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Creating Robust Measures of Poverty and Inequality: Explorations for Rwanda

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Introduction

Measuring poverty is surprisingly difficult, and even apparently modest changes in the methods used to collect the data needed to measure monetary poverty can have a dramatic impact on measured poverty rates (Beegle et al. 2012). The problem is not simplified by using a multi-dimensional index of poverty, where data gaps are common, and there is little consensus on what measures to include as practical matter (Ferreira 2011).

Yet it continues to be important to measure poverty, not only because the elimination of poverty tops the list of Sustainable Development Goals (United Nations 2022), but because if poverty is not measured carefully, it becomes too easy for societies to overlook the poor, and to be dismissive of the published statistics.

Even after household survey data have been collected, the measurement of monetary poverty and inequality requires dozens of methodological decisions, such as the determination of the poverty line, the construction of a welfare measure, the choice of adult equivalents, the method employed to adjust for price variation, or the valuation of durable goods (Haughton and Khandker 2009; United Nations 2005).

Almost two decades ago, Deaton and Zaidi (2002) offered practical, and widely-followed, advice on the construction of consumption aggregates. Some of this advice has stood the test of time, but other recommendations may need to be updated. The recent excellent book by Mancini and Vecchi (2022) explicitly seeks to update the advice given by Deaton and Zaidi. And there are discussion in the region about the possibility of adopting a common set of guidelines to be used in measuring poverty, to facilitate regional comparisons.

In this paper, we evaluate some of the more contentious choices related to the measurement of poverty. We explore the impact of these choices on the measured poverty rate in Rwanda, mainly using data from the *Enquête Intégrale sur les Conditions de Vie des Ménages* (EICV) of 2016/17, which is administered by the National Institute of Statistics of Rwanda (NISR). While we use data from Rwanda to evaluate the choices, the analysis has wider validity, because other countries in the region and elsewhere face similar issues and constraints.

Our technique is straightforward: we simulate the effects of different choices on the poverty rate, and the Gini measure of inequality, one at a time, in order to identify which decisions matter the most. We are especially interested in the issues where there is ongoing disagreement or controversy.

It may be helpful at this point to summarize our key findings, in the process providing a guide to the rest of the paper.

1. As in most low-income countries, Rwanda measures welfare using consumption rather than income. The EICV uses multiple visits to collect data on food consumption, in addition to using a two-week recall period at the time of the first visit. The latter leads to a substantially lower measure of consumption, and hence a higher measured poverty rate.
2. In measuring consumption, the user cost of durable goods may be estimated using a number of different methods, but, in practice, the choice of technique matters little for the identification of who is poor.

3. To get a measure of real income, consumption must be deflated to take account of price differences over time and space. We compare the current one-index approach with the use of household-level price indexes. The latter is appropriate if we are trying to measure money-metric utility, and gives a more plausible reading of inequality while making little difference to who is identified as poor.
4. There are scores of possible ways to create an adult equivalent scale. Our results shows that the choice of scale is important in identifying who is poor, and in creating a compelling poverty profile. We suggest a new scale that combines information on caloric needs with economies of scale.
5. Rwanda has used a cost-of-basic-needs approach to measuring the poverty line. This calls for the establishment of a minimal caloric threshold, and we assess whether Rwanda's choice of 2,500 kcal per adult equivalent per day is appropriate, concluding that it appears to be about ten percent too high.

Recall period

It is well known that the design of the surveys, and the protocols used to collect the data, can have a substantial influence on measures of poverty (Beegle et al. 2012) and hunger (De Weerdt et al. 2015).

For Deaton and Zaidi (2002), the ideal, rarely attained, would be to visit households multiple times, in different seasons of the year. In practice, many surveys rely on a single visit, where households are asked to recall their consumption over the previous one or two weeks, or during a "typical month." Given a choice between these two, they favor the latter, although subsequent evidence suggests that this is likely not the best option (Mancini and Vecchi 2022). Some surveys ask households to complete diaries that record their consumption; and surveys vary widely in the number of food and non-food items that they list on the questionnaire.

In a carefully-designed study, Beegle et al. (2012) used eight different designs to collect data on consumption from randomly-selected households in Tanzania in 2007-2008. Three of the designs used a diary method to record consumption data; the others used recall methods that differed in length (7 days vs. 14 days for commonly-consumed items), or differed in the number of listed items (11 vs. 17 vs. 58 food items). The headcount poverty rates computed from these designs, using a poverty line of $1.25 per person per day, varied from 47.5% (using individual diaries) to 66.8% (using a short list of items).

The results based on asking households to recall what they consumed over the past 7 days, using a fairly long list of items, were quite close to the results based on individual diaries, with the latter considered by some to be the gold standard. Given the expense, and sometimes difficulty, of using the individual diary method in a poor country, Beegle et al. tend to favor the 7-day recall method. Recent efforts to promote a common living standards survey methodology among East African countries also appear to favor this approach.

In its flagship Integrated Living Standards Surveys (EICV), Rwanda uses a method that was not examined by Beegle et al., and that works as follows: Rural households are visited initially, and then seven more times at two-day intervals; for commonly-consumed goods, the enumerators record how much was consumed over the previous two days. After the initial visit, urban households are visited ten times, at three-day intervals.

On the initial visits, households are also asked to estimate their consumption of these items over the previous seven days. An extract from the EICV5 (2016-17) questionnaire, in Figure 1, shows how this is done. To date, the seven-day-recall data have not been used to measure consumption or poverty.

SECTION 8: HOUSEHOLD EXPENDITURE AND CONSUMPTION
PART B: FOOD EXPENDITURE
RESPONDENT: People responsible for food purchases of the household

Name of people interviewed	No ID

DATES OF THE VISITS	1st visit	2nd visit	3rd visit	4th visit	5th visit	6th visit	7th visit	8th visit	9th visit	10th visit	11th visit
	DD MM	DD MM	DD MM	DD MM	DD MM	DD MM	DD MM	DD MM	DD MM	DD MM	DD MM

ITEMS	0.ITEM NUMBER	1. COICOP CODE	2. How many months did you purchase this out of the last 12 months?	3. How much did you spend on "…" over the last 7 days?	4. How much did you spend on "…." since my last visit?	5. How much did you spend on "…." since my last visit?	6. How much did you spend on "…." since my last visit?	7. How much did you spend on "…." since my last visit?	8. How much did you spend on "…." since my last visit?	9. How much did you spend on "…." since my last visit?	10. How much did you spend on "…." since my last visit?	11. How much did you spend on "…." since my last visit?	12. How much did you spend on "…." since my last visit?	13. How much did you spend on "…." since my last visit?	14. Where do you buy"…" most often? Small shop/boutique…….01 Supermarket/ big shop….02 Specialised shop…………03 Market……………………04 Mobile seller…………….05 Individual…………………06 Service provider…………07 Bar/restaurant……………08 Other……………………..09 Do not ever buy it……….10 Don't know………………98
			Number of months	Amount	Amount	Amount	Amount	Amount	Amount	Amount	Amount	Amount	Amount	Amount	
CEREALS															
Local rice	1	01.1.1.1.01													
Imported rice	2	01.1.1.1.02													
Maize (fresh)	3	01.1.1.2.01													
Dry maize (grain)	4	01.1.1.2.02													
Sorghum	5	01.1.1.2.03													
Fermented sorghum	6	01.1.1.2.04													
Wheat (grain)	7	01.1.1.2.05													

Figure 1. Extract from English version of EICV5 questionnaire

In this section we ask two questions:

(i) If measures of poverty and inequality were based on the seven-day-recall data, and not on the data collected in the course of multiple visits, would the results be different?

