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MAKING THE DEMOGRAPHIC AND HEALTH SURVEYS WEALTH INDEX COMPARABLE

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Making the Demographic and Health Surveys Wealth Index Comparable

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Preface

The Demographic and Health Surveys (DHS) Program has become one of the principal sources of international data on fertility, family planning, maternal and child health, nutrition, mortality, and HIV/AIDS. The relationship between these indicators and economic status is of utmost importance to researchers and policymakers worldwide.

One of the objectives of The DHS Program is to advance the methodology and procedures used to carry out national-level surveys as well as to offer additional tools for analysis. This will improve the accuracy and depth of information relied on by policymakers and program managers in developing countries.

The topics in the DHS Methodological Reports series are selected by The DHS Program staff in consultation with the U.S. Agency for International Development. While data quality is a main topic of the reports, they also examine issues of sampling, questionnaire comparability, survey procedures, and methodological approaches.

It is hoped that the DHS Methodological Reports series will be useful to researchers, policymakers, and survey specialists, particularly those engaged in work in developing countries.

Sunita Kishor

Director, The DHS Program

Executive Summary

The Demographic and Health Surveys (DHS) and Multiple Indicator Cluster Surveys (MICS) contain a vast amount of information on the health and demographic situation of the populations of less developed countries. The development of the DHS Wealth Index more than a decade ago provided the opportunity to analyze economic differences between households based on indicators of wealth rather than socio-demographic indicators such as education, occupation, residence, and ethnic group. The DHS wealth index is a survey-specific measure of the relative economic status of households based on analysis of household assets and service amenities at a particular point in time. There has been a substantial limitation to comparative and trend analysis because the DHS wealth index is calculated separately for each survey. Each index has a mean value of zero and a standard deviation value of one. Thus, specific scores and quintile values represent different levels of economic status within specific surveys and cannot be directly compared.

In this report we describe an experimental methodology, the Comparative Wealth Index (CWI), for calculating wealth indexes that are comparable across surveys and time and that allow for direct comparison of levels of economic status. The CWI was computed for 172 DHS surveys conducted between 1990 and 2012. Of the 172 surveys, 87 were conducted in sub-Saharan Africa, 21 in North Africa/West Asia/Eastern Europe, 4 in Central Asia, 28 in South and Southeast Asia, and 32 in Latin America and the Caribbean. Calculations of means and standard deviations for each survey, as well as trends and regional averages, show that the experimental CWI is effective in producing aggregate results that tend to comport with per capita income measures for countries and regions.

In the four illustrative analyses undertaken for indicators of child mortality, fertility, maternal health care, and child nutritional status, the Comparative Wealth Index performed well, highlighting the importance of absolute levels of wealth in comparing national survey data—usually more important than relative levels of wealth. At the same time, the Comparative Wealth Index does not replace the original DHS Wealth Index for analysis of issues of poverty because in most of the analyses discussed in this report it was found that both indexes are related to outcome indicators. The importance of a comparative measure of wealth—such as the one described here for trend analysis within and across countries—is its utility as a pragmatic tool for sorting out the effects of health programs from the effects of changes in economic status of the population.

1 Introduction

From the earliest phase of the Demographic and Health Surveys (DHS) project researchers and policymakers were interested in creating a measure of economic status that would be independent of demographic characteristics such as education and residence. Direct estimates of household income and expenditures in the DHS surveys are desirable but not practical. Collection of accurate income or expenditure data in health-related household surveys is hampered by factors such as seasonality, volatility, misreporting, and limited interview time (Deaton, 1997; Montgomery et al., 2000).

At a World Health Organization (WHO) meeting in 1997 on "Health for All by the Year 2000," Rutstein used a previously created index to illustrate that information on differences in health equity can be derived from existing DHS survey data, even when there are no data on income and expenditures. This index was based on assets and household amenities and services that were included in the surveys because of links to health concerns (e.g., the association between diarrhea and dirt flooring, or water supply and type of toilet). The separate items were formed into an index by a weighted sum with an ad hoc weighting scheme in which either a 0-1 coefficient or a simple scale was used (e.g., for vehicles, a value of "0" is assigned for none and a value of "3" is assigned for cars). On this scale, owning a refrigerator counted the same as having electricity. At the same time, Filmer and Pritchett (1999; 2001) at the World Bank were working on a similar index (based on data from DHS surveys) for use in evaluating education by economic status. As a result of the WHO meeting and a subsequent meeting at the World Bank in 1998, the World Bank agreed to fund a project to develop a series of population and health indicators using a wealth index based on 42 existing DHS country datasets (national surveys implemented from 1990 to 1998). The Filmer-Pritchett principal component methodology was used to determine the item weights. Later, the World Bank funded a second project that expanded the list of indicators to include the earlier surveys as well as new surveys through 2001—a total of 75 DHS surveys. Because of the demonstrated utility of the wealth index for researchers and policymakers, the DHS project decided to include the wealth index as a standard recode variable in all DHS survey datasets (Rutstein and Johnson, 2004).

With widespread adoption of the DHS wealth index for analyzing differences in population and health indicators between wealth quintiles, it was suggested that more items be added to the DHS household questionnaire to increase the precision of the index and to correct for a possible urban bias. The items added included more assets, ownership and size of land holdings and farm animals, and lower-end and upper-end possessions and amenities, such as tables, chairs, shelves, windows, windows with glass, any kind of bank account, and computers and internet connections. Later on, separate urban and rural wealth indexes were calculated and then combined into a national wealth index (Rutstein, 2008). This procedure allowed for different weighting of items in the two areas of residence and facilitated urban-specific and rural-specific analyses.

Currently, the DHS Wealth Index is calculated using coefficients and some items (assets, services, amenities) that are specific to urban and rural areas. The procedure involves first calculating a wealth index that uses items thought to be common and to have common weighting in both urban and rural areas. Then residence-specific wealth indexes are calculated for the urban and rural areas. These residence-specific indexes include additional items (beyond those that make up the common wealth index) such as number of farm animals, size of agricultural land, and items not present in both areas, for example, a flush toilet connected to a sewer. The urban and rural wealth indexes are then linearly regressed on the common wealth index. For each area of residence, predicted wealth scores are calculated where the constant term of the regression adjusts the level of each area's index relative to the common and the coefficient adjusts the dispersion in the distribution. The predicted scores for each area of residence are joined to make the combined wealth score at the national level. Quintiles for urban and rural areas and the country as a whole are then calculated using the de jure household populations of the two residential areas, to produce urban,

rural and combined wealth indexes, respectively. Rutstein (2008) provides additional details on current DHS procedures for calculating urban, rural, and total wealth indexes.

1.1 Need for a Comparative Wealth Index

The DHS wealth index remains a survey-specific measure of economic status, i.e., the results are applicable only for a particular country and for a particular survey period in that country—with one exception, Peru.[1] While the DHS wealth index is useful for analyzing differentials in economic status within countries, for the purpose of exploring issues of economic equity and poverty, it should be emphasized that the wealth index is constructed as a relative index within each country at the time of the survey. Each wealth index has a mean value of zero and a standard deviation of one. Thus, specific scores cannot be directly compared across countries or over time. For example, in an extremely poor country a household may be included in the highest wealth quintile but is not necessarily well-off in absolute terms.

Using external information where economic poverty is determined outside the DHS survey, poverty lines based on, for example, current per capita income of less than $2.50 per day (originally $1.00 per day) (Ravallion, Chen, and Sangraula, 2013) or other definitions could be carried into the DHS data sets by determining cutpoints where the percentage of households (or population) ordered by the DHS wealth index is the same as that in the external data. Then households can be assigned to "not poor," "poor" and "extremely poor" categories based on the cutpoints for the wealth index. While this procedure is useful if comparable economic poverty lines exist from external sources, it is somewhat problematic and does not inform the comparability across the rest of the economic status spectrum nor reveal much about trends if the definition of economic poverty has changed over time.

Clearly, there is a need for a DHS Wealth Index that is comparable across countries and time. Ideally, such a Comparative Wealth Index (CWI) would help analysts ascertain the following: 1) whether the economic situation has improved over time, 2) whether improvements in health and other indicators are due to general improvements in economic status or to the effects of government programs focused on the poorer sectors of the population, and 3) whether international funding of health and development programs is reaching the poorer sectors of the population.

The remainder of this section describes alternative measures of economic status at aggregate and individual levels, as background to development of the CWI. Section 2 describes the methodology developed by DHS for computing the CWI. Section 3 presents the results of calculation of CWIs for 172 DHS surveys and compares results with measures of per capita income. Section 4 presents illustrative applications of the CWI procedure to the topics of young child mortality, fertility, maternal health care, and children's nutritional status. Section 5 discusses conclusions about the CWI methodology, its limitations, and prospects for future applications.

[1] The DHS wealth indexes constructed for each of the five survey cycles of the Peru Continuous DHS survey (carried out between 2004 and 2008) were designed to be comparable with the wealth index constructed for the most recent standard DHS survey in that country—the 2000 Peru DHS. The wealth indexes for the survey cycles 2004 through 2008 were made comparable by using the same items as in the 2000 Peru DHS, using the same estimating equation (mean, standard deviation, and PCA coefficients) as in the 2000 Peru DHS, and using the same quintile cutpoints as in the 2000 Peru DHS. Thus, in 2008, the "quintiles" no longer represent 20% of the de jure household population, as they did in 2000; rather they indicate the same level of economic status.

