MULTIDIMENSIONAL CHILD POVERTY AND DEPRIVATION IN UGANDA VOLUME ONE: THE EXTENT AND NATURE OF MULTIDIMENSIONAL CHILD POVERTY AND DEPRIVATION

APPENDICES

CONTENTS

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APPENDIX 1:

MEASURING MULTIDIMENSIONAL POVERTY IN UGANDA: A STEP-BY-STEP GUIDE

Table A1.1 shows the 35 material and social deprivation questions selected by UBOS after a detailed expert review of similar deprivation question modules that had been used in African (particularly South Africa) and other developing countries. UBOS consulted with UNICEF and academics at the University of Bristol and was also advised by Dr Viliami Fifita (the Government Statistician, Kingdom of Tonga), who is Chair of the Pacific Statistics Steering Committee (PSSC) on poverty measurement for the SDGs. This represents an excellent example of South-South cooperation in improving poverty measurement methodology.

TABLE A1.1: CONSENSUAL POVERTY QUESTIONS IN THE 2016/17 UNHS

SECTION 12B: CONSENSUAL POVERTY

CHILD ITEMS (ANY ONE BELOW 18 YEARS OF AGE)

Please say whether you think each of the following is essential for every parent or caregiver to be able to afford for children they care for in order for them to enjoy an acceptable standard of living in Uganda today. If you think it is essential please say 'ESSENTIAL'. If you think it is desirable but not essential please say 'DESIRABLE'. If you think it is not essential and not desirable please say 'NEITHER'. So the three possible answers are 'ESSENTIAL', 'DESIRABLE' or 'NEITHER'.

Item	Is [ITEM] 1=Essential 2= Desirable, but not essential 3= Neither 98= DK	Do you have [item]? 1=Have it 2= Don't have , can't afford 3= Don't have, don't want 4= Don't have, for another reason 98= DK/NA
	CP01	CP02
QC1 Three meals a day		
QC2 Two pairs of properly fitting shoes, including a pair of all-weather shoes		
QC3 Toiletries to be able to wash every day (e.g. soap, hairbrush/comb)		
QC4 Books at home suitable for their age (including reference and story books)		
QC5 Some new clothes (not second hand or handed on/down)		
QC6 Educational toys and games		
QC7 A visit to a health facility when ill and all the medication prescribed to treat the illness		
QC8 Own bed		
QC9 Own blanket		
QC10 Two sets of clothing		
QC11 Presents for children once a year on special occasions, e.g. birthdays, Christmas, Eid		
QC12 All fees, uniform of correct size and equipment required for school (e.g. books, school bag, lunch/lunch money, stationery)		
QC13 To be able to participate in school trips or events that cost money		
QC14 A desk and chair for homework for school aged children		
QC15 Bus/taxi fare or other transport (e.g. bicycle) to get to school		
QC16 Own room for children over 10 of different sexes		
QC17 Some fashionable clothes for secondary school aged children		
QC18 Own cell phone for secondary school aged children		

HOUSEHOLD ITEMS (relevant to all household members)

Please say whether you think each of the following is essential for everyone to be able to afford in order for them to enjoy an acceptable standard of living in Uganda today. If you think it is essential please say 'ESSENTIAL'. If you think it is desirable but not essential please say 'DESIRABLE'. If you think it is not essential and not desirable please say 'NEITHER'. So the three possible answers are 'ESSENTIAL', 'DESIRABLE' or 'NEITHER'

Item	Is [ITEM] 1=Essential 2= Desirable, but not essential 3= Neither 98= DK	Do you have [item]? 1=Have it 2= Don't have , can't afford 3= Don't have, don't want 4= Don't have, for another reason 98= DK/NA
	HP01	HP02
QH1 Enough money to repair or replace any worn out furniture		
QH2 Enough money to repair or replace broken electrical goods, e.g. a refrigerator		
QH3 To be able to make regular savings for emergencies		
QH4 To be able to replace broken pots and pans for cooking		
QH5 Enough money to repair a leaking roof for the main living quarters		
QH6 Have your own means of transportation (e.g. car, bike, motorcycle, etc)		

ADULT ITEMS (relevant to household members aged 18+)

Please say whether you think each of the following is essential for every adult (18+ years) to be able to afford in order for them to enjoy an acceptable standard of living in Uganda today. If you think it is essential please say 'ESSENTIAL'. If you think it is desirable but not essential please say 'DESIRABLE'. If you think it is not essential and not desirable please say 'NEITHER'. So the three possible answers are 'ESSENTIAL', 'DESIRABLE' or 'NEITHER'

Item	Is [ITEM] 1=Essential 2= Desirable, but not essential 3= Neither 98= DK	Do you have [item]? 1=Have it 2= Don't have , can't afford 3= Don't have, don't want 4= Don't have, for another reason 98= DK/NA
	AP01	AP02
QA1 A visit to a health facility when ill and all the medication prescribed to treat the illness		
QA2 Toiletries to be able to wash every day (e.g. soap, hairbrush/comb)		
QA3 Two pairs of properly fitting shoes, including a pair of all-weather shoes		
QA4 A small amount of money to spend each week on yourself		
QA5 Replace worn-out clothes by some new (not second-hand) ones		
QA6 To get together with friends/family (relatives) for a drink/meal at least once a month		
QA7 Celebrations on special occasions, such as Christmas, Eid.		
QA8 Attend weddings, funerals and other such occasions		
QA9 Able to access safe, reliable public transport , such as buses and boats		
QA10 Enough money to pay school fees for children		
QA11 Enough money to take children to a medical facility when sick		

ANALYTICAL METHOD

Unfortunately, many studies use arbitrary poverty measures that are simply a collection of things the authors think are 'bad', added together in an arbitrary manner. These studies invariably have limited credibility or impact (Gordon, 1995). The robust measurement of both adult and child poverty requires a methodology that allows the 'best' set of deprivation indicators to be selected and also the rejection of inadequate indicators.

Building on recent methodological advances from the Poverty and Social Exclusion project,[1] Guio, Gordon & Marlier (2012) proposed a theory-based analytical framework for developing robust aggregate deprivation indicators that can be used for analytical and monitoring purposes at national and regional levels (see also Guio et al., 2016, 2017a, 2017b). The optimal list of deprivation indicators should be identified based on four criteria:

1. The **suitability** of each deprivation item, in order to check that citizens in Uganda (as well as the different population subgroups within the country) perceive them as necessary for people to have an 'acceptable' standard of living. 'Suitability' should thus be understood as the 'face validity' of the measure among Ugandan citizens.

2. The **validity** of individual deprivation items, to ensure that each item exhibits statistically significant relative risk ratios with independent variables known to be correlated with deprivation. Five validators were used to assess criterion validity (Cronbach & Meehl, 1955):

    a) Head of household's education level (scored from 1 to 8 – from *'degree' to 'no formal education'*)

    b) Expenditure poverty using the official measure

    c) Head of household's economic activity (*'working in the cash economy' vs 'subsistence/ family worker or unemployed'*)

    d) Subjective poverty (scored from 1 to 5 - from *'very rich' to 'very poor'*); and

    e) International Socio-Economic Index (ISEI) of occupational status – a widely used measure of occupational status.

    Extensive research has shown that people suffering from deprivation are more likely to have lower incomes, worse education and lower-status occupations than people who are not deprived. In addition, people who are deprived are a priori more likely to consider themselves to be 'poor' (Bradshaw & Finch, 2003).

6. The **reliability** of the deprivation scale, to assess the internal consistency of the scale as a whole, i.e. how closely related the set of deprivation items are as a group. This assessment can be undertaken using the basis of the Cronbach's Alpha statistic and a Classical Test Theory framework, and complemented with additional tests on the reliability of each individual item in the scale based on Item Response Theory (IRT).

7. The **additivity** of items, to check whether a child or adult with a deprivation indicator score of '2' (suffering from 2 deprivations) is in reality suffering from more severe deprivation than a person with a score of '1', i.e. that the deprivation indicator's components add up.

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1 http://www.poverty.ac.uk/

Only the deprivation items that successfully pass these four steps should be considered eligible for being aggregated into a final deprivation index. In particular, it is important that a deprivation measure does not attempt to aggregate 'apples and pears' – the components of such a measure need to be adequate measures of an underlying latent construct (i.e. poverty).

The step by step details of the results of these tests can be found below:

STEP 1: CREATING A SUITABLE DEPRIVATION INDEX

Select the deprivation indicators that 50% or more of the population agree are 'essentials' for everyone to be able to afford in order for them to enjoy an acceptable standard of living (see Table A1.1)

TABLE A1.2: PERCENTAGE OF RESPONDENTS WHO VIEW THE CHILD DEPRIVATION ITEM AS ESSENTIAL

	CHILD DEPRIVATION ITEMS	ESSENTIAL
1	A visit to the health facility when ill and all prescribed medication	97%
2	Three meals a day	96%
3	Two sets of clothing	94%
4	Toiletries to be able to wash every day	93%
5	All fees, uniforms of correct size and equipment	88%
6	Own blanket	85%
7	Own bed	81%
8	Two pairs of properly-fitting shoes	79%
9	Own room for children over 10 of different sexes	76%
10	Books at home for their age	71%
11	Some new clothes	70%
12	To be able to participate in school trips	69%
13	Bus/taxi fare or other transport	68%
14	A desk and chair for homework	55%
15	Presents for children once a year on special occasions	54%
16	Educational toys and games	53%
17	Some fashionable clothes for secondary school-aged children	37%
18	Own cell phone for secondary school-aged children	22%

Source: UNHS (N= 15,658 respondents)
Note: Unless otherwise stated, throughout the threshold analyses, cases were weighted by sample adjusted for age and sex and weighted down to original sample size.

TABLE A1.3: PERCENTAGE OF RESPONDENTS WHO VIEW THE ADULT DEPRIVATION ITEM AS ESSENTIAL

	Adult deprivation items	Essential
1	A visit to the health facility when ill and all prescribed medication	98%
2	Enough money to take the child to a medical facility when sick	95%
3	Enough money to pay school fees	92%
4	Toiletries to be able to wash every day	93%
5	Access to safe, reliable public transport	87%
6	Celebrations on special occasions e.g. Christmas, Eid	82%
7	To attend weddings, funerals and other such occasions	80%
8	Two pairs of properly-fitting shoes	77%
9	To be able to replace worn-out clothes with some new ones	66%
10	A small amount of money to spend	60%
11	To get together with friends/relatives at least once a month	56%

Source: UNHS (N= 15,658 respondents)

TABLE A1.4: PERCENTAGE OF RESPONDENTS WHO VIEW THE HOUSEHOLD DEPRIVATION ITEM AS ESSENTIAL

Household deprivation items		Essential
1	To be able to make regular savings for emergencies	92%
2	Enough money to repair a leaking roof for main living quarters	86%
3	To be able to replace broken pots and pans for cooking	84%
4	Have your own means of transportation	79%
5	Enough money to repair or replace any worn-out furniture	78%
6	Enough money to repair or replace broken electrical goods	56%

Source: UNHS (N= 15,658 respondents)

Tables A1.2 to A1.4 show that only the two deprivation items below were dropped, meaning that fewer than 50% of respondents considered them to be essentials. This means that these items do not have the support of the majority of the Ugandan population and thus lack face validity.

- Some fashionable clothes for secondary school-aged children (37%)
- Own cell phone for secondary school-aged children (22%)

The remaining 33 deprivation items (16 Child, 11 Adult and 6 Household) were then tested to see if they were valid indicators of poverty.

STEP 2 - CREATING 'A PREFERENCE FREE' DEPRIVATION INDEX

In order to distinguish respondents' choices about how to live from constraints resulting from insufficient income and other resources, only select (where available) items for the deprivation index that people 'don't have because they can't afford' them.

