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Abstract
This paper contains spatial and intertemporal comparisons of multidimensional poverty and inequality in Malawi using two non-monetary dimensions, namely an asset index and child nutritional status. Through stochastic dominance tests, we establish that poverty and inequality are unambiguously higher in rural areas, the Southern region and households headed by females. We find, using decomposition analysis, that most poor people live in rural areas which make up 85% of total population. Poverty comparisons over time, between 1992 and 2010, show that poverty has significantly declined in Malawi and that these gains have largely been pro-poor in both absolute and relative terms. The paper shows that Malawi's poverty profile is a 'bad picture' in the sense that almost half of the population is still poor but a 'good movie' in that the incidence of poverty has fallen from as high as 80%. Interestingly, we find that poverty and inequality estimates do not vary much across regions and areas with respect to child nutritional status but large differences exist when assets are used. We also find that stunting is a bigger problem among under-5 children in Malawi than wasting and being underweight. Econometric analysis shows that asset ownership is positively associated with household size (suggesting economies of scale), age of household head and education attainment. Age dependency ratio and shocks to sickness are negatively associated with asset ownership. Multivariate analysis of child nutrition reveals that malnutrition first worsens before improvement begins to take place at some critical age. This is consistent with possible recovery from malnutrition as has been found in some of the studies that track children over time. Also consistent with some literature is the finding that boys have weaker nutritional status than girls.

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1. INTRODUCTION

1.1 Background and study motivation

Poverty and inequality remain big concerns in Malawi, a very poor country. Deprivation exists in a number of dimensions such as education, consumption, child nutritional status and assets. Based on household per capita consumption estimates from Malawi's Third Household Integrated Survey (IHS3), about 50.7% of households in Malawi are poor. In addition, the Gini coefficient shows that inequality has increased over the past five survey years from 0.390 in 2005 to 0.452 in 2011. Estimates based on the 2010 Malawi Demographic Health Survey (MDHS) indicate that the incidence of child stunting in Malawi stands at 47% (NSO & ICF Macro, 2011).

Following the works of Sen (1985, 1987), a number of approaches have been developed to measure multidimensional poverty. A multidimensional view of poverty considers more than one aspect of deprivation. Conventionally and for a long time, poverty has been looked at in terms of either income or consumption. However, this view of poverty has been criticised for ignoring other important dimensions of well-being such as health, education, empowerment and freedom of association. Based on the literature, one can group the existing approaches to the measurement of multidimensional poverty into four alternatives.

The first approach aggregates a number of dimensions of poverty such as life expectancy, literacy and Gross Domestic Product (GDP) into a single one-dimensional index. Examples include the Human Development Index (HDI) and the Multidimensional Poverty Index (MPI). The second approach compiles a wealth or asset index using data from Demographic and Health Surveys (DHS). In this approach, just like with the HDI, an index is computed from a number of asset variables and this forms the basis for ranking households by their long-run socio-economic status. This approach has gained popularity in recent years (Filmer & Pritchett, 1998, Sahn & Stifel, 2000 and Booysen, F., Van der Berg, S., Burger, R., Von Maltiz, M., & Du Rand, G., 2008). The third approach considers two or more dimensions of poverty such as income, education, health, etc. but analyses each dimension independently, without taking into account the possible correlations which may exist between the dimensions (e.g., Sahn & Stifel, 2003; Mussa, 2010).The fourth approach also considers two or more dimensions but unlike the third approach takes into account the potential interrelationships among dimensions (e.g., Gondwe, 2011; Duclos, J.Y., Sahn, D. & Younger, S., 2006; Batana, 2008; Batana & Duclos, 2008). In this approach, a poverty line is set for each of the dimensions and then a decision is made as to whether an individual is to be considered poor if deprived in just one, some or all of the chosen indicators. In the literature, poverty has been found to be higher in distributions with higher correlations between the measures of well-being than those with lower correlations. Therefore, it is possible that univariate and multivariate analyses of poverty produce different rankings of poverty between distributions.

Specifically, this fourth approach looks at poverty measures that make for possible substitutions and complementarities between the levels of dimensions. Assuming two dimensions, for the substitutability assumption, we expect that the more someone has of one dimension of poverty, the less is overall poverty deemed to be reduced if his/her value of the other dimension is increased. On the other hand, for the complementarity assumption, increasing one dimension would reduce overall poverty. For example, transferring education from the poorly nourished to the better nourished would reduce overall poverty because better-nourished children learn better.

Most previous studies on poverty in Malawi concentrated on unidimensional poverty analysis (Murkherjee & Benson, 2003, Bokosi, 2006 and Phangaphanga, 2000). The first study on multidimensional poverty in Malawi was Mussa (2010) which considered three dimensions of poverty and inequality in Malawi, namely household per capita consumption, education and health. However, the paper looked at the three dimensions one-at-a-time (or independently) without taking into account the correlations that exist between the dimensions of well-being. Gondwe (2011) did account for the possible correlations that exist between the dimensions of poverty. Two dimensions were used, household per capita consumption and education.

This study conducts spatial comparisons of multidimensional poverty and inequality using two non-monetary dimensions, namely an asset index and child nutritional status. We look at the two dimensions separately. It is the first time attempt to apply the asset index approach to the measurement of poverty in Malawi and uses a more recent DHS data set compared to the 2004 DHS data used by Alkire and Santos (2010). Also, the study conducts pro-poor growth analysis in the selected dimensions of living standards over two decades, from 1992 to 2010.

The paper achieves five objectives. First, it presents spatial poverty and inequality comparisons in assets and child nutritional status across population groups (areas, regions and sex of household head) in Malawi. Related to this, we conduct poverty and inequality decompositions to see the relative contributions by the respective population groups or distributions. Second, it establishes a robust ranking of poverty and inequality across the groups that are compared. Third, it identifies the factors associated with asset poverty and child nutritional status in Malawi. Fourth, it tracks the incidences of asset poverty and child malnutrition in Malawi over the past two decades using a series of cross-sectional data sets. Finally, it establishes if the observed changes in living standards and child nutritional status over time have been pro-poor, absolutely and relatively speaking.

The rest of the paper is organised as follows. Section 2 provides a discussion of methodology and the data used. Section 3 provides the poverty and inequality estimates. Econometric results on asset poverty and child nutritional status in Malawi are presented in Section 4. Section 5 conducts pro-poor growth analysis. Finally, Section 6 provides conclusions and policy discussions.

2. METHODOLOGY AND DATA

2.1 Poverty measurement

Several poverty measures are available in the literature such as the Watts index and the Sen-Shorrocks-Thon index, among others. In this study, we use the Foster-Greer-Thorbecke (FGT) measures because of their decomposability property which they possess in addition to other favourable characteristics. We consider three indices, namely the headcount index, poverty gap index and the poverty gap or poverty severity index (Foster, Greer & Thorbecke, 1984).

The poverty headcount index measures the proportion of the population that is counted as poor. It is denoted by

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

Where: y_i, z, N are the welfare indicator, poverty line and population size. $I(.)$ is an indicator function that takes on a value of 1 if the expression is true and 0 otherwise.

The poverty gap index indicates the extent to which individuals on average fall below the poverty line and expresses it as a percentage of the poverty line. It is given by

$$P_1 = \frac{1}{N}\sum_{i=1}^{N} \frac{G_i}{z} \tag{2}$$

Where: $G_i = (z - y_i).I(y_i < z)$

It is defined as the poverty line less the welfare indicator for the poor; otherwise takes the value of zero for the non-poor.

The squared gap index averages the squares of the poverty gaps relative to the poverty line. It is defined as:-

$$P_2 = \frac{1}{N}\sum_{i=1}^{N} \left(\frac{G_i}{z}\right)^2 \tag{3}$$

2.2 Inequality measurement

Unlike poverty analysis which only focuses on the poor people or households, inequality is defined over the entire population and takes into account both the rich and poor. Here we only consider the Gini and Theil indices measures due to their desirable properties. The other measures of inequality discussed in the literature include Decile Dispersion Ratio, Atkinson's inequality measures and Coefficient of Variation. A more detailed discussion on inequality measurement is given in Haughton and Khandker (2009) and Duclos and Araar (2009).

The Theil index is advantageous because it is additive across different population subgroups and enables us to see between and with group inequalities. On the other hand, the Gini is easy to understand and has a desirable graphical representation. It is for this reason that the Gini is preferred in most studies. The Gini coefficient varies between 0 (representing equal distribution) and 1 (representing a complete inequality). On the other hand, GE values vary between zero and infinity, which reflect complete equality and inequality, respectively. Graphically, the Gini coefficient is calculated as the area above the curve but below the line of perfect equality divided by the total area below the line of perfect equality. Apart from measuring the level of inequality, the Lorenz curve is also be used to test for inequality dominance between two distributions.

Letting x_i and y_i be points on the x-axis and y-axis, then we have:

$$Gini = 1 - \sum_{i=1}^{N} (x_i - x_{1-1})(y_i + y_{i-1}) \tag{4}$$

If there are N equal intervals on the x-axis, equation (4) collapses to:

$$Gini = 1 - \frac{1}{N} \sum_{i=1}^{N} (y_i + y_{i-1}) \tag{5}$$

The Gini satisfies four main properties and these are mean independence, population size independence and the Pigou-Dalton Transfer sensitivity. However, the Gini does not satisfy two important characteristics namely decomposability by population groups, dimensions or sources and statistical testability over time although this is less problematic now due to the fact that confidence intervals can typically be obtained through the use of bootstrap techniques. The GE measures satisfy all of the six properties.

The Theil index is part of a larger family of measures referred to as the Generalised Entropy (GE) class of indices. The general specification of the GE measures is given as

$$GE(\theta) = \frac{1}{\theta(\theta - 1)} \left[\frac{1}{N} \sum_{i=1}^{N} \left(\frac{y_i}{\overline{y}} \right)^{\theta} - 1 \right] \tag{6}$$

Where: y is the selected welfare indicator or dimension and $\overline{y}$ is its average or mean. The parameter θ gives the weight given to distances between values of a given indicator at different parts of the distribution, and can take any real value. The GE index is more sensitive to changes in the lower tail of the distribution for lower values of θ, and for higher values, GE is more sensitive to changes occurring at the upper tail. When $\theta = 0$, we have the Theil-L index, also called mean the mean log deviation measure, and when $\theta = 1$, the result is the Theil-T index.

2.3 Stochastic dominance analysis

Dominance tests are necessary because poverty or inequality ranking can be reversed by different choices of poverty lines, measures, aggregation procedures and samples. These are the four main reasons why measures of poverty or inequality may not be robust. Stochastic dominance analysis seeks to achieve non-ambiguous ranking in terms of welfare and inequality between any two distributions.

2.3.1 Poverty dominance

Assume two distributions A and B for our dimensions of poverty such as asset and child nutritional status. F_A and F_B will be the cumulative density functions (CDFs). Distribution B is said to dominate distribution A stochastically at first order if, for any argument y, $F_A(y) \geq F_B(y)$. In terms of poverty, this means that there is (weakly) more poverty in distribution A than there is in B. Higher orders of stochastic dominance are obtained through repeated integrals of the CDF of each distribution. Generally we have,

$$D^1(y) = F(y), \quad D^{s+1}(y) = \int_0^y D^s(z) \ dz, \quad for \quad s = 1,2,3,... \tag{7}$$

Where:

D^1 is the CDF of the distribution under study;

$D^2(y)$ is the integral of D^1 from 0 to y;

$D^3(y)$ is the integral of D^2 from 0 to y, and so on.

By definition, distribution B dominates A at order s if $D_A^s(y) \geq D_B^s(y)$ for all arguments y. First-order dominance implies dominance at all higher orders. Where first order dominance is not established, we proceed to higher levels but stop at third order dominance as is the practice in the literature (e.g., Mussa, 2013).

2.3.2 Inequality dominance

Lorenz curves are the widely used approach to testing stochastic dominance in inequality (Araar, 2006). A given distribution is said to Lorenz dominate another distribution if the Lorenz curve of the first distribution lies everywhere above that of the latter. We then say that there is less inequality in the distribution with the higher curve than in that with a lower curve.

Specifically, inequality is higher in A than in B if $L_B(p)$ is everywhere above $L_A(p)$. Distribution B dominates distribution A in inequality, with the second order, if

$$L_A(p) > L_B(p) \quad \forall p \in [0,1] \tag{8}$$

Where p is the percentile. The Lorenz curve for the percentile p_i can be defined as follows:

$$L(p = p_i) = \frac{1}{\mu}\sum_{j=1}^{i} \pi_j y_j \qquad (9)$$

In this study, we use generalised Lorenz dominance, introduced by Shorrocks (1983), which turns out to be the same thing as second-order stochastic poverty dominance.

2.4 Poverty and inequality decomposition

As indicated in Sections 2.1 and 2.2, the FGT and GE indices are decomposable by population groups. In this study, we follow decompositions based on Araar and Duclos (2013).

The decomposition of the FGT index enables us to determine the absolute or relative contribution of each group such as area, region or etc. The decomposition takes the following form:-

$$\hat{P}(z;\alpha) = \sum_{g=1}^{G} \hat{\phi}(g)\hat{P}(z;\alpha;g) \qquad (10)$$

Where:

G refers to the total number of population groups;
$\hat{P}(z;\alpha;g)$ and $\hat{\phi}(g)$ are the estimated FGT index and population share of subgroup g;
$\hat{\phi}(g)\hat{P}(z;\alpha;g)$ and $\frac{\hat{\phi}(g)\hat{P}(z;\alpha;g)}{\hat{P}(z;\alpha)}$ are the estimated absolute and relative contributions to total poverty by subgroup g.

GE decomposition takes the following form:-

$$\hat{I}(\theta) = \sum_{k=1}^{K} \hat{\phi}(k)\left(\frac{\hat{\mu}(k)}{\hat{\mu}}\right)^{\theta} \bullet \hat{I}(k;\theta) + \overset{\wedge}{\bar{I}}(\theta) \qquad (11)$$

Where:

K refers to the total number of population groups;
$\hat{\phi}(k)$ is population share of subgroup k;
$\hat{\mu}(k)$ is the mean of the selected indicator subgroup k;
$\hat{I}(k;\theta)$ is the inequality within subgroup k;
$\overset{\wedge}{\bar{I}}(\theta)$ is population inequality if each individual in subgroup k is given the mean for the poverty indicator of subgroup k, $\hat{\mu}(k)$

2.5 Pro-poor growth analysis

In the literature, outcomes of pro-poor growth between any two given periods are analysed by calculating the growth rate (g) and five different pro-poor indices (Duclos & Verdier-Chouchane, 2010). The first three of these indices are measures of absolute pro-poorness and they are: the Ravallion and Chen (2003) index, the Kwakwani and Pernia (2000) index and the PEGR index. The other two indices namely, the Ravallion and Chen (2003) index minus (g) and the PEGR index minus (g) are indices of relative pro-poor growth.

There exist two different approaches to the definition of pro-poor growth, namely a relative and an absolute approach. Growth is defined as pro-poor in the absolute sense if it reduces absolute poverty. Using the relative approach, growth is pro-poor if reduces inequality and relative poverty. In this sense, the poor proportionately benefit more from growth than the non-poor.

If the growth rate and the Ravallion and Chen (2003), the Kwakwani and Pernia (2000) and the Poverty Equivalent Growth Rate (PEGR) indices are positive, there is absolute pro-poor growth from one period to another. When g is positive and the Kwakwani and Pernia (2000) is negative or when g is negative and the Kwakwani and Pernia (2000) index is positive, then the distributive change has increased absolute poverty. Growth is said to be anti-poor when this is the case. When the Ravallion & Chen (2003) minus g and the PEGR minus g are positive, the distributive change is considered to be relatively pro-poor. A similar conclusion is arrived at if the Kakwani and Pernia (2000)'s index is larger than 1. In this case, growth among the poor is higher than average growth. The poor have, therefore, been favourably affected by the change.

2.5.1 The Ravallion and Chen (2003) index

In order to understand Ravallion and Chen (2003)'s growth incidence curves, we first of all explain what a “quantile” is. Suppose there are n incomes in a given distribution ranked from the lowest to the highest. A quantile of a given population is given by the income level that is found at a particular rank in that distribution. The rank of the level of income y_i will be given by i/n. Growth incidence in the population can be understood by comparing *quantile* curves before and after a change in a distribution has taken place. Let the pre-change distribution be given by y_A and the post-change distribution be given by y_B, each of equal size n. We can build quantile curves for each of these distributions; these are given by the incomes y_i^A and y_i^B found at different ranks i/n. We can then assess the incidence of growth at any particular rank i/n by comparing the quantile curves at the point i/n. The absolute value change is given by $y_i^B - y_i^A$. The proportional change is given by $\frac{y_i^B - y_i^A}{y_i^A}$.

The Ravallion and Chen (2003) growth incidence curve is a plot of the proportional change against all possible values of ranks i/n. The incidence curve shows the rates of growth for various ranks in the distribution. Absolute pro-poorness of growth is obtained when the absolute value change is everywhere positive for the range of ranks over which the initially poor individuals or households are located. Relative pro-poorness of growth is obtained when the growth incidence curve is everywhere above the proportional change in the mean income.

2.5.2 The Kwakwani and Pernia (2000) index

The Kakwani and Pernia (2000) index compares the actual poverty outcome of a distributive change to the outcome that would have been observed if the change had been distribution-neutral (Kakwani and Pernia, 2000). Two main distribution-neutrality criteria are provided. The first one assumes that everyone's income has changed by the same absolute amount while the second one considers that everyone's income has changed by the same proportional amount. There exist several views on what that proportion should be. However, the most common one is the proportional change in average income.

Suppose **Error! Bookmark not defined.** P^A and P^B be the actual pre- and post-change poverty levels, and P^{BN} let be post change poverty under distribution neutrality. Then,

$\frac{P^A - P^B}{P^A - P^{BN}}$ is the ratio of the actual change in poverty to the change that would have been observed under distribution neutrality. Several poverty indices can be chosen for P . In the main text, P is specified as the headcount ratio. Several scenarios of distribution neutrality can also serve to specify BN . Let for instance $A = y_1^A, y_2^A, ..., y_n^A$ and $B = y_1^B, y_2^B, ..., y_n^B$. Kakwani and Pernia (2000)'s index uses the following definition for BN :

$$BN = \left(\frac{\mu_B}{\mu_A} y_1^A, \frac{\mu_B}{\mu_A} y_2^A, \frac{\mu_B}{\mu_A} y_n^A \right) \quad (12)$$

It says that a change is distribution neutral if incomes change in proportion to the proportional change in average income. This index thus gives the ratio of the observed change in poverty to the change that would have been observed under constant inequality.

