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The DHS Wealth Index: Approaches for Rural and Urban Areas

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ABSTRACT

The DHS Wealth Index originally was constructed from existing data on household assets, services, and amenities in order to tabulate health, population, nutrition, education, and other indicators according to economic status. The Wealth Index has proved to be one of the most useful background characteristics available from the Demographic and Health Survey (DHS) data. It is now standard in DHS and UNICEF Multiple Indicator Cluster Survey (MICS) final reports and data sets. However, the Index has been criticized as being too urban in its construction and not able to distinguish the poorest of the poor from other poor households.

This paper examines the extent of these problems and suggests and evaluates several possible remedies for them. One remedy that has already been taken by the DHS is to include questions in the standard questionnaires that have been specifically designed to ascertain rural stores of wealth and to distinguish among the poor. For example, questions have been added on rural stores of wealth, such as size of landholdings and number of farm animals by type. To better distinguish among the poor, the surveys ask about possession of furniture items, such as tables, chairs, and beds, because the extremely poor may not have such items. The lack of windows and the lack of windows with glass panes may also indicate an extremely poor household.

A second remedy that could be applied is the use of urban- and rural-specific indexes, or quintile classifications of a common index. These approaches imply, respectively, the construction of separate indexes for urban and rural areas, or the calculation of wealth quintiles separately by type of area. A third approach would be to more finely divide the national index into deciles (which may distinguish better among the poor). These approaches are applied to

data from the 2003 Bolivia DHS and to the 2007 Zambia DHS (in an appendix), and their advantages and drawbacks are discussed in the text.

A fourth approach is to construct totally separate indexes for each area and then scale them so that a given score on each index means the same level of wealth. The paper describes two methods of combining separate rural and urban indexes. A method based on regression coefficients is demonstrated using data from the Bolivia 2003 and Zambia 2007 DHS surveys and proves the feasibility of basing urban and rural indexes on differing sets of indicator variables and then scaling these indicators so that a composite index can be calculated. This composite index allows comparability between urban and rural areas.

INTRODUCTION

The DHS Wealth Index is widely employed to examine health, population, nutrition, education, and other indicators of societal well-being according to economic status. The World Bank has used the Index for its policy and program recommendations and has recently produced reports that use the Index for each of 52 countries participating in the Demographic and Health Survey (DHS) program [for an overview, see Gwatkin et al. (2007)]. The Wealth Index has been adopted for general use in DHS reports and in UNICEF'S Multiple Indicator Cluster Survey (MICS) reports, as well as for AIDS Indicator Surveys (AIS) and Malaria Indicator Surveys (MIS).

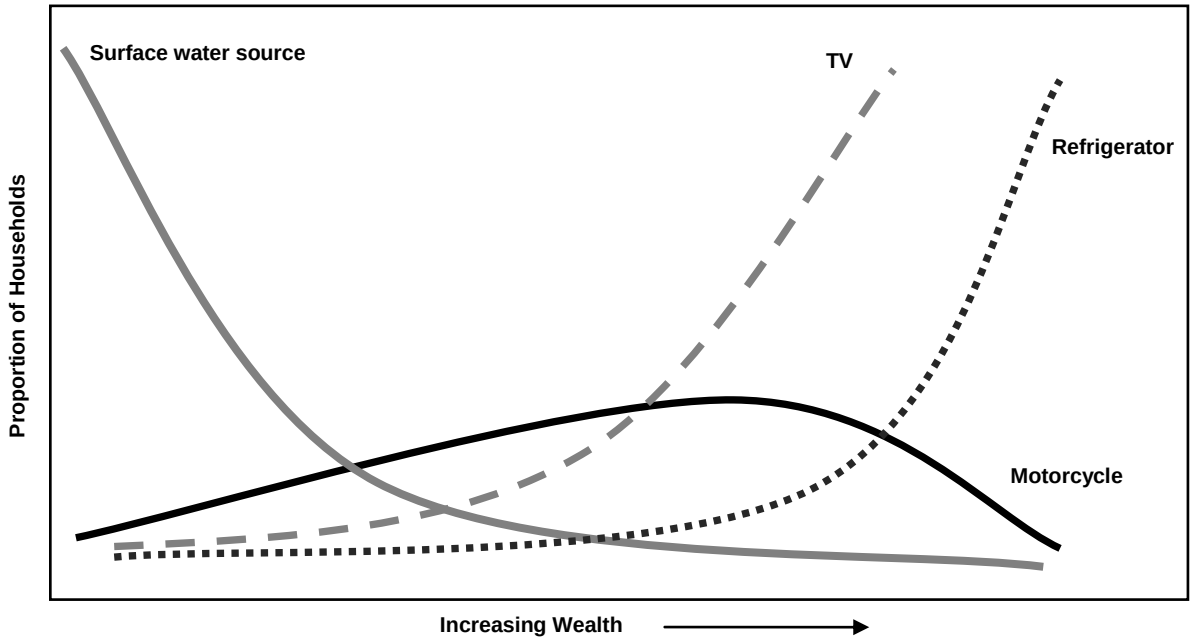
The general methodology used to calculate the Wealth Index is given in Filmer and Pritchett (2001). The specific approach used in the DHS is described in Rutstein and Johnson (2004). Both papers compare the DHS Wealth Index with more traditional indexes of consumer expenditures, concluding that the Wealth Index better represents long-term (permanent) economic status, and also is much easier to implement. Wagstaff and Watanabe (2003) also discuss the choice of socio-economic status in the measurement of health inequality, concluding that an index based on assets performs as well as one based on consumption.