TABLE A1.5: PERCENTAGE OF CHILDREN DEPRIVED OF THE ITEM

Child deprivations		Don't have, can't afford
1	Own bed	74%
2	Two pairs of properly-fitting shoes	71%
3	Presents for children once a year on special occasions	70%
4	Own blanket	66%
5	Some new clothes	63%
6	Books at home for their age	59%
7	Three meals a day	48%
8	A desk and chair for homework	45%
9	Educational toys and games	44%
10	Bus/taxi fare or other transport	41%
11	To be able to participate in school trips	38%
12	All fees, uniforms of correct size and equipment	34%
13	A visit to the health facility when ill and all prescribed medication	33%
14	Toiletries to be able to wash every day	29%
15	Two sets of clothing	17%
16	Own room for children over 10 of different sexes	17%
17	Some fashionable clothes for secondary school children	9%
18	Own cell phone for secondary school-aged children	9%

Source: UNHS (N= 41,088 children)

TABLE A1.6 PERCENTAGE OF ADULTS DEPRIVED OF THE ITEM

	Adult deprivations	Don't have, can't afford
1	A small amount of money to spend	68%
2	To get together with friends/relatives at least once a month	65%
3	To be able to replace worn-out clothes with some new ones	58%
4	Two pairs of properly-fitting shoes	55%
5	Enough money to pay school fees	53%
6	Enough money to take the child to a medical facility when sick	49%
7	Access to safe, reliable public transport	31%
8	A visit to the health facility when ill and all prescribed medication	31%
9	Toiletries to be able to wash every day	24%
10	To attend weddings, funerals and other such occasions	23%
11	Celebrations on special occasions e.g. Christmas, Eid	20%

Source: UNHS (N=33,159 adults)

TABLE A1.7 PERCENTAGE OF HOUSEHOLDS DEPRIVED OF THE ITEM

	Household deprivations	Don't have, can't afford
1	Have your own means of transportation	67%
2	Enough money to repair or replace broken electrical goods	65%
3	Enough money to repair or replace any worn-out furniture	62%
4	To be able to make regular savings for emergencies	55%
5	Enough money to repair a leaking roof for main living quarters	42%
6	To be able to replace broken pots and pans for cooking	40%

Source: UNHS (N=15,708 respondents)

Age-appropriate child indicators in Uganda

Children's needs change as they grow older, thus deprivation measures for children need to be age appropriate. The following protocol was used:

- Age 11–17 for bedrooms for every child of different sex
- Age 6–17 for a desk and chair for homework, going on a school trip. Bus/taxi fare, school fees and uniforms
- Age 3–17 for books suitable for age
- Age 13–17 for some fashionable clothes and cell phone
- Age 0–17 for all other child items.

STEP 3 – CREATING A VALID DEPRIVATION INDEX

It is essential that each component in the index is a valid measure of deprivation. The simplest way to achieve this is to ensure that every deprivation item has a high odds ratio (using logistic regression[2]) with independent indicators known to correlate highly with poverty – specifically:

1. Head of household's education level (scored from 1 to 8 – from *'degree'* to *'no formal education'*) – **HHEd**

2. Expenditure poverty using the official measure (1 poor, 0 not poor) – **Poor**

3. Head of household's economic activity (*'working in the cash economy'* vs *'subsistence/ family worker or unemployed'*) – **HHact**

4. Subjective poverty (scored from 1 to 5 - from *'very rich'* to *'very poor'*) – **Sub_pov**

5. International Socio-Economic Index (ISEI) of occupational status– a widely-used measure of occupational status. Lower scores indicate higher occupational prestige – **ISEI.**

TABLE A1.8: LOGISTIC REGRESSION VALIDITY TESTS FOR CHILDREN AND HOUSEHOLD DEPRIVATION ITEMS

	Children and household items + 2 adult items concerning children	HHEd	Poor	HHact	Sub_pov	ISEI
1	**Child:** Three meals a day	1.5	5.5	1.8	3.5	28.7
2	**Child:** Two pairs of properly-fitting shoes	1.6	6.9	2.3	2.9	44.6
3	**Child:** Toiletries to be able to wash every day	1.4	3.3	1.5	2.7	15.2
4	**Child:** Books at home for their age	1.3	2.1	1.3	1.6	7.1
5	**Child:** Some new clothes	1.4	4.1	1.8	2.6	18.0
6	**Child:** Educational toys and games	1.2	2.4	1.3	1.4	4.1
7	**Child:** A visit to health facility when ill and all prescribed medication	1.2	1.7	1.1	2.0	6.3
8	**Child:** Own bed	1.5	5.1	1.8	2.5	16.8
9	**Child:** Own blanket	1.5	5.1	1.8	2.5	19.1
10	**Child:** Two sets of clothing	1.4	2.9	1.6	2.6	17.5
11	**Child:** Presents for children once a year on special occasions	1.3	3.1	1.7	2.1	8.9
12	**Child**: All school fees, uniforms of correct size and equipment	1.3	2.1	1.4	1.7	7.8
13	**Child:** To be able to participate in school trips	1.2	1.8	1.2	1.5	5.1
14	**Child:** A desk and chair for homework	1.2	1.6	1.1	1.3	3.0
15	**Child:** Bus/taxi fare or other transport	1.2	1.7	1.3	1.5	3.9
16	**Child:** Own room for children over 10 of different sexes	1.1	1.3	1.0	1.3	1.2
17	**Household:** Enough money to repair or replace worn-out furniture	1.4	4.1	1.9	2.9	19.0
18	**Household:** Enough money to repair or replace electronic goods	1.2	2.0	1.3	1.6	5.7
19	**Household:** To be able to make savings for emergencies	1.3	3.4	1.8	2.6	10.5
20	**Household:** Enough money to repair a leaking roof for main living q.	1.3	2.4	1.5	2.0	9.7
21	**Household:** To have own means of transport	1.2	2.1	1.7	1.9	3.2
22	**Household:** Enough money to replace broken pots and pans	1.3	2.9	1.8	2.3	11.6
23	**Adult:** Enough money to pay school fees	1.3	1.9	1.3	1.7	5.6
24	**Adult:** Enough money to take the child to a medical facility when sick	1.3	3.0	1.6	2.4	10.7

Source: UNHS (N= 41,088 children)
Note: All above analyses were run on children only including the two adult items that concern their children. The odd ratios highlighted in bold are not statistically significant at >0.05 level. The rest are significant at >0.001 level.

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2   In all logistic regression, household head's age and sex were used as controls.

TABLE A1.9: LOGISTIC REGRESSION RESULTS FOR ADULT DEPRIVATION ITEMS

Adult and household items	HHEd	Poor	HHact	Sub_pov	ISEI
1 **Adult:** A visit to the health facility when ill and all prescribed medication	1.3	2.2	1.3	2.2	7.8
2 **Adult:** Toiletries to be able to wash every day	1.4	3.2	1.6	2.6	12.9
3 **Adult:** Two pairs of properly-fitting shoes	1.6	8.7	2.6	3.3	50.0
4 **Adult:** A small amount of money to spend	1.4	4.3	2.0	2.5	14.1
5 **Adult:** To be able to replace worn-out clothes with some new ones	1.4	4.4	2.0	2.7	19.6
6 **Adult:** To get together with friends/relatives at least once a month	1.2	2.4	1.4	2.0	6.5
7 **Adult:** Celebrations on special occasions, e.g. Christmas, Eid	1.3	2.0	1.4	2.4	8.7
8 **Adult:** To attend weddings, funerals and other such occasions	1.2	1.8	1.4	2.4	5.9
9 **Adult:** Access to safe, reliable public transport	1.3	2.2	1.5	2.5	10.5

Source: UNHS (N=33,159 adults)
Note: All above analyses were run on adults only. All odd ratios are above 1 and significant at p<0.001 level.

After allowing for age and gender differences, the odds ratio table A1.8 above shows that respondents, who cannot afford for their children to eat *'three meals a day'*, are 5.5 times more likely to be below the monetary poverty line (Poor). They were also nearly 29 times more likely to have an occupation with low prestige (e.g. subsistence farming, unskilled manual work, etc). In both these cases, the 95% confidence intervals for these odds does not span 1.0 and so can be considered to be statistically 'significant'.

Tables A1.8 and A1.9 show that all the adult, household and child deprivation items passed all five validity tests, with the exception of *'own room for children over 10 of different sexes'* which just failed one of the five tests (Head of Household Economic Activity). However, all 33 items are considered to be valid indicators of deprivation as, given the large number of separate tests (33 * 5 =165 tests), it would be expected that there would be some false negative results due to random error (Guio et al., 2012).

STEP 4 – CREATING A RELIABLE INDEX OF DEPRIVATION (CLASSICAL TEST THEORY)

Deprivation indices need to be both valid and reliable. A valid index is one which has an acceptably low level of *systematic* measurement error and a reliable index is one with an acceptably low level of *random* measurement error. The most common way to measure reliability is to use a Classical Test Theory framework and the Cronbach's Alpha statistic (Cronbach, 1951). A Cronbach's Alpha above 0.7 is considered acceptable in the Social Sciences. Table A1.10 shows that the Alpha for the 24 valid child and household deprivation items was 0.894 which indicates a high level of reliability.

TABLE A1.10: CHRONBACH'S ALPHA SCORES FOR CHILD AND HOUSEHOLD ITEMS COMBINED

	Children and household items, combined with adult items concerning children	Alpha if deleted
1	**Child:** all school fees, uniforms of correct size and equipment	0.8869
2	**Adult:** Enough money to pay school fees	0.8873
3	**Adult:** Enough money to take the child to a medical facility when sick	0.8877
4	**Child:** Some new clothes	0.8878
5	**Child:** to be able to participate in school trips	0.8878
6	**Child:** Books at home for their age	0.8880
7	**Child:** Own bed	0.8882
8	**Child:** Own blanket	0.8882
9	**Household:** enough money to repair or replace worn-out furniture	0.8882
10	**Child:** bus/taxi fare or other transport	0.8885
11	**Child:** Two pairs of properly-fitting shoes	0.8886
12	**Household:** Enough money to replace broken pots and pans	0.8887
13	**Household:** To be able to make savings for emergencies	0.8887
14	**Child:** A desk and chair for homework	0.8892
15	**Household:** Enough money to repair a leaking roof for main living quarters	0.8892
16	**Child:** Two sets of clothing	0.8899
17	**Child:** A visit to health facility when ill and all prescribed medication	0.8903
18	**Child:** Toiletries to be able to wash every day	0.8905
19	**Child:** Presents for children once a year on special occasions	0.8910
20	**Child:** Three meals a day	0.8911
21	**Child:** Educational toys and games	0.8939
22	**Household:** To have own means of transport	**0.8941**
23	**Household:** Enough money to repair or replace electronic goods	**0.8942**
24	**Child:** own room for children over 10 of different sexes	**0.8945**
	Total weighted alpha score	**0.8940**

Source: UNHS (N= 41,088 children)
Note: The total weighted alpha score suggests that the items are internally consistent. However, items highlighted in bold may be unreliable given the higher alpha scores when the item is deleted.