1.2 Alternate Measures of Economic Status and Poverty

Gross National Income per capita based on purchasing power parity (GNI/p, PPP)

A key nationally-comparable metric of monetary household income is Gross National Income per capita based on purchasing power parity (GNI/p, PPP). Gross National Income is "the sum of value added by all resident producers plus any product taxes (less subsidies) not included in the valuation of output plus net receipts of primary income (compensation of employees and property income) from abroad." (World Bank, 2013) These estimates are divided by population to produce a per capita estimate and converted to international dollars using purchasing-power parity maps. GNI/p, PPP is an aggregate population-level measure that is related to (but distinct from) household income. Its main advantage is that it is comparable over place and time. As an indicator of poverty, it suffers from drawbacks. First, the average says nothing about relative distribution of resources among the population. Countries with large revenues from natural resources such as oil will appear better off than other countries, even when only a small minority of the population earns large incomes. Second, the accuracy of income data is difficult to ascertain, particularly in countries with large informal sectors. Despite these limitations, GNI/p, PPP is one of the most useful aggregate metrics for comparing average income across countries and over time.

International Wealth Index

The International Wealth Index (IWI) is a comparable asset index based on data from 165 household surveys, primarily the Demographic and Health Surveys (Smits and Steendijk, 2012). The authors pooled data from 1996 to 2011 and computed an index using principal component analysis (PCA) for a common set of assets in the data. The factors were distilled into a more generalized set of weights that score households between 0 and 100. The IWI has the advantage of easy reproducibility: a comparable score can be instantly produced for any individual household with the requisite information; there are no population parameters to anchor. By the same token, its universality is a drawback. Finding a small set of assets common to such a large number of surveys requires discarding a lot of the asset information gathered about any given household. There is an inherent loss of information about the full spectrum of assets that were chosen as the most salient measures of wealth in any given survey. Smits and Steendijk, however, show high correlation between the IWI and relative wealth in a number of DHS surveys and argue that the loss of information does not make the index "clump" on any particular values (Smits and Steendijk, 2012).

While universality and reproducibility of the set parameters are advantageous, one key disadvantage of this pooled data method is that the computations were done at a single point in time; this reduces comparability as additional surveys are added. In other words, if the data were re-pooled each time a new survey was added then a different set of weights would emerge from PCA. With one or two additions the differences may be minor, but with dozens of additional surveys the original weighting becomes increasingly arbitrary.

Similar comparable wealth indexes were produced by Gakidou et al. (2007) using 42 DHS surveys to look at improving child survival and by Gakidou and Vayena (2007) using 55 DHS surveys to examine use of modern contraceptive methods by the poor. In both these papers, comparability was determined by the weighted means of the pooled wealth index threshold points, with the weights being the product of the survey sampling weight and the population size of each country. The "quintiles" produced are similarly based on the weighted pooled datasets. As with the IWI, the drawback of this approach is that the "baseline" changes as new surveys are undertaken and pooled, reducing comparability.

Unsatisfied Basic Needs (UBN)

In the early 1980s the U.N. Economic Commission for Latin America (ECLAC) developed a framework (index) of Unsatisfied Basic Needs (UBN), *Indice de Necesidades Básicas Insatisfechas*, designed to measure nonmonetary dimensions of poverty (Feres and Mancero, 2001a). The UBN framework was inspired by Amartya Sen's seminal work on the measurement of poverty and living standards (Sen, 1976; 1984), but it was developed as an index for the pragmatic reason that it uses census data to measure poverty, independent of income (Feres and Mancero, 2001a). The development of the UBN index was based on multidimensional poverty mapping first done in Chile (Kast Rist and Silva, 1975). However, according to Feres and Mancero it was the joint work of ECLAC and the Census in Argentina (Instituto Nacional de Estadística y Censos [INDEC]) that established a precedent for the use of the UBN index in poverty assessments and poverty mapping (INDEC, 1984). The aim was to develop an index of human deprivation but the UBN index also identified non-income factors strongly associated with poverty. For example, it was found that poverty is more closely associated with overcrowding than with age of household head or housing tenure, so overcrowding was chosen as a key indicator of unsatisfied housing need (INDEC, 1984). The five UBN indicators established in Argentina were lack of suitable housing, deficient sanitary conditions, household overcrowding, lack of schooling, and high economic dependency in the household. Since then, the UBN framework has been adopted and adapted in other Latin American countries, using similar available indicators judged appropriate to the local situation.

According to Feres and Mancero (2001b), six key deprivations form the common denominator of the cross-national measurement of UBNs in Latin America: 1) overcrowding, 2) inadequate housing, 3) inadequate source of water, 4) lack of or unsuitability of toilet facilities, 5) children not attending school, and 6) economic capacity, which is an indirect measure of poverty. Countries generally use a subset of these indicators and measure them in slightly different ways.[2] In practice, the typical use of UBNs in poverty measurement is to set a threshold cutpoint for each (e.g., overcrowding is defined as three or more persons per room) and count the number of unsatisfied basic needs for each household. Some countries transform these measures into a poverty index using a scoring system for each indicator, mapping these onto normalized scores, and then weighting them to produce an index value for poverty (Hicks, 1998).

The UBN method has the advantage of being easy to measure with census data and thus used to disaggregate poverty in very small areas. Over time it has been tested against income measures in many countries. The lack of a universal definition for the UBN index is symptomatic of its key disadvantage: the selection of indicators and cutpoints is arbitrary, as is how they translate into terms like "poverty" or "extreme poverty." Additionally, indicators such as "source of drinking water" and "type of toilet" are sensitive to urban-rural residence, and measures of school attendance are not applicable to households lacking school-age children.

Multidimensional Poverty Index (MPI)

The Multidimensional Poverty Index (MPI) was developed by the Oxford Poverty and Human Development Initiative for the UNDP Human Development Report (UNDP, 2010). Like the UBN index, it was inspired by Amartya Sen's work on poverty, human capabilities, and standards of living (Sen, 1999; Sen and Hawthorn, 1988). The MPI goes further than the UBN by considering a larger set of human deprivations that include educational attainment and nutrition.

[2] For details, see Feres and Mancero (2001a).

The MPI uses the Alkire-Foster method (Alkire and Foster, 2011) to compute the prevalence and intensity of poverty. The three equally-weighted components of the MPI are health, education, and living standards (Alkire et al., 2013). Each component itself is comprised of equally-weighted indicators: for health, the indicators are child mortality and nutrition; for education, they are years of schooling and children enrolled in school; and for living standards, they are fuel, water source, type of toilet, electricity, floor, and assets.

The MPI is an aggregate-level population indicator derived by multiplying the prevalence of poverty and the average severity of poverty. As such, it is useful in a broad cross-national or historical perspective but it is not intended to directly compare individual households within countries or to assess inequalities within countries. For example, according to the education component, households with school-age children are the only ones "at risk" of being deprived of half the education score.[3] For the health component, the measure of child mortality extends over the entire history of a woman's reproductive lifespan, a period so long it reduces comparability among women of different ages or those living in countries with recent famine or conflict. Additionally, households are counted as malnourished if any member meets the specified anthropometric criteria for malnutrition; this requirement makes the measure sensitive to 1) whether there was subsampling of anthropometric data within a country and across countries and 2) whether the survey collected these data for women, men, and/or children. The MPI is a useful aggregate measure of population well-being, but it is not intended for use in household-level analysis.

World Health Survey Measures of Economic Status

In work for the World Health Survey, Ferguson et al. (2003) developed a methodology for estimating permanent income using asset indicator variables that is similar to the relative DHS Wealth Index procedure that will be described here. It uses anchoring points to estimate permanent income from assets. Their approach differs principally by using a dichotomous variant of the hierarchical ordered probit (DIHOPIT) model instead of principal components analysis (PCA) used in the DHS Wealth Index. Whereas PCA gives scores that have a mean of zero and a standard deviation value of one, Ferguson et al. assert that "the DIHOPIT model used to estimate permanent income has the potential to be modified so that estimates of permanent income can be directly compared across countries" and they present three potential methods. One method is to fix the level of two or more indicator variables—as discussed in Tandon et al. (2003) for adjusting self-reported health scales—to one that is common across countries and surveys, through the use of anchoring vignettes. This approach suggested the one used here—albeit with modification to the mapping, and including nonuse of random effects—that allows determination of comparable wealth indexes from those already produced for the DHS surveys using the PCA method.

Ngo (2012) employed an approach to rescaling based on the DIHOPIT method, with fixed cutpoints for some of the indicator variables, and applied it to data from the Nicaragua Living Standards Measurement Surveys. She found that the rescaled indexes performed fairly well when compared with per capita consumption expenditures. However, both Ferguson et al. and Ngo agree that there is little difference in the results obtained using the PCA and DIHOPIT methods.

[3] According to Alkire et al. (2013), "People living in households with no school-aged children are considered non-deprived in school attendance."

2 Methods

2.1 The Procedure in Brief

While it is possible to calculate comparable wealth indexes by using the same set of variables and categories in every survey—as well as a standard set of z-scores and principal components analysis coefficients and standard quintile break points—differences between surveys in the questions asked and the ways in which questions are categorized make this procedure difficult to implement without discarding much of the information used in each country to construct the wealth index.

Instead, the procedure we use to calculate a Comparative Wealth Index (CWI) makes use of several techniques: 1) comparison with a baseline, an idea similar to that used for price indexes; 2) use of unsatisfied basic needs and other items that are common to most DHS surveys since 1990 as "anchoring" points; 3) use of proportions of households at given levels of the "anchors" to determine cutpoints; and 4) adjusting the survey-specific DHS Wealth Indexes through regression on anchor cutpoints of the baseline wealth index.

The anchoring points approach was originally developed for the World Health Organization's World Health Survey (2002-2004), which was designed to produce comparable cross-national estimates of adult self-reported health (Murray et al., 2000; Murray et al., 2003; Salomon et al., 2001; Tandon et al., 2003). Ferguson et al. (2003) used the anchoring approach to estimate permanent income from assets, using data from household surveys of Pakistan and Peru. The anchoring approach has subsequently been applied to cross-survey metrics looking at topics as diverse as political freedom (King et al., 2004) and job satisfaction (Kristensen and Johansson, 2008).

