of formulating poverty reduction policies on strategies that can be effective in reducing poverty. For example, with high income inequality, in addition to economic growth, income redistribution can also be used as a policy measure to reduce absolute poverty; and when income inequality is very low output/income growth becomes almost the only measure to achieve poverty reduction. For these reasons, a measure of income inequality in rural areas of mainland Tanzania is also calculated. For comparison purpose, regional income inequality measures are also presented.

In this study, the Gini coefficient is used to measure income inequality in rural areas. It gives a summary of how equal or unequal is the income distribution. The coefficient usually ranges between zero and unit, with higher values indicating higher degrees of income inequality. Table 4.7 below shows that the Gini coefficient for rural areas in Tanzania is 0.32. Income inequality in rural areas is fairly low. Aggregate regional figures are shown in the last two columns. Generally, income inequality seems to be lower in rural areas relative to urban areas, where the Gini coefficient is 0.36. The degree of income inequality seems to have not changed in the 1990s given the fact that the Gini coefficient for rural areas in 1991/92 was 0.33.

Table 4.7. Gini coefficients by region

Source: 2000/01 Household Budget Survey.

Region	Rural			Rural and urban	
	Gini Coefficient (rural)	Standard error	Rank	Gini Coefficient	Standard error
Dodoma	0.28	0.012	5	0.29	0.014
Arusha	0.32	0.017	12	0.33	0.026
Kilimanjaro	0.28	0.014	6	0.29	0.015
Tanga	0.27	0.013	3	0.28	0.012
Morogoro	0.27	0.013	4	0.31	0.017
Pwani	0.34	0.020	17	0.34	0.014
Dar es Salaam	0.34	0.038	18	0.35	0.013
Lindi	0.33	0.019	14	0.34	0.014
Mtwara	0.31	0.013	9	0.31	0.013
Ruvuma	0.33	0.031	15	0.35	0.026
Iringa	0.32	0.020	13	0.33	0.036
Mbeya	0.31	0.017	10	0.31	0.02
Singida	0.34	0.056	16	0.34	0.052
Tabora	0.26	0.023	2	0.29	0.015
Rukwa	0.24	0.019	1	0.26	0.021
Kigoma	0.28	0.021	7	0.31	0.029
Shinyanga	0.32	0.033	11	0.33	0.035
Kagera	0.29	0.019	8	0.30	0.027
Mwanza	0.40	0.041	20	0.40	0.033
Mara	0.38	0.020	19	0.38	0.02
All rural	**0.32**	**0.007**		**0.34**	**0.007**

In almost all regions, income inequality in rural areas is slightly less than aggregate income inequality. Whereas income inequality is lowest in Rukwa, it is highest in Mwanza region. Actually, income inequality in Mwanza Rural seems to be higher than the national average (0.34). Income inequality in rural Mara is also higher than the national average.

Generally, there are does not seem to be a clear pattern of correlation between income inequality and poverty rates. Whereas in some cases there are seems to be some correlation, in other cases, there does not seem to be association between income inequality and poverty. For example, a pattern observed in the case of Kilimanjaro, Tabora, and (low income inequality and low rates of poverty); and Mara and Mwanza (high income inequality and high poverty rates) tend to suggest that poverty and income inequality are positively correlated. However, a pattern observed in the case of Mbeya and Iringa does not suggest that kind of correlation. While these regions are among the five regions with low rates of poverty, they are not among the nine regions with low levels of income inequality.

4.5 Determinants of poverty in rural areas

In section 4.3 we assessed the magnitude of poverty in rural areas. It was noted that poverty rate in rural areas is very high; and it is higher than the rate in urban areas. It has also been observed that poverty rates differ across regions and agricultural ecological zones. The findings also roughly suggest that there might be correlation between agricultural ecological factors and poverty.

In this section, we want to identify "determinants" of poverty in rural areas. The main source of data for this analysis again is the Household Budget survey. The performance of agriculture is closely linked with the welfare of the rural population in the sense that rising agricultural incomes is a necessary condition to reducing poverty. Given this link, a study on determinants of poverty in rural areas has to investigate also factors (such as usage of agricultural inputs, agricultural practices (such as weeding and crop storage), and extension services, which influence production and eventually farmers incomes.

In the case of Tanzania, good sources of such information are the agricultural surveys that are conducted by the Ministry of Agriculture and Food Security in collaboration with the National Bureau of Statistics. The original intention in this study was to use the 1998/99 Integrated District Agricultural Survey (IDAS) to analyze the determinants of regional patterns of poverty. The IDAS data set has two major potential advantages. First, it has data for variables such as usage of inputs, and agricultural practices that influence agricultural production. Second, the survey is representative at a district level.

However, attempts to put together the data from the survey failed because of two major reasons. First, a large number of observations were missing in different scattered files. Second, different data files did not have a unique identifier to facilitate pooling together the relevant information from the different scattered files. Due to these limitations, this study uses the 2000/01 Household Budget Survey, which is representative at the regional level.

4.5.1 Methods

The objective in this section is to examine the factors associated with poverty among rural households in Tanzania. We use the rural households in the 2000/01 Household Budget Survey (HBS) for this analysis. The dependent variable is the poverty status of a household. A household is considered to be either poor or not poor, depending on whether its per adult-equivalent expenditure falls below or above the basic needs poverty line (Tshs. 7,258/= per month). The dependent variable, y, equals 1 if the household is poor and 0 if it is not.

We consider a set of explanatory variables from the HBS that may influence the probability of a household being poor, namely:

- Age of the household head
- Education of the household head
- Size of the household
- Dependence ratio
- Distance to the nearest primary school (proxy for education)
- Distance to the nearest health center (proxy for health services)
- Distance to the nearest market place
- Distance to the nearest public transport
- Degree of monetization of economic activity
- Distance to the nearest bank branch (proxy of access to credit)
- Distance to nearest primary co-operative society.

Age of the household head is assumed to have varying impact on the probability of a household being poor. At very low level of age, an individual does not have sufficient working experience, and the individual has not accumulated much wealth or productive assets. Thus, we expect a young individual to be earning a low income so the probability of poverty is higher.

As an individual gets older, working experience and stock of wealth/productive assets increase, but at a decreasing rate, until a certain level of age is reached when physical and mental capacity declines. We expect the income of an individual to decrease with age at higher ages. To take into account this kind of behavior, both the age and the square of age of the household head are included in the model as explanatory variables.

The number of dependants, the young and the old who cannot be engaged in productive activities, constitute an economic burden to a household. Thus the higher is the number of dependants, relative to the number of productive members, in the household, the higher the probability that a household will be poor. In this study, dependants are defined as those below ten years and those above 65 years.

Distance to the nearest health center and primary school are treated a proxy of human capital. It is assumed that the nearer is the household is to these facilities, the lower the probability that a household will be poor. Proximity to a market place is assumed to create economic opportunities that stimulate household's efforts to engage in economic activities. Thus, it is expected that the closer is a household to the market place, the lower the probability that a household will be poor.

Proximity to public transport enhances the chances of having access to inputs. It also enhances market opportunities for the products. Proximity to public transport, therefore, is expected to be associated with lower probability for a household to be poor. Monetization of economic activity facilitates transactions, enhances economic opportunities, and stimulates efforts to engage in more production.

Thus, other things remaining equal, it is expected that a high degree of monetization of activities reduces the probability of a household being poor. This study uses the proportion of monetary consumption in total consumption as a proxy measure of monetization of the activities of a household. Access to credit facilities enhances the chances for a household to afford inputs that essential for increased production. The probability for a household to be poor is therefore expected to decrease with access to credit facilities.

In this study, two variables (access to bank loans and belonging to informal saving groups) have been included as explanatory variables in order to assess the impact of access to credit on the status of poverty for a household. While access to a bank loan is intended to capture the influence of formal sources of credit, belonging to informal saving groups is intended to capture the influence of informal channels of credit on the status of poverty.

Summary statistics for the explanatory variables used in the regression analysis are shown in Table 4.8. The table reveals some extreme values in the data. For example, the minimum age of the head of household is just 15, which may reflect households in which the household head is an HIV/AIDS orphan. Similarly, the maximum distances to the nearest primary school, health centre, market place, and public transport are quite large. One suspects that some of these may reflect measurement errors. Since these "extreme" values would influence the regression results, the distances were trimmed, with observations in the top 5 percent being adjusted to equal the value at the 95th percentile. After adjustment, the maximum distance to the nearest primary school was 10 kilometers and the maximum distance to a health care center was 30 kilometers. For the market place and public transport, the adjusted maximum distances was 40 kilometers. However, these adjustments did not change the results significantly.

Table 4.8. Descriptive statistics of explanatory variables

Variable	Description	Mean	Standard deviation	Mini-mum	Maxi-mum
h_educ	Education of the household head (years)	3.16	1.69	1	10
h_age	Age of household head (years)	44.16	15.46	15	98
sqage	Square of the age of household head	2189.42	1557.39	225	9604
edist	Distance to the nearest primary school (km)	1.88	3.32	0	112
hdist	Distance to the nearest health center (km)	4.45	6.09	0	130
bloan	Access to bank loan (0 if no, 1 otherwise)	0.01	0.08	0	1
bsav	Belongs to informal saving group (1=yes)	0.03	0.18	0	1
elgrid	Connected to main grid electricity (1=yes)	0.04	0.20	0	1
flandy1	Farming land owned last year (acres)	5.86	23.15	0	1235
flandy2	Farming land owned this year (acres)	5.47	20.52	0	1235
mon	Degree of monetization (ratio)	0.59	0.28	0	1
marktdist	Distance to nearest market place (km)	3.11	5.23	0	150
ptransdist	Distance to nearest public transport (km)	5.35	8.26	0	150
hhsize	Household size (persons)	5.29	3.34	1	40
depratio	Dependency ratio (ratio)	0.42	1.82	0.34	0.91

Source: 2000/2001 Household Budget Survey.

Because the dependent variable is binary (0 or 1), the use of a ordinary least squares would be inappropriate. The error terms would not be normally distributed, violating one of the assumptions behind OLS. Instead, we use the probit and logit models, designed for use with binary dependent variables.

It is possible that there is a two-way causal relationship between the dependent variable and some of the explanatory variables. For example, an increase in monetization may reduce the likelihood of a household being poor but it is also possible that a relatively rich household can be in a better position to engage itself in monetary transactions than a poor household. In such a case, because of the problem of simultaneous equation bias, it is advisable to use the simultaneous equation methods such as the two stage-least squares and three-stage-least squares to estimate the model. In view of the fact that quite a good number of studies such as have used and found single equation logit and probit models to be fairly adequate, simultaneous equation estimation methods are not employed.

4.5.2 Results

The results of the probit and logit regression analysis are shown in Table 4.9 and 4.10. Table 4.9 shows the original regression coefficients, while Table 4.10 shows the marginal effect of a one unit change in the explanatory variable on the probability that a household is poor. The logit and probit models give fairly similar results. In most cases, the same variables are statistically significant in both models. All but two variables, all the variables have the expected signs.

- Education of the head of household (h_educ) has the expected negative sign and is significant at 1 percent in both the probit and logit models. This implies that households in which the head of household has more education are significantly less likely to be poor. As shown in Table 4.10, both models suggest that each additional year of education reduces the probability that a household is poor by about 5 percent.

- The age of the head of household (h_age) and age squared (sqage) show a weak relationship with poverty in the probit model only. The signs (positive and negative, respectively) indicate that poverty rises until about the age of 50, then declines. This is not the relationship expected, but the statistical evidence for the relationship is weak.

- The distance to the nearest primary school (edist) and distance to the nearest health care center (hdist) are not significantly related to the probability that a household is poor. Even if the access to education and health services influences use of those services, the impact on income and poverty is not direct. Another interpretation of these results is that the location of schools and clinics is such that the access of poor rural households is as good as that of better-off rural households.

- Access to bank loans (bloan), belonging to informal saving group (bsave), and connection to main grid electricity (elgrid) have the expected signs, but they are not statistically significant in explaining the probability of a household being poor.

- Farm land owned last year (flandy1) and farm land owned this year (flandy2) have the expected negative sign, suggesting that households with larger farms are less likely to be poor. However, of the two variables, only farm land owned this year is statistically significant at 10 percent in the logit model. Even one of the two variables is removed to address multicollinearity, the effect is not strong. There are at least two possible explanations for this weak relationship. First, our sample includes both agricultural and non-agricultural households living in rural areas. Non agricultural household have little land but tend to have higher incomes, thus contradicting the expected relationship. Second, the regression model does not control for land quality. In general, farmers in drier zones with poor soils have larger holdings (particularly those depending on livestock production). Farmers in high-rainfall zones with good soils tend to have smaller farms. Again, this pattern weakens the expected relationship between farm size and income.

- The degree of monetization of economic activity (mon) has a negative sign, as expected, and is statistically significant at the 1 percent level. This suggests that more monetized households are less likely to be poor.

- The most unexpected finding is that the coefficient for distance to market (marktdist) is negative and statistically significant at the 5 percent level, implying that households farther from a market are less likely to be poor. The respondents may have used different definitions of "market", introducing measurement error. It is also possible that there is multicollinearity with other distance variables. For example, if distance to public transportation is dropped from the model, the coefficient for distance to market is no longer statistically significant.

- Household size (hhsize) has the expected positive sign, and is significant at the 1 percent level. In other words, both models suggest that adding additional members to a household increases

- The dependence ratio (depratio) has the expected positive sign, but it is not statistically significant at the conventional levels. This seems to be due to the high correlation (0.87) between this variable and the household size (large households tend to have a large proportion of children). When the household size variable is dropped from the model, the dependency ratio is statistically significant at the 5 percent level, confirming the suspicion that multicollinearity is the reason for the variable not being significant.

