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THE ROBUSTNESS OF POVERTY PROFILES RECONSIDERED

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ABSTRACT

Poverty measures and profiles are used increasingly to guide antipoverty policies in low-income countries. An essential element in these analyses is the specification of a poverty line. However, there are many different methods for setting poverty lines, and different methods can yield strikingly different results, with correspondingly different policy implications. Using recent household survey data from Mozambique, this paper explores the differences that occur using the most common poverty line methodologies, the Food Energy Intake (FEI) and the Cost of Basic Needs (CBN) methods, over different levels of geographic specificity. We find that regional and provincial rankings of Foster, Greer, and Thorbecke poverty indices are not robust to the method of poverty line determination, but that the characteristics of the poor are reasonably similar under all methods. The FEI poverty lines often yield counterintuitive results, whereas the family of CBN poverty lines was more robust. Food consumption patterns of the poor show a high degree of substitution among basic staples from one region to another, which is consistent with observed differences in relative food prices, indicating that CBN poverty lines that allow for regional variation in the food consumption bundle may be most appropriate in these settings.

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1. INTRODUCTION

Poverty reduction is a fundamental goal of economic development, and there is a long and rich literature on the theory, conceptualization, and measurement of poverty. Yet, numerous conceptual and technical issues remain.[1] The lack of consensus on concepts and methods—and more precisely, the differing results that may arise from different methods—presents a serious challenge for policymakers aiming to allocate scarce resources effectively for poverty reduction. Poverty measures and poverty profiles are increasingly used as guides in targeting resources for poverty reduction, but an allocation that is efficient according to one methodology may yield unacceptable leakages and inadequate coverage if a different methodology is applied. Conversely, if different methods produce similar results, policymakers can be more confident that their allocation decisions are robust.

In this paper, we examine alternative methods used to set absolute poverty lines for the measurement of consumption poverty. Recent literature has compared the two most common methods for setting poverty lines, the Food Energy Intake (FEI) and the Cost of Basic Needs (CBN), using the criteria of consistency (treating persons with the same living standards equally) and specificity (using notions of poverty that are applicable to the communities under consideration). The emerging consensus appears to be that for subgroup comparisons, the CBN method is more consistent than the FEI

[1] See, for example, Ravallion (1994), Sen (1999), Kanbur and Squire (1999), and Narayan et al. (2000).

method, and also sufficiently specific.[2] However, the common practice of specifying a single national food bundle may be inappropriate in settings where the food consumption patterns of the poor are heterogeneous because of differences in the relative prices of staple foods. Data from Mozambique, a large and agro-ecologically diverse country with extremely poor market integration, are used to test the robustness of different methods for setting the poverty line. We also address a shortcoming of the existing literature, namely, the lack of systematic definition of domains over which a poverty line applies.[3]

Section 2 examines the methodological aspects of determining poverty lines, and briefly makes the case for consistency and specificity of poverty comparisons across subgroups. This is followed by a discussion of data and the Mozambique country context in Section 3. Section 4 details our methodology for determining the FEI and CBN poverty lines, and Section 5 presents six sets of poverty lines and estimates of poverty indices. The characteristics of the poor are compared in Section 6 along the lines of standard poverty profiles, followed by an investigation of the factors underlying the differences in poverty comparisons in Section 7. Section 8 offers a summary and concluding comments.

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[2] See Ravallion and Bidani (1994), Ravallion and Sen (1996), and Wodon (1997).

[3] Often a single FEI poverty line, or a rural/urban pair of FEI poverty lines, is compared to a set of CBN lines defined by a single food consumption bundle and multiple region-specific price vectors corresponding to that bundle. For example, Ravallion and Bidani (1994) and Wodon (1997) each use a pair of rural/urban FEI poverty lines, but a much more disaggregated set of regional price vectors (50 and 14, respectively) to construct CBN poverty lines.

2. POVERTY LINE PRINCIPLES AND PRACTICE

In economics, the analysis of absolute poverty has four basic steps. First, the analyst chooses a welfare measure; this is usually household expenditure or income, adjusted for the size and/or composition of the household. Second, a poverty line is set at a level of welfare corresponding to some minimum acceptable standard of living. The poverty line acts as a threshold, with households falling below the poverty line considered poor and those above the poverty line considered nonpoor. Third, once the poor have been identified, poverty measures such as the headcount ratio, poverty gap, and squared poverty gap are estimated. Fourth, poverty profiles can be constructed, showing how poverty varies over population subgroups (for example, across regions), or by characteristics of the household (for example, landowners and landless). Poverty profiles are important: what matters most to many policymakers is not so much the precise location of the poverty line, but the implied poverty comparison across subgroups or across time (Lipton and Ravallion 1995).

Absolute poverty lines are typically set to represent the expenditure (or consumption or income) required to attain some minimum level of welfare, so the line is meant to reflect the cost of obtaining a given reference level of utility or standard of living that defines the threshold to poverty. Usually the minimum level of welfare is anchored to nutritional requirements, supplemented by an allowance for basic nonfood needs. The poverty line can therefore be thought of as a deflator that maps nominal value of welfare into real terms and establishes the comparability of the welfare measure across

the population under study (Bidani and Ravallion 1993).[4] When the welfare measure is expressed in real terms, an assessment of the robustness of alternative poverty lines can be made by plotting the cumulative density functions (CDF) (or integrals thereof) of relevant subgroups and testing for welfare dominance over a range of relevant poverty lines (Ravallion 1998; Deaton 1997). The robustness we consider in this paper is fundamentally different. Rather than testing for dominance in a relevant range of the given real welfare distributions, we go one step back in the process to examine how the choice of poverty lines affects the shape of the welfare distribution itself.[5]

There are four major methods for setting absolute poverty lines, the Food Energy Intake (FEI) approach, the Cost of Basic Needs (CBN) approach, the dollar-a-day criterion used for international comparisons by the World Bank and others, and a social subjective poverty line. In this paper, we concentrate on an assessment of the consistency and specificity of the FEI and CBN methods.[6]

The FEI approach (Dandekar and Roth 1971) associates the poverty line with the monetary value of the total expenditure or income for an average (or representative)

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[4] When poverty lines are based on a single consumption bundle, they function as a low-income Laspeyre price index. When multiple bundles are permitted in addition to price variation, poverty lines may be viewed more generally as a low-income "cost of living" index.

[5] For example, if two deflators were sufficiently different, under one deflator, the CDF of one subgroup could dominate the CDF of another group over the entire range of observed welfare levels, whereas the opposite result could obtain under the other deflator. Yet either of these scenarios could be assessed as robust by conventional dominance tests, because given the real welfare distribution, any poverty line would yield the same welfare ranking of subgroups.

[6] Other potential points of contention include the setting of caloric requirements, equivalence scales, poverty indices, and the calorie content of various food items. We do not pursue the difficulties inherent in these steps here, as they are well covered in the literature. See Atkinson (1991) and Lipton and Ravallion (1995).

household that just manages to meet stipulated caloric requirements. It is common practice to derive the FEI poverty line from the parameters estimated in a regression of the relationship between energy intake and expenditure or income. Functional forms vary, and energy intake may appear on the right- or left-hand side (with expenditure or income on the other). The analysis can be carried out on a per-capita or an adult equivalent basis. The FEI approach can be implemented on a national sample to generate a single national poverty line, but in practice a disaggregated approach is usually chosen, estimating separate rural and urban FEI lines, or even regional or provincial lines (Greer and Thorbecke 1985, 1986). The actual consumption baskets of the poor are implicit in the FEI poverty line(s) and are based on observed behavior, in response to prices faced, by the group of households around the predetermined caloric threshold. Thus, a major advantage of the FEI approach is its specificity. Another advantage is simplicity—FEI establishes in a straightforward manner the level of expenditure or income at which a typical household meets its nutritional requirements.

The CBN method that is focused on ensuring consistent welfare comparisons is also based on nutritional requirements. It (1) identifies a basic food bundle from the data that is consistent with the consumption patterns of persons who are perceived to be poor, (2) scales the quantities in this bundle up or down to correspond to nutritional requirements, and (3) calculates the cost of acquiring the basket that results from the previous two steps. Subsequently, a nonfood poverty line is calculated, for example, by estimating the cost of consuming a basic set of nonfood goods and services, or by estimating the average nonfood budget share of the relatively poor (in each subgroup).

The sum of the food and nonfood poverty lines is the total poverty line from which poverty measures and comparisons are derived.

