

Methodology for Consumption-Poverty Estimation, 2018 and Poverty Trends, 2011-2018, in Sierra Leone¹



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INTRODUCTION

1. Statistics Sierra Leone (Stats SL) and its partners have been collecting nationally representative household survey data since 2003 through the Sierra Leone Integrated Household Survey (SLIHS). This survey covers a wide range of social and economic topics; it is the primary source for estimations of poverty within the country and provides information on other indicators for the National Development Plan.

2. Stats SL has conducted three rounds of the SLIHS, in 2003/04, 2011 and 2018. In each case, data collection took place over a 12-month period. The SLIHS 2018 was conducted from January to December 2018, covering 6840 households. It used the 2015 Population and Housing Census as the sampling frame. The households were clustered at the level of census enumeration area (EA), with 10 households per EA surveyed. The sample was stratified by district (using the 14 districts defined as of the 2015 census) and urban/rural areas. Field staff were divided into 19 teams, each team comprising 3 interviewers (responsible for one EA per month), a data entry clerk and a supervisor. Data capture was done on paper questionnaires with simultaneous data entry on laptops used by the team's data entry clerk. The data entry application performed extensive checks, and inconsistencies were flagged for correction by the interviewer, reverting to the original household as needed.

3. Poverty analysis requires three main elements. The first is a welfare indicator (called a "consumption aggregate" for this analysis) that can be used to compare the wellbeing of individuals or households. The second is a poverty line which can be compared against the welfare indicator to ascertain the poverty status of households / individuals. Last, a way (or ways) to aggregate these comparisons to produce overall measures of poverty (such as the national poverty rate) is needed.

4. The methodology used to estimate poverty in 2018 improves on and therefore diverges from that used in 2003/04 and 2011. In particular, it includes more nonfood items in the aggregate, uses a more appropriate recall period for some items, and adjusts for differences in food prices between rural and urban areas. After construction of the main aggregates and poverty analysis for 2018, trends in comparable measures of poverty between 2011 and 2018 are analyzed.

5. This note explains the steps involved in the construction of the consumption aggregate, the derivation of the poverty line, and the estimation of poverty measures. The first section explains the construction of the nominal total household consumption, covering food, non-food items, health and education services, durable goods, housing and utilities. Section 2 discusses the adjustment for differences in cost-of-living differences across the country and in the demographic composition and size across households. Section 3 presents the poverty analysis: the derivation of the poverty lines, the poverty measures used and the resultant poverty rates for 2018. The last section explains the construction of comparable consumption aggregates and poverty lines for 2011 and 2018, and changes in poverty over that period. Appendices present details of the constructions and conduct several robustness checks, presenting results for alternative specifications.

1. CONSTRUCTION OF NOMINAL TOTAL CONSUMPTION

6. Research on poverty over the last years has reached some consensus on using economic measures of living standards, hence these are regularly employed in poverty analysis. Although they do not cover all aspects of human welfare, they do capture a central component of any assessment of living conditions. Following common practice in Sierra Leone (and in other countries of similar income level), consumption is chosen as the welfare indicator because it is likely to be a more reliable and accurate measure of long-term living standards than income.²

7. A number of theoretical and practical considerations guided the construction of the consumption aggregate. First, it was designed to be as comprehensive as possible. The COICOP classification of household consumption was consulted in the design of the questionnaire, to make sure that all classes of household consumption were included on the questionnaire.³ Second, both market and non-market transactions are included; this meant ensuring that own production of food products and gifts of food (including eating with family/friends) were captured.⁴ Third, for purchases of food and non-food items, the survey collects data on expenditure rather than consumption. It is noted that expenditure is not the same as consumption, but the recall period to some extent reconciles the two.⁵ However, an exception is made for "lumpy" purchases such as durable goods and owner-occupied dwellings where additional analysis is performed to compute the "annual use value" of these assets. Consumption is annualized.

8. The consumption aggregate comprises five main components: food, health and education services, non-food items, durable goods, and housing (including utilities).

Table 1: Components of Consumption Aggregate

Consumption Aggregate	Questionnaire Sections
food consumption	Book 4A and 4B: sections X and Z
health and education services	Book 1: sections D and B
non-food items	Book 2: section N, Books 4A and 4B: section Y (items included in both N and Y are taken from N)
durable goods	Book 2: section L
housing and utilizes	Book 2: section K

Food

9. The food aggregate is based on a diary that the households kept over a twenty-day period (with interviewers visiting at least every fifth day to check the diary and complete the questionnaire). Every food item purchased (whether to cook at home, or ready-to-eat food purchased and consumed outside of the home), or consumed from home production, or received for free (as in-kind payment, gift or meals received free at school or workplaces or others' houses) was recorded. The food items were coded using over 200 food item codes. For purchases, the total expenditure and quantity bought was recorded. For others, the total quantity consumed, and unit value (implied price) as estimated by the respondent was recorded.

² See Deaton and Zaidi (2002) and Haughton and Khandker (2009).

³ "Consumption aggregate" refers to total value of food consumed (whether purchased or home produced), expenditure on non food during the recall periods specified in the questionnaire and use value of durable goods and owner occupied housing.

⁴ Own production of non-food items, such as firewood or traditional handicraft items, is not included.

⁵ For example, if the recall period for clothing is one year, it is not assumed that all clothes purchases are used up within the year, but rather that the amount purchased in any given year is roughly equal to the amount consumed.

Data on bulk purchase (defined as buying more than a two-week supply of a food item) over the past 2 months were also recorded; these purchases are included in the consumption aggregate using a 2 month recall period. The food aggregate excludes tobacco, kola nuts (a local narcotic) and alcohol except local palm wine (which as a significant calorie value is usually minimally alcoholic); these items are included in the non-food aggregate.

Health and Education Services

10. Household expenditures on health and education services for all household members were collected. The aggregate does not include hospitalization expenses. It includes consultation fees, payments for prescribed medications purchased within or outside of the health care provider, and fees for tests and medical supplies over the past 4 weeks. It also includes dental expenses over the past one year. Education expenses include spending on school fees and purchase of uniforms, school supplies, school books etc. and also Quranic education.

Non-Food Items

11. Expenditure on-food items were collected in two sections of the questionnaire. For those items that are purchased frequently by the household, data was collected alongside the food diary. When the interviewer compiled the food diary every fifth day, he/she also asked about expenditure on a list of frequently purchased non-food items over the past 5 days. For less frequently purchased non-food items, the household was first asked how many times they purchased the item in the last year. If 12 times or more, the household is asked about total expenditure over the past 3 months. If less than 12 times, the household is asked about total expenditure over the last year.⁶ The aggregate includes expenditure on insurance (the only slightly notable category is vehicle insurance which is best understood as a legal expense for owning a vehicle) and games of chance. Information on tobacco, kola nuts and alcohol (except palm wine) was collected as described in the food section but included as part of non-food.

12. Other expenditures on taxes, weddings/dowry, funeral expenses, donations, remittances sent, loan payments, contributions to savings groups etc. are recorded but are not included in the consumption aggregate.

Durable Goods

13. Ownership of durable goods can be an important component of the welfare of the population. Since these goods last for many years, the expenditure on durables is not the proper indicator to consider. Rather, we estimate the annual use value of the stream of services that the household derives from consumer durables in its possession.

14. The survey collected information on 31 durable goods: number owned, purchase price, age and current value (the last three being collected separately for up to two items of each good). To compute annual use value, we first compute the implied depreciation rate for each observed item as follows, where δ_i is the depreciation rate for durable good of kind i , π is inflation, p_t is the current value of the item, p_{t-T} is the purchase price, and T is the age in years.

$$\delta - \pi = 1 - \left(\frac{p_t}{p_{t-T}} \right)^{1/T}$$

Then the median depreciation rate of each type of good is calculated (Appendix B shows the various goods and their median depreciation rates.) The annual use value of each durable good is then computed as follows, where r is the interest rate.

⁶ This unusual method has been used on the SLIHS since 2003.

$$UV = p_t(r - \pi + \delta_i)$$

The interest rate used is 15.58% (average official Monetary Policy Rate for the Bank of Sierra Leone, Jan to Dec 2018). The inflation rate used is 16.8% (average official CPI inflation, Jan to Dec 2018).

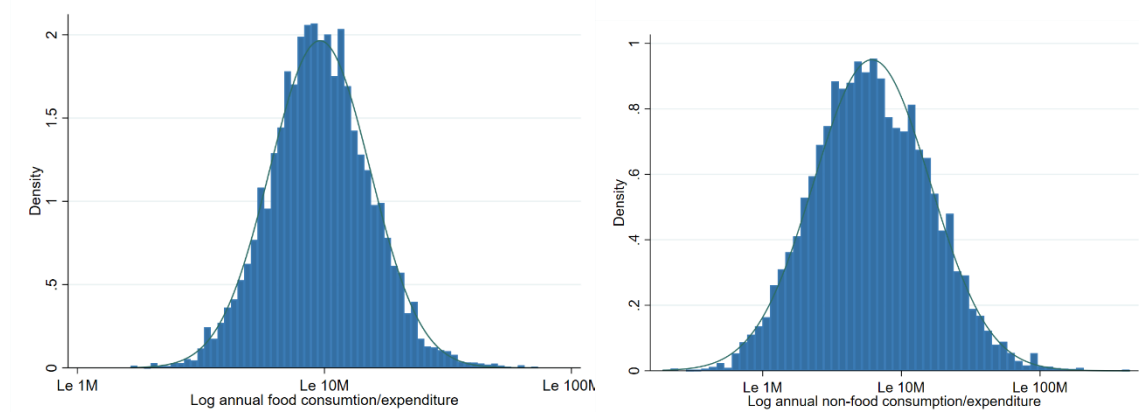
Housing and Utilities

15. Housing conditions are an essential part of people's living standards. As in the case of durable goods, the objective is to measure the annual use value received by the household from occupying its own dwelling. When a household rents its dwelling, and provided rental markets function well, the use value of housing is the actual rent paid. If the household does not rent its dwelling (because it owns the dwelling, has a dwelling provided for free or is occupying a dwelling otherwise without paying) there are two options to measure use value. One is to use the reports by households as to how much the household could receive if it were to rent out the dwelling. Alternatively, if enough people live in rented dwellings, those observations could be used to impute rents (based on housing traits available for both renters and non-renters) for those that do not pay rent.