(ii) Is there evidence of respondent fatigue, resulting from the many visits by the enumerators?

We already have estimates of poverty and inequality based on measures of consumption per adult equivalent using the multiple-visit data, so we just need to recalculate consumption per adult equivalent based on the seven-day recall data.

Seven-Day Recall?

The seven-day recall data were collected (in addition to the multiple-visit data) for purchases of 149 items of food, consumption of 97 items of home-produced food, and purchases of 37 common non-food items. There were additional questions about items that were consumed less frequently, including transport and clothing, that used a lookback period of four weeks or of a year, depending on the item, and that we do not discuss further here. By international standards, these are long lists.

To measure poverty, consumption per adult equivalent has to be compared to a poverty line that is set in the national prices of January 2014. Prices vary across the five provinces of Rwanda, and by month and commodity, so the values of nominal consumption per adult equivalent, collected between October 2016 and September 2017, had to be deflated. The procedure was to use data, by province and month, collected separately for hundreds of products at markets around the country, and which are mainly used to construct the Consumer Price Index (CPI). We created a food price index, and a non-food price index, whose weights reflect the consumption pattern of the poorest two-fifths of the population; the overall price index is a weighted average of these.

So, for each household we measured consumption per adult equivalent, and then deflated using the price index for the year, month, and province of that household.

The pattern of spending, based on the seven-day recall data, is somewhat different from that based on the multiple-visit data, so separate price indexes were created for this.

Table 1 shows the measure of real (i.e., deflated) consumption per adult equivalent based on the standard multiple-visit data (column A), and on the seven-day-recall data (column B). The first thing to note is that measured consumption is lower with the seven-day-recall data, both nationally and for the sub-groups shown here (provinces, urban/rural).

Table 1. Consumption and Poverty Based on Two Models of Data Collection, 2016/17

	Multiple-visit data	7-day recall data	Difference
		RWF per year	
Expenditure/adult equivalent/yr	278,920	267,642	-11,279
Standard deviation	353,756	405,579	
		percentages	
Headcount poverty rate, Rwanda	**38.2**	**47.4**	**9.8**
By province			
Kigali	13.9	18.3	4.4
South	41.4	54.6	13.1
West	47.1	58.8	11.7
North	42.3	47.8	5.4
East	37.4	47.9	10.5
By area			
Urban	15.8	20.6	4.8
Rural	43.1	53.9	10.9

Notes: Data are from the 2016/17 EICV survey of 14,580 households. Spending is in RWF in prices of January 2014.

It is not surprising that the seven-day-recall data show substantially higher poverty rates than the multiple-visit data, but the difference is striking: nationally, the former gives a poverty rate of 47.4%, compared to 38.2% for the standard data. An important implication is that if Rwanda were to use only seven-day-recall data in the future, the poverty numbers would not be comparable with those reported to date.

Large numbers of households are reclassified when the seven-day-recall data are used instead of the multiple-visit data: of the 14,580 households in the EICV5 sample, 3,089 (i.e., 21%) saw their status change, either from non-poor to poor (15%) or from poor to non-poor (6%). Some of this is to be expected: by using a 7-day recall period instead of data collected over 14 days (rural areas) or 30 days (urban areas), there will be greater variance in estimated consumption (as Table 1 confirms), and the ability to classify individual households accurately is diminished.

The choice of how to collect consumption data has a major effect on the measured geographical pattern of poverty. For instance, Nyamasheke is clearly the poorest district using the multiple-visit data, but is not even in the poorest five districts if seven-day-recall data are used, as Figure 2 shows.

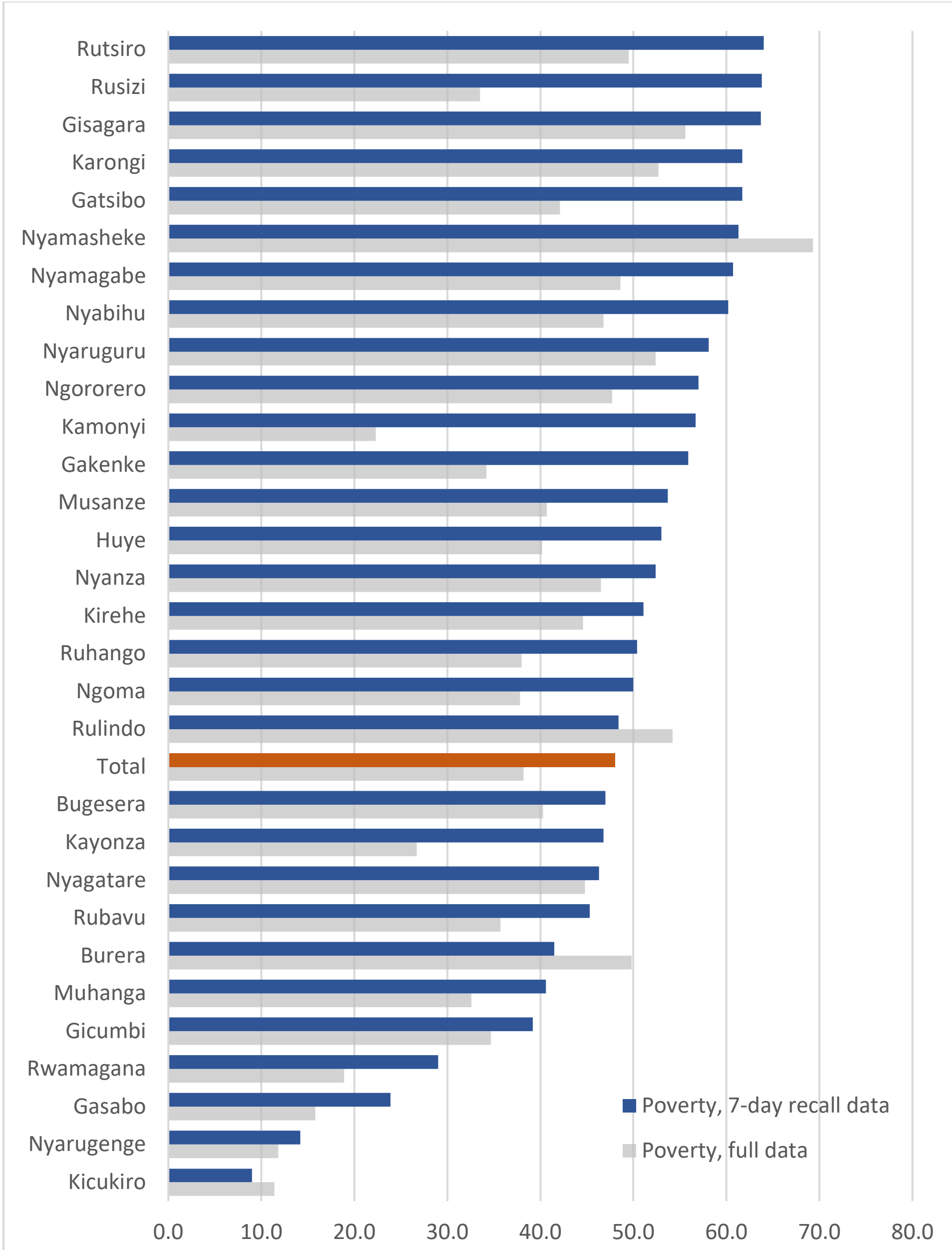

Figure 2. Headcount Poverty Rates by Region, 2016/17, for Two Models of Data Collection