The consumption bundles (implicit in FEI, explicit in CBN) are based on observed consumption patterns. Moreover, to be considered nonpoor, a household or individual is neither required to consume the specific items in the bundle, nor to consume the minimum number of calories on which the poverty line is based. As such, both the FEI and CBN methods of setting poverty lines are attempts to measure consumption poverty, not undernutrition. Despite these similarities, the FEI and CBN approaches, and their different versions, can generate vastly different poverty lines and yield contradictory poverty profiles. The trade-off is between the specificity of the FEI approach and the strength, i.e., consistency, of the CBN approach.

Using Indonesian data, Ravallion and Bidani (1994) found zero correlation between the poverty comparisons generated by the selected FEI and CBN methods (the FEI results were based on separate lines for the rural and the urban subgroups, while CBN used a single national bundle and 50 region-specific price vectors). They also compared the average consumption of households in the vicinity of an FEI poverty line in rural and urban areas. Although both contained around 2,100 kilocalories (kcal) per capita, the average urban diet had more rice, expensive vegetables, meat, food, and drink outside of home and less of the cheap staple foods than the average rural diet of people in the vicinity of the rural FEI line. The urban poverty line was sufficient to acquire a consumption bundle that almost all Indonesians would prefer relative to the rural bundle. Ravallion and Bidani conclude that the CBN estimates yield more consistent poverty

comparisons across subgroups and therefore are preferable. Ravallion and Sen (1996) and Wodon (1997) arrive at similar conclusions in analyses of poverty in Bangladesh.

It is not uncommon for analyses based on the disaggregated FEI approach, where separate urban and rural poverty lines are set, to indicate higher poverty rates in urban than in rural areas. At a given level of income, urban households tend to consume fewer—but more expensive (higher quality)—calories than rural households. This will push the urban poverty line higher than can be justified on welfare grounds. Applying the FEI approach to generate a single national poverty line does not resolve the problem, and may result in the opposite situation. Whenever food is relatively cheaper in rural areas, as is usually the case, a single nominal poverty line underestimates urban poverty relative to rural poverty. These shortcomings of the FEI approach—which lead to potentially inconsistent poverty comparisons across subgroups—are by now fairly well known. Less attention has been drawn to the issue that the CBN methodology also faces potential problems when making subgroup comparisons.

From the discussion above, it is clear that consistency is desirable when setting poverty lines, i.e., treating two individuals with the same level of welfare identically (Ravallion 1998). To put it differently, "…whether or not a given standard of living constitutes poverty should not depend on the subgroup to which the person with that standard of living belongs" (Ravallion and Bidani 1994). If the monetary cost of attaining a given minimum level of welfare is higher in Region A than in Region B, the poverty line for Region A should be correspondingly higher than the poverty line of Region B.

This consideration is important in settings where the prices of basic goods vary spatially or temporally; it also highlights the role of the poverty line as a price index.

One common method of attempting to ensure consistency is the use of a single consumption bundle throughout a country, only allowing the poverty line to vary because of differences in the price level encountered by different subgroups. However, using the same bundle across subgroups does not guarantee comparability of welfare levels. As observed by Greer and Thorbecke (1985, 1986), a given "poverty line is valid only if it refers to a group of households sharing similar food preferences and facing uniform prices."

If relative prices are not uniform, the CBN method with a single national bundle (CBN-1, for short) can generate inconsistent poverty comparisons. For an illustrative example—without loss of generality, consider two regions that have the same distribution of welfare, and are therefore equally poor. The populations of the two regions are of the same size and composition, and consumption preferences of the poor in the two regions are identical. The poor consume three food items: maize, cassava, and beans. In this stylized example, maize and cassava are perfect substitutes in consumption, and beans are a complementary food item. The salient difference between the two regions is the relative prices of maize and cassava. In Region A, we assume maize is twice as expensive as cassava, whereas in Region B, cassava is three times the price of maize; the price of beans relative to the cheaper staple is the same in each region. In keeping with standard CBN food poverty line practice, these are expressed as the cost of a calorie from each source.

Table 1 shows the arithmetic of this example. Given the identical preferences but differing relative prices described above, we see that poor households in Region A get 1,500 kcal per day from cassava, 500 from beans, and none from maize. Consumption in Region B is the same, except that the roles of cassava and maize are reversed. In both regions, the total outlay required to consume the food bundle relevant to the poor is 2,000 units of the national currency. The last two columns of the table show the quantities and values of the associated fixed bundle CBN food poverty lines for the two regions. The food quantities in the CBN-1 bundles are simply the mean values of the consumption of each item in the two regions; the bundle provides 2,000 kcal.

Table 1—Illustrative example of inconsistency of cost of basic needs (CBN)-fixed bundle food poverty lines

	Cost per calorie	Calories consumed	Total expenditure	CBN-1 bundle (calories)	CBN-1 food poverty line
Region A					
Cassava	1	1,500	1,500	750	750
Maize	2	0	0	750	1,500
Beans	1	500	500	500	500
Total		2,000	2,000	2,000	2,750
Region B					
Cassava	3	0	0	750	2,250
Maize	1	1,500	1,500	750	750
Beans	1	500	500	500	500
Total		2,000	2,000	2,000	3,500

However, we note that in the final column the food poverty line in Region B is 25 percent higher than that in Region A.[7] Despite the identical welfare distributions of the two regions, Region B will appear to be poorer in poverty comparisons, solely because of the relatively high price of cassava, even though cassava is not consumed by the poor in that region. This result is not dependent upon achieving the corner solution described here; the perfect substitutability assumption does not drive the result; it merely simplifies the exposition.

The need to ensure consistency in the treatment of bundles consumed across subgroups leads directly to the criterion that poverty lines should reflect local perceptions of what constitutes poverty, or what Ravallion and Bidani (1994) refer to as specificity. Specificity requires that a locally irrelevant basket of goods should not be imposed. In the words of Ravallion and Bidani, "specificity may be interpreted as either a separate goal of basic needs consistency or as another way to define consistency, by which the measure of individual well being is broadened to include feelings of relative deprivation.[8]

Thus, allowing bundles to vary across subgroups runs the risk that the welfare of the relatively poor in each subgroup is not identical, resulting in inconsistent comparisons. The danger of the opposite, a uniform bundle, is that this basket may be

[7] It is also noteworthy that both poverty lines are well above the cost of acquiring the region-specific bundles, since the CBN-1 bundle is not the cost minimizing allocation for achieving that level of utility in either region. This aspect alone will not generate inconsistent poverty comparisons between Region A and Region B, but it may affect intra-regional poverty comparisons if welfare dominance between subgroups does not obtain within this range (i.e., if poverty comparisons are not robust to the specific placement of the poverty line).

[8] For this reason, poverty lines also tend to increase with mean income even if they are supposed to reflect absolute, not relative, poverty (Ravallion, Datt, and van de Walle 1991).

locally irrelevant, which can also generate inconsistent comparisons. Striking the right balance between the need for consistency and specificity is therefore far from easy. The appropriate balance will depend on the heterogeneity of the country in question as well as on the particular purpose of the analysis.

While the direction of the rural/urban biases inherent in the FEI approach appears well understood, this cannot be said in general for the CBN method. Here the direction of the bias is unknown. Standard CBN practice as applied by Ravallion and Bidani (1994), World Bank (1996), and Wodon (1997) is to rely on one national (or fixed) food bundle, which is multiplied by price vectors that are specific to the subgroups (regions) considered. Variations in the estimated regional poverty lines are therefore solely a function of price differences. Yet, according to Ravallion and Sen (1996), "While the (implicit) bundle of goods in the FEI method [that is, with a rural/urban distinction] almost certainly varies too much to be consistent with the same standard of living, the (explicit) bundle in the CBN method varies too little." Furthermore, the basis used for assessing the FEI and CBN approaches in Ravallion and Bidani (1994) and Wodon (1997) appears problematic. FEI estimates based on separate urban and rural poverty lines are compared with CBN estimates based on one national bundle evaluated at subgroup price vectors. A more complete set of comparisons of the two methods is called for and, indeed, motivates this paper.

When relative prices differ across regions, it is perfectly reasonable for a poor household in one region to consume a different basic needs bundle than an equally poor household in another region. What is not acceptable is for the differences in poverty lines

to reflect differences in standards of living, as would be the case if poor households in Region A prefer the basic needs bundle in Region B to their own basic needs bundle. One attractive and transparent approach of trying to deal with these problems that has not so far been applied widely is to make use of the multiple-bundle version of the CBN methodology in which both bundles and prices vary by subgroup (Lanjouw 1994; Datt, Jolliffe, and Sharma 1998; MPF/EMU/IFPRI 1998). There would seem to be a priori justification for the use of the multiple bundle approach in countries with poorly integrated food markets. If substitution effects are significant, the imposition of a fixed bundle will distort regional welfare comparisons. If substitution effects are not significant, the multiple bundle approach should collapse to a single national bundle.

