Poverty in Kagera, Tanzania: Characteristics, Causes and Constraints

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Abstract

This paper analyses the determinants of household welfare in the Northwest region of Tanzania using micro-level cross section data. Despite having gone through a series of structural adjustment programs in the late-1980s, Tanzania is still considered one of the poorest countries in Sub-Saharan Africa. The paper argues that the determinants of household welfare are numerous and complex, ranging from individual and household to community and social characteristics, but that the relative importance of these factors varies across the welfare distribution. Using quantile regressions, we find that human, social and physical capital all play a significant role in improving households' living standards, but that the relatively poor are harmed more by weather shocks because they face more constraints in diversifying out of agriculture. Our results also reveal subtle insights into the relationships between gender and poverty.

JEL Codes: D31, D63, I32, O12, O15

Keywords: Poverty, inequality, quantile regression, gender, rainfall, shocks, agriculture, vulnerability, Kagera, Tanzania.

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1.Introduction

Kupata si werevu, na kukosa si ujinga

(Swahili proverb: Getting something is not necessarily because of cleverness, and missing something is not necessarily because of ignorance)

Establishing routes out of poverty has long been an issue facing individuals, households and policy makers alike. Ascertaining the socio-economic characteristics of the poor, and the constraints they face, is a prerequisite for effective policy design and the achievement of development goals. Evidence from many studies suggests that increased well being is linked to increased human and social capital, as well as improved institutions and better governance.[1] The issues related to development and growth are especially relevant in the context of Sub-Saharan Africa. Not only is Africa the poorest region in the world, but it is also plagued by lower poverty reduction rates in comparison with other developing regions (World Bank, 2006a). The Kagera region of Northwest Tanzania is characteristic of many parts of Sub-Saharan Africa. Being predominantly rural, completely land-locked and remote from the coast and capital, and largely dependent on agriculture, understanding the nature of poverty in Kagera may enable us to gain a better understanding of poverty in sub-Saharan Africa more broadly.

At the time of independence in 1961, Tanzania was one of the poorest countries in the world and, in the mid 1970s and early 1980s, as a consequence of the experimental socialist policies inspired by president Nyerere, suffered macroeconomic imbalances, economic stagnation, and a sharp decline in the standard of living. By 1983, Nyerere himself admitted the failure of the "ujamaa" experiment,[2] and in 1986 the Tanzanian government, supported by the IMF and World Bank, began a series of structural adjustment programs, necessitating a shift away from socialism towards a more market-oriented economy. Although some progress has been made, Tanzania remains one of the poorest countries in Africa.[3] Table 1 provides some of the context.

[1] IFAD (2000) reveals that the rural poor typically have lower levels of assets, of all types, less access to technology and weaker access to markets and other institutions. The World Development Report (2007) emphasises the role of good governance and transparency in providing a future of hope for all generations.

[2] See The Guardian, Friday October 15, 1999, and World Bank http://siteresources.worldbank.org/IDA/Resources/IDA-Tanzania.pdf

[3] World Development Indicators database, World Bank, 2008.

Table 1: Economic and Welfare Indicators, Tanzania

Total GDP (US$)[1]	$12.78 billion
GNI per capita (PPP)[1]	$980
Agriculture, value added as % of GDP[1]	45
Total Population[1]	39.46 million
Rural population, as % of total population [2]	76.9
Total Exports, as % of GDP[1]	24
Total Imports, as % of GDP[1]	31
Agricultural exports, as % total exports[3]	44.1
HDI rank[4]	
Tanzania	159
Uganda	154
Kenya	148
Mozambique	172
Zambia	165

Sources:
[1] World Development Indicators, April 2008: note: estimates are for 2006; [2] United Republic of Tanzania (2002). [3] World Bank (2008): note: average from 2003-2005; [4] UNDP (2007): note: ranked out of 177 countries.

The 2008 World Development Report (WDR) emphasises the importance of agriculture in achieving the Millennium Development Goal of halving the number of people living in extreme poverty worldwide by 2015.[4] Sub-Saharan Africa has the largest proportion of total and rural populations living below the $1-a-day poverty line (Ravallion, Chen and Sangraula, 2007). It seems little surprise therefore, given the rural nature of Tanzania's economy and its dependence on agricultural exports, that Tanzania was ranked 159th out of 177 countries in 2006, [5] in terms of GNI per capita in 2006 PPP dollars, and is one of the poorest countries in Sub-Saharan Africa.

The overall aim of this paper is to identify and understand the features of households, their members and their surrounding environment, that make them more or less likely to be poor, in the specific context of Kagera, Tanzania. First however we need to define poverty. There exists a vast amount of literature and empirical work on the measurement and determinants of poverty in developing countries. One clear conclusion is that poverty itself goes beyond the lack of income or other monetary resources. Poverty is generally understood to be multidimensional, encompassing economic, social, political and institutional perspectives and Sen (2001) makes the distinction between income deprivation and the lack of opportunities and freedom. Poverty analysis necessitates the use of a proxy for welfare but defining this proxy can be difficult, both conceptually, as there is

[4] Ghana, for example, has been considered a success story in poverty reduction by targeting the agricultural sector; see Coulombe and Wodon (2007).
[5] United Nations Development Program (2007).

no consensus which indicator or indicators should be used and operationally, given the nature of household survey data, in terms of availability and quality. Multi-dimensional approaches are intellectually appealing as they enable a broad range of functionings to be encapsulated, but require the specification of a minimum threshold for each indicator, involve value judgements about the relative weights of each indicator and ignore how different attributes interact with each other (Thorbecke, 2005). Classifying households or individuals as poor becomes complicated when some but not all functionings are achieved. Single indicator approaches have the conceptual advantage of being simple to construct and understand but clearly are inferior at capturing other attributes that are important for the avoidance or escape from poverty. Income and consumption, in particular, by using market prices to value own consumption and production and to capture the relative utilities of different goods and services, may under-estimate poverty, particularly where markets are imperfect or missing.

Despite the weight of academic debate that lends support to a multi-dimensional approach, in practice few empirical studies go beyond using more than around three indicators. Furthermore there is some evidence that conclusions about who is poor and who is not are fairly robust to a wide range of approaches to defining poverty. Glewwe and van der Gaag (1990) found strong levels of correlation between the poverty rankings of households on a range of different indicators and, more recently, Deutsch and Silber (2005) testing four different approaches to multi-dimensional poverty measurement, find that "[the] .... impact on poverty of many of the [regressor] variables is not very different from the one that is observed when poverty measurement is based only on the income or the total expenditures of the households."

This paper adopts the income approach. Specifically we use various normalisations of household consumption as our measures of living standards. Deaton (1997) argues that per capita aggregate consumption is not only a more accurate reflection of an individual's well being than income, but that the measurement of income, particularly in rural settings, is essentially more difficult. Consumption data has been used extensively in the cross-section literature on poverty and growth in Sub-Saharan Africa (Ferreira, 1996; Dercon, 2001; De Weerdt, 2006) yet the Kagera income and consumption data is relatively under-exploited. The use of a "per capita" normalization is standard in the literature on developing countries. This stems from the general presumption that there is rather little scope for economies of scale in consumption for poor people. We challenge this assumption and allow for both differing needs of individual members of households and small to modest economies of scale

in consumption, following the World Health Organisation (WHO, 1985) recommended daily calorie intakes and White and Masset (2003).

The income approach relies on the construction of poverty lines, below which individuals are considered poor, but defining such a benchmark is not straightforward. The income approach has been the subject of much criticism due to the arbitrary nature of poverty lines. Poverty lines also vary, spatially and temporally, making poverty comparisons all the more intricate.[6] We do use a poverty line for constructing poverty estimates and for some of our regression analysis but we move away from the need to specify such a line by applying dominance analysis and by estimating quantile regression models. The former analysis allows us to show that poverty has fallen over time in Kagera, while the latter that covariates have different effects on different parts of the conditional consumption distribution. This can be interpreted as suggesting that there are different returns to characteristics for the relatively poor compared to the relatively rich.

Thus our first objective is to examine to what extent poverty in Kagera can be analysed using the income approach. Our second aim is to explore some of the features of households and their surroundings in some detail. We focus on two main features, broadly speaking gender and shocks. Our motivation for an exploration of gender lies in the observation that poverty is not gender neutral, with women often having less access to assets, credit, education, and skilled work yet it has been shown that assets in the hands of women rather than men were found to significantly increase child nutrition, household output and education expenditure in several countries by Alderman (2005), Haddad et al (1997), and Kennedy and Peters (1992). We cannot test this hypothesis directly with our data because we do not have data on who owns, or controls, which assets within households. Instead we include a dummy for the gender of the household head and a measure of the proportion of household members that are female. We find that female headed households are more likely to be poor and on average have lower levels of living standards but the results on the effect of the gender composition of the household are very sensitive to how differing calorific needs of household members are specified in the welfare indicator. We also find that these gender effects differ across the conditional consumption distribution. In addition we use anthropometric data on weights of the most senior male and female[7] in the household to test if the nutritional

[6] According to Appleton (2001), Uganda's poverty line is higher than that of Tanzania (using 1993 PPP exchange rates). This is not surprising, given that Uganda has a higher HDI ranking, but it would seem that Tanzania's poverty line is very low from a regional and international perspective (see United Republic of Tanzania Human Development Report, 2005)

[7] We identify the "alpha" male and "alpha" female as the two people in each household with the closest relationship to the head of the household. In most cases this is simply the head and spouse, but in a small number of cases is a son or daughter, or son or daughter in law, or other close relative.

status of women matters more or less for overall household welfare than men's nutritional status.[8] We find that at lower consumption quantiles, female health, as measured by the z-score of her weight, has as much importance for overall welfare as does male heath, but at higher quantiles the male weight dominates the female. This suggests that a more equitable allocation of resources within the household has a larger effect on household welfare among the poor.

Our second focus is on shocks and how households protect themselves from risk and uncertainty. As the proverb quoted at the beginning of the paper suggests, some people will be poor not through any lack of action or fault of their own, while others will be better off simply because of good fortune. Luck, good or bad, plays a role. Much attention in the literature has been given to informal risk-sharing of households. Their ability to deal with shocks and offset present or future consumption losses has been strongly linked to welfare increases. The 2008 WDR highlights the issues concerning the vulnerability of households to weather shocks and their heightened dependence on the timing and amount of rainfall. [9] One important aspect of how households protect themselves is connectedness. Remoteness and decreased market access, a common characteristic amongst rural communities, has been found to significantly stifle growth. Analysis of Brazil, Ecuador, Thailand, Malawi, and Vietnam show that poverty rates tend to be deeper and more severe in remote areas.[10] Recent advances in communication technologies have provided timely access to information and exterior markets.[11] This has proven successful in much of West Africa. [12]As well as physical connectedness, social connectedness matters. Social networks may lower the risks and costs of different livelihood strategies, from migration to marketing. De Weerdt and Dercon (2006) highlight the role of networks within villages for mutual insurance in Tanzania.[13] Livelihood diversification is another insurance mechanism. In Niger, Ravallion and Chen (2007) find that those most successful in moving out of poverty were found to be farmers who diversified their farming activities.

[8] We initially planned to use the data on height as there is an obvious potential problem of endogeneity between current weight and current consumption expenditure. However the data on heights were much less clean than that for weight. We discuss the endogeneity problems below.

[9] In Kilimanjaro, Tanzania, farmers who reported rainfall patterns well below normal in the year prior to the survey, experienced a 50 percent reduction in their agricultural revenues and a 10 percent reduction in their consumption (see World Development Report, 2008).

[10] See Minot, Baulch, and Epprecht (2003) for Vietnam; Benson, Chamberlin, and Rhinehart (2005) for Malawi; Buys et al (2007) for the other countries

[11] Stark and Bloom (1985).

[12] In West Africa a public-private partnership set up TradeNet, a trading platform in Ghana that allows sellers and buyers to get into contact over the Internet and by cell phones, with great success in Burkina Faso, Mali, and Nigeria. Source: Debrah, (2007); DeMaagd and Moore (2006)

[13] Other studies on sharing of risk and responsiveness to shocks in Sub Saharan Africa include: risk sharing within marriages in Ethiopia (Dercon and Krishnan, 2000), risk sharing elements in credit contracts in Nigeria (Udry, 1994), entering new activities to deal with shocks in Mali (Harrower and Hoddinott, 2005).

We explore these issues in a number of ways. First we exploit the historic community level data on rainfall which allows us to identify whether rainfall in 2004 was substantially above or below normal levels, and therefore to measure the effect of weather shocks on households, not just at the mean but at other parts of the conditional expenditure distribution. This allows us to test hypotheses about the extent to which the poor are harmed by weather shocks, compared to the relatively better off. We find that generally the effect of abnormal weather shocks are of a larger magnitude for the poor than for the better off and that differences in effects across the distribution are statistically significant. This reveals the greater vulnerability of poorer households to external shocks and in particular the difficulties faced by the poor in adopting livelihood strategies that help to insure against such shocks. This effect is particularly interesting given that we observe in the data that richer communities seem to have experienced relatively bigger declines in rainfall during 2004 (see Figure 4 in Appendix C). Second, the effect of social connectedness, which we measure as the monetary value of assistance received from outside of the household, is strong and statistically significant, and generally larger for the poor than for the relatively well off. Our indicators of physical connectedness also give us some support. Urban households, those living in communities with a post office, and those nearer to mobile phone coverage are relatively better off and for some of these there do appear to be proportionally greater adverse affects of remoteness for poorer households. Finally we find that diversification, either in terms of the employment of their household members or in terms of their asset base, is associated with improvements in household welfare, and that these effects are particularly strong for the relatively rich.