TABLE A1.11: ALPHA SCORES FOR ADULT AND HOUSEHOLD ITEMS COMBINED

	Adult and household items	Alpha if deleted
1	**Household:** Enough money to replace broken pots and pans	0.8714
2	**Adult:** To be able to replace worn-out clothes with some new ones	0.8725
3	**Household:** Enough money to repair or replace worn-out furniture	0.8726
4	**Household:** To be able to make savings for emergencies	0.8727
5	**Household:** Enough money to repair a leaking roof for main living quarters	0.8728
6	**Adult:** Two pairs of properly-fitting shoes	0.8736
7	**Adult:** A visit to the health facility when ill and all prescribed medication	0.8743
8	**Adult:** A small amount of money to spend	0.8748
9	**Adult:** Access to safe, reliable public transport	0.8748
10	**Adult:** Celebrations on special occasions e.g. Christmas, Eid.	0.8751
11	**Adult:** Toiletries to be able to wash every day	0.8751
12	**Adult:** To attend weddings, funerals and other such occasions	0.8754
13	**Adult:** To get together with friends/relatives at least once a month	0.8765
14	**Household:** enough money to repair or replace electronic goods	0.8823
15	**Household:** to have own means of transport	**0.8829**
	Total weighted alpha score	**0.8825**

Source: UNHS (N=33,159 adults)
Note: The total weighted alpha score suggests the items are internally consistent.

STEP 4B – CREATING A RELIABLE INDEX OF DEPRIVATION (ITEM RESPONSE THEORY)

Item Response Theory (IRT) models can provide additional information on the reliability of each individual item in the deprivation scale/index. IRT models describe the relationship between a person's response to questions and an unobserved latent trait such as knowledge of biology, level of happiness or amount of deprivation**.**

In Table A1.12, the column marked 'Severity' can be interpreted as the likely severity of deprivation suffered by a child who lacks an item because their household/parents can't afford it. The severity scores in this table are measured in units of standard deviation from the population average. The table shows that respondents who do not have enough money to repair or replace broken electrical goods have the lowest latent deprivation score, while those who cannot afford for their children to have two sets of clothes are likely to be much more severely deprived.

The column marked 'Discrimination' in Table A1.12 indicates how well the deprivation item distinguishes between 'deprived' and 'not deprived' children. The discrimination score has been converted into a correlation[3] (ranging between 0 and 1) and a score above 0.4 is considered to be an acceptable level of discrimination (Guio et al., 2012). Thus, Table A1.12 shows that having enough money to replace or repair electrical goods does not discriminate well between the deprived and not deprived (discrimination = 0.38). By contrast, being unable to afford for your children to have their own bed has a very high discrimination score (0.72)

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3   The IRT discrimination coefficients (d) can be converted to correlations using the following formula: $d / \sqrt{3.29 + d^{2}}$

TABLE A1.12: SEVERITY AND DISCRIMINATION SCORES FOR CHILDREN AND HOUSEHOLD DEPRIVATIONS

	Children and household items, plus adult items concerning children	Severity	Discrimination
1	**Household:** Enough money to repair or replace electronic goods	- 1.01	**0.38**
2	**Child:** Presents for children once a year on special occasions	- 0.86	0.55
3	**Child:** Own bed	- 0.84	0.72
4	**Household:** To have own means of transport	- 0.78	**0.35**
5	**Child:** Two pairs of properly-fitting shoes	- 0.75	0.68
6	**Child:** Own blanket	- 0.57	0.68
7	**Household:** Enough money to repair or replace worn-out furniture	- 0.55	0.66
8	**Child:** Some new clothes	- 0.42	0.70
9	**Household:** To be able to make savings for emergencies	- 0.30	0.63
10	**Child:** Books at home for their age	- 0.25	0.75
11	**Adult:** Enough money to take the child to a medical facility when sick	0.05	0.70
12	**Child:** Three meals a day	0.13	0.51
13	**Child:** A desk and chair for homework	0.18	0.78
14	**Household:** Enough money to repair a leaking roof for main living quarters	0.24	0.60
15	**Child:** Bus/taxi fare or other transport	0.30	0.82
16	**Child:** To be able to participate in school trips	0.35	0.86
17	**Child:** Educational toys and games	0.36	0.40
18	**Household:** Enough money to replace broken pots and pans	0.36	0.62
19	**Adult:** Enough money to pay school fees	0.40	0.90
20	**Child:** All school fees, uniforms of correct size and equipment	0.44	0.92
21	**Child:** A visit to health facility when ill and all prescribed medication	0.74	0.59
22	**Child:** Toiletries to be able to wash every day	0.93	0.58
23	**Child:** Own room for children over 10 of different sexes	1.69	0.55
24	**Child:** Two sets of clothing	1.81	0.50

Note (*) Except for the two items with <0.40 factor scores, all items appear to have a relatively high ability to distinguish between the deprived and the non-deprived. The negative severity scores mean that respondents who lack the associated items are UNLIKELY to be severely deprived.

TABLE A1.13: SEVERITY AND DISCRIMINATION SCORES FOR ADULT AND HOUSEHOLD DEPRIVATION ITEMS COMBINED

	Adult and household items	Severity	Discrimination
1	**Household**: To have own means of transport	- 0.66	0.47
2	**Household:** Enough money to repair or replace electronic goods	- 0.63	0.50
3	**Adult:** A small amount of money to spend	- 0.58	0.77
4	**Adult:** To get together with friends/relatives at least once a month	- 0.53	0.69
5	**Household:** Enough money to repair or replace worn-out furniture	- 0.30	0.79
6	**Adult:** To be able to replace worn-out clothes with some new ones	- 0.25	0.79
7	**Adult:** Two pairs of properly-fitting shoes	- 0.16	0.76
8	**Household:** To be able to make savings for emergencies	- 0.12	0.78
9	**Household:** Enough money to repair a leaking roof for main living quarters.	0.30	0.78
10	**Household:** Enough money to replace broken pots and pans	0.37	0.83
11	**Adult:** A visit to the health facility when ill and all prescribed medicines	0.64	0.76
12	**Adult:** Access to safe, reliable public transport	0.65	0.73
13	**Adult:** Toiletries to be able to wash every day	0.89	0.79
14	**Adult:** To attend weddings, funerals and other such occasions	0.95	0.77
15	**Adult:** Celebrations on special occasions e.g. Christmas, Eid	1.00	0.81

Note (*) The IRT scores suggest that all items have a high ability to distinguish between the deprived and the non-deprived. The negative severity scores mean that respondents who lack the associated items are UNLIKELY to be severely deprived.

Tables A1.10 to A1.12 show that the two items below failed both the Classical Test Theory and Item Response Theory tests, i.e. they seem to be measures of a relatively high standard of living (more than 0.6 standard deviations above the average person's standard of living in Uganda) and had therefore low discrimination (<0.4 correlation), i.e. a lack of ability to distinguish the 'poor' from the 'not poor' in Uganda.

- To have own means of transport
- Enough money to repair or replace electronic goods

Summary of items that failed suitability, reliability and validity tests

Suitability
- Some fashionable clothes for secondary school children
- Own cell phone for secondary school-aged children

Validity
- All of the remaining items are considered to pass the validity tests

Reliability
- Enough money to repair or replace broken electrical goods
- To have own means of transport

Out of the 35 deprivation questions included in the consensual deprivation module of the UHNS 2016/17, four items failed the suitability, validity or reliability tests and were thus excluded and 31 deprivation items were retained for further testing.

STEP 5 – CHECKING THE REVISED INDEX IS ADDITIVE AFTER REMOVING OUTLIERS

The components of any deprivation index should be additive, e.g. a person or household with a deprivation score of three should be poorer than a person or household with a deprivation score of two. Some components of the index may not be additive, for example, it is important to check that a respondent who 'cannot afford' two pairs of properly-fitting shoes and a bed for each of their children is poorer than a person who 'cannot afford' beds but has shoes for their children.
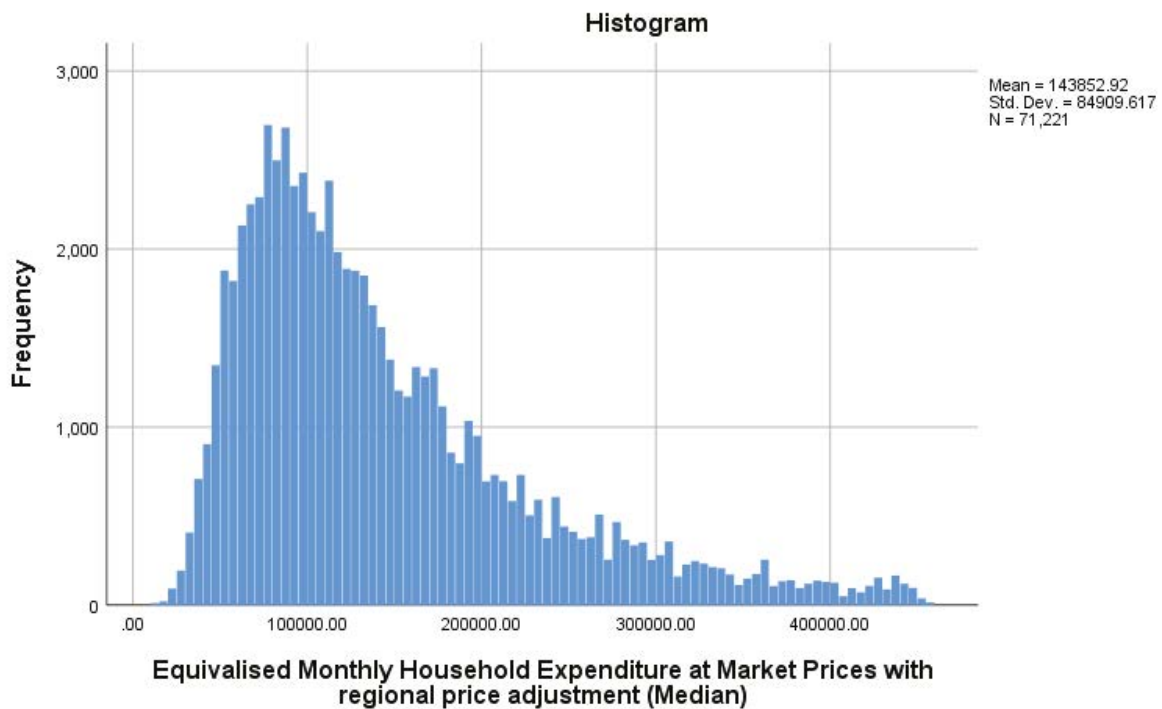
It is also essential to remove large outliers.[4] For example, there is invariably somebody in a survey who says they earn millions of shillings but cannot afford any of the deprivation items. Figure A1.1 shows the distribution of equivalised monthly household expenditure after the removal of likely outliers. As would be expected, Figure A1.1 shows a right-skewed normal distribution of household expenditure, after adjusting for household size and composition (ie. equivalisation – see Appendix 2).

It should be noted that these 'rich' households were only excluded in the models used to identify the additivity of the deprivation items and the optimum poverty line (as their inclusion would have distorted these results). The 'rich' households are of course included in all the results tables in the main report (e.g. Chapter 4).

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4   The outlier labelling rule of Hoaglin & Iglewicz (1987) was used for determining the equivalised household expenditure cut-off point for: [Q3 + 2.2 X (Q3-Q1)].
     In total 2,891 outliers were omitted which is approximately 3.8% of the UNHS sample.