It is interesting to see which food consumption items appear to be relatively under- or over-counted when the seven-day recall method is used. The items in Table 2 are listed because their share of food consumption was at least 1% (using the multiple-visit data). Note that these numbers include both purchases of food, and consumption from home-production.

The largest differences in the pattern of food consumption, between the two different methods of data collection, are for tubers and beans. The shares of potatoes, dry beans, and cassava – all key staples – are higher when recorded in the course of multiple visits than with 7-day recall. It is certainly possible that some of these foodstuffs may be double-counted in the course of multiple visits, but another possibility is that unless care is taken to record consumption regularly, households underestimate how much of these foods they really consume.

Table 2. Food shares of major items (including purchases and home-produced items), EICV5

	Multiple-visit data	7-day-recall data	Diff.
	Percentage of food consumption		
Sweet potato	**14.5**	**11.9**	**-2.6**
Dry bean	**14.4**	**12.6**	**-1.7**
Irish potato	**9.5**	**7.0**	**-2.6**
Corn (flour)	8.6	8.9	0.3
Cassava (flour)	**6.5**	**5.0**	**-1.5**
Banana - cooking (Inyamunyo)	3.3	2.9	-0.4
Local rice	3.3	3.0	-0.3
Fresh bean	2.9	3.0	0.1
Cassava (root)	**2.7**	**2.2**	**-0.6**
Dry maize (grain)	**2.2**	**4.1**	**1.9**
Peanut oil, vegetable oil, sunflower oil	1.7	1.9	0.2
Salt	1.7	1.5	-0.2
Maize (fresh)	1.6	1.5	-0.2
Tomato	1.5	1.5	0.0
Groundnut flour	1.4	1.3	-0.2
Taro/amateke	1.4	1.1	-0.3
Amaranth (small leafed green) (dodo, inyab)	1.3	1.3	0.1
Bar drinks	1.1	1.0	-0.2
Sorghum (flour)	1.1	1.4	0.2
Imported rice	1.1	0.9	-0.3
Local sorghum beer (ikigage)	1.5	2.0	0.5
Subtotal	**83.6**	**75.7**	

Source: EICV5 survey of 2016/17. Only items that account for at least 1% of food consumption are included here.

Respondent Fatigue?

It might be argued that multiple visits by enumerators are wearying for households, and that respondent fatigue may lead to more perfunctory answers in the later survey rounds. We examined this proposition by comparing the mean reported consumption of food for the first three rounds compared to the last three rounds (in rural areas; the first five with the last five in urban areas), with the results shown in Table 3. The spending amounts are in RWF per household, annualized. The p-values apply to a paired t-test where the null hypothesis is that there is no difference in spending between the two periods, and the alternative is that spending is lower in the last periods (which would reflect respondent fatigue). For frequent non-food spending and for autoconsumption, and for the sum of the three categories, there is no evidence of respondent fatigue, at least as measured here. However, in the case of food purchases, reported spending is 3% lower in the last periods than in the first periods, and this difference is statistically significant, suggesting some possible respondent fatigue in this case.

Table 3. Test of respondent fatigue, EICV5

	First periods	Last periods	Difference
		RWF per household per year	
Frequent non-food spending	180,473	187,686	-7,214
p-value			**0.9985**
Food purchases	559,038	542,844	16,195
p-value			**<0.0001**
Autoconsumption, food	184,790	192,396	-7,605
p-value			**>0.9995**
Total of above three categories	924,301	922,925	1,375
p-value			**0.3931**

Notes: Spending is per household per year. The "first periods" refer to visits 2-4 in rural areas and 2-6 in urban areas; the "last periods" refer to visits 6-8 in rural areas and 7-11 in urban areas. The data are from the EICV5 survey of 2016/17. The p-value tests the null hypothesis of no difference in spending between periods against the alternative that spending is lower in the last periods relative to the first periods; a low p-value rejects the null hypothesis in favor of the alternative.

One can argue, plausibly, that the seven-day-recall data understate consumption because respondents have imperfect memories of what they have consumed. On the other hand, it is possible that the multiple-visit data overstate consumption, if items are (inadvertently) double-counted.

What approach should countries take? To maintain consistency with past surveys, it would make sense to continue to collect data using multiple visits, if this is what was already being done. If this is too costly, the number of visits could be reduced without serious effects on the measure of the overall poverty rate, but this will increase the variance of estimated household consumption. On the other hand, it would also make sense to continue to collect the seven-day-recall data, and perhaps to train enumerators more thoroughly on this part of their work, so that if the method has to be used in the future, it will be possible to make appropriate adjustments to allow for viable comparisons over time.

Measuring Consumption

Many practical decisions are required when constructing the measure of consumption. Here we address two issues: how to estimate the user cost of durable goods, and what prices to use to value food items.

User Cost of Durable Goods

According to the EICV5 survey of 2016/17, Rwandan households owned an average of RWF 153,760 (USD 188) worth of durable goods. The last three columns of Table 4 show the breakdown of durable goods owned by value, and by incidence. For instance, 64% of households owned a mobile phone, whose average current value was estimated to be USD 12. And 14% owed bicycles for personal use, each worth on average USD 37.

In constructing a measure of consumption, it is appropriate to incorporate the contribution of durable goods. In principle, the best way to do this may be to include, in consumption, the rental value of durables. In practice, this is typically approximated by a measure of the user cost of capital, which ignores transactions costs.

The issue addressed here is how much difference the choice of method used to measure user cost makes to the identification of who is poor.

Many household surveys ask about the current value and age of durable goods, but data on the original purchase price are rarely collected, and are anyway likely to be unreliable given that the purchases were often made many years earlier. This constrains the methods that may be used to estimate user cost. Assuming the price of an asset tracks inflation, then the user cost of an asset with current price p_t may be approximated by

$$UC \approx p_t(r_t + \delta)$$

where r_t is the real annual interest rate (i.e., the opportunity cost of locking up capital in the asset) and δ is the depreciation rate (i.e., the loss of real value of the asset from one year to the next). The value of r_t can be hard to measure, so many analysts either ignore it, or use a value that seems "reasonable", such as 4 percent.