Brief Review of the Theory and Construction of the DHS Wealth Index

The DHS Wealth Index is based on the assumption that an underlying continuum of economic status exists which is related to the wealth of a household. While economic wealth can be objectively measured (net worth equal to the total value of assets less the total value of liabilities), in practice a household's wealth is very difficult to measure directly and would take up most of the available interviewing time in a survey. Moreover, many households may be

reluctant to give the necessary information. A more reasonable approach, especially in surveys where many indicators are collected, is to treat wealth (and economic status) as an underlying unobserved dimension that can be estimated using latent variable techniques such as factor analysis or latent trait analysis. In the DHS, it is assumed that the possession of observable or easily asked about assets, services, and amenities is related to the relative economic position of the household in the country. The assumed relationship is shown in Figure 1 below.

Figure 1. Assumed Distribution of Assets and Services



For example the proportion of households in developing countries with a surface water source (lake, pond, river, stream) is likely to decrease with increasing wealth, and the proportions of households with a TV or a refrigerator is likely to increase with wealth. Having a motorcycle is likely to peak at mid levels of wealth, with poorer households likely to have bicycles only or no vehicles, and wealthier households likely to have cars and trucks.

The original list of assets and services used to calculate the DHS Wealth Index was based on questions already in the household questionnaire for purposes other than determining economic status. For example, type of flooring, type of toilet, and type of water supply were asked because of their relationship with diarrhea. In the latest phase of the MEASURE DHS project, additional questions were added to better represent the wealth of households at both the lower and upper ends of the distribution. Table 1 below presents the list of assets and services currently asked in the standard DHS questionnaires that can be used for calculating the Wealth Index.

Table 1. Assets and Services Usually Asked in DHS Surveys

• Type of Flooring • Type of Roofing • Wall material • Water Supply • Sanitation Facilities • Electricity • Radio • Television • Refrigerator • **Watch** • Type of Vehicle • **At least five items of furniture:** — **Table** — **Chair** — **Sofa** — **Bed** — **Armoire** — **Cabinet**	• Persons per sleeping room • **Ownership of agricultural land and size** • **Ownership of farm animals by type and number** • Domestic servant • Telephone (fixed and mobile) • Cooking fuel • Bank account • **Windows** — **With shutters** — **With glass** — **With screens** — **With curtains** • Appliance items, including at least — **3 that a poor household may have: Clock, water pump, grain grinder, sewing machine,** — 3 that a middle wealth household may have: Fan, blender, water heater, camera, color TV, cassette/CD player, VCR/DVD player — 3 that a rich household may have: **Electric generator**, washing machine, microwave oven, computer, air conditioner

The items in bold have been added to better distinguish the wealth of rural households.

Each of the above categorical items (such as type of water supply) is separated into dichotomous indicator variables (has, does not have), and together with continuous variables (such as number of persons per sleeping room) they are included in a principal components analysis (PCA). The first principal component is taken as the underlying index of wealth, and each household's position on it is calculated using the PCA weights. The PCA procedure produces an index that is "normalized" so that it has a mean value of zero and a standard deviation of one.

A second step is necessary for most uses of the Index: distinguishing the poor from the not poor. Together with analysts from the World Bank, it was decided that dividing the Index into quintiles of the national household population was the most useful grouping for the majority of analyses of health equity.

Concerns

The DHS Wealth Index as currently calculated relates to the national population as a whole. A concern with the originally constituted Index was that it was too "urban" in its construction, depending on asset and services that mainly urban populations would have but that rural populations would not have.