2.5.3 The Poverty Equivalent Growth Rate (PEGR) index

PEGR, also called the Kakwani, Khandker and Son (2003) index, assesses the pro-poorness of growth by calculating "poverty equivalent growth rates". PEGR is the growth rate that would have resulted in the same observed level of poverty change if the distribution of income shares had not changed. PEGR can be thought of as the counterfactual distribution of income

$BN = ((1+PEGR)y_1^A, (1+PEGR)y_2^A, ..., (1+PEGR)y_n^A)$ as giving the same final level of poverty as the one that is actually observed. When the growth rate PEGR is applied to all of initial income y^A , poverty thus equals poverty with the distribution of y^B .We therefore have $P_B = P_{BN}$ and thus that $P_A - P_B = P_A - P_{BN}$

If PEGR is greater than 0, the distributive change is judged to be absolutely pro-poor by this approach. This is the case if and only if $P_A - P_B > 0$.

Let $g = \frac{\mu_B - \mu_A}{\mu_A}$ and it is thus the actual rate of growth in average income. If income shares remain constant in the movement from A to B , then we must have that $y_i^B = (1+g)y_i^A$ for all i . Since $P_A - P_{BN}$, with constant income shares, it must be that $PEGR = g$. The poverty equivalent growth rate is, therefore, just the usual growth rate if inequality has remained unchanged. Movements in inequality will, however, create a divergence between the poverty equivalent growth rate and the usual growth rate. The greater the adverse effects of inequality on the poor, the greater the value of P_B , and therefore the lower the value of $PEGR$.

The difference, $PEGR - g$, can therefore help assess whether the distributive change has affected the income shares of the poor. If $PEGR - g$ is negative, poverty equivalent growth is lower than growth in average income, growth among the poor is lower than average growth, and the income shares of the poor have therefore been adversely affected by the change. The converse is true when $PEGR-g$ is positive.

2.6 Data

Malawi has participated in four nationally representative Demographic Health Surveys (DHSs). These surveys have provided up-to-date information on living conditions and health programmes in Malawi. The surveys were conducted by the National Statistical Office (NSO) and the Community Health Sciences Unit (CHSU) during different times in the calendar year. Traditionally, DHSs consist of data sets relating to the household, men, women and children. This study makes use of the household and children's data sets only. Child nutritional status is particularly important because it affects their growth and development, which has a direct link to their future health status as adult men and women. The household data set contains information on assets which are found to be more reliable than consumption expenditure and income as a measure of the long term living standards for the household, as we will see in Section 2.7.1. Table 1 provides a summary of the DHS data sets used in the study.

From the data sets, we derive the household asset index and anthropometric indices of children and use them as our variables of interest. The number of children indicated in the table is after data cleaning and excludes children whose age, height and weight measurements are missing. Poverty and inequality measurement is based on the 2010 data sets only. On the other hand, pro-poor growth analysis is done using all the DHS survey periods from 1992 to 2010.

2.7 Measures of welfare

This paper uses two non-monetary measures of welfare, namely asset index and child nutritional status. We now discuss these measures briefly.

2.7.1 Asset index

Household income, consumption expenditures and assets are the three main indicators of economic status in the literature. The use of assets as a measure of economic status has been found to be advantageous. Wealth[1] is not only said to represent a more permanent status than income and expenditure but is also more easily measured with only a single respondent required in most cases (Rutstein & Johnson, 2004).

The derivation of the asset index requires that indicator variables for asset ownership[2] be captured or transformed into binary form, e.g. 1 for "yes" if a household owns a given asset and 0 for "no" if a household does not own the asset. It is, however, not necessary to transform variables that are already categorical such as source of drinking water, type of toilet facility, floor, wall, roof material and source of cooking fuel. Stata 13, the software used, understands the categorization automatically even in cases where there are more than two categories.

After categorisation in the manner explained in the preceding paragraph, the mca command was applied to the asset variables. The index is weighted by household size and sample weight. Principal components analysis (PCA) and factor analysis (FA) were used as robustness checks.

Asset and poverty indices typically contain negative values which are unsuitable for poverty and inequality measurement. Following the literature, we adjusted the asset index by adding to it a value slightly higher than the absolute value of the most negative number (e.g., Da Maia, 2012). In our

[1] In the literature, wealth and asset index are loosely used synonymously because the assets owned by a household represent its asset wealth.

[2] In this study, asset ownership is used to mean ownership of private assets as well as access to public services.

case, since -1.056288 was the minimum value, we added 1.056289 to the asset index. This results in a shift of the distribution of the asset index to the right as indicated in Figure 1. The resultant asset index, which we call the adjusted asset index, is what is used in this study for poverty and inequality analysis. Table 2 provides the descriptive statistics.

The kernel density plots for the asset index across population sub-groups are presented in Figures 1 to 6. Urban areas have a higher average of asset index scores compared to rural areas. Amongst regions, the Northern region has the highest asset score values seconded by the Central region and finally the Southern region. A similar trend is observed amongst Rural north, Rural centre and Rural south. On the other hand, Urban centre and Urban south seem to be doing better than Urban north.

2.7.2 Child nutritional status

Our sample only consists of children aged between 0 and 59 months. From the data set, we calculate three anthropometric indices or z-scores, namely height-for-age (HAZ), weight-for-age (WAZ) and weight-for-height (WHZ). We discuss each of these three measures separately in the next few paragraphs.

Firstly, HAZ measures stunted growth and reflects cumulative linear growth and failure to receive adequate nutrition over a long period. It is also affected by recurrent and chronic illness rather than recent, short-term changes in dietary intake. HAZ, therefore, indicates the long-term effects of malnutrition in a population. Secondly, WHZ is a measure body mass in relation to body height or length and reflects current nutritional status. It can be used to describe body wasting which represents the failure to receive adequate nutrition in the period immediately preceding the survey. Wasting may result from inadequate food intake or recent episodes of illness causing loss of weight and the onset of malnutrition. Finally, WAZ is a composite index of HAZ and WHZ. It gives the overall picture of malnutrition and takes into account both acute and chronic malnutrition. WAZ measures the state of body weight.

The z-scores are calculated using the new 2006 World Health Organisation (WHO) child growth standards based on the Multicentre Growth Reference Study done on a 'healthy' sample size of 8,440 children drawn from six countries across the world. The analysis is done using Stata 13, Special Edition (Stata Corporation, College Station, USA) with the use of the $zscore06$ module[3]. The z-scores express normal and abnormal departures of an individual child's height or weight from the average height or weight of comparable children of the same sex and age in the standard reference population.

According to WHO (2006), z-scores below -2 standard deviations (SD) and -3 SD from the median of the reference population indicate malnourishment and extreme malnourishment, respectively. Normal children have z-scores of greater than or equal to -2 SD (>=-2SD). Figure 7 provides kernel density estimates for HAZ, WAZ and WHZ. Summary descriptive statistics are provided in Table 3.

Levels of child malnutrition seem to depend on the choice of measure. HAZ shows the highest levels of child malnutrition, whereas WAZ and especially WHZ appear to reflect lower levels. Child malnutrition rates for the sample (i.e. scores more than 2 standard deviations below the mean for the standard reference population) stand at 46%, 14% and 4% as based on HAZ, WAZ and WHZ, respectively. Extreme child malnutrition (more than 3 standard deviations below the reference population mean) stands at 19%, 3% and 2% based on HAZ, WAZ and WHZ, respectively.

[3] zscore06: Stata command for the calculation of anthropometric z-scores using the 2006 WHO child growth standards; http://www.ifpri.org/staffprofile/jefleroy.

The level of malnutrition is higher amongst children aged above 24 months compared to those below 24 months. We follow the WHO age-group comparison although a more detailed analysis can be done across smaller age groups. Malnutrition levels are also lower amongst girls compared to boys. Urban residents have a lower incidence of child malnutrition compared to rural residents. Amongst regions, child malnutrition is the highest in the Southern region followed by the Central region. Similar observations are made across areas and regions combined.

However, it is worth noting that the gap in the levels of child mal-nutrition across regions, areas and regions are smaller compared to those obtained by age, sex and area. Specifically, we get very similar incidence levels of child mal-nutrition amongst the three regions, rural areas (Rural north, Rural Centre and Rural South) and urban areas (Urban north, Urban Centre and Urban South). This seems to suggest that Malawi is uniform in terms of the incidence of child malnutrition. On the other hand, we get a different picture with assets where the incidence levels seem much different not only between areas but also across regions and by sex of the household head. See Figures 2 to 6.

3. POVERTY AND INEQUALITY ESTIMATES

3.1 Poverty lines

Based on household expenditure data, as indicated in Section 1, 50.7% of households in Malawi live below the poverty line. This is what is used to set the asset poverty line, i.e. it is assumed that the appropriate asset poverty line should place the same proportion of households in poverty. The absolute poverty line for the asset index is, therefore, obtained by calculating the value at the 50.7th percentile and this turns out to be 0.63399.

With respect to child nutritional status, we convert each of the three anthropometric z-scores into percentiles. This involves calculating the area under the standard normal curve to the left of the z-score. The area under the curve adds up to unity and the mean (z-score of 0) splits the area into two halves of 0.5 each. The conversion is monotonic and does not affect the ranking of the children. Specifically, for each point of the SDs, there is a corresponding percentile or cumulative probability which is fixed along the x-axis. For example, if we look up in the standard normal distribution tables, a z-score of -2 gives 0.0228 as the area to the left of -2 or simply the 2.3rd percentile. Similarly, -3 corresponds to 0.0013 or the 0.13rd percentile.

In this study, we are interested in malnutrition (<-2 SD) as opposed to extreme malnutrition (<-3 SD) and, therefore, use 2.3 as our poverty line. A percentile gives the value of a variable below which a certain percentage of observations (or population) falls. In our case, as we can see from Figure 7, almost half of the data points for HAZ lie to the left of -2. We also note that all our three anthropometric measures (HAZ, WAZ and WHZ) follow the standard normal distribution pattern.

3.2 Cumulative density curves

Cumulative density curves (CDCs) indicate how poverty incidence varies with the level of poverty lines but are also used to test for dominance between two distributions. In Figures 8 to 11, we present the CDCs for the asset index, i.e. when $\alpha = 0$.

A distribution whose curve lies above the other reflects higher level of poverty. The figures generally show that there is poverty dominance in the poverty relevant range. The CDCs only cross each other at very high asset levels where it is difficult to conclude that poverty is higher in one population subgroup than the other. However, it is only the poverty relevant range that we are interested in for practical purposes. The figures also show that the gap between the CDCs is largest between urban and rural areas; small differences exist between regions and by sex of household head.

3.3 FGT poverty estimates

Table 4 shows our poverty estimates for the three FGT classes, namely the headcount index ($\alpha = 0$), the average poverty gap index ($\alpha = 1$) and the poverty severity index ($\alpha = 2$), respectively. Household observations are weighted by sampling weights and household size. Sampling weights are used so that the chosen households are representative of all households in Malawi. On the other hand, household size takes into account the effect of size on welfare. Thus, a poor household with more members is given a higher weight in the analysis than a similarly poor household with fewer members. For the children's data set, we only apply sampling weights since household size is not applicable for individual level data. Without the use of weights, our results would be either overestimated or underestimated.

The difference between the results in Table 4 and Figures 8 to 11 is that the latter are calculated for the whole range of the poverty lines while the former is calculated at a specific and chosen level of the poverty line. For example with the poverty line set at as asset index of 0.63399, the table shows that 46.0% of the Malawian population is asset poor for $\alpha = 0$. For the same measure (headcount index), asset poverty is higher in rural areas (53.3%) compared to urban areas (7.2%). The Central region has the highest levels of asset poverty amongst the three regions with the incidence of household poverty at 51.3%. A similar observation is made for rural centre and urban centre where 59.4% and 9.2% of the households are living below the poverty line, respectively. Asset poverty is also higher in female headed households than male headed households.

Child malnutrition estimates are dependent on the type of measure used except for rural-urban population group where rural areas are found to be the poorer than urban areas for all the three indicators, namely HAZ, WAZ and WHZ. At a national level and for $\alpha = 0$, 47.1% of the children are malnourished when HAZ is used as a measure compared to 13.2% and 4.2% when WAZ and WHZ are used, respectively.

It is, however, important to state that the national poverty estimates based on HAZ and asset index are similar in magnitude confirming that deprivation in Malawi has many dimensions. We also note that the differences in the incidence of poverty between groups (e.g. rural and urban areas) seem to be larger for the asset index than for the three anthropometric measures. As earlier pointed out in Section 2.7.2, the results tell us that levels of malnutrition are similar in magnitude across many population subgroups in Malawi. On the other hand, the incidence of asset poverty varies much by population groups and a similar pattern is obtained based on household consumption expenditure studies such as Mussa (2010). Although we have not presented the CDCs of HAZ, WAZ and WHZ, we find them to be much closer to one another than is the case for the asset index in Figures 8 to 11.

Poverty ranking by population group is the same for all the three indices, $\alpha = 0$, $\alpha = 1$ and $\alpha = 2$. However, this result only holds at the specific chosen level of poverty line and not all poverty lines. As discussed, the results presented in Figures 8 to 11 indicate that it is difficult to conclusively identify which population groups have higher poverty levels because the CDCs cross at different levels. The estimates depend on the choice of the poverty measure used as is the case with child nutritional status. This problem is resolved through stochastic dominance analysis dealt with in Section 3.4.

3.4 Poverty dominance analysis

Our dominance tests are done up to the third order, as is the tradition in the literature (e.g., Mussa, 2010). Naturally, where first order dominance exists, there is no need to test for second or third order dominance, or where second order dominance exists, there is no need to test for third order dominance, as it would automatically hold. Table 5 shows the results. Poverty dominance is measured and interpreted in terms of welfare or standard of living. A distribution that dominates the other has lower levels of poverty than the one that is dominated.

As with the FGT estimates, dominance test results for child nutritional status depend on the measure used. Where dominance is established, order of dominance is not reversed. For example, all measures establish that urban areas are better in terms of welfare than rural areas and not the opposite. Using HAZ, urban areas dominate rural areas at second order dominance. Likewise, urban north dominates urban centre. No dominance is established for the rest of the subgroups. When WAZ is used, no dominance is established at all for all the pairs of subgroups. Finally, when WHZ is used, non-dominance is found for the Central and Southern regions, Rural centre and Rural south and Urban centre and Urban south. No dominance is established between male and female headed households- the same finding for HAZ and WAZ. It is, however, important to note that in most of these cases, non-dominance occurs outside the poverty relevant ranges of the poverty line as illustrated in the CDCs of Section 3.2.

Using the asset index, urban areas dominate rural areas at first order. The Northern region dominates the Southern region. When areas and regions are further broken down, dominance is only established for two pairs, namely rural north dominates rural south and urban centre dominates urban south. Male headed households dominate those headed by females.

3.5 Gini and GE inequality estimates

In Figures 12 to 15 are Lorenz curves for Malawi's population groups based on the asset index only. The Lorenz curve maps the cumulative share of the asset index, on the vertical axis against the population distribution on the horizontal axis. The 45 degree line indicates perfect equality, a case in which each household has the same share of assets.

A Lorenz curve that lies lower represents higher levels of inequalities for the distribution it represents. Looking at Figure 12, inequality is higher in rural areas compared to urban areas. Among the regions, it is difficult to graphically distinguish between the Central and Southern regions. We are, however, able to see that inequality is lowest in the Northern region. It is also difficult to distinguish between rural areas because of the closeness of the curves. Urban centre, however, has the highest level of inequality among urban areas. Female headed households seem to have higher levels of inequalities compared to those headed by males.

Having looked at the graphical estimates, we now present numerical inequality estimates for both the asset index and child malnutrition in Table 6. The results show that inequality is higher in rural areas compared to urban areas and this is consistent for all the three inequality measures used, namely Gini, Theil L and Theil T. Nevertheless, amongst the three measures of child nutrition, HAZ generally yields the highest levels of inequality.

Just as with poverty measurement, levels of inequalities depend on the measure used. Consequently, it is difficult to conclude without ambiguity which population groups have higher levels of inequality. We therefore turn to inequality dominance testing as a solution. The inequality dominance test results are presented in Section 3.6 and act as robustness checks.

3.6 Inequality dominance analysis

Results of the Lorenz dominance tests are presented in Table 7. Using HAZ, inequality dominance is only established for the urban and rural area pair. Since the Lorenz curve for urban areas lies above that of rural areas, inequality is said to be lower in urban areas compared to rural areas. This finding is confirmed with WHZ as well as the asset index. No dominance is established using WAZ.

Amongst the three regions, no inequality dominance is established using HAZ, WAZ and asset index. For WHZ, inequality is found to be the highest in the Northern region compared to both the Central and Southern regions. With respect to the sex of the household head, dominance is established for the asset index only, in which case inequality is found to be higher among male headed households. WHZ and asset index establish dominance between some areas such as Rural north, Rural south, Urban north, Urban centre and Urban south.

3.7 Poverty decomposition

Table 8 shows results of the FGT decompositions across rural-urban areas, regions, areas and sex of the household head for the three anthropometric indicators and the asset index. We provide the estimated population share of each subgroup as well as the estimated relative contribution of each subgroup to total poverty. Three FGT measures are used, namely the poverty headcount, average poverty gap and poverty severity indices. The population shares and relative contributions to poverty sum up to unity. The objective here is to establish if the most populated areas are also the ones with the incidence of poverty.

Our decomposition results for the asset index indicate that most poor people in Malawi are also in the rural areas-where the population is large. For example, the table shows that 84% of the households are based in rural areas which contribute 97.5% to the poverty headcount. The contributions are slightly higher with the poverty gap and severity indices at 97.8% and 98%, respectively. This does not only indicate that the incidence of poverty is above the national average in rural areas but also that the poorer parts of the population are more concentrated in rural areas. Amongst the three regions, much of the poverty is contributed by the Central region and followed by the Northern region. A similar observation is made within rural and urban areas, e.g. Rural north and Rural centre. Male headed households contribute more to poverty than those headed by females.

Using the nutritional measures, rural areas are also found to contribute more to poverty than urban areas but the difference between the rural population share and the contribution of rural areas to these measures of nutritional poverty is small. This is surprising since it appears as if nutritional status is not much better in urban than in rural areas, despite the fact that asset holdings in urban areas are definitely considerably greater and asset poverty less severe.

With respect to the three regions of the country, it is the Central region that contributes the highest to poverty in both absolutes and relative terms. Rural centre and urban centre also contribute more to poverty than the other population subgroups. Finally, just as is the case with the asset index, male headed households contribute more to poverty than those headed by females.

3.8 Within and between subgroup inequality decomposition

Table 9 presents generalised entropy inequality estimates decomposed to indicate within (vertical) and between (horizontal) subgroup inequalities.