The paper is structured as follows. The following section provides some background on the Kagera setting and on the data used in the analysis. Section 3 presents a poverty profile of Kagera, while the estimation strategy and specifications are explained in section 4. Section 5 presents the empirical results. The final section concludes the discussion.

2. The Kagera Context and Data

Kagera is situated in North West Tanzania, on the western shore of Lake Victoria, bordering Uganda in the North and Rwanda and Burundi in the West (see map A1 in appendix A). The region covers 40,838 km² of land surface and 11,885 km² of water surface. At the time of the survey in 2004 Kagera consisted of 6 districts: Biharamulo, Bukoba, divided into a rural area and an urban area, Karagwe, Muleba and Ngara (see map A2 in appendix A).[14] Its population is of diverse ethnic make-up, with Haya and Nyambo tribes dominating in the North and Subi, Sukuma, Zinza and Hangaza in the South. The population (1.3 million in 1988, about 2 million in 2002[15]) is predominantly rural and primarily engaged in producing bananas and coffee in the North and rain-fed annual crops (maize, sorghum and tobacco) in the South. More recently, fishing in Lake Victoria has provided alternative sources of income.

Kagera is not one of the poorest regions of Tanzania but it does encapsulate many of the stark contrasts that exist within the country. URT (2005) estimates that 29% of the Kagera population were below the nationally defined poverty line, ranking it the eighth least poorest out of twenty-two regions. However, this relatively promising picture conceals wide disparities within the region: the urban area of Bukoba has one of the lowest poverty rates in the whole country, around 11%, yet Biharamulo has one of the highest, at 48%; Ngara and rural parts of Bukoba have some of the highest under-five mortality rates in the country, and Bukoba, both urban and rural, has high rates of orphanhood. It is this variation in welfare indicators that makes Kagera an interesting region to study.

The results presented in the paper are based on the analysis of household survey data from the Kagera Health and Development Survey (KHDS) 1991-1994 and 2004, conducted by the World Bank, Muhimbili University College of Health Sciences (MUCHS) and University of Dar es Salaam. The KHDS was originally adapted from the World Bank's Living Standards Measurement Study (LSMS) questionnaires and consisted of 912 households[16] interviewed between 1991 and 1994, in nearly 50 communities. The extensive tracking phase of the 2004 round ensured very low attrition rates. The 2004 survey re-contacted 832 of the 1991-94 baseline

[14] Two more districts were added recently, although the borders do remain the same. Part of Biharamulo became Chato and part of Bukoba Rural became Mishenyi.
[15] United Republic of Tanzania, Population and Housing Census (2002).

household members (93%), [17] a good result compared to other low and high income panel surveys.[18] The survey contains information on household demographics, ethnicity, education, health, economic activities, employment, assets and a range of community-level variables, as well as household consumption and expenditure.

One of the main purposes of the Kagera survey was to collect data that could be used to inform on the impact of HIV/AIDS. Kagera is an area of both high and early HIV prevalence, with prevalence rates in the late 1980s as high as 24% (Beegle et al, 2006). The KHDS contains important household and community data that can be used to assess the impact of HIV/AIDS on the population (see for example Beegle et al, 2007 on the consequences of prime age mortality). The data has also been used to examine other processes. For example Beegle et al (2008) examine the effect of child labour on outcomes in adult life such as employment and marriage. De Weerdt (2006) uses the panel to identify successful strategies for escaping poverty, but uses growth in the value of assets as the measure of welfare, rather than income or expenditure. This can easily be justified on the grounds of reducing noise in the dependent variable, particularly relevant for dynamic analyses, but it was partly this observation that prompted us to explore the usefulness of the consumption data for an analysis of poverty. Although the KHDS does contain some income data, we chose to focus on expenditure given the well known problems of measuring income in rural low income areas. Expenditure data may also be less prone to seasonal fluctuations. [19]

In this paper we use the two waves of the panel, i.e. 1991/4 to 2004, for a brief analysis of the change in poverty over the period, and then exploit the 2004 data to examine the determinants of household welfare. Our first indicator of household welfare is annual total household expenditure per capita, and we supplement this with two estimates of expenditure per adult equivalent, making different assumptions about household economics of scale. Sample weights are not available for 2004, although we weight household level observations by household size in order to make inferences about individuals rather than households. This has the effect of increasing our poverty estimates because larger families tend to be found at the bottom of the per capita expenditure distribution. Household consumption and asset aggregates, as well as historic rainfall data (1980-

[16] A household was defined as a person or group of persons who live in the same dwelling and eat meals together for at least three of the 12 months preceding the date of the survey. There are a number of exceptions (see appendix B section 2)

[17] These 832 households had split into 2,774 households, excluding households in which all previous members were deceased (17 households with 27 people), see Map A3 in appendix A. See also Beegle, De Weerdt, and Dercon (2006).

[18] Frankenberg, Thomas, and Beegle (1999) report that the Indonesia Family Life Survey (IFLS) has a 94 percent re-contact rate after five years and they state: "This re-contact places the IFLS in the same class as the best longitudinal surveys in the world …" (page 7).

2004), were obtained from the EDI (Economic Development Initiatives) website, while the remaining household and community questionnaire data (1991-94 and 2004) were obtained from the Living Standards Measurement Survey (LSMS) website of the World Bank. Prior to the analysis of the KHDS 2004, households with missing expenditure data were removed.[20] In addition, only households which still resided in Kagera in 2004, were retained in this analysis as we believed that households that had left the region, including Tanzania entirely, probably constitute a non-random sample of the original 1991 sample.[21]

[19] It has been argued that assets may be more revealing than consumption, or expenditure, in describing the experiences of the poor. However, it has also been found that assets could be more prone to changes related to occupational mobility and investment choice rather than reflect welfare changes per se (see De Weerdt, 2006).

[20] See appendix B section 1 for more details on adjustments made to the data.

[21] We estimate that 28% of households that left the region by 2004 were poor compared to 67% of those that stayed, and that mean per capita expenditure was almost double among those that left compared to those that stayed.

3. Poverty in Kagera

3.1 Evolution of Poverty in Kagera between 1991 and 2004

The KHDS provides an opportunity to examine the evolution of living standards between 1991 and 2004 in Kagera. The expenditure data from the 1991-94 surveys were adjusted to 2004 prices by EDI and a poverty line was found by converting the World Bank $1.08 PPP/day[22] poverty line into Tanzanian Shillings, using the 2004 United Nations PPP exchange rate of $1.00 = 495TShs. Households were classified as poor if their annual per capita expenditure fell below 194,616TShs per year.

Table 2 displays a number of welfare measures from the 1991-94 and 2004 surveys. Mean reported expenditures in Kagera barely increased over the decade, at a time when national GDP per capita is estimated to have doubled (World Bank, 2007). The discrepancy is most likely due to the under-reporting of expenditures inherent in survey data (Deaton, 1997) but may also reflect the evidence that urban incomes have grown faster than rural incomes, and Kagera is predominantly rural. Declines in poverty estimates are modest, but do correspond to evidence from national household surveys (URT, 2005).[23] The proportion of individuals living below the poverty line fell by 7%,[24] with poverty depth decreasing by 10% from 1994 to 2004, and severity decreasing by 13%. These changes in poverty suggest a decrease in the resources needed to further reduce poverty.

Table 2: Evolution of Welfare: 1991/94 and 2004

	1991-94	2004
Mean expenditure per capita	173,436	188,483
Head Count Ratio[1]	0.727	0.673
Normalised Poverty Gap	0.295	0.266
Poverty Severity	0.149	0.134
No. of Households	875	2347
No of Individuals	5070	11290

Notes
[1] Poverty estimates are based on per capita expenditure and a poverty line equivalent to $1.08 a day in Tanzanian shillings, and are the first three members of the Foster-Greer-Thorbecke class of poverty measures.
[2] The sample sizes in each year were determined by non-missing expenditures and residence in Kagera at the time of the survey (see appendix B section 1. The 2004 sample used to construct this comparative table is slightly lower than that used for the summary statistics for 2004 and the regression analysis to ensure comparability of the consumption data over the panel.
Source: Own calculations from E.D.I constructed panel data.

[22] This is higher than the national poverty line used in URT (2005) but both are arbitrary.
[23] Our poverty estimates are higher because firstly we use a higher poverty line and secondly we weight observations by household size: since poorer households are likely to be larger, this inflates our figures relative to those based on counts of households.
[24] Poverty Incidence has been predicted to continue decreasing, see URT (2005).

In order to shed light on changes in the distribution of welfare over the period, we present estimates of mean expenditures by decile group and for those below the poverty line in Table 3. The results suggest that welfare gains were experienced across the distribution, but not uniformly, with living standards rising much more strongly among the rich. The poorest 50% of the population experienced very modest gains, and this is also reflected in the very small rise in living standards among the poor. Note, however, that the variation of per capita household expenditure among the poor was slightly higher in 2004 compared to 1991-94.[25]

Table 3: Changes in the Distribution of Expenditure , 1991-4-2004

Decile group	1991-94	2004
1 (poorest 10%)	56,293	56,618
2	78,964	82,777
3	97,735	101,809
4	112,704	118,774
5	129,362	138,050
6	146,097	160,988
7	169,938	186,770
8	204,140	224,758
9	258,757	288,027
10 (richest 10%)	481,845	527,715
Average per capita household expenditure among the poor	115,713	117,689
Standard Deviation of per capita household exp among the poor.	38,998	40,363
N (households)	875	2,347
N (Individuals)	5,070	11,290

Source: Own calculations from E.D.I panel data

One of the challenges in measuring poverty is the need to specify a poverty line. Given that the poverty line is itself likely to be measured with error, rather than estimating a set of poverty measures for a range of different possible poverty lines, we instead adopt a dominance approach. Atkinson (1987) demonstrated that first order poverty dominance (that is, where the cumulative density function (c.d.f) for one distribution lies everywhere above another) implies that all members of the Foster-Greer-Thorbecke class of poverty measures will rank the two welfare distributions in the same way and importantly for all poverty lines. In the case of Kagera, we can see in Figures 1 (for the whole distribution) and 2 (a snapshot of the lower tail) that regardless of where the poverty line is drawn, the c.d.f. for 2004 lies everywhere below the c.d.f. for 1994, so we can therefore conclude that, to the extent that reporting of expenditures is no more or less accurate in 2004 than in 1991-94, all poverty estimates unambiguously fell over the period regardless of where we choose to set the poverty line and which

[25] At first glance, this result appears to go against the fall in the poverty severity measure, displayed in table 2. However, it is important to note that FGT(2) measures deviations from the poverty line, not from the mean expenditure among the poor.

member of the FGT class we choose as a measure. This is an important result given the debate over the setting of the poverty line.