Table 4.9. Regression analysis of factors associated with rural poverty

	Logit				Probit			
Variable	**Coeff**	**Std. Error**	**t-Statistic**		**Coeff**	**Std. Error**	**t-Statistic**	
h_educ	-0.2271	0.0543	-4.18	***	-0.1349	0.0330	-4.09	***
h_age	0.0355	0.0222	1.6		0.0230	0.0132	1.74	*
sqage	-0.0003	0.0002	-1.57		0.0002	0.0001	-1.70	*
edist	-0.0076	0.0162	-0.47		-0.0068	0.0099	-0.69	
hdist	0.0074	0.0099	0.76		0.0043	0.0058	0.73	
bloan	-0.5191	0.7979	-0.65		-0.3080	0.4681	-0.66	
bsav	-0.5610	0.4462	-1.26		-0.3178	0.2540	-1.25	
elgrid	-0.4621	0.4101	-1.13		-0.2452	0.2271	-1.08	
flandy1	-0.0040	0.0056	-0.73		-0.0014	0.0027	-0.52	
flandy2	-0.0190	0.0111	-1.71	*	-0.0054	0.0043	-1.27	
mon	-0.9762	0.2591	-3.77	***	-0.5609	0.1605	-3.49	***
marktdist	-0.0364	0.0162	-2.25	**	-0.0227	0.0097	-2.34	**
ptransdist	0.0131	0.0088	1.49		0.0072	0.0054	1.33	
hhsize	0.1625	0.0283	5.75	***	0.0869	0.0171	5.09	***
depratio	0.0021	0.0015	1.42		0.0083	0.0014	1.41	
_cons	-1.0481	0.6137	-1.71	*	-0.6626	0.3725	-1.78	*
No. of obs	7067				7067			
F-statistic	7.36				6.84			
F P-Value	0.0000				0.0000			

Table 4.9
Source: Regression analysis of 2000/2001 Household Budget Survey.

Table 4.10. Marginal effects in regression models of factors associated with rural poverty

	Logit				Probit			
Variable	**Dy/dx**	**Std. Error**	**z-Statistic**		**Dy/dx**	**Std. Error**	**z-Statistic**	
h_educ	-0.0531	0.0127	-4.18	***	-0.0512	0.0125	-4.09	***
h_age	0.0083	0.0052	1.6		0.0087	0.0050	1.74	*
sqage	-0.0001	0.0001	-1.58		-0.0001	0.0001	-1.7	*
edist	-0.0018	0.0038	-0.47		-0.0026	0.0038	-0.69	
hdist	0.0017	0.0023	0.76		0.0016	0.0022	0.73	
Bloan	-0.1118	0.1550	-0.72		-0.1096	0.1541	-0.71	
bsav*	-0.1205	0.0860	-1.4		-0.1133	0.0839	-1.35	
elgrid*	-0.1008	0.0821	-1.23		-0.0887	0.0778	-1.14	
flandy1	-0.0009	0.0013	-0.73		-0.0005	0.0010	-0.52	
flandy2	-0.0044	0.0026	-1.7	*	-0.0021	0.0016	-1.27	
mon	-0.2284	0.0615	-3.72	***	-0.2127	0.0616	-3.45	***
marktdist	-0.0085	0.0038	-2.24	**	-0.0086	0.0037	-2.34	**
ptransdist	0.0031	0.0021	1.5		0.0027	0.0021	1.33	
hhsize	0.0380	0.0069	5.55	***	0.0329	0.0066	4.98	***
depratio	0.0261	0.0186	1.406		0.0238	0.0173	1.375	

Table 4.10
Source: Regression analysis of 2000/2001 Household Budget Survey.

5 *REPOA (2004), Trends in Malnutrition in Tanzania mimeo World Bank.*

4.6 Conclusions

Poverty in Tanzania is a very serious problem because the rate of poverty in rural areas where the majority of the people (more than 70 percent of the population) live is very high. The degree of income inequality in rural areas, which is fairly low, rules out the feasibility of using income redistribution measures to reduce poverty in rural areas. This implies that increasing productivity in rural areas and specifically in agriculture is a necessary condition for reducing poverty in rural areas.

Progress in reducing poverty has been modest during the past 15 years. The little progress can partly be explained by the unsatisfactory of the agricultural sector over the period. Although economic reforms implemented since mid 1980s, have succeeded in creating a stable macroeconomic environment necessary for promoting investment and economic growth, they have not been sufficient enough to bring about fundamental changes needed to raise productivity and incomes in rural areas.

The implementation of long-term policies such as (RDS, ASDS and ASDP) designed to bring about fundamental changes in the sector and rising productivity and incomes in the rural areas started about four years ago. At this time, it is too early to assess whether implementation of these policies has had a significant impact on the performance of the agricultural sector and poverty reduction. Looking at the performance of the agricultural sector during the last four years gives an impression that the policies may be working. Over that period, the annual growth rate of agricultural output has been fairly stable, and has persistently been 4 percent and above.

Education, land ownership, degree of monetization of economic activities and access to markets are significant variables that determine the probability of a household in rural areas being poor. These findings have important policy implications. Policies aimed at improving access to education are necessary for poverty reduction. Promotion of commercial activities and improving access to markets are also important measures that must be taken to reduce poverty in rural areas. Policies that guarantee land ownership for poor are important not only for reducing poverty in rural areas, but also preventing increase in income inequality.

5 Malnutrition in Tanzania: Patterns and trends[1]

5.1 Introduction

Nutrition can be referred to as a way by which our body assimilates food and uses it for growth and maintenance. Child nutrition is of great importance for assurance of strength and health protection. Children who receive balanced food have lower chances of being ill and tend to recover quickly from infections. Nutrition is becoming increasingly important, as what matters is not only the quality but also the right mix and quantity of food/nutrients. The right mix of nutrients can provide energy; allow growth and protection by repairing and regulating body functions. Thus malnutrition can be considered a sign and symptom of various social and biological processes in society, the ultimate manifestation of which is high death rates (Kavishe, 1992).

Different government policy papers including but not limited to the Food and Nutrition Policy for Tanzania (1992), Poverty Reduction Strategy Paper (PRSP, 2001), National Strategy for Growth and Reduction of Poverty (NSGRP- MKUKUTA draft 2005) and the Poverty and Human Development Report (PHDR, 2002 and 2003) look at nutrition as an important issue that needs to be controlled to see reduction in poverty. In the PRSP and NSGRP, malnutrition among children under five years is recognized as an indicator of social well being or poverty level.

Malnutrition has a long-term effect on the future of children, as it limits both physical and mental functions of a child and may eventually lead to death (Kavishe, 1986). Thus child nutrition especially those under five is very important, as the highest cost of malnutrition is its threatening effects on the survival of the community[2]. Major policies and strategies set by Tanzania in the PRSP and in the Millennium Development Goals touch on curbing malnutrition. Different groups are affected differently; in this study the focus will be on the nutrition status of children below age five[3]. The Tanzanian Demographic Health Survey (DHS) of 1991 will be the main source of data and is supported by subsequent DHS of 1996 and 1999.

The objective of the study is to provide information on the trends and spatial patterns in child malnutrition in Tanzania. In this paper, nutritional status of children in line with WHO and NCHS (US National Center for Health Statistics) standards is measured by analyzing and evaluating against the reference population. Those who are 2-3 standard deviations below the median are considered moderately to severely malnourished while those who are more than 3 standard deviations below the median are considered severely malnourished. In this study we will focus on children under five who are moderately or severely malnourished.[4] The three measures of nutritional status used in this report are:

- Height-for-age or stunting, which measures long-term nutritional status,
- Weight-for-height or wasting, which reflects current nutritional status, and
- Weight-for-age or underweight, which combines aspects of both stunting and wasting in one measure.

This report borrows extensively from a paper titled "Trends in Malnutrition in Tanzania" that was prepared by REPOA for the World Bank (see REPOA, 2004).

1 This chapter was prepared by Blandina Kilima, Research on Poverty Alleviation (REPOA).
2 This may even affect socio-economic development.
3 Anthropometric measures are only provided for children under the age of five.
4 This includes both the moderately and the severely malnourished (children less than 2sd below median)

5.2 Trends in malnutrition

When looking at the trends of malnutrition, a quick glance at the malnutrition trend in Tanzania shows that the rates have stagnated for the years 1991-1999[5]. Stunting, wasting and underweight hardly show a noticeable change. There us no have information preceding 1991. But the trends after 1991 are shown in Table 5.1 below.

Source: REPOA (2004) and DHS 2004/05

Table 5.1. Trends in nutrition indicators in children under 5 years old

Year	Height-for-age (stunting)	Weight-for-age (underweight	Weight-for-height (wasting)
		(percentage of children)	
1991/92	43	29	6
1996	44	31	7
1999	43	29	6
2004/05	37.7	21.8	3

In 1991/92, 43% of the children were categorized as moderate to severely stunted (height-for-age), in 1996 this was 44% and in 1999 the rate was again at 43%. The same trend can be observed in weight-for-age where 29% of children were underweight in 1991, increased to 31% in 1999 and went back again to 1991 level in 1999. The same trend is observed in weight-for-height. But when looking at 2004, the rates drop to 38 percent in stunting, to 22 percent in underweight and a 50 percent drop in wasting reaching 3 percent.

After looking at the overall malnutrition rates, Table 5.2 looks at the trends of stunting of all children under five years of age by residence (urban rural).

Source: REPOA (2004) and DHS 2004/05

Table 5.2. Stunting by place of residence in children under 5 years old

Place of Residence	1991/92	1996	1999	2004/05
Urban	38	33	24	25.8
Rural	45	46	47	45

We see that there is substantial difference in stunting rates between the urban and rural residence. Where children residing in the urban areas show an increasing lower rate of stunting in the 1990s while their counterparts in the rural areas show an increasing higher rate of stunting during the same period. The case is different for 2004 where the rate in the rural area drop to 41 percent while that of urban areas increased to 26 percent.

Table 5.3 shows the stunting rates of children in different wealth categories. The categories were constructed by pooling the three DHS surveys undertaken in the 1990s (1991/92, 1996, and 1999) and calculating an asset index using the method proposed by Filmer and Pritchett (2001). They showed that the welfare indicators constructed using household assets are comparable to standard household expenditure variables. More information on these calculations can be found in REPOA (2004).

Source: REPOA (2004).

Table 5.3. Prevalence of moderate/severe stunting by wealth poverty status, 1991-1999

	1991/92	1996	1999	Combined
Poorest 20%	47[43-50]	50[46-55]	52[47-58]	49[47-52]
Second 20%	50[45-54]	47[42-52]	46[40-52]	48[45-51]
Middle 20%	51[47-55]	49[45-53]	49[42-56]	50[47-52]
Fourth 20%	40[36-44]	45[41-49]	40[34-46]	42[39-45]
Least poor 20%	31[24-37]	30[26-33]	28[21-35]	30[26-33]

Table 5.3 shows that stunted children are more likely to live in poorer (less wealthy) households. Looking at the poorest 20%, the level of stunting appears similar to those children in the rural areas

5 *REPOA (2004), Trends in Malnutrition in Tanzania mimeo World Bank*

Figure 5.1

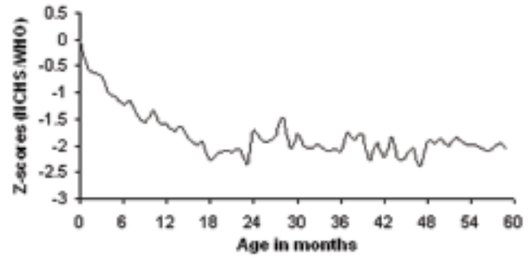


Figure 5.1. Stunting among children by age,1991/92

Source: Author's calculation using 1991 DHS

and the same for the least poor 20% where they follow the same trend of the urban residence. Looking closely at table 1.3, we see that 60% of the poorest have the same proportion of stunting and non-stunting. While the situation is different for the least poor, it should be noted that all the different wealth/poverty status observes similar stagnant trends in 1990s.

Tables 5.2 and 5.3 indicate that children who are least poor and live in the urban areas can escape malnutrition. It needs to be noted that these rates are very high for all the various statuses and areas. So there is little trend but a slight improvement mainly observed in the urban areas.

Figure 5.1 shows that stunting commences right after birth and continues till 24 months then tends to stabilize though still fluctuating. This figure supports the idea that intervention for malnutrition should be done at early age. And thus damage control must commence within the earliest months of the child's life.

5.3 Geographical patterns

Tanzania has vast area, thus proximity to the shores or to the market or being in the north or south of the country has different impacts on the quality and manner of living. People along the coast are influenced by Arabic culture; while people in the north have different cultures, including Bantu, Nilotic and Cushitic (note that there are more than 125 dialects in Tanzania). Given these differences, it is most likely that feeding practices will differ as well as the nutritional status. Thus in this section we first look at neighbouring countries, then zonal, regional and later urban-rural nutrition status levels. It is important to note that the 1991 DHS is only representative at urban rural desegregation, thus results stipulated in this section at zonal and regional levels need to be treated with great caution.

For an international comparison, Figure 5.2 examines the levels of stunting in Tanzania and three neighboring African countries in years close to 1991/92. Kenya (32.7%) had a lower level of malnutrition when compared to Malawi (48%), Uganda (45%) and Tanzania (43%). However, it should be noted that all these stunting rates are relatively high.

Figure 5.3 shows different nutritional status by zone[6]. According to Figure 5.3, the South zone (Mtwara and Lindi) has the worst nutritional status with highest levels of height-for-age and weight-for-age malnutrition. By these two measures, the Northern Highlands and the Lake Zone have the best nutritional status.