Irrespective of the measures used, inequalities are largely driven by within population subgroups as opposed to between population subgroups. Between sub-group inequality is only a greater magnitude for the urban-rural areas comparison using the Theil L or Theil T measure for asset inequality, when it contributes somewhere between one-quarter and one-third to overall asset inequality. All other between group contributions to inequality are extremely small, reflecting the fact that locational differences in nutritional status appear to be non-systematic.

3.9 Poverty and inequality maps

The maps are drawn to provide a visual representation of the FGT headcount and Gini inequality estimates presented in Table 4 and Table 6. They are drawn for Malawi's three regions (Northern, Central and Southern) using StatPlanet, an interactive data visualisation and mapping software[4]. The colours on the maps vary positively with the levels of poverty and inequality. Therefore, darker and lighter colours represent areas with higher and lower levels of poverty and inequality, respectively. Figures 16 to 23 provide the mapping using our four selected indicators, namely the asset index, HAZ, WAZ and WHZ. The mapping clearly shows that, except for the asset index, both poverty and inequality estimates are do not vary much across Malawi's regions.

The maps also confirm that regardless of the indicator used, the poverty incidence is the lowest in the Northern region. The ranking between the Central and Southern regions is dependent on the indicator used. Based on the asset index, WAZ and WHZ, the Central region has the highest incidence of poverty. On the other hand, the Southern region has the highest incidence of poverty when HAZ is used as the indicator.

With respect to Gini mapping, it is also shown that inequality is lowest in the Northern region for all the measures used. The Central and Southern regions fairly rank the same for all the measures used apart from HAZ where inequality is highest in the Southern region. This ranking is similar to the one found in the poverty headcount when HAZ is used.

4. ECONOMETRIC RESULTS ON ASSET POVERTY AND CHILD NUTRITIONAL STATUS

4.1 Asset poverty

We present findings on the factors associated with asset poverty in Malawi based on the 2010 MDHS data. Our dependent variable is the asset index, reflecting long term economic status. The choice of the explanatory variables is informed by the literature.

The correlates include household size, age dependency ratio, age of the household head, sex of the household head (male=1, female=2), incidence of sickness in the household (no=0, yes=1) and the levels of education in the household. We also include dummies for area (urban=1, rural=2) and region (1=Northern, 2=Central and 3=Southern region) to control for the location in which the households reside. The educational status of household members has four categories, namely 0=no education and preschool, 1=primary education, 2=secondary education and 3=post-secondary education. Shocks to the household are represented by incidence of sickness in the household, captured as (no=0, yes=1).

Table 10 shows descriptive statistics of the variables used in our analysis of asset poverty. The proportions relate to categorical variables. The asset index has a mean value of about 0.95 and standard deviation of 0.903. On average, the household head is aged about 43 years with standard deviation of 16.368. Based on the sample, the average household size in Malawi is about 4.79 persons. Based on an alternative data set, the Malawi IHS3 data, the average household size is 4.6 members. The age dependency ratio stands at 49% and is calculated as the number of children aged 0 to 14 years and the number of persons aged 65 years divided by the household size[5].

[4] We multiply our estimates by 100 for easy customisation of the map colours in StatPlanet.

[5] Strictly speaking, age dependency ratio is given as the ratio of dependents (people younger than 15 or older than 64) to the working-age population (those aged 15-64). However, this strict definition generates missing values since some of the households do not have people in either of the three age categories.

About 28% of the households are headed by females. With respect to incidence of sickness, only about 2.5% of the households reported not to have been very sick for 3 or more months in the year prior to the survey. With regards to the levels of education, most households (about 61%) have primary education as the highest level of qualification. This is followed by no education or preschool education at 19%, secondary education at 17.3% and finally post-secondary education at 2.6%. With regard to area of residence, about 88% of the people reside in households which are rural compared to 12% which are urban. The Southern region has the highest number of households with 49%, followed by the Central region with 34% and finally the Northern region with 17%.

4.1.1 OLS regression results for asset poverty

Table 11 presents the OLS regression results of the asset index. The results show that about 55% of the variance in the asset index is explained by the explanatory variables. All the variables have the expected signs and statistically significant at conventional levels. There is also satisfactory performance for our control variables.

We checked for the robustness of the model based on an alternative definition of the age dependency ratio and use of sickness of the father and mother in place of sickness for any of the household members. Our preferred model, which is presented, was chosen because it gives the largest size of R-squared and age of the household head had the expected positive sign.

The coefficient for household size is positive and statistically significant. It indicates that a unit increase in household size is associated with an increase of 0.071 standard deviations in the asset index while holding all the other factors constant. Put differently, larger households are associated with more assets. The coefficient for age dependency ratio is also significant coefficient but negative indicating that the greater the proportion of economically inactive members in the household, the poorer is that household in terms of asset ownership. Households that are headed by older people are associated with better long-term economic status by about 0.005 standard deviations. The regression results indicate that the there is no statistically significant difference in the asset ownership between male and female headed households.

With respect to education, it is found that higher levels of education are positively associated with asset ownership in Malawi when compared to the base category (no education). It is worth noting with great interest that the size of the education coefficient increases with the level of education. Urban areas are associated with higher levels of asset ownership than rural areas by about 1.051 standard deviations. Regional dummies have mixed performance with the Central region being statistically different from the Northern region which is the base. Controlling for the 27 districts in the data does not add much to the model so we do not report in the tables[6].

4.2 Child nutritional status in Malawi

We look at factors associated with child nutritional status in Malawi using the 2010 MDHS children data set. Our dependent variables in the study are HAZ, WAZ and WHZ as indicators of stunting, underweight and body wasting, respectively.

Explanatory variables include child characteristics such as sex (male=1, female=2), age in months, age squared included to account for the possible non-linearity between age and nutritional status,

[6] A complete set of results can be requested from the author.

the weight at birth and the status of being a twin (no=0, yes=1) and absolute birth order. We control for area of residence (urban=1, rural=2), sex of the household head (male head=1, female head=2), mothers' and fathers' education (0/5). The levels of education for the father and mother are represented by dummies representing six categories, namely no education, incomplete primary, complete primary, incomplete secondary, complete secondary and higher education(post-secondary education). Father's education has five categories only. There are no fathers with complete secondary education in the data set.

The age difference between the father and mother to captures the bargaining position of the mother in the household. According to the bargaining literature on household decisions, bargaining status could influence the resources that the mother may receive for herself as well as for her child, possibly leading to adverse nutrition consequences (Smith et al., 2003; Linnemayr et al., 2008). Finally, we include the asset index to capture the economic status of the household to which the child belongs. In the literature, economic status has been found to be a strong determinant of the nutritional status of the children (e.g., Dancer et al., 2008).

Table 12 shows descriptive statistics of the variables used in our three nutrition models. The proportions relate to all categorical variables just as before. The table reveals that amongst the three measures, WHZ has the highest mean followed by WAZ. The average age of the children is about 29 months. On average, the children were born with a weight of around 5.64kg which is actually high and in line with our statistic suggesting that being underweight is the least of the malnutrition problems in Malawi. The difference in age between fathers and mothers is about 5.52 years. The average birth order of the children in our study is 3.69. Rural areas constitute a very large proportion of children- about 90% of the total. The incidence of a twin is very low at 3.2% of the total number of children. Only about 8% of the children come from households which are headed by females. The majority of the mothers have incomplete primary education (60.6%) compared to 56.3% for fathers. The Southern region is home to the majority of the children with about 46% followed by the Central region at 37%.

4.2.1 Multivariate analysis of child nutrition

Table 13 presents results from the OLS regression analysis of HAZ, WAZ and WHZ[7]. The model statistics show that the R-squared stands at 10%, 9% and 11% for HAZ, WAZ and WHZ, respectively. Though the F-statistics indicate the hypothesis that all slope coefficients are equal to zero, it is important to note that the WHZ model does not perform well. The results do not improve even if we regress by the recommended WHO age categories of <24 months and >=24 months. See Table 14. This is in line with an earlier study by Chirwa and Ngalawa (2008) and also here in Section 2.7.2 that children in Malawi seem to be 'fatter for their age'. There could be other factors such as poor feeding practices or genetic factors that affect their nutritional status or indeed a concern for consistent measurement error.

Child characteristics such as age, sex and twin status are statistically significant for HAZ and WAZ but not WHZ. Birth order is significant for the WAZ and WHZ models only. The relationship between the age of the children and nutritional status is negative and statistically significant for HAZ and WAZ

[7] Area of residence, the weight of the child at birth, parental age difference and sex of the household head are not significant and, therefore, not reported in the results.

only. The square of age is included to account for possible non linearity that exists between child nutrition and age.

The coefficient of age-squared is positive for HAZ and WAZ and statistically significant at 1%. Specifically, we find that the relationship between age and nutritional status of a child is U-shaped (convexity) for HAZ and WHZ and inverted U-shaped (concavity) for WHZ. This indicates that malnutrition in under-five children worsens or improves with age but this is only up to some critical age beyond which a child's nutrition status improves with age.

The critical ages are 37 months for HAZ, 44 months for WAZ and 54 months for WHZ. The significance and signs of coefficients for both of age and age squared is also confirmed in Chirwa and Ngalawa (2006) who find 30, 34 and 35 months as critical ages for HAZ, WAZ and WHZ. There exists literature which links recovery from stunting to cognitive outcomes. For example, a panel data study by Casale and Desmond (2015) in South Africa finds that children who were stunted at age 2 (in years) but recovered by age 5 performed better than children who remained stunted over the study period. They also find that children who recover from stunting by age 5 perform significantly worse on cognitive tests than children who do not experience early malnutrition. Moreover, they find that recovery from stunting is not uncommon among children- a similar finding in this paper. However, the most important thing is the timing of recovery as well as the need to provide the required nutritional inputs at an early stage if the goal is to help improve children's cognitive performance. Evidence in this paper suggests it took longer by between 7 and 19 months for children to 'recover' in 2010 compared to what Chirwa and Ngalawa (2006) found using the 1997/8 data[8].

The coefficient of a variable capturing the status of being one of a twin is negative in all models but only statistically significant for HAZ and WAZ. Mussa (2011) uses HAZ as a measure of long term nutritional status and finds opposite signs of coefficients for age, age-squared and twin status of a child. With respect to age and age-squared, Mussa (2011) finds concavity in which case the nutritional status of a child improves with age but begins to worsen after some time. This is the same finding in this study for the WHZ model although not statistically significant. We have found that the coefficient for birth order is also positive and statistically significant for WAZ and WHZ. Mussa (2011) finds a significant relationship for rural areas only which seems to confirm the empirical finding that the effect of child-order is cultural and must be interpreted within a given cultural context. With respect to parental age-difference, we find no significant relation for all the three models. On the other hand, Mussa (2011) finds a negative relationship implying that households with older fathers compared to mothers perform worse in terms of child nutritional outcomes.

The level of education of the mother matters more than that of the father in our models for child nutritional status. For both the fathers and mothers, no education at all is used as the base category. All levels of mothers' education except post-secondary education play a significant role in the WAZ model. In the HAZ model it is only incomplete secondary that matters while for WHZ, incomplete primary and complete secondary school levels play a role. The education level of the father is only significant for incomplete primary education and only for the WAZ model. However, this happens at

[8] Since we do not have panel data, we cannot conclude this is recovery but simply a finding that is consistent with possible patterns of recovery.

the lowest levels of education and has a negative coefficient implying that lower levels of education are associated with poor nutritional status. Mussa (2011), who also uses "no education" as the base category, finds negative coefficients for all levels of education but only statistically significant for some levels of educations. Chirwa and Ngalawa (2006) find mixed results, a case also found in this study. Lower levels of education have negative coefficients while higher levels have positive coefficients. Chirwa and Ngalawa (2006) find that both the mothers' and father's matter.

Higher asset index scores are associated with better levels of child nutrition levels for two models only, HAZ and WAZ. Mussa (2011) uses five categories of the asset index of the households, namely poorest, poor, middle, richer and richest. Using the poorest as the base category, he finds that household wealth seems to matter more in improving height-for-age z-scores in rural areas than in urban areas. For example, a child born into the wealthiest quintile in rural areas has a height-for-age z-score that is 0.31 standard deviations better than that of a child from the poorest wealth quintile. In this study, we also used asset quintiles (poorest as the base category) and found significant results (HAZ and WAZ only) for all quintiles except the middle quintile. Of great similarity is the finding that a child from the richest quintile is better by 0.33 and 0.32 standard deviations for HAZ and WAZ, respectively. The square of the asset index displays convexity for HAZ and WAZ and concavity for WHZ. The turning points are asset index scores of 5.66 (richest quintile), 7.11 (richest quintile) and -0.45(middle quintile) for HAZ, WAZ and WHZ.

5. PRO-POOR GROWTH ANALYSIS

5.1 Asset index pro-poor growth analysis

Over time, DHS surveys have been upgraded to include more information and also adjusted for technological and demographic changes that have taken place. Our comparisons are, therefore, only based on 9 asset variables which are common in all data sets.

Table 15 shows that the average MCA asset index scores have increased over time from 0.67 in 1992 to 1.04 in 2010, respectively. The spread as measured by standard deviation has declined suggesting a change in the distribution of asset index scores. Specifically, the asset score values are getting more compact over time.

Figure 24 shows the poverty incidence curves drawn using the asset index scores for 1992, 2000, 2004 and 2010. Higher curves indicate higher levels of poverty. The curves indicate that at lower levels of the MCA asset index scores, asset poverty is lowest in 2010, followed by 2004, 2000 and finally 1992. For higher levels of the poverty line, the curves cross making it difficult for us to conclude in which year poverty is higher.

We now calculate differences in the incidence of asset poverty since 1992 with the poverty line set at the 50.7th percentile which gives an asset score of 0.807 as the cut-off point below which households are considered asset poor. The null difference is that there exists no difference in household asset ownership between any two chosen periods against the alternative hypothesis that there exist differences.

Table 16 shows that there has been an improvement in living standards in Malawi as shown by the reduction in poverty incidence from 79.5% in 1992 to 50.0% in 2010. Poverty incidence increased by 1 percentage point from 79.5% in 1992 to 80.5% in 2000 but the increase was not statistically significant. During this period, Malawi generally experienced a down turn in economic activity although we do not place a causal link here. This worsening of long term economic conditions was, however, offset by the improvements made over the three survey period from 2000 and 2010. The greatest improvement was registered between 2004 and 2010 during which a 'boom' in the agricultural sector was experienced in the country[9]. Generally, this was one of the periods of economic prosperity for Malawi.

5.1.1 Absolute and relative pro-poorness in household assets

Table 17 provides the growth rate in the asset index and estimates from the five different pro-poor indices discussed in Section 2.5. The results indicate that there has been both absolute and relative pro-poor growth in asset ownership in Malawi over the entire period of study from 1992 and 2010.

Malawi experienced a negative growth rate of 0.08% between 1992 and 2000. Specifically, we find that there was anti-poor growth; poverty did not only increase but the poor households were also negatively affected in relative terms. Between 2000 and 2004, we find evidence of absolute but not relative pro-poor growth. However, for the period between 2004 and 2010, we are able to conclude absolute but not relative pro-poor growth because the PEGR index – g is negative.

5.1.2 Mean access of assets by area of residence and region, all periods and pooled

Table 18 shows the mean access of assets by area of residence and region based on the pooled data set. The table helps us to determine the driving factors behind the observed rural-urban and regional differences in the levels of asset poverty in Malawi.

With respect to private assets, large differences in ownership are noted for "Bicycle", "Electricity", "Car/truck" and "Motorcycle" between urban and rural areas. Most of the households from the Northern region own "Paraffin lamps". Ownership of toilet facilities is low in Malawi; even in urban areas, mean access is at a dismal 14%. Traditional pit latrines remain the dominant form of toilet facilities. Decent floor material (tile and cement) and excellent water sources are more accessible in urban areas.

5.1.3 Access to assets by time and survey period

Figure 25 shows access to assets by type and survey period. This explains the sources of the movements in the asset index over time. The movements themselves could be due to so many factors including technological changes and changing tastes and preferences. This exercise is important because as pointed out in Section 2.7.1, adjusting the asset index shifts the distribution to the right and this may be a limitation for poverty comparisons over time because the mean has changed. We use this as robustness checks for our pro-poor growth analysis results.

Between 1992 and 2010, ownership of radio and bicycle has expanded by 14 and 24 percentage points, respectively. On the other hand, ownership of paraffin lamp has dropped by 50 percentage points from 84% in 1992 to 34% in 2010. Access to tile/cement floor and electricity has marginally increased by around 1 percentage point over the period from 1992 and 2010. Ownership of car/truck and motorcycle/scooter has stagnated at 2% and 1%, respectively. Ownership of flush toilet and access to piped water into the dwelling has dropped by 2 percentage points.

5.2 Pro-poor growth in child nutritional status

Our analysis is based on HAZ owing to the fact that it is long term as explained in Section 2.7.2. Our HAZ scores have been calculated using the new WHO (2006) child growth standards and, therefore,

[9] The agricultural sector is one of the most important economic sectors in Malawi and it contributed about 38.49% to national GDP between 2000 and 2005 (Chirwa et al., 2008).

directly comparable over time. In Table 19, we provide statistics on HAZ based on the mean, standard deviation, minimum and maximum values. Just as with the asset index, there has been an improvement in the average HAZ scores from -2.01 in 1992 to -1.76 in 2010. The spread in the HAZ scores has slightly increased.

The poverty incidence curves given in Figure 26 indicate that incidence of poverty headcount is unambiguously highest in 1992. For the rest of the years, the curves are compact except for specific lower ranges of the z-scores.

Results for the calculated differences in the FGT headcount index over time and for successive survey periods are given in Table 20. As explained in Section 2.7.2, the poverty line is set at 2.3rd percentile which corresponds to the international cut-off of -2SD proposed in the WHO (2006) standards below which children are considered malnourished. The null hypothesis is that there exists no statistical difference in the nutritional status of under-five children between any two chosen periods against an alternative that there exist differences.

The results show that there has been an improvement in the nutritional status of children aged below 5 years in Malawi during the period between 1992 and 2010. Specifically, the incidence of stunting levels amongst under-five aged children in Malawi has decreased from about 54% in 1992 and to about 46% in 2010.We also find significant improvements in the levels of child nutritional status for the successive survey periods apart from the 1992 and 2000 pair where the reduction in the incidence of malnutrition is not statistically different from zero.

Using the asset index as a measure of welfare, results indicated that poverty increased between 1992 and 2000 but not statistically significant. Therefore, it is concluded that the results are similar and that both asset poverty and child nutritional status remained the same over the period.

5.2.1 Indices of pro-poorness for child nutritional status

Malawi experienced both absolute and relative pro-poor growth in child nutritional status for 2000-2004, 2004-2010 and 1992-2010. Not only did absolute poverty decline but the poor also benefited more. Table 21 provides the summary results. For 1992 and 2000, the Ravallion and Chen (2003) index gives a negative estimate of 0.203 thereby making us unable to conclude absolute pro-poorness despite the fact the Kakwani and Pernia (2000) index and PEGR index indicate otherwise. We are also unable to conclude relative pro-poorness using all the three relative measures, namely the Ravallion and Chen (2003) index – g, PEGR index- g and the Kakwani and Pernia (2000)'s index.