16. Following the practice in previous years of the SLIHS, the value of owner-occupied dwellings (or any other housing used without payment) is imputed. A hedonic rental regression is estimated using actual rents as the dependent variable, and models log rent as function of the number of rooms, various region-urban/rural dummies, characteristics of water source, cooking fuel and lighting sources, and building materials of the dwelling. The same specification is used as was used for 2003/04 and 2011. This imputation performs quite well matching respondent estimates of rental value, despite most observations of actual rent being in urban areas and of higher quality dwellings. Appendix B shows the output of the rental model.

17. Expenditures on utilities (water, electricity, waste disposal, sewage and maintenance) are also included. No attempt is made to estimate the value of public utilities (mainly water from public taps or wells) for which households do not pay.

Figure 1: Distribution of log Food and Nonfood Consumption



2. REAL, PER ADULT EQUIVALENT CONSUMPTION

Adjustments for Cost-of-Living Differences

18. The nominal consumption of the household must be adjusted for temporal and spatial cost-of-living differences. Temporal differences are associated with the duration of the fieldwork (12 months, during which prices may vary seasonably as well as be subject to general inflation). Spatial differences are associated with the location of the household, particularly the difference between rural and urban areas.

19. The first step corrects for the differences in prices levels over time (temporal adjustments). For the temporal adjustments, the official overall CPI price level was used.⁷ A separate index series is created for each of the four regions of the country (see Table 2). The base for each spatial price index is the region during the entire period of fieldwork (Jan to Dec 2018).

Table 2: Temporal Price Adjustments

Month	Price Index			
	<i>East</i>	<i>North⁸</i>	<i>South</i>	<i>West</i>
January	0.927	0.917	0.931	0.934
February	0.937	0.935	0.942	0.942
March	0.952	0.949	0.954	0.951
April	0.962	0.966	0.959	0.957
May	0.975	0.979	0.969	0.971
June	0.991	0.994	0.983	0.986
July	1.014	1.013	1.005	1.010
August	1.023	1.025	1.019	1.027
September	1.036	1.041	1.039	1.042
October	1.048	1.047	1.049	1.049
November	1.061	1.062	1.068	1.059
December	1.075	1.072	1.083	1.071
2018	1.000	1.000	1.000	1.000

20. For spatial price adjustments, different deflators were used for food and non-food components. The food price index was based on quantities and unit prices from the food consumption section of the questionnaire, dividing the country into seven areas based on region and urban/rural.⁹ First, a list of food items to use was selected. Prepared meals were dropped as being too heterogeneous in quality and nutrition, and the 30 items codes for different kinds of fish were collapsed into just three codes (fresh fish, smoked fish and dried fish) as were used in earlier rounds of the SLIHS. Food consumption patterns for Western Area, other urban areas and rural areas were analyzed, and a list of 40 items selected which account for at least 80% of food consumption across the three areas (these will be the items used for the food basket). Conversion factors were applied for any nonstandard unit accounting for at least 10% of the observations. Only items that had at least 40 observations for each of the seven areas were

⁷ Note that the trends are quite similar by region, so constructing one national temporal price index and applying that has very similar results.

⁸ Temporal price adjustments are done by four regions: East, North, South and West. In July 2017, the Northern region into two provinces: North and North-West. No CPI data is collected in the North-West province. See Appendix I for maps showing the different spatial divisions of Sierra Leone.

⁹ All of Western area is considered as one area as 97% of its population live in urban areas.

used; this results in a list of 33 items.¹⁰ Price and quantities for each area were combined into a Paasche price index, using the overall national prices as the reference prices.

21. For the non-food aggregate, monthly data on prices of each of the nonfood items included in the CPI, for each of the five markets¹¹ where the CPI collects the price data was used. For each market and item, the ratio between the price in that market and the national average price (taking the prices from each market, weighted with population shares from the census) was calculated. The mean ratio of prices for each of the eleven top-level COICOP classes for nonfood items was calculated. Then these averages were combined using the official CPI weights for the top-level COICOP classes.¹²

Table 3: Spatial Price Indices

Food		Non-Food	
Area	Price Index	Market¹³	Price Index
East Rural	0.941	Kenema	1.030
East Urban	0.996	Kono	0.963
North Rural	0.954	Makeni	0.967
North Urban	1.002		
South Rural	0.902	Bo	0.978
South Urban	1.116		
Western Area	1.156	Freetown	1.069
Sierra Leone	1.000		1.000

Adjustments for Household Composition

22. The final step in constructing the consumption aggregate is to account for the size and composition of the household. This addresses total household size and demographic differences (children eat less food than adults) although not economies of scale (housing costs per person usually decline with household size). The household consumption aggregate is adjusted to per adult equivalent terms, using the scale in Table 4.

Table 4: Adult Equivalence Scale¹⁴

Age Range	Male	Female
0	0.25	0.25
1 to 3	0.45	0.45
4 to 6	0.62	0.62
7 to 10	0.69	0.69
11 to 14	0.86	0.76
15 to 18	1.03	0.76
19 to 25	1.00	0.76
26 to 50	1.00	0.76
51 and above	0.79	0.66

Source: Statistics Sierra Leone/WB (2013).

¹⁰ Representing 97% of the cost of the food basket used to set the poverty line.

¹¹ These are Freetown (applied to the Western Area), Makeni (applied to the North, including the North and North West provinces), Bo (applied to the South), Kenema (applied to Kenema and Kailahun districts in the East) and Koidu (applied to Kono district in the East).

¹² See Appendix D for alternative ways to calculate spatial price deflators.

¹³ See Appendix I for maps showing the different spatial divisions of Sierra Leone.

¹⁴ This scale is based on the daily calorie requirements by age and sex from the 10th edition of the Recommended Daily Allowances, which gives 2900 for adult males. The slight simplification and conversion into an equivalency scale was done by the Ghana Statistical Service, and has also been used in Sierra Leone since at least 2003.

Weights

23. Cluster level weights were constructed based on the inverse probability a household was selected in the two-stage sampling designed (selection of clusters from within each strata, and households within each cluster.) These weights were then post-stratified to match the estimated number of households in each chiefdom in mid 2018 (based on the number of households per chiefdom in the 2015 census and the growth rate in household per chiefdom between the 2004 and 2015 censuses). In addition, the analysis of consumption aggregates and poverty makes a small non-response correction. Although the target number of households (6840) answered most of the questionnaire, a few (44) were missing key sections such that the consumption aggregate could not be constructed. A non-response correction was added at the level of cluster, based on the number of households in the cluster for whom the consumption aggregate was constructed. For more details on construction of weights see Appendix A.

3. POVERTY ANALYSIS

Poverty Lines

24. The poverty line comprises two components: food and nonfood. The food poverty line represents the cost of a food basket that provides 2700 calories per day. The composition of this food basket is determined by examining the food consumption patterns of the 10th to 70th percentile of the population (in terms of real per adult equivalent food consumption).¹⁵ The 40 food items selected for the spatial food price index were used. The average consumption of each food item per adult equivalent in 100 grams for the reference population was constructed. Calorie values from the FAO database for West Arica were used to assign calorie values, and then the quantity for each item was scaled up so that the overall basket provides 2700 calories. The cost of this basket was then calculated using the overall national price of each food item (see Appendix F), and then multiplied by 365 to get the annual cost. This provides the food poverty line: 2125 thousand Leones per adult equivalent per year.

25. The nonfood allowance represents an allowance for basic nonfood needs. It is estimated non-parametrically as the average nonfood consumption of the population whose food consumption is close to the food poverty line (upper Ravallion method). The procedure starts by estimating the average nonfood consumption of the population whose food consumption lies within plus or minus 1% of the food poverty line. The same exercise is then repeated for those lying within plus or minus 2%, 3% and up to 10%. The nonfood allowance is the average of those ten nonfood consumption figures. Last, the total poverty line is the sum of the food poverty line and the nonfood allowance.

Table 5: Poverty Lines: Annual per Adult Equivalent

Poverty Line	3921
Food Poverty Line	2125

Note: All figures in thousands of Leones.

Poverty Measures

26. Two different methods are used to compare household consumption aggregates to the poverty lines. The extreme poor are defined as those whose consumption aggregate is less than the food poverty line, therefore less than sufficient to purchase 2700 calories per adult equivalent given standard food consumption patterns. The poor are defined as those whose consumption aggregate is less than the poverty line. Once the poverty of households is defined in these ways, we will use poverty measures from the class proposed by Foster, Greer and Thorbecke (FGT) to aggregate household level poverty status to the overall level of poverty in the country. The FGT family of measures can be summarized by the following equation:

$$FGT_{\alpha} = \frac{1}{N} \sum_{i=1}^H \left(\frac{z - y_i}{z} \right)^{\alpha}$$

where α is some non-negative parameter, z is the poverty line, y denotes consumption, i represents individuals, N is the total number of individuals in the population, and H is the number of individuals with consumption below the poverty line.