6 *Zones are compromised of regions as follows - Coastal Zone: (Tanga, Morogoro, Coast and Dar e Salaam), Northern Highland: (Arusha and Kilimanjaro), Lake: (Tabora, Shinyanga, Kagerra Mwanza and Mara), Central: (Dodoma and Singida), Southern highland: (Iringa, Mbeya and Rukwa), and South (lindi Mtwara and Ruvuma DHS 1996 pg2*

Figure 5.2

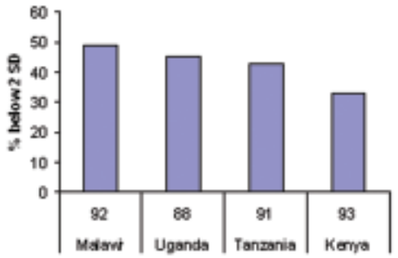


Figure 5.2 Stunting in selected African countries

Source: DHS of Malawi, Uganda, Kenya and Tanzania

Figure 5.3

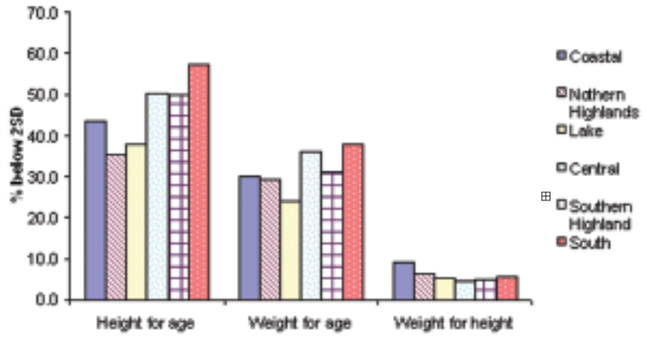


Figure 5.3 Stunting, underweight, and wasting among children by zone in 1991

Source: Author's calculation using 1991 DHS

Table 5.4 shows the level of stunting, wasting and underweight for different regions in the 1990s[7]. From the table the highest levels of stunting (63%) are observed in Mtwara and Lindi (58 %). This is similar to the zonal level comparison; where South has lower nutritional status. Dar es Salaam has the best nutritional status of (26.9%). This level might explain the lower levels of stunting at the coastal zone. It is important to note that these levels are very high for both worst performing and best performing regions.

Table 5.4. Regional differences in malnutrition in the 1990s

Region	Height-for-age	Weight-for-age	Weight-for-height
Mtwara	63.2	49.0	6.9
Lindi	58.2	30.6	5.8
Morogoro	57.9	34.8	5.0
Dodoma	57.5	37.1	2.9
Iringa	56.5	37.4	3.9
Ruvuma	52.5	34.3	4.5
Coast	51.3	37.4	6.0
Kigoma	48.6	34.1	5.8
Mbeya	46.2	25.8	6.1
Rukwa	42.2	26.7	4.8
Tabora	41.7	24.9	4.8
Kagera	41.1	27.5	5.8
Tanga	39.8	31.4	16.6
Singida	37.2	33.9	7.2
Arusha	35.6	31.4	6.4
Mara	35.1	18.9	4.7
Kilimanjaro	35.0	27.0	6.6
Mwanza	34.9	21.2	4.4
Shinyanga	33.2	21.0	5.9
Dar es Salaam	26.9	19.5	7.1

Table 5.4 Source: Author's calculations using DHS data of 1991/92, 1996, and 1999

7 *To curb representation problem, in the REPOA (2004) Trends in Malnutrition in Tanzania, the three DHS were pooled then the regional estimates were calculated (see p11)*

Figure 5.4

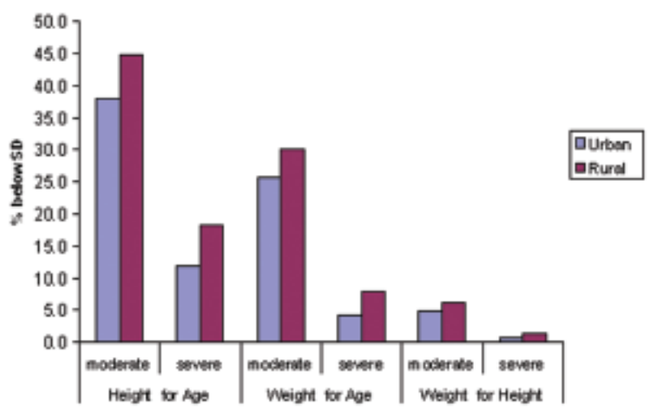


Figure 5.4. Urban-rural differences in malnutrition in 1991

Source: Author's calculation using 1991 DHS

Again looking at weight-for-age, Mtwara is the worst while Mara is the best. Weight-for-height malnutrition levels are generally low, ranging from 3% to about 8%.

Having seen the zonal and regional differences in nutritional status, Figure 5.4 depicts urban rural differences in malnutrition. There is a notable difference in nutritional status between urban and rural areas in terms of moderate and severe malnutrition. Urban children tend to do better than their rural counterparts. This is true for all three different measures of malnutrition. It worthwhile to note that availability of all social services in the early 1990s was free of charge so cost will provide very little explanation for the differences.

5.4 Health factors

Good nutrition both in terms of quality and quantity helps deter diseases and allow for quick recovery. Thus sufficient food supply and absence of diseases describes good nutrition (URT 1992).

As mentioned in the NSGRP, observing the trends in Protein Energy Malnutrition (PEM), Anemia, Iodine Deficiency, Vitamin A Deficiency is very important. Anemia, Iodization of salt and Vitamin A supplementation are captured in the DHS 2004 report. With the then recorded success of the national micronutrient supplement programmes for IDD, Vitamin A and Anemia, these 3 elements were left out in the 1990's DHS. After seeing the PEM in the earlier sections, in this section we look at the variables related to the current health status limited to prevalence of diarrhoea, fever, cough and breastfeeding. These were recorded using their occurrence or frequency in the two weeks preceding the survey. We also look at anemia[8], iodization of salt and vitamin A[9].

Diarrhoea

Figure 5.5 shows the level of diarrhoea during the two weeks preceding the survey by age. The peak is observed when children are between the ages of eight (8) to 18 months, this is a period when children are introduced to new liquids and food and also become mobile, with attendant risk of contamination. But the situation then stabilizes, with minor fluctuations.

Fever

Figure 5.6 shows the level of fever in the two weeks preceding the survey by age. Fever can be used as proxy for malaria and even sometimes anemia. Unlike diarrhoea, fever/malaria prevalence peaks on

8 *Only children who stayed in the household the night before the interview were tested.*

9 *Supplement taken six months preceding the survey, this information is based on mother's recall.*

Figure 5.5.

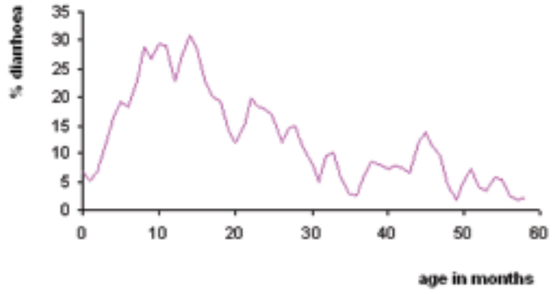


Figure 5.5
Percentage of children under 5 who experienced diarrhoea in 1991

Source: Author's ca;calculation using 1991 DHS

Figure 5.6.

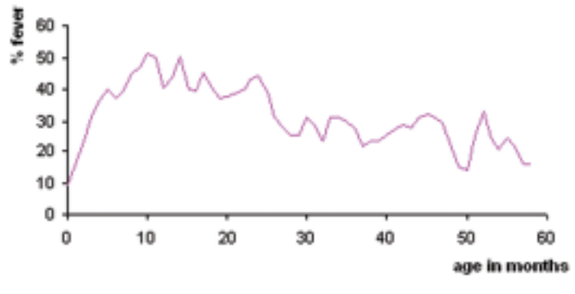


Figure 5.6
Percentage of children under 5 who experienced fever in 1991

Source: Author's calculation using 1991 DHS

Figure 5.7

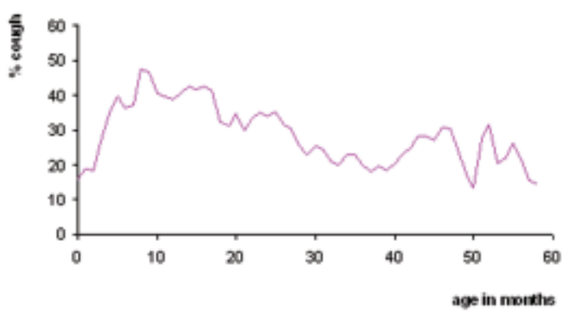


Figure 5.7
Percentage of children under 5 who experienced cough in 1991

Source: Author's calculation using 1991 DHS

the 10th month and remains fairly constant until aged 24 months, and these prevalence rates remain higher than those of diarrhoea.

In the 2004 DHS, where anemia is captured, around two thirds (65.2percent) of children were anemic; of these 24.2 percent had mild anemia, 37.6 had moderate anemia and 3.4 percent had severe anemia.

Cough

Figure 5.7 shows the level of cough in the two weeks preceding the survey by age. Cough follows a more stable trend, where older infants (8 to 18 months) are affected more, and then later the situation plateaus at high levels.

Looking at the 1990s, the REPOA 2004 study shows that diarrhoea is comparable among quintiles, and older children who had diarrhoea had an increasing risk of being stunted. Furthermore, fever is mainly observed in regions along the coast, and the effects are comparable to diarrhoea.

Figure 5.8

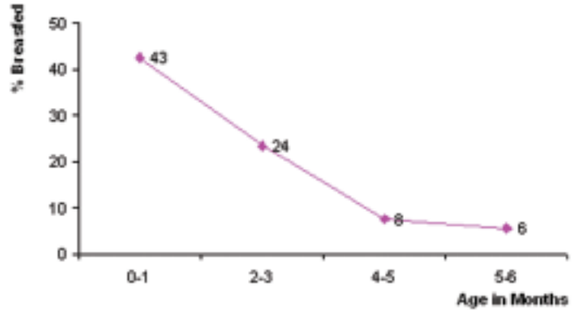


Figure 5.8
Percentage of children under 5 who were exclusively breastfed in 1991

Source: 1991 DHS

Breastfeeding and exclusive breastfeeding

According to WHO, for optimal effects infants should be exclusively breastfed for the first six months of life, and thereafter should receive appropriate complementary feeding with continued breastfeeding up to two years or beyond. Exclusive breastfeeding means a child is only given milk, while those receiving plain water in addition to breast milk are considered fully breastfed[10].

Breastfeeding was universal in 1991 with 98% of children being breastfed, and the rates remain high. Though exclusive breastfeeding is recommended for the first six months after the child's birth, Figure 5.8 shows that there is great variation.

Figure 5.8 shows that of the children who are less than six months, only about six percent were exclusively breastfed. In the 2004 DHS, 70% of children under two months were exclusive breastfed, 42% of those aged between two and three months, and 14% of those aged between four and five months and only 1.7%. While for the majority the percent drops rapidly after the first and third months, there are a number of factors that may help explain this, not limited to the status of employment and education level attained by the mothers. Where employed women breastfed their children less, thus introduce them to supplementary foods earlier, a lower level of education limits the understanding of importance of breast milk.

As we will see in the next section, the 1991 DHS data shows that mothers' level of education tends to also affect when a child is first breastfed. First breast milk is very important for the child, as it is rich in antibodies. About 63% of mothers with at least secondary education started breastfeeding their children within an hour of birth compared to 53% for mothers with no education (DHS 1996). Furthermore, education has more effect in older mothers[11]. The data further indicate that women who are more than 27 years old[12] and have some education have children with lower stunting rates than their counterparts.

All these graphs suggest that the effects of malnutrition are acquired prior to 24 months. This is concurrent with studies done by TFNC.

5.5 Household characteristics

It is believed that higher educational attainment of both the mother and the father help improve nutritional status of children, while provision of safer drinking water and better toilets in homes can bring about a reduction in the burden of diarrhoea. In this section, level of education attained by the mother and that of the head of household, as well as sources of drinking water and presence of better toilets are examined.

10 DHS. The initial introduction of water or food to mostly children under fives is believed to have some impact on the rates of diarrhoea. Early introduction to supplementary food can be explained by need for employed mothers to go back to work.

11 For younger children who are less than 36 months the education of their mother, or of the head of household has little or no effect on breastfeeding.

12 Dividing women in two equal groups, 50% of women are aged above or below 27 years.

Table 5.5. Malnutrition levels looking at parents level of education and in 1991

	Percentage of households	Percentage of children stunted	Percentage of children under-weight
All under fives			
Mother with no education	34.00	47.16*	32.63*
Mother with some education	66.00	41.50*	27.57*
Head with no education	24.30	44.90	30.79*
Head with some education	75.70	43.00	28.60*
Mother younger than 27 with no education	80.50	43.35	32.71*
Mother younger than 27 with some education	19.50	41.38	27.23*
Mother older than 27 with no education	51.80	48.67*	32.60*
Mother older than 27 with some education	48.20	41.67*	27.96*
36-59 months			
Mother with no education	37.00	53.02	30.94
Mother with some education	63.00	50.87	27.71
Head with no education	25.00	51.86	28.50
Head with some education	75.00	51.48	28.80
Mother younger than 27 with no education	80.20	49.89	29.51*
Mother younger than 27 with some education	19.80	50.94	25.91*
Mother older than 27 with no education	50.90	53.91	31.35
Mother older than 27 with some education	49.10	50.79	29.71
Up to 36 months			
Mother with no education	32.50	43.91*	33.57*
Mother with some education	67.50	37.23*	27.43*
Head with no education	23.90	41.16	32.02*
Head with some education	76.10	38.74	28.50*
Mother younger than 27 with no education	80.60	40.83	33.94*
Mother younger than 27 with some education	19.40	37.79	27.72*
Mother older than 27 with no education	52.40	45.36*	33.39*
Mother older than 27 with some education	47.60	36.25*	26.92*

Source: Author's calculations using DHS 1991

*Note: * indicates statistical significance at 5% level of confidence*

Table 5.5 presents the effect of the education of the head of household and the mother on the proportion of children under five that are stunted or underweight. The figures indicate that the children of mothers with some education are significantly less likely to be stunted or underweight compared to the children of mothers with no education. For example, 47 percent of children under five who have mothers with no education are stunted, compared to 41 percent among children of mothers with some education.