Additivity was checked using an analysis of variance (ANOVA) model and all suitable, valid and reliable deprivations passed these additivity tests.[5]

FIGURE A1.1: HISTOGRAM OF EQUIVALISED MONTHLY HOUSEHOLD EXPENDITURE IN THE 2016/17 UNHS AFTER THE REMOVAL OF LIKELY OUTLIERS

Histogram

Mean = 143852.92
Std. Dev. = 84909.617
N = 71,221

Equivalised Monthly Household Expenditure at Market Prices with regional price adjustment (Median)

Cases weighted by Sample adjusted for age and sex, weighted down to original sample size

The final suitable, valid, reliable and additive material and social deprivation index included four household deprivations, nine adult deprivation and 18 child deprivations (31 deprivations in total) and is shown in Table A1.14 (below)

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5   The detailed additivity results are not shown here but are available from Professor Gordon (email: dave.gordon@bristol.ac.uk)

TABLE A1.14: FINAL ADULT AND CHILD DEPRIVATION INDEX

1.	To be able to replace broken pots and pans for cooking
2.	To be able to make regular savings for emergencies
3.	Enough money to repair a leaking roof for the main living quarters
4.	Enough money to repair or replace any worn-out furniture
5.	Replace worn-out clothes with some new (not secondhand) ones
6.	Two pairs of properly-fitting shoes, including a pair of all-weather shoes
7.	A visit to a health facility when ill and all the medication prescribed to treat the illness
8.	Able to access to safe, reliable public transport, such as buses and boats
9.	Toiletries to be able to wash every day (e.g. soap, hairbrush/comb)
10.	A small amount of money to spend each week on yourself
11.	Attend weddings, funerals and other such occasions
12.	Celebrations on special occasions, such as Christmas, Eid
13.	To get together with friends/family (relatives) for a drink/meal at least once a month
14.	All fees, uniform of correct size and equipment required for school (e.g. books, school bag, lunch/lunch money, station
15.	Enough money to pay school fees for children
16.	Bus/taxi fare or other transport (e.g. bicycle) to get to school
17.	To be able to participate in school trips or events that cost money
18.	A desk and chair for homework for school-aged children
19.	Enough money to take children to a medical facility when sick
20.	Books at home suitable for their age (including reference and story books)
21.	Some new clothes (not second-hand or handed on/down)
22.	Two sets of clothing
23.	Two pairs of properly-fitting shoes, including a pair of all-weather shoes
24.	Own blanket
25.	Own bed
26.	A visit to a health facility when ill and all the medication prescribed to treat the illness
27.	Toiletries to be able to wash every day (e.g. soap, hairbrush/comb)
28.	Presents for children once a year on special occasions, e.g. birthdays, Christmas, Eid
29.	Three meals a day
30.	Own room for children over 10 of different sexes
31.	Educational toys and games

This deprivation index includes age appropriate deprivation measures, e.g. deprivations which only affect school-aged children, adults, etc. Thus, different age groups can potentially have different maximum scores. Nevertheless, the final adult and child deprivation index is both valid and highly reliable for all age groups.

Reliability by age groups:

Pre-school (0-5):	Alpha = 0.872	Lambda 2 = 0.876	N=16
Primary-school (6-12):	Alpha = 0.911	Lambda 2 = 0.914	N=22
Secondary School/Teenage (13-17):	Alpha = 0.916	Lambda 2 = 0.918	N=21
Working age (18-60):	Alpha = 0.880	Lambda 2 = 0.882	N=13
Older Adults (60+):	Alpha = 0.883	Lambda 2 = 0.885	N=13

Values of Cronbach's Alpha above 0.7 are considered to indicate a reliable index and values above 0.8 indicate a highly reliable deprivation index. The results of the Classical Test Theory analyses show that Alpha is greater than 0.8 for all age groups and is highly reliable.

STEP 6 – FINDING THE 'OBJECTIVE' POVERTY LINE

The 'objective' poverty line can be defined as the division between the 'poor' group and the 'not poor' group that maximises the between group sum of squares and minimises the within group sum of squares. The graph below illustrates a multidimensional poverty line – where the 'poor' are identified as those with both a low income[6] and a low standard of living (e.g. a high deprivation score). The 'objective' or 'optimal' poverty line is shown in Figure A1.2 (below).

FIGURE A1.2: MULTIDIMENSIONAL POVERTY LINE
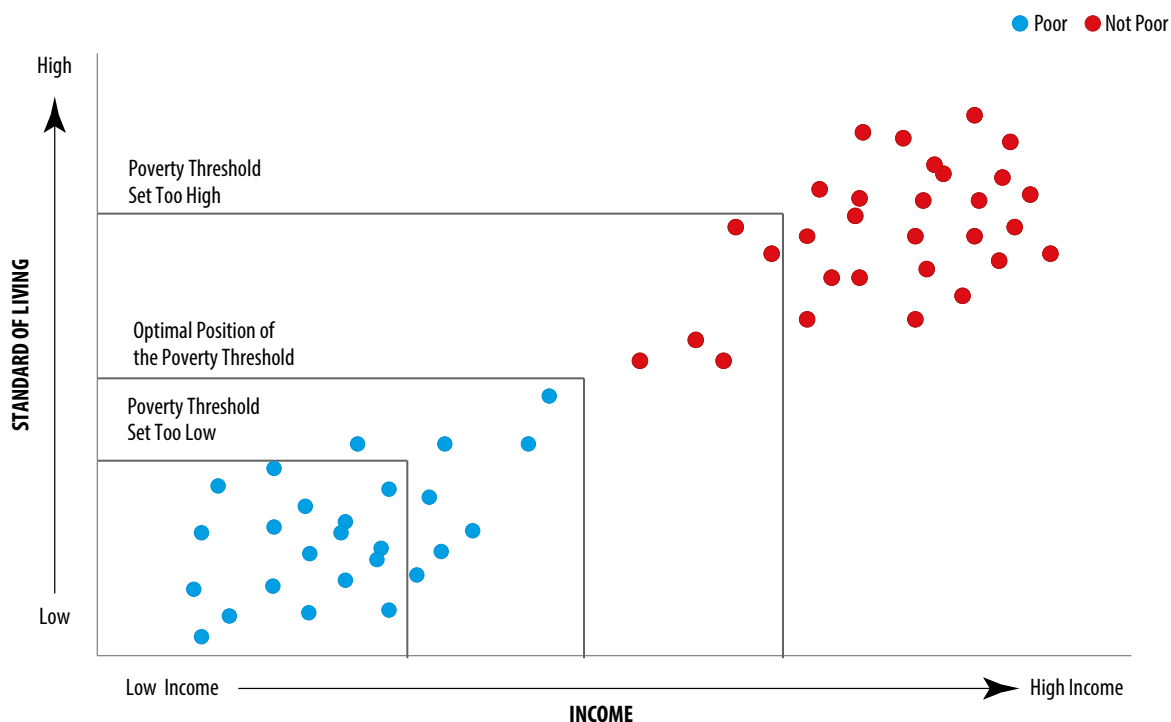
The 'objective' combined poverty line can be identified using the General Linear Model (GLM) in one of its forms (e.g. ANOVA, Discriminant Analysis or Logistic Regression), controlling for income, deprivation and household size and composition. The richest 3.8% of households were excluded from the modelling exercise

The General Linear Models (both ANOVA and Logistic Regression) were used to determine the scientific poverty threshold, i.e. the deprivation score that maximises the between group differences and minimises the within group differences (sum of squares). These techniques were applied to a succession of groups created by increasing the number of items of which respondents were deprived. Thus, the first analysis was undertaken on groups defined by people lacking no items compared with people lacking one or more items (a deprivation score of one or more). Similarly, the second analysis was undertaken on a group comprised of people lacking one or no items against two or more items, and so forth.

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6   Note: In setting the poverty threshold for Uganda, household expenditure- is used instead of income.

The dependent variable in the ANOVA model was the equivalised monthly household expenditure (at market prices with regional price adjustments) and the independent variables were deprivation group (constructed as described above), number of adults in each household and the number of children in each household. With the Logistic Regression models, the dependent variable was the deprivation group and the independent variables were the equivalised monthly household expenditure at market prices with regional price adjustments, number of adults and number of children in the household.

TABLE A.15: ANOVA AND LOGISTIC REGRESSION RESULTS FOR 10 DEPRIVATION GROUPS

Model *	Adult and Children F Statistic for corrected ANOVA Model	Adult and Children LR Chi2 Statistic for Logistic Regression Model
Null Model **	246	-
Deprivation score of 1 or more	494	5,164
Deprivation score of 2 or more	630	8,205
Deprivation score of 3 or more	750	11,089
Deprivation score of 4 or more	799	12,513
Deprivation score of 5 or more	**801**	13,242
Deprivation score of 6 or more	764	**13,369**
Deprivation score of 7 or more	711	12,920
Deprivation score of 8 or more	643	11,723
Deprivation score of 9 or more	571	10,358
Deprivation score of 10 or more	510	9,024

Note (*): In both models, total number of people in the household that are under 14 and 14 and above are used as controls to ensure compatibility with the newly constructed equivalisation scale.

Note (**): The null model only contains the control variables

Table A1.15 shows that the ANOVA model suggests and optimum poverty threshold of five or more deprivations, whereas the Logistic Regression Model results suggest an optimum threshold value of six or more deprivations. In theory, both models should produce effectively the same results as they are both methods are versions of the General Linear Model (with different assumptions). Najera and Gordon (2019) have shown, using Monte Carlo modelling, that these differences can be the result of problems with the survey data and that under most circumstances, the 'true' optimum threshold tends to either lie between the ANOVA and Logistic Regression results or is identified by the Logistic Regression model[7].

As deprivation can only be measured in whole numbers for single person households, so the average household deprivation score has been rounded to the nearest integer and the poor have been identified as those households/people who suffer from low household expenditures (below 141,771 UGX per month) and six or more deprivations – marked 'Poor' in Figure A1.3 (bottom left hand corner). The error bar graph also shows the approximate location of the 'Not Poor' (Top Left), Vulnerable (Bottom Left) and Rising (Top Right) groups of households (see Step 7 below for details). Please note that the areas on the error bar graph do not correspond with the size of these four groups (i.e. there are many households with a deprivation score of zero).

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7   Logistic Regression models are less powerful than ANOVA models but make fewer assumptions so their results tend to be more robust as unsurprisingly in many circumstances data 'problems' are less likely to violate the Logistic Regression model's assumptions.

ADULT AND CHILD DEPRIVATION INDEX

Cases weighted by Sample adjusted for age and sex, weighted down to original sample size
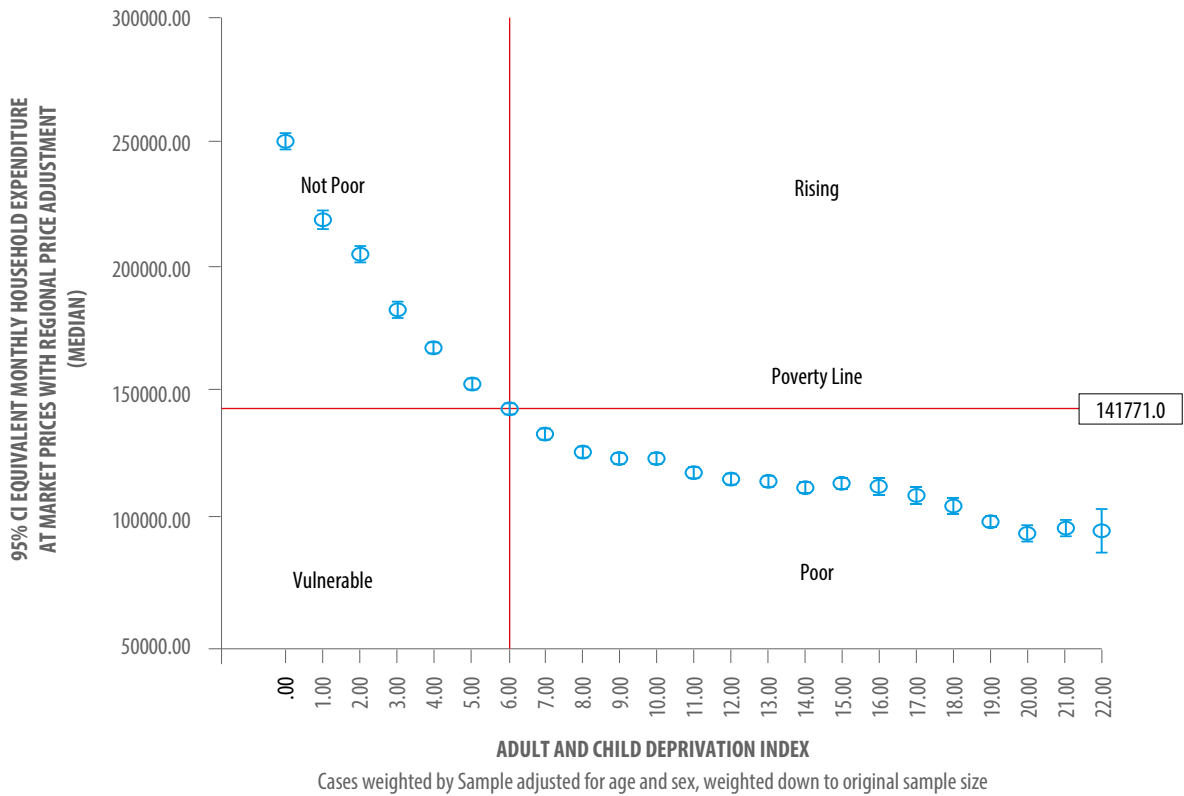
Figure A1.3 shows the relationship between the deprivation index score and monthly household expenditure (after adjusting for household size and type and regional price difference) in the 2016/17 UNHS, after the removal of expenditure outliers. Townsend (1979) argued that, as income declined, deprivation would increase but there came a point in this relationship where an additional small fall in income would result in a large increase in deprivation and this 'break of slope' could be used to identify the optimal poverty line. This is shown in Figure A1.3 as the poverty line. This identifies people as poor when they cannot afford but would like to have six or more essential deprivation items and their equivalent household income is less than 141,771 UGX per month[8].