To develop a "comparable" wealth index using the anchoring approach, several decisions needed to be made, specifically: 1) which survey's wealth index should serve as the baseline; 2) how many and what types of anchoring points should be used; 3) how the wealth score values for the anchoring cutpoints should be calculated; and 4) what should be done about surveys that have some items missing. These decisions are discussed below.

2.2 Selection of the Baseline Survey

Because the goal of the CWI was to make the existing survey-specific wealth indexes comparable with each other rather than to create a new absolute measure of economic status, the selection of the baseline survey was somewhat arbitrary (as is the base year in a price index). At the time of the selection, DHS surveys with wealth indexes were available from 1990 through 2011, so a survey around the year 2000 seemed appropriate. The most widely available and used indicator of country economic status is the World Bank's Gross National Income per capita (GNI/P) at purchasing power parity (PPP) (World Bank, 2013); so, it was decided to use this indicator (GNI/P at PPP) with data from the year 2000. Among countries with DHS surveys, Vietnam turned out to have the median value. The most recent DHS survey in Vietnam was in 2002, so this survey's wealth index was chosen as the baseline—it was in the middle of the time period of DHS surveys and in the middle income per capita of the countries with DHS surveys.

2.3 Selection and Calculation of the Anchoring Points

To ensure comparability it was necessary to spread the anchoring points across the economic distribution, i.e., including some points that are relevant at poorer levels and others that are relevant at wealthier levels. The Unsatisfied Basic Needs index (UBN), *Indice de Necesidades Básicas Insatisfechas*, developed by

the Economic Commission for Latin America and the Caribbean (ECLAC), is used as the basis for the anchoring points at the lowest level of the economic distribution. As discussed earlier, implementation of the framework varies by country; a version comparable to that of Peru has been calculated for the DHS surveys and seems to compare well with other indicators of poverty.[4] In Peru, the framework is used to divide the population into three categories: not poor (no points), poor (1 point), and extremely poor (2+ points). For our purposes, to ensure comparability, the point values themselves are used.

In Peru, the UBN framework (Llanos and INEI, 2000) assigns points for the following:

- A dwelling with inadequate walls (natural or rustic materials) or dirt flooring
- Crowding (more than three persons per room, excluding bathrooms, garages, kitchens, and hallways)
- Inadequate toilets (no facility, a pit latrine without a slab, a bucket or hanging toilet)
- Households with children 6 to 12 years who do not attend school
- High Economic Dependency: Households whose head has less than a primary complete education and with more than three persons per worker.

Information on these five items is available in almost all DHS surveys; however, in this report we made a few adjustments to the definitions of some UBN items and deleted one. "Crowding" was calculated as more than three persons per sleeping room.[5] The measure "inadequate toilets" was replaced with "inadequate sanitation," which was expanded to include either inadequate toilet facilities or an inadequate source of drinking water. In urban areas, a household was described as having an adequate source of drinking water if the water was piped into the dwelling or yard/plot or if the household used bottled water for drinking. In rural areas, any protected source of water was considered an adequate source of drinking water. Improved toilets and latrines were considered adequate toilet facilities unless shared with other households. The fourth item, "households with children 6 to 12 years who do not attend school," was dropped from the UBN because not all households have children that age. Lastly, households were considered to have "high economic dependency" if they had more than three household members per worker[6] and no working-age adult had completed primary education.[7] With these changes to the UBN framework, wealth scores were calculated for the percentage of households that had all four unsatisfied

[4] A recent alternative considered was the Multidimensional Poverty Index (MPI). While it is designed as an aggregate measure of the prevalence and depth of poverty, items on the index can themselves be used as anchoring points for poverty. However, as discussed in the previous section, some of the measures used in the MPI make it difficult to compare households directly because they are sensitive to the presence of school-aged children and the age of the mother. Other items used to compute the MPI are similar to those used for measuring the UBN.

[5] DHS generally does not count the number and type of rooms, but rather the number of rooms used for sleeping. In the Indonesian surveys, floor space in square meters is available instead of number of sleeping rooms, and an alternative measure of crowding based on the square footage per household member was used instead.

[6] DHS gathers data on employment status through individual rather than household interviews. Since male interviews are often done in only a subset of households, we tabulate the number of workers through women's interviews by summing the number of interviewed women and their husbands currently working. All households are assumed to have a minimum of one worker.

[7] For household members age 15 to 24, education is only considered if they are not attending school. If the only working-age adults are between 15-24 and attending school, then the education of the household member identified as head of household is used.

basic needs (4 points), three or more unsatisfied basic needs (3 points), two or more unsatisfied basic needs (2 points), and one or more unsatisfied basic need (1 point). These scores are then used as anchoring points for the relative wealth index.

Four items were chosen as anchoring points for households at the middle and upper end of the economic distribution: possession of a television, a refrigerator, a car/truck, and a fixed (landline) telephone. For these items, logistic regression analysis was used to determine the wealth index score at which half of the households had each possession. For each item in each survey, a logistic regression was run with the dichotomy for that item as the dependent variable and the wealth score as the independent variable.[8]

$$\ln\left[\frac{p}{1-p}\right] = a + b \times WS$$

Where p is the percentage with the asset and WS is the wealth score.

The predicted value of the wealth score where half of the households possess the item is therefore a value of zero for the dependent variable, the logit of .5 being 0.[9] The value of the predicted wealth score for this point is therefore –a/b.

Note that this procedure assumes a monotonically increasing trend in possession of the asset item with wealth. Each of the chosen assets does have this relationship in all DHS surveys. (An example of an asset that does not have a monotonic relationship with wealth, and thus would not work well, is possession of a motorcycle; having a motorcycle increases with wealth at first, but then decreases as wealthier households increasingly have cars.) Another advantage of these items is that they have not generally been subject to dramatic technological shifts over the time period in question. For example, mobile phones, computers, and even internet connectivity are used to compute the relative wealth index in surveys where they are asked about, but these items would not be appropriate anchoring points for relative wealth comparisons over time. Note that it is not necessary that more than 50% of the highest quintile have the possession because the calculation is based on the score and not on the quintile.

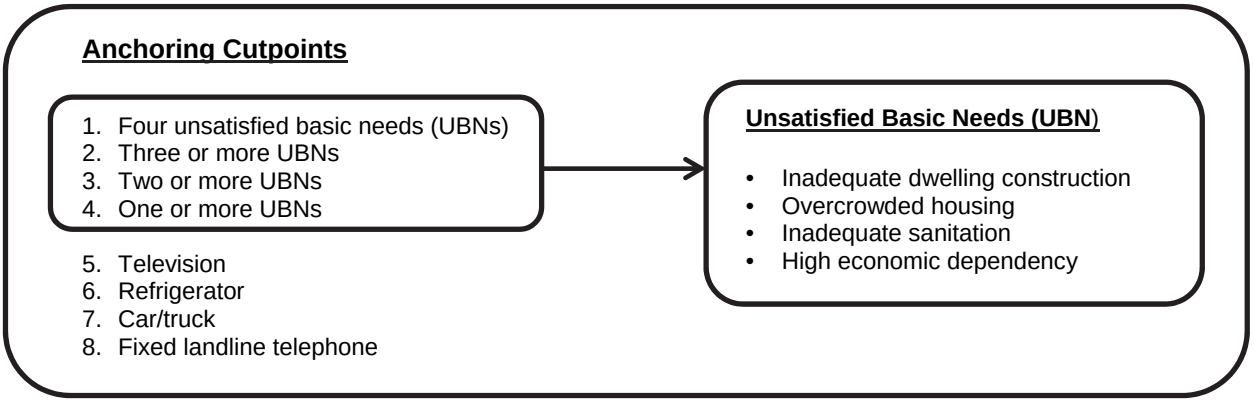
2.4 Transformation of Country-specific Wealth Indexes

The procedure given above was performed for the baseline survey (2002 Vietnam DHS survey) and for each specified survey, and for all eight wealth score cutpoints in the baseline and the specified survey, as summarized in Figure 2.1.

[8] Ferguson et al. (2003) used an analogous procedure, a dichotomous hierarchical probit analysis (DIHOPIT) to estimate the wealth index and the median values of items. Ferguson et al. state that the DIHOPIT approach is at least as good as PCA in estimating permanent income but that their analysis "has not explicitly addressed the problem of cross-population comparability."

[9] $\ln\left(\frac{.5}{1-.5}\right) = \ln(1) = 0$

Figure 2.1 Summary of anchoring cutpoints used for calculation of the experimental Comparative Wealth Index



Then, a linear regression was run with the baseline anchor cutpoint values as the dependent variable and the specified survey's anchor cutpoint values as the independent variable:

$$cpb_i = \alpha + \beta \times cpc_i$$

where *cpb* is the value of the cutpoint on the baseline wealth index of item *i* and *cpc* is the value on the specified survey's wealth index.

The constant α represents the amount of adjustment of the level of the survey-specific wealth index relative to the baseline wealth index and β represents the dispersion of the survey-specific index relative to the baseline index.

To produce the CWI score for each survey, each household's wealth index score is multiplied by the coefficient β and the constant term α is added to the product. To produce comparative wealth quintiles, the cutpoints for the quintiles of the baseline wealth index are used on the CWI. Note that these comparative quintile cutpoint values are, therefore, the same for all surveys.

2.5 Survey Inclusion and Survey-specific Adjustments

The CWI was calculated for 172 DHS[10] surveys conducted between 1990 and 2012 in 69 countries. It was not calculated for Jordan 1990 because most of the questions used in the procedure were not asked. DHS wealth indexes are not available for 11 surveys in the early 1990s and these were dropped from consideration; the surveys are the Dominican Republic 1991, Egypt 1992, Indonesia 1991 and 1994, Madagascar 1992, Niger 1992, Philippines 1993, Senegal 1992-93, Tanzania 1991-92, Yemen 1991-92, and Zambia 1992.