We divide mothers into two groups: young mothers are defined as those whose age is below the median age (27 years), while older mothers are those above the median age.

The effect of the mother's education in reducing child malnutrition is greater among older mothers than among young mothers. This is somewhat surprising because one might expect age (experience) to be a substitute for education. The effect of the mother's education on child malnutrition also seems to be stronger for children who are under three years old than for children 3-5 years old. Finally, the incidence of underweight children seems to be more sensitive than the incidence of stunting to differences in the age and education of the mother.

The education of the head of household also has a statistically significant relationship with the incidence of underweight children, though the relationship is not statistically significant for stunting, nor for children between the ages of 3 and 5. It is worth noting that the effect of the education of the head of household on the share of underweight children is less than the effect of the education of the child's mother.

The effect of age and education on wasting among children was also examined, though the figures are not presented here. None of the differences was statistically significant. This is not surprising since

Table 5.6. Water source, type of toilet, and levels of child stunting

	All under fives	Up to 36 months	35-59 months
Private piped water	24.73 *	20.59 *	32.95 *
Public piped water	46.90 *	41.43	58.45 *
Well	45.25	41.68	52.46
Spring	42.06	40.15	45.84
River/Stream/Pond lake	45.94 *	40.90	56.14 *
Flush toilet	19.81 *	16.82 *	28.92
Ventilated pit latrine	23.83 *	27.65	16.83 *
Traditional pit latrine	44.67 *	40.23 *	53.50 *
Bush/no toilet	39.28 *	37.48	43.56 *

Source: Author's calculations and DHS 1991

*Note: * indicates statistical significance at 5% level of confidence*

wasting is a reflection of short-term under-nutrition, it may be more affected by the seasonal crop cycle and recent weather rather than more stable variables such as age and education.

There is a relationship between housing characteristics and nutrition. The Food and Nutrition Policy for Tanzania describes the essentials of clothing and shelter for people:

> [Where] a person lacking good shelter and appropriate clothing has poor health conditions and would be vulnerable to diseases [these conditions then in turn] affect nutrition. A household without good shelter will fail to store and prepare food in a clean environment. (URT, 1992: 30).

According to HBS 2000/01 more than 90 percent of households use a toilet of some type, mostly the traditional pit latrine. When looking at different types of toilets, they have different implications for the malnutrition levels.

Table 5.6 shows the stunting rates for households with different water sources and different types of toilets. Using a cleaner source of water or a better type of toilet is associated with lower levels of stunting for children under five, while the use of public piped water as a source of drinking water and the use of traditional pit latrine have higher levels of being stunted.

5.6 Conclusions

Malnutrition levels remained essentially unchanged through the 1990s, but there is evidence of improved nutritional status between 1999 and 2004. All three measures of nutritional status improved over this period.

The data from the Demographic and Health Survey of 1991 indicates substantial differences in nutritional status between urban and rural areas, across zones and regions, and among different wealth categories.

- Malnutrition rates in rural areas are almost twice as high as in urban areas
- Malnutrition rates tend to increase with the age of the child up to about 18 months, after which the rate levels off.
- Malnutrition rates are highest in the South (Mtwara and Lindi) and lowest in the Northern Highlands and the Lake Zone.
- In terms of the pattern by region, malnutrition is lowest in Dar es Salaam. In terms of stunting, malnutrition is greatest in Mtwara, Lindi, Morogoro, and Dodoma. The ranking is similar for underweight.

- While malnutrition (stunting) affects children at a very early age, fever and cough affect children all throughout their childhood. Diarrhoea on the other hand reaches its peak after 6 months when children are introduced to new foods and start standing and walking. While breastfeeding is universal, only about 6% households with children under five practice exclusive breastfeeding.

- The risk that children are stunted or underweight varies is lower when the mother and or the head of household is educated, when the household has a clean water source, and when the household uses an "improved" form of toilet.

6 Nutrition mapping: An exploratory analysis[1]

6.1 Introduction

Poverty and underdevelopment have many dimensions. Although measures such as GDP per capita and the poverty headcount ratio tend to garner the most attention, other aspects of development such as child mortality, life expectancy, literacy, food security, access to clean water, physical security, and political freedom are also important barometers of living conditions.

Among non-income measures of welfare, children's nutritional status is arguably one of the most important and widely used. Children's nutritional status is important because it provides critical information about the living conditions of some of the most vulnerable members of society: young children. It also reflects how much investment is being made in the students and workers of the future. The popularity of children's nutritional status as a measure of well-being is attributable in part to the relative ease of collecting information. Anthropometry-based assessments of nutritional status require only collection of information about children's heights, weights, and ages, all of which is relatively non-invasive. Moreover, the international reference standards that form part of the assessment are widely accepted and easy to apply.

One of the targets of the first Millennium Development Goal is to reduce by one-half the proportion of people who suffer from hunger. One of the indicators adopted to measure progress towards this target is an anthropometry based measure: the percentage of children under the age of five years who are underweight (i.e., weigh substantially less than they should given their age and sex).

Although collecting anthropometry data is reasonably straightforward, most national surveys collect such information on only a few thousand children.[2] Although that may seem like a large number, it usually only provides sufficiently precise estimates at the national level and for large sub-national groupings, such as breakdowns by region, gender, or age group. Nutritional status estimates for large areas typically mask the high within-country variability that exists, including pockets of severe undernutrition[3] or "hunger hotspots." Developing policies and programs to improve nutritional status requires a more disaggregated picture of undernutrition, especially as countries move to greater levels of decentralization.

Over the past few years new methodologies have been developed that permit estimation of welfare measures for finely disaggregated population groups. These methods combine the strengths of household survey data (detailed information about a relatively small sample) with national census data (limited information about all or most of the country's population). In particular, small-area estimation methods have been applied to the measurement of poverty to produce high-resolution "poverty maps," which show the distribution of poverty for small geographic units (see, for example,

1 *This chapter was prepared by Ken Simler, Research Fellow, International Food Policy Research Institute.*

2 *Health clinics and growth monitoring programs typically measure many more children on an on-going basis, but these data are generally not representative of nutritional status in the larger population because those who attend clinics are a self-selected group that may systematically differ in some ways from the rest of the population.*

3 *Generally speaking, malnutrition encompasses both nutrient inadequacies (undernutrition) and nutrient excesses (overnutrition). Although the term malnutrition is used more often in everyday speech, this paper focuses exclusively on undernutrition and will use that term.*

Elbers et al. 2003; Minot 2000; and Simler and Nhate 2005). Poverty maps can be useful in various research and programmatic settings, such as informing geographic targeting of anti-poverty efforts, for exploring the geographic determinants of poverty, or investigating the inter-relationship between poverty, inequality, and crime.

This chapter applies the small-area estimation methodology to the analysis of child undernutrition in Tanzania. Although the steps for adapting poverty mapping analysis to undernutrition appear to be fairly clear, it remains uncertain whether it is possible to produce small-area estimates of undernutrition that are precise enough to be useful. This uncertainty arises because a large part of the precision of poverty maps is determined by the explanatory power of the first stage regression model that is estimated from the survey data. Overall, researchers have been less successful at explaining the variation in undernutrition than they have in explaining the variation in household income and expenditure. The only two nutrition mapping studies that we are aware of have yielded mixed results. Fujii (2005) made use of an unusually rich GIS database and an elaborate variance structure to describe the spatial patterns of child undernutrition in Cambodia with a reasonable level of precision down to the level of communes. Gilligan and Veiga (2004) generate point estimates of nutritional status at the *município* level in Brazil, but do not report standard errors, so it is not possible to assess the precision of their estimates.

This research contributes to the literature by applying nutrition mapping to another country setting, Tanzania, which to the best of our knowledge is the first nutrition map for an African country. There are two main research questions. First, is nutrition mapping feasible? And second, if it is feasible, what does a nutrition map for Tanzania look like, or more specifically, what is the spatial distribution of undernutrition in Tanzania?

This chapter is organized in follows. The next section describes the methods used to measure child nutritional status, estimate nutritional status regressions, and project those regressions onto the census population. Section 6.3 presents the results of the estimations, showing the spatial distribution of child undernutrition in Tanzania. The last section of the chapter summarizes the findings and presents some concluding comments.

6.2 Methods and data

This section presents information about the indicators used to measure children's nutritional status, the approach used to generate the small-area estimates of undernutrition in Tanzania, and a summary of the data used in this study. We begin with a review of the calculation of z-scores, which is a standard method for comparing child growth to an international reference standard.

6.2.1 Measuring children's nutritional status

Anthropometry—or measuring the human body—is commonly used to evaluate children's nutritional status. It is a relatively non-invasive method of collecting basic information about a child's growth status, from which one can make inferences about current and past nutritional status. Assessments of children's nutritional status using anthropometry are based on a comparison of measured height and weight with the age- and sex-specific heights and weights of a well-nourished reference population (WHO 1983, 1995). The most common way of expressing a child's nutritional status, especially for international work, is by calculation of a z-score. A z-score is defined as the number of standard deviation units a child's weight or height is from the median value for children of the same age and sex in the reference population. For example, in the reference population the median height of 32 month-old girls is 91.0 cm, with a standard deviation of 3.6.[4] Therefore, a 32 month-old girl who is 85.6 cm tall has a height-for-age z-score of –1.5 (85.6 – 91.0 / 3.6). Children with z-scores less than –2 are generally classified as undernourished according to that indicator. The principal indicators are height-for-age, weight-for-height, and weight-for-age. The proportion of children with z-scores below –2 is the prevalence of stunting (low height-for-age), wasting (low weight-for-height), and underweight (low weight-for-age).

4 *For some combinations of age and sex the reference distribution is asymmetric, with positive skewness. In these instances the standard deviation above the median is larger than that below the median, and the z-score is calculated using the standard deviation that corresponds to the child's height or weight relative to the median.*

Stunting, or linear growth faltering, is often viewed as a measure of chronic deprivation. Stunting is usually a result of a combination of insufficient nutrient intake and repeated illness. It is a cumulative process that in most cases cannot be reversed, especially in developing country settings where the resources for "catch up" growth are lacking. Wasting, on the other hand, indicates acute thinness, and is a measure of current nutritional status. Wasting is evident most often when a child is severely ill, and in times of crisis such as famines. Weight-for-age is a composite indicator of nutritional status. A child whose current health and nutrition are adequate may be underweight because he or she is stunted. That is, past events caused stunting, and the child is now shorter and lighter than the standards for his or her age. Alternatively, a child who is not stunted could be underweight because of current acute nutritional stress, so that the child is much lighter than the standards even though his or her height corresponds to the standards. In this study we will examine height-for-age and weight-for-age.

6.2.2 Estimating z-scores as a function of individual, household and community characteristics

The basic principles of the small-area estimation methodology are fairly simple. Household survey data—in this case the 1991–92 Demographic and Health Survey (DHS)—are used to estimate the statistical relationship between children's anthropometric z-scores and a set of independent variables that are expected to be correlated with nutritional status. The set of variables considered for the right hand side of the regression equations are limited to those variables that appear in both the household survey and the population census. Estimating the regression parameters from the survey data is commonly referred to as "Stage 1." In Stage 2, the estimated regression coefficients are applied to the census data to produce estimates of anthropometric z-scores for each child less than five years old who is recorded in the census. The z-score estimates are used in turn to estimate the prevalence of stunting and underweight. Because the Stage 2 nutritional status estimates are available for the entire population, it is possible to calculate undernutrition prevalence rates for small sub-groups of the population.

The explanatory variables in the first-stage regressions capture characteristics at various levels that are hypothesized to be related to the child's achieved growth. At the individual level, characteristics specific to the child—such as the child's age and sex—are typically significant explanatory variables. At the household level, there are several variables that reflect the household's socioeconomic status, which is also usually correlated with nutritional status. Potential household-level variables may include the education level of the head of household and other adults, the number of members in the household and the proportion that are of working age, the age of the head of the household, and dwelling characteristics such as type of water source, type of sanitation facilities, and access to electricity.

Even after accounting for household and individual characteristics, there is usually some variation in children's nutritional status that is captured by community-level characteristics. In other words, nutritional status levels often move together in a particular area, being systematically higher or lower than other areas even after controlling for household and individual characteristics. Accounting for this spatial correlation, or "location effect," in children's z-scores is important for maximizing the precision of the small-area estimates. The two main sources of community-level variables are geographic variables drawn from GIS data sets, and community-level variables constructed from the unit record data in the Census; these data sources are described later in this section. As it was not possible to match enumeration areas in the survey with enumeration areas in the Census, the community-level variables were constructed at the level of the district. Candidate variables include

demographic patterns (e.g., proportion of the district population less than five years old, proportion of female-headed households, population density, sex ratio), housing conditions (e.g., proportion of dwellings with electricity, proportion without toilet or latrine), and geographic characteristics (e.g., elevation, mean annual rainfall, distance to market centers).