To measure user cost, a number of approaches have been suggested, including the following:

(i) UC0. Specify "reasonable" depreciation rates. Rwanda did this for its EICV household surveys in 2013/14 and 2016/17, using rates of 10%, 20%, and 40%, a set out in Table 4. The depreciation rates for motor vehicles look too high, but the other rates are defensible.

(ii) UC1. Deaton and Zaidi (2002) suggest a depreciation rate of

$$\delta = \frac{1}{E(\text{years of remaining life})}.$$

So, if an asset is expected to last for four more years, the depreciation rate would be 0.25. Assuming that assets have been acquired at a constant pace over the past several years, we have

$$E(\text{remaining life}) \approx 2\bar{A} - A$$

where A is the age of the asset at the time of the survey, and $\bar{A}$ is the mean age of assets in the same class. Thus, if radios are on average 4.7 years old, and your radio is 3.1 years old, the expected remaining life is 6.3 years. Some assets last far longer than expected, so it might be appropriate to set a minimum non-negative value on expected remaining life, perhaps at an arbitrary level such as two years (Deaton & Zaidi p. 34), or at the mean age. In the simulations reported below, we use the latter, so

$$E(\text{remaining life}) = \max(2\bar{A} - A, \bar{A}).$$

A useful feature of this approach is that it customizes the depreciation rate, allowing higher depreciation rates to be applied to the (small remaining) value of older assets.

(iii) UC2. It would make sense to augment the measure in (ii) with a real interest rate; we use 4% in what follows.

(iv) UC3. In the analysis based on earlier EICV surveys, Rwanda measured the depreciation rate as:

$$\delta = \frac{1}{2\bar{A}}.$$

This is equivalent to assuming a remaining life that is equivalent to the full expected life of the asset when it was new.

(v) UC4. Mancini & Vecchi (2022) show that

$$\delta \approx 1 - \alpha^{1/Tmax}$$

where $Tmax$ is the expected life of the asset when new, and α is the proportion or remaining value, such as 0.05, at which point the asset is of no further practical use and has to be scrapped. We assume, following Mancini & Vecchi, that $\alpha = 0.05$, and we use the 95th percentile of age to give $Tmax$. In addition, we add a real interest rate of 4%. This depreciation rate is conceptually similar to UC0 and UC3, in that it applies a single depreciation rate to any given asset, no matter how old that asset might be.

These alternatives do not exhaust all the ways in which one might measure the user cost, but they provide a useful variety of possibilities.

We now examine whether the choice of method of measuring user cost matters. To address this, we measure the user cost of durable goods with data from the Rwandan household survey of 2016/17 (EICV5), which is the most recent complete survey. The different user cost rates are shown in Table 4, for the 23 listed durable goods covered in the survey. Housing is covered separately. The Table also shows the average age of assets held, the average reported value (in USD) per item for those with the asset, and the percentage of households owning the asset. By far the most widely-owned assets are mobile phones.

In Table 5, we show the average use value of durables per household, in RWF. In the baseline case, durable goods constituted 5.2% of consumption; the other methods show the weight of durables to range from 1.8% to 4.5% of consumption.

The next step is to ask how many of the 14,574 households covered by the survey would have been reclassified as poor (or not poor) using different approaches to measuring user cost. To do this, we recalibrated the poverty line in each case, so the poverty rate was 38.2% as in the baseline case.

We found that only 0.2% of the sample would be reclassified if one of the alternatives to UC0 were used. If we simply left the user cost of durables out of our measure of consumption (and of the poverty line), then 0.32% of the sample would have been reclassified, still a small proportion.

Table 5 also reports the Gini coefficient for consumption per adult equivalent. This is a widely-used measure of inequality that ranges from 0 (no inequality) to 1 (complete inequality). In all cases, the estimates are below that of the baseline case. This is plausible: the practice in the EICV surveys of 2013/14 and 2016/17 was to depreciate cars, motorbikes, and bicycles at 40%. This surely overestimated the true consumption of high-income households, resulting in an unduly high estimate of inequality.

The conclusion we draw is that the choice of method used to measure the user cost of durable goods is not particularly important in the determination of who is poor. Of the methods considered here, we find UC2, which depreciates at one over the expected remaining life, adjusted for a real interest rate, to be the most conceptually satisfactory.

Deflating Consumption

The prices of goods and services vary over time and space, both between surveys and within the span of a single survey. In order to get real consumption, it is necessary to deflate household consumption to a common time and place.

Table 4. User cost rates by product using alternative methods to measure depreciation, applicable to Rwanda in 2016/17

	UC0	UC1	UC2	UC3	UC4	Age	Vusd	Own
Radio	10	17	21	11	22	4.7	9	43.1
Mobile phone	20	40	44	26	40	1.9	12	63.9
TV set	10	19	23	12	26	4.2	106	10.5
Satellite dish	10	20	24	13	26	3.9	41	1.4
Video/DVD player	10	20	24	12	30	4.0	20	6.8
Decoder	10	30	34	18	39	2.7	18	7.5
Music system	20	22	26	14	33	3.6	50	0.4
Computer & accessories	20	26	30	16	34	3.1	212	3.0
Living room suite	10	12	16	8	19	6.4	119	18.1
Bicycle for home use	40	15	19	10	20	5.0	37	13.8
Cupboard	10	9	13	6	15	8.6	85	10.8
Cooker	20	37	41	24	41	2.1	63	2.6
Laundry machine	20	27	31	16	46	3.1	463	0.1
Electric fan	20	21	25	13	32	3.9	31	0.2
Sewing machine	20	10	14	7	16	7.4	68	1.4
Refrigerator	20	14	18	9	21	5.5	181	1.6
Electric generator	20	19	23	11	30	4.7	289	0.0
Electric hotplate	10	20	24	12	29	4.1	77	0.5
Power stabilizer	20	17	21	11	26	4.7	18	1.7
Still camera	20	13	17	8	20	6.6	71	0.6
Video camera	20	14	18	8	26	6.0	222	0.1
Motorcycle for home use	40	26	30	17	30	2.9	708	1.1
Car for home use	40	22	26	14	30	3.7	7,744	1.0

Notes: User cost methods are explained in the text. UC0 is the "baseline" user cost employed in official measures of poverty; UC1 depreciates using one over the expected remaining life; UC2 adds a 4% real interest rate to UC1; UC3 depreciates using one over total life; UC4 relates depreciation to the life of an asset and the scrapping point. Age gives the average reported age of assets in 2016/17; Vusd shows the mean reported value by asset, for those who have assets, and uses an exchange rate of RWF820/USD; and Own gives the proportion of households who own at least one asset in each category.
Source: Data for Age, Vusd and Own come from the Rwanda EICV5 survey of 2016/17.