The DHS Wealth Index may have an urban bias since publicly provided services (electricity, piped water, sewers) are not available in many rural areas; some assets depend on having electricity, piped water, etc.; and the original Index did not include principal rural stores of wealth, such as land holdings and animal herds.

Another concern is that DHS Wealth Index does not distinguish the poorest of the poor from other poor households, especially in rural areas. Data from the Bolivia 2003 DHS help

illustrate the problem. The Wealth Index calculated for the whole Bolivia survey is given in Table 2. (Another example is given in the appendix for the 2007 Zambia DHS.)

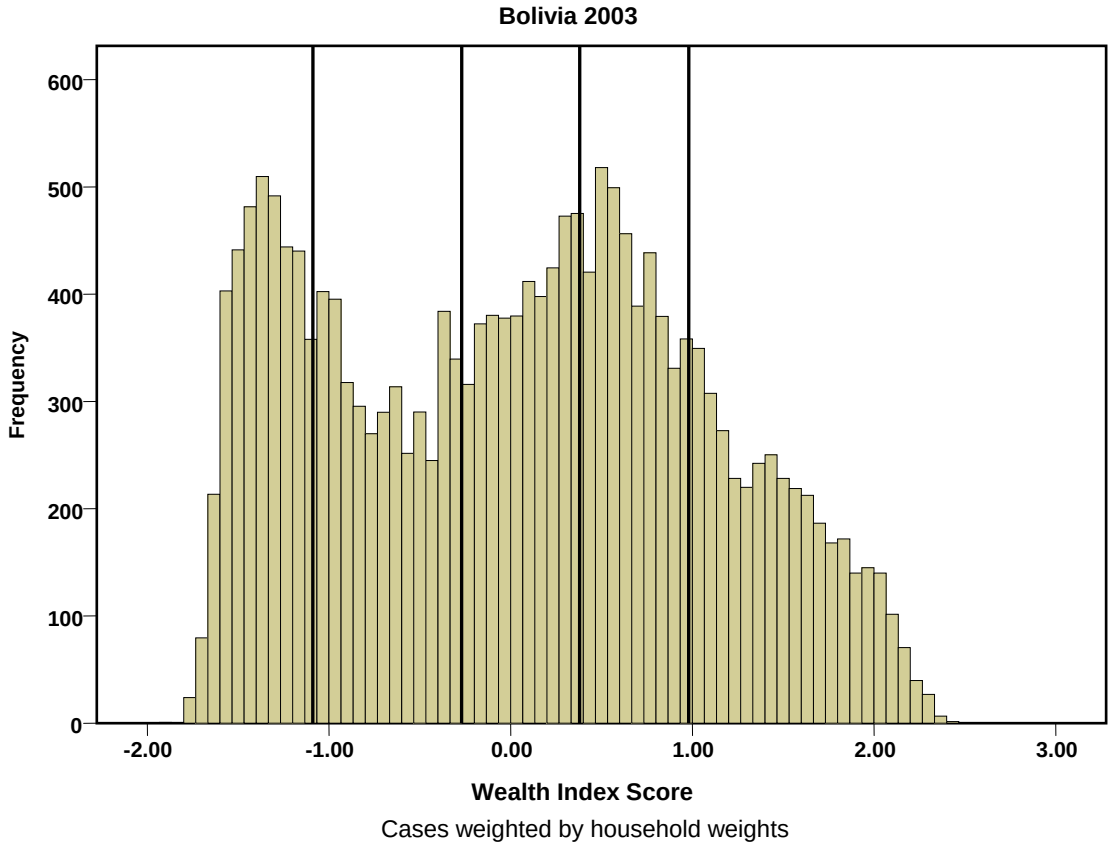
Table 2. Bolivia 2003 National Wealth Index Distribution

• N 19207 • Mean 0.03 • Median 0.08 • Std. Dev. 1.03	• Minimum -1.90 • Maximum +2.43 • Percentiles — 20 -1.08 — 40 -0.27 — 60 +0.38 — 80 +0.98

Table 2 is based on the household population of the survey rather than on households themselves. For that reason, the mean value of the Index is slightly different from exactly zero, and the standard deviation is slightly different from exactly one.

Figure 2 shows the histogram of the Wealth Index scores. It can be clearly seen that the distribution of the Index is bi-modal (i.e. has two major peaks). The vertical black lines indicate the national population quintiles of the distribution.

Figure 2. National Wealth Index Distribution



To see the differences between urban and rural areas, distributions on the national Wealth Index were tabulated for each type of area individually. Tables 3 and 4 and Figures 3 and 4 present these results.