Before estimating the first stage regressions it is first necessary to identify which potential correlates of children's nutritional status were collected in both the Census and the Demographic and Health Survey (DHS). This is accomplished by examining the respective questionnaires. However, sometimes even questions that appear to be worded the same actually have different underlying definitions, or are implemented differently in the field, so that they are not measuring the same concept. The means and variances of the candidate variables are compared between the Census and the DHS to ensure that they are capturing the same information; this process is sometimes called "Stage 0." If the distribution of a variable is substantially different in the two data sets, that variable is eliminated from consideration as a regressor. This issue only arises for the individual- and household-level variables, as all of the district-level variables are calculated either from the Census alone or a separate geographic data base.

More formally, the first stage regressions estimate children's anthropometric z-scores as a function of observable individual, household, and community characteristics, using a linear approximation of the form

$$z_{chi} = X'_{chi}\beta + W'_{ch}\gamma + V'_{c}\lambda + \varepsilon_{chi} \quad (1)$$

where z_{chi} is the z-score of child i in household h in community c. X_{chi}, W_{ch}, and V_c are vectors of individual, household, and community characteristics, respectively, and E_{chi} is a child-specific stochastic disturbance term with mean zero and variance σ^2. β, γ and λ are vectors of regression coefficients to be estimated. The DHS is not a self-weighting survey, as the probability of selection varies by enumeration area. Thus the regressions are estimated using sample weights, which are the inverse of the probability of selection in the DHS sample.

Rather than impose the assumption that the quantitative relationship between z-scores and the regressors is uniform throughout Tanzania, separate regressions are estimated for each of the survey strata. The 1991–92 DHS is stratified by rural and urban area of residence. Separate models were also estimated for children 0–23.9 months old and children 24–59.9 months old. This was done because the relationship between age and nutritional status is clearly non-linear in Tanzania, as seen in Chapter 5. The pattern of rapid deterioration in nutritional status from 0 to 24 months followed by a plateau is found in most low income countries. One approach to accommodating the non-linear relationship between age and z-score would be to estimate a single model in each stratum for all underfives, but including a quadratic term for the age of the child. We opted not to use that approach because (a) the descriptive data suggests more of a piecewise linear relationship than a quadratic relationship, and (b) we wanted to allow for the possibility that the coefficients on other variables also vary between the two age groups. Regressions for height-for-age z-scores and weight-for-age z-scores were estimated separately for each of the four groups of children. The combination of two strata, two age groups within each stratum, and two nutritional status measures for each stratum-age combination yields a total of eight regression models.

The same set of candidate variables is considered for each of the models, with final variable selection determined by a stepwise procedure supplemented with extensive ex post diagnostics. A backward elimination procedure was used to select variables, requiring a coefficient's p-value to be less than 0.05 for the variable to remain in the model.[5]

5 *Because of software limitations, this threshold is not as strict as it might seem. The significance levels in the stepwise procedure did not take into account the cluster sample design, so the true significance threshold for inclusion in the model is considerably lower. Ex post analysis showed it to be in the neighborhood of 0.10.*

6.2.3 Estimating z-scores in the census data

After estimating the regressions, the estimated regression coefficients are applied to the corresponding set of explanatory variables in the Census data. The procedure followed is analogous to that described in chapter 2 for analyzing poverty trends, with some minor modifications. Specifically, the cutoff value for undernutrition prevalence of –2 z-scores is used in place of a monetary poverty line, and there is no need for a logarithmic transformation because the distribution of z-scores tends to have a normal or near-normal distribution.

For each child with long form Census data, the expected value of the probability that child i is stunted or underweight (U_i) conditional on observed characteristics is

$$E\left(U_i \mid X^C_{chi}, W^C_{ch}, V^C_c, \hat{\beta}, \hat{\gamma}, \hat{\lambda}, \hat{\sigma}\right) = \Phi\left[\frac{-2 - (X^{rC}_{chi}\hat{\beta} + W^{rC}_{ch}\hat{\gamma} + V^{rC}_{c}\hat{\lambda})}{\hat{\sigma}}\right] \quad (2)$$

where the superscript C denotes census data, the circumflexes denote estimated coefficients, and $\hat{\sigma}$ is the estimated standard error of the regression. The estimated stunting or underweight prevalence for a given population sub-group, such as a district or a ward, is calculated by taking the mean of these probabilities over all children in that sub-group, using sample weights as appropriate.

Standard errors of the point estimates of undernutrition prevalence for small-areas are calculated taking into account three sources of statistical error in the estimation process. One source is idiosyncratic error, or the part of the variation in children's z-scores that is not explained by the variables in the regression. A second source is model error, which arises because the estimated coefficients are not known with certainty. Rather, the estimated coefficients are random variables that have confidence intervals, and the wider are these confidence intervals, the less precise the small-area estimates will be. Third, because the long form of the Census was only administered to a random subset of households, there is a sampling error associated with the long form census variables, which also affects the overall precision of the Stage 2 estimates.

6.2.4 Data

This study uses three data sources: the 1988 Population Census, the 1991–92 Demographic and Health Survey (DHS), and a collection of geographic information system (GIS) variables compiled by Corbett et al. (2000).

The 1988 Population Census was carried out in August 1988, and was Tanzania's third census since attaining independence. Like the earlier censuses, it used two data collection forms. The short form was administered universally, to meet the principal census objective of enumerating the entire population and determining the basic demographic composition of the country. A long form was administered to a randomly selected sample of approximately 20 percent of all households. The long form collected a range of socioeconomic information, including employment, education levels, and housing conditions. Long form data are available for approximately 766,000 children under the age of five years. It should be noted that the 1988 Population Census was used because the 2002 Census data were not available for this study.

The 1991–92 DHS is the source of information about child anthropometry and many of the explanatory variables in the anthropometry regressions. Tanzania has DHS data for several years; the 1991–92 survey was chosen for this study because it was collected closest in time to the 1988 Census. As it is likely that the relationship between children's z-scores and the explanatory variables evolves over time, it is preferable that the data set used for estimating the relationship (stage 1) is as close as possible in time to the data set used to generate the small-area estimates (stage 2).

The 1991–92 DHS was conducted by the National Bureau of Statistics, in collaboration with the Ministry of Health. Macro International, Inc. provided technical assistance for the implementation

and analysis of the survey. The main objective of the survey was to collect information on health, fertility, and family planning in Tanzania. The survey collected information on 8,327 households located throughout Tanzania, with interviews taking place from October 1991 through March 1992. The main target group of the survey was women of reproductive age (15–49 years old at the time of the interview). The sample includes approximately 5,500 children under the age of five, and the survey collected information on their height, weight, and age in months. The stratified, three-stage cluster sample design was intended to be nationally representative, and also support disaggregation by rural and urban area. Because of the sampling procedures used and the sample size, the 1991–92 DHS is not representative at the level of the region or smaller administrative units.

In addition to the 1988 Population Census and the 1991–92 DHS data, geographic data are also used as explanatory variables in the nutrition regressions. These publicly available geo-referenced data include information on geographic features (e.g., elevation, distance to coast, distance to primary or secondary road), climactic conditions (e.g., mean annual rainfall, mean temperature), and human settlement (e.g., population density, cattle density). To integrate the geo-referenced data with the tabular data from the DHS and the Census, the relevant variables are summarized at the district level by calculating the mean or median value for each district. For example, the variable representing surface elevation is constructed by calculating the median of the elevation data points within each district, and then merged with the child-level anthropometry data on the basis of district identifiers. Note that the same geographic data set is used in both stage 1 and stage 2. This is acceptable because all of the variables used can be considered constant over the period between the Census and the 1991–92 DHS, because they change very slowly.[6]

6.3 Results

In this section we present the results of the analysis, organized as follows. First, we present the results of the regression analysis, including an examination of the models' goodness of fit and ability to predict undernutrition prevalence rates within the DHS sample. Then the models are applied to the 1988 Census data, showing the undernutrition prevalence rates at progressively higher resolution, starting with region-level results, and proceeding to district and sub-district estimates. The precision of the small-area estimates is then assessed, with respect to the size of the standard errors and the ability to identify areas where the estimates for larger areas mask significantly higher or lower rates in constituent sub-areas.

6.3.1 Regression results

As noted in section 6.2.2, all variables common to the 1988 Census long form and the 1991–92 DHS were identified, and then compared to see that the distribution of each variable was similar in the two data sources. When the distribution of a Census variable was very different from the distribution of the corresponding variable in the DHS, that variable was eliminated from consideration for the models. Approximately 30 explanatory variables were retained as candidate variables, and the stepwise procedure described earlier was used to select the variables that contributed the greatest explanatory power. The subset of variables selected was allowed to vary across the eight models. For example, the age of the head of household might be included in the model for rural children less than two years of age, but not in the model for urban children less than two years of age. Or a variable might be included in the height-for-age regression, but not the weight for age regression.

Table 6.1 shows the means for the variables that were selected for the final models, along with the standard errors of the means. The descriptive statistics are shown separately for each of the four categories of children, split by age and rural/urban area of residence. A few unusual aspects of the data bear mentioning. Most are a result of the limitations of Census data, which are rarely as detailed as survey data because of the Census's more comprehensive coverage of households. Most notably, although most anthropometry analyses use age in months as an explanatory variable, the Census only has age in years, so that is how it is measured in the Stage 1 regressions as well. Birth order is also frequently used in anthropometry regressions, but the Census does not link mothers and children, so we constructed a variable called "age order" which indicates a child's age rank among underfives in the household.[7]

Finally, the definition of the education variables is a bit unusual, although not because of limitations in the Census data. Rather than define education on the basis of the household head, these models follow the approach used by Jolliffe (2002), who finds that it is often the highest level of education of any adult household member (rather than a specific member, such as the head) that is most closely related to household welfare. In this case education is operationalized as a set of dummy variables for four different educational levels: incomplete primary education, complete primary education, incomplete secondary education, and complete secondary education. The omitted category is no schooling whatsoever. The dummy variables take the value 1 if at least one adult in the household had reached that level of education and 0 otherwise.

6 *In this context it bears emphasizing that the average annual rainfall variable is a long term (usually 30 year) average, and not the annual rainfall level itself.*

7 *The age order variable differs from birth order in at least three ways. First, it doesn't count children five years or older. Second, it does not count children who have died or who are not living in the household for some reason. Third, when there is more than one mother of an under five in the household, it combines the children into one ordering, rather than establishing separate orderings for each mother.*

Table 6.1. Means and standard errors of mean for variables used in first stage regressions

	Rural areas		Urban areas	
	Children 0-24 months old	Children 24-60 months old	Children 0-24 months old	Children 24-60 months old
Height-for-age z-score	-1.578	-2.035	-1.376	-1.823
	[0.038]	[0.049]	[0.143]	[0.140]
Weight-for-age z-score	-1.185	-1.471	-1.022	-1.303
	[0.043]	[0.039]	[0.089]	[0.100]
Child's age in years	0.512	2.939	0.496	
	[0.012]	[0.018]	[0.038]	
Male child	0.499			
	[0.013]			
Age order	1.143	1.842	1.074	
	[0.017]	[0.050]	[0.012]	
Number of household members	8.339			
	[0.302]			
Number of children less than 5 years old		2.410		
		[0.094]		
Age of head of household		42.373		41.000
		[0.495]		[0.904]
Highest education level in HH is incomplete primary		0.227	0.105	
		[0.013]	[0.016]	
Highest education level in HH is incomplete secondary	0.058	0.053		0.223
	[0.010]	[0.008]		[0.041]
Highest education level in HH is completed secondary			0.033	0.032
			[0.011]	[0.012]
Household has electricity				0.232
				[0.046]
Household has no toilet or latrine		0.176		
		[0.022]		
District sex ratio minus 100		-6.665		
		[0.475]		
District mean years of education for household heads	3.385	3.415		4.101
	[0.052]	[0.053]		[0.238]
District proportion of female-headed households	0.319	0.317		0.304
	[0.004]	[0.004]		[0.007]
District proportion of population less than 5 years old	0.145	0.145	0.130	
	[0.001]	[0.001]	[0.005]	
District proportion of households using piped water				0.536
			[0.033]	
District proportion of households with no toilet			0.106	
		[0.017]		
District median elevation of district (meters)		1052.038		
	[35.505]			
District median annual rainfall (millimeters)		956.015		
	[17.673]			
District mean population density (persons per km2)		79.199	420.294	457.229
		[10.044]	[100.438]	[95.949]
District mean distance to regional headquarters (km)	90.997	89.855		
	[3.312]	[3.156]		
District mean distance to primary / secondary roads (km)	25.408			
	[1.674]			
District mean distance to Dar es Salaam (km)		602.278	410.605	
	[22.393]	[41.198]		
District mean distance to Tanzania coast (km)	495.856			
	[23.245]			

Source: Author's calculations from 1991–92 DHS
Standard error of mean in brackets, taking into account stratified cluster sample designs

The height-for-age regressions are shown in Table 6.2. Between 8 and 15 variables are retained in each of the four different models. Despite having relatively few observations, the urban models performed better than the rural models, explaining between 19 and 24 percent of the variation in height-for-age z-scores in the 1991–92 DHS data. The rural models for older children performed the worst of the four groups, with an R^2 of only 0.08.

The weight-for-age regressions are shown in Table 6.3. The results are largely similar to those observed in the height-for-age estimations, although in the urban stratum the explanatory power is generally lower in the weight-for-age models. The R^2 for all the models are considerably lower than those typically found in poverty mapping applications, in which the natural logarithm of consumption is the dependent variable. Even with the constraints of census data, Stage 1 regressions for poverty mapping usually have R^2 value between 0.3 and 0.7, often being in the neighborhood of 0.5. As noted in section 6.1, the lower explanatory power of the nutrition models means that the small area estimates will be less precise than the estimates usually obtained when analyzing poverty.