3. DATA AND COUNTRY CONTEXT

The household-level data used in this paper come from the Mozambique *Inquérito Nacional aos Agregados Familiares Sobre as Condições de Vida* (IAF), or National Household Survey of Living Conditions. The survey was conducted by the National Institute of Statistics, *Instituto Nacional de Estatística* (INE), from February 1996 through April 1997, and is the first nationally representative household survey in Mozambique. Coverage and quality of this dataset are comparable to the World Bank-sponsored Living Standards Measurement Study (LSMS) surveys conducted in many

countries.[9] The survey used a stratified three-stage cluster sampling design, is intended to be representative at the provincial level, and supports subdivision by rural and urban area of residence. The sample comprises 42,180 individuals living in 8,250 households. All standard errors reported in this paper take account of the complex sample design, using the variance estimators available in the survey analysis routines of the statistical software package *Stata* (Deaton 1997; Howes and Lanjouw 1997; StataCorp 2000).

Mozambique is one of the poorest countries in the world. It is a large and agro-ecologically diverse country, spanning almost 2,000 kilometers from south to north. The northern and central provinces tend to be more fertile than those of the south. Humidity and rainfall also vary a great deal. In the south, average annual rainfall is only about 600 millimeters, whereas in the central region and throughout the north, rainfall is between 1,000 and 1,800 millimeters. Adverse climatic conditions, defined as a climate outcome producing a greater than 25 percent decline in maize yields relative to the most likely of five climate scenarios, have been estimated to occur 18, 30, and 63 percent of the time in the north, central, and south regions of Mozambique, respectively.[10]

Three million farm households, located in dispersed settlements throughout the country, dominate the agricultural sector. The total population at the time of the last census (August 1997) was 16.1 million, of which more than 70 percent is rural (INE

[9] As in other surveys, food quantity information (e.g., grams of particular foods consumed) is measured with more error than the monetary value of this consumption. The primary reason for this is the reporting of consumption in nonstandard units, such as bowls, heaps, etc. To minimize the effects of this measurement error, households with extreme values for quantities are excluded from the FEI regressions and the construction of the CBN food bundles. As the monetary value data are more reliable, these households are included in the analysis following the specification of poverty lines.

[10] See Tarp and Arndt (2000) for this and other descriptive data used in the remainder of this section.

1999). Population density is 20 people per kilometer squared (km^2) on average, ranging from 37.5 people per km^2 in the province of Nampula to less than six people per km^2 in Niassa in the north. The poor state of infrastructure, particularly in rural areas, affects economic and social life in a variety of ways. Transport costs are high, and some regions are isolated. Markets are poorly developed as a consequence of the colonial heritage, command economy economic policies pursued after independence in the mid-1970s, and the effects of the war that devastated the country during the 1980s and early 1990s. While some improvement has taken place in recent years, this is from an extremely low starting point, and is concentrated in the southern part of the country.

There are substantial differences in production and consumption patterns across the country's 10 provinces. The production pattern reflects in part the diverse agroecological conditions. In addition, because of high marketing margins and the lack of market integration, rural households often consume a large proportion of their own production. Average domestic marketing costs for cassava amount to 80 percent of market prices, while maize margins are much lower at around 25 percent, but substantial regional variation exists.

While cassava and maize are the two key staple crops, their importance in production and consumption also varies drastically across regions. Maize is a marketable crop that is found in production and consumption patterns throughout Mozambique. By contrast, in some areas, cassava is almost nonexistent whereas elsewhere it dominates. In addition to the widely varying agro-ecological and marketing conditions already noted,

interactions between agricultural technology, risk, and gender also play significant roles (Arndt and Tarp 2000).

When one considers the extreme diversity and lack of integration of the Mozambican economy, it is hardly surprising that there are large spatial differences in absolute and relative prices. These differences should be taken into account to provide a true picture of the distribution of poverty. This issue is particularly relevant to policymakers, who are rightly concerned about the need to reduce existing asymmetries and disparities across the different parts of the country (GRM 2000). They should be alert to the robustness of conclusions emerging from applying differing methodologies for poverty assessment.

4. METHODOLOGY

In this section we describe in detail the steps taken to establish each set of poverty lines. Six sets of poverty lines are considered, employing the two basic methods (FEI and CBN) at three different levels of aggregation. They correspond in the FEI approach to the number of unique poverty lines, whereas they reflect the distinct number of food bundles used for the CBN poverty lines. The three levels of aggregation, or specificity, are (1) national, (2) rural/urban area of residence, and (3) 13 geographic regions delineated by rural/urban area of residence and provincial boundaries. For convenience, the six sets of poverty lines will be referred to as FEI-1, FEI-2, FEI-13, CBN-1, CBN-2, and CBN-13.

The variable for total consumption per capita *in nominal terms* is the same throughout for each household. The total consumption measure includes purchases and home consumption of food items, purchases of nonfood goods and services, and imputed use-values for household durables and owner-occupied housing (Hentschel and Lanjouw 1996). Monetary values for food consumption were adjusted to take temporal price variation into account, using available market price information corresponding to the survey period (MAP 1998).

Definition of areas as rural or urban follows the classification used in the sample design of the IAF survey (Cavero 1998). The city of Maputo, all provincial capitals, and other selected urban areas make up the urban stratum. The 13 regions were defined based upon the principles of grouping areas in which food prices and the food consumption patterns of the poor are similar, while maintaining an adequate sample size. The regions and the number of sample households in each are shown in Table 2.

The calorie requirements used are the same for each set of poverty lines. They were based on a study by the World Health Organization (WHO 1985), taking into account differences in age and sex, as well as the pregnancy and lactation status of women. Moderate activity levels and body mass are assumed. Given the demographic composition of Mozambique's population, requirements average approximately 2,150 kcal per person per day.

Table 2—Distribution of sample households, by poverty line domains

Spatial domain	Number of households	Percent of total sample
Niassa and Cabo Delgado — Rural	1,186	14.4
Niassa and Cabo Delgado — Urban	214	2.6
Nampula — Rural	719	8.7
Nampula — Urban	236	2.9
Sofala and Zambézia — Rural	1,301	15.8
Sofala and Zambézia — Urban	345	4.2
Manica and Tete — Rural	987	12.0
Manica and Tete — Urban	285	3.5
Gaza and Inhambane — Rural	1,187	14.4
Gaza and Inhambane — Urban	179	2.2
Maputo Province — Rural	431	5.2
Maputo Province — Urban	287	3.5
Maputo City	893	10.8
Total	8,250	100.0

Note: The poverty line domains are those regions used to construct separate poverty lines, thereby partially controlling for spatial differences in prices, preferences, and household composition.

FOOD ENERGY INTAKE (FEI)

For the FEI poverty lines we ran regressions of the form

$$ln(y) = a + bC + e,$$

where y is daily per capita consumption, C is calories consumed, and e is the disturbance term. The FEI poverty lines correspond to the level of expenditure per capita at which caloric intake is equal to the recommended daily caloric requirements per capita. Thus, the poverty lines are calculated as

$$z_k^{FEI} = \exp(\hat{a}_k + C_k^* \hat{b}_k),$$

where $\hat{a}$ and $\hat{b}$ are the parameter estimates, C^* is the calorie requirement, and k indexes the region.[11] The regression approach and functional form follows that of Greer and Thorbecke (1985, 1986). Results are shown in Table 3, with good fits in all cases except for FEI-13 in urban Maputo Province. Compared to Greer and Thorbecke, three special features in our implementation deserve mention. First, we use total consumption rather than food consumption as the welfare indicator. Second, we exclude influential observations based on a DFBETA criterion.[12] Third, we do the entire analysis on per-capita terms in order to maintain comparability between the FEI and the CBN poverty lines. Experiments with calorie intake per adult equivalent unit (AEU) produced similar results.[13] Because the FEI method relates calorie intake to total consumption, an allowance for nonfood consumption is automatically included.

[11] The regression was run once on the entire sample to establish the FEI-1 poverty line and run separately on the urban and rural subsamples to establish FEI-2 lines. Separate regressions were run on each of the 13 regions to give the FEI-13 lines.

[12] Observations are excluded if $|\text{DFBETA}_i| > 2/\sqrt{n}$. This is a common criterion for excluding outliers, as described in Belsley, Kuh, and Welsch (1980).

[13] Lanjouw and Ravallion (1995) have explored the implications of different equivalence scales. While it appears that equivalence scales may matter in cross-country comparisons of poverty (Lancaster and Valenzuela (1999), there is no reason to believe this to be the case in our comparison of methods for a given country.