Table 3. Urban Wealth Index Distribution Bolivia 2003

• Urban N 12046 • Mean 0.61 • Median 0.59 • Std. Dev. 0.78	• Minimum -1.74 • Maximum +2.43 • Percentiles — 20 -0.04 — 40 +0.41 — 60 +0.78 — 80 +1.31

Figure 3. Urban Wealth Index Distribution

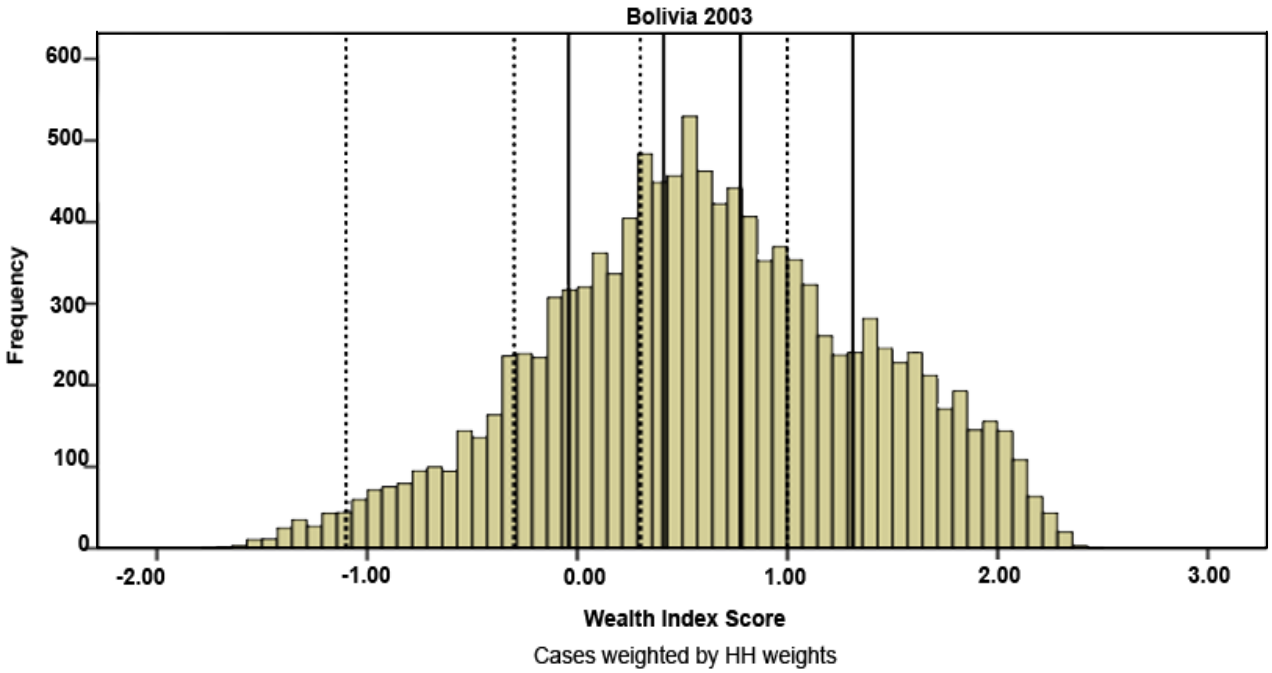
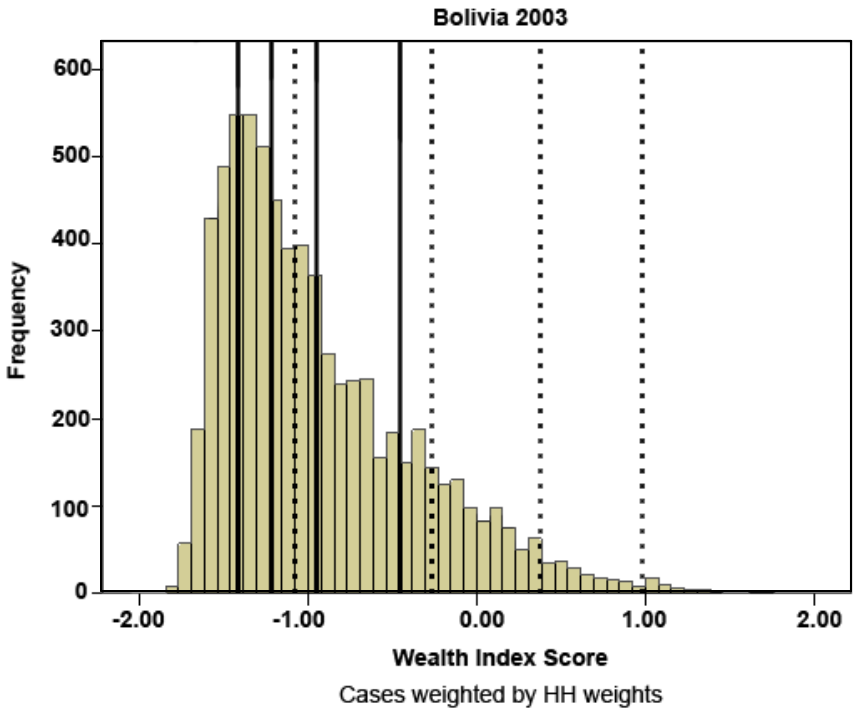