As the regression equations are not intended to be causal models, one should not dwell on interpreting the signs and magnitudes of the regression coefficients. This is especially true because of the collinearity among the explanatory variables. With those caveats in mind, we note the expected negative sign on the age coefficient and positive signs on the higher levels of education.

One simple test for assessing the quality of the regressions is to examine their ability to predict accurately within the estimation sample. This test not very demanding, because the predicted values from the regressions should closely mimic the actual values when using the same data that were used to estimate the models. Table 6.4 presents the actual and predicted stunting and underweight prevalence rates at the national, urban, and rural levels. The table shows that the within-sample predictive power of the models is very good. Most of the predictions are within one-tenth of a percentage point of the actual values, and none of the differences between the actual values and the predicted values are statistically significant.

6.3.2 Small-area estimates of stunting and underweight

Table 6.4 represents the highest degree of disaggregation that the 1991–92 DHS is designed to support on its own, but one can get a more detailed geographic picture from the Stage 2 estimation using the regression results and the census data. Figures 6.1 through 6.3 show the estimated stunting rates in 1988 (the Census year) at the region, district, and "grouped ward" levels.[8] The progressively higher resolution maps show that there is often a great deal of heterogeneity underlying region or district level means. Among the many illustrative examples, one of the most striking is Iringa region. Figure 6.1 shows that the estimated stunting prevalence for Iringa Region in 1988 is between 60 and 70 percent (the actual estimate is 65 percent). This is higher than the national mean of 50.5. Moving to the district level map in Figure 6.2, we see that Makete and Iringa Rural districts have estimated stunting rates over 70 percent, whereas less than 40 percent of the underfives in Njombe district are estimated to be stunted. Zooming in one step closer to the grouped ward level, it is revealed that the relatively low stunting rate in Njombe district is largely attributable to low stunting rates in a few wards, while the rest of the district has stunting rates of 60 percent or higher. Similar, albeit somewhat less dramatic, stories may be seen in other regions, including Arusha and Kilimanjaro. Mwanza Region shows a contrary picture, with a regional stunting prevalence that is below the national average, but that is driven by low stunting in a few of the more densely populated areas, and above average stunting over most of the rest of the region.

8 *Technically it is possible to use the small area estimation procedure to estimate undernutrition rates for the units as small as a ward. However the combination of the small size of many wards and the limitation of the 20 percent sample for the census long form means that most ward level estimates are too imprecise to be useful. To get sub-district estimates, adjacent wards were grouped so that each of the resulting "grouped wards" has approximately 1,000 observations on children less than five years of age.*

Table 6.2. Regressions for height-for-age z-scores

	Rural areas		Urban areas	
	Children 0-24 months old	Children 24-60 months old	Children 0-24 months old	Children 24-60 months old
Child's age in years	-0.8685***	-0.0872*	-0.7463***	
	[12.36]	[1.80]	[6.34]	
Male child	-0.2161***			
	[3.49]			
Age order	-0.1680*	0.1501**	-0.5422**	
	[1.78]	[2.07]	[2.21]	
Number of household members	0.0206**			
	[2.53]			
Number of children less than 5 years old		-0.068		
		[1.34]		
Age of head of household		0.0100***		-0.0127**
		[4.26]		[2.58]
Highest education level in HH is incomplete primary		-0.1366	-0.7014**	
		[1.36]	[2.61]	
Highest education level in HH is incomplete secondary	0.3319**	0.3603**		0.3933***
	[2.18]	[2.16]		[3.14]
Highest education level in HH is completed secondary			0.8604***	1.0718***
			[2.99]	[3.88]
Household has electricity				0.4590***
				[3.58]
District sex ratio minus 100		0.0217*		
		[1.80]		
District mean years of education	0.1935***	0.1877**		0.3906***
	[3.33]	[2.43]		[6.91]
District proportion of female-headed households	1.5643**	2.1005**		2.6762**
	[2.09]	[2.06]		[2.58]
District proportion of population less than 5 years old	5.8480***	10.0210***	-15.6651***	
	[2.86]	[3.19]	[3.02]	
District proportion of households using piped water				-1.7649***
				[7.65]
District proportion of households with no toilet			2.7290***	
			[2.76]	
District median elevation of district (meters)		-0.0003**		
		[2.34]		
District median annual rainfall (millimeters)		-0.0008***		
		[3.43]		
District mean population density (persons per km2)		0.0006***	0.0004***	0.0003***
		[2.91]	[3.28]	[3.30]
District mean distance to regional headquarters (km)	-0.0023**	-0.0043***		
	[2.28]	[3.73]		
District mean distance to primary/ secondary road (km)	-0.0040**			
	[2.54]			
District mean distance to Dar es Salaam (km)		0.0009***	0.0012***	
		[4.27]	[4.08]	
Constant	-2.7195***	-4.0579***	0.7194	-3.1484***
	[5.18]	[6.04]	[1.23]	[8.62]
Number of observations	2154	2413	409	479
Number of primary sampling units	232	232	88	87
R^2	0.1406	0.0756	0.2357	0.1930

Source: Author's calculations from 1991–92 DHS
*Absolute value of t statistics in brackets * significant at 10%; ** significant at 5%; *** significant at 1%*

Table 6. 3. Regressions for weight-for-age z-score

	Rural areas		Urban areas	
	Children less than 24 months	Chilren 24 months and older	Children less than 24 months	Children 24 months and older
Child's age in years	-0.8819 ***		-0.7916 ***	
	[12.15]		[5.74]	
Male child	-0.1548 **			
	[2.40]			
Age order		0.1288 ***		
		[3.15]		
Female-headed household		-0.2026 ***	0.3728	
		[2.82]	[1.36]	
Number of children less than 5 years old		-0.0557		
		[1.62]		
Age of head of household		0.0070 ***		
		[3.52]		
Highest education level in HH is incomplete primary		-0.1358 *	-0.369	
		[1.95]	[1.43]	
Highest education level in HH is incomplete secondary	0.2942	0.2821 **		0.2483 *
	[1.23]	[2.56]		[1.76]
Household has electricity			0.3262 **	0.3604 ***
			[2.07]	[3.05]
Household has no toilet or latrine		0.2028 ***		
		[2.65]		
District mean years of education for household heads	0.2117 ***			0.2179 ***
	[3.54]			[3.45]
District proportion of female-headed households	2.3277 ***			
	[3.24]			
District proportion of population less than 5 years old				-12.5533 ***
				[3.21]
District proportion of households using piped water				-1.0931 ***
				[4.67]
District median elevation of district (meters)				0.0003 ***
				[2.77]
District median annual rainfall (millimeters)		-0.0005 ***		
		[3.15]		
District mean population density (persons per km^2)		0.0006 ***	0.0003 ***	
		[3.49]	[2.67]	
District mean distance to regional headquarters (km)	-0.0045 ***	-0.0033 ***		
	[5.10]	[3.18]		
District mean distance to primary / secondary roads (km)		0.0040 ***		
		[2.96]		
District mean distance to Dar es Salaam (km)		0.0009 ***	0.0004 *	
		[8.21]	[1.85]	
District mean distance to Tanzania coast (km)	0.0004 **			
	[2.19]			
Constant	-1.9064 ***	-1.8386 ***	-1.0420 ***	-0.3921
	[5.34]	[9.50]	[6.93]	[0.64]
Number of observations	2154	2413	409	479
Number of primary sampling units	232	232	88	87

Source: Author's calculations from 1991–92 DHS
*Absolute value of t statistics in brackets *significant at 10%; **significant at 5%; ***significant at 1%*

Source: Author's calculations from 1991–92 DHS.

Table 6.4. Within-sample prediction of stunting and underweight prevalence

	Actual 1991–92	Estimated 1991–92
Stunting — all	43.6	43.9
Rural	45.1	45.0
Urban	37.8	39.5
Underweight — all	29.2	29.4
Rural	30.3	30.3
Urban	24.8	25.9

Nutrition maps for underweight (low weight-for-age) are shown in Figures 6.4 through 6.6. Although there are several differences between the stunting and underweight maps, the overall impression is consistent in the two sets of maps. In addition to the heterogeneity that exists at the district and sub-district level, one of the patterns that emerges with some consistency is the generally lower rates of undernutrition (both stunting and underweight) in urban areas compared to rural areas, even for small urban areas. That said, it should also be noted that urban areas are themselves heterogeneous, with some areas showing as much undernutrition as rural areas.

How many of the differences at the district and sub-district level are statistically significant? One way to answer the question is by doing pairwise tests for all possible combinations. Rather than undertaking that tedious exercise, another useful way to look at the question is to see which districts or grouped-wards have undernutrition estimates are significantly different from the regional or district means. In other words, what new information do we gain from the small-area estimation?

Figure 6.7 shows the grouped wards in which the stunting prevalence is significantly different from the prevalence at the district level. For most of the country the differences are not statistically significant. The area with the most significant differences is southeastern Tanzania. The corresponding map for underweight is shown in Figure 6.8 for underweight there are slightly fewer significant differences, and they appear to be more scattered around the country.

Although there appears to be considerable differences in the point estimates, most are not statistically significant because of the relatively large standard errors associated with the regional, district, and sub-district estimates. For all three levels of aggregation the median standard error—expressed as a percentage of the point estimate—is around 12 percent. So a sub-district with a stunting prevalence of 50 percent would typically have a standard error of around 6 percentage points, which implies a rather broad 95 percent confidence interval that ranges from 38 percent to 62 percent.