¹⁵ The initial food poverty line set for analysis of the 2003/04 data used the bottom 70% as the reference population. Using this population for 2018 results in a slightly lower food poverty line (2115) and total poverty line (3905), thus extreme poverty (12.8%) and total poverty (56.6%) are very slightly lower.

27. The headcount index ($\alpha = 0$) gives the share of the poor in the total population, the percentage of the population whose consumption is below the poverty line. This is the most widely used poverty measure mainly because it is simple to understand. However, it has some limitations. It does not consider how close or far the consumption levels of the poor are with respect to the poverty line, nor the distribution of consumption among the poor. The poverty gap ($\alpha = 1$) is the average consumption shortfall of the population relative to the poverty line. Since the greater the shortfall, the higher the gap, this measure overcomes the first limitation of the headcount. Finally, the severity of poverty ($\alpha = 2$) is sensitive to the distribution of consumption among the poor, because a transfer from a poor person to somebody less poor may leave unaffected the headcount or the poverty gap but will increase this measure.

Poverty Results for 2018

28. The incidence of poverty stands at 56.8%. The percent of the population that is poor in rural areas is more than double that in urban areas (see Table 6). Looking by regions, the West has a much lower poverty rate than all others; the highest poverty rate is seen in the North. There is, however, significant variation within each region. The three poorest districts (Pujehun, Tonkolili, and Falaba) span the far south, center and far north-east of the country.

Table 6: Total Poverty Indices

	Incidence	(SE)	Gap	(SE)	Severity	(SE)
Sierra Leone	56.8	1.2	18.0	0.6	7.5	0.3
rural	73.9	1.6	25.2	0.9	11.0	0.5
urban	34.8	2.0	8.7	0.6	3.0	0.3
Greater Freetown¹⁶	22.8	3.2	5.0	0.9	1.6	0.3
other urban	49.3	2.5	13.1	0.9	4.7	0.4
East	64.1	2.9	21.8	1.4	9.6	0.8
North	76.5	2.0	26.6	1.3	11.6	0.8
North West	62.3	2.9	17.6	1.3	6.7	0.7
South	67.7	2.6	21.9	1.4	9.3	0.8
West	23.3	3.3	5.4	1.0	1.8	0.4
Kailahun	56.7	6.9	20.6	3.4	9.2	1.8
Kenema	78.0	2.6	28.1	1.7	13.0	1.2
Kono	52.4	5.9	14.2	2.3	5.3	1.2
Bombali	64.1	4.4	22.3	2.3	9.7	1.3
Falaba	81.3	5.3	24.7	2.7	9.4	1.4
Koinadugu	76.6	3.9	23.9	2.3	9.7	1.3
Tonkolili	84.8	2.3	31.2	2.4	14.3	1.6
Kambia	45.8	7.0	10.7	2.5	3.8	1.1
Karene	77.3	4.1	25.3	2.2	10.6	1.3
Port Loko	64.3	3.9	17.7	1.8	6.5	1.0
Bo	60.2	4.5	19.2	2.0	8.0	1.2
Bonthe	51.9	6.5	14.3	2.2	5.1	0.9
Moyamba	73.5	5.5	22.6	3.6	9.4	2.3
Pujehun	84.6	2.5	30.8	2.3	14.2	1.5
WAR	37.7	7.9	9.5	2.4	3.2	0.9
Freetown	16.3	2.0	3.4	0.6	1.2	0.3

¹⁶ This is Western Area Urban (Freetown Municipality) and other urban areas in Western Area.

29. The incidence of extreme poverty, those whose total consumption is less than the food poverty line, stands at 12.9%. Extreme poverty is highly concentrated in the rural areas. Once again, the West has by far the lowest extreme poverty rate and the North the highest rate. Looking at extreme poverty, Pujehun is still the poorest district, followed by Tonkolili and Kenema.

Table 7: Extreme Poverty Indices

	Incidence	(SE)	Gap	(SE)	Severity	(SE)
Sierra Leone	12.9	0.9	2.5	0.2	0.8	0.1
rural	19.9	1.4	4.0	0.4	1.2	0.1
urban	3.8	0.6	0.6	0.1	0.2	0.1
Greater Freetown	2.1	0.7	0.3	0.2	0.1	0.1
other urban	5.7	1.0	1.0	0.2	0.2	0.1
East	17.9	2.1	3.7	0.5	1.1	0.2
North	20.5	2.4	4.1	0.6	1.2	0.2
North West	8.8	1.7	1.6	0.4	0.5	0.1
South	16.5	2.3	3.3	0.6	1.0	0.2
West	2.6	0.9	0.4	0.2	0.1	0.1
Kailahun	19.6	4.7	3.5	1.0	0.8	0.3
Kenema	24.2	3.2	5.6	0.9	1.8	0.4
Kono	7.1	2.5	1.3	0.7	0.4	0.3
Bombali	15.9	3.0	3.4	0.9	1.0	0.4
Falaba	11.8	3.3	1.8	0.7	0.4	0.2
Koinadugu	17.4	4.1	2.5	0.7	0.6	0.3
Tonkolili	27.4	5.1	5.8	1.4	1.8	0.5
Kambia	3.2	2.0	0.6	0.4	0.1	0.1
Karene	15.1	3.8	3.1	0.9	0.9	0.4
Port Loko	9.0	2.7	1.4	0.6	0.4	0.2
Bo	13.0	2.7	2.7	0.9	0.9	0.4
Bonthe	6.6	2.4	0.6	0.3	0.1	0.0
Moyamba	17.4	6.7	3.5	1.6	1.1	0.6
Pujehun	27.9	4.6	5.8	1.2	1.6	0.4
WAR	5.1	2.1	0.6	0.3	0.1	0.1
Freetown	1.4	0.7	0.3	0.3	0.1	0.1

4. TRENDS 2011 TO 2018

30. The more comprehensive data collected by the 2018 SLIHS compared to previous years allowed several improvements to be made to the methodology. The consumption aggregate in 2018 adjusts for urban vs. rural food price differences, it includes more nonfood items and it uses a more appropriate recall period for some items. Therefore, the aggregates cannot be directly compared to the official aggregates from 2003/4 and 2011. In addition, a new poverty line is calculated for 2018. The initial poverty line was calculated based on the 2003/4 survey, and then inflated using CPI price inflation between 2004 and 2011. The limited data available from 2003/4¹⁷ constrained the construction of the initial poverty line. As well, official price inflation from the CPI may not accurately measured the cost of the basket of goods consumed by the majority of the population from 2004 to 2018.¹⁸ Finally, the structure of the economy has changed significantly since 2003, when Sierra Leone was just emerging from the war. Availability and price of housing, mix of locally produced and imported foods and their relative prices, means of transport and lighting have all changed significantly since then. These factors will all impact the cost of a basic standard of living.

31. The analysis presented in this section focuses on constructing comparable consumption aggregates and poverty lines for 2011 and 2018 in order to examine poverty trends in a robust manner. We do not attempt to extend this analysis to 2003/04 due to the very limited data (particularly CPI data) available before 2004. Table 23 and Table 28 in Appendix J compare the survey design and methodology for constructing welfare aggregates and poverty lines in 2011 and in 2018.

32. The post-stratification of weights for 2011 was also updated. The original post-stratification used estimated populations extrapolated from the 2004 census. We redid this using chiefdom-level growth rates between the 2004 and 2015 censuses to get the estimated number of households per chiefdom in 2011. This has a small effect on the urban/rural distribution, the percent of households in urban areas decreases from 39.2% to 38.5%. Updating the weights increases the 2011 poverty rate estimate from 52.9% to 53.5%.¹⁹

Comparable Aggregates

33. To analyze changes in poverty between 2011 and 2018, comparable aggregates are constructed for both years and appropriate poverty lines defined. These aggregates only use data that was collected in both years. We construct nominal total household consumption for 2018, using only those items that were included in 2011 (excluding food received for free, some nonfood items and about half the durable goods) and using the same recall period for every item as in 2011.²⁰ This comparable measure of nominal total household consumption is

¹⁷ Expenditure on food items was recorded over a 3 to 12 month period instead of the diary method which was used in 2011 and 2018. Expenditures on vegetables (including onions and leafy greens like cassava leaf and potato leaf) was not captured. The quantity of food consumed was not captured but constructed based on total expenditure and prices from the CPI.

¹⁸ The CPI only collects data in urban areas; inflation in rural areas may be different, especially over long periods of time. It includes a large number of manufactured / imported goods which do not appear in the basket of foods consumed by the bulk of the population, and whose prices may increase more quickly (as the Leone depreciates) than those of locally or regionally produced foods.

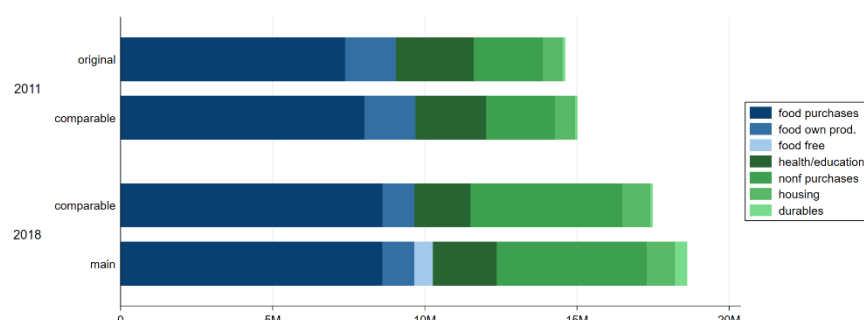
¹⁹ Analysis for the Sierra Leone Strategic Country Diagnostic did a similar post-stratification of weights, using preliminary census figures which resulted in a revised 2011 poverty rate of 53.8%.