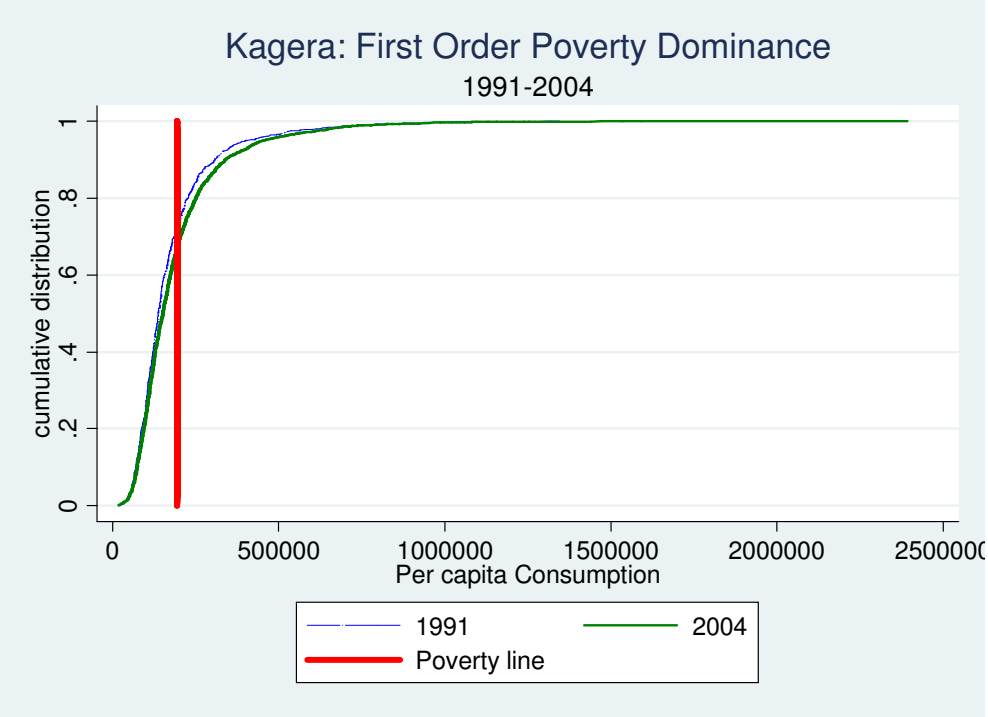


Figure 1: Poverty dominance

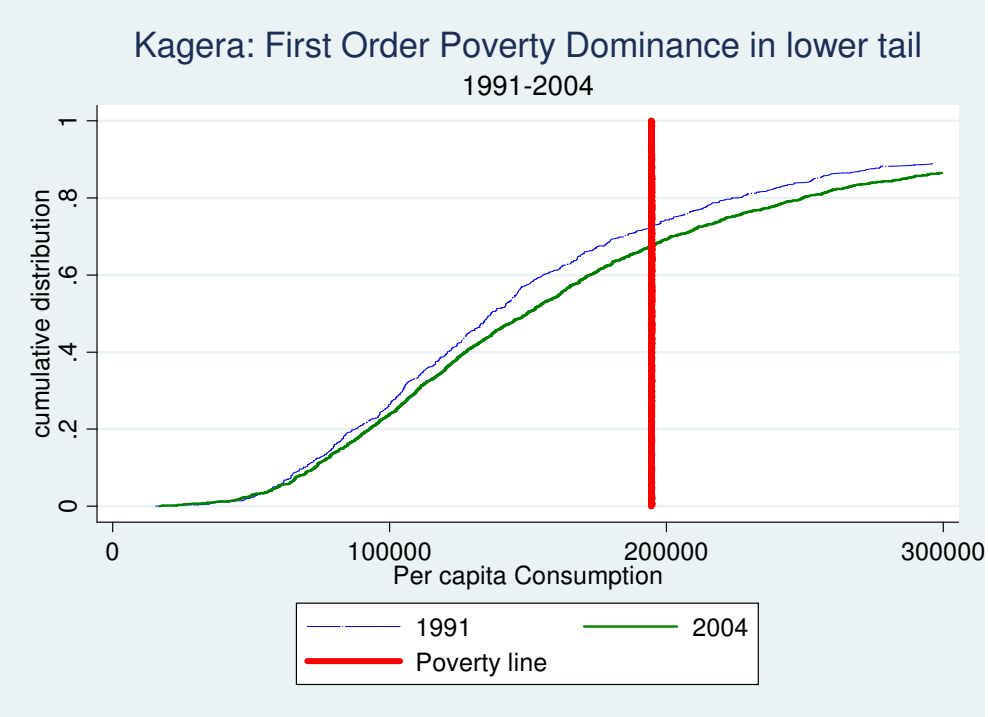


Figure 2: Poverty dominance, lower tail

3.2 Poverty profile of Kagera in 2004.

We now briefly examine how welfare varies across a number of individual and household characteristics.[26] Table 4 shows that inequalities exist between districts and between urban and rural areas. Rural areas are generally poorer than urban areas and rural households are over-represented among the poor. Mean per capita expenditure in urban Bukoba, the only urban district in the Kagera region, is more than twice that in Biharamulo, which is predominantly rural and less densely populated. Inequalities also exist amongst the rural areas, with both large variations in means and in poverty estimates. The poverty share, arguably, a better measure of the concentration of poverty, shows that each of the rural districts are over-represented among the poor, although urban Bukoba, despite having the highest mean expenditure levels, contributes just over a fifth of individuals living in extreme poverty, due to a significantly large population share. This raises issues relating to the targeting of poverty reduction strategies: whether strategies should target the southern regions (Biharamulo and Ngara) with the highest headcount ratios or the area with the greatest share of the poor, Bukoba Urban, or both.

Table 4: Poverty Statistics by District, 2004

District	population share	mean expenditure	headcount ratio	poverty gap	poverty severity	poverty share	poverty risk
Biharamulo	0.08	116,403	0.91	0.48	0.30	0.11	1.40
Bukoba Rural	0.28	185,860	0.69	0.26	0.12	0.30	1.07
Bukoba Urban	0.32	254,608	0.47	0.14	0.06	0.23	0.72
Karagwe	0.14	192,281	0.65	0.23	0.10	0.14	1.00
Muleba	0.08	175,934	0.73	0.26	0.12	0.09	1.13
Ngara	0.10	149,141	0.81	0.36	0.19	0.13	1.24
Urban	0.32	254,608	0.47	0.14	0.06	0.23	0.72
Rural	0.68	172,426	0.73	0.29	0.15	0.77	1.13
All Kagera		198,466	0.65	0.24	0.12		

Notes: N=2415. Only households with non-missing expenditure and characteristic data were included: see appendix B section 1.
Source: Own calculations from KHDS 2004 data set

Table 5 presents household expenditure per capita levels by the gender and age group of the household head. Female headed households reported, on average, slightly lower per capita expenditures and had higher headcount ratios and poverty risk measures than male headed households, but do not appear in this simple analysis to be significantly over-represented among the poor. Similar results were found for younger (aged less than 40) compared to older headed households (aged over 40).

[26] Our sample size is slightly greater than that used in the panel. See appendix B section 1 for details.

Table 5: Poverty Statistics by age and gender of the household head, 2004

Group	population share	mean expenditure	headcount ratio	poverty gap	poverty severity	poverty share	poverty risk
Male head	0.81	200,928	0.64	0.24	0.12	0.80	0.99
Female head	0.19	188,231	0.67	0.25	0.12	0.20	1.03
Heads aged <40	0.48	208,280	0.62	0.23	0.11	0.46	0.96
Heads aged >40	0.52	189,310	0.67	0.26	0.13	0.54	1.04

Notes: N=2415. Only households with non-missing expenditure and characteristic data were included: see appendix B section 1.
Source: Own calculations from KHDS 2004 data set

Poverty measures by economic activity were also calculated, see table 6. The vast majority of household heads in the survey reported their main activity as being agriculture, and three-quarters of these were below the poverty line. Individuals with heads employed in agriculture were substantially over-represented among the poor. Individuals with heads in administrative positions had the highest living standards, on average, with the lowest headcount ratio, poverty gap and poverty severity measures. These statistics indicate that any economic activity other that agriculture resulted in a lower risk of being poor, a veritable escape from poverty.

Table 6. Poverty Statistics by Economic Activity, 2004

Activity	population share	mean expenditure	headcount ratio	poverty gap	poverty severity	poverty share	poverty risk
Agriculture	0.54	160,399	0.75	0.30	0.15	0.62	1.16
Fishing	0.02	258,392	0.50	0.15	0.06	0.02	0.77
Merchant	0.07	282,704	0.42	0.11	0.05	0.05	0.65
Admin/Clerical	0.04	331,691	0.31	0.08	0.03	0.02	0.47
Transport	0.03	308,730	0.43	0.11	0.04	0.02	0.65
Hotel/Restaurant Owner	0.04	247,194	0.56	0.20	0.09	0.03	0.86
Other	0.23	210,587	0.60	0.21	0.10	0.21	0.92
No job	0.03	187,801	0.60	0.26	0.15	0.03	0.93

Notes: N=2415 Only households with non-missing expenditure and characteristic data were included: see appendix B section 1.
Source: Own calculations from KHDS 2004 data set

Eighty-two percent of household heads had attended school in 2004 but over half of these households lived below the poverty line. We present in Table 7 poverty statistics using the levels of education achieved by other household members. Putting households into groups according to their maximum education attained by any individual member reveals interesting results.

Table 7: Poverty Statistics by Maximum Educational Attainment of Household members, 2004

Education Level Attained	population share	mean expenditure	headcount ratio	poverty gap	poverty severity	poverty share	poverty risk
No education	0.04	156,195	0.77	0.36	0.21	0.04	1.19
Primary	0.12	157,095	0.75	0.35	0.19	0.13	1.16
Secondary (lower)	0.61	182,524	0.69	0.26	0.13	0.65	1.06
Secondary (upper)	0.04	212,760	0.66	0.21	0.09	0.04	1.02
Adult education	0.19	266,092	0.45	0.13	0.05	0.13	0.70
Higher education - UG	0.01	512,760	0	0	0	0	0
Higher education - PG	0.00	477,822	0	0	0	0	0

Notes: N=2415. Only households with non-missing expenditure and characteristic data were included: see appendix B section 1.
Source: Own calculations from KHDS 2004 data set

The poverty headcount, and poverty risk measures, fall substantially as the level of education within the household rises. Additional human capital, in this case education, is strongly related to increasing mean expenditure levels. Individuals living in households where no-one has any formal education are considerably over-represented among the poor.

These preliminary results are consistent with the hypothesis that differences in household welfare exist between districts, education levels, economic activity and age and gender of the household head. Moreover, the agricultural sector contributes a significantly large share of poverty, with rural households suffering from relatively high poverty risks. Increased human capital has significant poverty alleviation characteristics. These findings inform the econometric analysis in later sections.

4. Methodology

Our aim is to shed light on the factors associate with welfare levels. We adopt a three-pronged strategy, beginning with a discrete approach and then estimating continuous models at the mean and at various quantiles of the conditional expenditure distribution. Modelling welfare using monetary indicators requires making assumptions about the relative costs of household members of different age and gender and also about economies of scale in consumption, so we present results for both per capita household expenditure and equivalised expenditure, using the adult equivalence and economies of scale parameters, following White and Masset (2003) detailed in appendix B.

4.1 Probit Model

Firstly, a discrete, probit, modelling approach will be used to look at the effects of household and community characteristics on the risk of being poor or not poor. Based on the evidence from the poverty profile, and the poverty literature, a number of household and community variables are plausible determinants of welfare. Household expenditure levels will be used to classify households as poor or not poor, as a proxy for welfare. Households whose per capita expenditure fell below 194,616TShs per year are classified as poor and those above this benchmark are classified as not poor.

The dependant variable in this probit model assumes a value of either zero or one depending on whether a household was poor or not. The dependant variable is defined as the binary outcome of an unobserved underlying latent variable, welfare in this case. The probit model expresses the dependant variable as a function of a set of explanatory variables in the following form:

$$y^{*}{}_{i} = \alpha + x_{i}\beta_{i} + u_{i} \qquad [1]$$

Where y^{*} refers to the underlying latent variable and is assumed to be unobserved; y_i is defined as the binary observed realization of the underlying latent variable y^{*}, expressing the poverty outcome of a household, 0 = not poor and 1 = poor; i = 1, …,n; x_i is a column vector of realisations on k explanatory variables for the i^{th} household; β_i is a corresponding column vector of k unknown parameters for the i^{th} household; u_i is an error

term for the i[th] household, and $u_i \sim N(0,\sigma^2)$. The maximum likelihood (ML) estimates for β_i, provide the *ceteris paribus* effect of their respective characteristics on the binary dependant variable. The probability can be linked to the dependant variable as follows:

$$\Pr ob[y_i^* > 0] = \Pr ob[y_i = 1] = \Phi(z_i) \qquad [2]$$

Where y_i is the binary realization of the latent dependent variable; $\Phi(\cdot)$ denotes the cumulative distribution function for the standard normal; and $z_i = x_i'\beta/\sigma$. The estimated probit coefficients can be interpreted by reference to their effect on the standardized probit index.[27]

The maximum likelihood estimation (MLE) of probit-type models assumes an exact knowledge of the probability distribution function, up to the set of unknown parameters that are the subject of the estimation. The estimates are sensitive to departures from the specification of the likelihood function. Thus, the failure of the normality assumption may have implications for model specification. We can ignore the normality problem, as the estimates remain consistent in the presence of deviations from normality (see Reilly, 2005, and Deaton, 1997). The presence of heteroscedasticity in the model, however, yields inconsistent results.[28] Due to issues relating to the assumption of homoscedastic errors, the probit maximum likelihood function will be computed using the robust variance-covariance matrix.

The pseudo-R^2 compares the log-likelihood, LogL, with the log-likelihood that would have been obtained with only the intercept in the regression, $LogL_0$ (Dougherty, 2001:309). The pseudo-R^2 is the proportion by which the LogL is smaller than the $LogL_0$, in absolute values, as follows:

$$pseudoR^2 = 1 - \frac{\log L}{\log Lo} \qquad [3]$$

Where $0 < pseudoR^2 < 1$. Variations in the likelihood can be used as a basis for tests. In particular, the explanatory power of the model can be tested via the likelihood ratio statistic. However, the pseudo-R^2 values

[27] It is easier to interpret the effects of changes in the explanatory variables by calculating marginal effects for continuous variables and impact effects for dummy variables.

[28] It has been argued that in most cases, this problem in a probit model can be overlooked (Johnston and DiNardo ,1999: pp. 426–427). See also Deaton (1997), pp 85-86.

cannot be interpreted in the same way as the ordinary least squares R^2 (or adjusted-R^2) values. We also present in Appendix C the classification tables and plots of sensitivity and specificity against probability cut-offs.

4.2 OLS Model

Poverty functions, like the probit analysis, are useful when the underlying dependant variable of interest is unobservable, but are often criticised for introducing measurement errors by using arbitrarily defined poverty lines. Reducing a continuous variable, such as expenditure, to a qualitative variable, such as a poor or not poor binary variable, may throw away information (see Deaton, 1997).[29] In this section we use household expenditure per capita, and two per adult equivalent measures, as a continuous proxy for welfare. The following model is estimated using OLS:

$$\ln(pce)_i = \alpha + x_i\beta_i + u_i \qquad [4]$$

Where $\ln(pce)_i$ is the natural log of per capita expenditure for the i^{th} household; α is an intercept term; x_i and β_i, are defined as in expression [1]; u_i is an error term for the i^{th} household; and $u_i \sim N(0,\sigma^2)$. The OLS estimates for β_i, provide the *ceteris paribus* effect of their respective characteristics on the log of annual, household, per capita, expenditure, ln(pce).