It should be noted that the official poverty line is set at about half this expenditure level (at 2017 prices). This is a very low expenditure level and Ugandans with such low expenditures are likely to suffer from 22 or more deprivations on average. This seems to be more like a destitution threshold than a poverty threshold in present day Uganda – the UBoS poverty line varies from the equivalent of $0.88 to $1 a day depending on the region of the country (Owori, 2018).

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8   It is also possible to calculate an expenditure poverty line for children based only the child deprivation indicators (and relevant household deprivation indicators) – this results in a 'poverty' line of 141,608 UXG, which is effectively identical to the combined adult and child poverty line of 141,771 UXG.

STEP 7 - IDENTIFYING THOSE RISING OUT OF POVERTY AND SINKING INTO POVERTY (VULNERABLE)

In a cross-sectional survey, there will probably be a few people who are 'rising out of poverty', e.g. those with a high deprivation score and a high income. Their incomes and/or 'standard of living' should have increased in the recent past. These few cases can be identified using boxplots of household expenditure by 'deprivation threshold group' (found on Step 6) and controlling for household size/type. The outliers (with high household expenditures) in each household type should be those rising out of poverty.

The boxplot below shows that there are a few children and adults who have deprivation scores of six or more but also high household equivalised expenditures – over 318,425 UXG per month (e.g. rising out of poverty) – see top right of the boxplot (Figure A1.4).

FIGURE A1.4: BOXPLOT SHOWING THE MULTIDIMENSIONAL POVERTY GROUPS

Cases weighted by Sample adjusted for age and sex, weighted down to original sample size
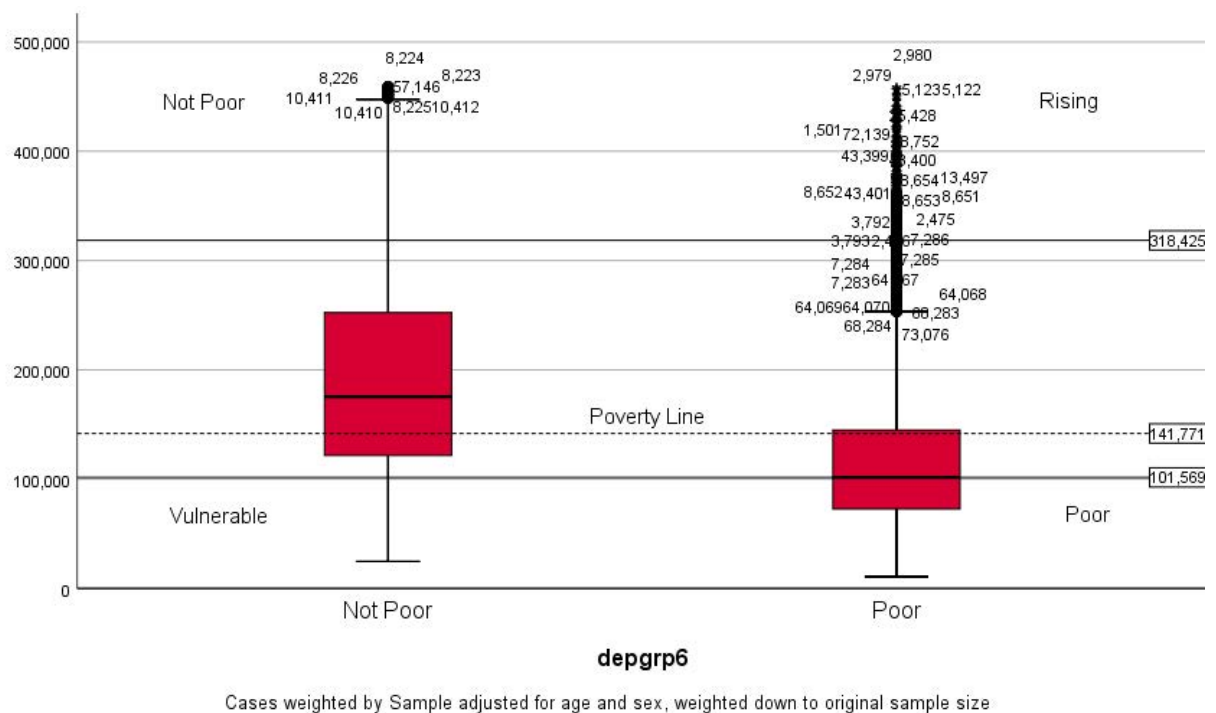
The boxplot also shows the other three groups of households. The 'Poor' are those households suffering from six or more deprivations and low equivalised household expenditures (under 141,771 UXG). The 'Vulnerable' are those households with a low score deprivation (less than six deprivations), who also have a low equivalised household expenditure (below 101,569 UXG per month), i.e. the median income of depgrp6. The 'not poor' are the remaining households that have not been classified as 'poor', 'rising' or 'vulnerable'.

Using these definitions, the UNHS found that in Uganda in 2016/17:
- 56% of children were living in multidimensional poverty
- 2% were rising out of poverty
- 6% were potentially vulnerable to poverty
- Only just over one-third (36%) were relatively well off.

APPENDIX 2:

EQUIVALISATION – ADJUSTING EXPENDITURE FOR DIFFERENCES IN HOUSEHOLD TYPE AND COMPOSITION IN UGANDA – AND SENSITIVITY ANALYSES

All poverty measures attempt to compare the living standards of people living in households of different sizes and compositions (e.g. households with different numbers of adults and children). It is clear that a four person household requires more money than a single person household to have the same living standard. However, there are likely to be some economies of scale so it is also likely that a four person household does not require four times the income of a single person household to maintain an identical standard of living. However, the exact equivalent amount is not easy to calculate (Whiteford, 1985).

Various methods have been used to establish demographic equivalence relations, usually in the form of adult equivalence scales which 'deflate' the household's income or consumption to express it as resources per equivalent adult (Bollinger et al., 2012). A range of assumptions are often made – for example (Berthoud et al., 2004):

a) each additional adult imposes an additional cost, but less than the base cost of the first adult;

b) each child represents an additional cost, lower than that of an additional adult, which is the same whether it is the first or the fifth child in the family; but

c) older children cost more than younger ones

In Uganda, the equivalisation method of Appleton (2001) is used which assumes that the relative needs of children and adults of different ages and genders are equivalent to the differences in their average calorie needs (see Table 4.2 from Appleton 2001 – below).

Table A4.2.   Daily Calorific Requirements and Equivalence Scales

Age	Male Calorie requirement	Male Equivalence scale	Female Calorie requirement	Female Equivalence scale
0	755	0.25	700	0.23
1	1,200	0.40	1,140	0.38
2	1,410	0.47	1,310	0.44
3	1,560	0.52	1,440	0.48
4	1,690	0.56	1,540	0.51
5	1,810	0.60	1,630	0.54
6	1,900	0.63	1,700	0.57
7	1,990	0.66	1,770	0.59
8	2,070	0.69	1,830	0.61
9	2,150	0.72	1,880	0.63
10	2,190	0.73	2,015	0.67
11	2,340	0.78	2,130	0.71
12	2,440	0.81	2,225	0.74
13	2,560	0.85	2,295	0.77
14	2,735	0.91	2,370	0.79
15	2,875	0.98	2,385	0.88
16	2,990	1.00	2,425	0.89
17	3,090	1.02	2,435	0.89
18–29	3,025	1.00	2,350	0.87
30–39	2,960	0.99	2,325	0.87
40–59	2,960	0.99	2,295	0.86
60+	2,290	0.86	1,830	0.77

Note: Equivalence scales for children aged 14 and under are obtained by dividing calorific requirements by 3,000. Equivalence scales for adults are given by 0.42 + 0.58 × (calorie requirements/3,000).

Source: Calorie requirements are author's calculations from the IHS based on guidelines from WHO (1985).

Thus Appleton's (2001) equivalisation method makes assumption (b) and (c) but not (a). Specifically, it assumes that there are no economies in scale in households and that young children have much lower needs than 18 year old adult men. For example, a baby girl is assumed to need only 23% of the expenditure of an 18 year old adult man in order to have an equivalent standard of living. These are arguably unrealistic assumptions which both underestimate the costs of young children and overestimate the costs of large households.

It is clearly important, when measuring the extent and nature of child poverty not to underestimate the needs of young children, therefore, this research adopted an equivalisation method that does not give undue weight to the costs of adults and older children compared with younger children.

Zaidi and Burchardt (2003) implemented a relative needs equivalisation method of Berthoud, Lakey and McKay (1993) and Berthoud and Ford (1996) concerning the use of standard of living/deprivation scales to identify the additional costs of disability for income equivalisation purposes. They argued that their Figure 1 (below), *"highlights the theoretical relationship between income, standard of living and disability used in this approach. Standard of living is assumed to rise with income for all households, but for a household with greater needs – for example, one containing a disabled person –the same income results in lower standard of living (as is shown by the shift to the bold line for a disabled person that is lower than the line for a non-disabled person). Conversely, the same standard of living can be achieved by a household with greater needs if it also has a higher income. Thus in Figure 1a, income B for a disabled household translates into the same standard of living as income A for a non-disabled household, and B minus A gives an estimate of the extra costs of disability."* This approach can also be used to identify the additional costs of a child or an adult.