Table 3—Food energy intake (FEI) regression results

Method	Domain	Slope coefficient		Intercept		N	R^2
FEI-1	National	0.261	(20.75)**	0.884	(25.07)**	6,048	0.16
FEI-2	Urban	0.381	(11.34)**	1.177	(12.61)**	1,849	0.23
	Rural	0.228	(19.02)**	0.814	(25.35)**	4,150	0.18
FEI-13	Rural Niassa and Cabo Delgado	0.211	(6.83)**	0.670	(6.74)**	824	0.19
	Urban Niassa and Cabo Delgado	0.235	(4.22)**	1.039	(9.30)**	149	0.15
	Rural Nampula	0.241	(10.80)**	0.430	(5.95)**	514	0.25
	Urban Nampula	0.379	(3.40)*	0.553	(3.64)*	178	0.28
	Rural Sofala and Zambézia	0.341	(17.85)**	0.664	(17.08)**	875	0.42
	Urban Sofala and Zambézia	0.267	(4.87)**	1.325	(12.21)**	278	0.16
	Rural Manica and Tete	0.295	(9.31)**	0.632	(8.68)**	711	0.27
	Urban Manica and Tete	0.279	(6.79)**	1.273	(13.88)**	191	0.22
	Rural Gaza and Inhambane	0.319	(12.73)**	0.992	(16.69)**	950	0.27
	Urban Gaza and Inhambane	0.459	(4.14)*	1.269	(7.47)**	138	0.20
	Rural Maputo Province	0.319	(11.58)**	1.194	(19.42)**	316	0.27
	Urban Maputo Province	0.014	(-0.36)	2.082	(16.45)**	172	0.001
	Maputo City	0.472	(15.25)**	1.311	(17.09)**	768	0.34

Notes: Robust t-statistics in parentheses; * significant at 5 percent level; ** significant at 1 percent level; dependent variable: Natural log of total daily consumption per capita (Mozambican meticais, in 1,000s); independent variable: Daily calorie consumption per capita/1,000.

COST OF BASIC NEEDS (CBN)

For all of the CBN poverty lines estimated here, the poor were defined as those households whose per-capita calorie consumption was below the recommended minimum requirement of approximately 2,150 kcal per person. A more conventional practice is to use the consumption patterns of those households whose total consumption in nominal terms is below a certain level, which serves as a "first guess" of the poverty line, and then

iterate.[14] For the CBN-1 and CBN-2 poverty lines, a group of 23 food items was selected for the food bundle, including all items that made significant contributions to total caloric intake. Over most of the country, these items account for 73 to 96 percent of calorie consumption of the relatively poor. The only exception is the city of Maputo, where these 23 items contribute 65 percent—still a large share—of the calorie consumption of the poor. In all areas, the remainder of calorie intake comes from small contributions of up to 100 different food items. These are necessarily excluded from the CBN-1 and CBN-2 food bundles because of the practical problem of including a food item in the bundle for which there is no observed corresponding price in a given region. However, they are included in the CBN-13 food bundles; at this higher level of spatial disaggregation, consumption of these items is always observed with a corresponding price or unit value.

Regardless of the level of specificity of the food bundle, region-specific unit values are used throughout to calculate the cost of acquiring the food bundle, which defines the CBN food poverty line. Allowing prices to vary by region is by now common practice in CBN analyses (Ravallion 1998).[15] The household survey provides information on the quantity and value of all foods consumed, whether from market purchases, home

[14] See Ravallion (1998). We initially used this approach on the Mozambique data, but the range of the resulting CBN-13 poverty lines appeared implausibly large. The large differences in poverty lines could not be explained entirely by differing prices, and examination of the consumption bundles suggested that the poverty lines in southern Mozambique commanded a higher standard of living than the poverty lines in northern regions. We therefore opted for using the consumption bundle of people whose food energy intake is below the requirement and scaled up to requirements. Upon reexamination, we can affirm that the comparisons in this paper would not change in any important way had the more conventional approach been employed.

[15] Please also note that CBN-1, without allowing for regional price variation, would resemble FEI-1, although they would not be identical.

production, transfers, payment in kind, or any other source. The quantities in grams are readily converted to calorie equivalents using food nutrient tables. From these food consumption data, the calorie-weighted mean price paid per calorie (unit value) was calculated within each region for each item in the food bundle. This is equivalent to calculating the region-specific mean unit value of a "composite" calorie, with the weights of the composite calorie determined by the actual consumption patterns of the poor.[16]

As the calorie consumption of the poor is less than the recommended minimum, the cost of acquiring the food bundle must be scaled up to the level of calorie requirements. We therefore increased the quantities of each item in the bundle proportionally, so the calorie requirement is satisfied and the calorie shares from each item in the bundle are preserved. To put it slightly differently, the mean cost of a composite calorie is multiplied by the calorie requirement to obtain the region-specific food poverty line.

The construction of the CBN food poverty lines may be summarized as follows:

CBN-1: $$z_k^F = \sum_{i=1}^{23} p_{ik} q_i \quad (1)$$

CBN-2: $$z_k^F = \sum_{i=1}^{23} p_{ik} q_{ij} \quad (2)$$

CBN-13: $$z_k^F = \sum_{i=1}^{N} p_{ik} q_{ik} \,, \quad (3)$$

[16] The use of unit values instead of market prices implies that we are not controlling for differences in quality of the foods consumed. We do not explore the potential biases from such quality differences in this paper.

where z_k^F is the CBN food poverty line in region k, p_{ik} is the average unit value (price) of a calorie of commodity i in region k, q_i is the quantity of calories that commodity i contributes to the food bundle (already scaled to requirements), j indexes rural or urban area of residence, and k indexes the 13 regions shown in Table 2. N is the number of food items included in the food bundle, which is fixed at 23 for CBN-1 and CBN-2.

An allowance for nonfood basic needs was derived by nonparametrically estimating the mean nonfood expenditure of those households whose total consumption is in the neighborhood (plus or minus 20 percent) of the food poverty line (Ravallion 1998). The nonfood poverty line was allowed to vary by the 13 regions.

Finally, in the present study as in the literature more generally, the FEI and CBN methodologies focus on different subsamples when estimating the link between total consumption and calorie intake. The FEI method typically uses the entire sample of households in a regression framework. The CBN approach, on the other hand, focuses exclusively on those considered to be poor according to some criterion, such as nominal total consumption or calorie intake, and explicitly ignores the upper part of the distribution. These differences are, as suggested in Section 2, likely to lead to systematic differences in poverty lines because at higher incomes people tend to buy more expensive calories. This has no impact on the CBN calculation, but might bias FEI estimates of poverty lines and poverty indices upward, particularly when subgroup disaggregation is allowed.

Poverty statistics are calculated using a subset of the standard Foster-Greer-Thorbecke (FGT) P" class of poverty measures (Foster, Greer, and Thorbecke 1984). This family of poverty measures is defined as

$$P_a = \frac{1}{n}\sum_{y \le z}(1 - y/z)^a , \qquad (4)$$

where y = consumption (or income), z = the poverty line and n = total population. We work with $\alpha = 0, 1, 2$, corresponding to the headcount, the poverty gap, and the squared poverty gap measures, respectively.

5. POVERTY LINES AND INDICES

In this section, we review results, summarize the estimates of poverty indices, and examine changes in regional poverty rankings. We also compare the poverty estimates to a variety of nonmonetary welfare indicators. The natural starting point is the food poverty lines. The CBN food poverty lines are shown in Table 4 (as applied here, the FEI methodology does not generate separate food and nonfood poverty lines). They suggest that the cost per calorie, and thereby the food poverty lines, tends to decrease as the number of subgroups over which the bundle is allowed to vary increases. Moving from a fixed national bundle (CBN-1) to separate rural and urban bundles (CBN-2), the change is limited. Under the CBN-13 approach, the food poverty lines fall relative to the CBN-1 in 11 of the 13 regions, and the national average drops by a significant 25 percent.