4.3 Quantile Regressions

In addition to estimating the discrete and continuous household expenditure models described above, we examine the determinants of changes in ln(pce) for specific quantiles of the welfare distribution. The estimation of a set of conditional quantile functions potentially allows a more detailed portrait of the relationship between the conditional distribution of welfare, and the selected covariates. This allows us to focus on returns to characteristics for poor households, at lower quantiles, and for the relatively rich households, at higher quantiles.

One criticism of the continuous expenditure models is that the effects of changes in the independent determinant variables are estimated at the mean of the dependant variable, ln(pce) in this case. In contrast to the OLS

[29] It would appear that this is a particularly serious problem when large numbers of observations are concentrated around the poverty line. In the Kagera sample, there does not seem to be excessive clustering of households in the neighbourhood of the poverty line, but given the arbitrary nature of the line we continue to estimate continuous models.

approach, the quantile regression procedure is arguably less sensitive to outliers and provides a more robust estimator in the face of departures from normality (Koenker, 2005; Koenker and Bassett, 1978). This approach appears to have significant intuitive appeal and may also have better properties than the OLS ones in presence of heteroscedasticity (for discussion see Deaton, 1997).

The quantile regressions use the procedure of minimizing the absolute sum of errors rather than, as in OLS, minimizing the sum of the squared residuals. The estimator is also known as the Least Absolute Deviations estimator, or LAD. The median regression coefficients can be estimated by minimizing Φ:

$$\Phi = \sum_{i=1}^{n} | y_i - x_i'\beta | = \sum_{i=1}^{n} (y_i - x_i'\beta)\,\mathrm{sgn}(y_i - x_i'\beta) \qquad [5]$$

Where y_i in this application is the natural logarithm of per capita or per equivalent adult expenditure of the i^{th} household; sgn(a) is the sign of a, 1 if a is positive, and -1 if a is negative or zero, where a is the difference between the actual and the expected values of ln(pce) for the i^{th} household; x_i is a column vector of realizations on k explanatory variables; and β is a corresponding column vector of k unknown parameters. It is desirable in this case to explore quantile regressions other than at the median, and these can be defined by minimizing the following:

$$\begin{aligned} \Phi_q &= -(1-q)\sum_{y \le x'\beta} (y_i - x_i'\beta) + q \sum_{y > x'\beta} (y_i - x_i'\beta) \\ &= \sum_{i=1}^{n} [q - 1(y_i \le x_i'\beta)](y_i - x_i'\beta) \end{aligned} \qquad [6]$$

Where 0<q<1 is the quantile of interest, and the value of the function 1(z) signals the truth (1) or otherwise (0) of the statement z. In the context of the models specified in expressions [5] and [6], quantile regressions allow us to estimate the β parameters at any quantile. These estimates allow us to establish the magnitudes of the *ceteris paribus* effects of the covariates at different points of the conditional ln(pce) distribution, and in this paper we focus on the 10^{th}, 25^{th}, 50^{th}, 75^{th} and 90^{th} quantiles. The use of the variance-covariance matrix during

the LAD regression estimation, however, will not be valid. [30] One solution is to bootstrap these, following Efron (1979, 1997), for estimating standard errors of the estimated coefficients (see Deaton, 1997, for discussion). The estimated standard errors were computed using the bootstrap method with k=500 replications in order to obtain accurate standard error estimates.

4.4 Model Specification

Our model specifications are in each case relatively simple, and incorporate a range of household head, household and community characteristics that between them capture human, physical and social capital, physical connectedness to infrastructure and public services and climate shocks. Table 8 provides a description, and summary statistics, of the variables included in the econometric analysis. We group the characteristics into three classes.

The first class is a set of household head, and spouse where present, characteristics, including:

- age (in years) of the household head, entered with an interaction term for heads aged over 40, which approximates very closely to the mean age of heads;
- gender;
- relative body weight of the senior male and female in the household measured as z-scores using age and gender specific sample means and standard errors,[31] which attempt to pick up the health status of a household, and possibly the effects of recent shocks to incomes;[32]
- sector of employment of the main job of the household head;
- a dummy for whether either of the head and/or spouse parents had some formal education, which might detect intergenerational transfers of welfare, [33]
- religion of the household head, namely Christian, Muslim or other.

The second class is a set of household characteristics including:

[30] This is confirmed by the significance of the different slope parameters at different points of the conditional ln(pce) distribution.

[31] Age groups were 0-2 years, 2-5, 5-9, 9-14, 14-19, 19-29, 29-39, 39-69 and 69 plus. Note that we do not use the WHO international reference for calculating z-scores, preferring instead to use sample standards and so pick up the effects of relative deprivation in health, rather than absolute.

[32] We also experimented with height for age measures, which might capture less recent shocks to incomes. However, we found there were more cases of missing data with heights than for weights, and also that female height exerted significant effects only at the lower quantiles. This suggests that the effect of health works only via the male of the household, which rather goes against the literature. We feel the more interesting story, and more reliable one given the data issues surrounding heights, is told by the weights of men and women in the household.

- maximum education attained by any individual in the household;
- measures of household demographics: the dependency ratio, defined as the proportion of young and elderly in the household, household size and its square;
- a measure of social capital, the value of monetary and "in kind" help received from outside of the household, including official assistance, measured in natural logs;
- literacy ratio, defined as the proportion of household members over aged six that self-report as being literate;
- a measure of physical capital, the total value of household assets (measured in millions of TShs);
- the percentage of physical capital that is agricultural, i.e. land, livestock, farm equipment and buildings;
- the proportion of household members that are female, and
- a measure of livelihood diversification, the proportion of active adults employed in agriculture.

The third class is a set of community characteristics including:

- measures of access to key services and infrastructure, namely the presence of a post office in the community and the distance to be travelled to get mobile phone reception;
- the use of chemical fertilizers by farmers in the community;[34]
- whether the community was urban or rural,[35] and
- a measure of climate shocks, the z-score of rainfall, calculated using district-specific 10-year historic data.

A number of other variables were also included in earlier models but were dropped due to significantly high correlation with other variables, or too few observations in some categories, see appendix B table B3.

[33] Paxson and Schady (2005) argue that trans-generation transfers of education play a vital role in households' living standards, maternal education in particular.
[34] Farmers were asked individually about the use of modern inputs but very few responded to this question.
[35] We dropped the set of district dummies because these were collinear with the rainfall data, which was collected at the district level.

Table 8: Details of Variables Used (From 2004 KHDS)

Variable Name	Variable Description	Type	Observations	Mean	Std. Dev.	Min	Max
Age	Age of household head	Continuous	2415	42.444	17.271	10	99
Gender (male)	Gender of household head: male=0, female =1	Discrete	2415	0.213	0.410	0	1
Z-score of Weight of Senior Male	Age and gender specific weight in z-scores using sample mean and standard deviation	Continuous	2415	0.035	0.7402	-5.428	4.224
Z-score of Weight of Senior Female	Age and gender specific weight in z-scores using sample mean and standard deviation	Continuous	2415	-0.008	0.799	-2.438	5.719
Main Job	Main economic activity, or job, of household head. Assumes values of 1-8.	Discrete	2415			1	8
Agriculture	Household head's main economic activity is agriculture	Discrete	1271				
Fishing	Household head's main economic activity is fishing	Discrete	60				
Merchant	Household head's main economic activity is a commodity trading	Discrete	176				
Admin/Clerical	Household head's main economic activity is administrative or clerical	Discrete	95				
Transport	Household head's main economic activity is transport	Discrete	90				
Hotel/Restaurant Owner	Household head's main economic activity is hotel, restaurant or bar owner	Discrete	98				
Other	Household head's main economic activity not classified as any of the above	Discrete	538				
No Job	Household head has no main economic activity or job	Discrete	87				
Maximum Education Attained by Parents	The maximum level of education attained by the parents of the household head, no education=0, some education=1	Discrete	2415				
Religion of Head	Main religion of household head: 1=Muslim, 2=Christian, 3=other	Discrete	2415				
Muslim	Muslim	Discrete	352				
Christian	Catholic, Protestant, any other Christian	Discrete	2020				
Other	Traditional/Other	Discrete	43				
Maximum Education Attained	The maximum level of education attained in the household as a whole.	Discrete	2415				
None	No education attained in household.	Discrete	150				
Primary/Secondary (lower)	Household's highest level of educational attainment is primary or lower secondary	Discrete	1776				
Secondary (upper)/Adult ed	Household's highest level of educational attainment is upper secondary or adult ed	Discrete	471				
Higher	Household's highest level of educational attainment is higher (under/post graduate)	Discrete	18				
Dependency Ratio	Ratio of dependant household members to working aged household members: (number of children + number of elderly)/number of working aged adults	Continuous	2415	0.985	0.864	0	8
Natural Log of Total Help to Household	Natural log of total help received by household, including monetary and in-kind help	Continuous	2415	7.638	3.541	0	14.048
Household Size	Number of household members	Continuous	2415	4.767	2.611	1	22
Literacy ratio	Ratio of literate household members: number of literate members/household size	Continuous	2415	0.563	0.293	0	1
Female Ratio	Ratio of female household members: number of female members/household size	Continuous	2415	0.500	0.237	0	1
Agricultural Share in Labour	Number members employed in agriculture divided by the number of active members.	Continuous	2415	0.714	0.399	0	1
Total Value of Assets (in millions of TSHs)	Total monetary value of all household assets, including: physical, business, durables, equipment, land, livestock, inhabited/uninhabited buildings	Continuous	2415	6.228	27.800	0	886
Agricultural Share in Assets	Value of land, livestock, farm buildings and equipment as a percentage of total assets.	Continuous	2415	28.946	15.796	0	100
Post Office	Presence of a post office in the community. 0=yes, 1=no	Discrete	2415				
Mobile Phone Reception	Distance required to travel in order to get reception on mobile phone, in km's	Continuous	2415	5.558	15.721	0	80
Bank	Presence of a bank in the community. 0=yes, 1=no	Discrete	2415				
Distance to Nursery School	Distance to nearest nursery school, in km's	Continuous	2415	5.952	20.738	0	100
Health Centre	Presence of a health centre in the community. 0=yes, 1=no	Discrete	2415				
Use of Chemical Fertilizers	Do farmers in community use chemical fertilizers. 0=yes, 1=no	Discrete	2415				
Rural	Is the household located in an urban or rural area. 0=Rural, 1=Urban	Discrete	2415				
Z-score of Rainfall	Community rainfall in z-scores, calculated using 10 year district historic mean and standard deviation.	Continuous	2415	-1.279	0.867	-2.307	0.456

Source: Own calculations from KHDS 2004 data set

5. Empirical Results

This section presents the probit, OLS and quantile model estimates. Table 9 presents the results for per capita household expenditure. The first column displays the OLS results, the second the estimated marginal effects of the probit model, and the remaining columns quantile estimates (10^{th}, 25^{th}, 50^{th}, 75^{th} and 90^{th} respectively). We first discuss in detail the results for the per capita expenditure indicator, and then highlight where results differ when we make different assumptions about the relative cost of children and household economies of scale. The results obtained by each estimation strategy are fairly consistent, but nevertheless reveal subtle insights into the factors associated with welfare. We discuss the results for each class of characteristics.

5.1 Household Head Characteristics

Individuals living in female headed households face higher probabilities of being poor, and lower living standards, compared to those in male headed households. The probability of being poor is higher, on average and *ceteris paribus*, by about 13 percentage points and they experience about 13% lower per capita expenditure levels. The disadvantage faced by those in female headed households appears to be particularly acute higher up the conditional expenditure distribution: among those at the bottom of the distribution the expenditure difference is around 11% while at the top the difference is around 18%. Given that employment in agriculture falls as we move up the expenditure distribution, this implies that gender-income gaps are higher outside of agriculture and traditional sectors of employment. Similarly it also reflects a greater dependence on subsistence farming, where gender gaps in incomes are likely to be small, among those households at the bottom of the distribution.[36]

Age brings with it gains in welfare although these begin to decline from age forty, and rapidly for those in the lower quantiles. This suggests that declines in physical health offset the advantages of experience in a household's ability to maintain its living standards, and particularly so for relatively poor households where the majority of household members are employed in agriculture.

[36] In Sub-Saharan Africa, statistics from national surveys report low female wage labour, but the emerging literature suggests that many women, particularly poor women, rely increasingly on agricultural wage labour. See Cramer and Sender (1999), and Erlebach (2006).