Table 5. Estimated effects of using different user costs, Rwanda, 2016/17

	Use value of durables	Value of consumption	D/C (%)	HH recla-ssified	% HH re-classified	Gini of C/ae
Ignore durables	0	1,601,852	0.0	47	0.32	0.411
UC0.EICV5 (baseline)	83,080	1,685,025	5.2	0	0.00	0.429
UC1. Deaton/Zaidi	52,611	1,654,463	3.2	27	0.19	0.421
UC2: UC1 + 4%	65,874	1,667,725	3.9	31	0.21	0.424
UC3: EICV3	29,983	1,631,835	1.8	29	0.20	0.417
UC4: Scrap formula + 4%	75,317	1,677,169	4.5	27	0.19	0.426

Notes: Value of consumption includes the use value of durables. *D/C* measures use value of durables as a percentage of consumption. *HH reclassified* shows the number, out of 14,574 households, who would be reclassified as poor or non-poor using different methods, relative to the baseline that was actually used. The penultimate column shows the percentage of households reclassified in this way.
Source: Rwanda EIcv5 survey of 2016/17.

For the Rwanda household surveys of 2013/14 (EICV4) and 2016/17 (EICV5), the reference point was national prices in January 2014. The data on prices of goods come from monthly surveys, undertaken by the CPI (Consumer Price Index) office, of markets around the country, and these data are aggregated to create a mean value for each of the five provinces for each month and for each product.

These prices are then weighted to create a poor-person price index. Using undeflated data from the household surveys, the consumption pattern of the poorest two-fifths of households (as measured by consumption per adult equivalent) is used to weight the price data, separately for food and non-food items. There are CPI prices and information on household consumption for 120 food items and 121 non-food items.

Given this information, we examine three possible ways to deflate household consumption to the prices of January 2014.

(i) One index. Here, we combine the food and non-food price indexes into a single index, for each region and month, using the national average weights of food and non-food in the baskets of poor households. This is the approach used in published reports (NISR 2018). The relevant levels of spending, and poverty rates, are shown in the first column of numbers in Table 6, and are based on the Rwanda household survey of 2016/17 (EICV5).

(ii) Separate food and non-food indexes. In this case, each household's food consumption is deflated using the food price index, and their non-food consumption by the non-food price index. The results are set out in the middle column of Table 6. As expected, the measure of poverty is slightly lower, but the differences are minor at the provincial level.[1]

(iii) Household-level deflation. Here, instead of using price indexes, household spending on food is deflated item by item. This is equivalent to using a Paasche price index that is tailored to the food spending patterns of each household, which is theoretically appropriate if we take a money-metric approach to measuring welfare (Deaton & Zaidi 2002). Non-food spending is deflated using the non-food price index. The key numbers are in the final column of Table

[1] This hypothetical example illustrates the process of applying a single, dual, or household-level deflation. We assume just two goods (sweet potatoes, and Irish potatoes) with the spending pattern shown.

		HH1	HH2	HH2		Jan 2014 prices	Dec 2019
Share of food consumption	Sweet potatoes	0.7	0.5	0.5		100	150
	Irish potatoes	0.3	0.5	0.5		100	120
December 2019 consumption	Food	500	500	450		100	138
	Non-food	200	200	250		100	110
HH C in Dec 2019	Total	700	700	700		100	130
HH C in Jan 2014 prices, single index	Total	**538.46**	**538.46**	**538.46**			
HH C in 2014 prices, food and nf indexes	Food	362.32	362.32	326.09			
	Non-food	181.82	181.82	227.27			
	Total	**544.14**	**544.14**	**553.36**			
HH C in 2014 prices, HH weights	Sweet potatoes	233.33	166.67	150.00			
	Irish potatoes	125.00	208.33	187.50			
	Food	358.33	375.00	337.50			
	Non-food	181.82	181.82	227.27			
	Total	**540.15**	**556.82**	**564.77**			
	Dec 2019 price indexes based on consumption patterns of HH1 and HH2						

6, and show a slightly lower national poverty rate, a distinctly lower poverty rate in Kigali and in urban areas, and higher poverty rates in the South, West, and North provinces.

Table 6 also shows the Gini coefficient of inequality that results from the three deflation methods, for consumption per adult equivalent and for consumption per capita. Measured inequality is somewhat higher when household-level deflation is used, probably because it allows somewhat anomalous cases to carry more weight. In passing, we note that measured inequality is slightly higher when consumption is measured per person, rather than per adult equivalent, possibly reflecting differences in household size and composition at the two extremes of the distribution.

Of the 14,564 households for which data are complete, 401 (2.8%) are reclassified (from poor to non-poor, or the reverse) if we change from using a single price index to household-level price indexes. This is a fairly substantial change, and can alter the observed patterns of poverty, as Table 6 makes clear. Rural poverty hardly changes, probably because the poor-person price index does a good job of reflecting the food consumption patterns of rural households, who tend to be poor; but the observed poverty rate in urban areas, and especially Kigali, are surely better reflected when deflating is done at the household level.

Table 6. Consumption and Poverty Based on Alternative Deflation methods, Rwanda, 2016/17

	One index	Food & non-food Indexes	Household-level deflation
All Rwanda			
Expenditure/adult equivalent/yr	278,886	282,860	289,595
Standard deviation	353,716	367,928	382,914
Headcount poverty rate (%)	**38.2**	**38.1**	**38.0**
By province			
Kigali	13.9	13.8	10.3
South	41.4	41.5	43.0
West	47.1	47.1	48.3
North	42.2	42.3	44.5
East	37.4	37.1	34.7
By area			
Urban	15.8	15.6	14.8
Rural	43.1	43.0	43.0
Gini coefficient of inequality			
Consumption per adult equivalent	0.429	0.434	0.444
Consumption per capita	0.437	0.442	0.452

Notes: Data are from the 2016/17 EICV survey of 14,564 households. Spending is in RWF in prices of January 2014.

Figure 3 shows the estimated poverty rates for 2016/17 for the 30 districts of Rwanda, using a single price index to deflate (blue dots) or household-level deflation (orange dots). The rank of a fifth of the districts changes by two or more positions, but most of the differences attributable to the choice of deflation method are relatively small.

Figure 3. Poverty rates by district, Rwanda, 2016/17
Blue dots show poverty rates computed using a single price index; orange dots show poverty rates using household-level price indexes.

Adult Equivalence

Households differ in size and composition, so total household consumption has to be adjusted to take these factors into account. In the words of Deaton and Zaidi (2002, p.47): "Equivalence scales are the deflators that are used to convert household real expenditures into money metric utility measures of individual welfare."

Some researchers have tried to create equivalence scales "objectively" – see Bellù and Liberati (2005a) for a discussion – but these are not entirely satisfactory (Deaton 1997). We therefore need to make some choices, which will necessarily be more "subjective" (Bellù and Liberati 2005b).

In this section, we review some of the more widely-used adult equivalence scales, and apply them to data from the Rwandan household survey of 2016/17 (EICV5) to determine the extent to which the choice of scale matters for (i) the pattern of poverty ("poverty profile"), and (ii) the measurement of inequality.

1. Use **consumption per capita**. Perhaps the most widely-used measure of welfare is consumption per capita, which is equivalent to assigning every household member an adult equivalence of 1. The measure is easy to calculate and to explain. Deaton and Zaidi (2002) recommend reporting results using this scale, even if other equivalence scales are used as well. International comparisons such as the World Bank's *PovCalnet* use per capita measures in arriving at poverty rates and indexes of inequality.