6. CONCLUSION AND POLICY DISCUSSION

6.1 Conclusions

In this study, we have measured poverty and inequality in Malawi both spatially and over time. Over the period between 1992 and 2010, we find evidence of pro-poor growth in both absolute and relative terms. We have also identified factors associated with asset poverty in Malawi. Results from the study indicate that while household size is positively correlated with asset accumulation, age dependency ratio has a negative association. There is no statistically significance difference in asset ownership between male and female headed households. Households with older household heads do better in terms of asset ownership than those headed by younger people. Shock to sickness in the household has a negative association with asset ownership. Education attainment by the members of the household has been found to have a positive association with the level of assets in the household. Rural areas have higher levels of asset poverty compared to their urban counterparts. Significant regional differences between the northern and central regions have also been found in terms of asset poverty with the latter lagging behind.

We have also identified factors that are associated with the nutritional status of under-five children in Malawi. Using three anthropometric measures of nutrition, namely HAZ for stunting, WAZ for underweight and WHZ for wasting, it is shown that the incidence of stunting is the highest of the nutritional problems amongst under 5 children in Malawi followed by underweight. On the one hand, there no large differences between regions and areas in terms of child nutritional status. On the other, when assets are used, the welfare gap between regions and areas is bigger.

6.2 Policy discussion

A number of policy conclusions can be drawn from the results. Firstly, the negative association that has been found between asset ownership and age dependency ratio suggests that increasing the income generating opportunities for the economically active population could help in reducing asset poverty in Malawi. Younger household members could, for example, be equipped with the necessary skills as they wait to enter the working age group. Secondly, the significance of education attainment and the fact that the sizes of coefficients increase with the level of education imply that post primary education should be emphasised in Malawi. Currently, the focus of education policy is to achieve basic education (completion of primary education). Thirdly, since shocks to illnesses are negatively associated with asset ownership, it may be important to consider looking into policies that improve access to health and assist households to withstand shocks thereby preventing them from being pushed into poverty traps.

The multivariate analysis of child malnutrition reveals that characteristics such as age, sex and twin status matter in the outcomes of nutritional status at the child level. Child birth order, mother education and economic status have a positive association with child nutritional status. This has a number of policy implications too. Firstly, based on the literature linking recovery from stunting to cognitive outcomes, the paper suggests that timing of nutritional inputs is critical in the cognitive development of children. Secondly, since male children tend to have weaker nutritional status compared to their female counterparts, nutritional feeding programmes might consider addressing this gender imbalance. Thirdly, the importance of female education for the nutritional status of children suggests that training women in child nutrition may require emphasis. Fourthly, related to the second implication, the significance of higher levels of education suggests that post primary education should be emphasised in general. Currently, the focus of education policy is to achieve basic or primary education. Finally, since higher levels of economic status are associated with better nutritional status, policy should continue to be geared towards improving households' living conditions.

Pro-poor growth analysis does not only allow us to identify the progress made in the fight against poverty over the years but also to analyse the redistribution effects that arise it with growth in living standards.

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LIST OF TABLES

Table 1: Summary of Malawi DHS data sets used

Year	Survey period	No. of households	No. of children (0-59 months)
1992	September-November 1992	5,323	3,353
2000	July-November 2000	14,213	9,753
2004	October 2004 -January 2005	13,664	8,707
2010	June-November 2010	24,825	4,801

Source: Own computation from MDHS 1992, 2000, 2004 and 2010

Table 2: Descriptive statistics for the poverty and asset indices

Description	Poverty index	Asset index	Adjusted asset index
Percentiles			
1%	-3.65	-0.92	0.14
5%	-1.84	-0.85	0.20
10%	-1.00	-0.80	0.26
25%	-0.08	-0.67	0.38
50%	0.43	-0.43	0.63
75%	0.67	0.08	1.13
90%	0.80	1.00	2.06
95%	0.85	1.84	2.90
99%	0.92	3.65	4.71
Statistic			
Minimum	-5.29	-1.06	0.00
Maximum	1.06	5.29	6.34
Mean	0.11	-0.11	0.94
Standard deviation	0.91	0.91	0.91
Variance	0.82	0.82	0.82
Skewness	-2.35	2.35	2.35
Kurtosis	9.36	9.36	9.36
Observations	24,825	24,825	24,825

Source: Own computation from MDHS 2010

Table 3: Child malnutrition rates by population groups

Description	HAZ		WAZ		WHZ		BMIZ	
	<-2SD	< -3SD	<-2SD	< -3SD	<-2SD	< -3SD	<-2SD	< -3SD
Age in months								
0-23	38.6%	18.2%	13.5%	3.7%	6.4%	2.6%	6.1%	2.7%
24-59	50.7%	19.8%	13.8%	3.3%	2.3%	0.7%	2.2%	0.9%
Sex								
Male	49.0%	22.2%	14.8%	3.1%	4.4%	1.8%	3.9%	1.9%
Female	42.2%	16.2%	12.6%	3.8%	3.8%	1.3%	3.8%	1.4%
Areas								
Urban	39.4%	15.3%	11.4%	3.2%	2.4%	0.6%	2.2%	0.7%
Rural	46.6%	19.8%	14.1%	3.5%	4.4%	1.7%	4.1%	1.8%
Region								
Northern	42.5%	17.9%	12.7%	2.5%	2.7%	0.5%	2.1%	0.9%
Central	45.4%	18.5%	14.1%	4.0%	4.4%	1.8%	4.3%	2.0%
Southern	46.4%	20.0%	13.4%	3.2%	4.1%	1.5%	3.7%	1.5%
Residence								
Rural North	42.5%	18.3%	13.8%	2.5%	3.0%	0.6%	2.3%	1.0%
Rural Centre	46.3%	19.2%	14.3%	4.0%	4.6%	2.0%	4.6%	2.3%
Rural South	48.1%	20.8%	13.9%	3.3%	4.5%	1.7%	4.1%	1.5%
Urban North	41.7%	14.9%	3.4%	2.5%	0.8%	0.0%	0.8%	0.0%
Urban Centre	40.5%	14.4%	13.2%	3.6%	2.8%	0.6%	2.8%	0.0%
Urban South	38.1%	16.2%	11.1%	2.8%	2.2%	0.6%	2.0%	1.4%
Total	**45.5%**	**19.1%**	**13.7%**	**3.5%**	**4.1%**	**1.5%**	**3.8%**	**1.7%**

Source: Own computation from MDHS 2010

Table 4: Estimates for the poverty headcount, average poverty gap and poverty severity indices

Description	HAZ			WAZ			WHZ			Asset index		
	α=0	α=1	α=2	α=0	α=1	α=2	α=0	α=1	α=2	α=0	α=1	α=2
Area												
Urban	40.8%	31.0%	26.4%	10.5%	6.7%	5.1%	2.5%	1.8%	1.5%	7.2%	2.4%	1.1%
Rural	48.3%	38.0%	33.2%	13.7%	8.7%	7.0%	4.6%	3.3%	2.8%	53.3%	20.3%	10.1%
Region												
Northern	44.8%	34.6%	30.0%	11.8%	6.8%	5.2%	2.9%	1.5%	1.0%	32.4%	11.0%	5.1%
Central	47.2%	37.2%	32.3%	13.5%	9.0%	7.2%	4.5%	3.4%	2.9%	51.3%	20.6%	10.6%
Southern	47.6%	37.3%	32.6%	13.2%	8.3%	6.5%	4.3%	3.0%	2.6%	44.5%	16.2%	7.7%
Residence												
Rural north	44.9%	35.0%	30.5%	12.9%	7.3%	5.6%	3.1%	1.6%	1.1%	34.5%	11.8%	5.5%
Rural centre	48.1%	38.0%	33.1%	13.8%	9.1%	7.3%	4.8%	3.6%	3.2%	59.4%	24.0%	12.3%
Rural south	49.3%	38.9%	34.1%	13.8%	8.7%	6.9%	4.7%	3.3%	2.8%	52.9%	19.3%	9.2%
Urban north	43.8%	32.0%	26.0%	2.9%	2.3%	2.0%	0.9%	0.6%	0.5%	8.6%	2.0%	0.7%
Urban centre	42.1%	32.4%	27.7%	12.3%	8.4%	6.6%	2.9%	2.1%	1.6%	9.2%	3.1%	1.5%
Urban south	39.2%	29.5%	25.3%	10.0%	5.9%	4.2%	2.3%	1.8%	1.6%	5.3%	1.8%	0.8%
Sex												
Male head	47.1%	36.8%	32.1%	12.9%	8.4%	6.7%	4.3%	3.0%	2.6%	41.7%	14.8%	6.9%
Female head	47.6%	38.5%	34.0%	17.0%	9.3%	6.8%	4.1%	3.2%	2.7%	59.1%	25.8%	13.9%
Malawi	**47.1%**	**37.0%**	**32.2%**	**13.2%**	**8.4%**	**6.7%**	**4.2%**	**3.0%**	**2.6%**	**46.0%**	**17.5%**	**8.6%**

Source: Own computation from MDHS 2010

Table 5: Poverty stochastic dominance test results for population subgroups

Population group pair	HAZ	WAZ	WHZ	Asset
Area				
Urban v. Rural	U>R: order 2	ND	U>R: order 2	U>R: order 1
Region				
Northern v. Central	ND	ND	N>C: order 2	ND
Northern v. Southern	ND	ND	N>S: order 1	N>S: order 3
Central v. Southern	ND	ND	ND	ND
Residence				
Rural north v. Rural centre	ND	ND	RN>RC: order 3	ND
Rural north v. Rural south	ND	ND	RN>RS: order 1	RN>RS: order 2
Rural centre v. Rural south	ND	ND	ND	ND
Urban north v. Urban centre	UN>UC: order 2	ND	UN>UC: order 2	ND
Urban north v. Urban south	ND	ND	UN>US: order 1	ND
Urban centre v. Urban south	ND	ND	ND	UC>US: order 2
Sex				
Male head v. female head	ND	ND	ND	MH>FH

Source: Own computation from MDHS 2010

Notes: *U=Urban areas, R=Rural areas, ND= no dominance up to third order, UN=Urban north, UC=Urban centre, US=Urban south, N=Northern region, C=Central region, S=Southern region, RN=Rural north, RC=Rural centre, RS=Rural south, MH=male-headed household, FH=female-headed household*

Table 6: Inequality estimates across population subgroups

Description	Gini				Theil L (theta=0)				Theil T (theta=1)			
	HAZ	WAZ	WHZ	Asset	HAZ	WAZ	WHZ	Asset	HAZ	WAZ	WHZ	Asset
Area												
Urban	0.683	0.461	0.281	0.326	2.165	0.756	0.279	0.205	0.852	0.364	0.149	0.170
Rural	0.744	0.521	0.313	0.397	2.563	0.889	0.429	0.261	1.058	0.459	0.186	0.267
Region												
Northern region	0.733	0.502	0.290	0.376	2.416	0.787	0.292	0.244	1.018	0.424	0.159	0.230
Central region	0.734	0.513	0.306	0.457	2.547	0.918	0.430	0.353	1.021	0.447	0.181	0.356
Southern region	0.736	0.513	0.314	0.462	2.481	0.840	0.408	0.362	1.029	0.445	0.186	0.361
Residence												
Rural north	0.739	0.512	0.300	0.361	2.487	0.794	0.310	0.225	1.040	0.441	0.168	0.210
Rural centre	0.742	0.519	0.309	0.394	2.608	0.943	0.450	0.257	1.051	0.457	0.183	0.265
Rural south	0.747	0.523	0.321	0.397	2.532	0.851	0.437	0.259	1.070	0.462	0.194	0.272
Urban north	0.680	0.413	0.197	0.337	1.811	0.691	0.116	*0.200*	0.845	0.282	0.075	0.180
Urban centre	0.681	0.475	0.292	0.338	2.189	0.768	0.316	0.220	0.850	0.390	0.166	0.182
Urban south	0.678	0.454	0.281	0.308	2.182	0.752	0.268	0.184	0.842	0.353	0.145	0.152
Sex												
Male head	0.734	0.512	0.308	0.441	2.502	0.872	0.402	0.327	1.022	0.443	0.180	0.325
Female head	0.741	0.519	0.313	0.478	2.528	0.856	0.453	0.385	1.048	0.459	0.186	0.400
Malawi	**0.735**	**0.513**	**0.308**	**0.453**	**2.505**	**0.871**	**0.406**	**0.348**	**1.024**	**0.444**	**0.181**	**0.346**

Source: Own computation from MDHS 2010

Table 7: Generalised Lorenz dominance test results across population subgroups

Population group pair	HAZ	WAZ	WHZ	Asset
Area				
Urban v. Rural	U>R:order 2	ND	U>R: order 2	U>R: order 2
Region				
Northern v. Central	ND	ND	N<C	ND
Northern v. Southern	ND	ND	N<S	ND
Central v. Southern	ND	ND	ND	ND
Residence				
Rural north v. Rural centre	ND	ND	ND	ND
Rural north v. Rural south	ND	ND	RN<RS: order 2	RN<RS: order 2
Rural centre v. Rural south	ND	ND	ND	ND
Urban north v. Urban centre	ND	ND	UN<UC: order 2	ND
Urban north v. Urban south	ND	ND	UN<US: order 2	ND
Urban centre v. Urban south	ND	ND	ND	UC<US: order 2
Sex				
Male head v. female head	ND	ND	ND	MH<FH: order 2

Source: Own computation from MDHS 2010

Notes: *U=Urban areas, R=Rural areas, ND= no dominance, UN=Urban north, UC=Urban centre, US=Urban south, N=Northern region, C=Central region, S=Southern region, RN=Rural north, RC=Rural centre, RS=Rural south, MH=male-headed household, FH=female-headed household*

Table 8: FGT poverty sub-group decomposition

Description	Population share	HAZ			WAZ			WHZ			Asset index		
		α=0	α=1	α=2	α=0	α=1	α=2	α=0	α=1	α=2	α=0	α=1	α=2
Area													
Urban	15.0%	13.0%	12.6%	12.4%	12.6%	12.9%	12.6%	8.6%	8.8%	8.4%	2.5%	2.2%	2.0%
Rural	85.0%	87.0%	87.4%	87.6%	87.4%	87.1%	87.4%	91.4%	91.2%	91.6%	97.5%	97.8%	98.0%
Region													
Northern	10.7%	10.0%	9.8%	9.8%	10.0%	9.4%	9.4%	7.1%	5.1%	4.3%	8.4%	7.5%	7.0%
Central	46.4%	46.3%	46.5%	46.4%	47.8%	48.9%	49.1%	49.6%	52.3%	53.0%	48.4%	51.1%	53.0%
Southern	42.9%	43.7%	43.7%	43.8%	42.3%	41.7%	41.5%	43.3%	42.7%	42.7%	43.3%	41.4%	40.0%
Residence													
Rural north	9.6%	9.0%	8.9%	8.9%	9.7%	9.1%	9.0%	6.9%	4.8%	4.1%	8.2%	7.4%	6.9%
Rural centre	39.6%	40.2%	40.5%	40.5%	41.3%	42.2%	42.7%	45.1%	47.8%	49.1%	47.0%	49.9%	51.8%
Rural south	35.8%	37.7%	38.0%	38.2%	36.4%	35.8%	35.8%	39.4%	38.5%	38.4%	42.3%	40.6%	39.2%
Urban north	1.1%	1.0%	1.0%	0.9%	0.3%	0.4%	0.4%	0.2%	0.2%	0.2%	0.2%	0.1%	0.1%
Urban centre	6.7%	6.0%	5.9%	5.8%	6.4%	6.6%	6.4%	4.5%	4.5%	3.9%	1.4%	1.3%	1.2%
Urban south	7.2%	6.0%	5.7%	5.6%	5.9%	5.9%	5.7%	3.9%	4.1%	4.3%	0.9%	0.8%	0.7%
Sex													
Male head	91.9%	91.9%	91.6%	91.5%	90.0%	91.4%	91.9%	91.6%	90.6%	90.4%	68.5%	63.9%	60.6%
Female head	8.1%	8.1%	8.4%	8.5%	10.0%	8.6%	8.1%	8.4%	9.4%	9.6%	31.5%	36.1%	39.4%
Malawi	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Source: Own computation from MDHS 2010

Table 9: GE inequality decomposition for asset index and child nutrition

Description	Sub-group	Areas		Regions		Within areas/regions		Household head	
GE index	Type	Absolute	Relative	Absolute	Relative	Absolute	Relative	Absolute	Relative
	Within	0.254	72.2%	0.349	99.0%	0.248	70.3%	0.344	97.5%
Asset Theil L	Between	0.098	27.8%	0.004	1.0%	0.105	29.7%	0.009	2.5%
	Total	**0.353**	**100.0%**	**0.353**	**100.0%**	**0.353**	**100.0%**	**0.353**	**100.0%**
	Within	0.236	66.9%	0.348	99.0%	0.230	65.3%	0.344	97.6%
Asset Theil T	Between	0.116	33.1%	0.004	1.0%	0.122	34.7%	0.008	2.4%
	Total	**0.352**	**100.0%**	**0.352**	**100.0%**	**0.352**	**100.0%**	**0.352**	**100.0%**
	Within	2.503	99.9%	2.505	100.0%	2.501	99.9%	2.505	100.0%
HAZ Theil L	Between	0.002	0.1%	0.000	0.0%	0.003	0.1%	0.000	0.0%
	Total	**2.505**	**100.0%**	**2.505**	**100.0%**	**2.505**	**100.0%**	**2.505**	**100.0%**
	Within	1.022	99.8%	1.024	100.0%	1.020	99.7%	1.024	100.0%
HAZ Theil T	Between	0.002	0.2%	0.000	0.0%	0.003	0.3%	0.000	0.0%
	Total	**1.024**	**100.0%**	**1.024**	**100.0%**	**1.024**	**100.0%**	**1.024**	**100.0%**
	Within	0.869	99.7%	0.871	99.9%	0.868	99.6%	0.871	100.0%
WAZ Theil L	Between	0.002	0.3%	0.001	0.1%	0.004	0.4%	0.000	0.0%
	Total	**0.871**	**100.0%**	**0.871**	**100.0%**	**0.871**	**100.0%**	**0.871**	**100.0%**
	Within	0.442	99.5%	0.444	99.9%	0.441	99.2%	0.444	100.0%
WAZ Theil T	Between	0.002	0.5%	0.001	0.1%	0.004	0.8%	0.000	0.0%
	Total	**0.444**	**100.0%**	**0.444**	**100.0%**	**0.444**	**100.0%**	**0.444**	**100.0%**
	Within	0.406	100.0%	0.406	100.0%	0.406	99.9%	0.406	100.0%
WHZ Theil L	Between	0.000	0.1%	0.000	0.0%	0.000	0.1%	0.000	0.0%
	Total	**0.406**	**100.0%**	**0.406**	**100.0%**	**0.406**	**100.0%**	**0.406**	**100.0%**
	Within	0.180	99.9%	0.180	99.9%	0.180	99.7%	0.180	100.0%
WHZ Theil T	Between	0.000	0.2%	0.000	0.0%	0.000	0.2%	0.000	0.0%
	Total	**0.181**	**100.0%**	**0.180**	**100.0%**	**0.180**	**100.0%**	**0.180**	**100.0%**