Before 2000, many DHS surveys did not ask questions on the sharing of toilet facilities (24 surveys). In Phase 4 of the DHS project, around the year 2000, the question on the number of sleeping rooms was

[10] Nonstandard DHS surveys such as the Malaria Indicator Surveys (MIS), the AIDS Indicator Surveys (AIS), surveys with restricted data, and region-specific surveys were excluded from the analysis. Nigeria 1999 was also excluded because of the poor quality of the data. Additional survey exclusions are described in the text.

dropped from the standard questionnaire, although many surveys in this phase still asked the question[11] (18 surveys lack information on the number of sleeping rooms). The question on possession of a car or truck was left out of 15 surveys and the question on possession of a fixed telephone was left out of 29 surveys, mostly during the 1990s (DHS Phase 2 and Phase 3). Seven surveys did not have information on possession of a refrigerator and three lacked information on television sets (see Appendix Table A.1 for details by country). Instead of the full complement of eight regression data points, 48 surveys had seven data points, 9 had six data points, and 6 had five data points. Where the number of sleeping rooms was lacking, the surveys were regressed against a special baseline wealth index from Vietnam 2002 that excluded that item. Other surveys made use of the regression points that existed.

2.6 Illustration of the Process

The process of calculating cutpoints for the comparative wealth index is illustrated in Table 2.1 using the 2006 Benin DHS survey as the specified survey with the 2002 Vietnam DHS as the baseline survey. Columns 1 and 4 show the percentage of households in each survey, respectively, with four household assets—a car or truck, a refrigerator, a fixed telephone, and a television—and the UBN point scores. Columns 2 and 5 show the cumulative percentage of households by UBN score; and columns 3 and 6 show the wealth index cutpoint values for the median of the asset items and for the cumulative percentages of UBN scores. Linearly regressing column 6 on column 3 gives the coefficients α and β of -0.6688 and 0.8117, respectively, which represent the level and the dispersion of the Comparative Wealth Index (CWI) calculated for Benin 2006. For each survey, the CWI score for each household is calculated by multiplying the relative wealth index score of each household by β and adding α to that product.

Table 2.1 Calculation of wealth index cutpoints for 2006 Benin DHS using 2002 Vietnam DHS as baseline

	Baseline: Vietnam 2002			Benin 2006		
Items	% of households with item	Cumulative % of households by UBN score	Cutpoints for median or cumulative %	% of households with item	Cumulative % of households by UBN score	Cutpoints for median or cumulative %
	(1)	(2)	(3)	(4)	(5)	(6)
Car/truck	1.1		3.5060	4.4		3.5550
Refrigerator	14.3		1.2385	5.6		2.3600
Fixed telephone	17.9		0.9946	2.7		3.0487
TV	70.1		-0.7245	22.6		0.6720
UBN score						
0	16.6	100.0		4.6	100.0	
1	37.6	83.3	0.9969	25.1	95.4	2.2804
2	29.3	45.7	-0.2754	42.7	70.3	0.2060
3	12.7	16.4	-1.0009	20.8	27.6	-0.6325
4	3.7	3.7	-1.4374	6.8	6.8	-0.8348
				Regression of column 6 on column 3:		
					α	-0.6688
					β	0.8117

[11] The Indonesian surveys used a question on floor area, so the minimum floor area per person was used as a measure of household crowding instead of the number of sleeping rooms per person.

The final part of the process is illustrated in Table 2.2, which shows the results of comparing the two wealth indexes. For Benin 2006, on the baseline wealth index, the mean for the household members' wealth score is -0.6336 and the standard deviation is 0.8329. The comparative baseline quintile cutpoints are -0.9080, -0.3858, -0.1189, and +0.7416. (The original Benin 2006 wealth index has a mean of 0.0288, a standard deviation of 1.0431, and quintile cutpoints of -0.7095, -0.5129, -0.1932, and +0.6566.) From this calculation, it can be seen that Benin in 2006 was generally poorer than Vietnam in 2002 as the mean wealth score for Benin is lower than the zero mean for Vietnam.

Table 2.2 Results of comparison of 2006 Benin DHS wealth index and 2002 Vietnam DHS wealth index

Household population wealth index scores	Baseline: Vietnam 2002			Benin 2006		
	Country-specific	Comparative		Country-specific	Comparative	
Mean	-0.0481	-0.0481		0.0288	-0.6336	
Standard deviation	0.9833	0.9833		1.0431	0.8329	
Minimum	-1.9339	-1.9339		-1.0300	-1.5062	
Maximum	2.7995	2.7995		7.5700	5.4727	
Wealth quintiles	**Country-specific cutpoint with next highest quintile**	**Comparative cutpoint with next highest quintile**	**Percent of household population**	**Country-specific cutpoint with next highest quintile**	**Comparative cutpoint with next highest quintile**	**Percent of household population**
1	-0.9080	-0.9080	20.0	-0.7095	-0.9080	53.7
2	-0.3858	-0.3858	20.0	-0.5129	-0.3858	19.7
3	-0.1189	-0.1189	20.0	-0.1932	-0.1189	8.1
4	0.7416	0.7416	20.0	0.6566	0.7416	10.8
5	na	na	20.0	na	na	7.7

2.7 Sensitivity Testing

Testing was conducted to establish how sensitive the new wealth index was to alternate specifications. For these tests, 10 surveys with eight anchoring points were sampled systematically from a list of all such surveys.[12] Because values of the CWI are derived from the estimated regression coefficients between the anchoring points for each survey and those of the baseline, which we will call α and β, respectively, these coefficients are compared with those of the sensitivity tests. The sensitivity test comparisons are evaluated using the average difference in the regression coefficients for the 10 surveys, the correlation between the regression coefficients, and the significance of the correlations.

The first test was to see how sensitive the index was to removal of the cutpoint for fixed telephone. Because possession of a fixed telephone is relatively rare in less developed countries, and the question about it was absent in a number of surveys—for example, a fixed phone is not necessarily needed,

[12] The 10 surveys systematically selected for sensitivity testing were Armenia 2005, Cameroon 1998, Dominican Republic 1999, Ghana 2008, Indonesia 2007, Madagascar 1997, Nicaragua 2001, Peru 1996, Sierra Leone 2008, and Uzbekistan 1996.

desired, nor available through existing infrastructure in some areas,[13] including Africa—we experimented with removing the anchoring point entirely, decreasing the number of cutpoints from eight to seven. In 10 test countries, the average change in alpha was .036, which was not statistically significant. The cutpoint for fixed telephone was kept in the countries where the question was asked.

A second test was conducted to look at the difference between using toilets alone for the definition of adequate sanitation, versus a more comprehensive definition of sanitation that also includes adequate drinking water; the latter requires different urban and rural definitions. It was found that the original definition from Peru (toilets only) did not result in a statistically significant difference in α and β. It was decided that the more comprehensive definition was preferred for substantive reasons and it was incorporated into the final definition.

A third test was conducted to see how sensitive country rankings are to the choice of baseline. Each of the 10 countries (plus Vietnam) was used as a baseline for the other countries, and the resulting set of scores and rankings was compared with the set for Vietnam. It was found that the ranking of the 11 countries relative to each other was 98% to 100% correlated when any other baseline was used, suggesting that the method employed here is relatively—but not entirely—robust to alternate specifications of the baseline.

Additional consideration was given to counting UBNs as separate anchoring points (one for each item) rather than a sum of the items. The sensitivity test is evaluated by judging whether the non-accumulated UBN anchoring points have the same monotonic relationship as the anchoring points of the 10 surveys. It was found that using the four UBN criteria as individual anchoring points, instead of their accumulation, did not result in the same monotonic order for the 10 surveys. Therefore, counting UBNs as separate anchoring points is not equivalent to, or better than, using the accumulated UBN scores.

2.8 Establishing a Monetary Equivalent

The Comparative Wealth Index does not have a fixed absolute value; it is an index that is relative to the baseline survey so that an index score can be compared across DHS surveys. However, the cutpoints for the UBN estimate of poverty and extreme poverty for the baseline survey could be applied to the CWIs for each of the surveys, giving comparable lines for poverty and extreme poverty across the surveys. Table 2.1, shows the cutpoint between poor and not poor would be a value of +0.9969 and between poor and extremely poor would be -0.2754. For Vietnam in 2002, this means that 46% of the household population was extremely poor, 38% was poor but not extremely, and 16% was not poor. For Benin in 2006, 70% of the household population was extremely poor, 25% was poor but not extremely, and just 5% was not poor.

An approach to assigning a monetary value to the wealth score would be to translate it into per capita income. However, while both income and wealth are measures of economic status, they are not equivalent concepts. Income can vary substantially due to market fluctuations and boom and bust times while wealth is much less volatile. Permanent income as espoused by Milton Friedman (1957) is a more useful measure since it represents long-run household conditions and decision-making rather than the vagaries of short-run fluctuations. Moreover, the DHS wealth index is a household measure while Gross National Income (GNI) includes income not distributed to households. Additionally, the DHS wealth index is not as affected by the large inequalities of income distribution that shape the GNI.

[13] For example, in Africa the development of infrastructure for landlines was effectively outpaced by widespread use of mobile phones and, in many communities, landline phones are not available (Aker and Mbiti, 2010).

Be that as it may, one way to proceed would be to obtain GNI/P at PPP for each country at the time of the DHS survey and then regress the comparative wealth scores for each country (and survey period) against income per capita. (Note that the form of the regression may not necessarily be linear.) Then use the coefficients from this regression to estimate the income index corresponding to the CWI. The validity of the regression depends in part on the assumption that assets have a monotonically increasing relationship with permanent income.