   However, the measure does not take into account the fact that household members have different minimum needs, especially nutrition, at different ages. Nor does it recognize that as households get larger, they benefit from economies of scale in consumption; it is, for instance, cheaper to house four people in a single dwelling than in four separate places.

2. Use a **calorie-related scale**, like the one used currently by Rwanda (and some neighbors, including Uganda). The current weights used by Rwanda are shown in Table 7, and are believed to be based on caloric needs, possibly the FAO guidelines of the early 1980s, as they are similar to those proposed by Visaria (1980).

Table 7. Adult Equivalent Weights Used in Official Measures of Poverty in Rwanda

<1	1-3	4-6	7-9	10-12	13-15	16-19	20-39	40-49	50-59	60-69	70+
0.41	0.56	0.76	0.91	M: 0.97 F: 1.08	M: 0.97 F: 1.13	M: 1.02 F: 1.05	1.00	0.95	0.90	0.80	0.70

If all consumption spending were devoted to food, such a scale would be defensible, but even for poor people, about a third of consumption is devoted to other essentials such as clothing and shelter. The particular scale used by Rwanda also has unusually high caloric-based weights for teenage girls.

3. Use an **OECD scale**. The original version (OECD 1) is defined as AE = 1 + 0.7(A-1) + 0.5C, where AE is adult equivalents, A is the number of adults, and C is the number of children (typically defined as those under 16 years old). This adjusts for economies of scale in that the first adult has a weight of 1, and subsequent adults a weight of 0.7; and assumes that children have a lower weight than adults (0.5 vs. 0.7).

4. Use a **general scale**, like this: $AE = (A + \alpha C)^{\theta}$, as proposed by the National Research Council in 1995. The α measures the weight of children relative to adults, and θ measures the extent of economies of scale. Deaton and Zaidi (2002) suggest that for poor countries, an appropriate parameterization of this scale is $AE = (A + 0.25C)^{0.9}$, which puts a low weight on children, and allows for only modest economies of scale.

5. Use a **combined scale** that applies caloric weights to food spending, and economies of scale to non-food spending. This would strike a balance between recognizing the importance of caloric needs in the food budget, and allowing for economies of scale that may be modest, but are surely real, on the non-food side. In the simulations that follow, we use the following:

   AE = (2/3) (Calorie-based equivalence scale) + (1/3) (Non-food-based equivalence scale).

   Our proposed calorie-based equivalence scale, broadly following WHO and FAO guidelines (FAO/WHO/UNU 2004), would be as shown in Table 8, and the non-food-based equivalence scale would be given by $(A + 0.7C)^{0.9}$.

Table 8. Proposed Caloric Weights

	<1	1-2	3-4	5-7	8-9	10-11	12-13	14-15	16-17	18-29	30-59	60+
M F	0.3	0.4	0.5	0.6	0.7	0.8	1.0 0.9	1.1 0.9	1.2 0.9	1.0 0.8	1.0 0.8	0.8 0.7

To illustrate the way in which equivalence scales work, consider Table 9, which computes the adult equivalents for three households of different sizes and with different demographic characteristics. The differences in adult equivalents by household type, and by type of equivalence scale, are substantial, and it should come as no surprise that the choice of scale will influence the measured pattern of poverty.

Table 9. Equivalence scales illustrated

	Household	Household 2	Household 3
Adults	F35,M41	F54,M61	F82,M59,F53,M34,F31
Children	M8,F11,M13		F1,M3,F4
Equivalence scale			
NISR (through EICV5)	4.91	1.70	6.23
Per capita	5.00	2.00	8.00
OECD 1	3.20	1.70	5.30
Deaton-Zaidi ("poor")	2.49	1.87	4.83
Proposed combined scale	4.19	1.69	5.68

There are many other possible scales that could have been examined, but that we consider to be less relevant to the situation in countries like Rwanda. For instance, there is a revised OECD scale (OECD 2) given by AE = 1 + 0.5(A-1) + 0.3C, but has very large economies of scale. Deaton and Zaidi suggest that for richer countries, an appropriate generate scale might be AE = $(A + C)^{0.75}$, but they note that this generates excessive economies of scale, and puts too much weight on children relative to adults, to be applicable in most poor countries. An increasingly popular scale in the United States OECD countries, used by the Luxembourg Income Studies, is $AE = \sqrt{N}$, where N is the number of people in the household. It accounts for strong economies of scale (in a particular manner), but not for the differential needs of household members.

Poverty simulations

To explore the implications of different adult equivalence scales, we undertook a number of simulations. For the poverty simulations we adjusted the poverty line so that the national headcount poverty rate, using EICV5 data for Rwanda for 2016/17, was set to 38.2%, which is the rate found for 2016/17. We then examined whether the choice of scale would:

a. Reclassify large numbers of people as poor or non-poor; and
b. Lead to different conclusions about the distribution of poverty by province, age, and household size.

We also simulated the effects of different choices of equivalence scale on inequality, as measured by the Gini coefficient.

Taking the NISR equivalence scale as the base, we now ask what proportion of the population would be re-classified if a different scale were used (but the national poverty rate held the same). Table 10 shows that if we use per capita consumption, 4.2% of the population would be reclassified: 2.1% of these would be people considered as poor under the NISR scale but not poor using a per capita scale; while 2.1% would move in the other direction.

A remarkable 11.6% of the population would be reclassified if we were to use the Deaton-Zaidi scale that they propose as appropriate for poor countries. Put another way, 5.8% of the population would be reclassified as not-poor; this is almost a sixth of those who were counted as poor under the NISR standards.

Table 10. Proportion of people reclassified when equivalence scale is changed, EICV5

	% reclassified
Equivalence scale	
NISR (“calorie scale”): reference	0.0
Per capita	4.2
OECD 1	5.8
Deaton-Zaidi ("poor")	11.6
Proposed combined scale	3.1

Note: By design, the national poverty rate is held at 38.2% in all these simulations.

Still holding the national poverty rate at 38.2%, we now ask what effect the use of different equivalence scales would have on the distribution of poverty. Table 11 shows that the regional breakdown of poverty would look substantially the same under any equivalence scale.

Table 11. Poverty rate by province using different equivalence scales, EICV5

	Kigali	Southern	Western	Northern	Eastern	All
Equivalence scale						
NISR (“calorie scale”)	13.9	41.4	47.1	42.3	37.4	38.2
Per capita	14.8	41.3	46.6	42.0	37.6	38.2
OECD 1	15.1	41.1	46.7	42.8	37.1	38.2
Deaton-Zaidi ("poor")	15.3	41.9	45.8	43.5	36.6	38.2
Proposed combined scale	13.6	41.5	46.8	42.9	37.5	38.2

Note: By design, the national poverty rate is held at 38.2% in all these simulations.

The story changes when examining the breakdown of poverty rates by age, as shown in Table 12. Depending on the scale chosen, poverty among the elderly (defined as 60 and older) could be as low as 26% (NISR scale) and as high as 44% (Deaton-Zaidi scale). Child poverty could also vary substantially, from 39 to 45 percent, depending on the scale used.