Table 9: Modelling Welfare in Kagera: per capita indicator							
	1	2	3	4	5	6	7
	OLS	Probit	10th pctile	25th pctile	Median	75th pctile	90th pctile
Characteristics of the household head and spouse							
Age of head (less than 40)	0.004*	-0.003*	0.004*	0.004*	0.003*	0.003*	0.004
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Age of head (more than forty)	-0.002*	0.001**	-0.003*	-0.003*	-0.001**	-0.001**	-0.001
	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Gender of head (*male*)	-0.129*	0.125*	-0.112*	-0.125*	-0.148*	-0.166*	-0.182*
	(0.012)	(0.012)	(0.024)	(0.016)	(0.014)	(0.019)	(0.034)
Weight of senior male (z-score)	0.061*	-0.039*	0.072*	0.072*	0.069*	0.061*	0.054*
	(0.005)	(0.006)	(0.009)	(0.008)	(0.009)	(0.010)	(0.011)
Weight of senior female (z-score)	0.053*	-0.036*	0.063*	0.043*	0.043*	0.049*	0.047*
	(0.005)	(0.006)	(0.011)	(0.007)	(0.006)	(0.008)	(0.010)
Main job of head (*agriculture*)							
Fishing	0.027	0.004	-0.007	-0.015	-0.072*	0.096	0.202*
	(0.034)	(0.032)	(0.066)	(0.039)	(0.028)	(0.075)	(0.054)
Merchant	0.143*	-0.061**	0.028	0.106*	0.129*	0.140*	0.261*
	(0.021)	(0.024)	(0.043)	(0.028)	(0.025)	(0.040)	(0.051)
Admin/Clerical	0.164*	-0.158*	0.152*	0.160*	0.099*	0.168*	0.252*
	(0.024)	(0.032)	(0.047)	(0.034)	(0.030)	(0.057)	(0.044)
Transport	0.070**	0.029	-0.062	0.030	0.050	0.041	0.146*
	(0.028)	(0.025)	(0.032)	(0.072)	(0.027)	(0.044)	(0.055)
Hotel/restaurant owner	-0.090*	0.120*	-0.029	-0.148*	-0.175*	-0.051	-0.075
	(0.028)	(0.022)	(0.053)	(0.029)	(0.032)	(0.052)	(0.054)
Other	0.108*	-0.100*	0.070*	0.060*	0.054*	0.115*	0.162*
	(0.014)	(0.017)	(0.021)	(0.019)	(0.018)	(0.021)	(0.032)
No job	-0.188*	0.029	-0.337*	-0.255*	-0.172*	-0.091	0.029
	(0.032)	(0.030)	(0.050)	(0.093)	(0.027)	(0.049)	(0.058)
Maximum education of parents (*none*)	0.031*	-0.034*	0.065*	0.016	-0.003	0.027	0.041
	(0.011)	(0.012)	(0.021)	(0.016)	(0.013)	(0.018)	(0.025)
Religion of the head (*Muslim*)							
Christian	-0.056*	0.041*	-0.061**	-0.046**	-0.072*	-0.058*	-0.091*
	(0.012)	(0.015)	(0.025)	(0.023)	(0.014)	(0.021)	(0.028)
Other	0.007	-0.033	0.019	0.019	0.186*	0.015	-0.153
	(0.035)	(0.047)	(0.100)	(0.070)	(0.049)	(0.034)	(0.102)
Household characteristics							
Maximum education attained (*none*)							
Primary/Secondary (lower)	-0.031	0.030	-0.074	-0.066**	0.018	-0.075**	0.002
	(0.028)	(0.031)	(0.057)	(0.032)	(0.046)	(0.036)	(0.059)
Secondary (upper)/Adult Ed	0.137*	-0.098*	0.093	0.085**	0.213*	0.082	0.144**
	(0.030)	(0.035)	(0.061)	(0.036)	(0.048)	(0.044)	(0.065)
Higher	0.459*		0.642*	0.516*	0.497*	0.136	0.412*
	(0.041)		(0.071)	(0.047)	(0.056)	(0.076)	(0.158)
Dependency ratio	-0.056*	0.073*	-0.053*	-0.065*	-0.052*	-0.038*	-0.054*
	(0.006)	(0.007)	(0.012)	(0.009)	(0.009)	(0.010)	(0.011)
Natural log of total help to household	0.024*	-0.022*	0.030*	0.027*	0.020*	0.024*	0.022*
	(0.002)	(0.002)	(0.003)	(0.003)	(0.002)	(0.002)	(0.004)

Household Size	-0.121*	0.074*	-0.083*	-0.105*	-0.121*	-0.130*	-0.152*
	(0.005)	(0.006)	(0.011)	(0.010)	(0.007)	(0.009)	(0.014)
Household size squared	0.004*	-0.001*	0.003*	0.004*	0.004*	0.004*	0.004*
	(0.000)	(0.000)	(0.001)	(0.001)	(0.000)	(0.000)	(0.001)
Literacy ratio	0.395*	-0.216*	0.504*	0.407*	0.400*	0.357*	0.320*
	(0.024)	(0.024)	(0.047)	(0.035)	(0.035)	(0.034)	(0.048)
Total value of assets (TShs millions)	0.001*	-0.001*	0.001*	0.001*	0.002*	0.004*	0.005*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)
Agriculture share in Assets	-0.003*	0.003*	-0.002*	-0.004*	-0.003*	-0.004*	-0.004*
	(0.000)	(0.000)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)
Female ratio	-0.034	-0.048	-0.036	-0.016	-0.011	-0.006	0.012
	(0.025)	(0.026)	(0.049)	(0.037)	(0.028)	(0.035)	(0.056)
Household labour share in agriculture	-0.274*	0.252*	-0.225*	-0.280*	-0.297*	-0.313*	-0.268*
	(0.018)	(0.019)	(0.027)	(0.027)	(0.022)	(0.031)	(0.042)
Community characteristics							
Post Office (*yes*)	-0.152*	0.135*	-0.107*	-0.155*	-0.165*	-0.095*	-0.115*
	(0.015)	(0.021)	(0.023)	(0.031)	(0.019)	(0.025)	(0.038)
Mobile phone reception (km)	-0.006*	0.005*	-0.009*	-0.006*	-0.005*	-0.006*	-0.005*
	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Use of Chemical fertilisers (yes)	-0.066*	0.118*	-0.056	-0.010	-0.053**	-0.080*	-0.155*
	(0.014)	(0.017)	(0.034)	(0.023)	(0.024)	(0.023)	(0.029)
Urban (*rural*)	0.207*	-0.183*	0.257*	0.277*	0.196*	0.202*	0.183*
	(0.019)	(0.023)	(0.032)	(0.024)	(0.030)	(0.026)	(0.045)
Rainfall variation (z-score)	0.032*	-0.033*	0.070*	0.054*	0.030**	0.034*	0.009
	(0.009)	(0.011)	(0.013)	(0.010)	(0.014)	(0.012)	(0.023)
Constant	12.604*		11.785*	12.238*	12.660*	12.997*	13.347*
	(0.055)		(0.088)	(0.073)	(0.074)	(0.084)	(0.139)
Observations	11513	11420	11513	11513	11513	11513	11513
R^2 /pseudo R^2	0.485	0.2908	0.283	0.268	0.276	0.305	0.342

Notes:
Number of observations correspond to the number of individuals. The sample size for the probit is slightly smaller than the continuous models as 18 households were dropped because higher education perfectly predicted a household as being not poor. Probit results are marginal and impact effects. Classification tables and sensitivity/specification plots were constructed revealing a good sensitivity/specificity trade off and are shown in Appendix B.
Base categories are shown in italics. Robust standard errors for OLS and probit estimates and bootstrapped standard errors for the quantile estimates are shown in parentheses.
** significant at 5%; * significant at 1%

This ties in with the results that belonging to a household whose head is employed outside of agriculture appears to have positive effects on welfare by increasing household's expenditure levels and lowering the probability of being poor. This in turn relates to the results for the share of household labour employed in agriculture: households with less diversification outside of agriculture have higher probabilities of being poor and expenditure levels around 30% below the mean. Having an unemployed head reduces welfare at the mean by around 20% relative to a household with a head employed in agriculture but has much stronger impacts at the lower half of the distribution, lowering living standards by 34% at the 10^{th} percentile.

Malnutrition and health, captured by the z-scores of weights of the senior male and female head and spouse, also appear to have statistically significant effects on household welfare, with increases in weight being associated with higher expenditure levels and lower probabilities of poverty. At the mean, an extra standard deviation in the senior male weight raises per capita expenditure by 6%, and in female weight by 5%. The effects across the expenditure distribution though are different for the male and female. Among the very poor, i.e. at the 10^{th} percentile, female weight has statistically the same effect on expenditure as male weight, whereas at the 25^{th} and 50^{th} percentiles, the effect of the senior female weight falls away relative to the males, although remaining statistically significant. These results suggest that improving female nutrition among the very poor has particularly beneficial effects on household welfare, and also reflects the importance of achieving a greater degree of intra-household equality among the very poor in order to improve overall household welfare.

Having educated parents is estimated to have a positive effect on household's per capita expenditure, and a negative impact on the probability of being poor. At the mean, belonging to a household where the parents of the head or spouse had received some formal education increases current living standards by around 3%, and by approximately 6% at the 10^{th} percentile. At higher percentiles of the conditional expenditure distribution, parents' education appears to have little effect on current welfare of offspring. This suggests a degree of intergenerational transmission of poverty in Kagera, via education.

5.2 Household Characteristics

An increase in the size of a household was linked to an increase in the likelihood of being poor, and reductions in living standards but at a decreasing rate. The significance of the negative quadratic term suggests the existence of a turning point, at around 15 household members, after which an increase in household size results in an improvement in welfare. At all parts of the distribution additional members are associated with a decline in living standards but the effect is less at lower parts of the welfare distribution. The pattern of coefficients across the conditional expenditure distribution suggests two things. Firstly the increase in the magnitude of the coefficient on the quadratic term as we move up the expenditure distribution suggests that additional household members are much more costly to welfare at higher levels of the expenditure distribution. Secondly the turning point occurs earlier for households at lower percentiles. This suggests that additional household members, while costly, are able to contribute more to household welfare among the poor than among the rich. This may reflect opportunities for children and other additional members to assist in household production and these are

likely to be greater in the labour intensive activities more commonly undertaken by the poor. Household demographics are further explored with the dependency ratio and the share of household members that are women. More dependents increase the probability of being poor and are associated with lower expenditure levels, with greater impacts at the 25th percentile than at the 75th. Having a greater share of women in the household lowers welfare but the estimated effects are not statistically significant. We return however to these results when we examine the sensitivity of results to assumptions about relative costs of children and women and about economies of scale.

Human capital of household members, measured by the literacy ratio and the maximum level of education attained by any household member, are generally associated with very large gains in welfare across the expenditure distribution. Physical capital, measured by the total value of household assets, also gives positive returns, increasing towards the top of the expenditure distribution. This finding may appear counter-intuitive. However it suggests that if the composition of assets varies with expenditure level then the rich possess more higher yielding assets. We find that households with higher shares of agricultural assets have generally lower welfare levels, again suggesting that livelihoods outside of agriculture give better outcomes.

Finally we move to our measure of social capital. In the absence of network data, we use the value of outside help to infer on the ability of households to call on external resources, either via extended kin networks or official sources. Receiving assistance from external sources reduces the probability of a household being poor by around 2 percentage points for every 1% increase in the value of help received, with slightly larger effects at the 10th percentile.

5.3. Community Characteristics

Remoteness is significant for poverty outcomes. Rural communities were worse off than urban ones, with an 18 percentage point greater chance of being poor. Communications access also appears to have positive effects on household welfare. Not having a post office in the community increases the chance of being poor by around 13 percentage points, with a decrease in expenditure of 0.6 percent for every extra kilometre travelled in order to get reception on a mobile phone. These effects are slightly higher for households at the lower end of the expenditure distribution which suggests that poorer households in more remote regions of Sub-Saharan Africa incur higher real and opportunity costs because of their remoteness from infrastructure and services.

The rural nature of Kagera and its dependence on agriculture, mainly subsistence farming, is reflected by the estimates for the marginal effect of rainfall on household's welfare. An extra standard deviation of rainfall, compared to the 10-year historic district level mean, is estimated to decrease a household's likelihood of being poor by around 3 percentage points, with households at the 10^{th} percentile losing around 7 percent of per capita expenditure for a one standard deviation decline in rainfall. The effect falls steadily across the conditional distribution with no statistically significant effect of rainfall on expenditure at the 90^{th} percentile. Differences between the estimated coefficients at the 10^{th} percentile and the median, and higher percentiles, are statistically significant and confirm the hypothesis that the poor are harmed more by shocks such as rainfall.

The absence of fertilizers in a community is our proxy for access to fertilizers and was found to increase significantly the probability of households being poor by 12 percentage points overall, but with statistically significant losses only at the median and higher percentiles. Those at the top seem to be harmed more by the lack of access to fertilisers than those lower down which might be explained by greater use of improved varieties that require chemical inputs to maintain yields.

5.4 Sensitivity analysis.

So far our analysis has used a per capita definition of living standards. Given that it is well documented that children and women require fewer calories than male adults, and that there may be important economies of scale in consumption, we re-estimated the above models using two alternative per adult equivalent indicators, described in Appendix B. These two alternatives use the WHO recommended calorie intakes, by age group and gender, to construct the cost of different members relative to an adult, and also weight the household number of adult equivalents by a factor that captures economies of scale. We use two estimates of economies of scale. Table 10 shows our results for the OLS and quantile regression models using a value for alpha (α) of 0.15 for economies of scale.[37] Results obtained using 0.30 are shown in Appendix C.

[37] We chose not to re-estimate the probit as that would have required re-estimating a per adult equivalent poverty line.