²⁰ In 2011, infrequently purchased items were asked about with a 5x5 day recall period. In 2018, these items were asked about using both the 4x5 day recall period and the 3/12 months recall period. Expenditures over the longer recall period are used for the main 2018 aggregates, and over the shorter period for the comparable aggregates.

highly correlated to the full measure (0.957) and about 6% lower at the median, as it excludes some items.

34. Likewise, a few adjustments were made to the 2011 consumption aggregate. A data processing error in the 2011 data resulted in no purchases of food of items with item code 100 or higher being recorded for the last 5-day period, total food consumption was adjusted to assume the purchase of these items was constant across the 25-day recall period. The same method of price adjustments (for both spatial and temporal) was applied to the 2011 comparable aggregate (see the value of the deflators in Appendix J) as described for the 2018 comparable aggregate. A couple of nonfood items (educational insurance, transport specifically to access medical care) that were not collected in 2018 were excluded.

Figure 2: Comparable vs. Full Nominal Total Household Consumption, 2011 and 2018



35. Adjustments for adult equivalency, temporal price differences and nonfood spatial price differences are done in the same way as for the main aggregates of 2018. Adjustments for food spatial price differences are done by pricing the 2018 food basket using prices of individual food items from the CPI data.²¹ This produces a food price index for the five markets where CPI data is collected, similar to the nonfood spatial prices index used for the main aggregates of 2018. The price deflators originally used for 2011 had a large difference between Freetown and all the other districts, this difference is much less in the newly computed spatial deflators. See Appendix J for more details on the different spatial price deflators.

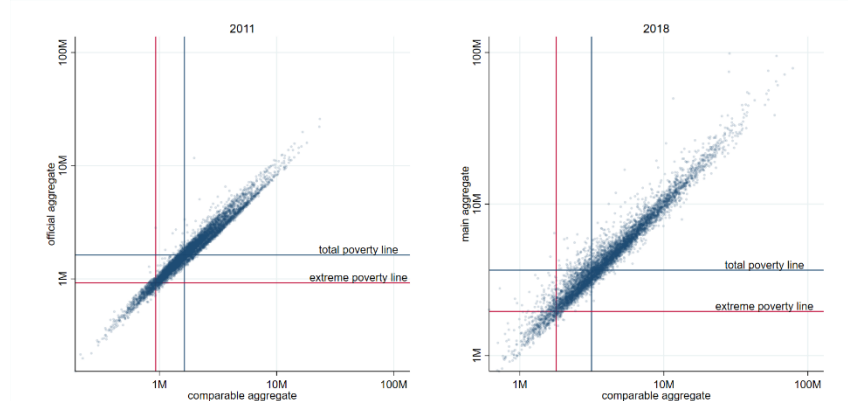
Comparable Poverty Lines

36. When constructing poverty lines suitable for the 2018 comparable aggregates, our main concern is to have consistent poverty rates for 2018, whether the main aggregate or the comparable aggregate is used.²² Thus the comparable total poverty line for 2018 is set such that comparing the comparable aggregate against the comparable poverty line yields the same poverty rate (56.8%) as we get in the main analysis. The same process is used to set to the food poverty line such that the food poverty rate (54.5%) is preserved. (See the first two lines of Table 8). This results in significantly lower poverty lines. Figure 3 shows the scatter plot of main versus comparable aggregates with their corresponding extreme and total poverty lines. The food poverty line is also slightly lower using the comparable aggregates. Using the comparable estimates, we see an even bigger gap between poverty in urban and rural areas (31.1% vs 78.5%) as expected since the comparable aggregates do not adjust for lower prices in rural areas.

²¹ Of the 40 items in the basket, 35 have price data collected as part of the CPI, and another 3 have very close substitutes. The remaining two items (accounting for less than 1% of the total cost) were dropped.

²² The main analysis is the best estimation of the actual level of poverty in the country in 2018, so the "correct" poverty line for the comparable aggregates is one that yields the correct (best estimate of the) poverty rate.

Figure 3: Main vs Comparable Aggregates with Poverty Lines



37. We then deflate these lines to 2011 prices using CPI inflation. The food poverty line is deflated to 2011 price levels using CPI food price inflation for this period, and the non-food allowance using CPI non-food price inflation. The two are summed to produce the comparable total poverty line for 2011. Note that this results in very similar food poverty line to that originally calculated in 2003 and inflated to 2011 prices. The nonfood component, however, is substantially higher.

Table 8: Poverty Lines and Rates, 2011 and 2018

	food poverty line	nonfood allowance	total poverty line	extreme poverty rate	food poverty rate	total poverty rate
2018 main	2125	1796	3921	12.9%	54.5%	56.8%
2018 comparable	1960	1708	3668	15.1%	54.5%	56.8%
2011 comparable	963	931	1894	14.4%	46.1%	62.4%
2011 original	925	701	1626	13.9%	47.7%	52.9%

Poverty lines in thousands of Leones annually per adult equivalent.

Trends Results

38. The results show an overall decrease in total poverty of 5.6 percentage points between 2011 and 2018. Poverty in rural areas is essentially unchanged; poverty in urban areas has decreased by 6.2 percentage points, particularly outside of Freetown. Poverty has decreased in each of the four regions, but only the change in Western Area is large enough to be statistically significant. The poverty gap (average % shortfall in consumption of poor households) and severity (square of the average % shortfall in consumption of poor households) have decreased in urban areas.

Table 9: Changes in Total Poverty, 2011 to 2018

	Incidence		Gap		Severity	
	change in percentage points					
Sierra Leone	-5.6	***	-2.0	**	-1.0	*
rural	1.1		1.1		0.6	
urban	-6.2	**	-2.2	**	-1.1	**
Freetown	-3.1		-0.7		-0.3	
other urban	-7.2	*	-3.2	**	-1.7	**
East	-4.0		0.6		1.0	
North	-2.4		-2.0		-1.4	
South	-1.3		-0.4		-0.4	
West	-7.6	*	-2.5	*	-1.1	*

Note: Significance level of the difference: 1% (***), 5% (**) and 10% (*).

39. Extreme poverty has not changed significantly between 2011 and 2018, however it has increased in rural areas and the East. There is also an increase in the gap and severity of extreme poverty in the East.

Table 10: Changes in Extreme Poverty, 2011 to 2018

	Incidence		Gap		Severity	
	<i>change in percentage points</i>					
Sierra Leone	0.7		0.1		0.0	
rural	5.3	**	1.0		0.2	
urban	-1.6		-0.3		-0.1	
Freetown	-0.4		-0.1		0.0	
other urban	-2.6		-0.5		-0.2	
East	5.9	**	2.1	***	0.8	***
North	0.3		-0.5		-0.3	
South	1.7		0.5		0.2	
West	-1.2		-0.3		-0.1	

Note: Significance level of the difference: 1% (***), 5% (**) and 10% (*).

40. Note that the designation of households into rural or urban areas is based on the official designation of the EA from the sampling frame. For 2011, this is based on the 2004 census, for 2018, this is based on the 2015 census. Thus the same geographical location might be classified as rural in 2011 but urban in 2018.

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Appendix A CONSTRUCTION OF WEIGHTS

41. The construction of weights for the 2018 SLIHS consisted of calculating initial selection weights, post-stratification and non-response correction for consumption aggregates. The sample was designed with 10 households in each of 684 clusters (census enumeration areas) spread over 27 strata, with two stage sampling. The number of clusters per strata was decided to maximize the efficiency of the estimates of poverty at the strata level. In the first stage of sampling, the requested number of clusters for each strata (R_s for $s = 1$ to 27) were then selected from the total number of clusters for that strata the sampling frame (C_s),²³ using probability proportional to size (that is, the number of households in the cluster according to the frame, F_c). Then, a household listing was done for each selected cluster. In the second stage of sampling, 10 households were selected from the total number listed (L_c).²⁴ Thus the probability of selecting a household in cluster c in strata s is

$$p_{sc} = p_1 \times p_2 = \frac{R_s F_c}{C_s} \times \frac{10}{L_c}$$

where p_1 is the probability the cluster was selected in the first stage, and p_2 is the probability the household was selected in the second stage.

42. Using selection weights (equal to one over the probability of selection), we estimated the total number of households per chiefdom (H_f).²⁵ We also estimated the total number of households per chiefdom by using the chiefdom-level growth in number of households between the 2004 and 2015 censuses and projecting this forward to mid 2018 (H'_f). Then, for each chiefdom, a post-stratification factor of H'_f/H_f was applied to the weight. This gives the final probability weight included in each SLIHS dataset

43. In each cluster, the interviewers were able to complete the majority of the questionnaire with the target number of households (10), resulting in a full sample size of 6840 households. A few households (44), however, did not have all the data necessary to construct the consumption aggregate. Thus a non-response correction is added at the cluster level for the weights used for the poverty analysis.

²³ The frame used by Statistics Sierra Leone was based on some preliminary work for the 2015 census, and the estimated total number of households per strata differed significantly from the final totals from the census results, particularly the relative share of urban and rural households.

²⁴ For clusters shared with the MICS 2017, 10 households and 5 replacements were selected from the 26 households actually interviewed by the MICS team. For the SLIHS only clusters, 10 households and 5 replacements were selected from all the households listed. In each case, 10 households completed most of the questionnaire in each cluster.

²⁵ This SLIHS covered 145 of 149 chiefdoms (definitions prior to July 2017) as well as all 17 chiefdoms-level administrative units for city councils (Makeni City Council, etc), WAR (Mountain etc) and Freetown (East I etc). Those chiefdoms not covered by the SLIHS sampled were combined with a similar neighboring chiefdom in the same district for the purposes of this stage of the weighting.