If the NISR scale is used, poverty is low in one- and two-member households (see Table 13), while the Deaton-Zaidi scale shows relative high poverty even among these groups.

Table 12. Poverty rate by age using different equivalence scales, EICV5

	<16	Adult	60+	All
Equivalence scale				
NISR (“calorie scale”): reference	44.4	33.9	25.7	38.2
Per capita	44.6	33.4	27.3	38.2
OECD 1	42.6	34.5	33.7	38.2
Deaton-Zaidi ("poor")	39.0	36.9	43.6	38.2
Proposed combined scale	43.4	34.3	30.0	38.2

Note: By design, the national poverty rate is held at 38.2% in all these simulations.

Table 13. Poverty rate by size of household using different equivalence scales, EICV5

	1	2	3	4	5	6	7	8	9	10+	All
Equivalence scale											
NISR (“calorie scale”)	3.0	14.5	23.9	34.3	40.4	45.3	48.0	48.8	52.9	44.3	38.2
Per capita	3.9	14.7	25.5	35.7	40.6	44.7	46.6	46.9	50.1	43.9	38.2
OECD 1	12.1	23.3	31.2	37.5	39.9	42.4	43.0	42.3	43.8	42.2	38.2

Deaton-Zaidi ("poor")	19.9	32.3	38.0	39.2	38.5	39.5	39.1	39.0	39.1	38.6	38.2
Proposed combined scale	6.2	17.7	27.0	35.3	39.9	44.7	46.0	46.7	50.1	43.4	38.2

Note: By design, the national poverty rate is held at 38.2% in all these simulations.

Based on the Rwandan data, we conclude that, when measuring the pattern of poverty, the choice of equivalence scale matters if the focus is on age or household size, but not if our interest is in regional variations.

Inequality simulations

The Gini coefficient of inequality varies from 0 (perfect equality) to 1 (complete inequality), although in practice the observed values go from about 0.25 through 0.63.[2] The data from the EICV surveys are used to compute the Gini coefficient, and in doing so have typically used the NISR adult equivalence scale.

Inequality measures the relative real incomes of the whole income distribution, not just those at or near the poverty line. For that reason, an adult equivalence scale that is tailored to trying to get an accurate measure of poverty may not be as suitable when the full spectrum of the income distribution needs to be taken into account. International comparisons of inequality almost invariably use per capita consumption (or income).

We simulated the effects on the Gini coefficient of using different equivalence scales, with the results shown in Table 14.

Table 14. Gini coefficient for different adult equivalence scales, EICV5

Equivalence scale	Gini
NISR ("calorie scale"): reference	0.429
Per capita	0.437
OECD 1	0.419
Deaton-Zaidi ("poor")	0.400
Proposed combined scale	0.421

The per capita value for Rwanda corresponds with that reported by the World Bank (Index Mundi), where Rwanda is ranked as the 32nd most unequal country out of the 162 countries on the list. If the Gini coefficient were 0.400, it would be the 57th most unequal country. So, although the Gini coefficients look relatively similar in Table 16, even small differences in how the Gini is computed can matter.

Caloric thresholds for cost-of-basic-needs calculations

In setting its poverty line in 2013/14, Rwanda used a cost-of-basic-needs approach, which first defines the number of calories that are needed for an adequate diet for an adult (2,500 kcals per day), and then adds a non-food component. Household consumption per adult equivalent is then compared to this poverty line, where the adult equivalents are defined as in Table 9. The poverty line used in 2016/17 was based on the 2013/14 version, updated for inflation.

[2] Here is an accessible ranking of inequality across countries, based on World Bank data. https://www.indexmundi.com/facts/indicators/SI.POV.GINI/rankings

The issue we wish to address here is whether the food threshold of 2,500 kcals/adult/day is appropriate. To provide some context, we briefly review what other, especially nearby, countries do, and then draw on FAO practices to arrive at a plausible calorie threshold.

Comparisons of caloric thresholds

Table 15 shows the number of kcals that are considered necessary, by different countries, to sustain an adult for a day, as used in estimating poverty lines. All of the countries listed here apply adult equivalence scales, largely based on caloric needs, so that average caloric needs are lower than these; for instance, the average caloric need in Uganda in 2016 was 2,283 kcals per person – not per adult – as reported by the World Bank (2016).

Table 15. Caloric Requirements Used in Estimating Poverty Lines

	Kcals per adult per day
Burundi	2,100
Tanzania, Zambia	2,200
Ethiopia, Kenya	2,250
South Sudan	2,400
Rwanda	2,500
Uganda	3,000

Sources: Kenya (2007) for Kenya and Ethiopia; World Bank (2015) for Uganda; Mkenda et al. (2004) for Zambia; Collier et al. (1986) for Tanzania.

Where do the numbers in Table 15 come from? For Uganda, the data come from a study by Appleton et al. (1999) that shows "recommended daily caloric intakes" of 3,000 kcals/day for men aged 18-29. These figures appear to be based on FAO/WHO scales, and assume "moderate activity" levels, and weights of about 65kg for men and 60kg for women.

In their study of food insecurity in Sub-Saharan Africa, Smith et al. (2006) used a scale based on the numbers shown in Table 16. They took the scale from Hoddinott, who based it on the same FAO/WHO report of 1985 as used in Uganda.

Table 16. Caloric Requirements in Sub-Saharan Africa

	<1	1-	2-	3-4	5-6	7-9	10-11	12-13	14-15	16-17	18-29	30-59	60+
M	820	1150	1350	1550	1850	2100	2200	2400	2650	2850	2600	2500	2100
F	820	1150	1350	1550	1750	1800	1950	2100	2150	2150	2000	2050	1850
M	0.32	0.44	0.52	0.60	0.71	0.81	0.85	0.92	1.02	1.10	1.00	0.96	0.81
F	0.32	0.44	0.52	0.60	0.67	0.69	0.75	0.81	0.83	0.83	0.77	0.79	0.71

Notes: Row 1 gives age (in years); rows 2 and 3 give kcals per day needed; rows 4 and 5 normalize the caloric requirements, setting to 1 the requirement for men aged 18-29.
Sources: Smith et al. (2006).

This scale is similar to the one used by Uganda except that it uses as its reference point "light activity" for adults (see yellowed cells). Note that it shows that teenage boys need more food than young adult men. But it also has a 2,500-kcal threshold for prime-age men, which is in line with the Rwandan threshold.

Caloric needs vary by age, gender, and weight, and also by how active the individual is. The latter is usually represented as a multiple of the basal metabolic rate (BMR): a multiple of 1.55 represents light activity, while a multiple of 1.8 reflects "moderate" activity. There is a wide choice of possible numbers here. The FAO/WHO (WHO 1985) is fairly clear about the caloric needs for those aged less than 17. Table 19 shows an excerpt from the FAO/WHO tables, for men aged 18-30. From a table like this, Uganda picked a threshold of 3,000 kcals (yellowed in this table), while Smith et al. (2006) picked 2,600 kcals, which is consistent with a BMR of 1.55 and weight of 65 kg – see the green cells in Table 17. The Rwanda cutoff of 2,500 kcals is consistent with light activity and an average weight of 60 kg.