Figure 6.1

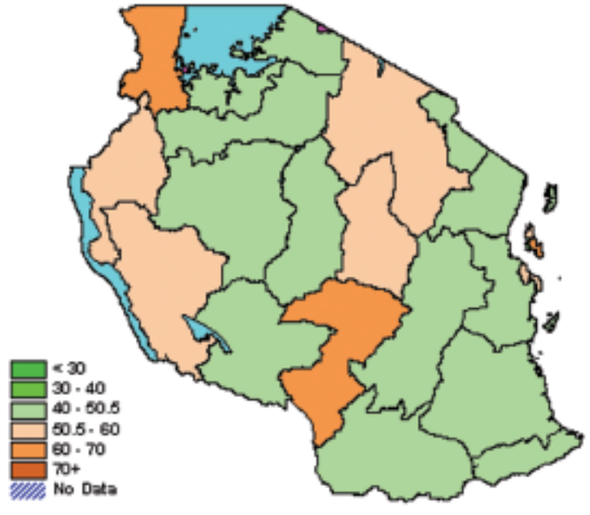


Figure 6.1
Estimates of stunting prevalence at region level

Figure 6.2

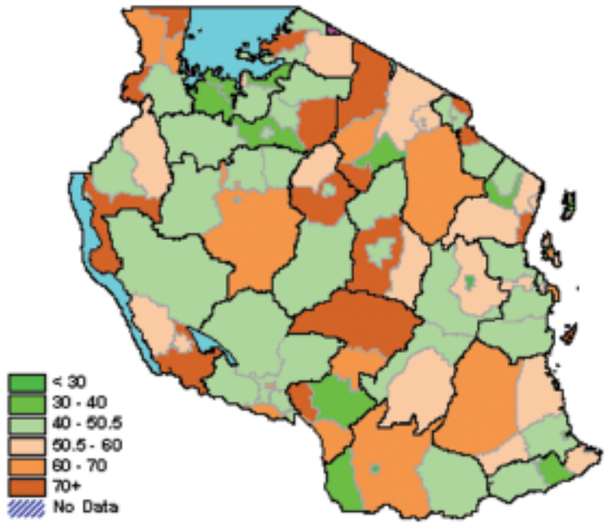


Figure 6.2
Estimates of stunting prevalence at district level

Figure 6.3
Estimated stunting prevalence by grouped wards

Figure 6.3

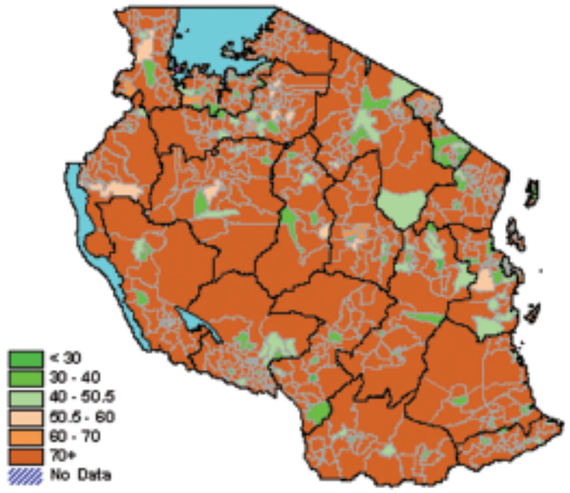


Figure 6.4
Estimated underweight prevalence by region

Figure 6.4

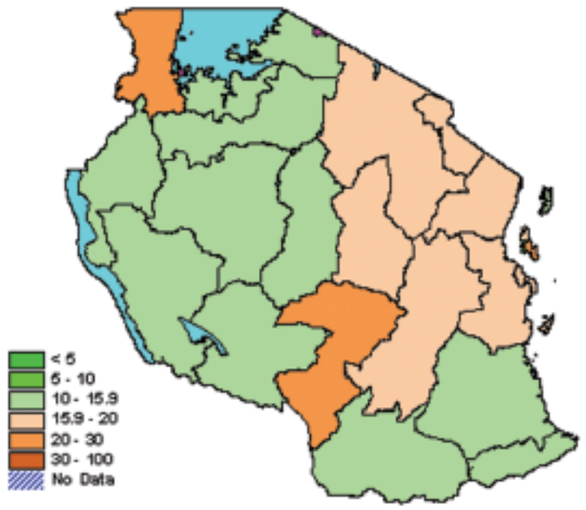


Figure 6.5

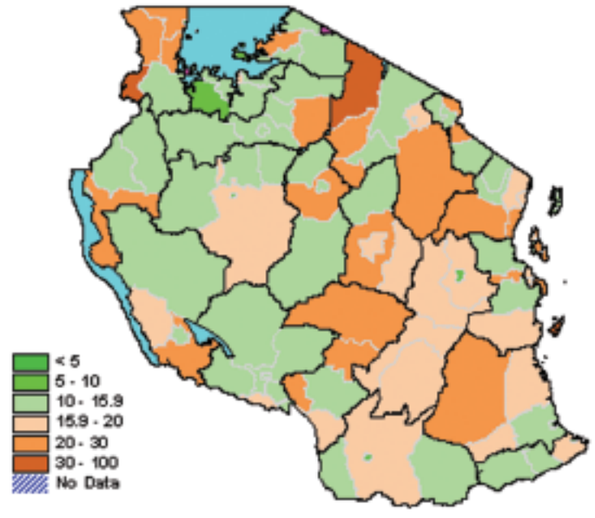


Figure 6.5
Estimated underweight prevalence by district

Figure 6.6

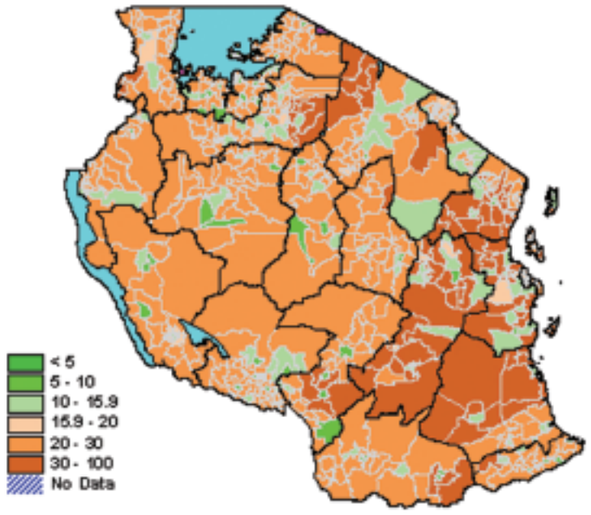


Figure 6.6
Estimated underweight prevalence by grouped wards

Figure 6.7

Figure 6.7
Significant differences in stunting prevalence between district and sub-district

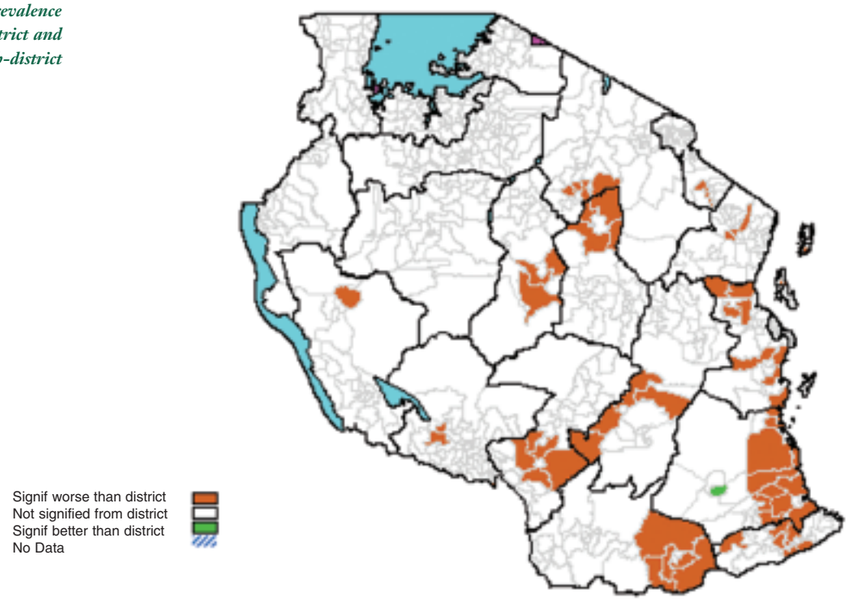
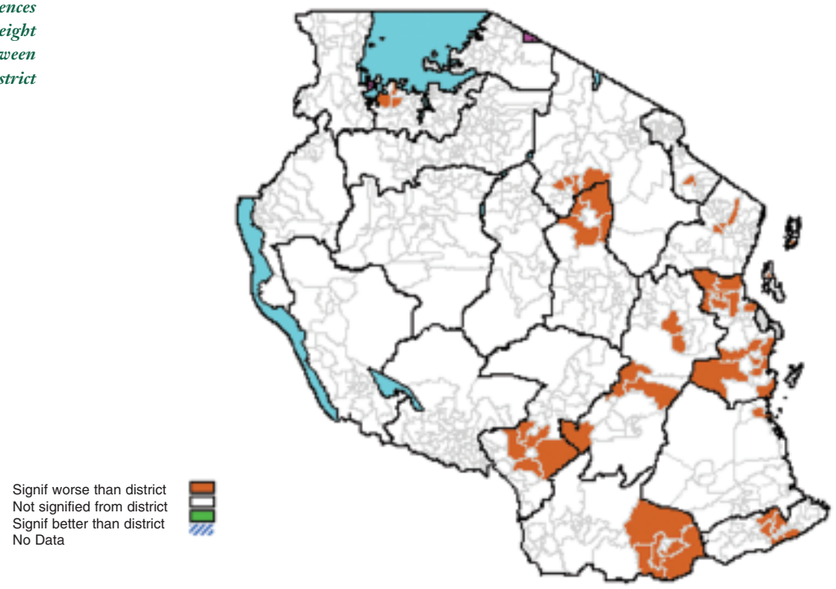


Figure 6.8

Figure 6.8
Significant differences in underweight prevalence between district and sub-district



6.4 Summary and conclusions

This chapter has described an approach for adapting small-area estimation, or poverty mapping, methodology for the analysis of child nutritional status. It has briefly discussed the main anthropometric measures used to assess nutritional status of children less than five years old, focusing on height-for-age and weight-for-age. The chapter presented the three stage approach that has become familiar in the poverty mapping literature, with modifications as required for estimating prevalence of undernutrition instead of poverty. The essence of the method is to combine the strengths of "narrow and deep" detailed household surveys with "broad and shallow" census data to arrive at estimates of undernutrition for finely disaggregated sub-groups of the population.

The first stage, logically dubbed "Stage 0," involves identification of common variables in the survey and the census, and careful comparison of the distributions of the variables to ensure that variables that appear to be similar are indeed comparable. Stage 1 follows by employing regression analysis on the household survey data set to estimate the quantitative relationship between standardized anthropometric measures and a set of characteristics available in both data sets that are believed to be correlated with nutritional status. In Stage 2 the estimated regression coefficients are applied to the census data to estimate anthropometric z-scores for every child less than five years old recorded in the long form of the census. The predicted z-scores are then transformed into the expected probability of being stunted or underweight, and prevalence rates are calculated for various levels of geographic aggregation. In Tanzania the levels are the region, the district, and sub-districts defined by the grouping of adjacent wards.

The Stage 1 regression results were somewhat disappointing. Although a good number of explanatory variables were identified, they only accounted for about one-fifth of the variation in z-scores in urban areas, and less than 15 percent in rural areas. As a result, the Stage 2 estimates have wide confidence intervals, so it is difficult to detect statistically significant differences.

That said, the point estimates are suggestive of distinct spatial patterns in undernutrition in Tanzania. While there is some variation in undernutrition rates between regions, there is a much greater range of undernutrition among the districts and sub-districts that make up a region. A pattern that emerges frequently is an urban center—including small urban centers such as district headquarters—with lower than average undernutrition rates surrounded by rural areas with rates that are higher than average. This suggests the need for greater attention to meeting nutrition needs in rural areas. This entails not only ensuring an sufficient supply of nutritious food, but also adequate health care, nutrition extension, safe water supplies, and other factors that determine nutritional outcomes.

Returning to the first of the research questions posed at the outset of this chapter, is nutrition mapping feasible? We believe the answer is a qualified yes. Although the models are not as successful as poverty mapping models in explaining variation in the dependent variable, that was expected. Even with the lower R2, the spatial pattern of undernutrition appears perfectly plausible, and it is possible to detect some significant differences at the sub-regional level.

The findings in this chapter indicate that it would be worthwhile to attempt to update these nutrition maps by using the 2002 Population Census and a recent DHS survey. Drawing from the experience of this study, high priority should be given to improving the precision of the estimates, to strengthen the inferences that can be made from the analysis. One potential avenue for achieving this is greater use of spatial variables from geographic information systems and other sources. For future work it may be necessary to devote more resources to more intensive development of these data sources. Another avenue would be to try to improve the efficiency of the estimates by following the approach of Fujii (2005), incorporating information about contemporaneous correlation of the error terms of an individual's height-for-age and weight-for-age z-scores, as well as modeling a common household component to the error term for multiple underfives in the same household.

7 Summary and conclusions

7.1 Project summary

This report describes the methods, and results of a research project entitled "Agricultural marketing, poverty, and malnutrition in Tanzania: Evidence from spatial and temporal patterns." The project was funded by the Rockefeller Foundation and implemented by the International Food Policy Research Institute, in collaboration with Research on Poverty Alleviation and researchers from the Economic Research Bureau of the University of Dar es Salaam and the National Bureau of Statistics. As discussed in Chapter 1, the objectives of the project were the following:

- to estimate changes in poverty since 1990,
- to examine the impact of market access and agro-climactic variables on poverty in Tanzania,
- to estimate and map the spatial distribution of child malnutrition in Tanzania,
- to strengthen the capacity of Tanzanian institutions to use poverty mapping methods, and
- to disseminate the methods and results among analysts and policymakers in Tanzania.

In order to achieve these objectives, the project carried out four types of activities, as described below:

- *Collection of secondary data:* The project was designed to make better use of existing survey data rather than to collect new data. Thus, the project obtained and re-analyzed three household budget surveys, four Demographic and Health Surveys (DHSs), the 1988 Population Census, and GIS data on topography, rainfall, temperature, land cover, and various measures of market access.

- *Capacity strengthening:* The project carried out three one-week training courses for 10-15 Tanzanian analysts from the University of Dar es Salaam, the National Bureau of Statistics, Research on Poverty Alleviation (REPOA), the Economic and Social Research Foundation (ESRF), Sokoine University of Agriculture, and other institutions. All three courses were given at the University Computing Centre of the University of Dar es Salaam and involved hands-on computer applications and exercises. The courses were on "The Use of Geographic Information Systems (GIS) for Economic Research in Tanzania," "Using Stata for Survey Data Analysis in Tanzania," and "Introduction to Poverty Mapping Methods with Applications to Tanzania."

- *Data analysis:* The project involved two research components. The first component focuses on the patterns and trends in poverty. Household budget survey data were combined with the results of four Demographic and Health Surveys (DHSs) to examine the trends in poverty between 1991 and 2003. We looked at whether geographic variables such as market access help to explain patterns and trends in poverty. And we explore the sensitivity of these results to changes in methods and assumptions. The second component examines patterns and trends in child malnutrition. This includes a review of existing data and studies on child malnutrition in Tanzania and a nutrition mapping analysis. In the latter, the 1991 DHS and the 1988 Census data were combined to explore the feasibility of generating a spatially disaggregated map of the prevalence of child malnutrition.

- *Dissemination activities:* The methods and results of this analysis have been disseminated in various ways. As mentioned above, the project carried out three one-week training courses to develop local capacity in the methods. Two workshops were held to explain the methods and present

preliminary results of the analysis, and a final workshop was held on 21 July 2005. This report and an accompanying policy brief represent the final outputs of the project.

More information on the background, objectives, and activities of the project can be found in Chapter 1. The following sections describe the main findings of the study and discuss their implications for policy and future research.

7.2 Patterns and trends in poverty

The analysis of patterns and trends in poverty was motivated largely by the controversy regarding the impact of the economic reforms carried out in Tanzania since the late 1980s. These reforms reduced the role of the state in economic decision-making, encouraged the development of markets, and promoted the private sector. In the agricultural sector, agricultural price controls were eliminated, input subsidies were phased out, marketing was liberalized, and many state enterprises were privatized or closed. The macroeconomic impact of these reforms have been generally positive: inflation has been reduced to around 5 percent and per capita GDP growth has recently been 5 percent per year. But the effects of these reforms on household living standards is less well understood and more widely debated. Critics of the reforms say they have increased unemployment, exacerbated social inequalities, and increased poverty. A less extreme but perhaps more widespread view is that the benefits of the economic reforms have been concentrated among the better-off Tanzanians, urban entrepreneurs, more educated professionals, and larger farmers with good market access, who can take advantage of the opportunities created by liberalized markets. But the debate has been hampered by a lack of empirical evidence on the changes in income, poverty, and malnutrition since the reforms were launched.

A number of household surveys have been carried out, notably the 1991 Household Budget Survey and the 2000/01 Household Budget Survey. But comparison of poverty estimates generated by household surveys is made difficult by inevitable differences in questionnaire design and sampling methods, as well as the complex task of taking into account changes in the cost of living.