Table 4—Cost of basic needs (CBN) food poverty lines for Mozambique

	Meticais per person per day		
	CBN-1	**CBN-2**	**CBN-13**
Rural Niassa and Cabo Delgado	4,342	4,108	3,011
Urban Niassa and Cabo Delgado	7,134	6,465	3,687
Rural Nampula	4,029	3,794	2,742
Urban Nampula	4,087	4,560	3,642
Rural Zambézia and Sofala	4,975	4,836	3,719
Urban Zambézia and Sofala	4,874	5,025	5,370
Rural Tete and Manica	3,929	3,678	3,845
Urban Tete and Manica	5,070	5,421	5,548
Rural Gaza and Inhambane	8,215	8,377	4,971
Urban Gaza and Inhambane	8,037	7,802	5,714
Rural Maputo Province	6,790	6,894	5,418
Urban Maputo Province	6,717	7,201	6,047
Maputo City	7,814	6,576	6,192
Rural mean	5,111	4,979	3,702
Urban mean	6,254	6,000	5,253
National mean	5,344	5,187	4,018

There are good reasons for this. Imposing a uniform national bundle across regions leads to a basket that does not minimize consumer costs for a given level of utility. However, it is crucial that the estimated differences in the cost of the regional bundles (when moving from one aggregation level to another) are due only to substitution effects. Otherwise, the multiple bundle approach will be inconsistent. By and large, this does not appear to be the case in any problematic way when moving from the CBN-1 to the CBN-13 approach. The estimated CBN-13 poverty lines correspond quite well with known “stylized fact” about the Mozambican economy. Maputo City has relatively high

costs of living, and the same goes for other urban as compared to rural areas. Nevertheless, there are relatively modest increases in two urban food poverty lines when moving from CBN-1 to CBN-13, caused by a higher prevalence of relatively expensive calories in the regional food bundles. This may be at odds with the requirement that welfare remains comparable, and is a warning that inconsistency cannot be completely ruled out. This potential problem is more pronounced when moving from the CBN-1 to the CBN-2 approach, where food poverty lines increase in 6 out of 13 cases.

The total poverty lines for all six estimation methods are presented in Table 5. With the same two exceptions as before, the regional CBN-1 total poverty lines are

Table 5—Food energy intake (FEI) and cost of basic needs (CBN) total poverty lines

	Meticais per person per day					
	FEI-1	**FEI-2**	**FEI-13**	**CBN-1**	**CBN-2**	**CBN-13**
Rural Niassa and Cabo Delgado	4,253	3,693	3,078	5,807	5,442	4,023
Urban Niassa and Cabo Delgado	4,253	7,439	4,648	10,051	9,138	5,434
Rural Nampula	4,253	3,693	2,587	4,785	4,499	3,359
Urban Nampula	4,253	7,439	3,914	5,857	6,481	4,949
Rural Zambézia and Sofala	4,253	3,693	4,071	6,537	6,333	4,854
Urban Zambézia and Sofala	4,253	7,439	6,719	6,954	7,159	7,600
Rural Tete and Manica	4,253	3,693	3,506	4,819	4,500	4,713
Urban Tete and Manica	4,253	7,439	6,541	6,670	7,225	7,414
Rural Gaza and Inhambane	4,253	3,693	5,342	10,808	11,025	6,433
Urban Gaza and Inhambane	4,253	7,439	9,606	11,175	10,925	7,827
Rural Maputo Province	4,253	3,693	6,491	9,211	9,375	7,316
Urban Maputo Province	4,253	7,439	8,275	9,545	10,215	8,714
Maputo City	4,253	7,439	10,570	11,032	9,145	8,541
Rural mean	4,253	3,693	3,847	6,595	6,413	4,759
Urban mean	4,253	7,439	7,526	8,799	8,403	7,297
National mean	4,253	4,455	4,595	7,043	6,818	5,276

higher than the corresponding CBN-13 regional poverty lines. Poverty lines also appear to increase from north to south and rural to urban regions in a reasonable way. Food is normally more expensive in urban as compared to rural areas due to marketing costs, and the same goes for food that moves from north to south. The cost of nonfood basic needs is also greater in urban areas, and the nonfood budget share of the relatively poor is substantially higher in the towns. This rural/urban difference in living costs is not captured well in the FEI approach. Under FEI-1 the same poverty line is implausibly imposed in both rural and urban areas. Under FEI-2 and FEI-13, the rural/urban differentiation in poverty lines expands so that, on average, the urban lines become 99 percent and 93 percent higher, respectively, than the rural. This degree of differentiation is equally questionable. From the CBN poverty lines, the implied differences in the average urban costs of living, relative to rural, are 33, 31, and 53 percent, all of which would appear to be inside the plausible range.

POVERTY ESTIMATES AND COMPARISONS

National-level estimates of the poverty headcount, poverty gap, and squared poverty gap are presented in Table 6 for each of the poverty lines. Poverty is high in Mozambique, ranging from 58 to 82 percent of the population. CBN-1 produces the highest poverty levels, while FEI-2 and FEI-13 yield the lowest headcounts. Similar observations apply to the depth and severity of poverty. In Table 7, the poverty measures are shown for each set of poverty lines, disaggregated by urban and rural area of

Table 6—National-level poverty estimates under different poverty lines

	FEI-1	FEI-2	FEI-13	CBN-1	CBN-2	CBN-13
Headcount (P_0)	0.596	0.581	0.589	0.820	0.802	0.694
	(0.014)	(0.013)	(0.013)	(0.009)	(0.009)	(0.011)
Poverty gap (P_1)	0.239	0.227	0.223	0.410	0.395	0.293
	(0.008)	(0.008)	(0.007)	(0.008)	(0.008)	(0.008)
Squared poverty gap (P_2)	0.124	0.118	0.111	0.245	0.234	0.156
	(0.005)	(0.006)	(0.005)	(0.006)	(0.006)	(0.006)

Notes: Standard errors in parentheses, adjusted for stratified cluster sample design.

residence. Results are clearly not robust to the choice of poverty line approach. All of the CBN estimates indicate that the incidence, depth, and severity of poverty are greater in rural than in urban areas, and this is statistically significant. Based on FEI-1, we reach the same conclusion, but rural/urban differences in poverty appear to be much larger. Yet, FEI-2 and FEI-13 reverse the ranking, and indicate significantly higher urban than rural

Table 7—Rural/urban poverty estimates under different poverty lines

	FEI-1	FEI-2	FEI-13	CBN-1	CBN-2	CBN-13
Rural headcount (P_0)	0.660	0.575	0.579	0.852	0.835	0.712
	(0.013)	(0.014)	(0.015)	(0.008)	(0.009)	(0.012)
Urban headcount (P_0)	0.345	0.605	0.630	0.697	0.672	0.620
	(0.035)	(0.029)	(0.025)	(0.024)	(0.024)	(0.027)
Rural poverty gap (P_1)	0.266	0.212	0.213	0.430	0.414	0.299
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Urban poverty gap (P_1)	0.134	0.284	0.260	0.331	0.319	0.267
	(0.019)	(0.023)	(0.017)	(0.019)	(0.020)	(0.018)
Rural P_2	0.138	0.104	0.105	0.258	0.246	0.159
	(0.006)	(0.005)	(0.005)	(0.007)	(0.007)	(0.006)
Urban P_2	0.071	0.170	0.137	0.194	0.189	0.146
	(0.013)	(0.018)	(0.013)	(0.015)	(0.016)	(0.014)

Notes: Standard errors in parentheses, adjusted for stratified cluster sample design.

poverty. The lack of robustness of FEI to the choice of the number of subgroups is striking.

Policy discussions and regional comparisons in Mozambique often focus on disparities and asymmetries among the southern, central, and northern regions. In Table 8, we show poverty estimates for these three regions and Maputo City, using the six different analytical approaches. Remarkable differences in the regional rankings emerge. FEI-1 and FEI-2 show poverty to be clearly falling by all three measures as one moves from north to south, whereas FEI-13 shows the opposite pattern. In Maputo City, FEI-13 finds poverty to be above average, while FEI-1 indicates that the Maputo headcount is only a sixth of the national headcount, with similar results for the depth and severity of poverty. Broadly speaking, all the CBN results agree that poverty is more or less uniformly high outside the capital city, and agree that poverty in Maputo is substantially lower than the rest of the country. The CBN-1 and CBN-2 poverty lines indicate that there is no statistically significant difference between the north and central regions for any of the three poverty measures, while the south (excluding Maputo City) is significantly poorer according to all three measures. In contrast, CBN-13 indicates no significant differences between the south and either of the other two regions, but shows the central to be significantly poorer than the north on all three measures.