Appendix B - DEPRECIATION RATES FOR DURABLE GOODS

Table 11: Median Depreciation Rates

Durable Good	Depreciation Rate
3- or 4-piece sofa set	0.25
dining table and chairs	0.26
sideboard	0.25
other table	0.27
other chairs	0.27
bed	0.23
mattress	0.27
sewing machine	0.22
cooker (gas/electric)	0.21
stove (electric)	0.39
stove (gas)	0.27
stove (kerosene)	0.27
refrigerator	0.25
freezer	0.26
air conditioner	0.22
washing machine	0.30
iron (electric)	0.28
electric fan	0.30
iron (charcoal)	0.29
generator	0.27
car (personal)	0.24
motorcycle	0.30
bicycle	0.33
mobile phone	0.37
radio	0.33
television	0.26
stereo system	0.26
video / DVD equipment	0.30
camera	0.28
computer	0.26
microwave	0.27

Appendix C - HOUSING VALUE IMPUTATION MODEL

Table 12: Housing Value Imputation Model

Variable	Coef.	Std. Err.	z	P > z	95% CI	
size						
log number of rooms	0.139	0.0143	9.68	0.000	0.111	0.167
log number of rooms squared	-0.050	0.0084	-5.87	0.000	-0.066	-0.033
geographical strata						
South, urban	-0.039	0.0110	-3.51	0.000	-0.060	-0.017
South, rural	-0.104	0.0280	-3.70	0.000	-0.159	-0.049
East, urban	-0.083	0.0115	-7.22	0.000	-0.105	-0.060
East, rural	-0.169	0.0345	-4.91	0.000	-0.237	-0.102
North, urban	-0.063	0.0111	-5.71	0.000	-0.085	-0.042
North, rural	-0.177	0.0336	-5.26	0.000	-0.243	-0.111
West, urban	(omitted)					
West, rural	-0.074	0.0677	-1.10	0.273	-0.207	0.058
water source						
private, protected	(omitted)					
public, protected	0.020	0.0115	1.72	0.086	-0.003	0.042
unprotected	0.014	0.0192	0.73	0.463	-0.024	0.052
electricity main source of light	0.052	0.0079	6.62	0.000	0.037	0.067
cooking fuel						
wood	-0.030	0.0159	-1.90	0.057	-0.061	0.001
charcoal	0.010	0.0126	0.82	0.411	-0.014	0.035
other (mainly gas)	(omitted)					
toilet facility						
flush toilet	0.088	0.0255	3.47	0.001	0.038	0.138
other kind of toilet/latrine	0.019	0.0247	0.77	0.442	-0.029	0.067
no toilet	(omitted)					
main material of walls						
cement blocks	0.027	0.0179	1.50	0.134	-0.008	0.062
mud	(omitted)					
other	-0.022	0.0174	-1.27	0.203	-0.056	0.012
floor						
mud floor	(omitted)					
cement, wood or other	0.076	0.0202	3.77	0.000	0.037	0.116

Notes: (a) Dependent variable: log actual annual rent

(b) Number of observations: 1562

(c) Note that this model includes some factors which are not characteristics of the dwelling (mainly type of cooking fuel) but are rather proxies for wealth level of the household. It also does not include type of roof (thatch vs. corrugated metal sheets). An alternate model was tested using more precisely factors of housing itself that are relevant in Sierra Leone context, but it produced very similar results; it was slightly better correlated with actual rents, but slightly worse correlated with respondent estimated rents. Thus, the original model from 2003/04 and 2011 was maintained.

Appendix D - ROBUSTNESS CHECK: METHOD OF PRICE ADJUSTMENT

44. There are three different sources of data which can be used to adjust for spatial and temporal price variations. The first two come from the CPI. The CPI collects data on both food and non-food items, but only in the major urban centers. Food items should be weighed giving exact per kg prices. The list of items and the weighting of individual items may not be correct / up-to-date as it is based on the 2003/04 SLIHS which is now 15 years old and had some data quality issues.²⁶ The CPI data shows a very (perhaps suspiciously) smooth and consistent increase in prices across all categories over the 12-month period.

45. The first source of data is the official CPI price levels. These are provided by region and month for each of the 12 top-level COICOP categories and reflect relative price levels for that region in that month compared to those for the region in the base month.

46. The second source of data is prices of individual items from the CPI, for each month, for each of the five market towns with CPI data is collected. These are raw prices, so the price of an item in one market can be compared to the average price across all markets, and spatial price indices constructed. These individual prices can also be used to cost a basket of items, for example the food basket used to calculate the 2018 food poverty line.

47. The third source of data is unit prices for food items derived from respondent reports of quantities purchased and expenditure. The survey covers the full spectrum of urban and rural areas, but it only collects data on food prices. The prices used in calculating the food price index are based only on the most common unit used when purchasing (to avoid introducing possible errors in conversion of non-standard units), but it is possible different survey teams were not consistent in how they coded units which could introduce errors.

48. Five different combinations were tested, as summarized in the table below. The values of the various deflators are given in

49. Table 24 and Table 25 in Appendix J.

Table 13: Alternative Spatial Price Adjustments

Temporal		Spatial	
		<i>food</i>	<i>nonfood</i>
Main method		Paasche food survey price index, by region x urban/rural	aggregate of CPI nonfood prices by market
Alternative 1	by region, overall CPI by month	cost of food basket at CPI prices	aggregate of CPI nonfood prices by market
Alternative 2		Paasche food price index, food prices from survey, by region x urban/rural	
Alternative 3		aggregate of CPI food prices by market	aggregate of CPI nonfood prices by market
Alternative 4	region-month index, food expenditure shares x CPI prices (similar to 2003/04, 2011 method)		

50. The five different methods result in slightly different overall poverty rates, and different distribution of poverty between urban and rural. In all cases, however, rural areas are more

²⁶ The 2003/04 SLIHS asked about expenditure on food items over a 3 month recall period, and did not include most vegetables, such as leafy greens and onions.

than twice as poor as urban areas, the West is by far the least poor region and the North the most poor.

Table 14: Robustness of Poverty Results to Method of Spatial Price Adjustment

		Main method	Alternative 1	Alternative 2	Alternative 3	Alternative 4
total poverty line		3921	3786	3812	3920	3765
absolute poverty incidence	Sierra Leone	56.8	55.1	55.1	57.1	54.4
	Rural	73.9	72.6	74.2	75.5	73.2
	Urban	34.8	32.4	30.5	33.3	30.1
	Rural/Urban ratio	2.1	2.2	2.4	2.3	2.4
	East	64.1	61.9	63.3	62.9	61.1
	North	76.5	74.6	74.9	77.1	74.7
	North-West	62.3	59.8	59.6	65.3	58.3
	South	67.7	68.2	70.8	68.3	69.1
	West	23.3	20.7	17.8	22.4	19.0

Appendix E - ROBUSTNESS CHECK: DAILY CALORIE REQUIREMENT AND COST OF BASKET

51. The level of the food poverty line, the total poverty line and the poverty rate are extremely sensitive to the choice of the daily caloric requirement for the adult male, used to set the quantities in the food basket. The initial analysis of the 2003/04 SLIHS computed poverty lines for a variety of calorie requirements between 2200 and 3000 before adopting 2700 as the standard. This is lower than the 2900 calories given in the RDA report used to set the adult equivalency scale, but fairly high based on the imputed actual caloric intakes for households in the SLIHS.

Table 15: Poverty Lines and Incidence with Different Calorie Requirements

Calorie requirement	Food poverty line	Total poverty line	Poverty incidence	Extreme poverty incidence
2200	1731	3272	43.2%	6.0%
2500	1968	3633	51.0%	10.0%
2700	2125	3921	56.8%	12.9%
2900	2282	4264	62.5%	17.1%
3000	2361	4486	65.7%	19.1%

52. The bottom line poverty rate is extremely sensitive to small changes in the poverty rate, as much of the population lives close to the poverty line. In addition, the total poverty line can be quite sensitive to the food poverty line, given the nature of the Ravallion process used to construct the total poverty line. Table 16 shows the total poverty line and poverty rate for food poverty lines that are 1%, 5% and 10% above or below that finally used. The final poverty rate is then quite sensitive to how you define the typical diet. It is possible to construct a plausible food basket that provides 2700 calories but contains a little less fish and a little more cassava and results in a much lower poverty line.