Table 10. Modelling Welfare in Kagera, per adult equivalent indicator (alpha=0.15)						
	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	10th pctile	25th pctile	Median	75th pctile	90th pctile
Characteristics of the household head and spouse						
Age of head (less than forty)	0.004*	0.007*	0.004*	0.004*	0.004*	0.004**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Age of Head (more than forty)	-0.003*	-0.005*	-0.003*	-0.003*	-0.003*	-0.003**
	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Gender (male)	-0.137*	-0.117*	-0.114*	-0.167*	-0.164*	-0.171*
	(0.012)	(0.027)	(0.013)	(0.016)	(0.019)	(0.032)
Weight of Senior Male (z-score)	0.061*	0.077*	0.076*	0.067*	0.056*	0.052*
	(0.005)	(0.010)	(0.008)	(0.008)	(0.010)	(0.011)
Weight of Senior Female (z-score)	0.047*	0.062*	0.043*	0.036*	0.036*	0.038*
	(0.005)	(0.012)	(0.006)	(0.007)	(0.007)	(0.009)
Main job of head (*agriculture*)						
Fishing	0.038	-0.062	0.020	-0.089*	0.048	0.139*
	(0.033)	(0.085)	(0.032)	(0.031)	(0.055)	(0.043)
Merchant	0.149*	0.087**	0.097*	0.080*	0.138*	0.199*
	(0.021)	(0.036)	(0.029)	(0.025)	(0.032)	(0.039)
Admin/Clerical	0.139*	0.131**	0.135*	0.058	0.142*	0.188*
	(0.024)	(0.059)	(0.029)	(0.032)	(0.046)	(0.042)
Transport	0.070**	-0.054	-0.028	0.047	0.104**	0.123**
	(0.028)	(0.034)	(0.039)	(0.042)	(0.047)	(0.062)
Hotel/restaurant owner	-0.070**	-0.013	-0.162*	-0.171*	-0.067	-0.078
	(0.028)	(0.052)	(0.029)	(0.034)	(0.059)	(0.047)
Other	0.123*	0.105*	0.068*	0.048**	0.131*	0.132*
	(0.014)	(0.027)	(0.020)	(0.019)	(0.026)	(0.031)
No job	-0.179*	-0.355*	-0.305*	-0.184*	-0.125**	0.009
	(0.032)	(0.059)	(0.064)	(0.043)	(0.055)	(0.096)
Maximum education of parents (*none*)	0.043*	0.071*	0.025	0.007	0.022	0.046**
	(0.010)	(0.024)	(0.016)	(0.018)	(0.018)	(0.023)
Religion of the head (*Muslim*)						
Christian	-0.058*	-0.110*	-0.069*	-0.083*	-0.048**	-0.085*
	(0.012)	(0.027)	(0.019)	(0.016)	(0.020)	(0.028)
Other	-0.016	-0.014	0.001	0.147*	0.026	-0.086**
	(0.035)	(0.079)	(0.087)	(0.038)	(0.029)	(0.041)
Household characteristics						
Maximum education attained (none)						
Primary/Secondary (lower)	0.020	0.069	-0.043	0.091**	-0.020	0.078**
	(0.028)	(0.076)	(0.025)	(0.039)	(0.032)	(0.038)
Secondary (upper)/Adult Ed	0.174*	0.212*	0.108*	0.243*	0.107*	0.220*
	(0.030)	(0.079)	(0.029)	(0.041)	(0.039)	(0.044)
Higher	0.529*	0.868*	0.594*	0.562*	0.252**	0.317**
	(0.041)	(0.088)	(0.040)	(0.053)	(0.098)	(0.125)
Dependency ratio	-0.023*	0.000	-0.027*	-0.031*	-0.004	-0.024**
	(0.005)	(0.011)	(0.008)	(0.006)	(0.008)	(0.010)
Natural log of total help to household	0.023*	0.027*	0.023*	0.020*	0.022*	0.017*
	(0.002)	(0.004)	(0.002)	(0.002)	(0.003)	(0.003)
Household Size	-0.063*	-0.025**	-0.055*	-0.057*	-0.081*	-0.093*
	(0.005)	(0.010)	(0.011)	(0.007)	(0.006)	(0.008)
Household size squared	0.002*	0.001	0.003*	0.002*	0.003*	0.002*
	(0.000)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)
Literacy ratio	0.242*	0.324*	0.231*	0.238*	0.221*	0.135*
	(0.023)	(0.058)	(0.028)	(0.031)	(0.031)	(0.041)
Total value of assets (TShs millions)	0.001*	0.001*	0.001*	0.001	0.003*	0.005*
	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)
Agriculture share of Assets	-0.003*	-0.003*	-0.003*	-0.004*	-0.004*	-0.003*
	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)	(0.001)
Female ratio	0.134*	0.129*	0.121*	0.168*	0.124*	0.180*
	(0.025)	(0.047)	(0.030)	(0.036)	(0.032)	(0.052)
Household labour share in agriculture	-0.245*	-0.200*	-0.269*	-0.299*	-0.294*	-0.296*
	(0.018)	(0.033)	(0.020)	(0.026)	(0.035)	(0.032)
Community characteristics						
Post Office (*yes*)	-0.159*	-0.106*	-0.117*	-0.177*	-0.116*	-0.142*
	(0.015)	(0.027)	(0.026)	(0.025)	(0.018)	(0.050)
Mobile phone reception (km)	-0.006*	-0.009*	-0.006*	-0.005*	-0.005*	-0.004*
	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Use of Chemical fertilisers (yes)	-0.059*	-0.015	-0.007	-0.058*	-0.106*	-0.136*
	(0.014)	(0.038)	(0.018)	(0.021)	(0.022)	(0.021)
Urban (*rural*)	0.233*	0.253*	0.304*	0.244*	0.246*	0.240*

	(0.019)	(0.047)	(0.021)	(0.029)	(0.035)	(0.036)
Rainfall variation (z-score)	0.041*	0.066*	0.068*	0.050*	0.061*	0.036
	(0.009)	(0.022)	(0.009)	(0.014)	(0.018)	(0.020)
Constant	12.745*	11.769*	12.474*	12.807*	13.218*	13.549*
	(0.054)	(0.123)	(0.071)	(0.073)	(0.076)	(0.119)
Observations	11513	11513	11513	11513	11513	11513
R^2 /Pseudo R^2	0.407	0.251	0.223	0.225	0.246	0.273

Notes:
Number of observations correspond to the number of individuals.
Base categories are shown in italics. Robust standard errors for OLS estimates and bootstrapped standard errors for the quantile estimates are shown in parentheses.
** significant at 5%; * significant at 1%

Most of the parameter estimates are very stable to changes in the definition of the welfare indicator. Allowing for lower costs of children and women relative to men, and small economies of scale in consumption makes little difference to the majority of estimates. The results relating to the effects of rainfall, remoteness and connectedness are qualitatively the same, with similar findings about differential effects across the conditional expenditure distribution. Thus our earlier findings are robust to changes in the definition of the welfare indicator. However, as would be expected, the results for household size and composition change in interesting ways. Household size generally has a smaller effect on welfare, although estimates remain statistically significant and follow the same pattern across the conditional expenditure distribution, with bigger effects among richer households. The coefficients for the dependency ratio are also smaller in magnitude and now no longer always statistically significant. The most striking change is that the share of females in the household had a negative but statistically insignificant effect on welfare in the per capita results but now has a positive effect, and estimates are statistically significant at the mean and at all quantiles. We can draw from this that the presence of women in a household is positive and that women can and do play a significant role in the welfare of their households.

6. Conclusions

The primary aim of our research was to examine how useful the income approach is in analysing poverty in Kagera. We found that the data on consumption do record a rise in living standards over the period but that this is well below that which is suggested by national accounts. However, De Weerdt (2006) reports that the value of assets fell by almost 24% in the same period so it is possible that the consumption data are in fact accurate given the high prevalence of HIV/AIDS in some districts of Kagera. The rise in living standards is mirrored by a modest fall in poverty, which is robust to choice of both the poverty line and the poverty measure. This is encouraging.

From the regression analysis we also obtain a set of findings that are broadly consistent with the poverty literature. Human, physical and social capital have the expected effects on consumption levels and on the probability of a household being poor, as do economic activity and demographic features of the household size and age and gender composition. Varying our assumptions about the existence of economies of scale in consumption and differing needs of household members also leads to fairly predictable results in the effects of demographic attributes. This provides further encouragement that the income approach is worth pursuing, at least with datasets of the same quality of the KHDS.

We also set out to explore the nature of two specific features of households, issues concerning gender and issues surrounding shocks and households' ability to hedge against them. Our gender analysis reveals that female headed households are more likely to be poor and have lower consumption levels than male headed households. Female headed households are found fairly evenly through the consumption distribution yet we found that the disadvantage faced by female headed households was more acute at the upper end of the distribution than at the lower. We argue that this mostly reflects increased gender inequality in sectors of employment outside of agriculture. Subsistence farming and low wage agricultural labour are the main forms of employment at lower parts of the distribution: over 70% of households have a head employed in agriculture in the lowest 10% of the expenditure distribution, compared to only around 27% in the richest 10%. The corresponding figures for female headed households are much higher at 82% and 44% respectively. We further explored the gender dimension by examining the gender composition of the household. We find that, accounting for lower calorie requirements of female members, having a larger share of female members increases welfare. This follows from

the arithmetic and demonstrates the weakness of the simple per capita approach dominant in the literature. Finally we examined the effects on household welfare of the relative health of the households' senior or "alpha" male and female. We find that households with women that were relatively healthy, as measured by their weight-for-age z-score, were better off and interestingly that among the very poor the effect of the alpha female's weight was as important as that of the alpha male. We argue that this reflects the potential for increasing overall welfare by reducing intra-household inequality.

Finally, we explored a number of issues surrounding shocks and coping mechanisms. The KHDS historic data on rainfall shows that 2004 was a year of below average rainfall in Kagera with some clusters experiencing a two standard deviation decline in rainfall compared to the 10 year historic mean. Low rainfall does emerge in our analysis as having detrimental effects on household welfare and has much stronger effects, and statistically significantly so, effects at lower expenditure levels. This is consistent with both a higher engagement in agriculture by household heads and very little diversification outside of agriculture at lower expenditure levels compared to higher levels, and with constraints that poorer households face in developing insurance mechanisms. We believe this finding is particularly robust given that we observe in the data that clusters with higher mean per capita expenditures experienced larger falls in rainfall in 2004 than clusters with lower mean per capita expenditures.[38]

With increased openness to global commodity markets, poor countries and poor households, both of which tend to be net food importers, will inevitably be more vulnerable to supply shocks and price fluctuations. "For the rich the global food crisis is an inconvenience, for the poor it is a catastrophe" writes Paul Collier.[39] More globalisation may well be the answer but the fortunes of the poor cannot be left to chance. This paper has attempted to show that the fortunes of households in sub-Saharan Africa, even those that take steps to spread their risk, are still at the mercy of good and bad luck.

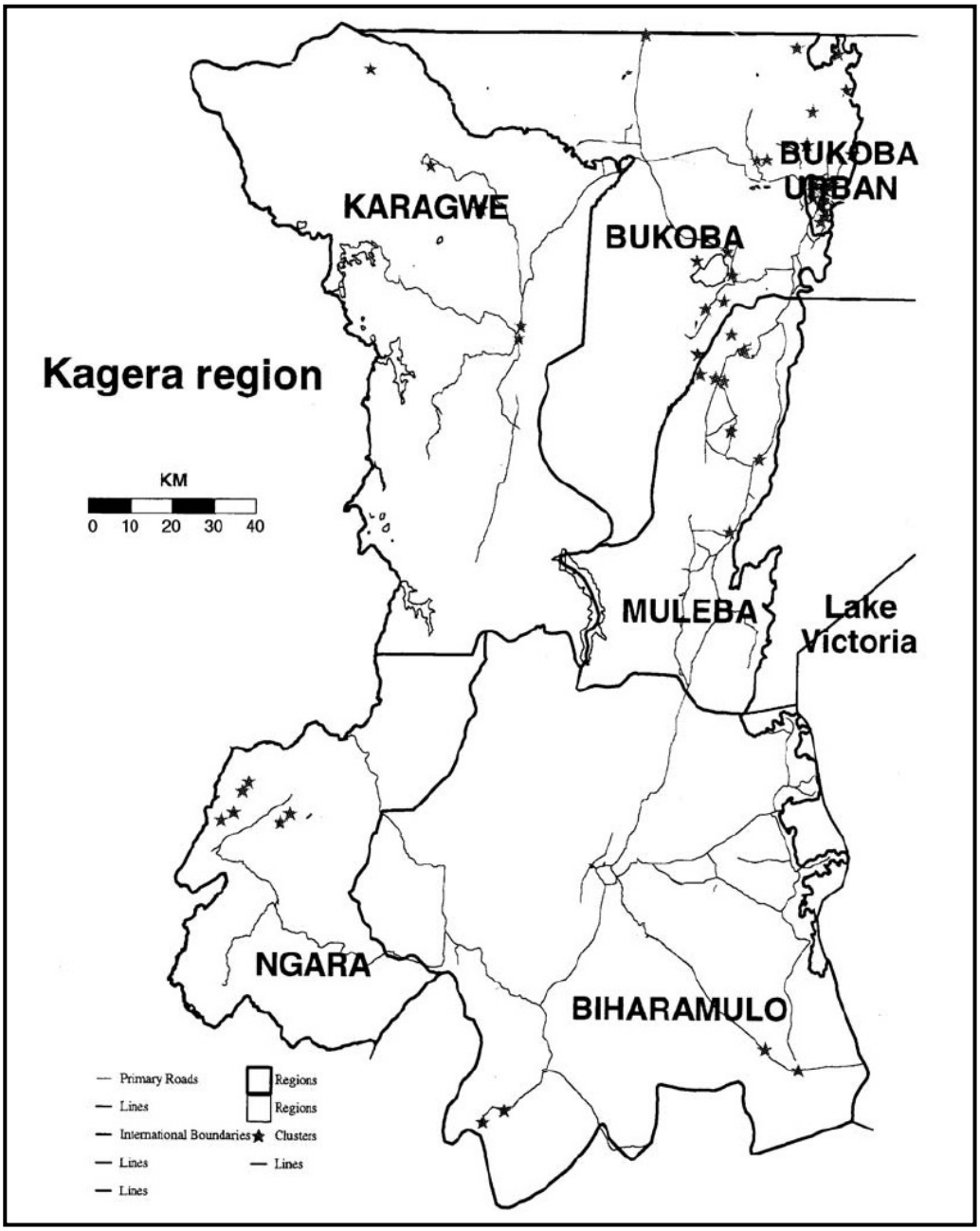
[38] See Figure 4 in Appendix C.
[39] The Times, April 15th 2008.