3 Results

3.1 Levels of Wealth

The experimental Comparative Wealth Index (CWI) was computed for 172 DHS surveys conducted between 1990 and 2012. Of the 172 surveys, 87 were conducted in sub-Saharan Africa, 21 in North Africa/West Asia/Eastern Europe, 4 in Central Asia, 28 in South and Southeast Asia, and 32 in Latin America and the Caribbean. Table 3.1 presents the results of producing CWIs for the 172 DHS surveys, while Figure 3.1 provides a visual representation of the results, by level of mean CWI score. Turkey in 2003 has the highest mean and Malawi 2004 has the lowest. The highest levels of divergence in the wealth index scores, as noted by the standard deviation values, occur in Guatemala 1998-99, Peru 1991-92, and South Africa 1998, indicating higher levels of economic inequality, and the lowest levels of divergence of the wealth scores are in Rwanda 1992 and Malawi 1992, indicating less inequality and more economically homogenous societies. Compared with the baseline, the unweighted average of the means of the CWI scores for all 172 surveys is -0.124 and the unweighted average of the standard deviations is 0.948 (Table 3.2). The average survey date is 2002, the year of the baseline. Given that the median per capita income among DHS countries was used to choose the baseline—and it might be expected that averages would be closer to 0 for the mean and closer to 1 for the standard deviation—in fact, many countries have multiple surveys. The average below 0 thus indicates that the relatively poorer countries are those with more surveys.[14]

By region, the 21 surveys in North Africa, West Asia, and Eastern Europe have the highest average of the means of the wealth scores. Sub-Saharan Africa has the lowest average of the means. Of the 87 surveys conducted in sub-Saharan Africa over the 23-year period, only 6 surveys (Gabon 2000 and 2012, Namibia 2006-07, São Tomé and Principe 2008-09, South Africa 1998, and Swaziland 2006-07) have a mean wealth score greater than 0. The Latin America and Caribbean region has the highest average value of standard deviations, indicating greater divergence of wealth than the other regions (Table 3.2).

Table 3.1 Values of comparative wealth index in relation to baseline, mean, and standard deviation, DHS surveys, 1990-2012

Region and country	Year	Mean	Standard deviation
Sub-Saharan Africa			
Benin	1996	-0.909	1.038
Benin	2001	-0.927	0.983
Benin	2006	-0.634	0.833
Burkina Faso	1993	-0.880	0.694
Burkina Faso	1998-99	-0.889	0.684
Burkina Faso	2003	-0.968	0.906
Cameroon	1991	-0.588	1.014
Cameroon	1998	-0.546	1.059
Cameroon	2004	-0.418	0.887
Cameroon	2011	-0.283	0.824
CAR	1994-95	-0.962	0.488

(Continued...)

[14] Gross National Income per capita also includes non-household income, so countries might have been ranked differently if only household income (not available) had been used to select the baseline.

Table 3.1 – *Continued*

Region and country	Year	Mean	Standard deviation
Chad	1996-97	-0.962	0.298
Chad	2004	-1.089	0.508
Comoros	1996	-0.740	0.880
Congo (Brazzaville)	2005	-0.346	0.727
Congo Democratic Republic	2007	-0.626	0.551
Côte d'Ivoire	1994	-0.252	1.108
Côte d'Ivoire	1998-99	-0.335	1.147
Côte d'Ivoire	2011-12	-0.418	0.828
Eritrea	1995	-1.177	0.872
Eritrea	2002	-1.022	1.077
Ethiopia	2000	-1.088	0.575
Ethiopia	2005	-1.401	0.677
Ethiopia	2011	-1.281	0.842
Gabon	2000	0.344	1.132
Gabon	2012	0.509	0.802
Ghana	1993	-0.573	0.868
Ghana	1998	-0.339	0.794
Ghana	2003	-0.360	0.925
Ghana	2008	-0.074	0.943
Guinea	1999	-0.663	0.798
Guinea	2005	-0.619	0.869
Kenya	1993	-0.832	0.592
Kenya	1998	-0.686	0.857
Kenya	2003	-0.700	0.985
Kenya	2008-09	-0.501	0.894
Lesotho	2004	-0.597	1.033
Lesotho	2009	-0.362	1.012
Liberia	2007	-0.720	0.807
Madagascar	1997	-0.733	0.611
Madagascar	2003-04	-0.514	0.878
Madagascar	2008-09	-0.843	0.865
Malawi	1992	-0.990	0.271
Malawi	2000	-1.013	0.339
Malawi	2004	-1.014	0.733
Malawi	2010	-0.890	0.734
Mali	1995-96	-0.643	0.438
Mali	2001	-1.081	0.833
Mali	2006	-0.876	0.851
Mauritania	2000-01	-0.729	0.901
Mozambique	1997	-0.927	0.506
Mozambique	2003	-0.874	0.676
Mozambique	2011	-0.687	0.796
Namibia	1992	-0.145	1.296
Namibia	2000	-0.132	1.352
Namibia	2006-07	0.096	1.285
Niger	1998	-1.043	0.581
Niger	2006	-1.042	0.587
Nigeria	2003	-0.249	1.019
Nigeria	2008	-0.165	0.796

(Continued...)

Table 3.1 – *Continued*

Region and country	Year	Mean	Standard deviation
Rwanda	1992	-1.054	0.252
Rwanda	2000	-1.276	0.592
Rwanda	2005	-0.965	0.447
Rwanda	2007-08	-0.929	0.472
Rwanda	2010	-0.600	0.434
Sao Tome and Principe	2008-09	0.128	1.091
Senegal	1997	-0.398	1.109
Senegal	2005	-0.295	1.318
Senegal	2010-11	-0.337	0.705
Sierra Leone	2008	-0.752	0.697
South Africa	1998	0.681	1.606
Swaziland	2006-07	0.087	1.104
Tanzania	1996	-0.901	0.546
Tanzania	1999	-0.910	0.629
Tanzania	2003-04	-0.797	0.844
Tanzania	2010	-0.682	0.801
Togo	1998	-0.701	0.794
Uganda	1995	-0.927	0.387
Uganda	2000-01	-1.284	0.614
Uganda	2006	-0.872	0.651
Zambia	1996	-0.706	1.066
Zambia	2001-02	-0.841	1.054
Zambia	2007	-0.668	1.076
Zimbabwe	1994	-0.301	1.090
Zimbabwe	1999	-0.197	1.061
Zimbabwe	2005-06	-0.126	1.141
Zimbabwe	2010-11	-0.037	0.939
North Africa-West Asia-Europe			
Albania	2008-09	1.338	0.638
Armenia	2000	1.236	0.829
Armenia	2005	1.819	1.140
Azerbaijan	2006	1.254	0.987
Egypt	1995	0.746	1.351
Egypt	2000	1.027	1.120
Egypt	2003	1.390	1.146
Egypt	2005	1.456	1.005
Egypt	2008	1.566	0.943
Jordan	1997	1.268	0.558
Jordan	2002	1.860	0.795
Jordan	2007	1.687	1.004
Jordan	2009	1.520	0.864
Moldova	2005	1.296	1.233
Morocco	1992	0.071	1.460
Morocco	2003-04	0.707	1.405
Turkey	1993	1.286	1.293
Turkey	1998	1.585	1.190
Turkey	2003	2.059	1.305
Ukraine	2007	1.684	0.910
Yemen	1997	-0.453	1.255

(Continued...)

Table 3.1 – *Continued*

Region and country	Year	Mean	Standard deviation
Central Asia			
Kazakhstan	1995	0.682	0.689
Kazakhstan	1999	0.830	0.740
Kyrgyz Republic	1997	0.500	0.812
Uzbekistan	1996	0.648	0.768
South and Southeast Asia			
Bangladesh	1993-94	-1.120	0.506
Bangladesh	1996-97	-0.960	0.536
Bangladesh	1999-2000	-0.803	0.609
Bangladesh	2004	-0.855	0.755
Bangladesh	2007	-0.807	0.762
Bangladesh	2011	-0.661	1.032
Cambodia	2000	-0.684	0.715
Cambodia	2005	-0.609	0.877
Cambodia	2010	-0.356	0.915
India	1992-3	-0.986	1.199
India	1998-99	-0.050	0.920
India	2005-06	-0.368	1.270
Indonesia	1997	0.127	1.114
Indonesia	2002-03	0.017	1.219
Indonesia	2007	0.682	1.045
Indonesia	2012	0.696	0.876
Maldives	2009	0.883	0.807
Nepal	1996	-1.144	0.423
Nepal	2001	-1.120	0.636
Nepal	2006	-0.775	0.879
Nepal	2011	-0.366	0.992
Pakistan	2006-07	-0.076	1.309
Philippines	1998	0.482	1.222
Philippines	2003	0.724	1.433
Philippines	2008	0.495	1.224
Timor-Leste	2009	-0.311	0.519
Vietnam	1997	-0.379	0.892
Vietnam--baseline	2002	-0.035	0.977
Latin America and Caribbean			
Bolivia	1994	-0.160	1.049
Bolivia	1998	0.324	1.465
Bolivia	2003	0.069	1.421
Bolivia	2008	0.338	1.310
Brazil	1996	1.114	1.006
Colombia	1990	0.946	1.265
Colombia	1995	1.076	1.270
Colombia	2000	1.715	1.304
Colombia	2005	0.905	1.056
Colombia	2010	1.404	0.979
Dominican Republic	1996	0.281	1.295
Dominican Republic	1999	0.911	0.900
Dominican Republic	2002	1.173	1.103

(Continued...)