Table 8—Regional poverty estimates under different poverty lines

	FEI-1	FEI-2	FEI-13	CBN-1	CBN-2	CBN-13
			Headcount (P_0)			
North	0.728	0.685	0.497	0.835	0.809	0.663
	(0.019)	(0.021)	(0.025)	(0.013)	(0.015)	(0.023)
Central	0.644	0.604	0.633	0.822	0.810	0.738
	(0.019)	(0.020)	(0.020)	(0.015)	(0.015)	(0.016)
South	0.417	0.409	0.640	0.850	0.858	0.717
	(0.030)	(0.025)	(0.023)	(0.022)	(0.017)	(0.024)
Maputo	0.107	0.393	0.622	0.645	0.529	0.478
	(0.018)	(0.043)	(0.038)	(0.033)	(0.043)	(0.041)
			Poverty gap (P_1)			
North	0.310	0.297	0.175	0.413	0.392	0.266
	(0.014)	(0.017)	(0.013)	(0.014)	(0.015)	(0.015)
Central	0.261	0.233	0.246	0.403	0.390	0.327
	(0.012)	(0.011)	(0.011)	(0.011)	(0.011)	(0.012)
South	0.134	0.124	0.248	0.472	0.479	0.302
	(0.012)	(0.011)	(0.015)	(0.020)	(0.019)	(0.016)
	0.030	0.124	0.240	0.256	0.187	0.165
	(0.008)	(0.017)	(0.023)	(0.024)	(0.021)	(0.020)
			Squared poverty gap (P_2)			
North	0.166	0.166	0.083	0.243	0.228	0.139
	(0.011)	(0.013)	(0.009)	(0.012)	(0.012)	(0.011)
Central	0.137	0.118	0.126	0.239	0.228	0.180
	(0.008)	(0.008)	(0.008)	(0.009)	(0.009)	(0.009)
South	0.058	0.053	0.124	0.298	0.305	0.159
	(0.007)	(0.006)	(0.010)	(0.016)	(0.016)	(0.011)
Maputo	0.014	0.056	0.121	0.132	0.090	0.077
	(0.006)	(0.010)	(0.015)	(0.016)	(0.013)	(0.012)

Notes: Standard errors in parentheses, adjusted for stratified cluster sample design.

Thus, geographic guidelines for targeting poverty alleviation are not robust to method.[17] This is particularly true for all of the FEI lines. Within the CBN family of

[17] The same holds true when analysis is carried out at the provincial level, where several statistically significant rerankings occur.

poverty lines, the results are considerably more robust, albeit with some reranking of regions depending upon the number of basic needs food bundles considered. In addition, the changes in ordinal rankings that occur under the CBN lines should be kept in perspective. For example, although the CBN-13 headcount index is significantly higher in the central than in the north, the difference between 74 and 66 percent may not matter much in practice, since poverty is extremely high all over the country. No doubt, the *how* of poverty alleviation is sometimes more important than the *where* to policymakers. However, these results demonstrate the intricacies involved in pursuing regional targeting.

COMPARISON WITH OTHER WELFARE INDICATORS

Given the wide dispersion in geographical poverty rankings, analysts and policymakers would be hard pressed to suggest methodologically robust allocation criteria. We therefore complemented our analysis of regional poverty estimates with nonmonetary welfare indicators. In Table 9, the Pearson correlation coefficients between the provincial headcounts from each of the poverty lines and provincially disaggregated nonconsumption-based indicators of welfare are shown.[18] Nonmonetary indicators available at the provincial level include infant and child mortality rates, life expectancy at

[18] Because of the nature of the data, these comparisons are made using aggregated data for the 10 provinces of Mozambique plus the city of Maputo, comparing provincial-level measures. As the sample size is only 11, statistical significance is not achieved easily.

Table 9—Pearson correlation coefficients of provincial-level poverty headcount index and nonconsumption-based measures of well-being

	FEI-1	FEI-2	FEI-13	CBN-1	CBN-2	CBN-13
Child mortality rate (Census)	0.69	0.40	-0.38	0.40	0.42	0.13
Child mortality rate (DHS)	0.60	0.62	0.00	0.21	0.18	0.34
Stunting (IAF)	0.32	0.04	-0.16	0.19	0.25	0.12
Female illiteracy (Census)	0.84	0.55	-0.27	0.49	0.53	0.35
Female illiteracy (IAF)	0.81	0.52	-0.24	0.49	0.58	0.39
Male illiteracy (Census)	0.76	0.48	-0.44	0.42	0.43	0.17
Male illiteracy (IAF)	0.78	0.48	-0.31	0.51	0.55	0.32
Total illiteracy (Census)	0.80	0.50	-0.34	0.48	0.51	0.29
Infant mortality rate (Census)	0.68	0.40	-0.35	0.41	0.43	0.14
Life expectancy (Census)	-0.71	-0.39	0.31	-0.44	-0.50	-0.25
Infant mortality rate (DHS)	0.84	0.76	0.10	0.66	0.63	0.54
Potable water (Census)	0.72	0.38	-0.18	0.53	0.59	0.42
Potable water (IAF)	0.66	0.34	0.01	0.55	0.67	0.53
HDI (1998)	-0.73	-0.39	0.30	-0.57	-0.62	-0.29
HPI (1997)	0.77	0.47	-0.37	0.41	0.43	0.24

* = significant at 5 percent level.

birth, illiteracy rates, potable water access, stunting prevalence for children under-five years, the United Nations Development Programme's (UNDP) Human Development Index (HDI) and Human Poverty Index (HPI). We do not see these indicators as superior welfare measures, and they should not supersede poverty analysis. Many of the nonmonetary welfare indicators reflect the consequences of past deprivation, whereas we are concerned here with current consumption. However, taken together, an interesting comparative reference point emerges.

In particular, there is a striking degree of consistency in the way correlations between poverty measures and the nonconsumption-based indicators are able to order the

results of the different poverty line methodologies. FEI-13 stands out with signs that are opposite to our expectations for most of the 15 measures considered. However, all of the other pair-wise correlations show the expected signs. The highest correlations occur under FEI-1, most of which are statistically significant at the 5 percent level. FEI-2, CBN-1, and CBN-2 show very substantial correlation with the nonmonetary welfare indicators, but only a few of these are statistically significant. Correlations of the CBN-13 measures are somewhat lower, and none are significant at the 5 percent level.

Although useful, correlations of provincial-level data on poverty headcount, literacy rates, infant mortality rates, and so forth obscure the underlying distributions. It is therefore possibly more instructive to analyze how the different poverty estimates are correlated with key health outcomes at the level of individual children. In Table 10, the Pearson correlation coefficients for the three main P_a poverty measures and anthropometric Z-scores for children in the IAF sample below five years of age are shown. The table shows results for height-for-age, a measure of long-term nutritional status. Both FEI-2 and FEI-13 have unexpected positive correlations between poverty and the height-for-age Z-score. On the other hand, FEI-1, CBN-1, and CBN-2 have sizeable correlations with height-for-age Z-score, with the direction of the correlation as expected. CBN-13 has close to zero correlation with height-for-age Z-scores.

The high FEI-1 correlations with nonmonetary indicators are striking. It might therefore be tempting to discard FEI-2 and FEI-13 on the above basis. However, it is well documented in Mozambique that food is more expensive in urban than in rural areas.

Table 10—Correlation coefficients of individual-level child anthropometric *Z*-scores with household-level poverty measures

	P_0	P_1	P_2
FEI-1	-0.045*	-0.049*	-0.034*
FEI-2	-0.007	0.006	0.017
FEI-13	0.003	0.012	0.013
CBN-1	-0.086*	-0.026	-0.011
CBN-2	-0.079*	-0.022	-0.006
CBN-13	-0.002	-0.009	-0.008

* = Significant at 5 percent level.

Moreover, the FEI-1 correlation with nonmonetary indicators may, in large part, be explained by remoteness. Under FEI-1 the poorest provinces are in the north and central regions. Many of these areas are agriculturally productive but are not served well by infrastructure. Hence, food prices tend to be lower than in the south, due to the relatively large extent of home consumption in the north. The southern provinces therefore have relatively higher poverty lines and poverty incidence under the CBN approach, which is sensitive to these price differentials. Yet, many social services are more developed in the south, resulting in relatively better performance on health and education indicators. Therefore, the common factor of remoteness, resulting in poor social services, and low food prices in the food-exporting north, help explain the strong correlations under FEI-1.

6. CHARACTERISTICS OF THE POOR

Apart from the regional incidence and severity of poverty, policymakers are typically interested in the characteristics of poor households, often referred to as a

poverty profile. This provides clues as to the determinants of poverty and is useful in design of poverty alleviation policies and programs based on household targeting, as opposed to regional targeting.

We investigated how a number of key characteristics and variables vary between the poor and nonpoor for each of the six methods. For reasons of space, the tables are not included here.[19] The conclusion was that the characteristics of the poor only depend to a very limited extent on the method used for setting the poverty line. Thus, it was found that larger households are more likely to be poor regardless of poverty line, even after controlling for economies of household size. Female-headed households are, on average, more likely to be poor than male-headed households in urban areas, and less poor than male-headed households in rural areas, again regardless of method. Poor families have higher dependency ratios and own less land under all six sets of poverty lines. Measures of human capital display a large gap between urban and rural sectors and a smaller gap between the poor and the nonpoor. That is, literacy rates, the likelihood of ever having attended school, and children's current school enrollment are higher among the urban and the nonpoor than among the rural and poor. Although estimates of the size of the poor/nonpoor gaps vary, these tendencies hold for each of the lines. For health variables, it was found that the poor and the rural children are less likely to receive a full set of vaccinations, and more likely to be stunted (low height-for-age). The incidence of low

[19] The poverty profile tables are available in a research report to the African Economic Research Consortium (Dava et al. 2000).

birthweight is not highly correlated with poverty status according to most of the poverty lines.