Source: Own computation from MDHS 2010

Table 10: Summary descriptive statistics for the asset model

Variables	Obs	Mean/Prop.	Std. Dev.
Asset index	24,825	0.95	0.903
Age of head	24,798	43.34	16.368
Household size	24,825	4.79	2.295
Dependency ratio	24,825	49.2%	0.245
Female head	24,825	28.4%	0.451
Sickness in the household	19,947	2.5%	0.157
Household's education			
Primary	24,724	61.0%	0.488
Secondary	24,724	17.3%	0.378
Higher	24,724	2.6%	0.160
Rural area	24,825	88.3%	0.322
Region			
Central	24,825	33.7%	0.473
Southern	24,825	48.8%	0.500

Source: Own computation from MDHS 2010

Table 11: OLS regression results for asset poverty

Description	Asset index	SE
Household size	0.071***	(0.005)
Age dependency ratio	-0.505***	(0.047)
Age of household head	0.005***	(0.001)
Sex of household head	0.038**	(0.015)
Household member is sick	-0.053	(0.034)
Household education		
Primary	0.236***	(0.015)
Secondary	0.864***	(0.037)
Higher	2.390***	(0.093)
Rural area	-1.051***	(0.067)
Region		
Central	-0.141***	(0.040)
Southern	0.003	(0.039)
Constant	2.283***	(0.130)
R-squared	0.5522	
N	19,900	
Prob >F	0.0000	
F statistic	190.35	

Notes: * p<0.05, ** p<0.01,***p<0.001
Source: Own computation from MDHS 2010

Table 12: Descriptive statistics for the nutritional models

Variable	Obs	Mean	Std. Dev.
HAZ	4,653	-1.76	1.662
WAZ	4,783	-0.79	1.215
WHZ	4,609	0.31	1.350
Age in months	4,801	28.91	16.903
Square of age in moths	4,801	11.22	10.334
Weight at birth	4,801	5.64	3.271
Parental age difference	4,411	5.52	4.692
Birth order number	4,801	3.69	2.321
Female child	4,801	50.6%	0.500
Rural area	4,801	90.0%	0.299
Child is twin	4,801	3.2%	0.176
Female household head	4,801	7.9%	0.269
Asset index	4,801	-0.097	0.899
Square of asset index	4,801	0.817	3.235
Mother's education			
Incomplete primary	4,801	60.6%	0.489
Complete primary	4,801	9.4%	0.292
Incomplete secondary	4,801	9.3%	0.291
Complete secondary	4,801	3.4%	0.182
Higher	4,801	0.5%	0.068

Father's education			
Incomplete primary	4,717	56.3%	0.496
Complete primary	4,717	8.3%	0.275
Incomplete secondary	4,717	23.9%	0.426
Higher	4,717	1.6%	0.127
Region			
Central	4,801	37.1%	0.483
Southern	4,801	45.5%	0.498

Source: Own computation from MDHS 2010

Table 13: OLS regression results for child nutritional status

	HAZ		WAZ		WHZ	
Variables	**Coeff**	**SE**	**Coeff**	**SE**	**Coeff**	**SE**
Age in months	-0.094***	(0.008)	-0.045***	(0.007)	0.002	(0.007)
Square of age	0.128***	(0.012)	0.052***	(0.010)	-0.001	(0.010)
Female child	0.280***	(0.057)	0.102*	(0.048)	-0.072	(0.049)
Child is twin	-0.930***	(0.169)	-0.901***	(0.160)	-0.286*	(0.145)
Birth order number	0.025	(0.016)	0.029*	(0.014)	0.038**	(0.015)
Mother's education						
Incomplete primary	0.082	(0.099)	0.154*	(0.076)	0.124	(0.083)
Complete primary	0.11	(0.138)	0.057	(0.10)	0.112	(0.118)
Incomplete secondary	0.186	(0.143)	0.302**	(0.114)	0.165	(0.116)
Complete secondary	0.06	(0.192)	0.243	(0.172)	0.369*	(0.166)
Post-secondary	0.439	(0.473)	0.236	(0.384)	-0.049	(0.428)
Father's education						
Incomplete primary	-0.095	(0.124)	-0.191*	(0.082)	-0.048	(0.094)
Complete primary	-0.178	(0.168)	-0.208	(0.111)	0.083	(0.130)
Incomplete secondary	-0.006	(0.139)	-0.202*	(0.101)	-0.092	(0.108)
Post-secondary	-0.055	(0.235)	-0.169	(0.159)	-0.007	(0.211)
Asset index	0.183**	(0.063)	0.195***	(0.052)	-0.002	(0.055)
Square of asset index	-0.011	(0.016)	-0.017	(0.011)	0.008	(0.014)
Rural area	0.127	(0.108)	0.052	(0.094)	-0.105	(0.095)
Region						
Central	-0.031	(0.111)	0.009	(0.075)	-0.102	(0.075)
Southern	-0.006	(0.110)	-0.081	(0.072)	-0.174*	(0.072)
Constant	-1.031***	(0.261)	-0.259	(0.197)	0.368	(0.213)
R-squared	0.1011		0.0876		0.0112	
Prob > F	0.000		0.000		0.010	
N	4,574		4,700		4,531	

Notes: * p<0.05, ** p<0.01,***p<0.001

Source: Own computation from MDHS 2010

Table 14: WHZ regression results by age category

	Age<24 months		Age>=24 months	
Variables	**Coeff**	**SE**	**Coeff**	**SE**
Age in months	-0.080**	(0.029)	0.038	(0.025)
Square of age	0.286*	(0.114)	-0.05	(0.029)
Female child	0.036	(0.087)	-0.162**	(0.054)
Child is twin	-0.417	(0.250)	-0.101	(0.163)
Birth order number	0.045	(0.027)	0.032*	(0.013)
Mother's education				
Incomplete primary	0.200	(0.146)	0.059	(0.093)
Complete primary	-0.009	(0.209)	0.186	(0.126)
Incomplete secondary	0.173	(0.201)	0.144	(0.131)
Complete secondary	0.480	(0.252)	0.257	(0.201)
Post-secondary	-0.089	(0.763)	0.012	(0.370)
Father's education				
Incomplete primary	-0.052	(0.164)	-0.028	(0.099)
Complete primary	0.084	(0.218)	0.096	(0.135)
Incomplete secondary	-0.141	(0.190)	-0.028	(0.113)
Post-secondary	0.476	(0.317)	-0.331	(0.288)
Asset index	-0.002	(0.086)	0.000	(0.060)
Square of asset index	0.007	(0.023)	0.009	(0.016)
Rural area	-0.163	(0.142)	-0.042	(0.109)
Region				
Central	-0.162	(0.131)	-0.044	(0.094)
Southern	-0.215	(0.124)	-0.142	(0.094)
Constant	0.652	(0.358)	-0.127	(0.517)
R-squared	0.026		0.017	
Prob > F	0.004		0.097	
N	1,863		2,668	

Notes: * p<0.05, ** p<0.01, ***p<0.001

Source: Own computation from MDHS 2010

Table 15: Descriptive statistics for asset index scores

Survey year	Observations	Average	Standard deviation
1992	5,323	0.67	1.14
2000	14,213	0.62	0.99
2004	13,664	0.76	0.86
2010	24,825	1.04	0.92
Total	**58,025**	**0.84**	**0.97**

Source: Own computation from MDHS 1992, 2000, 2004 and 2010

Table 16: Differences in poverty headcount indices for household asset ownership

Description	Estimate	Std. Err.	t	P>|t|	[95% Conf. interval]		Pov. line
1992	0.795	0.006	143.76	0.000	0.784	0.806	0.807
2000	0.805	0.003	242.46	0.000	0.799	0.812	0.807
Difference	**0.010**	**0.006**	**1.56**	**0.118**	**-0.003**	**0.023**	**---**
2000	0.805	0.003	242.46	0.000	0.799	0.812	0.807
2004	0.785	0.004	223.15	0.000	0.778	0.792	0.807
Difference	**-0.021**	**0.005**	**-4.26**	**0.000**	**-0.030**	**-0.011**	**---**
2004	0.785	0.004	223.15	0.000	0.778	0.792	0.807
2010	0.500	0.007	70.05	0.000	0.486	0.514	0.807
Difference	**-0.284**	**0.008**	**-35.73**	**0.000**	**-0.300**	**-0.269**	**---**
1992	0.795	0.006	143.76	0.000	0.784	0.806	0.807
2010	0.500	0.007	70.05	0.000	0.486	0.514	0.807
Difference	**-0.295**	**0.009**	**-32.65**	**0.000**	**-0.313**	**-0.277**	**---**

Source: Own computation from MDHS 1992, 2000, 2004 and 2010

Table 17: Indices of pro-poorness in child nutritional status between 1992 and 2010

Pro-poor indices	1992-2000	2000-2004	2004-2010	1992-2010
Growth rate(g)	-0.076	0.217	0.445	0.626
Ravallion & Chen (2003) index	0.017	0.654	0.545	1.217
Kakwani & Pernia (2000) index	0.565	0.788	1.098	2.240
PEGR index	-0.043	0.171	0.489	1.402
Ravallion & Chen (2003) index - g	0.093	0.437	0.100	0.591
PEGR index - g	0.033	-0.046	0.044	0.776

Source: Own computation from MDHS 1992, 2000, 2004 and 2010

Table 18: Pooled mean access of assets by area and region, all periods

Description	Urban	Rural	Northern	Central	Southern	Total
Average household size	4.64	4.63	5.01	4.75	4.41	4.63
Private assets						
Radio	73.4%	51.0%	55.2%	52.5%	55.3%	54.3%
Bicycle	32.5%	42.9%	34.9%	42.0%	43.2%	41.4%
Paraffin lamp	61.7%	52.1%	65.6%	52.4%	50.2%	53.6%
Electricity	29.5%	2.3%	6.7%	5.0%	7.3%	6.4%
Car/truck	6.6%	0.7%	1.5%	1.6%	1.6%	1.6%
Motorcycle/scooter	2.1%	0.9%	0.9%	1.0%	1.1%	1.1%
Toilet facility						
Own flush toilet	14.0%	0.7%	2.4%	2.5%	2.9%	2.7%
Shared flush toilet	0.3%	0.1%	0.3%	0.0%	0.1%	0.1%
Traditional pit toilet	54.2%	44.3%	44.7%	45.2%	46.5%	45.7%
Ventilated improved pit latrine	7.0%	2.8%	2.6%	3.6%	3.6%	3.4%
No facility/bush	3.4%	17.4%	14.9%	17.2%	14.1%	15.3%
Other	21.2%	34.8%	35.2%	31.5%	32.9%	32.8%
Floor material						
Mud/earth	37.5%	85.4%	77.1%	79.8%	77.5%	78.2%
Cement	8.1%	0.7%	3.1%	1.5%	1.5%	1.8%
Bricks	0.1%	0.0%	0.2%	0.0%	0.0%	0.1%
Wood	0.3%	0.0%	0.0%	0.0%	0.1%	0.1%
Tiles	52.7%	11.6%	17.7%	14.8%	19.7%	17.7%
Other	1.2%	2.4%	1.9%	3.8%	1.1%	2.2%
Water source						
Piped into residence	13.4%	0.6%	2.7%	1.9%	2.9%	2.5%
Public tap	26.3%	2.5%	10.1%	4.5%	5.7%	6.0%
Piped into yard/plot	37.4%	9.9%	15.7%	8.7%	17.1%	14.0%
Well in residence	7.5%	32.6%	25.2%	29.8%	29.5%	28.9%
Public well	1.6%	3.8%	5.0%	4.0%	2.5%	3.4%
Protected well/borehole	2.6%	7.9%	4.5%	9.9%	6.1%	7.1%
Spring	1.9%	3.7%	2.7%	5.0%	2.6%	3.4%
River/stream	4.9%	18.6%	15.0%	19.7%	14.8%	16.5%
Pond/lake	3.0%	10.9%	7.0%	9.3%	10.9%	9.7%
Dam	0.2%	0.1%	0.3%	0.1%	0.1%	0.1%
Rainwater	0.1%	1.2%	1.1%	1.0%	1.1%	1.1%
Other	1.2%	8.2%	10.7%	6.2%	6.7%	7.2%

Source: Own computation from MDHS 1992, 2000, 2004 and 2010

Table 19: Descriptive statistics for HAZ

Survey year	Observations	Average	Standard deviation
1992	3,288	-2.01	1.57
2000	9,396	-1.93	1.79
2004	8,309	-1.94	1.80
2010	4,653	-1.76	1.66
Total	**25,646**	**-1.91**	**1.75**

Source: Own computation from MDHS 1992, 2000, 2004 and 2010

Table 20: Differences in the FGT poverty headcount index for HAZ

Description	Estimate	Std. Err.	t	P>|t|	[95% Conf. interval]		Pov. line
1992	0.539	0.011	49.174	0.000	0.517	0.561	2.300
2000	0.519	0.006	82.173	0.000	0.506	0.531	2.300
Difference	**-0.020**	**0.013**	**-1.601**	**0.111**	**-0.045**	**0.005**	**---**
2000	0.519	0.006	82.173	0.000	0.506	0.531	2.300
2004	0.496	0.007	70.046	0.000	0.482	0.510	2.300
Difference	**-0.023**	**0.009**	**-2.430**	**0.016**	**-0.042**	**-0.004**	**---**
2004	0.496	0.007	70.046	0.000	0.482	0.510	2.300
2010	0.457	0.000	.	.	0.457	0.457	2.300
Difference	**-0.039**	**0.007**	**-5.484**	**0.000**	**-0.053**	**-0.025**	**---**
1992	0.539	0.011	49.174	0.000	0.517	0.561	2.300
2010	0.457	0.000	.	.	0.457	0.457	2.300
Difference	**-0.082**	**0.011**	**-7.491**	**0.000**	**-0.104**	**-0.061**	**---**

Source: Own computation from MDHS 1992, 2000, 2004 and 2010

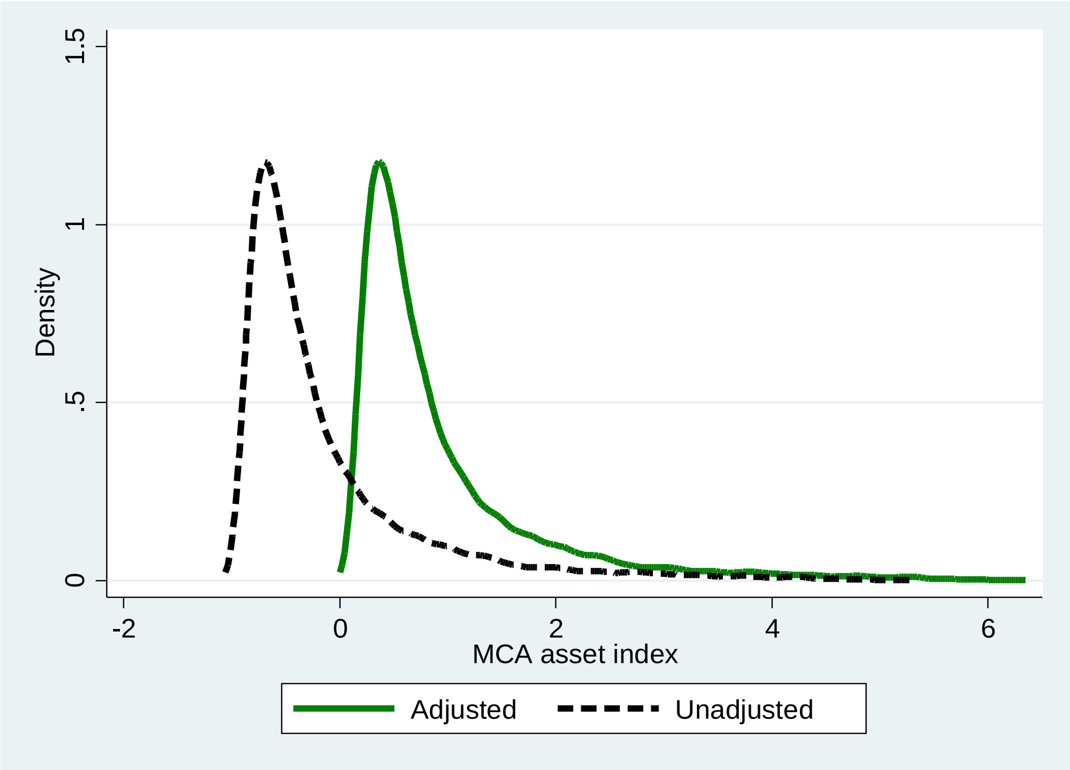
Table 21: Indices of pro-poorness for HAZ

Pro-poor indices	1992-2000	2000-2004	2004-2010	1992-2010
Growth rate(g)	0.223	0.028	0.044	0.313
Ravallion & Chen (2003)	-0.203	0.360	0.946	1.042
Kakwani & Pernia (2000)	0.624	8.547	7.702	2.965
PEGR index	0.139	0.241	7.702	0.928
Ravallion & Chen (2003) - g	-0.426	0.332	0.902	0.729
PEGR - g	-0.084	0.213	0.295	0.615