Table 4. Rural Wealth Index Distribution Bolivia 2003

• Rural N 7161 • Mean -0.93 • Median -1.09 • Std. Dev. 0.58	• Minimum -1.90 • Maximum +1.91 • Percentiles — 20 -1.42 — 40 -1.22 — 60 -0.95 — 80 -0.46

Figure 4. Rural Wealth Index Distribution



Several conclusions can be drawn from comparing the urban and rural distributions to the national distribution of the Wealth Index:

1. The bi-modality of the national distribution is due to the combination of the two unimodal distributions of the rural and urban areas.
2. While the urban distribution is approximately normal, the rural distribution is quite skewed to the left, with a heavy concentration in the lower (poorer) end of the Wealth Index.
3. The mean for the urban area is 1.54 units above that of the rural area, indicating that the urban population is far wealthier than the rural.
4. The rural distribution of wealth is more concentrated than the urban distribution, as indicated by their standard deviations (0.58 and 0.78, respectively).

5. The dotted vertical lines in the histograms indicate the national-level quintiles (from poorest on the left to wealthiest on the right). For urban areas, very few people are in the lowest national quintile. In contrast, for rural areas, very few people are in the fourth and highest national quintiles, while the great majority are in the lowest national quintiles.

To begin to address the concern that the rural population is misclassified into the poorer quintiles and that the Index has an inability to distinguish between the poor and extremely poor population, items that were mainly rural and items that not-as-poor families may have were added to the questionnaires, as indicated in Table 1 in bold[1].

Although the information is currently available for many DHS surveys, sizes of landholding and herds have not been used in the construction of the DHS Wealth Index because they are generally not applicable to urban areas.

Approaches to Creating Wealth Indexes for Urban and Rural Areas

Several approaches can be used to create wealth indexes for urban and rural areas. The first two approaches use separate wealth indexes for urban and rural areas, while the third and fourth favor a single index but constructed differently than the current DHS Wealth Index:

1. **Construction of totally separate indexes for the urban area and for the rural area.** This approach allows rural-only and urban-mostly variables to be used in the respective indexes, which is currently hard to do (e.g. in rural areas having chickens

[1] Some researchers have expressed the concern that other forms of wealth, particularly important to the rural population, should also be taken into account. They have in particular mentioned claims on the labor of others (for example, by a village chieftain) and social capital (social wealth), such as the ability to borrow from friends and relatives, which could be drawn upon in times of emergency. For a discussion of the origins and nature of social capital, see Portes (1998) and Halpern (2005). Knack and Keefer (1997) discuss the relevance of the concept of social capital for developing countries. To date, the wealth index does not attempt to incorporate social capital, due to the definitional variations in the concept and the difficulty of simple measurement.

may be positively correlated with wealth but in urban areas be negatively correlated with wealth).

2. **Using the national-level wealth scores as they are currently generated, and then dividing them separately into quintiles in urban and rural areas.** This approach is shown graphically by the solid vertical lines in Figures 3 and 4, which can be compared with the national quintiles shown by the broken vertical lines. Note that in Bolivia there are a large number of rural households (Figure 4) with similar Wealth Index scores, resulting in the narrow bands for the second and third quintiles.
3. **Using nationally determined deciles instead of quintiles to better distinguish among households in each area.** This approach takes the national scores but, rather than dividing them into fifths of the national population, divides them into tenths.
4. **Producing a single national-level composite index from wealth indexes that have been separately constructed for the urban and rural areas.** This approach allows for different sets of assets and services to be used in each area to make best use of the available information.

Figure 5. Rural Wealth Index Score Distribution with National Deciles

Consequences of Using Separate Wealth Indexes for Urban and Rural Areas

The decision whether to use separate wealth indexes for urban and rural areas depends on what is most useful for analysis and for policy. The first two approaches listed above allow for greater distinctions within each area, but at the cost that the indexes for each are not at all comparable. These two approaches could then lead to the anomalous policy of taking public funds from the rural areas with many households in the fourth and highest rural quintiles and allocating those funds to urban areas with households in the first and second urban quintiles. In reality, the households in the lower urban-defined quintiles may be wealthier than households in any of the rural-defined quintiles, since in most developing countries most people in poorer urban areas and slums are better off than most people in rural areas (which is largely why there is net rural-to-

urban migration rather than the reverse). When the DHS Wealth Index was developed with the World Bank, the utility of having separate indexes was discussed, and it was concluded that for most policy decisions a national index is best.