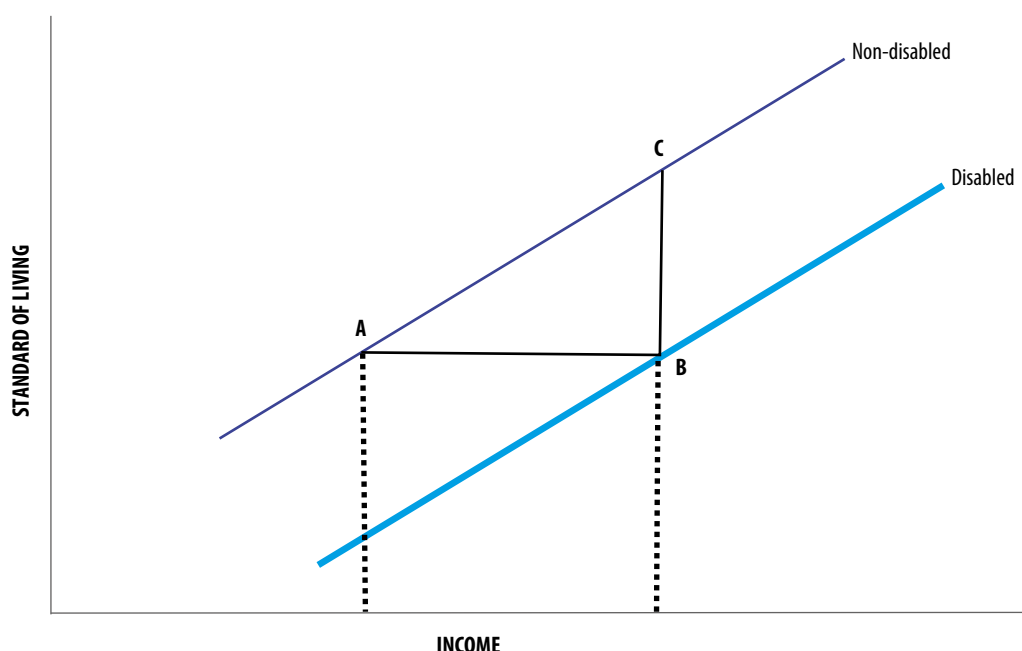FIGURE A2.1: STANDARD OF LIVING, INCOME AND DISABILITY

Figure A2.1 shows how the Median Household Monthly Expenditures of two adult households with 1, 2, 3 and 4 children, respectively, varies by deprivation index score (ranging from a score of 3 to a score of 7). These values of the deprivation index score were selected as

approximately between 33% and 66% of the Ugandan population live in households with these scores. Figure A2.3 shows the same relationship but for the Harmonic Mean, which like the Median is a measure of the central tendency (i.e. middle of the distribution) which is robust in the presence of expenditure outliers. Similarly Figures A2.4 and A2.5 shows how the Median Household Monthly Expenditures of households with different numbers of adults vary by deprivation index score.

FIGURE A2.2: MEDIAN HOUSEHOLD MONTHLY NOMINAL EXPENDITURE BY HOUSEHOLD TYPE AND DEPRIVATION SCORE

Two Adult Households with Children – Uganda 2016/17 Median Difference = 51,653
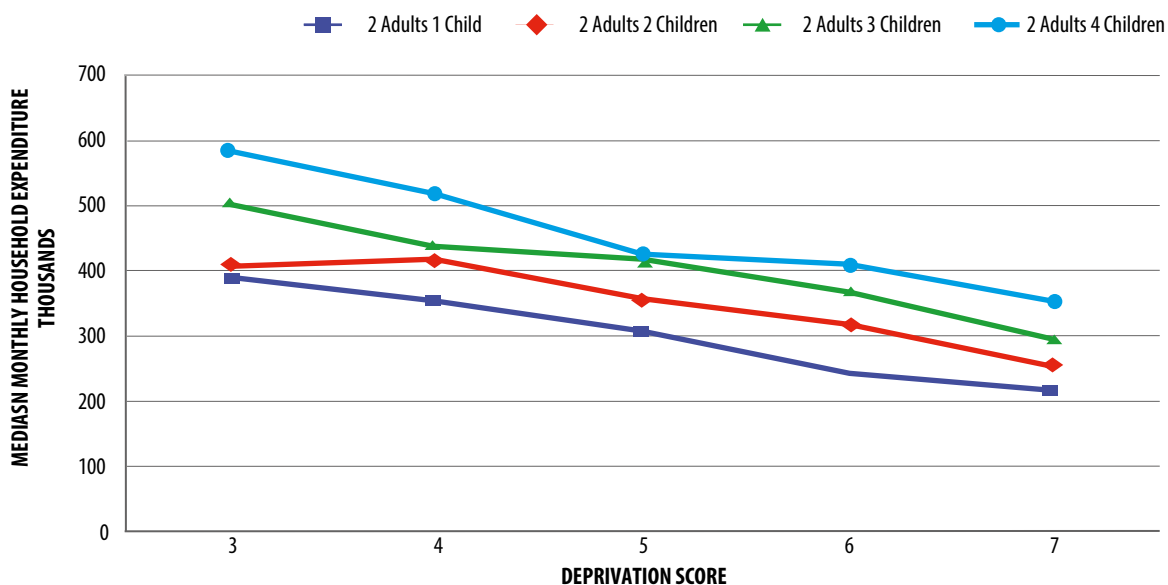
FIGURE A2.3: HARMONIC MEAN HOUSEHOLD MONTHLY NOMINAL EXPENDITURE BY HOUSEHOLD TYPE AND DEPRIVATION

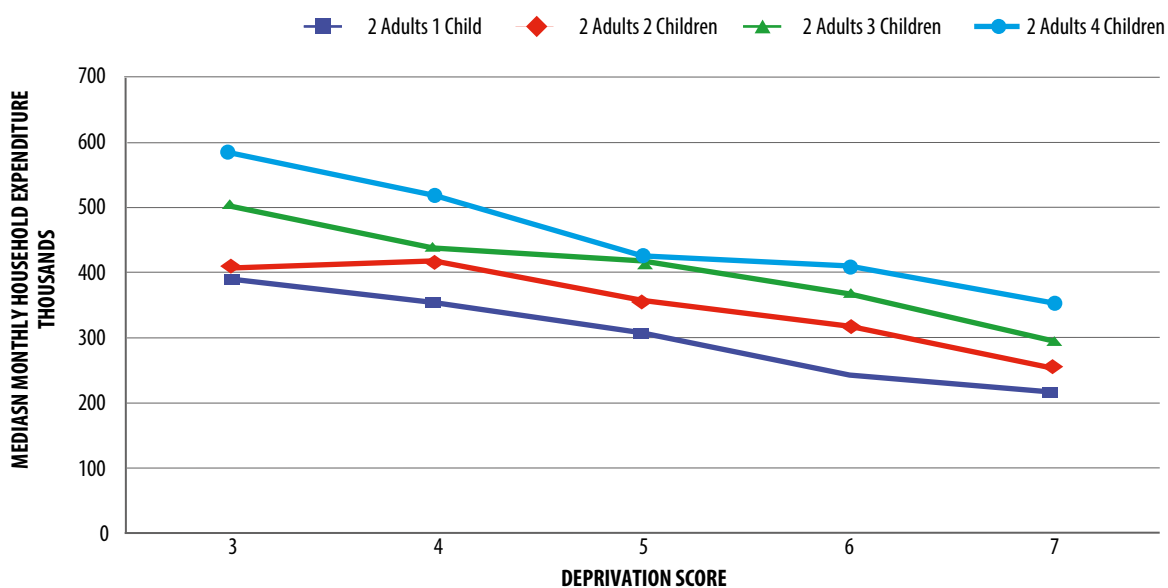Two Adult Households with Children – Uganda 2016/17 Harmonic Mean Difference = 40,349

FIGURE A2.4: MEDIAN HOUSEHOLD MONTHLY NOMINAL EXPENDITURE BY HOUSEHOLD TYPE AND DEPRIVATION SCORE

One and Two Adult Households – Uganda 2016/17 Median Diff = 107,117 Harmonic Mean diff = 95,416
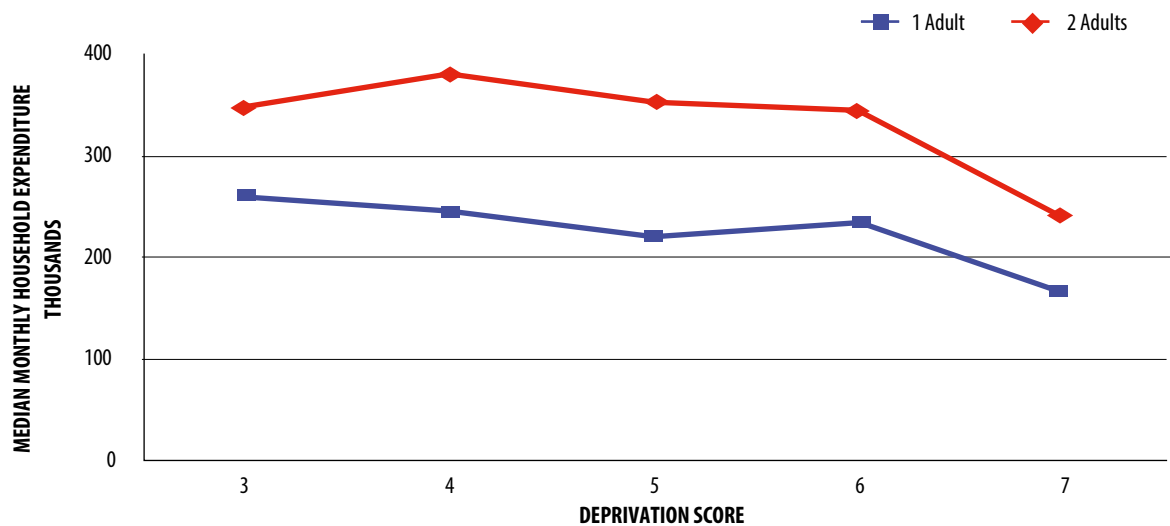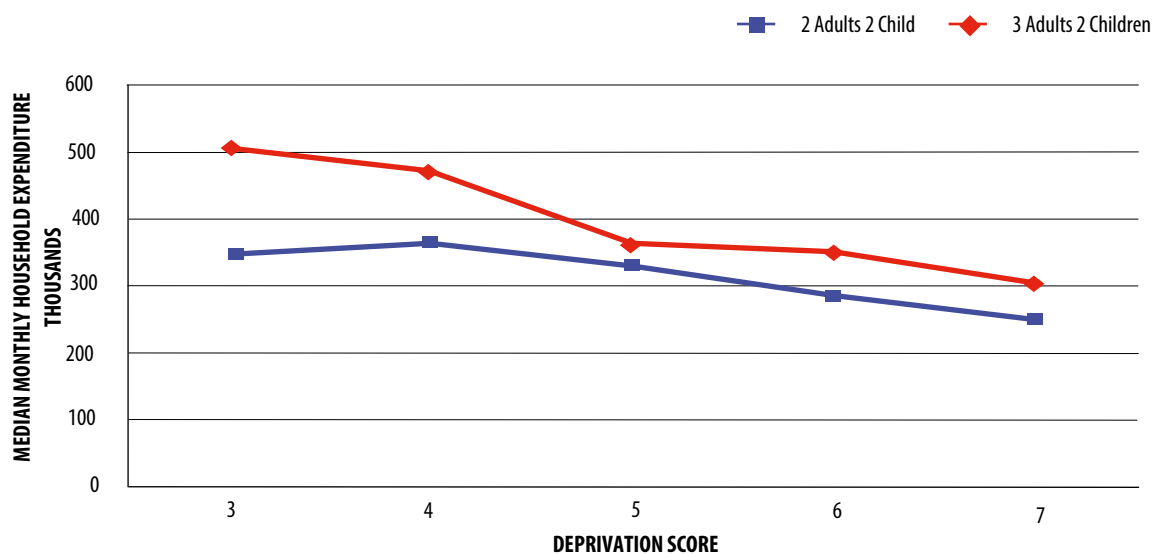

FIGURE A2.5: MEDIAN HOUSEHOLD MONTHLY NOMINAL EXPENDITURE BY HOUSEHOLD TYPE AND DEPRIVATION SCORE

One and Two Adult Households – Uganda 2016/17 Median Diff = 83,529 Harmonic Mean diff = 82,737

In their work on the extra costs of disability in the UK, Zaidi and Burchardt (2003) fitted OLS regression lines to their data and determined the extra costs as the difference in the intercept values of the two regression lines. However, in this research, the OLS regression method would be inappropriate as we have only used deprivation scores between 3 and 7 i.e. 5 data points per line. Thus, we have adopted a more straightforward and simpler approach for identifying the additional costs of an extra adult of child in the household (relative to a single person household) by using the average difference in the expenditures of two adult with 1, 2, 3 and 4 child households (to estimate the costs of a child) and the average difference between two adults with two children and three adults with two children households (too estimate the costs of an additional adult). For the purposes of equivalisation, a child is defined as under the

age of 14 and an adult is over the age of 14. This is a standard definition of an adult and child which has been used in equivalisation scales around the world (Whiteford, 1985).