Source: Own computation from MDHS 1992, 2000, 2004 and 2010

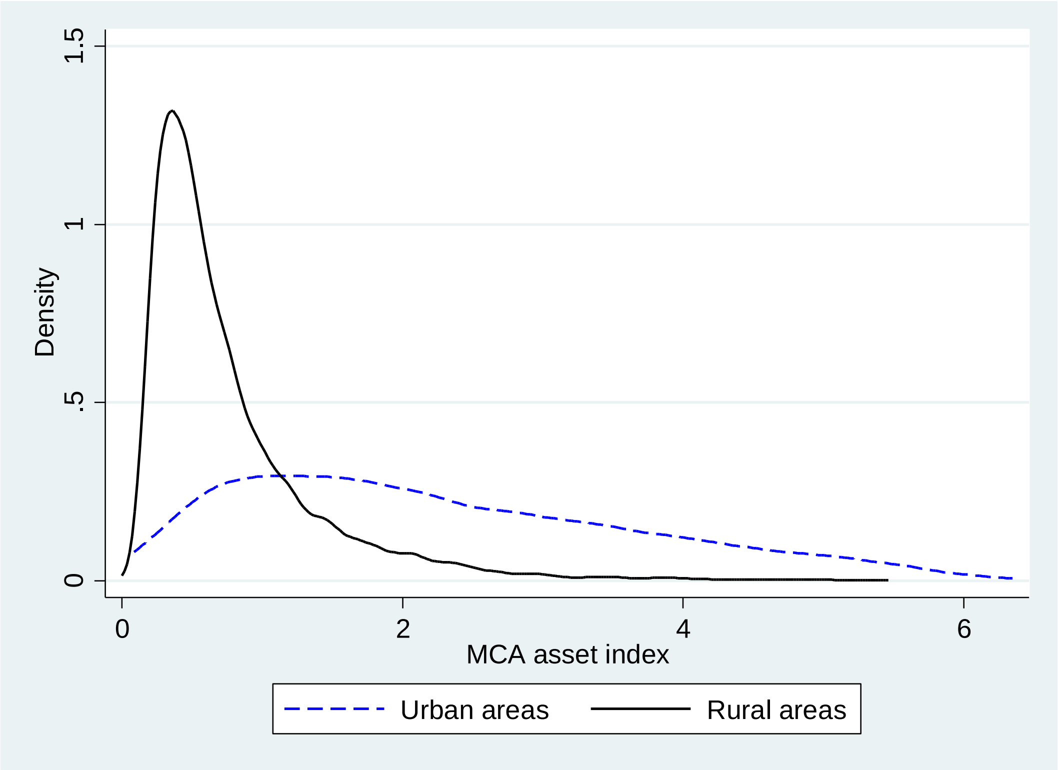
LIST OF FIGURES

Figure 1: Kernel density plots for the adjusted and unadjusted MCA asset indices



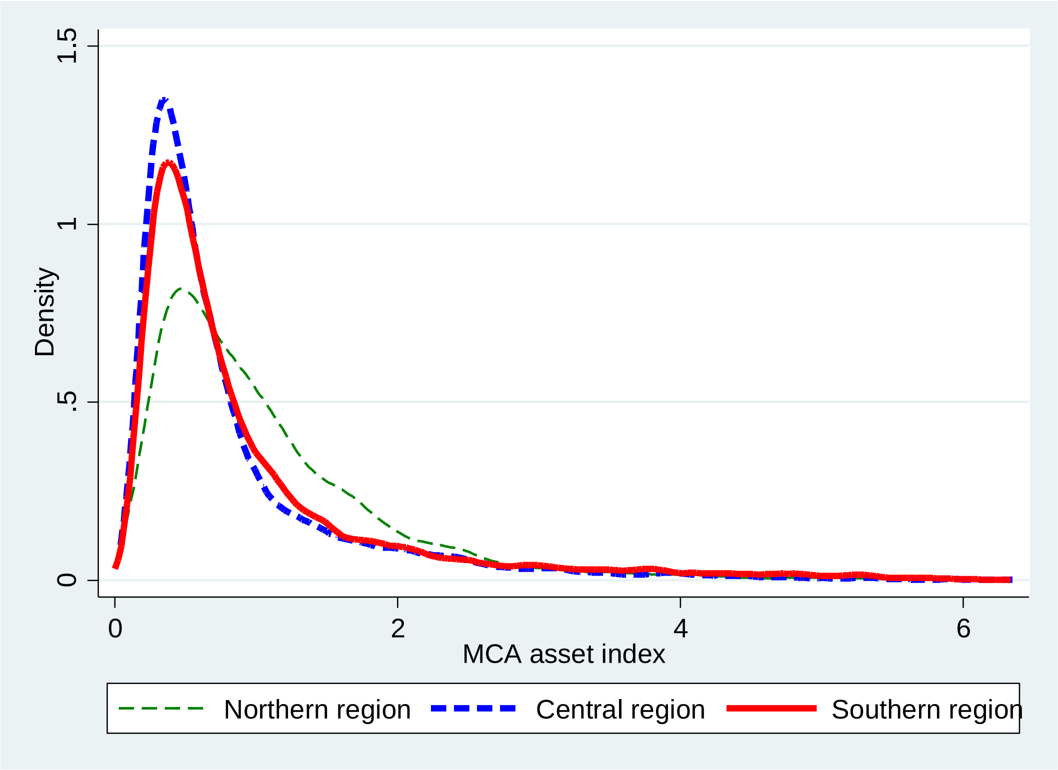
Source: Own computation from MDHS 2010

Figure 2: Asset index kernel density plots by area of residence



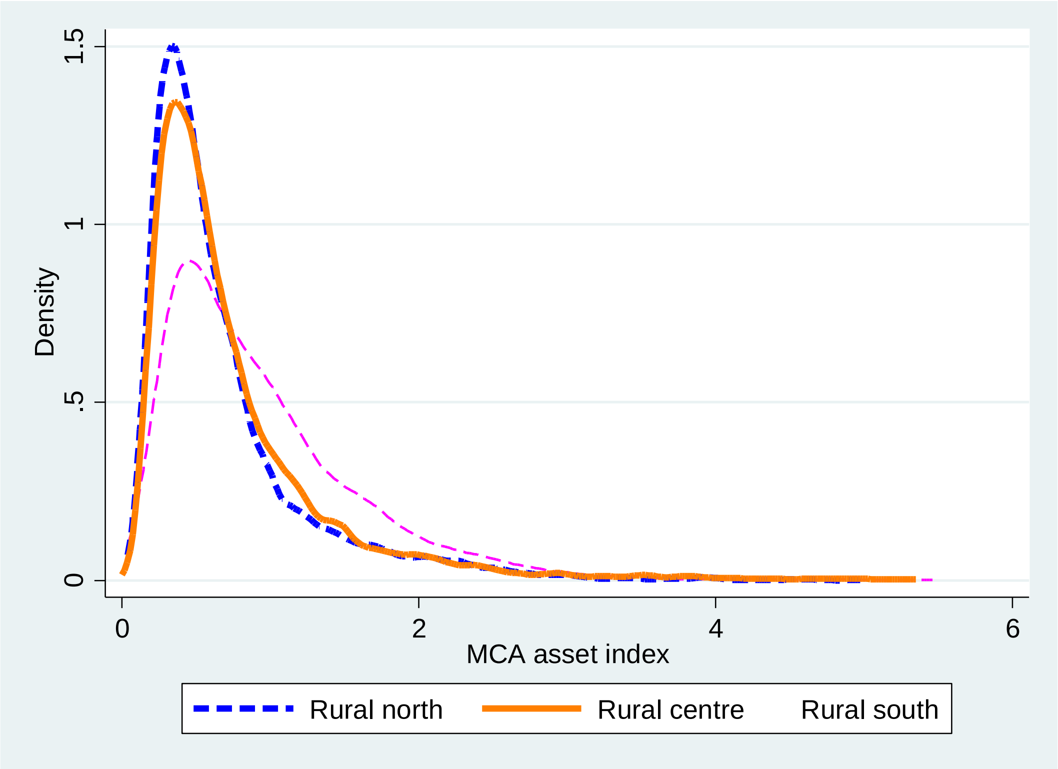
Source: Own computation from MDHS 2010

Figure 3: Asset index kernel density plots by region



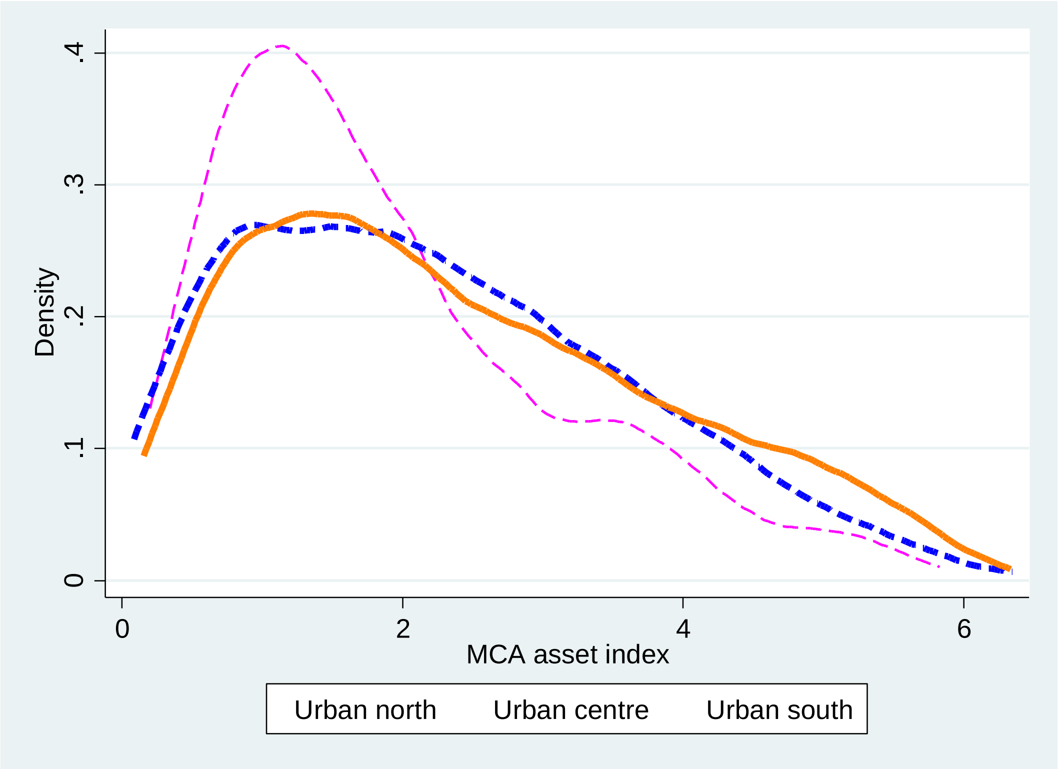
Source: Own computation from MDHS 2010

Figure 4: Asset index kernel density plots for rural areas



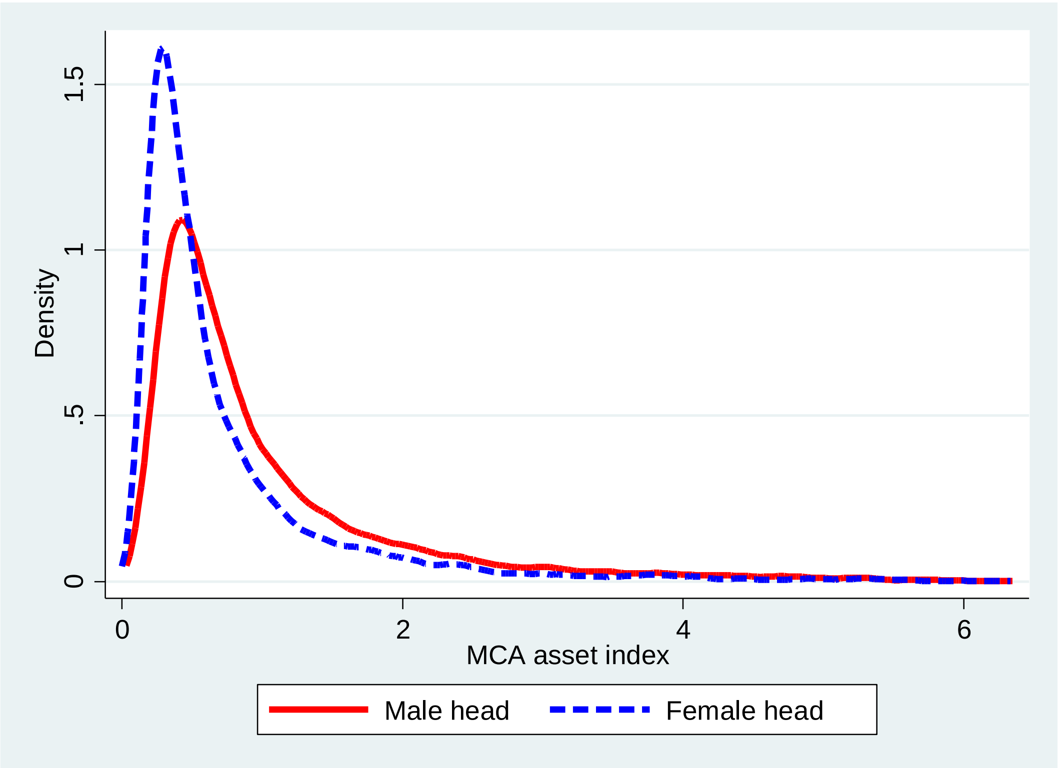
Source: Own computation from MDHS 2010

Figure 5: Asset index kernel density plots for urban areas



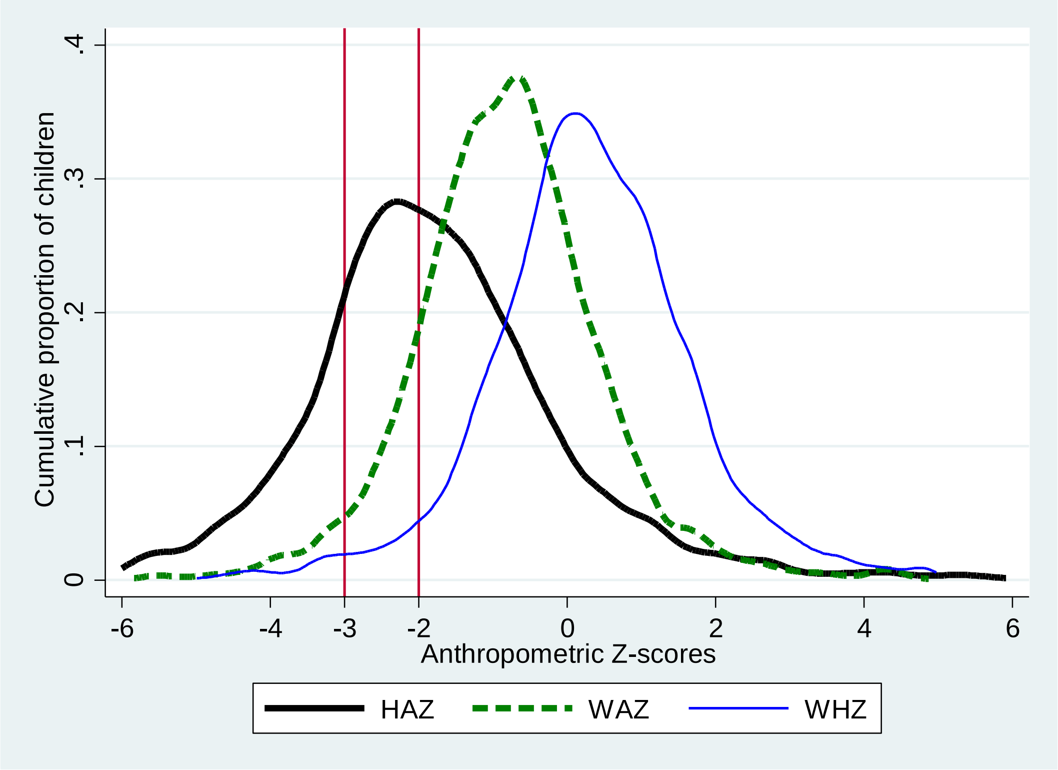
Source: Own computation from MDHS 2010

Figure 6: Asset index kernel density plots by sex of household head



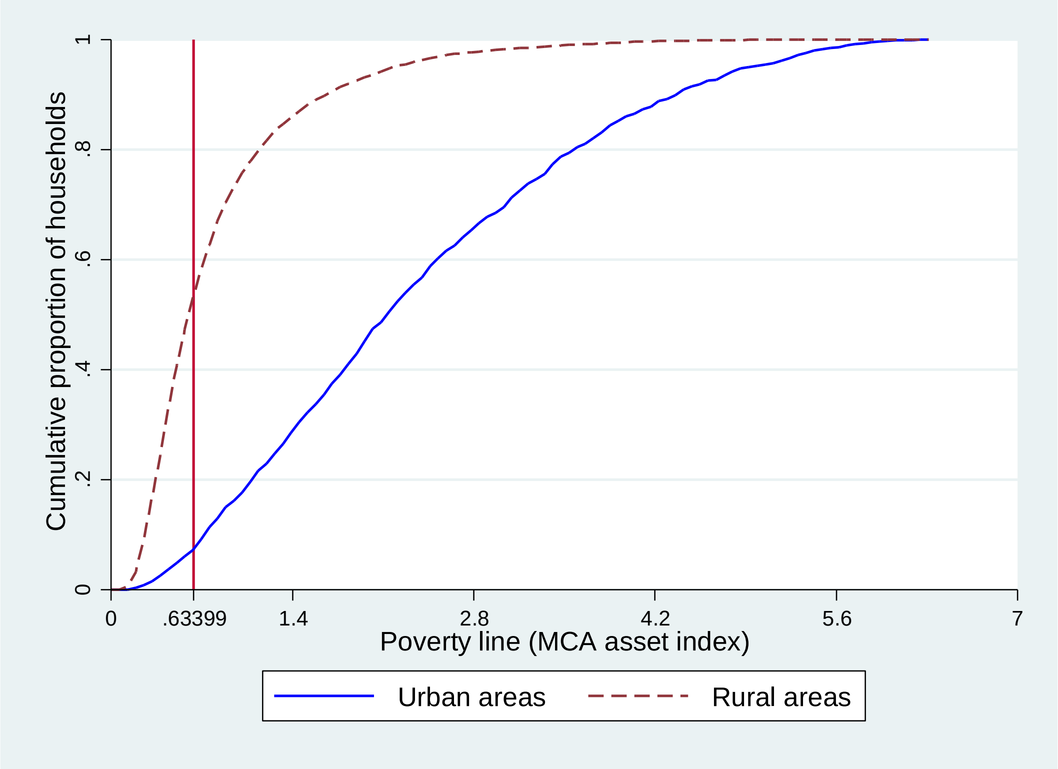
Source: Own computation from MDHS 2010

Figure 7: Distribution of anthropometric Z-scores for HAZ, WAZ and WHZ



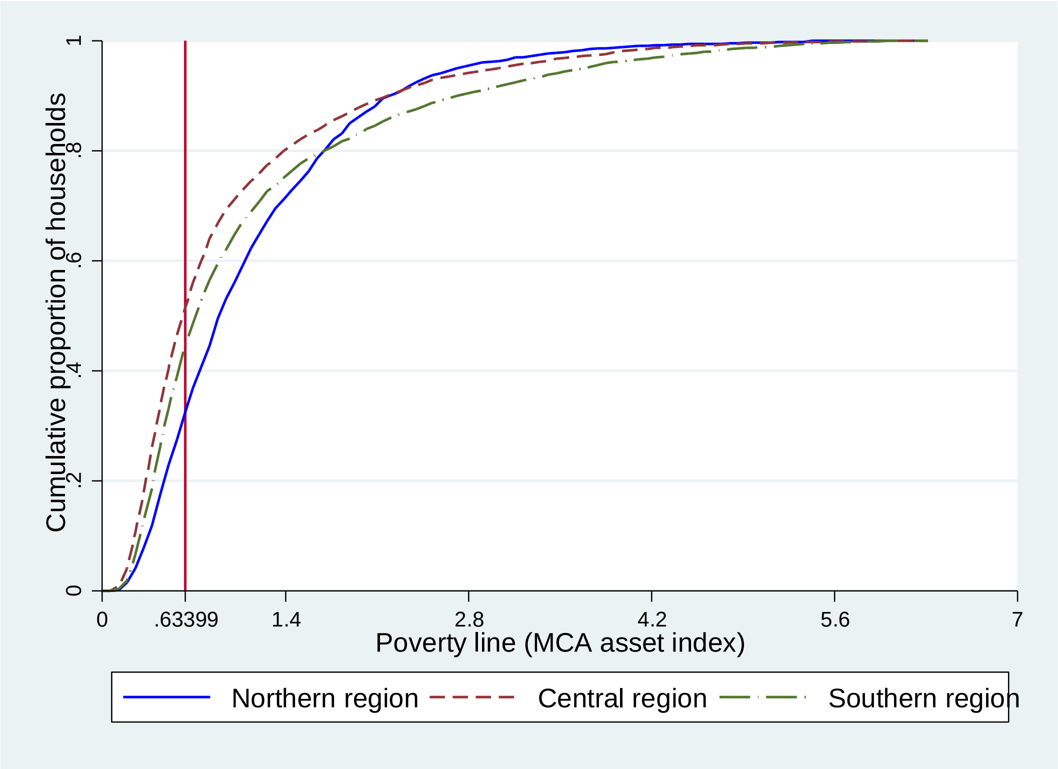
Source: Own computation from MDHS 2010