Appendix A: Maps and Survey Design

Map A1: Map of United Republic of Tanzania

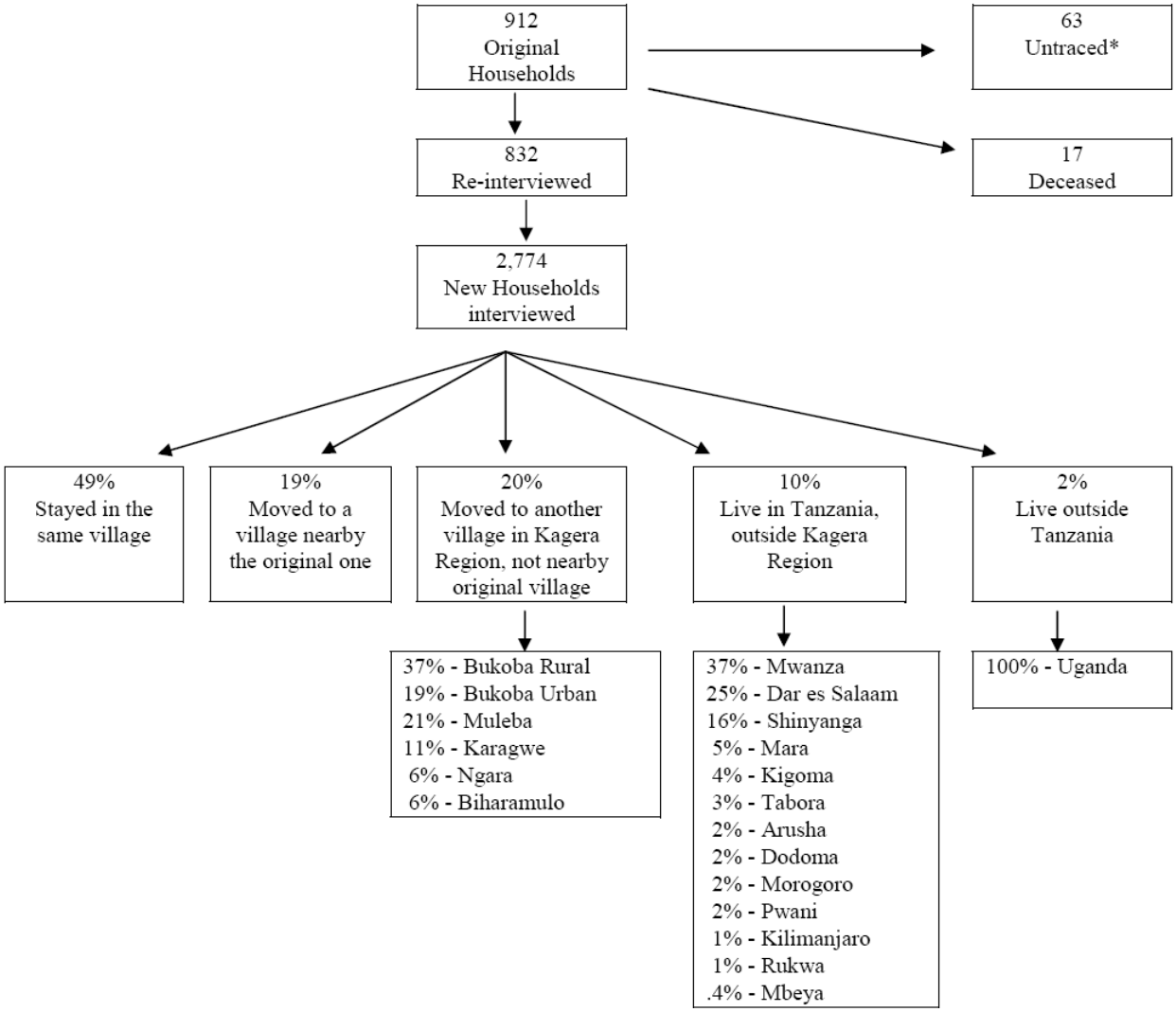
Source: Map No. 3667 Rev. 5 United Nations, Department of Peacekeeping Operations (Jan 2005), Cartographic Section

Map A2: Location of the KHDS clusters in Kagera Region, Tanzania



*_Source_: Ainsworth (2004).

Map A3: Re-interviewing 1991-94 Respondents After 10+ Years



**Notes*: "Re-interviewed" means that at least one member of the baseline household was re-interviewed in the KHDS 2004. "Deceased" means that all previous household members are reported to be dead. "Untraced" means that no previous household member was re-interviewed. * The locations of the sample of untraced individuals were reported by informants as: Kagera (57%), Dar es Salaam (8%), Mwanza (12%), other region (10%), other country (6%) and unknown (7%).
Source: Beegle, Kathleen, Joachim De Weerdt, and Stefan Dercon. (2006).

Appendix B: Data Preparation and Definitions

1. Data Cleaning

The econometric analysis in this paper used data from the Kagera Health and Development Survey (KHDS). The 2004 data required cleaning prior to analysis. The following steps were taken:

- From the initial 2,774 household who were re-contacted in the 2004 survey, around 82% of the household remained in the Kagera region, amounting to around 2,441 households. Slighlty less than these has a measure of consumption that was comparable to the earlier 1991-93 definition. All other observations were dropped, as the aim was to look at poverty in Kagera only.
- Having determined the variables of interest for each of the discrete and continuous regression models, the following variables contained missing observations and were recoded as follows:
    a. Did father attend school? Yes=1253, No=736, Missing=424 and Don't Know=27. *Missing* and *Don't Know* were recoded to *No*. Same procedure for mother's education.
    b. Can individual read or write? *Missing* and *Don't Know* were recoded to *No*.
    c. Has individual ever attended school? *Missing* and *Don't Know* were recoded to *No*.
    d. Tribe of household head? *Missing* and *Don't Know* were recoded to *Other*.
    e. Maximum education attained in household? *Missing* and *Don't Know* were recoded to *No*.
    f. What is individual's main economic activity? *Missing* and *Don't Know* were recoded to *No Job*.
    g. Share of active household members in agriculture. 4 *missing* observations were recoded (three to 1 and one to 0, depending on other household attributes)
    h. Weight of male and female head and spouse: *missing* observations, either because there was no head or spouse present in the household, or because respondents were not weighed, were recoded as zero.

  A number of households had item non-response for other variables and were dropped from the sample:
    a. Is respondent aged 6 years or more? *Yes*=2436, *No*=0, *Missing*=2 and *Don't Know*=3. *Missing* and D*on't Know* dropped.
    b. Age of individual? *Missing* and D*on't Know* dropped.
    c. Household size? *Missing* and D*on't Know* dropped.
    d. Annual household expenditure (constructed variable). *Missing* observations were dropped.

The remaining 2,420 observations were included in the Summary Statistics analysis.

- Having run an initial OLS regression, 5 observations were identified as outliers, having residuals more than 3 standard deviations away from the mean. These 5 observations were dropped from the final regression estimates. The remaining 2,415 observations were used during the estimation of the discrete and continuous regression models.

2. Household roster

The household roster lists all persons who are currently residing in the household. The household head is listed first and receives the id code 01. Household members are generally defined as including "all people who normally sleep and eat their meals together in the household during at least three (3) of the twelve (12) months preceding the interview" (Beegle et al, 2006). However, there are four exceptions to this definition:

- The following persons are household members, even if they have spent fewer than 3 months in the household in the past 12 months:
    - The person identified as the head of the household.
    - Persons who just joined the household and expect to be long-term residents (i.e. expected to be residing in the household in the next 6 months), such as newborn infants aged less than three months or new spouses.
- The following persons are not household members, even if they have slept in the same dwelling and taken their meals with the rest of the household for the entire 12 months before the survey:
    - Tenants and boarders and their dependents.
    - Contract servants and their dependents.

3. Accounting for size and composition of households

In addition to per capita expenditure estimates, we also analyse welfare as defined per equivalent adult, taking account also of economies of scale. Following White and Masset (2003), we define expenditure per equivalent adult (EPEA) as:

$$EPEA_i = \frac{E_i}{(AE_i)^{1-\alpha}} \quad \text{where} \quad AE_i = \sum_{j=1}^{N} \beta_{j,i} \qquad \text{[A6.2]}$$

where E is total household expenditure; α is the economies of scale coefficient (if $\alpha = 0$ then there are no economies of scale, if $\alpha = 1$ then there are extreme economies of scale) empirical estimates of α are typically in the range of 0.15 to 0.3, and β is the adult equivalent for individual j of household i.

We define $\alpha = 0.15$ and $\alpha = 0.3$, following White and Masset. The adult equivalent (β) for each individual was calculated by age group and gender using the WHO (1985) calorie guidelines presented in the following table:

Table B1: Recommended Calorific Intake by Age, Gender and Workload

Age	**Male**			**Female**		
1	820			820		
1-2	1150			1150		
2-3	1350			1350		
3-5	1550			1550		
5-7	1850			1750		
7-10	2100			1800		
10-12	2200			1950		
12-14	2400			2100		
14-16	2650			2150		
16-18	2850			2150		
	Workload			**Workload**		
	Light	Medium	Heavy	Light	Medium	Heavy
18-30	2600	3000	3550	2000	2100	2350
30-60	2500	2900	3400	2050	2150	2400
60+	2100	2450	2850	1850	1950	2150

Source: WHO (1985)

The following table yields the adult equivalence (in percent) for each group, using the WHO recommended daily calorie intake of 2800 calories for the average individual. In the absence of data on work-load in the data-sets, we assumed medium for all adults.

Table B2: Adult Equivalent Scales (%)

Age	Male			Female		
1	29			29		
1-2	41			41		
2-3	48			48		
3-5	55			55		
5-7	66			63		
7-10	75			64		
10-12	79			70		
12-14	86			75		
14-16	95			77		
16-18	102			77		
	Workload			**Workload**		
	Light	Medium	Heavy	Light	Medium	Heavy
18-30	93	107	127	71	75	84
30-60	89	104	121	73	77	86
60+	75	88	102	66	70	77

Source: Own Calculations

4. Other variables used in the analysis.

In addition to the variables described in table 8 of the text, a number of other variables were defined and tested in the econometric analysis. However, these were dropped due to high correlation or insignificant estimates. Their descriptions, and statistics, are included in table A3.

Table B3: Details of Variables Not Used in Final Regressions (From 2004 KHDS)