The analysis presented in Chapter 2 applies "poverty mapping" methods in a new way. In particular, we use the 1991 Household Budget Survey to identify the relationship between the per capita expenditure of households (including the value of home-produced food) and various characteristics of households including family size and composition, education, housing characteristics, access to water, electrification, and ownership of various consumer durables (bicycle, motorbike, radio, television, and so on). This relationship is then applied to the same household characteristics in four Demographic and Health Surveys carried out in 1991-92, 1996, 1999, and 2003. Then, we use GIS analysis to define six measures of market access. The relationship between poverty and market access is examined using non-parametric regression analysis, simple regression analysis, and multiple regression analysis. The results are as follows:

- Between 1991/92 and 2003, the overall incidence of headcount poverty fell by almost 9 percentage points. The degree of poverty reduction was similar between rural and urban areas. Poverty did not decline in Dar es Salaam according to our analysis, so all of the gains in urban areas were due to poverty reduction in other cities.

- The gains in poverty reduction were greater among less educated households than among more educated households. This suggests that economic growth has not favored the educated elite over others.

- On the other hand, poverty reduction was greater among male-headed households (10 percentage points) than among female-headed households (3.5 percentage points).

- The Coast, the Southern Highlands, and the South zones have gained the most in terms of poverty reduction. The Central Zone is the only one not to show any progress in poverty reduction.

- Rural poverty is associated with remoteness, but the relationship is surprisingly weak and it varies depending on the definition used.

- Rural poverty is more closely related to access to regional urban centers than distance to roads or to Dar es Salaam.

- Although poverty is somewhat higher in more remote rural areas, we find no evidence that remote areas are being "left behind" in the sense of gaining less from economic growth than other areas.

Overall, the results suggest that economic growth in Tanzania since 1991 has reduced poverty more than previously thought. More educated, urban households and rural households with good market access do not seem to have gained at the expense of less educated households and rural households in remote areas (more information on this component of the analysis can be found in Chapter 2).

This analysis, however, relies on the assumption that the relationship between per capita expenditure and household characteristics remains constant over time. In other words, we assume that the regression model estimated using data from the 1991 Household Budget Survey applies to all the DHS surveys up to the year 2003. In order to test this assumption, the analysis was repeated using the 2001/01 Household Budget Survey. As described in Chapter 3, the predictive power of the regression model falls somewhat and the estimated poverty rates for each year are about 2-6 percentage points lower. However, many of the basic patterns and trends are similar. Specifically, the results indicate that:

- The overall basic needs poverty rate in mainland Tanzania declines steadily across the four periods, though the overall poverty reduction is smaller (5.3 percentage points instead of 8.8 percentage points).

- Poverty declines more in the rural areas and other urban areas than in Dar es Salaam.

- Poverty declines more among male-headed households than female-headed households.

- Poverty rates are lowest in the Northern Highlands and Coast zones and highest in the Central Zone.

- Poverty reduction is greatest in the Coast and Southern Highlands and below average in the Central Zone.

- Poverty is essentially unchanged among households whose head has completed primary school; almost all the gains in poverty reduction are among households whose head did not complete primary school.

Thus, this analysis supports the findings in Chapter 2 that poverty reduction has not occurred evenly, favoring some types of households and some regions, but it does not seem to have left behind households with less education or those living in rural areas (see Chapter 3 for more information).

The above analysis identifies some patterns and trends in Tanzanian poverty over the past 15 years, but it does not examine the causes of poverty. Given the fact that most of the poverty in Tanzania is found in rural areas where agriculture is the dominant source of income, it is clear that there is an important link between agriculture and poverty. Chapter 4 explores this link, reviewing agricultural performance since the early 1990s and progress in reducing poverty. According to the 1991 and 2000-01 Household Budget Surveys, progress in reducing poverty was modest during the 1990s. The little progress can partly be explained by the unsatisfactory of the agricultural sector over the period. Although economic reforms implemented since mid 1980s, have succeeded in creating a stable macroeconomic environment necessary for promoting investment and economic growth, they have not been sufficient enough to bring about fundamental changes needed to raise productivity and incomes in rural areas.

The implementation of long-term policies designed to bring about fundamental changes in the sector and rising productivity and incomes in the rural areas started about four years ago. At this time, it is too early to assess whether implementation of these policies has had a significant impact on the performance of the agricultural sector and poverty reduction. Looking at the performance of the agricultural sector during the last four years gives an impression that the policies may be working. Over that period, the annual growth rate of agricultural output has been fairly stable, and has consistently been 4 percent and above.

An econometric analysis of the correlates of poverty, using the 2000-01 Household Budget Survey, reveals that education, land ownership, degree of monetization of economic activities, and access to markets have a statistically significant effect on the probability of a household in rural areas being poor. These findings have important policy implications. Policies aimed at improving access to education are necessary for poverty reduction. Promotion of commercial activities and improving access to markets are also important measures that must be taken to reduce poverty in rural areas. Policies that guarantee land ownership for the poor are important not only for reducing poverty in rural areas, but also for preventing increase in income inequality.

7.3 Patterns and trends in malnutrition

A review of patterns and trends in nutrition (see Chapter 5) reveals that child malnutrition levels remained essentially unchanged through the 1990s, but there is evidence of improved nutritional status between 1999 and 2004. All three measures of nutritional status improved over this latter period.

The data from the 1991 Demographic and Health Survey were used to examine patterns in child malnutrition across households. This analysis indicates substantial differences in nutritional status between urban and rural areas, across zones and regions, and among different wealth categories:

- Malnutrition rates in rural areas are almost twice as high as in urban areas
- Malnutrition rates tend to increase with the age of the child up to about 18 months, after which the rate levels off.
- Malnutrition rates are highest in the South (Mtwara and Lindi) and lowest in the Northern Highlands and the Lake Zone.
- In terms of the pattern by region, stunting malnutrition is lowest in Dar es Salaam and highest in Mtwara, Lindi, Morogoro, and Dodoma. The ranking is similar for underweight malnutrition.
- The risk that children are stunted or underweight is lower when the mother and/or the head of household is educated, when the household has a clean water source, and when the household uses an "improved" form of toilet.

We also explore the feasibility of nutrition mapping, defined as using small-area estimation methods to combine data from nutrition survey with census data to generate a spatially disaggregated estimates of child malnutrition (see Chapter 6). More specifically, regression analysis of the 1991-92 Tanzania DHS is used to estimate the relationship between various measures of child malnutrition and a set of individual, household, and community characteristics. Next, the estimated relationship is applied to the same characteristics in the census data to estimate nutritional status for each child less than five years old recorded in the long form of the census. From these estimates, the prevalence of child malnutrition is calculated for regions, districts, and sub-districts.

The regression results were somewhat disappointing. Although a good number of explanatory variables were identified, they only accounted for about one-fifth of the variation in z-scores in urban areas, and less than 15 percent in rural areas. As a result, the Stage 2 estimates have wide confidence intervals, so it is difficult to detect statistically significant differences. Nonetheless, the estimates are

suggestive of distinct spatial patterns in undernutrition in Tanzania. While there is some variation in undernutrition rates between regions, there is a much greater range of undernutrition among the districts and sub-districts that make up a region. A pattern that emerges frequently is an urban center—including small urban centers such as district headquarters—with lower than average undernutrition rates surrounded by rural areas with rates that are higher than average. This suggests the need for greater attention to meeting nutrition needs in rural areas. This entails not only ensuring an sufficient supply of nutritious food, but also adequate health care, nutrition extension, safe water supplies, and other factors that determine nutritional outcomes.

7.4 Conclusions

The overall message of the poverty trends analysis an encouraging one: that poverty may have fallen more than previously thought and that the gains in terms of poverty reduction extend to less educated households and to households living in remote rural areas. Below, we list a few broad implications of these findings.

Economic growth translates into household well-being in Tanzania. This may be obvious to many, but some critics contend that economic growth has an adverse effect on the quality of life because it is associated with a widening gap between urban and rural areas and between the rich and the poor. These results provide some reassurance that economic growth is translated into tangible benefits for ordinary Tanzanian households. We do not find evidence of a widening gap between urban and rural households, nor between educated and uneducated, implying that in Tanzania (at least) there is a relatively direct link between economic growth and poverty reduction.

The effect of market reforms may be more beneficial to poverty reduction in Tanzania than previously thought. Economic growth is influenced by many factors including weather, international markets, the level of confidence of consumers and investors, technological change, and government policy. But given that neither international markets nor weather has been particularly favorable to the Tanzanian economy in recent years, it is certainly plausible to attribute the steadily rising growth rate to the cumulative effect of a wide range of policies to liberalize markets, privatize state-owned enterprises, and create an environment more conducive to the private sector. To the extent that the high rates of economic growth can be attributed to market reforms, then the gains in poverty reduction are linked to the reforms.

The patterns in rural poverty reduction suggest a link with the patterns in agricultural growth. Significant poverty reduction in Mtwara may be linked to the rapid growth of the cashew-nut export sector, in which over 200 thousands of small farmers participate. Similarly, poverty reduction in Morogoro could be the result of improved road connections with Dar es Salaam and the removal of pan-territorial pricing. Poverty reduction in Mwanza is consistent with the growing fish industry which exports to the European Union. These results strengthen the case for an agriculture-led poverty reduction strategy.

Perceptions of the impact of market reforms may have an urban bias. It is interesting to speculate on the reasons for the discrepancy between the widespread skepticism regarding the impact of economic reforms and the findings in this report. One hypothesis is that "conventional wisdom" is generated by more educated groups in Dar es Salaam, a group that has been more affected than others by contraction in employment at state enterprises and slower growth in public-sector employment. Indeed, our results suggest that poverty has not declined in Dar es Salaam, nor among those households whose head has at least some secondary schooling.

The importance of market access may be over-rated. It is surprising that market access has such a weak relationship with the incidence of poverty. The average poverty rate for a rural household living just outside a regional center is about 38 percent, while the average among households living 100 km from the center is less than 45 percent. The other measures of market access are no stronger in their link to poverty. It is equally surprising that poverty reduction in remote areas is equal to that in better-connected rural areas. It is possible that our measures of market access do not capture some

important dimension of the concept. Alternatively, it may be that we have an exaggerated view of the importance of distance to markets and urban centers. The road network has improved since 1991/92 in many areas, reducing the effect of distance. Similarly, the rapid growth of the mobile phone networks in Tanzania has reduced the information gap between those in remote areas and those in well-connected areas. And migration and remittances probably play a role in reducing the differences income across rural areas.

But the results should not be taken as a justification for complacency in efforts to reduce poverty and malnutrition. First, the variables we use to estimate the incidence of poverty cover a broad range of indicators of material well-being, but they do not capture other dimensions of welfare. Our indicators do not include any measure of diet quality, health and life expectancy, vulnerability to shocks, personal security, and the social environment, all of which have a large effect on the quality of life. Second, even accepting our measure as a good indicator of poverty, many households and areas of Tanzania remain extremely poor. Over 70 percent of the population in Rukwa and Kigoma live below the basic needs poverty line. Among the poor, virtually all live in 2-room houses with earth floors and no electricity, and barely 30 percent can afford a radio.

Even accepting these encouraging results regarding poverty reduction over 1991-2003, Tanzania will have to improve its performance to meet the Millennium Development Goal for poverty reduction. Reducing poverty by 9 percentage points over 12 years is respectable progress, but based on our estimates, in order to halve poverty over the period 1990-2015, Tanzania will need to reduce the incidence of poverty another 15 percentage points over the 12 years between 2003 and 2015. Of course, GDP growth and poverty reduction have occurred at a faster rate since 1999. If this pace were maintained, the MDGs would probably be achieved by 2015.

The prevalence of child malnutrition has resisted improvement throughout the 1990s, but there are encouraging signs of progress in recent years. The prevalence of stunting and under-weight appear to have declined between 1999 and 2003. This may be related to the more rapid pace of economic growth since 2000 (4-5 percent per year in real GDP per capita) and related poverty reduction or due to sectoral policies in health and sanitation. In either case, the 2004 Demographic and Health Survey will create an opportunity to verify this positive trend.

The most prominent spatial pattern in the nutrition maps was the higher prevalence of child malnutrition in rural areas than in urban areas. An important question is whether this pattern is explained by higher incomes in urban areas, better access to medical facilities, and/or higher levels of education among urban residents. Addressing this question is complicated by the fact that all three factors are correlated with each other, but the answer would have important implications for the design of programs to reduce child malnutrition.

7.5 Implications for future research

It is difficult to predict child malnutrition based on the variables available in the census Child age, child sex, child order, maximum education in the household, and distance to roads and urban centers were all statistically significant predictors of child malnutrition, but it was only possible to explain 8-24 percent of the variation in child nutrition.

Nonetheless, it would be worth carrying out a nutrition mapping analysis using the 2002 Population Census and a recent Demographic and Health Survey. One way to improve the accuracy of the prediction equation would be to include a broader range of geographic variables such as elevation, soil type, and rainfall, as well as data on distance to medical facilities. This would only be possible if the Census data is geo-coded at least at the village level.

The use of Demographic and Health Surveys could be more widely used in medium-term poverty monitoring in Tanzania and elsewhere. Household budget surveys are invaluable for measuring long-term trends in poverty, but for cost reasons they are often not carried out more than once each decade. The use of DHS data combined with regression analysis of a household budget survey to estimate the "weights" shows promise as a means to monitor medium-term trends in poverty.

More research is needed to test the validity of applying a regression equation estimated for one year to DHS data for other years. In other words, when the incidence of poverty changes in a country, how much is attributable to changes in the indicators and how much is attributable to changes in the relationship between the indicators and income. An Oaxaca decomposition analysis might help address this issue.

More coordination is needed to identify a core set of welfare indicators to be included in all household surveys to ensure comparability. This task is already being undertaken by the Poverty Research and Analysis Working Group, but the results of this study serve to confirm the importance of this goal. The adoption of a consistent set of indicators with standardized wording would allow smaller surveys to generate an estimate of per capita expenditure (or income) for use in the analysis without the expense of collecting income and expenditure data.

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