Figure 8: MCA asset index cumulative density curves by area of residence



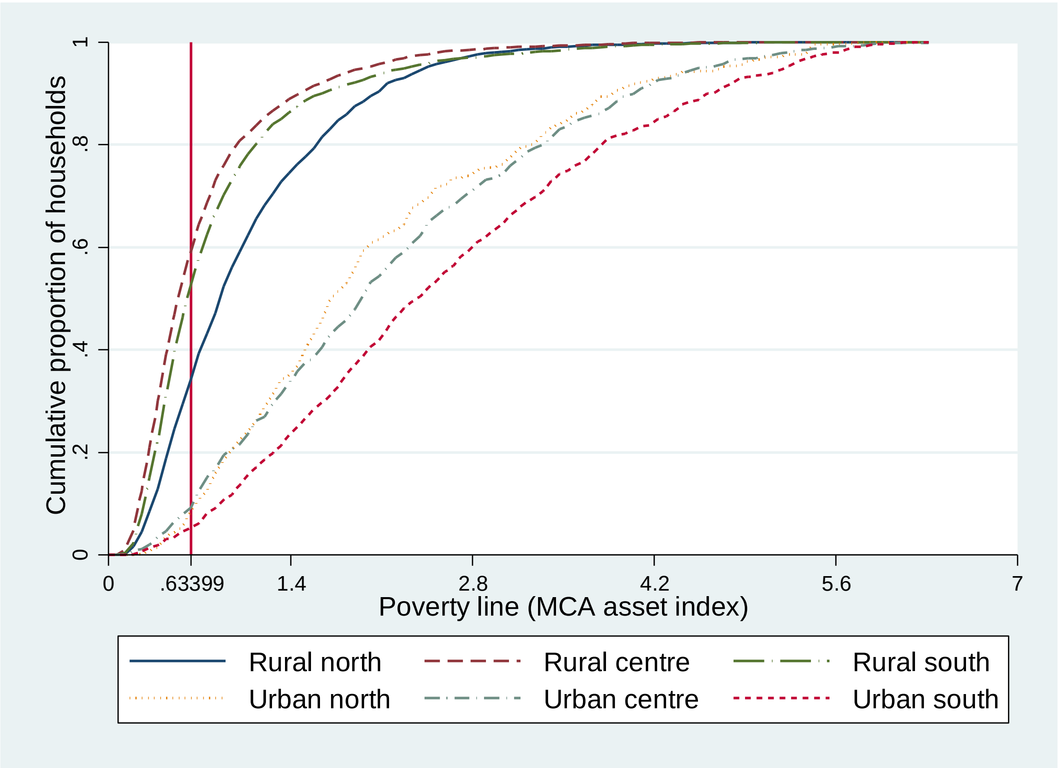
Source: Own computation from MDHS 2010

Figure 9: MCA asset index cumulative density curves by regions



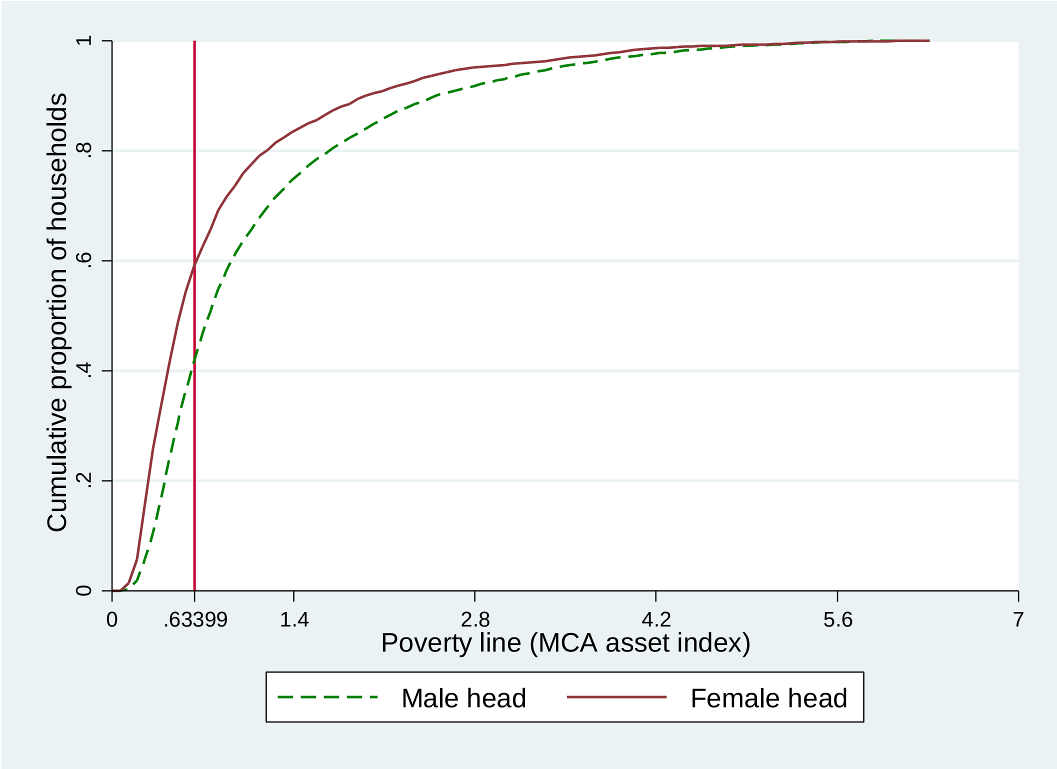
Source: Own computation from MDHS 2010

Figure 10: MCA asset index cumulative density curves by areas and regions



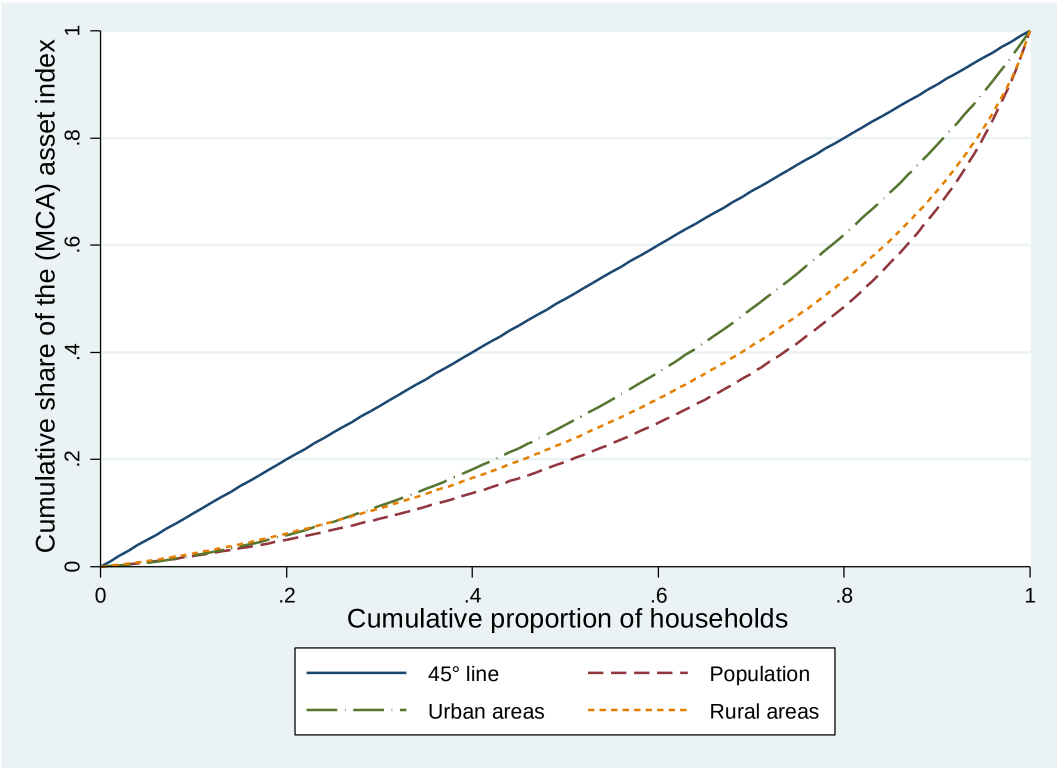
Source: Own computation from MDHS 2010

Figure 11: MCA asset index cumulative density curves by sex of household head



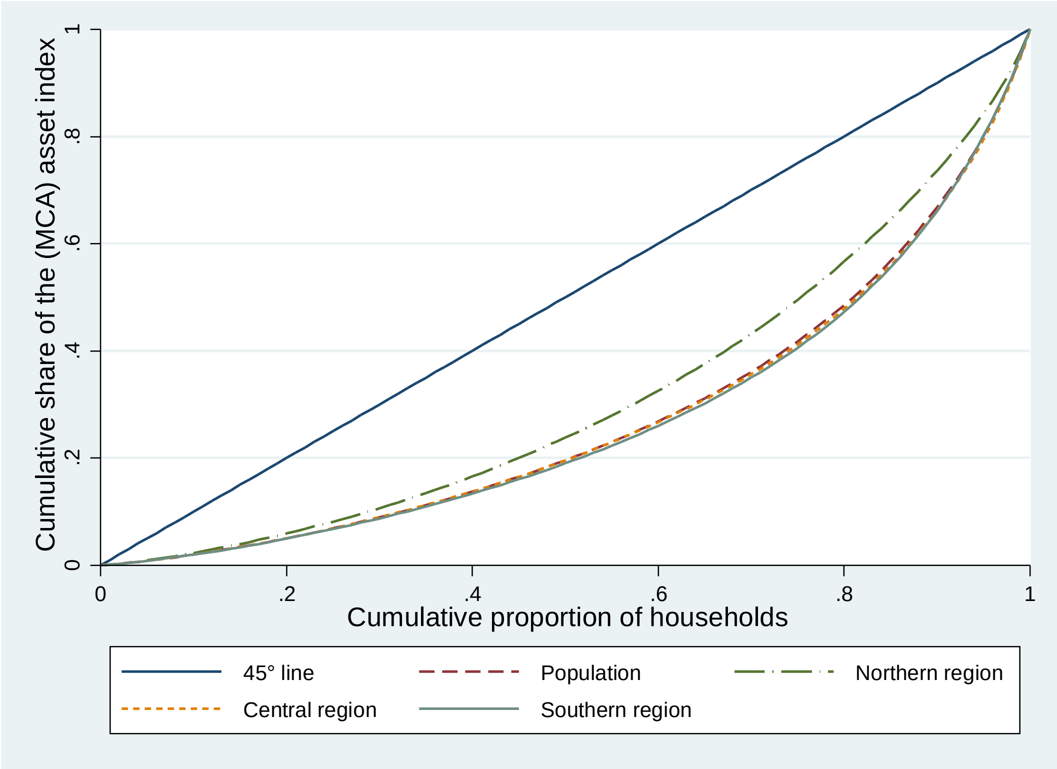
Source: Own computation from MDHS 2010

Figure 12: MCA asset index Lorenz curves by area of residence



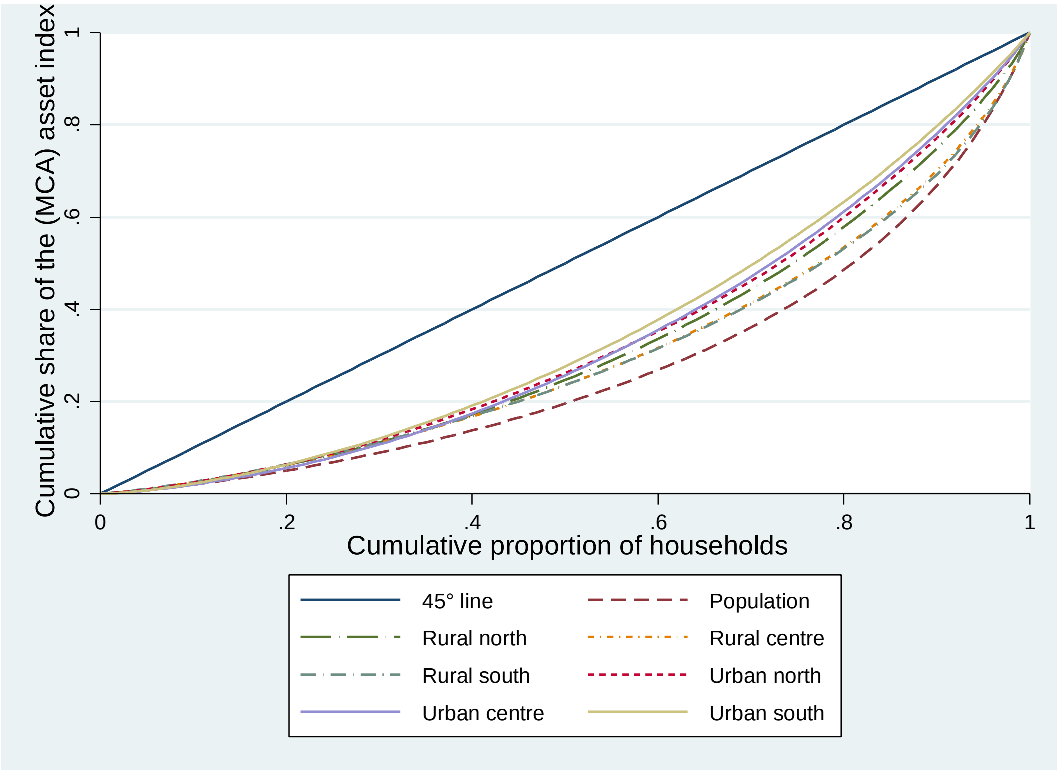
Source: Own computation from MDHS 2010

Figure 13: MCA asset index Lorenz curves by regions



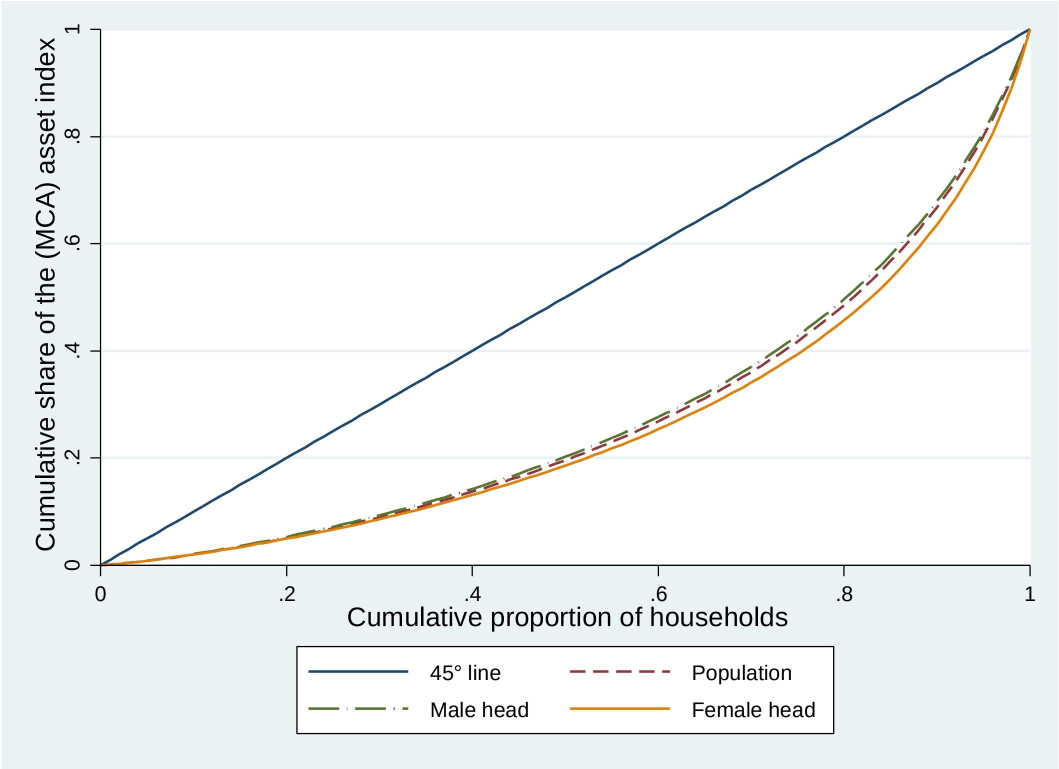
Source: Own computation from MDHS 2010

Figure 14: MCA asset index Lorenz curves by areas and regions



Source: Own computation from MDHS 2010

Figure 15: MCA asset index Lorenz curves by sex of household head



Source: Own computation from MDHS 2010