We have used two methods to estimate the 'average' – the Median and the Harmonic Mean – which are both robust measures of the central tendency, relatively unaffected by outliers in the expenditure data. The results showed that:

- The Median cost of a single adult was 107,117 UXG, the Median cost of an additional adult was 83,529UXG and the Median cost of a child was 51,653 UXG.

- The Harmonic Mean cost of a single adult was 95,416 UXG, the harmonic mean cost of an additional adult was 82,737 UXG and the Harmonic Mean cost of a child was 40,349 UXG.

Thus, relative to the estimated costs of a single adult, the estimated equivalisation scale for Uganda. using the Median expenditure results is:

1.0 First Adult, 0.8 additional adult (14+), 0.5 child (<14)

Relative to the estimated costs of a single adult, the estimated equivalisation scale for Uganda, using the Harmonic Mean expenditure results is:

1.0 First Adult, 0.9 additional adult (14+), 0.4 child (<14)

Thus, there are slight differences in the estimated relative costs of an adult and child using the Median and Harmonic Mean The Median method estimates are slightly lower for an additional adult (0.8 vs 0.9) and slightly higher for an additional child (0.5 vs 0.4). Table A2.1 compares these results with a range of widely used equivalisation scales.

TABLE A2.1: EQUIVALENCE SCALES WITH ELASTICITIES RANGING FROM 1 TO 0.5

Household Size	Equivalence Scales						
	Per Capita	UBOS Calorie Need	Uganda Deprivation Median	OECD	Uganda Deprivation Harmonic Mean	Modified OECD	Square Root of N
1 adult	1	1	1	1	1	1	1
2 adults	2	1.81	1.8[9]	1.7	1.9	1.5	1.4
2 adults, 1 child	3	2.4	2.3	2.2	2.3	1.8	1.7
2 adults, 2 children	4	3.0	2.8	2.7	2.7	2.1	2.0
2 adults, 3 children	5	3.6	3.3	3.2	3.1	2.4	2.2
2 adults, 4 children	6	4.2	3.8	3.7	3.5	2.7	2.4

Deprivation Median Equivalisation -1.0 First Adult, 0.8 additional adults (14+), 0.5 child (<14)

Deprivation Harmonic Mean Equivalisation – 1.0 First Adult, 0.9 additional adults, 0.4 child (< 14)

Per Capita – all adults and children = 1.0

UBoS/Appleton (2001) Relative Calorie Need Based Equivalisation – 1.0 - Average Man (age 31), 0.8 - Average Women (age 32), 0.6 - Average Child under 14 (age 6).

OECD - 1.0 First Adult, 0.7 additional adults (14+), 0.5 Child (<14)

Modified OECD - 1.0 First Adult, 0.5 additional adults (14+), 0.3 Child (<14)

Square root - number of adults and children

Table A2.1 orders the seven equivalisation scales by their elasticity. The Per Capita method has an elasticity of 1.0 (i.e. no economies of scale), the Square Root scale has an elasticity

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9   Assumes that first adult is a man and second adult is a women

of 0.5 and raw household income an elasticity of 0 (i.e. the economies of scale are infinite). The other scales (UBoS, Deprivation, OECD and Modified OECD) have Elasticities of between 1.0 and 0.5. For example, the OECD scale has an elasticity of 0.73 and the Modified OECD scale and elasticity of 0.53. The lower the elasticity, the higher the economies of scale of the equivalisation method. Since poor Ugandan households spend a high proportion of their incomes on basic needs (e.g. food, utilities, etc.) which usually have relatively high elasticities, then *a priori* it would be expected that the 'correct' equivalisation scale would lie somewhere between Per Capita (Elasticity = 1.0) and the Square Root of N equivalisation scale (Elasticity = 0.5).

In this research, we have used the Median equivalisation scale - 1.0 First Adult, 0.8 additional adult (14+), 0.5 child (<14) – which yields similar overall results to the calorie needs method of Appleton (2001) but has the important advantage of not underestimating the costs of young children or overestimating the costs of large households.

Sensitivity Analyses: Monetary Equivalisation Scales

In order to test the sensitivity of the Multidimensional Poverty line to different monetary equivalisation methods, ANOVA and Logistic models were run using the seven scales shown in Table A2.1, plus raw (i.e. un-equivalised) expenditure. The results are shown in Tables A2.2 to A2.9[10]

TABLE A2.2: POVERTY THRESHOLD: DEPRIVATION (MEDIAN) EXPENDITURE EQUIVALISATION

Model	Adult & Child F Statistic for corrected ANOVA Model	Adult & Child Logistic Regression Model Chi-square
Null Model[11]	2,163	
Deprivation score of 1 or more	3,891	5,662
Deprivation score of 2 or more	4,989	8,739
Deprivation score of 3 or more	5,966	11,615
Deprivation score of 4 or more	**6,296**	13,090
Deprivation score of 5 or more	6,235	13,843
Deprivation score of 6 or more	5,858	**13,869**
Deprivation score of 7 or more	5,385	13,333
Deprivation score of 8 or more	4,774	12,077
Deprivation score of 9 or more	4,172	10,635
Deprivation score of 10 or more	3,669	9,291

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10   In these analyses expenditure outliers were removed using the outlier labelling rule method (Hoaglin and Iglewicz, 1987)

11   The null model only contains the number of adults and the number of children in the household as independent variables

TABLE A2.3: POVERTY THRESHOLD: DEPRIVATION (HARMONIC MEAN) EXPENDITURE EQUIVALISATION

Model	Adult & Child F Statistic for corrected ANOVA Model	Adult & Child Logistic Regression Model Chi-square
Null Model	1,477	
Deprivation score of 1 or more	3,307	5,766
Deprivation score of 2 or more	4,480	9,096
Deprivation score of 3 or more	5,404	11,944
Deprivation score of 4 or more	**6,667**	13,332
Deprivation score of 5 or more	5,575	13,925
Deprivation score of 6 or more	5,240	**13,975**
Deprivation score of 7 or more	4,794	13,425
Deprivation score of 8 or more	4,213	12,152
Deprivation score of 9 or more	3,632	10,687
Deprivation score of 10 or more	3,135	9,293

TABLE A2.4: POVERTY THRESHOLD: DEPRIVATION (PER CAPITA) EXPENDITURE EQUIVALISATION

Model	Adult & Child F Statistic for corrected ANOVA Model	Adult & Child Logistic Regression Model Chi-square
Null Model	4,215	
Deprivation score of 1 or more	4,987	4,650
Deprivation score of 2 or more	5,986	7,248
Deprivation score of 3 or more	6,998	9,797
Deprivation score of 4 or more	**7,518**	11.514
Deprivation score of 5 or more	7,507	12,362
Deprivation score of 6 or more	7,253	**12,741**
Deprivation score of 7 or more	6,752	12.217
Deprivation score of 8 or more	6,194	11,294
Deprivation score of 9 or more	5,595	10,034
Deprivation score of 10 or more	5,074	8,803

TABLE A2.5: POVERTY THRESHOLD: DEPRIVATION (UBOS) EXPENDITURE EQUIVALISATION

Model	Adult & Child F Statistic for corrected ANOVA Model	Adult & Child Logistic Regression Model Chi-square
Null Model	2,647	
Deprivation score of 1 or more	4,160	5,408
Deprivation score of 2 or more	5,316	8,517
Deprivation score of 3 or more	6,164	10,908
Deprivation score of 4 or more	**6,526**	12,430
Deprivation score of 5 or more	6,392	13,019
Deprivation score of 6 or more	6,119	**13,309**
Deprivation score of 7 or more	5,721	12,996
Deprivation score of 8 or more	5,210	12,122
Deprivation score of 9 or more	4,617	10,779
Deprivation score of 10 or more	4,098	9,480

TABLE A2.6: POVERTY THRESHOLD: DEPRIVATION (OECD) EXPENDITURE EQUIVALISATION

Model	Adult & Child F Statistic for corrected ANOVA Model	Adult & Child Logistic Regression Model Chi-square
Null Model	2,342	
Deprivation score of 1 or more	4,051	5,583
Deprivation score of 2 or more	5,231	8,793
Deprivation score of 3 or more	6,228	11,659
Deprivation score of 4 or more	**6,551**	13,163
Deprivation score of 5 or more	6,461	13,899
Deprivation score of 6 or more	6,068	**13,913**
Deprivation score of 7 or more	5,571	13,383
Deprivation score of 8 or more	4,949	12,123
Deprivation score of 9 or more	4,338	10,680
Deprivation score of 10 or more	3,825	9,332

TABLE A2.7: POVERTY THRESHOLD: DEPRIVATION (MODIFIED OECD) EXPENDITURE EQUIVALISATION

Model	Adult & Child F Statistic for corrected ANOVA Model	Adult & Child Logistic Regression Model Chi-square
Null Model	1,391	
Deprivation score of 1 or more	3,038	5,288
Deprivation score of 2 or more	4,177	8,586
Deprivation score of 3 or more	5,062	11,263
Deprivation score of 4 or more	**5,454**	12,831
Deprivation score of 5 or more	5,437	**13,613**
Deprivation score of 6 or more	5,078	13,596
Deprivation score of 7 or more	4.638	13,080
Deprivation score of 8 or more	4,095	11,885
Deprivation score of 9 or more	3,526	10,413
Deprivation score of 10 or more	3,042	9,084

TABLE A2.8: POVERTY THRESHOLD: DEPRIVATION (SQUARE ROOT) EXPENDITURE EQUIVALISATION

Model	Adult & Child F Statistic for corrected ANOVA Model	Adult & Child Logistic Regression Model Chi-square
Null Model	6,051	
Deprivation score of 1 or more	6,649	5,052
Deprivation score of 2 or more	7,622	8,004
Deprivation score of 3 or more	8,723	11,182
Deprivation score of 4 or more	**9,002**	12,777
Deprivation score of 5 or more	8,749	13,280
Deprivation score of 6 or more	8,273	**13,208**
Deprivation score of 7 or more	7,746	12,625
Deprivation score of 8 or more	7,244	11,638
Deprivation score of 9 or more	6,664	10,273
Deprivation score of 10 or more	6,173	8,995

TABLE A2.9: POVERTY THRESHOLD: DEPRIVATION RAW EXPENDITURE (NO EQUIVALISATION)

Model	Adult & Child F Statistic for corrected ANOVA Model	Adult & Child Logistic Regression Model Chi-square
Null Model	8,453	
Deprivation score of 1 or more	9,342	7,581
Deprivation score of 2 or more	**9,356**	11,583
Deprivation score of 3 or more	9,172	14.238
Deprivation score of 4 or more	8,929	15,656
Deprivation score of 5 or more	8,491	**15,876**
Deprivation score of 6 or more	8,046	15,477
Deprivation score of 7 or more	7,690	14,775
Deprivation score of 8 or more	7,370	13,483
Deprivation score of 9 or more	7,041	11,826
Deprivation score of 10 or more	6,758	10,229

The results from both the ANOVA and Logistic Regression analyses are highly consistent. The ANOVA model identified a deprivation score of 4 as the optimum threshold for all 7 equivalisation scales and nominal household expenditure (un-equivalised), i.e. the ANOVA model deprivation threshold was unaffected by the equivalisation scale used.