Variable Name	Variable Description	Type	Observations	Mean	Std. Dev.	Min	Max
Tribe of Household Head	Household Head's Tribe. Assumes values 1-4. 1=Mhaya, 2=Myambo, 3=Mhangaza/Msubi/Mzinia, 4=Other		2415				
Mhaya	Household head belongs to the Mhaya tribe	Discrete	1576	-	-	-	-
Myambo	Household head belongs to the Myambo tribe	Discrete	306	-	-	-	-
Mhangaza/Msubi/Mzinza	Household head belongs to the Mhangaza, Msubi or Mzinza tribe	Discrete	346	-	-	-	-
Other	Household head belongs to another tribe	Discrete	187	-	-	-	-
Z-score of Height of Head	Age and gender specific height of head in z-scores using sample mean and standard deviation	Continuous	2415	0.097	0.838	-11.579	3.148
Z-score of Height of Spouse	Age and gender specific height of spouse in z-scores using sample mean and standard deviation	Continuous	2415	0.030	0.704	-12.001	2.895
Health Problems of Household Head	Has the household head been living with any health problems in the last 6 months. 0=yes, 1=no	Discrete	2415	0.740	0.439	0	1
Marital Status	What is the present marital status of the Household Head. Assumes values 1-3, 1=Never Married, 2=Married, 3=Divorced/Separated		2415				
Never Married	Household head was never married	Discrete	158	-	-	-	-
Married	Household head is married	Discrete	1720	-	-	-	-
Divorced/Separated	Household was married and is now divorced or separated	Discrete	537	-	-	-	-
Year Type	What type of year was in last year. Assumes values of 1-5. 1=Good, 2=OK, 3=Average, 4=Bad, 5=Very Bad		2415				
Good	Last year was reported to be a good year	Discrete	21	-	-	-	-
OK	Last year was reported to be an ok year	Discrete	250	-	-	-	-
Average	Last year was reported to be an average year	Discrete	1615	-	-	-	-
Bad	Last year was reported to be a bad year	Discrete	321	-	-	-	-
Very Bad	Last year was reported to be a very bad year	Discrete	208	-	-	-	-
Health Burden of Household	Proportion of ill or disabled household members to total household size: (number of ill + number of disabled household members)/household size	Continuous	2415	0.190	0.256	0	1
Distance from community centre	Distance in km's of the household from the community centre.	Continuous	2415				
District	Location of the household by district. Assumes values of 1-6. 1=Biharamulo, 2=Ngara, 3=Muleba, 4=Bukoba Rural, 5=Karagwe, 6=Bukoba Urban		2415				
Biharamulo	Household is located in the Biharamulo district	Discrete	170	-	-	-	-
Ngara	Household is located in the Ngara district	Discrete	257	-	-	-	-
Muleba	Household is located in the Muleba district	Discrete	182	-	-	-	-
Bukoba Rural	Household is located in the Bukoba Rural district	Discrete	722	-	-	-	-
Karagwe	Household is located in the Karagwe district	Discrete	307	-	-	-	-
Bukoba Urban	Household is located in the Bukoba Urban district	Discrete	777	-	-	-	-
Electricity	Amount of households in community with electricity. Assumes values of 1-3. 1=None, 2=Few, 3=Most		2415				
None	No household in the community have electricity	Discrete	774	-	-	-	-
Few	A few households in the community have electricity	Discrete	1561	-	-	-	-
Most	Most households in the community have electricity	Discrete	80	-	-	-	-
Pipe-Borne Water	Amount of households in community with pipe-borne water. Assumes values from 1-4. 1=None, 2=Half, 3=3/4, 4=Most.		2415				
None	No household in the community has pipe-borne water in their house	Discrete	1905	-	-	-	-
Half	Half the households in the community have pipe-borne water in their house	Discrete	334	-	-	-	-
¾	Three-quarters of the households in the community have pipe-borne water in their house	Discrete	136	-	-	-	-
Most	Almost all of the households in community have pipe-borne water in their house	Discrete	40	-	-	-	-
HIV/AIDs	Is HIV one of the three most common problems in the community? 0=no, 1=yes.	Discrete	2415			0	1
Bank	Presence of a bank in the community. 0=yes, 1=no	Discrete	2415				
Distance to Nursery School	Distance to nearest nursery school, in km's	Continuous	2415	5.952	20.738	0	100
Health Centre	Presence of a health centre in the community. 0=yes, 1=no	Discrete	2415				
Public Transport	Does public transport pass by/through the community. 0=yes, 1=no	Discrete	2415	0.325	0.468	0	1
Household in Community	Number of households residing in the community	Continuous	2415	655	474.056	238	2640
People in Community	Number of people residing in the community	Continuous	2415	3029	1895.735	540	9142

Appendix C: Additional Results

1. Sensitivity of results to equivalence scales and economies of scale.

Table C1 shows the OLS and quantile regression results obtained using the WHO adult equivalence scales and a value of alpha=0.3, i.e. moderate economies of scale in consumption.

Table C1. Modelling Welfare in Kagera, per adult equivalent indicator (alpha=0.30)						
	1	2	3	4	5	6
	OLS	10th pctile	25th pctile	Median	75th pctile	90th pctile
Characteristics of the household head and spouse						
Age of head (less than forty)	0.004*	0.006*	0.004*	0.004*	0.004**	0.004
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Age of head (more than forty)	-0.003*	-0.005*	-0.003*	-0.003*	-0.002*	-0.002**
	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Gender (male)	-0.137*	-0.099*	-0.123*	-0.162*	-0.155*	-0.155*
	(0.012)	(0.024)	(0.014)	(0.015)	(0.018)	(0.036)
Weight of senior male (z-score)	0.061*	0.076*	0.081*	0.068*	0.059*	0.043*
	(0.005)	(0.009)	(0.008)	(0.008)	(0.009)	(0.011)
Weight of senior female (z-score)	0.050*	0.067*	0.045*	0.036*	0.043*	0.038*
	(0.005)	(0.011)	(0.006)	(0.007)	(0.007)	(0.010)
Main job of head (*agriculture*)						
Fishing	0.038	-0.039	0.040	-0.102*	0.091	0.143*
	(0.033)	(0.087)	(0.034)	(0.036)	(0.050)	(0.046)
Merchant	0.152*	0.075	0.104*	0.095*	0.145*	0.226*
	(0.021)	(0.041)	(0.029)	(0.025)	(0.031)	(0.038)
Admin/Clerical	0.143*	0.155*	0.128*	0.070**	0.177*	0.180*
	(0.024)	(0.055)	(0.032)	(0.032)	(0.040)	(0.048)
Transport	0.072*	-0.048	-0.025	0.028	0.107**	0.148*
	(0.028)	(0.034)	(0.041)	(0.039)	(0.045)	(0.056)
Hotel/restaurant owner	-0.071**	0.003	-0.153*	-0.168*	-0.064	-0.038
	(0.028)	(0.048)	(0.030)	(0.033)	(0.053)	(0.046)
Other	0.124*	0.108*	0.065*	0.046**	0.133*	0.128*
	(0.014)	(0.024)	(0.020)	(0.019)	(0.025)	(0.030)
No job	-0.185*	-0.360*	-0.262*	-0.167*	-0.091	0.038
	(0.032)	(0.050)	(0.070)	(0.043)	(0.050)	(0.088)
Maximum education of parents (*none*)	0.043*	0.072*	0.021	0.001	0.044*	0.039
	(0.010)	(0.024)	(0.016)	(0.017)	(0.016)	(0.024)
Religion of the head (*Muslim*)						
Christian	-0.056*	-0.095*	-0.074*	-0.072*	-0.046**	-0.073*
	(0.012)	(0.024)	(0.019)	(0.017)	(0.021)	(0.025)
Other	-0.011	-0.044	-0.002	0.170*	0.016	-0.089
	(0.035)	(0.074)	(0.085)	(0.038)	(0.028)	(0.048)
Characteristics of the household						
Maximum education attained (none)						
Primary/Secondary (lower)	0.026	0.047	-0.046	0.090**	-0.004	0.085**
	(0.028)	(0.075)	(0.025)	(0.040)	(0.033)	(0.042)
Secondary (upper)/Adult Ed	0.186*	0.210*	0.108*	0.262*	0.135*	0.246*
	(0.030)	(0.076)	(0.029)	(0.042)	(0.039)	(0.045)
Higher	0.539*	0.785*	0.593*	0.567*	0.253*	0.384*
	(0.041)	(0.083)	(0.047)	(0.053)	(0.090)	(0.126)
Dependency ratio	-0.026*	-0.011	-0.029*	-0.031*	-0.003	-0.025**
	(0.005)	(0.012)	(0.008)	(0.007)	(0.008)	(0.011)
Natural log of total help to household	0.023*	0.027*	0.023*	0.019*	0.022*	0.017*
	(0.002)	(0.003)	(0.002)	(0.002)	(0.003)	(0.003)
Household Size	-0.021*	0.018	-0.016	-0.021*	-0.044*	-0.053*
	(0.005)	(0.009)	(0.014)	(0.006)	(0.007)	(0.008)
Household size squared	0.001*	-0.000	0.002	0.001*	0.002*	0.001*
	(0.000)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)
Literacy ratio	0.259*	0.332*	0.255*	0.283*	0.222*	0.166*
	(0.023)	(0.057)	(0.028)	(0.031)	(0.028)	(0.042)
Total value of assets (TShs millions)	0.001*	0.001*	0.001*	0.001	0.003**	0.005*
	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)

Ag share in assets	-0.003*	-0.002*	-0.003*	-0.004*	-0.004*	-0.003*
	(0.000)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)
Female ratio	0.114*	0.086	0.095*	0.129*	0.127*	0.130**
	(0.025)	(0.047)	(0.028)	(0.035)	(0.031)	(0.052)
Household labour share in agriculture	-0.245*	-0.195*	-0.262*	-0.286*	-0.269*	-0.301*
	(0.018)	(0.030)	(0.023)	(0.025)	(0.030)	(0.034)
Community characteristics						
Post Office (*yes*)	-0.157*	-0.114*	-0.106*	-0.172*	-0.107*	-0.125**
	(0.015)	(0.025)	(0.027)	(0.027)	(0.021)	(0.050)
Mobile phone reception (km)	-0.006*	-0.009*	-0.006*	-0.005*	-0.005*	-0.004*
	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Use of Chemical fertilisers (yes)	-0.059*	-0.057	-0.002	-0.046**	-0.107*	-0.150*
	(0.014)	(0.035)	(0.020)	(0.023)	(0.020)	(0.022)
Urban (*rural*)	0.229*	0.268*	0.288*	0.253*	0.241*	0.246*
	(0.019)	(0.042)	(0.021)	(0.030)	(0.031)	(0.039)
Rainfall variation (z-score)	0.039*	0.075*	0.065*	0.052*	0.058*	0.045**
	(0.009)	(0.019)	(0.009)	(0.013)	(0.016)	(0.022)
Constant	12.739*	11.852*	12.488*	12.818*	13.175*	13.548*
	(0.053)	(0.112)	(0.082)	(0.076)	(0.071)	(0.124)
Observations	11513	11513	11513	11513	11513	11513
R^2/Pseudo-R^2	0.402	0.258	0.228	0.223	0.240	0.264

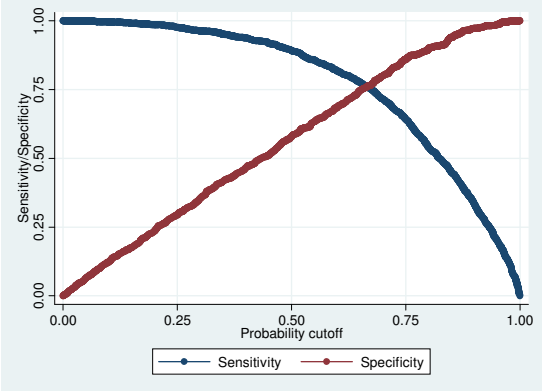
Notes:
Number of observations correspond to the number of individuals.
Base categories are shown in italics. Robust standard errors for OLS estimates and bootstrapped standard errors for the quantile estimates are shown in parentheses.
** significant at 5%; * significant at 1%

2. Probit Diagnostics

Table C2 shows the classification statistics for the probit model presented in Table 9. Generally the model does well at identifying the poor and non-poor, with over 78% of observations correctly classified. The matrix in the first panel shows that the model does better at correctly identifying the poor rather than the non-poor.

Table C2: Actual and Predicted Poverty Outcomes

	Actual		
Predicted	Poor	Not Poor	Total
Poor	6721	1643	8364
Not Poor	814	2242	3065
Total	7535	3895	11420



F
Figure 3: Sensitivity vs Specificity Plot for probit model

3. Rainfall and welfare in Kagera.

Figure 4 shows a simple scatter plot and fitted line for the z-score of rainfall in 2004 against the mean per capita expenditure, by cluster. It clearly shows that households in better off clusters experienced more adverse rainfall shocks than those in poorer clusters.

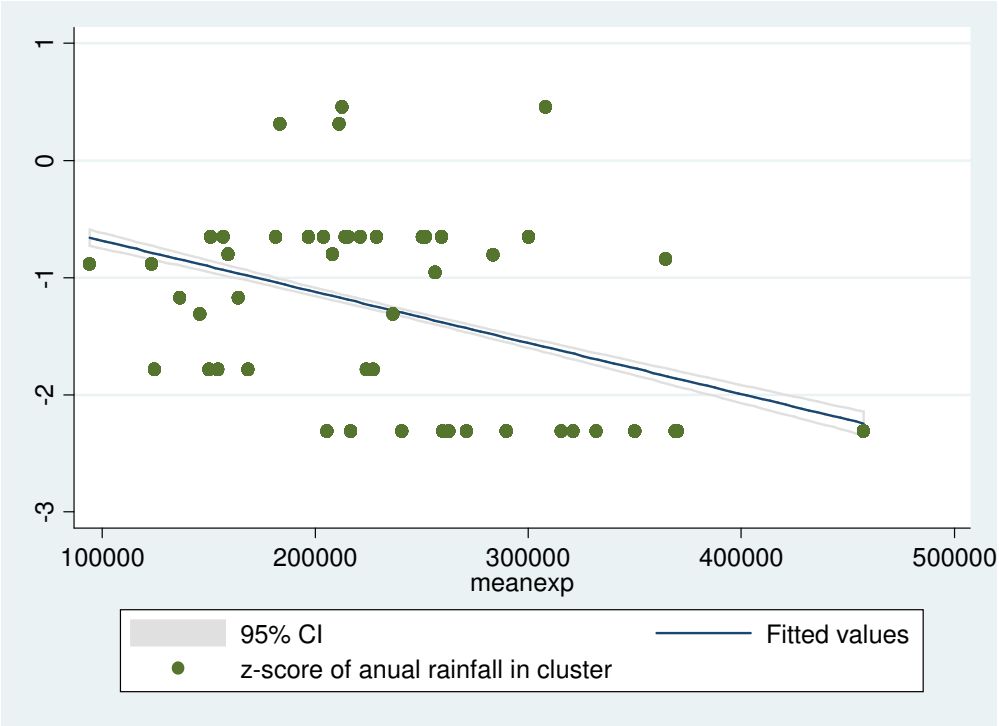


Figure 4: Larger adverse rain shocks for the wealthier clusters

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