Table 16: Poverty with Small Changes to Food Poverty Line

change in food poverty line	food poverty line	total poverty line	total poverty rate	extreme poverty rate
10% below	1912	3532	49.0%	8.8%
5% below	2019	3739	53.1%	10.8%
1% below	2104	3874	56.1%	12.6%
no change	2125	3921	56.8%	12.8%
1% above	2146	3970	57.7%	13.5%
5% above	2231	4135	60.6%	15.7%
10% above	2337	4398	64.6%	18.6%

Appendix F - FOOD BASKET FOR FOOD POVERTY LINE

Table 17: Basket for Food Poverty Line

	quant (100g)	calories	price (per 100g)	cost	% of calories	% of cost
101. rice – imported	2.437	860.386	0.484	1.179	31.9	20.3
102. rice – local	1.169	419.727	0.458	0.536	15.5	9.2
302. dried fish +	0.546	81.834	0.966	0.527	3.0	9.1
501. palm oil (palm wine)	0.767	690.378	0.664	0.510	25.6	8.8
301. fresh fish	0.477	47.713	1.056	0.504	1.8	8.7
910. pepper – fresh	0.204	9.186	1.229	0.251	0.3	4.3
906. maggi / jumbo etc	0.061	0.614	3.933	0.241	0.0	4.1
702. onions	0.396	14.651	0.535	0.212	0.5	3.6
731. cassava	0.671	102.723	0.213	0.143	3.8	2.5
303. smoked fish	0.125	18.822	1.043	0.131	0.7	2.2
103. bread	0.104	25.970	1.250	0.130	1.0	2.2
508. groundnut paste	0.084	49.928	1.427	0.120	1.8	2.1
24. soft drinks (coke, rubber drink)	0.104	4.698	1.037	0.108	0.2	1.9
903. salt	0.157	0.000	0.616	0.097	0.0	1.7
704. potato leaf	0.425	21.677	0.216	0.092	0.8	1.6
754. groundnuts - shelled, roasted	0.072	40.740	1.104	0.079	1.5	1.4
601. banana	0.401	39.700	0.190	0.076	1.5	1.3
703. cassava leaf	0.312	30.282	0.240	0.075	1.1	1.3
602. mango	0.367	19.106	0.186	0.068	0.7	1.2
801. sugar	0.082	32.853	0.805	0.066	1.2	1.1
506. vegetable oil	0.059	52.876	1.111	0.065	2.0	1.1
707. okra – fresh	0.044	1.454	1.266	0.056	0.1	1.0
705. kren kren leaf +	0.210	12.399	0.262	0.055	0.5	0.9
401. milk powder	0.010	5.098	5.000	0.051	0.2	0.9
756. big beans	0.125	42.886	0.410	0.051	1.6	0.9
734. sweet potato – red	0.200	22.990	0.232	0.046	0.9	0.8
212. wild game meat * ++	0.036	4.567	1.250	0.045	0.2	0.8
738. yam	0.120	15.360	0.372	0.045	0.6	0.8
911. pepper – dried	0.036	1.626	1.181	0.043	0.1	0.7
22. sachet water	0.643	0.000	0.057	0.037	0.0	0.6
207. cow beef *	0.011	1.341	3.113	0.033	0.0	0.6
757. back-eyed beans +	0.048	15.431	0.628	0.030	0.6	0.5
907. locally made seasonings	0.006	0.872	5.000	0.029	0.0	0.5
201. chicken *	0.009	1.254	1.906	0.018	0.0	0.3
86. bread and butter etc+ *	0.010	3.162	1.710	0.017	0.1	0.3
12. chocolate drinks *	0.002	0.769	7.531	0.015	0.0	0.3
505. margarine (butter, golden gate)	0.005	3.494	2.734	0.013	0.1	0.2
336. canned fish (sardines) *	0.002	1.747	5.319	0.010	0.1	0.2
409. chicken eggs	0.004	0.499	2.329	0.008	0.0	0.1
909. mayonnaise *	0.002	1.187	4.907	0.008	0.0	0.1
		2700.0	daily	5.822	100.00	100.00
			annual	2,125		

Notes: All prices, costs in thousands of Leones.

* not in spatial food price index due to few observations for some areas (region x urban/rural)

+ close substitute used for cost of basket at CPI prices, sorrel leaves for kren kren leaves; bread for bread with butter, smoked fish for dried fish.

++ not collected as part of CPI, so not included in alternative spatial food price index costing 2018 basket at CPI prices

Appendix G – TRENDS ROBUSTNESS CHECK: UPDATING ORIGINAL 2003 POVERTY LINE

53. The trends analysis presented in the main section of the paper used the newly calculated 2018 poverty line to compare poverty between 2011 and 2018, deflating the food and non-food components to 2011 prices using the CPI price level. As an alternative, we consider using the original 2003 poverty line (despite its limitations) and bringing it forward to 2018 prices. First, we adjust the line slightly for 2011.²⁷ Then, we inflate the both the food poverty line and the total poverty line using overall CPI inflation (the same method used to inflate the line initially between 2004 and 2011). This results in significantly lower poverty lines and lower poverty rates than those based on the newly calculated 2018 line (an overall poverty rate of 47.2% for 2018 as compared to our best estimate of 56.8%).

Table 18: Poverty Lines and Rates, 2011 and 2018, Alternative Method

	food poverty line	nonfood allowance	total poverty line	extreme poverty rate	food poverty rate	total poverty rate
2018 main	2125	1796	3921	12.9%	54.5%	56.8%
2018 comparable	1791	1357	3148	11.2%	46.6%	47.2%
2011 comparable	931	705	1636	13.1%	43.3%	51.8%
2011 original	925	701	1626	13.9%	47.7%	52.9%
2003/04 original	427	323	750	31.3%	68.1%	66.4%

Poverty lines in thousands of Leones annually per adult equivalent.

54. The trends between 2011 and 2018, however, are very similar: a modest reduction in poverty, mainly driven by urban areas outside of Freetown, and little overall change in extreme poverty. With the 2003 poverty line, poverty decreases by 4.7 percentage points between 2011 and 2018. There is a significant decrease in the incidence of poverty in urban area, and in the gap and severity in urban areas generally, and specifically those outside of Freetown. A small overall decrease in extreme poverty is now just statistically significant, with larger decreases in urban areas.

Table 19: Changes in Total Poverty, 2011 to 2018, Alternative Method

	Incidence		Gap		Severity	
	change in percentage points					
Sierra Leone	-4.7	***	-1.7	**	-0.8	*
rural	1.5		0.7		0.2	
urban	-4.4	*	-1.8	**	-0.9	**
Freetown	-2.5		-0.5		-0.2	
other urban	-4.6		-2.8	**	-1.4	**
East	-1.7		0.9		1.0	
North	-2.4		-2.1		-1.3	
South	-0.8		-0.7		-0.6	
West	-6.6	*	-1.8	*	-0.7	

Note: Significance level of the difference: 1% (***), 5% (**) and 10% (*).

²⁷ The original 2011 temporal price deflators used May 2011 as the base, while the revised deflators used for the comparable aggregate use the overall 2011 annual price.

Table 20: Changes in Extreme Poverty, 2011 to 2018, Alternative Method

	Incidence		Gap		Severity	
			<i>change in percentage points</i>			
Sierra Leone	-1.9	*	-0.4		-0.2	
rural	0.7		0.0		-0.1	
urban	-2.2	**	-0.4	*	-0.1	
Freetown	-0.9		-0.1		-0.1	
other urban	-3.3	**	-0.6	**	-0.2	*
East	3.4		1.2	**	0.4	**
North	-3.3		-1.1		-0.5	*
South	-2.1		-0.4		-0.2	
West	-1.7		-0.3		-0.1	

Note: Significance level of the difference: 1% (***), 5% (**) and 10% (*).

Appendix H - TRENDS ROBUSTNESS CHECK: SURVEY TO SURVEY IMPUTATION

55. There are some differences in the structure of the questionnaire and the methods of data entry between the 2018 SLIHS and the 2011 SLIHS that most likely affect the data collected and the comparability of the aggregates. In particular, the method of compiling and entering data from the food consumption diaries (which were completed by the households in the same way each year) differed significantly. In addition, the 2011 SLIHS faced a number of technical challenges in entering and compiling the data.²⁸ The process for 2018 worked much smoother, with data entry being done on laptops in the field and involving extensive data checks and feedback, allowing teams to immediately fix mistakes. This resulted in much cleaner data coming in, and thus a much lighter approach to data cleaning than had to be employed in 2011.

56. In order to validate the trends results found using monetary poverty, we also employ a survey-to-survey imputation method, using the method developed for SWIFT (Survey of Well-being via Instant, Frequent Tracking) (see Yoshida 2015). This method uses data from the 2018 survey to model our best welfare aggregate using other characteristics of the household which are also available in the 2011 survey. Separate models are developed for greater Freetown, other urban areas and rural areas. The models take the general form:

$$\ln y_h = x_h' \beta + u_h$$

where $\ln y_h$ refers to a natural logarithm of welfare of household h , x_h is a $(k \times 1)$ vector of poverty correlates of household h , β is a $(k \times 1)$ vector of coefficients of poverty correlates²⁹, and u_h is a projection error. To improve accuracy of projections, SWIFT adopts approaches used in machine learning, poverty mapping, and multiple imputation. The model developed for Sierra Leone using the 2018 data quite precisely mimics the poverty rates, both at the sector level at which the models were developed and at the regional level.

Table 21: Accuracy of Simulation Model with 2018 Data

	Absolute Poverty		
	simulation	original	difference
National	57.0%	56.9% ³⁰	0.0%
Freetown	23.5%	22.8%	-0.7%
Other Urban	49.5%	49.2%	-0.3%
Rural	73.6%	73.6%	0.0%
Eastern	64.0%	65.8%	1.8%
Northern	69.7%	69.6%	0.0%
Southern	67.8%	65.1%	-2.7%
Western	23.9%	23.5%	-0.4%

²⁸ Data entry for Part A of the questionnaire involved scanning questionnaire pages and using Optical Mark Recognition and Optical Character Recognition. This had many technical challenges. Part B was entered using CPro. There was some confusion as to whether amounts were to be entered in Leones or thousands of Leones that resulted in a tricky data cleaning operation.

²⁹ For Sierra Leone, this include household demographics and education levels, employment status, housing quality, ownership of durable goods and livestock.