Table 3.1 – *Continued*

Region and country	Year	Mean	Standard deviation
Dominican Republic	2007	1.156	1.257
Guatemala	1995	-0.272	1.434
Guatemala	1998-99	-0.161	1.606
Guyana	2009	1.361	1.078
Haiti	1994-95	-0.558	1.142
Haiti	2000	-0.615	1.170
Haiti	2005-06	-0.509	1.017
Haiti	2012	-0.371	0.671
Honduras	2005-06	0.225	1.596
Honduras	2011-2012	0.401	1.300
Nicaragua	1998	-0.283	1.464
Nicaragua	2001	-0.313	1.457
Peru	1991-92	0.520	1.623
Peru	1996	0.196	1.415
Peru	2000	0.319	1.371
Peru	2004-08	0.388	1.348
Peru	2009	0.397	1.309
Peru	2010	0.451	1.327
Peru	2011	0.539	1.266

Table 3.2 Mean comparative wealth index by region, average of means and average of standard deviations (SD), DHS surveys

Region	Date	Average of means	Average of standard deviations
Sub-Saharan Africa	2002.0	-0.633	0.824
North Africa/West Asia/Europe	2002.1	1.257	1.068
Central Asia	1996.8	0.665	0.752
South and Southeast Asia	2003.1	-0.298	0.917
Latin America and Caribbean	2001.8	0.405	1.259
All	**2002.0**	**-0.124**	**0.948**

Figure 3.1a Comparative wealth indexes for DHS surveys, by level of mean CWI score, 1990-2012

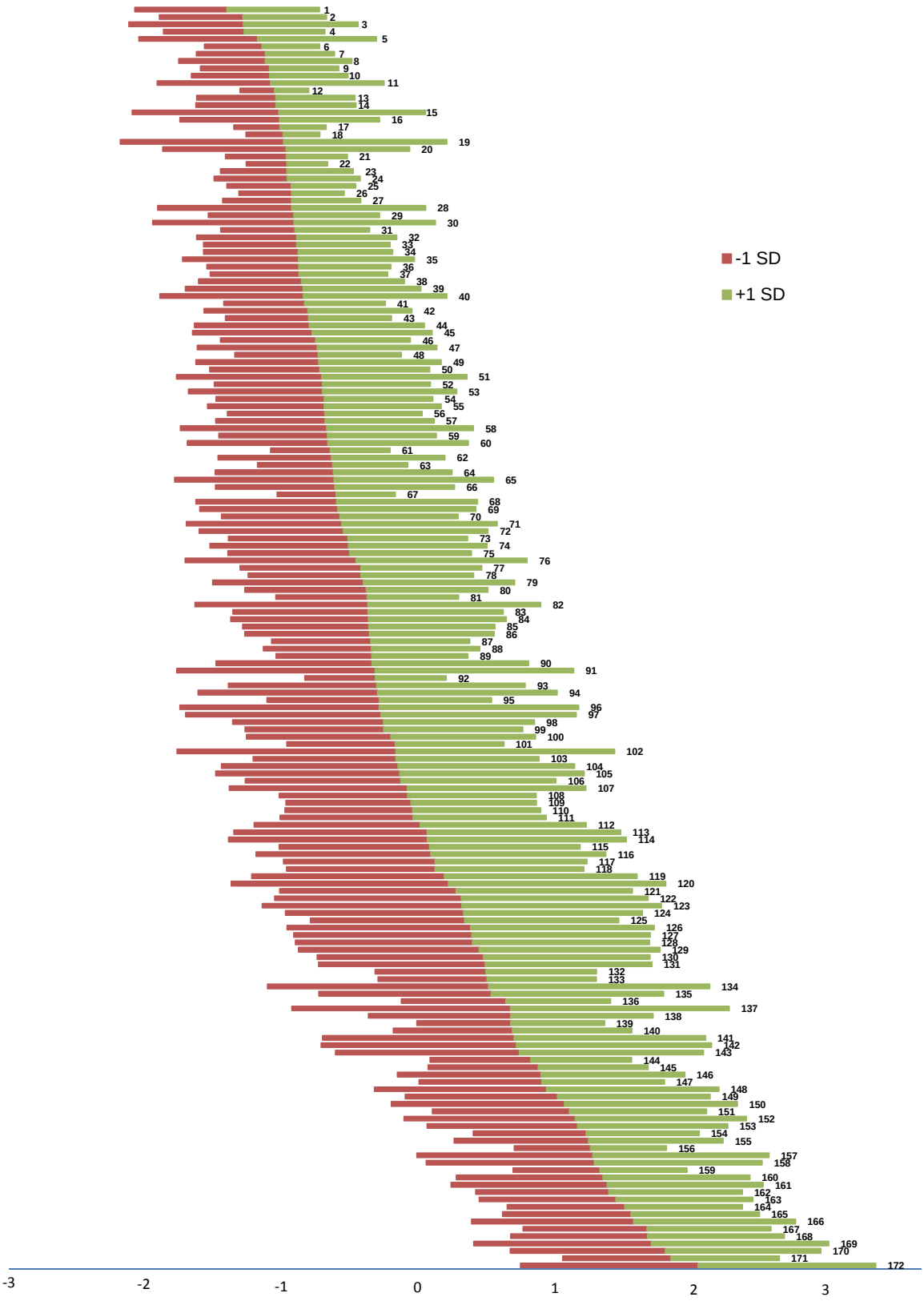


Figure 3.1b List of the names of the surveys

Number	Country and survey year	Number	Country and survey year
1	Ethiopia 2005	44	Tanzania 2003-04
2	Uganda 2000-01	45	Nepal 2006
3	Ethiopia 2011	46	Sierra Leone 2008
4	Rwanda 2000	47	Comoros 1996
5	Eritrea 1995	48	Madagascar 1997
6	Nepal 1996	49	Mauritania 2000-01
7	Bangladesh 1993-94	50	Liberia 2007
8	Nepal 2001	51	Zambia 1996
9	Chad 2004	52	Togo 1998
10	Ethiopia 2000	53	Kenya 2003
11	Mali 2001	54	Mozambique 2011
12	Rwanda 1992	55	Kenya 1998
13	Niger 1998	56	Cambodia 2000
14	Niger 2006	57	Tanzania 2010
15	Eritrea 2002	58	Zambia 2007
16	Malawi 2004	59	Guinea 1999
17	Malawi 2000	60	Bangladesh 2011
18	Malawi 1992	61	Mali 1995-96
19	India 1992-3	62	Benin 2006
20	Burkina Faso 2003	63	Congo Democratic Republic 2007
21	Rwanda 2005	64	Guinea 2005
22	Chad 1996-97	65	Haiti 2000
23	CAR 1994-95	66	Cambodia 2005
24	Bangladesh 1996-97	67	Rwanda 2010
25	Rwanda 2007-08	68	Lesotho 2004
26	Uganda 1995	69	Cameroon 1991
27	Mozambique 1997	70	Ghana 1993
28	Benin 2001	71	Haiti 1994-95
29	Tanzania 1999	72	Cameroon 1998
30	Benin 1996	73	Madagascar 2003-04
31	Tanzania 1996	74	Haiti 2005-06
32	Malawi 2010	75	Kenya 2008-09
33	Burkina Faso 1998-99	76	Yemen 1997
34	Burkina Faso 1993	77	Cameroon 2004
35	Mali 2006	78	Cote d'Ivoire 2011-12
36	Mozambique 2003	79	Senegal 1997
37	Uganda 2006	80	Vietnam 1997
38	Bangladesh 2004	81	Haiti 2012
39	Madagascar 2008-09	82	India 2005-06
40	Zambia 2001-02	83	Nepal 2011
41	Kenya 1993	84	Lesotho 2009
42	Bangladesh 2007	85	Ghana 2003
43	Bangladesh 1999-2000	86	Cambodia 2010

(Continued...)

Figure 3.1b – *Continued*

Number	Country and survey year	Number	Country and survey year
87	Congo Brazzaville 2005	130	Philippines 1998
88	Ghana 1998	131	Philippines 2008
89	Senegal 2010-11	132	Kyrgyz Republic 1997
90	Cote d'Ivoire 1998-99	133	Gabon 2012
91	Nicaragua 2001	134	Peru 1991-92
92	Timor-Leste 2009	135	Peru 2011
93	Zimbabwe 1994	136	Uzbekistan 1996
94	Senegal 2005	137	South Africa 1998
95	Cameroon 2011	138	Indonesia 2007
96	Nicaragua 1998	139	Kazakhstan 1995
97	Guatemala 1995	140	Indonesia 2012
98	Cote d'Ivoire 1994	141	Morocco 2003-04
99	Nigeria 2003	142	Philippines 2003
100	Zimbabwe 1999	143	Egypt 1995
101	Nigeria 2008	144	Kazakhstan 1999
102	Guatemala 1998-99	145	Maldives 2009
103	Bolivia 1994	146	Colombia 2005
104	Namibia 1992	147	Dominican Republic 1999
105	Namibia 2000	148	Colombia 1990
106	Zimbabwe 2005-06	149	Egypt 2000
107	Pakistan 2006-07	150	Colombia 1995
108	Ghana 2008	151	Brazil 1996
109	India 1998-99	152	Dominican Republic 2007
110	Zimbabwe 2010-11	153	Dominican Republic 2002
111	Vietnam--baseline 2002	154	Armenia 2000
112	Indonesia 2002-03	155	Azerbaijan 2006
113	Bolivia 2003	156	Jordan 1997
114	Morocco 1992	157	Turkey 1993
115	Swaziland 2006-07	158	Moldova 2005
116	Namibia 2006-07	159	Albania 2008-09
117	Indonesia 1997	160	Guyana 2009
118	Sao Tome and Principe 2008-09	161	Egypt 2003
119	Peru 1996	162	Colombia 2010
120	Honduras 2005-06	163	Egypt 2005
121	Dominican Republic 1996	164	Jordan 2009
122	Peru 2000	165	Egypt 2008
123	Bolivia 1998	166	Turkey 1998
124	Bolivia 2008	167	Ukraine 2007
125	Gabon 2000	168	Jordan 2007
126	Peru 2004-08	169	Colombia 2000
127	Peru 2009	170	Armenia 2005
128	Honduras 2011-12	171	Jordan 2002
129	Peru 2010	172	Turkey 2003

3.2 Trends in Wealth

For countries with multiple DHS surveys,[15] Table 3.3 shows the average change in the mean CWI between the earliest and the latest surveys. Of the 45 countries with more than one wealth index, 37 have had an increase in the mean CWI, while 7 countries (Burkina Faso, Chad, Côte d'Ivoire, Ethiopia, Madagascar, Mali, and Nicaragua) have had a decline. One country (Niger) remained unchanged.