The Logistic Regression model results are very interesting and identified a deprivation threshold score of 6 for all equivalisation scales with elasticities between 1.0 (per capita) and 0.53 (Modified OECD), for scales with elasticities between 0.53 and 0 the optimum deprivation threshold fell to a score of 5. However, given the relatively high expenditure of 'poor' Ugandan households on basic necessities (e.g. food, utilities, etc.), which generally have lower economies of scale, the 'correct' deprivation threshold is therefore likely to be 6 or more deprivations.

Table A2.10 shows the estimated monetary poverty threshold (for a single adult), using a deprivation score of 6 or more items (see Appendix 1) and the different equivalisation scales.

TABLE A2.10: POVERTY LINES FOR A SINGLE ADULT WITH A DEPRIVATION SCORE OF SIX USING DIFFERENT MONETARY EQUIVALISATION SCALES

Equivalisation Scale	Poverty Threshold
Per Capita	106,298
OECD	148792
Harmonic Mean (Deprivation)	144,793
UBOS	142,505
Median (Deprivation)	**141,771**
Modified OECD	194,998
Square Root	238,971
No equivalisation	264,650

The results in Table A2.10 show that, as would be expected, the value of the poverty threshold varies with the elasticity of the equivalisation method. It is, however, important to note that the deprivation (Median) derived equivalisation scale used in this research produces an effectively identical expenditure poverty threshold to the Appleton (2001) calorie based equivalisation

scale (marked as UBoS in Table A2.10). However, unlike the Appleton (2001) equivalistion scale, the median equivalisation scale has the advantage that it does not make unrealistically low assumptions about the expenditure needs of babies and young children or overestimate the costs of larger household.

Sensitivity Analyses: Deprivation Scales

The monetary equivalisation scales sensitivity analyses show that the location of the multi-dimensional poverty threshold is robust when using a range of plausible equivalisation scales. However, it is also important to determine if the multidimensional poverty threshold in Uganda is sensitive to changes in the deprivation scale. This was tested by using separate adult and child deprivation scales, i.e. the 13 item adult deprivation scale consisted of the valid and reliable adult and household items (but not child deprivations) and the 22 item child deprivation scale consisted of the valid and reliable child and household items (but no adult items). The results are shown in Table A2.11. For adults, the ANOVA results indicate a deprivation threshold of 4 or more (see Column 1) and the Logistic Regression results a threshold of 5 or more (Column 2). For children, the ANOVA results indicate a deprivation threshold of 5 or more (see Column 3) and the Logistic Regression results a threshold of 7 or more (Column 4).

TABLE A2.11: POVERTY THRESHOLDS FOR ADULTS AND CHILDREN USING SEPARATE DEPRIVATION SCALES[12]

Model	Adult F Statistic for corrected ANOVA Model	Adult Logistic Regression Model Chi-square	Child F Statistic for corrected ANOVA Model	Child Logistic Regression Model Chi-square
Null Model[11]	1,051		739	
Deprivation score of 1 or more	1,770	2,598	1,895	2,802
Deprivation score of 2 or more	2,359	4,097	2,370	3,991
Deprivation score of 3 or more	2,783	5,238	2,944	5,454
Deprivation score of 4 or more	**2,885**	5,684	3.204	6,378
Deprivation score of 5 or more	2,754	**6,690**	**3,376**	7,096
Deprivation score of 6 or more	2,521	5,427	3,294	7,223
Deprivation score of 7 or more	2,215	4,792	3,190	**7,248**
Deprivation score of 8 or more	1,837	3,775	2,975	6,997
Deprivation score of 9 or more	1,505	2,758	2,748	6,638
Deprivation score of 10 or more	1,261	1,998	2,479	6,156

The results in Table A2.11 are not surprising in that, if you compare the results from deprivation scales of different lengths (13 items vs 22 items) applied to different population groups (Adults Vs Children), you would expect the threshold values to be different. What is important is not if the deprivation threshold changes but if these changes result in any substantive differences in identifying whom is classified as 'poor' and 'not poor'.

Figures A2.6 and A2.7, respectively, show the relationship between Adult deprivation and equivalised household expenditure and Child deprivation and equivalised household expenditure. Both graphs show the expected relationships, i.e. the lower the equivalised household income the higher the deprivation index score. Similarly, both graphs show distinct breaks of slope at 5 deprivations for Adults and 7 deprivations for children.

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12   The null model only contains the number of adults and the number of children in the household as independent variables

ERROR BAR PLOT OF ADULT DEPRIVATION BY EQUIVALISED HOUSEHOLD EXPENDITURE

Cases weighted by Sample adjusted for age and sex, weighted down to original sample size
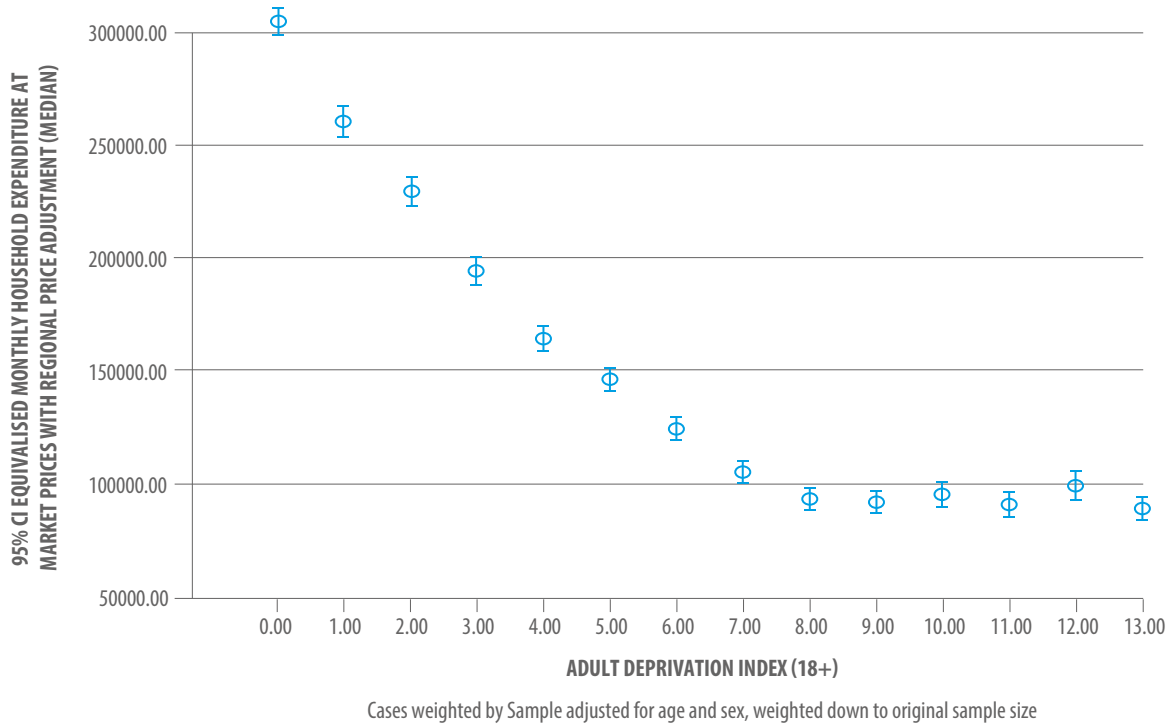
The monthly equivalised household expenditure poverty threshold for an adult deprivation score of 5 is **148,213.**

FIGURE A2.7: ERROR BAR PLOT OF CHILD DEPRIVATION BY EQUIVALISED HOUSEHOLD EXPENDITURE

Cases weighted by Sample adjusted for age and sex, weighted down to original sample size
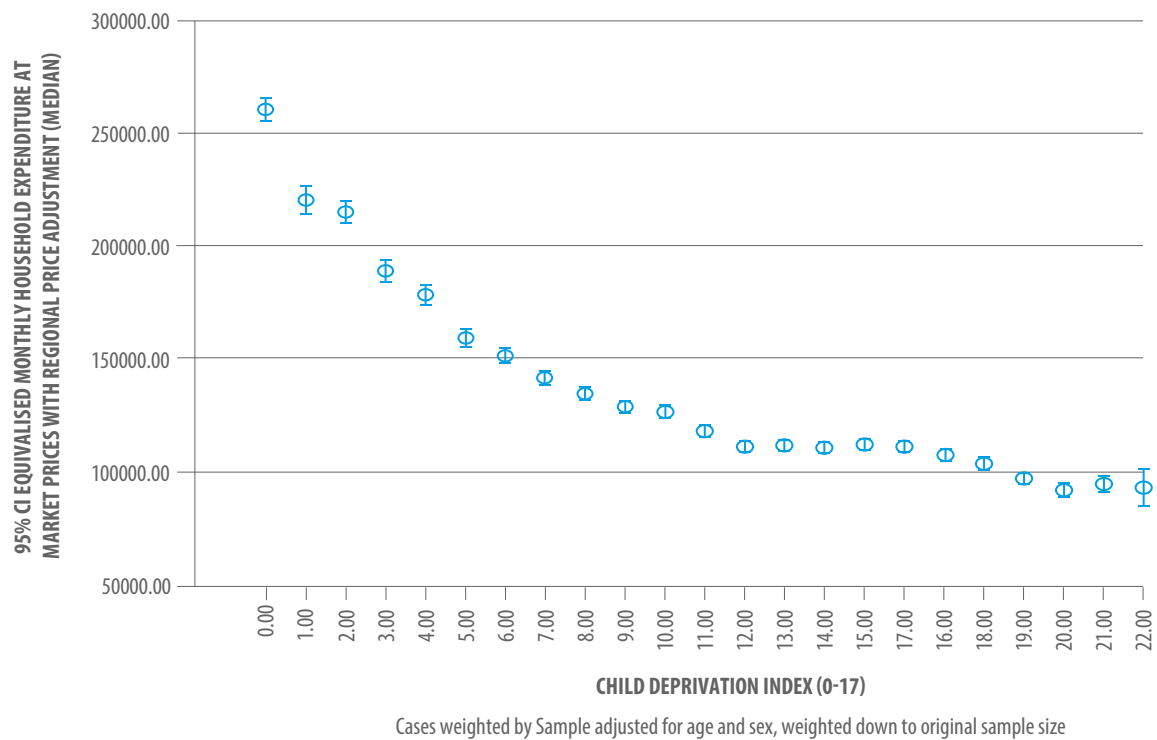
The monthly equivalised household expenditure poverty threshold for a child deprivation score of 7 is **141,608.**

The Logistic Regression results for the combined adult and child deprivation index, the child deprivation index and the adult deprivation index all produce similar equivalised monthly household expenditure poverty thresholds of circa 142,000 Ugandan Shillings. The Median equivalisation is for the cost of a single adult at nominal market prices after adjusting for regional and urban/rural price differences:

TABLE A2.12: MULTIDIMENSIONAL POVERTY THRESHOLDS USING THREE DIFFERENT DEPRIVATION SCALES

Deprivation Index	Deprivation Threshold	Expenditure Threshold
Adult & Child	6+	141,771
Child	7+	141,608
Adult	5+	148,213

The results shown in Table A2.12 and in Tables A2.2 to A2.8, all indicate that the Multidimensional Poverty measure used in this research is highly robust to changes in both the monetary equivalisation scale and the deprivation index. The results of these sensitivity analyses provide confidence in the substantive findings from this research.

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