Figure 16: Poverty headcount for asset index

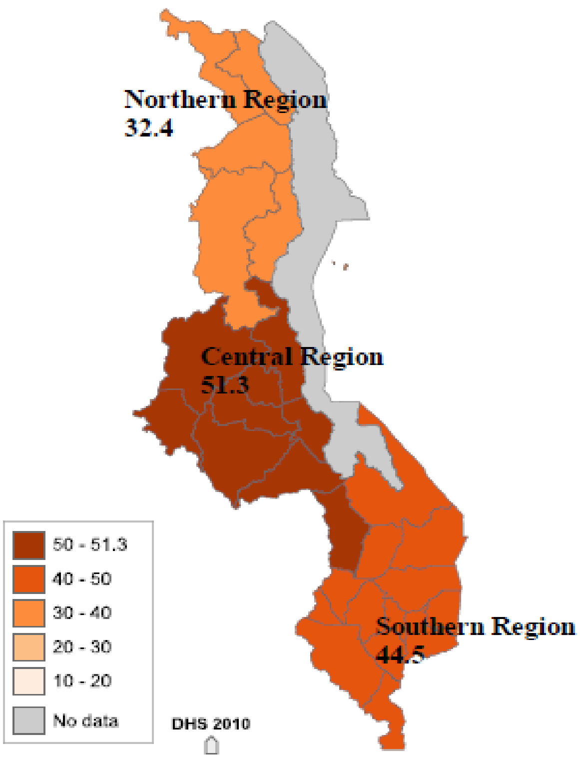


Figure 17: Poverty headcount for HAZ

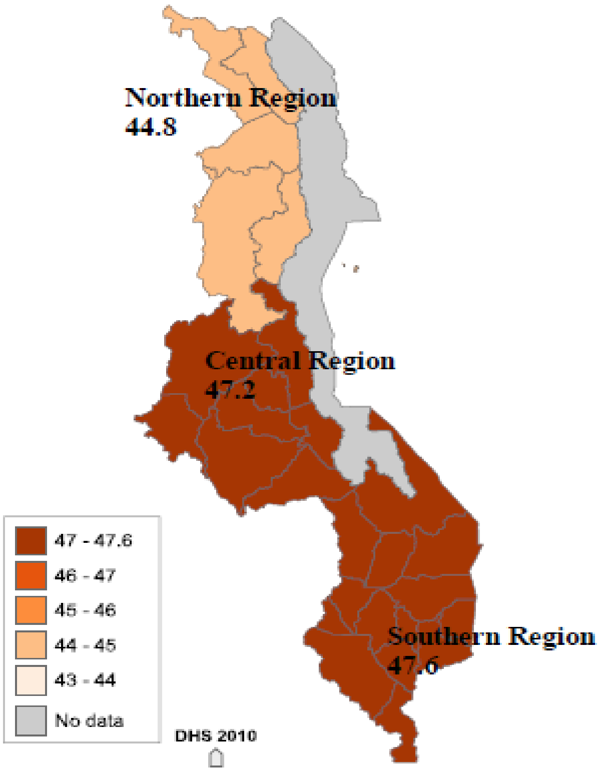


Figure 18: Poverty headcount for WAZ

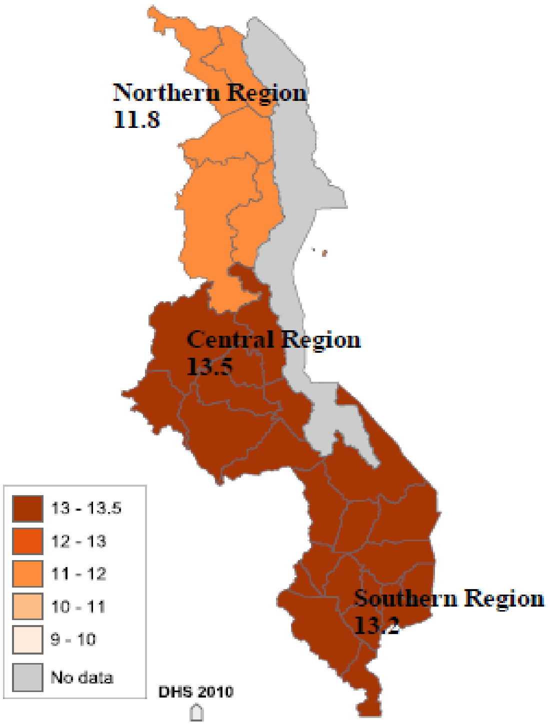


Figure 19: Poverty headcount for WHZ

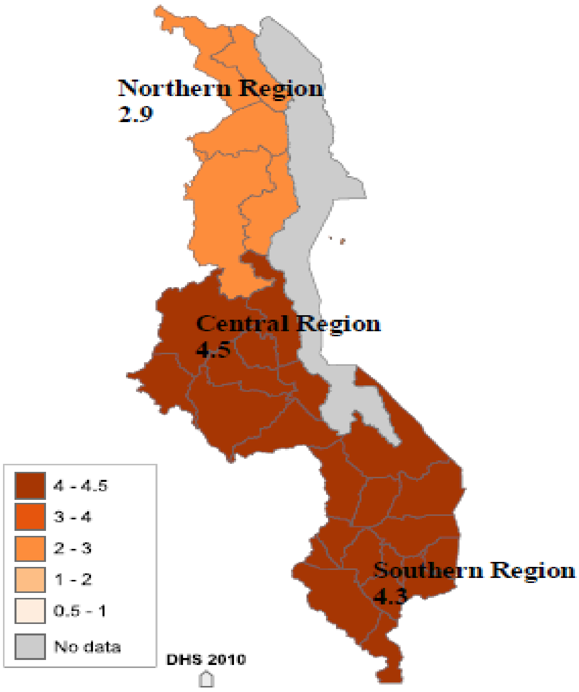


Figure 20: Gini inequality for the asset index

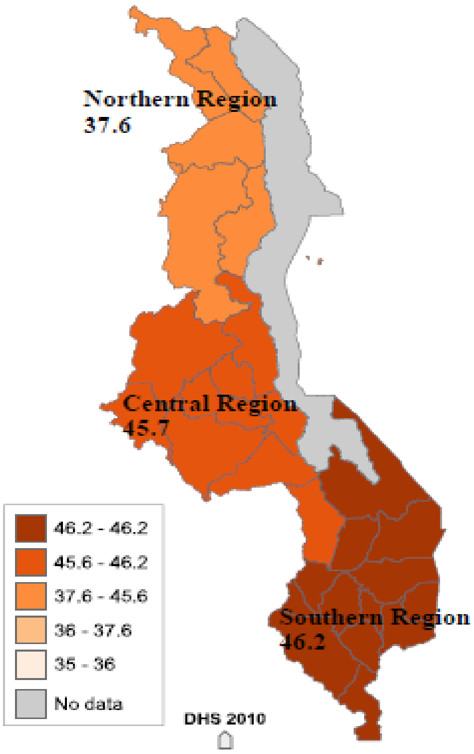


Figure 21: Gini inequality for HAZ

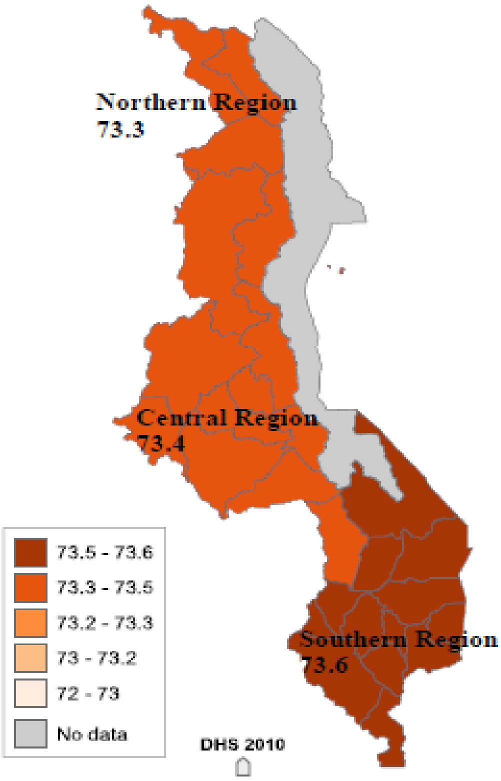


Figure 22: Gini inequality for WAZ

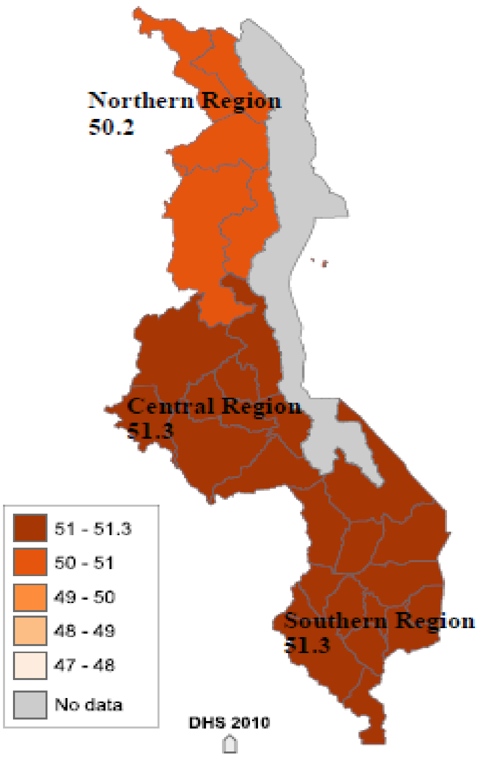


Figure 23: Gini inequality for WHZ

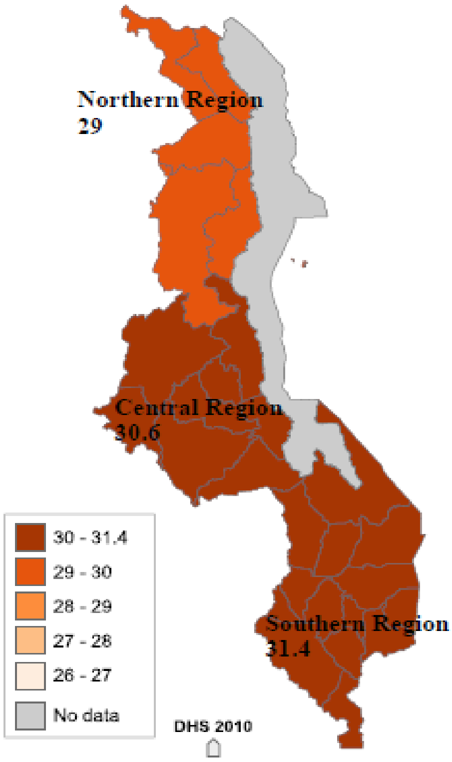
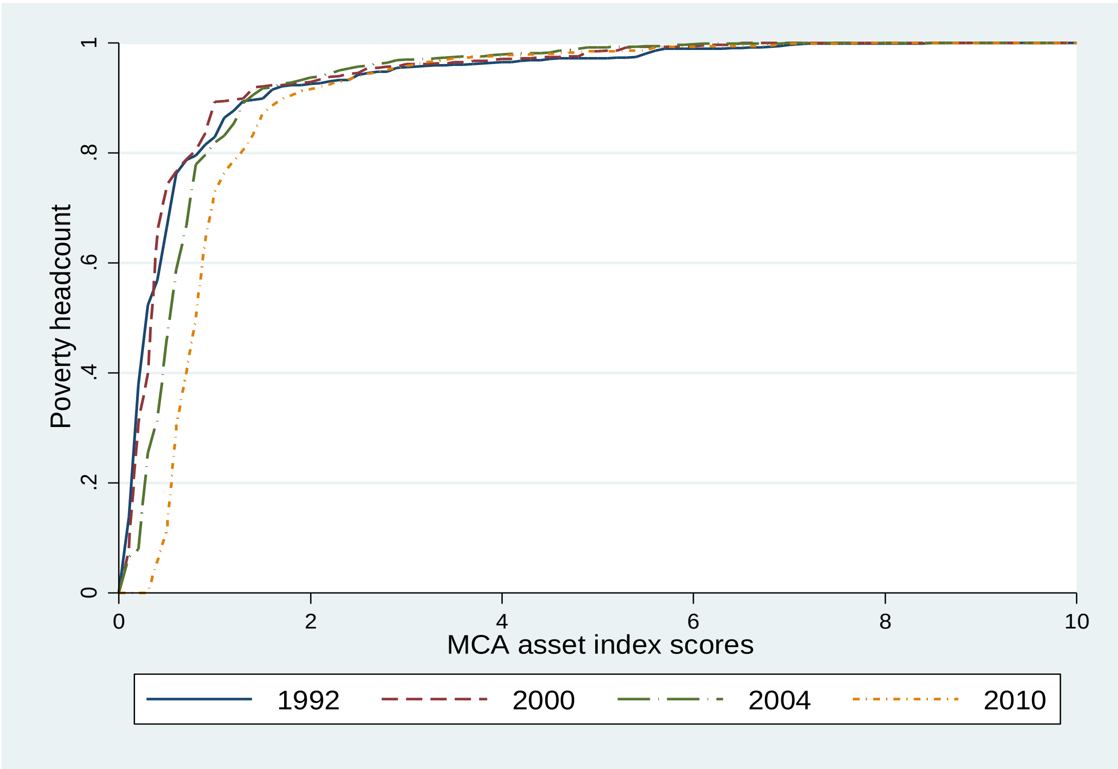
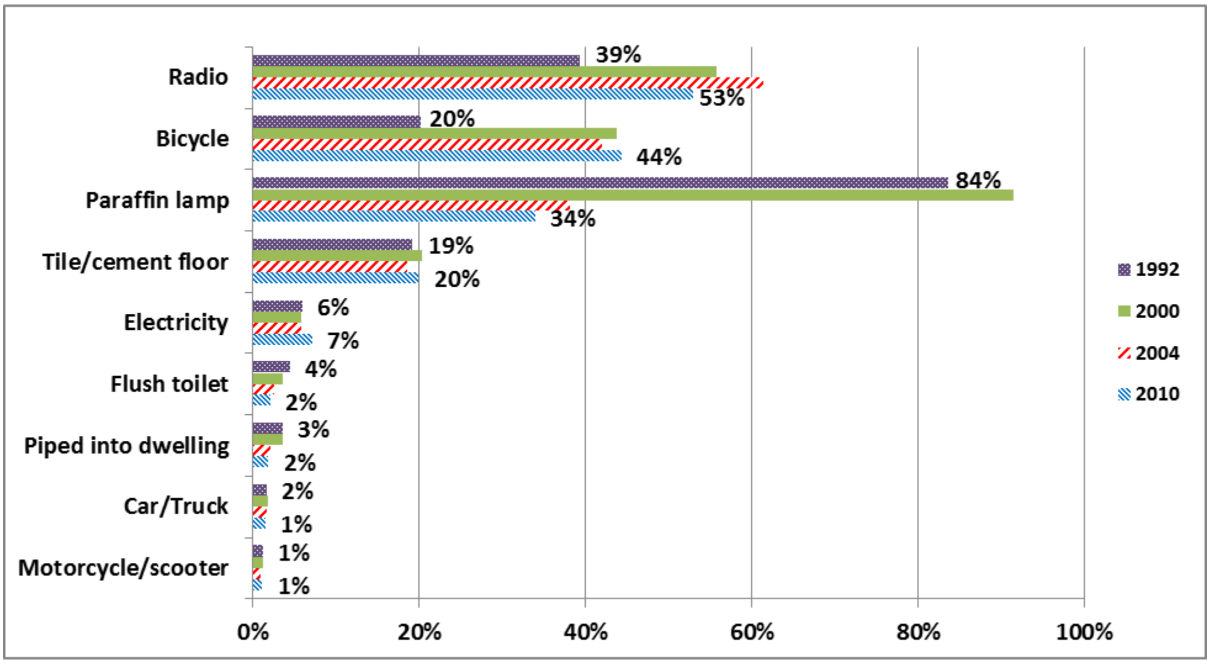


Figure 24: Asset poverty incidence curves by survey year



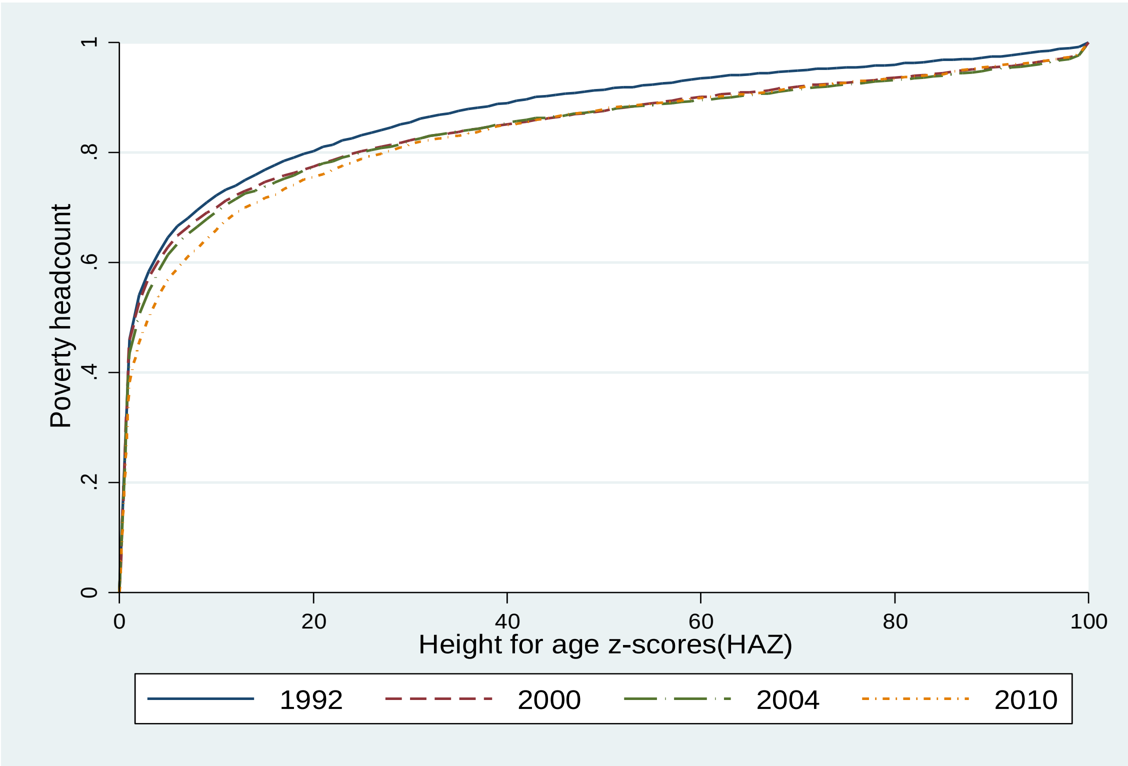
Source: Own computation from MDHS 1992, 2000, 2004 and 2010

Figure 25: Access to assets by time and survey period



Source: Own computation from MDHS 1992, 2000, 2004 and 2010; labels for 1992 and 2010

Figure 26: Poverty incidence curves for HAZ by DHS survey year



Source: Own computation from MDHS 1992, 2000, 2004 and 2010