Table 5 compares the results of using nationally calculated and area-specific wealth quintiles on the contraceptive prevalence rate in Bolivia. The first three rows are contraceptive prevalence rates based on the national wealth quintiles. Therefore, within each quintile in the upper panel, urban and rural areas are at approximately the same level of wealth. While there are differences in contraceptive prevalence between the areas at each quintile level, the differences are not large, at most 6 percentage points, even though the prevalence rates for the total urban and rural areas differ by 12 percentage points due to differing distributions of households among the quintiles. Indeed, there are few cases on which to base the estimate of contraceptive prevalence for the highest wealth quintile in the rural areas, as indicated by the parentheses[2].

The rows of the second panel are based on quintiles calculated specifically for each area. In this case the level of wealth represented by each quintile is different for each area, and there is a larger difference between areas within each quintile, from 15 to 18 percentage points. Combining the two areas into a national level (last row) does not correctly reproduce the contraceptive prevalence rates by wealth quintile at the national level, which is given in the first row.

Nevertheless, separately calculated quintiles may be useful for policies and programs that deal separately with either the urban or the rural area, but not with both areas jointly.

[2] Parentheses are placed around any statistic based on 25-49 unweighted cases.

Decile Approach

The national deciles applied to the rural area of Bolivia are shown by the vertical lines in Figure 5. While there is a better distinction made than national quintiles, there are still large concentrations of households in the first and second deciles, limiting the value of just more finely dividing the national wealth index distribution.

Table 5. Bolivia: Contraceptive Prevalence Rate by Type of Wealth Quintile

Bolivia 2003

	Lowest	Second	Third	Fourth	Highest	Total
National Quintiles						
National	42%	54%	58%	65%	71%	58%
Urban	44%	58%	59%	64%	71%	64%
Rural	42%	52%	55%	70%	(68%)	52%
Area-Specific Quintiles						
Urban	57%	60%	65%	67%	71%	64%
Rural	39%	43%	50%	52%	56%	52%
National	50%	54%	60%	62%	66%	58%

A New Approach

The fourth approach listed above is a promising one that uses separate indexes for urban and rural areas. This approach would allow for different variables in each type of area, and then combine them into a single wealth distribution by adjusting each of the scores on one or both of the indexes to make them comparable.

One way of combining wealth indexes used by Ferguson et al. (2003) to make the DHS Wealth Index comparable across countries is based on compound hierarchical ordered probit

regression (CHOPIT) analysis and the Anchors software routines (King et al. 2004; Wand, King and Lau, 2007). Ferguson et al. applied this method using several anchoring variables that are indicator variables for the Wealth Index in the same sense that variables from anchoring vignettes[3] have been used in adjusting the scales for self assessment. For more information on these uses in the World Health Survey, see Ferguson et al (2003) and Tandon et al. (2003).

To use the anchoring methodology for the purpose of combining urban and rural indexes into a single index, work needs to be done to determine which should be the anchoring variables and how to calculate the adjustment factors in the proper way when only two indexes are available for each country, rather than multiple indexes available for cross-country combinations.

Another way of combining the indexes involves constructing three indexes, a national index, an urban-specific index, and a rural-specific index. Then mappings (conversion adjustments) are made between the urban index and the national index, and between the rural index and the national index. This mapping is necessary because not only do the averages of the scores on the indexes (from scores constructed to have their average as zero) represent different levels of wealth, but also the distributions of the scores of the indexes (set so that the standard deviation is one) represent different dispersions of wealth.

Figure 6 shows how the urban and rural indexes need to be mapped onto the national index. For rural areas, the position of the mean needs to be lowered by a value of 0.9. For urban areas, the mean needs to be raised by 0.6. These adjustments are indicated by the dotted vertical lines. To adjust for distributions, each score needs to be multiplied by a given amount so that the

[3] When asked to rate their health on a scale of say one to ten, individuals tend to have differing internal references of what constitutes good health, depending on their personal characteristics, such as age, gender and geographic area. These differing references can mean that persons with the same health conditions rate themselves in good, fair or poor health. To overcome these different reference scales, anchoring vignettes that describe one or more fictional persons with various sets of activity-related health conditions (e.g., can run a marathon, can do a 10k walk, gets winded going up two flights of stairs, etc.) are added to self-rating questions. The scores that are given for the vignettes then provide anchors by which to make comparable the internal reference scales and to adjust the values given in the self-evaluation to a single reference scale.

dispersion of scores in each area is properly mapped into the national index. This calculation can be accomplished by multiplying each score by urban and rural coefficients, indicated by the diagonal broken lines in Figure 6.