Table 17. Daily average energy requirement and safe level of protein intake for men aged 18–30

Weight (kg)	BMR/kg.		Daily energy requirements according to BMR factor indicated:										Safe level of protein intake (g/day)
	(kcals)	(kJ)	1.4 BMR		1.6 BMR		1.8 BMR		2.0 BMR		2.2 BMR		
			(kcals)	(kJ)	(kcals)	(kJ)	(kcals)	(kJ)	(kcals)	(kJ)	(kcals)	(kJ)	
50	29	121.3	2 050	8 500	2 300	9 700	2 600	10 900	2 900	12 100	3 200	13 300	37.5
55	27.5	115.1	2 100	8 900	2 400	10 100	2 700	11 400	3 000	12 700	3 300	13 900	41
60	26.5	110.8	2 250	9 300	2 550	10 600	2 850	12 000	3 150	13 300	3 450	14 600	45
65	26	108.7	2 350	9 900	2 700	11 300	3 000	12 700	3 300	14 100	3 700	15 500	49
70	25	104.6	2 450	10 200	2 800	11 700	3 150	13 200	3 500	14 600	3 850	16 100	52.5
75	24.5	102.5	2 550	10 800	2 900	12 300	3 300	13 800	3 650	15 400	4 000	16 900	56
80	24	100.4	2 650	11 200	3 050	12 900	3 400	14 500	3 800	16 100	4 200	17 700	60

Source: WHO (1985), Table 42.

In 2001, the FAO/WHO/UNU (2004) organized an "expert consultation" to update the recommendations of the 1985 report (FAO 2004), which made only minor changes to the energy requirements for adults.

Our interest is in determining how many calories are needed, at a minimum, for people to function acceptably well. A good place to start is with the approach used by the Food and Agriculture Organization (FAO) of the United Nations in its studies of country-level undernourishment. A key component of these studies is identifying a minimal level of food adequacy.

Estimating MDERs

For those aged 10 and above, FAO (2008) proceeds as follows:

(i) Find the heights of people at each age, and by gender.

(ii) Given that different weights are consistent with a given height (for age, gender), pick the "lowest acceptable weight-for-height". This is taken as the 5th percentile of the Body Mass Index (BMI) for a healthy population. The BMI is defined as weight (in kg) divided by height (in meters) squared. Someone with a BMI below 18.5 is considered to be undernourished.

(iii) Use these weights to measure the basal metabolic rate (BMR) – i.e., one's energy needs when resting but awake – using established equations that link this to weight, age, and gender. This is traditionally done using the Schofield equations (James & Schofield 1990).

(iv) Add a provision for activity, using a physical activity level (PAL) index. The lowest acceptable activity level ("light activity", or "sedentary lifestyle") is given by a PAL of about 1.55. An average PAL is likely closer to 1.85.

This yields the minimum dietary energy requirement (MDER), by age and gender. The average MDER for a country is a weighted average of the individual MDERs, and in 2006-08 was 1,710 kcals for Rwanda (and 2,000 for the Netherlands, the country with the highest average MDER), according to the FAO (2008).

We applied the FAO approach to Rwanda using the following steps:

Step 1. Get heights for men aged 20-39 from the Demographic and Health Survey (DHS) of 2014-15 (Rwanda 2016). Based on 3,537 observations, the height at the fifth percentile was 1.555m, and the mean height was 1.667m.

Step 2. The expected weight is given by BMI × height^2. Taking a BMI of 18.5 as the cutoff for being underweight, this gives an estimated minimally-acceptable weight of 51.43 kg. The 5th percentile of observed weight in the DHS was 48.1 kg. These numbers are lower than the 65 kg implicitly assumed by Uganda, or by Smith et al. (2006).

Step 3. Use weight to get the basal metabolism rate (BMR), using the Schofield equations for the relevant age groups to estimate resting energy expenditure (REE). These yield:

For ages 18-30	15.057 × kg + 692.2 = 1,463 kcals
For ages 30-60	11.472 × kg + 873.1 = 1,465 kcals.

Step 4. Adjust for activity level. We use a PAL of 1.55 for "low activity", in line with FAO practice. This gives a minimum daily energy requirement (MDER) of 2,267 kcals (under 30), or 2,271 kcals (30+).

These calculations give numbers lower than the 2,500 threshold currently used by Rwanda. It would take a PAL of 1.7 to get to 2,500. There is also some evidence that Schofield's equations overestimate BMR for much of Africa, perhaps because less energy may be needed for a body in the tropics.

If we take 2,270 kcals as the right level for an adult male (instead of 2,500), then the national minimum daily energy requirement, using the equivalence weights currently employed, would be 2,066 kcals (using EICV5 data from 2016/17). This is still much higher than the MDER of 1,710 published by FAO. The main difference is that FAO uses lower caloric needs for women relative to men, compared to the Rwandan scale shown in Table 9.

Conclusions

Every poverty analyst grapples with the details – how the data are collected, aggregated, deflated, and presented. If consistent protocols are used, it is possible to get useful information on trend in poverty over time, and to construct helpful poverty profiles.

It is far harder to make valid comparisons of poverty rates across countries. While this may be a greater priority for international organizations than for national statistics offices, it is still helpful to try to identify "good practice", which may then be applied universally.

We have examined some of the more controversial methodological and practical challenges that arise in measuring poverty, testing the alternatives with Rwandan data. In many respects, Rwanda's economic situation is like that of many other countries in the region, so our findings have considerable external validity. Let us examine each in turn.

1. Household consumption data collected on multiple visits gives higher values than when based on seven-day recall. It is plausible that this mainly reflects a more-complete accounting for consumption. Perhaps surprisingly, there is very little evidence of respondent fatigue.

2. The choice of method used to estimate the user cost of durable goods has little influence on identifying who is poor.
3. It is common to deflate household consumption to give real consumption using a single price index (that may vary by region and month). This is less satisfactory than tailoring price indexes to the consumption patterns of each household, an approach already used by Kenya (2007) and that is in line with the theoretical Paasche indexes needed to measure money-metric utility. The choice of deflation method makes relatively little difference to the poverty profile, but does influence measures of inequality.
4. There is no ideal adult equivalence scale, yet the choice makes a real difference to identifying who is poor, and hence to poverty profiles. We propose a “combined” scale that uses caloric weights for food consumption (Table 10) and allows for some economies of scale for non-food consumption.
5. Rwanda builds its poverty line by using a cost-of-basic-needs approach, and assumes an adult male needs at least 2,500 kcals worth of food per day. We argue that a more appropriate minimum daily energy requirement for adult men would be at most 2,270 kcals per day.

We have not exhausted the list of topics that call for further discussion. For example, how should consumption and autoconsumption be valued – at self-reported or CPI-collected prices? Is the user cost of housing modelled adequately? Does the use of computer assisted personal interviewing (CAPI) eliminate the need to correct for outliers? What is the best way to deal with regrettable necessities.

While “good practice” in measuring poverty and inequality is increasingly coming into focus, there is still a need for inquiry and experimentation before getting to reasonably robust international comparisons of monetary poverty.

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