Table 3.3 Trends in mean comparative wealth index score by country

Country	Year of latest survey	Mean comparative score	Change from earliest to latest survey		
			Years	Mean	Per 5-years
Sub-Saharan Africa					
Benin	2006	-0.634	10.0	0.276	0.138
Burkina Faso	2003	-0.968	10.0	-0.088	-0.044
Cameroon	2011	-0.283	20.0	0.304	0.076
Chad	2004	-1.089	7.5	-0.127	-0.085
Côte d'Ivoire	2011-12	-0.418	17.5	-0.166	-0.048
Eritrea	2002	-1.022	7.0	0.155	0.111
Ethiopia	2011	-1.281	11.0	-0.193	-0.088
Gabon	2012	0.509	12.0	0.165	0.069
Ghana	2008	-0.074	15.0	0.498	0.166
Guinea	2005	-0.619	6.0	0.044	0.036
Kenya	2008-09	-0.501	15.5	0.331	0.107
Lesotho	2009	-0.362	5.0	0.235	0.235
Madagascar	2008-09	-0.843	11.5	-0.110	-0.048
Malawi	2010	-0.890	18.0	0.100	0.028
Mali	2006	-0.876	10.5	-0.233	-0.111
Mozambique	2011	-0.687	14.0	0.240	0.086
Namibia	2006-07	0.096	14.5	0.241	0.083
Niger	2006	-1.042	8.0	0.001	0.000
Nigeria	2008	-0.165	5.0	0.084	0.084
Rwanda	2010	-0.600	18.0	0.453	0.126
Senegal	2010-11	-0.337	13.5	0.062	0.023
Tanzania	2010	-0.682	14.0	0.219	0.078
Uganda	2006	-0.872	11.0	0.054	0.025
Zimbabwe	2010-11	-0.037	16.5	0.264	0.080
North Africa-West Asia-Europe					
Armenia	2005	1.819	5.0	0.583	0.583
Egypt	2008	1.566	13.0	0.820	0.315
Jordan	2009	1.520	12.0	0.252	0.105
Morocco	2003-04	0.707	11.5	0.636	0.277
Turkey	2003	2.059	10.0	0.772	0.386
Central Asia					
Kazakhstan	1999	0.830	4.0	0.148	0.185

(Continued...)

[15] Excluding the DHS-I countries for which a wealth index is not calculated.

Table 3.3 – *Continued*

Country	Year of latest survey	Mean comparative score	Change from earliest to latest survey		
			Years	Mean	Per 5 years
South and Southeast Asia					
Bangladesh	2011	-0.661	17.5	0.459	0.131
Cambodia	2010	-0.356	10.0	0.328	0.164
India	2005-06	-0.368	13.0	0.618	0.238
Indonesia	2012	0.696	15.0	0.568	0.189
Nepal	2011	-0.366	15.0	0.778	0.259
Philippines	2008	0.495	10.0	0.013	0.006
Vietnam	2002	-0.035	5.0	0.344	0.344
Latin America and Caribbean					
Bolivia	2008	0.338	14.0	0.498	0.178
Colombia	2010	1.404	20.0	0.458	0.114
Dominican Republic	2007	1.156	11.0	0.876	0.398
Guatemala	1998-99	-0.161	3.5	0.110	0.157
Haiti	2012	-0.371	17.5	0.187	0.053
Honduras	2011-2012	0.401	6.0	0.176	0.147
Nicaragua	2001	-0.313	3.0	-0.030	-0.051
Peru	2011	0.539	19.5	0.019	0.005

Because the number of years between surveys in the same country can vary, the five-year average change is a better indicator for use in comparing trends in wealth across countries. All 45 countries together had an increase of 0.118 in the CWI score as a five-year average change. The country with the greatest increase in the five-year mean CWI score was Armenia (+0.583), while Mali had the greatest decrease in the five-year mean CWI score (-0.111). By region, the five-year average increase in the CWI score was greatest in the North Africa/West Asia/Europe region (+0.333) and smallest in sub-Saharan Africa (+0.047) (Table 3.4).

Table 3.4 Trends in mean comparative wealth index score by region, DHS surveys 1998-2012

Region	Years between first and last surveys	Change	Five-year average change
Sub-Saharan Africa	12.1	0.117	0.047
North Africa-West Asia-Europe	10.3	0.613	0.333
Central Asia (Kazakhstan only)	4.0	0.148	0.185
South and Southeast Asia	12.2	0.444	0.190
Latin America and Caribbean	11.8	0.287	0.125
All	**11.7**	**0.254**	**0.118**

3.3 Monetary Equivalents

Keeping in mind the caveats given above, Figure 3.2 shows the relationship between the means of the CWI and the natural logarithm of GNI/p at ppp; Figure 3.3 shows the relationship as a fit line plot. There are several outliers, which is instructive regarding differences between the two types of values. Three former Soviet republics (Moldova, Armenia, and Ukraine) lie much above the trend line, indicating that

on average the population has a better economic status than that predicted by GNI/p at ppp. This anomaly may be due to either a recent decline in or an underestimation of GNI. Similarly, Zimbabwe lies well above the trend line, most likely due to its deteriorating economic situation. In the opposite direction, Gabon, with its high level of petroleum exports, is the DHS country with the highest GNI/p at ppp; however, the GNI/p at ppp is not reflected in the economic status of its population.

Figure 3.2 Mean of comparative wealth index (CWI) versus gross national income per capita at purchasing power parity (GNI/p at ppp), DHS surveys

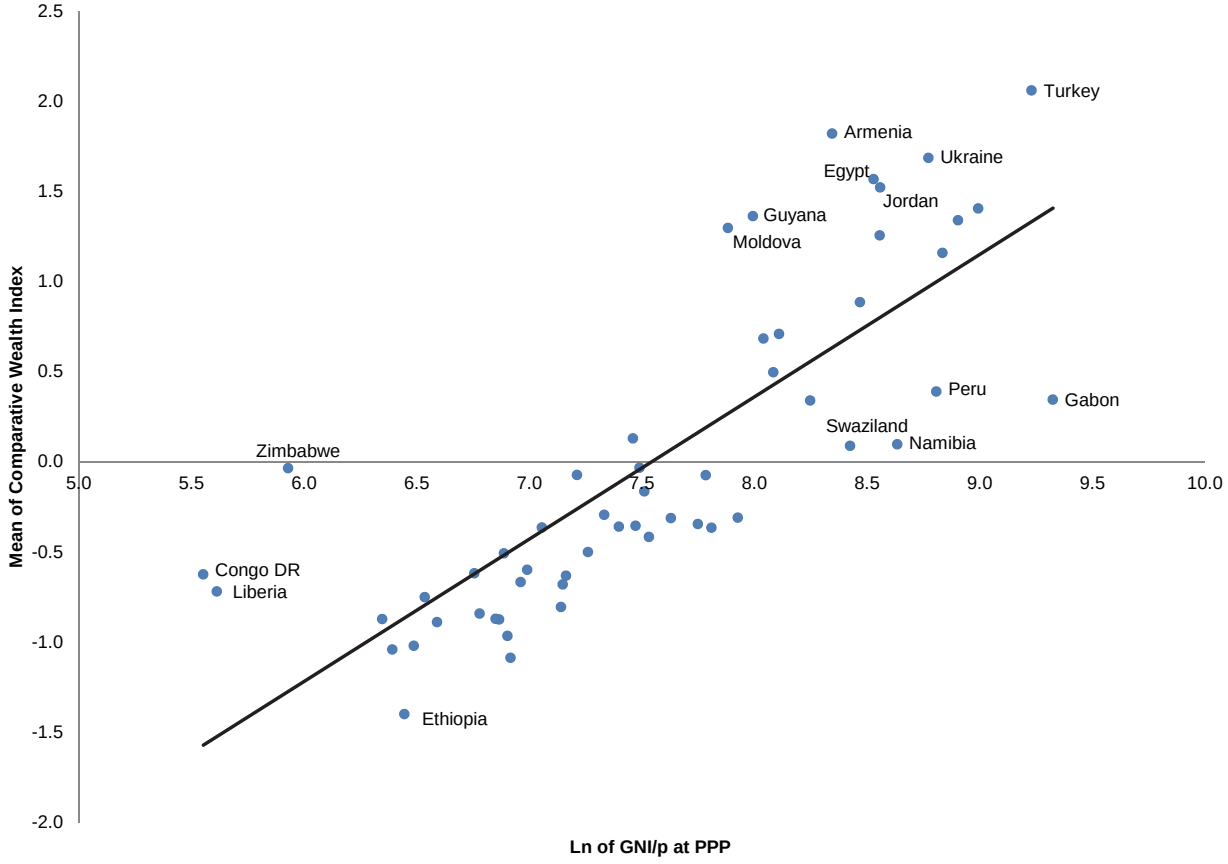
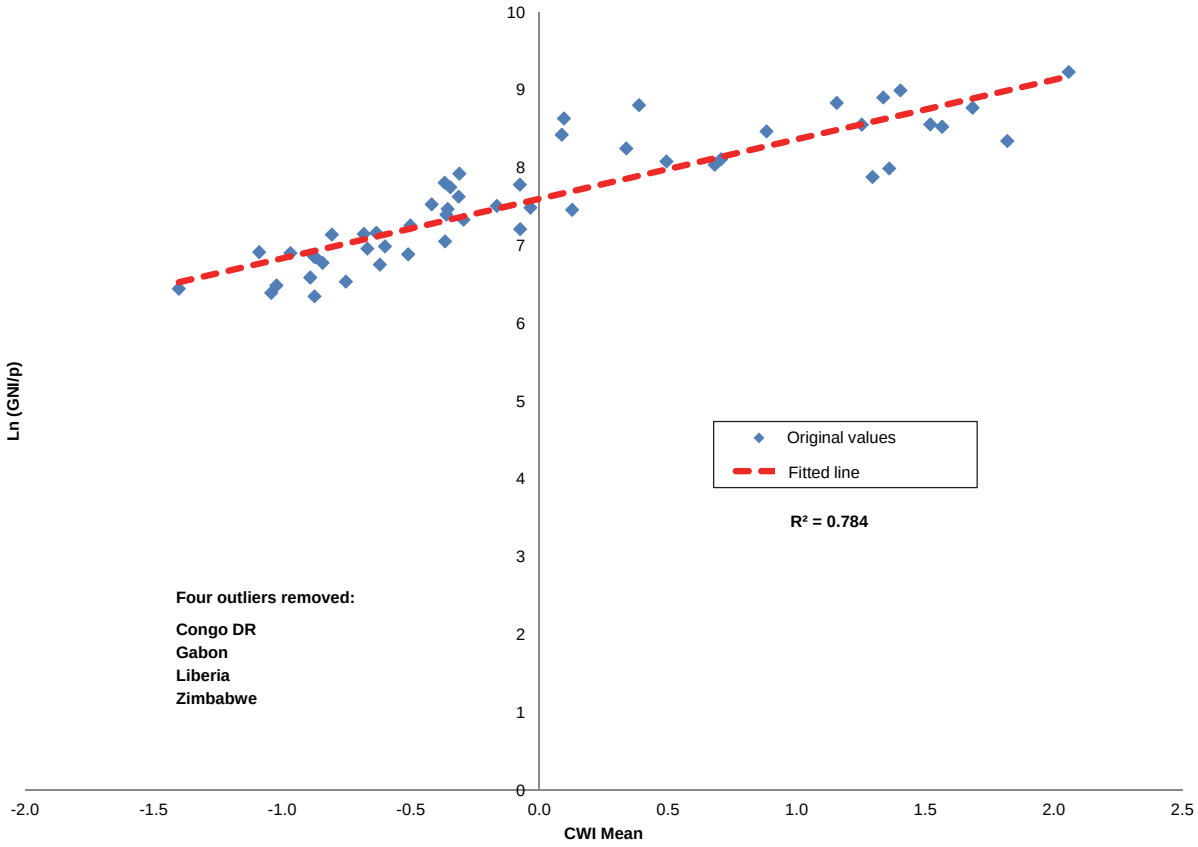