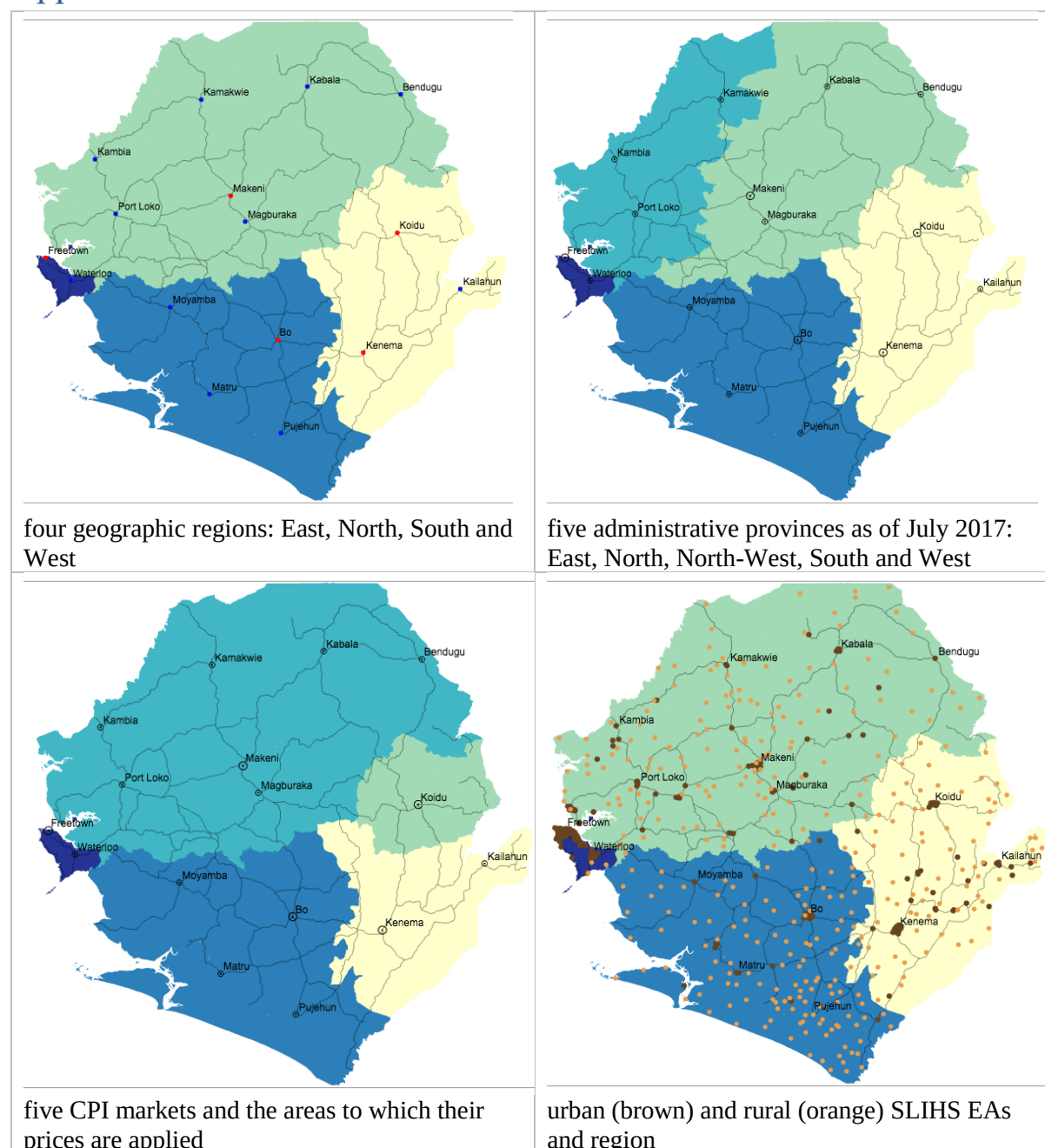
³⁰ The modelling was done with a non-finished version of the consumption aggregate, so these results do not exactly match those presented in the main part of the note.

57. We then apply this model to each household in the 2011 dataset to get a predicted level of household welfare for each household, and thus poverty rates. We compared the changes in poverty between the 2011 and 2018 using both the comparable consumption aggregates, and for 2018 the main consumption aggregated and for 2011 an imputed value of this aggregate based on non-monetary characteristics of the household. Overall, a roughly similar pattern emerges of a modest decrease in poverty driven by urban areas. Using the simulated results, the decrease is smaller, and not statistically significant. The decrease in poverty in urban areas outside of Freetown is very similar.

Table 22: Changes in Poverty Using Directly Calculated and Imputed Welfare

Absolute Poverty	Comparable Welfare Aggregate			Main Welfare Aggregate (imputed for 2011)			
	2011	2018	difference	2011	2018	difference	
Freetown	19.4%	17.9%	-1.5%	20.7%	22.8%	2.1%	
other urban	53.4%	49.1%	-4.3%	53.5%	49.2%	-4.4%	
rural	75.7%	76.5%	0.8%	69.8%	73.6%	3.8%	**
National	61.3%	56.9%	-4.4%	57.9%	56.9%	-1.0%	***

Appendix I - MAPS



59. Official CPI numbers are produced for the four geographic regions. These are used in calculating temporal price variations, so we have one temporal price index for each region.

60. In July 2017, the GoSL increased the number of administrative units at the chiefdom, district and province level, creating five administrative provinces instead of four (by splitting North into North and North-West and a few other minor boundary changes). Poverty results are presented at the level of the five current administrative provinces.

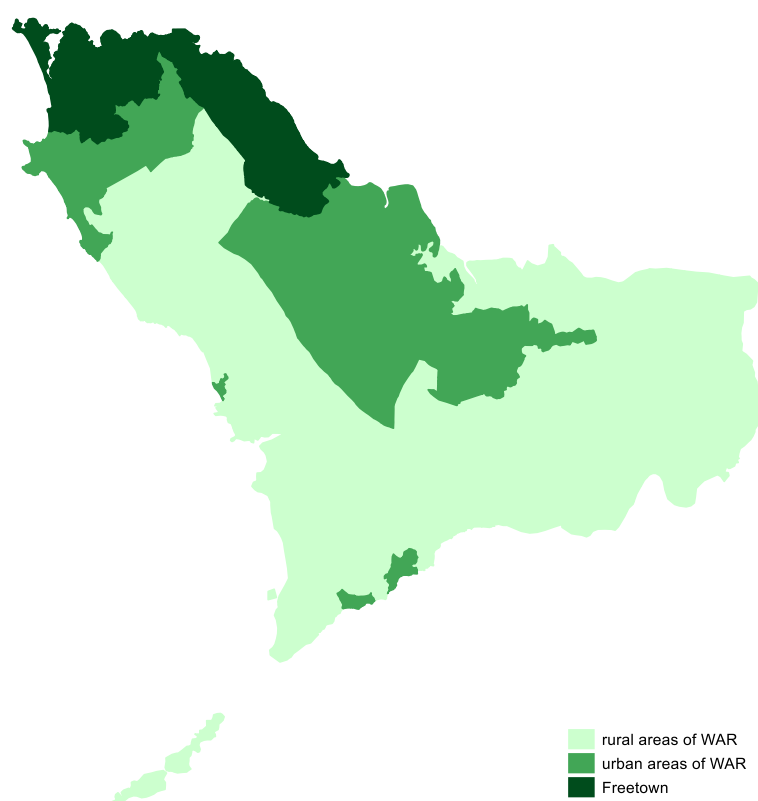
61. Price data for the CPI are collected in five markets throughout the country: Kenema and Koidu in the East, Makeni in the North, Bo in the South and Freetown in the West. (No price data is collected in the North West province.) Spatial price indices that rely on CPI prices (either aggregating all food or nonfood prices or costing the basket at CPI prices) are

constructed for these five markets. Prices in Kenema are taken as applicable for Kailahun and Kenema districts, prices in Koidu for Kono district.

62. Price data from the survey is aggregated at the level of 7 areas (geographic region crossed with urban/rural, all of Western area considered as one area) for computing a spatial food price index based on survey prices.

63. The Western Province is divided into two districts: Western Area Urban and Western Area Rural. Western Area Urban is Freetown. Western Area Rural (WAR) is the rest of the Western Province, outside Freetown city limits. "Rural" is a bit of a misnomer, as 90% of the population live in urban EAs according to the census classification. WAR consists of urban areas contiguous with Freetown, a few mid-sized towns (some of which are being rapidly engulfed by Freetown) and a few truly rural fishing and farming communities. All of Western area is considered together for the purposes of constructing spatial price indices (whether based on unit prices from the survey or CPI prices). The country is divided into "Greater Freetown" (Freetown proper and urban areas in Western Area Rural) versus other urban areas (ie those outside of Western Area) and rural (including rural areas in Western Area) for the purpose of analyzing consumption patterns to select items for the basket and price index, and for presentation of results. The presentation of results by district uses the official district boundaries.