In sum, poverty profile comparisons of household characteristics appear to be much more robust to choice of poverty line approach than geographical poverty comparisons. The poor, on average, have larger families, higher dependency ratios, less land, less education, worse health, and often benefit less from public services. This is an important finding, because it implies that all approaches would point to the same proxy means indicators for poverty, and hence that targeting on household characteristics is much more robust than regional targeting.

7. ASSESSING THE EVIDENCE

The FEI approach does not perform well in the comparisons undertaken in this paper. In contrast, none of the CBN versions applied here generated results that could be dismissed on a priori grounds. Yet, this immediately leads to more questions. First, which version of CBN should be used: fixed or multiple bundles? Second, if one decides in favor of multiple bundles, what is the optimal number of subgroups over which the food bundles should be allowed to vary? Third, and more fundamentally, how robust is a poverty profile based on CBN to choices regarding subgroups?

Starting with the last question, Section 6 showed that conclusions regarding characteristics of the poor are robust to choice of method. How robust are provincial poverty profiles? In Table 11, the Spearman rank correlations between provincial

headcounts are shown. An asterisk means that the hypothesis of different rank is rejected at the 5 percent level of significance. The CBN provincial ranks are highly correlated with each other, and for all, the hypothesis of different ranks is rejected. We conclude that, for these data, CBN poverty profiles are relatively robust to choice of subgroups. It also appears from the table that the FEI profiles are not robust—the provincial ranks under FEI-13 are significantly different from the other FEI results. The rank correlations between the FEI and the CBN results are all positive but not very large, and only two (CBN-1 with FEI-1 and FEI-2) out of nine rank correlations are significant, i.e., we cannot reject the null hypothesis that the rankings are different.

Table 11—Spearman rank correlation coefficients between provincial headcounts

	FEI-1	**FEI-2**	**FEI-13**	**CBN-1**	**CBN-2**	**CBN-13**
FEI-1	1					
FEI-2	0.910*	1				
FEI-13	0.100	0.336	1			
CBN-1	0.482	0.464	0.409	1		
CBN-2	0.373	0.327	0.409	0.964*	1	
CBN-13	0.646*	0.709*	0.664	0.782*	0.782*	1

Note: * Test of different rank correlations can be rejected at 5 percent level of significance.

To assess the optimal number of subgroups under CBN, one needs to consider carefully the food bundles used in the CBN-1, CBN-2, and CBN-13 poverty lines. Most important, it should be verified that the CBN multiple bundles represent comparable standards of living, and that the food bundles underlying the CBN-2 and CBN-13 poverty lines are not contaminated by differences in real income. Tables 12 and 13 show the

composition of the food bundles in the food poverty lines. Although in all cases the majority of calories are derived from the basic staples—maize, cassava, and rice, there are substantial movements in the composition of the bundles. Large substitution is especially observed between maize and cassava. Yet it does not seem to be the case that any one of the bundles dominates in the sense that most Mozambicans would agree that it is superior. One can, for example, compare the rural and the urban CBN-2 bundles. Maize and cassava dominate in the rural diet, while the urban bundle also has substantial rice, bread, and sugar; this pattern is even more pronounced in the southern urban bundles in CBN-13. The urban bundle does appear somewhat more diversified. Yet, the rural bundle actually has a little more of superior foods such as fish, meat, and groundnuts.

To what extent are movements in food bundle composition caused by regionally varying relative prices? Most CBN analyses do not address the question of substitution and relative price differences, the notable exceptions being Lanjouw (1994) and Ravallion and Sen (1996). In Tables 14 and 15, the changes taking place between CBN-13 and CBN-1 in the rural and urban food poverty lines, respectively, are decomposed and shown for each region. The tables are confined to the most important products. The tables show how quantity and price changes result in increases and decreases in outlays on each product in the CBN-13 food poverty lines (relative to CBN-1). The net effect of each product's implied change in outlay is its contribution to the difference between the CBN-1 and the CBN-13 food poverty line. There are more negative changes in outlay (i.e., lower outlay in regional than in national bundle) because the food poverty lines tend to be lower under CBN-13.

Table 12—Calorie shares, by subgroups, rural

	Poverty line method and spatial domain							
	CBN-1	CBN-2	CBN-13	CBN-13	CBN-13	CBN-13	CBN-13	CBN-13
Product	National	All rural	Niassa and Cabo Delgado	Nampula	Sofala and Zambézia	Manica and Tete	Gaza and Inhambane	Maputo Province
Bread	2.7	0.7	0.1	0.4	0.1	0.2	0.7	3.9
Rice	8.4	5.2	7.2	4.0	8.3	0.5	5.4	5.2
Maize and maize flour	29.8	32.7	37.7	14.1	34.6	49.2	32.3	30.2
Fish and meat	5.8	6.0	4.0	10.6	11.9	4.0	0.8	1.8
Cooking oil	2.2	0.7	0.1	0.8	0.5	1.1	0.7	1.0
Greens and vegetables	1.9	2.1	1.2	0.3	1.2	4.0	2.2	3.1
Coconut	3.2	2.8	0.7	0.4	5.3	0.0	3.7	0.8
Groundnuts	5.7	5.9	15.1	2.7	1.0	3.6	5.4	17.3
Beans	4.2	4.1	5.1	2.3	3.9	4.5	4.9	2.2
Sweet potatoes	1.5	1.6	0.5	0.3	0.1	3.5	1.2	8.7
Cassava	12.2	15.8	12.9	38.4	20.2	0.8	20.7	5.6
Sugar	2.8	1.2	0.4	0.9	0.7	1.2	2.3	1.3
Other foods[a]	19.7	21.0	14.8	25.0	12.1	27.3	19.8	19.0
Sum	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[a] Other foods comprise more than 100 different categories, not included in the CBN-1 and CBN-2 bundles.

Table 13—Calorie shares, by subgroup, urban

	Poverty line method and spatial domain								
	CBN-1	CBN-2	CBN-13	CBN-13	CBN-13	CBN-13	CBN-13	CBN-13	CBN-13
Product		All urban	Niassa and Cabo Delgado	Nampula	Sofala and Zambézia	Manica and Tete	Gaza and Inhambane	Maputo Province	Maputo City
Bread	2.7	7.2	1.7	2.1	7.1	2.4	3.5	8.0	9.0
Rice	8.4	15.5	4.6	5.6	14.3	6.7	15.8	26.1	19.8
Maize and maize flour	29.8	23.0	56.0	29.2	34.8	46.0	23.5	3.6	8.8
Fish and meat	5.8	5.1	2.8	16.0	5.4	6.7	1.9	3.0	2.2
Cooking oil	2.2	5.4	2.3	1.3	5.8	5.1	2.9	1.2	6.6
Greens and vegetables	1.9	1.3	0.4	1.1	0.7	2.1	0.5	3.1	1.1
Coconut	3.2	4.0	0.6	0.3	8.7	0.2	11.3	1.9	2.7
Groundnuts	5.7	5.1	4.0	3.3	2.3	2.1	8.3	7.8	5.1
Beans	4.2	4.4	7.1	4.7	2.3	8.6	1.4	5.5	3.0
Sweet potatoes	1.5	1.3	0.4	0.2	4.4	1.5	0.9	0.1	0.3
Cassava	12.2	3.8	1.2	28.5	1.8	1.0	2.2	1.8	1.4
Sugar	2.8	6.6	4.0	3.1	5.6	5.4	7.4	17.4	5.1
Other foods[a]	19.7	17.3	15.0	4.4	6.6	12.2	20.5	20.4	34.9
Sum	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[a] Other foods comprise more than 100 different categories, not included in the CBN-1 and CBN-2 bundles.