The problem then is how to determine the values of the adjustments. The values can be determined by first calculating area-specific and national index scores for each household. Necessarily, the construction of the national index uses the set of indicator variables that the rural and urban areas have in common (and is restricted to those that correlate with wealth in the same direction). Once the household scores have been calculated, the level and distribution adjustment values can be found by regressing the value of each household's area-specific index scores onto its national index score. For the Bolivia DHS 2003 survey, the results are:

Urban: $WSn = 0.609 + 0.761\ WSu \quad R^2 = 0.981$

(0.001) (0.001)

Rural: $WSn = -0.933 + 0.551\ WSr \quad R^2 = 0.908$

(0.002) (0.002)

where WSn, WSu, and WSr are the national, urban-specific, and rural-specific Wealth Index scores, respectively. The numbers in parentheses are the standard errors of the constants and coefficients.

In addition to using linear regression techniques, non-linear techniques were also used to find the best-fitting equations; however, non-linear regressions did not improve the fit.

Finally a composite national index is constructed by using the estimated national wealth scores for the households in each region.

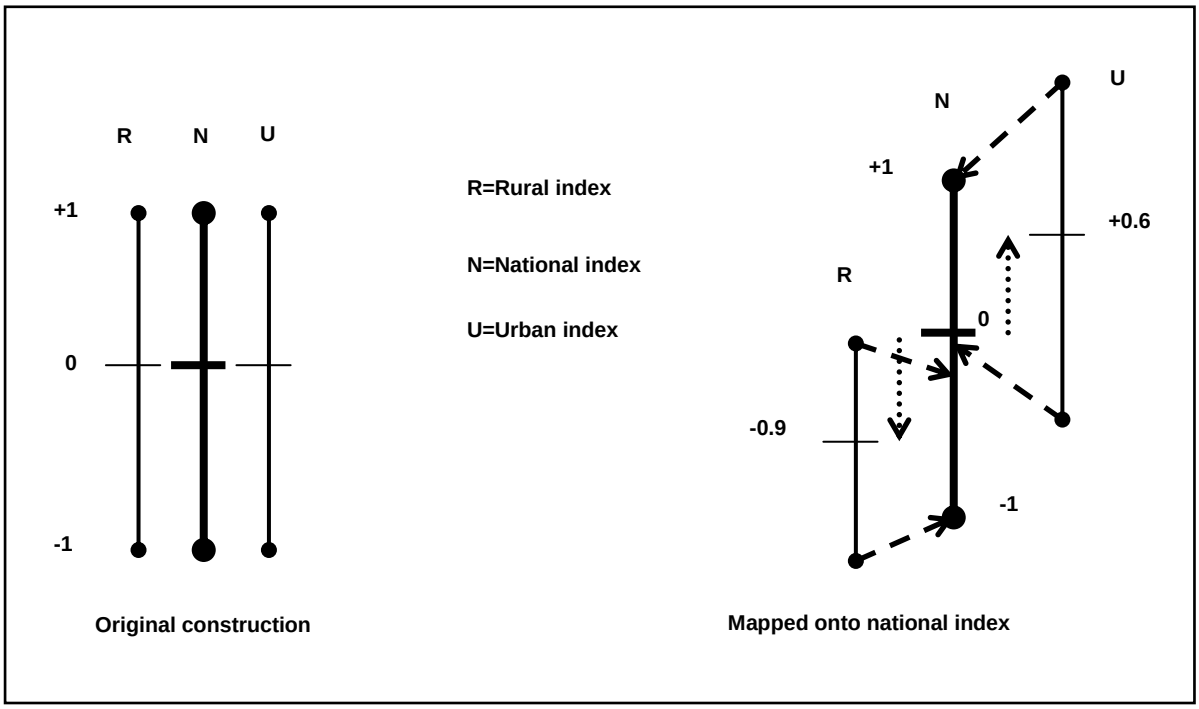
Regressing the composite national index on the original national index gives the following results:

$$WSn = 0.000048 + 1.00\ WSn^* \quad R^2 = 0.982$$

(0.001) (0.001)

where WSn* is the composite national index. This regression indicates that there is no difference in level or dispersion between the composite index and the original one, even though the indexes are based on somewhat different indicator variables.