Figure 4: Western Area



Appendix J - ADDITIONAL DETAILS FOR TRENDS METHODOLOGY

Table 23: Comparison of Survey Methodology

	2018	2011
Stratification	District x urban/rural	District x urban/rural
Target size	10 households x 684 EAs	10 households x 684 EAs
Households interviewed	6840	6763
Households with sufficient data to construct welfare	6796	6727
% urban EAs	49.7%	36.4%
Fieldwork period	Jan to Dec 2018	Jan to Dec 2011
Diary period	4 x 5 days	5 x 5 days
Diary to questionnaire	Each line for each day transcribed	Total for each item over 5 days calculated and entered
Data capture	Paper questionnaires immediately entered in CSPro using laptops in the field	Paper questionnaires, entered centrally, Book 1 via ScanTron, Book 2 in CSPro
Food price data collected	yes	no

Table 24: All Temporal Price Deflators

		(1)	(2)	(3)	(4)	(5)	(6)
		East	North	South	West	National	National reweighted
2018	January	0.927	0.917	0.931	0.934	0.928	0.929
	February	0.937	0.935	0.942	0.942	0.940	0.941
	March	0.952	0.949	0.954	0.951	0.952	0.953
	April	0.962	0.966	0.959	0.957	0.961	0.962
	May	0.975	0.979	0.969	0.971	0.973	0.974
	June	0.991	0.994	0.983	0.986	0.988	0.989
	July	1.014	1.013	1.005	1.010	1.010	1.008
	August	1.023	1.025	1.019	1.027	1.024	1.023
	September	1.036	1.041	1.039	1.042	1.040	1.040
	October	1.048	1.047	1.049	1.049	1.049	1.048
	November	1.061	1.062	1.068	1.059	1.062	1.060
	December	1.075	1.072	1.083	1.071	1.074	1.072
2011	January	0.982	0.975	0.982	0.975		
	February	0.984	0.980	0.984	0.976		
	March	0.987	0.987	0.986	0.978		
	April	0.990	0.991	0.990	0.985		
	May	0.993	0.993	0.995	0.990		
	June	0.995	0.999	0.997	0.993		
	July	1.003	1.005	1.003	1.003		
	August	1.006	1.008	1.005	1.008		
	September	1.010	1.011	1.008	1.018		
	October	1.014	1.013	1.012	1.022		
	November	1.017	1.016	1.018	1.025		
	December	1.017	1.020	1.020	1.028		

64. The regional deflators found in columns (1) to (4) are used for all aggregates. Column (5) is calculated based on national CPI levels, column (6) based on national CPI levels, with top COICOP categories weighted by SLIHS expenditure shares instead of the official CPI weights.

Table 25: All Spatial Price Deflators

		(1)	market	(2)	(3)	(4)
	region	Paasche food price index from survey data		Laspeyres food price index, cost of 2018 basket at CPI prices	Aggregate of all CPI food prices	Aggregate of all CPI nonfood prices
2018	East Rural	0.941	Kenema	1.021	0.937	1.030
	East Urban	0.996	Koidu	0.937	0.955	0.963
	North Rural	0.954	Makeni	0.968	0.991	0.967
	North Urban	1.002				
	South Rural	0.902	Bo	1.031	0.954	0.978
	South Urban	1.116				
	Western Area	1.156	Freetown	1.029	1.122	1.069
2011	Data not available		Kenema	1.053	1.011	0.999
			Koidu	0.978	1.050	0.992
			Makeni	0.901	0.934	0.963
			Bo	1.066	1.006	0.998
			Freetown	1.069	1.079	1.068

65. Columns (1) and (4) are used for the main 2018 aggregates. Columns (2) and (4) are used for the comparable aggregates for 2011 and 2018.

Table 26: Market-Month Price Index

	Kenema	Koidu	Makeni	Bo	Freetown
January	0.972	0.829	0.916	0.951	1.018
February	0.965	0.838	0.935	0.975	1.025
March	0.977	0.859	0.938	0.995	1.036
April	0.981	0.871	0.946	0.999	1.043
May	0.990	0.895	0.947	1.003	1.045
June	1.011	0.923	0.971	0.997	1.068
July	0.995	0.945	0.969	1.001	1.070
August	0.987	0.966	0.984	1.014	1.100
September	0.995	0.973	1.002	1.037	1.103
October	1.007	1.001	1.001	1.054	1.095
November	1.024	1.015	1.014	1.060	1.103
December	1.030	1.033	1.007	1.066	1.102
2018 annual			1.000		

66. This one market-month index, based on CPI prices of individual food items, and expenditure shares from the data, is very similar in theory to what was used for official aggregates for 2003/4 and 2011.

67. The price deflators used for the original 2011 analysis actually differ substantially from what we calculate for the comparable analysis, for reasons that are not entirely clear. Figure 5 shows the effective price deflators by month and CPI market, both the new food and nonfood price indices, and the original price index (based on food prices but used to deflate but food and nonfood expenditure). Note that the original price index is much noisier and shows a downturn towards the end of the year. This downturn is not reflected in any published CPI report (see, for example, Stats SL 2012). They also differ in the rankings of the regions, with the original showing Freetown much the most expensive, with the new indices showing Bo and Kenema as expensive at least in terms of food prices.

Figure 5: Various Price Deflators for 2011



68. The original price deflators are based on a series of spreadsheets showing prices for the four regions (with Kenema only representing the East, although CPI data in 2011 was collected in both Kenema and Koidu in the East) for food items as coded on the SLIHS questionnaire, supposedly constructed from CPI data. There are clear discrepancies between these prices, and those in the CPI price data for 2011 (with prices of individual items in the five CPI centers) provided by Stats SL in early 2019. Table 27 shows the four most important food items (according to both the weights calculated for the 2011 analysis and the 2018 food basket). Note that the price for imported rice in Bo is lower than the price for any of the grades of imported rice in Bo in the more detailed CPI data. Note also the fairly comparable prices for dried fish in the more detailed CPI data, compared to the much lower prices in Bo in the constructed prices used in the original 2011 price deflators.

Table 27: Key Food Prices, Jan 2011

food item	weight for original index	share of 2018 basket	constructed price used for Jan 2011		prices for Jan 2011 from CPI data provided in 2019	
			price in Freetown	price in Bo	price in Freetown	price in Bo
imported rice	0.245	0.203	2.830	2.825	2.900, 2.400, 2.800	3.560, 3.000, 2.977
local rice	0.184	0.092	2.808	3.086	2,800, 3.000	3.600, 3.000
palm oil	0.126	0.091	6.000	5.575	5.239	6.285
dried fish	0.078	0.088	15.559	2.395	8.000, 9.600, 12.000	7.698, 4.748, 15.000

Table 28: Comparison of Aggregate Construction and Poverty Analysis

	2018 Full	2018 Comparable	2011 Comparable	2011 Official
Aggregates				
Food	purchases, own production and free food; bulk purchases of food	purchases and own production	purchases (imputed for items 100+, day 21-25) and own production	purchases (only 20 days for items 100+) and own production
Durables	31 items	13 items		
	use value formula as described for full 2018			
Housing	actual rent or imputed value, purchased utilities			
Nonfood purchases	larger list of items, more appropriate recall period	smaller list of items, some infrequently purchased items asked every 5 days recall period		
	does not include		includes: helicopter fares, parking charges, landline charges, telegrams/fax, cassettes/video cassettes, wireless comms. equip., other comms. equip., repairs of comms. equip.	
	list of nonfood items reorganized to clarify and allow breakdown by COICOP		original list of nonfood items	
Health and education	does not include		includes: cost of post-natal care	
	does not include			medical transport, educational insurance
	includes medical supplies and tests; dental care	does not include		
	contraception recall period: 3 months		contraception recall period: 1 month	
	three questions: books, school supplies, school bag		one question on "books and school supplies"	
Price adjustments				
Temporal price adj	regional index from overall CPI			region-month price level based on food prices imputed from CPI data and expenditure shares
Food spatial price adj	Paasche index using unit prices and quantities from survey data	Laspeyres index, cost of 2018 basket at CPI prices for individual items		
Nonfood spatial price	aggregate of all CPI nonfood prices			
Adult equiv	modified Ghana scale			
Poverty Lines				
Food poverty line	cost of basket, ref pop: deciles 2 to 7; 2700 calories	such that extreme poverty rate is the same as 2018 main analysis	2018 comparable food poverty line deflated using CPI food price inflation	2003/4 basket; ref pop: deciles 1 to 7; 2700 calories; inflated using CPI food price inflation
Total poverty line	apply upper Ravallion method to food poverty line	such that the total poverty rate is the same as 2018 main analysis	deflate nonfood allowance of 2018 comp. food poverty line using CPI nonfood price inflation, add	upper Ravallion applied to get 2003/4 total poverty line, inflated using CPI food price inflation

Appendix K - OVERVIEW OF STATA .DO FILES

```
/* ===== */
// STEP 1: CONSUMPTION OF NONFOOD
//      -> non-food consumption, including health and education spending,
//      use value of durable goods, real and imputed rentals,
//      frequent and infrequent purchases
/* ===== */
do "${main}01_ConsNonfood.do"

/* ===== */
// STEP 2: CONSUMPTION OF FOOD
//      -> food consumption, also alcohol, tobacco and kola
//      -> own production, gifts and inkind payments valued by respondent
/* ===== */
do "${main}02_ConsFood.do"

/* ===== */
// STEP 3: CONSUMPTION AGGREGATES
//      -> household size, adult equiv, characteristics of head
//      -> food quantities and prices per 100 g for most common items and units
//      -> temporal and spatial price indices
/* ===== */
do "${main}03_Cons.do"

/* ===== */
// STEP 4: POVERTY ANALYSIS
//      -> construction of food basket and poverty lines
/* ===== */
do "${main}04_ConsPov.do"

/* ===== */
// STEP 5: POVERTY PROFILE
//      -> additional analysis (gap, severity; regional, urban/rural)
//      for the poverty profile with standard errors
//      -> analysis of inequality
/* ===== */
do "${main}05_Profile.do"

/* ===== */
// STEP 6: COMPARABLE NOMINAL AGGREGATES
//      -> constructs the ~80 standard variables for nominal total household
//      as found in the "Table" datasets for 2003/4 and 2011
//      -> small corrections to nominal total households cons/exp for 2003/4
//      and 2011
/* ===== */
do "${main}06_AggComp.do"

/* ===== */
// STEP 7: COMPARABLE POVERTY ANALYSIS
//      -> adjust to real, per adult equiv hh cons/exp for comparable aggregates
//      -> appropriate poverty line for comparable agg in 2018, deflate to 2011
/* ===== */
do "${main}07_PovComp.do"
```