Table 14—Decomposition of the change in rural food poverty lines

Domain	Unit	Product								
		Bread	Rice	Maize	Maize flour	Dried fish	Cooking oil	Cassava	Cassava flour	Sugar
CBN(1) Fixed national bundle										
Calories in bundle	kcal	58	180	172	464	84	46	131	131	61
CBN(13)										
Niassa and Cabo Delgado										
Calories in bundle	kcal	3	156	65	742	55	2	59	220	9
Cost per calorie	MT/kcal	5.76	1.52	1.51	0.85	1.96	3.58	1.39	1.62	2.72
Implied change in outlay	MT	-318	-37	-162	237	-56	-159	-100	144	-140
Nampula										
Calories in bundle	kcal	9	86	17	288	193	18	95	736	19
Cost per calorie	MT/kcal	4.60	2.13	0.96	0.94	1.43	1.82	1.29	0.64	1.98
Implied change in outlay	MT	-226	-201	-149	-166	156	-52	-46	387	-83
Sofala and ZambJzia										
Calories in bundle	kcal	3	181	33	711	219	11	85	354	15
Cost per calorie	MT/kcal	3.29	1.43	0.97	0.88	1.18	3.12	1.16	1.20	2.11
Implied change in outlay	MT	-183	2	-134	218	160	-111	-53	267	-97
Manica and Tete										
Calories in bundle	kcal	5	10	529	503	44	22	15	1	25
Cost per calorie	MT/kcal	3.45	2.65	0.65	0.96	2.95	3.66	1.66	0.78	2.54
Implied change in outlay	MT	-185	-449	233	37	-118	-89	-192	-101	-89
Gaza and Inhambane										
Calories in bundle	kcal	15	115	326	366	1	14	432	10	49
Cost per calorie	MT/kcal	8.98	2.02	0.92	1.81	3.00	2.59	1.41	9.45	2.17
Implied change in outlay	MT	-391	-131	141	-177	-250	-83	425	-1,144	-26
Maputo Province										
Calories in bundle	kcal	83	110	466	174	2	21	110	8	27
Cost per calorie	MT/kcal	3.59	1.95	1.10	1.48	8.93	3.36	3.79	3.05	2.20
Implied change in outlay	MT	88	-136	324	-430	-733	-85	-78	-377	-73

Many instances of substitution are evident among the basic staples, maize, maize flour, cassava, and cassava flour in response to local variations in the price per calorie of these foods. In almost all cases, CBN-13 is associated with a significant shift to a cheaper source of calories, such as maize to cassava in rural and urban Nampula, or cassava to

Table 15—Decomposition of the change in urban food poverty lines

		Product								
Domain	**Unit**	**Bread**	**Rice**	**Maize**	**Maize flour**	**Dried fish**	**Cooking oil**	**Cassava**	**Cassava flour**	**Sugar**
CBN(1) Fixed national bundle										
Calories in bundle	kcal	58	180	172	464	84	46	131	131	61
CBN(13)										
Niassa and Cabo Delgado										
Calories in bundle	kcal	36	98	104	1,084	38	48	20	6	84
Cost per calorie	MT/kcal	5.76	1.87	1.65	0.70	4.39	2.76	2.88	0.91	1.89
Implied change in outlay	MT	-126	-152	-113	433	-200	5	-320	-114	45
Nampula										
Calories in bundle	kcal	45	121	64	554	280	27	316	294	67
Cost per calorie	MT/kcal	3.89	1.47	1.58	1.17	0.97	1.82	1.05	0.95	1.59
Implied change in outlay	MT	-51	-88	-170	105	190	-36	195	156	10
Sofala and ZambJzia										
Calories in bundle	kcal	155	311	102	653	66	127	25	14	122
Cost per calorie	MT/kcal	2.50	1.62	1.85	0.99	1.71	2.67	1.21	2.17	1.75
Implied change in outlay	MT	242	212	-130	188	-29	215	-129	-256	107
Manica and Tete										
Calories in bundle	kcal	53	145	184	784	112	111	21	1	116
Cost per calorie	MT/kcal	5.05	2.02	1.23	1.03	2.34	2.90	1.39	1.13	1.86
Implied change in outlay	MT	-28	-71	15	329	67	188	-153	-147	104
Gaza and Inhambane										
Calories in bundle	kcal	75	342	161	349	5	63	23	24	161
Cost per calorie	MT/kcal	12.90	1.44	0.90	1.09	3.00	2.11	3.74	4.04	1.65
Implied change in outlay	MT	221	234	-10	-125	-238	35	-402	-432	165
Maputo Province										
Calories in bundle	kcal	174	566	7	71	11	26	29	10	377
Cost per calorie	MT/kcal	6.64	1.32	1.78	2.18	0.98	7.32	2.86	2.80	1.82
Implied change in outlay	MT	770	509	-293	-856	-71	-152	-290	-340	576
Maputo City										
Calories in bundle	kcal	199	439	89	106	7	146	29	3	113
Cost per calorie	MT/kcal	4.10	1.43	1.09	1.68	2.27	2.12	2.38	2.23	2.11
Implied change in outlay	MT	577	370	-90	-602	-175	211	-242	-286	110

maize in urban Niassa/Cabo Delgado, urban Sofala/Zambézia and rural Maputo Province. This is according to expectations and illustrates the advantage of the multiple-bundle CBN approach in terms of capturing locally relevant demand behavior, i.e., specificity.

Yet, we observe universally higher sugar consumption in urban areas, mostly higher consumption of cooking oil and more bread in the southern cities, despite the fact that these foods do not provide cheap calories. Does this mean that urban bundles are superior? It might, but observed per-calorie unit costs do not fully reflect household specific shadow costs.

The preparation of maize and cassava requires much more time and fuel than other foods. Rural/urban differences in fuel costs and in commuting time between house and place of work may help account for some of that variation. Food eaten away from home is more common among urban occupations, and would by necessity include more bread.[20] Also, cassava has high marketing costs and is not a cheap food in the towns. No systematic pattern in meat and fish consumption between rural and urban areas is observed. In sum, substitution effects in response to relative price differences are important, pointing to a need for regionalized bundles. Careful inspection of the food bundles cannot reveal any clear-cut case where the CBN region-specific food bundles are contaminated by income effects. We conclude that the region-specific CBN approach appears to have the advantage of specificity without suffering from the drawback of inconsistent comparisons.

[20] Abílio Bazo (1998) has shown that bread is an important source of calories, even among the extremely poor in Maputo. Besides convenience and cost of cooking fuel, bread figures prominently in the consumption bundle of the urban poor because it may be purchased in very small quantities that conform to the very low cash flow of this group.

8. CONCLUSIONS

Poverty lines can be set in different ways, and policymakers should be wary of how the underlying poverty measures have been constructed before using the derived poverty profiles to formulate poverty reduction policies. In this paper, we have revisited this debate and based on recent Mozambican data, we have estimated poverty lines and poverty indices using three variants of the FEI and CBN methodologies. Mozambique is a diverse country with wide regional differences, and provides a good context for assessing the importance of these issues. Moreover, in order to test the sensitivity of poverty analysis, care was taken to hold everything else besides the poverty line methodology constant, including the nominal welfare measure (total consumption per capita), the treatment of prices, the subgroups considered, and other factors.

From our paper it emerges that rural/urban and regional poverty comparisons are not robust to choice of approach. Overall, considerable variation that is statistically significant occurs in geographical poverty rankings. Some of this can be explained by the known weaknesses of the FEI method, including the underestimation of urban poverty under a single national poverty line (FEI-1) and the overestimation of urban poverty under the FEI-2 version with separate rural/urban poverty lines. In fact, the FEI lines in our paper reflect urban/rural differences in cost of living and poverty that are implausible. In contrast, a fairly high degree of robustness was found within the various versions of the CBN method considered. None of the CBN versions generated results that could be dismissed on a priori grounds, and none of the various multiple bundles examined appear

to be obviously inferior. The CBN approach therefore seems to generate fairly robust poverty profiles, and in this sense the unresolved issue of which CBN version to choose is less troubling than the weaknesses of FEI. However, while the present analysis provides support for the hypothesis that CBN profiles are relatively more robust than FEI, they are also sensitive to choice of subgroups.

The characteristics of the poor—the correlates or determinants of poverty at the level of the household and the individual—were found to be largely robust to method. For most of the variables considered, poverty line method matters little for conclusions regarding the characteristics of the poor along the lines of standard poverty profiles. This is because the household characteristics of the poor are little related to the systematic regional price variations that drive the geographic differences in poverty lines across poverty line methodologies.

The implication of these findings is that poverty-oriented policy interventions can in principle be targeted toward observable household characteristics related to poverty such as household size, dependency ratio, education, and land, provided cost-effective targeting mechanisms are available. The robustness of geographical targeting based on regional poverty profiles is more questionable, in particular because of the discrepancies between the FEI and CBN methodologies. Finally, it is clear that poverty is a widespread and endemic feature in Mozambique, affecting a broad range of socioeconomic and geographic groups. We would caution that consumption poverty does not capture the full multidimensional character of poverty, especially access to public services, and that it would not be wise to rely in any narrow sense on these estimates in making suggestions

on the allocation of government budgets. Reducing poverty in Mozambique will require both broad-based economic growth and extended reach of public services to underserved groups.

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