Figure 6. Mapping of Urban and Rural Indexes onto National Index



SUMMARY AND CONCLUSIONS

The DHS Wealth Index originally was constructed from existing data on household assets, services, and amenities in order to tabulate health, population, nutrition, education, and other indicators according to economic status. It has proved to be one of the most useful background characteristics available from the survey data. However, it has been criticized as being too urban in its construction and not able to distinguish the extremely poor from the poor but not extremely so.

There are several possible remedies for these problems. One that has been adopted is to include questions specifically designed to ascertain rural stores of wealth and to distinguish among the poor. A second is the use of urban- and rural-specific indexes or quintile classifications of a common index. This paper has discussed the consequences and utility of the various approaches to this second remedy, illustrating their advantages and drawbacks.

Two methods of combining separate rural and urban indexes have been described, and one based on regression coefficients has been demonstrated using data from the Bolivia 2003 and Zambia 2007 DHS surveys. The results prove the feasibility of basing urban and rural indexes on differing sets of indicator variables and then scaling these indicators so that a composite index can be calculated. The composite index would then allow comparability between the two areas.

This new approach to calculating the DHS Wealth Index does not invalidate the existing DHS Index; however, it is more precise, opening up the possibility of using urban-only and rural-only indicators of wealth and indicators that perform differently in each area.

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APPENDIX

Example Using 2007 Zambia DHS

Table A1. National Distribution Zambia 2007

• HH pop. 34,981 • Mean 0.04 • Median -0.52 • Std. Dev. 1.06	• Minimum -1.16 • Maximum +2.62 • Percentiles — 20 -0.87 — 40 -0.73 — 60 -0.05 — 80 +1.32

Table A2. Urban Distribution Zambia 2007

• N pop. 12457 • Mean +0.30 • Median +0.26 • Std. Dev. 0.97	• Minimum -1.74 • Maximum +3.42 • Percentiles — 20 -0.62 — 40 -0.07 — 60 +0.66 — 80 +1.26

Table A3. Rural Distribution Zambia 2007

• N pop. 22524 • Mean +0.01 • Median -0.30 • Std. Dev. 0.94	• Minimum -0.78 • Maximum +9.66 • Percentiles — 20 -0.55 — 40 -0.40 — 60 -0.17 — 80 +0.31

Table A4. Zambia Delivery at Home by Type of Quintile

	Lowest	Second	Third	Fourth	Highest	Total
National Index and Quintiles						
National	71%	69%	62%	26%	6%	44%
Urban	*	*	40%	20%	6%	48%
Rural	71%	69%	64%	43%	22%	66%
Area-Specific Indexes and Quintiles						
Urban	32%	13%	12%	8%	3%	15%
Rural	73%	70%	67%	66%	49%	66%
National	58%	51%	49%	48%	36%	41%

* Too few cases to show.

Estimation of the Composite Index

For the 2007 Zambia DHS, the linear regression results estimating the national index from the separate urban and rural indexes are:

Urban: $WSn = 0.672 + 1.024\ WSu \quad R^2 = 0.819$

(0.003) (0.003)

Rural: $WSn = -0.621 + 0.483\ WSr \quad R^2 = 0.840$

(0.001) (0.001)

where WSn, WSu, and WSr are the national, urban-specific and rural-specific Wealth Index scores, respectively. The numbers in parentheses are the standard errors of the constants and coefficients.

In the case of Zambia, quadratic forms of the regressions did improve the fit a little:

Urban: $WSn = 1.155 + 0.773\ WSu - 0.158\ WSu^2 \quad R^2 = 0.862$

(0.003) (0.003) (0.003)

Rural: $WSn = -0.606 + 0.540\ WSr - 0.018\ WSr^2 \quad R^2 = 0.847$

(0.001) (0.002) (0.001)

Two composite national indexes were constructed by using the estimated national wealth scores for the households in each region.

Regressing the composite national index from the linear regressions on the original national index gives the following results:

$WSn = 0.000098 + 1.00\ WSn^* \quad R^2 = 0.948$

(0.001) (0.001)

where WSn* is the composite national index from the linear equations.

Regressing the composite national index scaled using the quadratic regressions on the original national index gives the following results:

$WSn = 0.001 + 1.00\ WSn^{**} \quad R^2 = 0.956$

(0.001) (0.001)

where WSn** is the composite national index from the quadratic equations.

Both of these results indicate that there is no difference in level or dispersion between the composite index and the original one, even though the indexes are based on somewhat different indicator variables. There is little gain to be had in using the quadratic form instead of the linear form.