Figure 3.3 Relationship between the survey mean of the comparative wealth index (CWI) and the logarithm of gross national income per capita (Ln GNI/p), observed points and fitted line, DHS surveys



Re-estimating the trend relationship between the means of the CWI scores and GNI/p at ppp, after omitting these outliers gives the following:

$$\text{Ln (GNI/p)} = 7.603 + 0.7609 * \text{mean CWI}$$

Adjusted r^2=.784

These coefficients can be used to estimate the per capita income equivalent for each CWI score. As an example, the GNI/p at ppp equivalents for the comparative wealth quintile cutpoints are the following:

Cutpoint	Value	Ln(value)	GNI/p
1	-0.9080	6.909	$1,001
2	-0.3858	7.308	$1,492
3	-0.1189	7.512	$1,830
4	0.7416	8.170	$3,535

As noted earlier, these estimates should be interpreted with caution. Even at purchasing power parity (ppp), the price of assets themselves may vary substantially depending on such things as vintage of ownership, time period, and geographic access to household services and durable goods. Cross-country proclivities to owning the same asset at the same level of income may also vary substantially.

4 Example Applications

Beyond ranking countries on the basis of household wealth, the Comparative Wealth Index (CWI) is useful in cross-country and trend analysis of demographic and health outcomes. To illustrate a few of the analyses that can be done, the 52 most recent[16] DHS surveys for each country were pooled to analyze infant and child mortality, fertility, maternal health care, and children's nutritional status. For each topic, means and odds ratios, or relative risks, were calculated for the CWI and for the original DHS Wealth Index—called a "relative wealth index" here because it is within-survey relative—separately and with both indexes together. Unadjusted means and odds ratios, or relative risks, are presented and adjusted for principal confounding variables and for country effects.

4.1 Infant and Child Mortality

For young child mortality, two rates were used—infant mortality (IMR) and under-5 mortality (U5MR)—based on children born 0-59 months and children born 0-179 months preceding the survey, respectively. Unadjusted mortality rates for each wealth index were calculated using a life table procedure.[17] Adjusted relative risks for mortality were calculated using Cox hazard regression.[18] Table 4.1 shows the results of the analyses. The Wald statistic is used to measure the explanatory power of each wealth index. For each of the relative risk analyses the CWI has greater explanatory power, as indicated by its greater Wald statistic. Indeed, the relative wealth index performed badly after control variables were introduced but before country effects were taken into account. When country effects were taken into account the performance of the relative wealth index improved, indicating that the country effects are adjusting for differential levels in wealth. However, the CWI still has greater explanatory power even after taking country effects into account.

When the indexes are considered together, the CWI has the greater explanatory power for under-5 mortality, indicating that absolute economic status is more important than relative economic status; however, both indexes are related to level of mortality. For infant mortality, the relative wealth index becomes nonsignificant, indicating little relation to infant mortality once absolute economic status is taken into account. When wealth scores are used for each index rather than the quintiles—with control variables and country effects—the relative wealth index effect disappears, as indicated by an adjusted relative risk of 1.0 for a one-standard-deviation change in relative wealth, indicating no change in either under-5 or infant mortality. The CWI has an adjusted relative risk of 0.831 for under-5 mortality and 0.886 for infant mortality, given each standard deviation increase in the CWI (results not shown in a table).

[16] Most recent at the time the index was constructed. See complete list of surveys in Appendix table A.1.

[17] Survival procedure of IBM SPSS Statistics version 20.0.

[18] Cox procedure of IBM SPSS Statistics version 20.0.

Table 4.1 Infant and under-5 mortality: Deaths per 1,000 live births, 52 latest DHS surveys since 2003

	Infant mortality rate for children born 0-59 months preceding survey									Under-5 mortality rate for children born 0-179 months preceding survey								
Wealth quintile	**N**	**Mean**	**Relative risk**	**Adj. relative risk**	**Adj. mean**	**Adj. relative risk[1]**	**Adj. mean[1]**	**Adj. relative risk[2]**	**Adj. mean[2]**	**N**	**Mean**	**Relative risk**	**Adj. relative risk**	**Adj. mean**	**Adj. relative risk[1]**	**Adj. mean[1]**	**Adj. relative risk[2]**	**Adj. mean[2]**
Comparative wealth quintile																		
Wald statistic			1,902	532		123		42				18,083	4,788		1,242		411	
p-value			0.000	0.000		0.000		0.000				0.000	0.000		0.000		0.000	
Poorest (Ref.)	*182,240*	*.068*	*1.000*	*1.000*	*.068*	*1.000*	*.068*	*1.000*	*.068*	*507,751*	*.137*	*1.000*	*1.000*	*.137*	*1.000*	*.137*	*1.000*	*.137*
Second	79,495	.060	**.879**	**.925**	.063	**.957**	.065	.985	.067	222,168	.111	**.808**	**.884**	.121	**.897**	.123	**.926**	.127
Middle	39,037	.050	**.735**	**.789**	.054	**.853**	.059	**.887**	.060	110,064	.088	**.635**	**.737**	.101	**.814**	.112	**.851**	.117
Fourth	68,103	.041	**.613**	**.693**	.047	**.807**	.056	**.847**	.058	192,576	.066	**.481**	**.604**	.083	**.734**	.101	**.777**	.106
Wealthiest	95,399	.028	**.420**	**.542**	.037	**.731**	.051	**.787**	.054	284,699	.039	**.283**	**.430**	.059	**.618**	.085	**.675**	.092
Total	464,274	.053			.053		.053		.053	1,317,258	.097			.097		.097		.097
Relative wealth quintile																		
Wald statistic			253	21		91		8				3,211	67		895		52	
p-value			0.000	0.003		0.000		0.076				0.000	0.000		0.000		0.000	
Poorest (Ref.)	*117,692*	*.058*	*1.000*	*1.000*	*.058*	*1.000*	*.058*	*1.000*	*.058*	*334,432*	*.113*	*1.000*	*1.000*	*.113*	*1.000*	*.113*	*1.000*	*.113*
Second	99,479	.057	0.978	**1.044**	.061	.968	.056	.982	.057	282,968	.107	**0.948**	**1.038**	.117	**.948**	.107	**.976**	.110
Middle	92,340	.053	**0.919**	**1.050**	.061	**.912**	.053	.945	.055	261,187	.098	**0.873**	**1.049**	.119	**.886**	.100	**.947**	.107
Fourth	83,508	.051	**0.873**	**1.094**	.063	**.877**	.051	.956	.055	236,233	.088	**0.782**	**1.074**	.121	**.829**	.094	**.949**	.107
Wealthiest	71,255	.042	**0.717**	**1.093**	.063	**.772**	.045	.905	.052	202,438	.065	**0.576**	**1.052**	.119	**.692**	.078	**.886**	.100
Total	464,274	.053			.053		.053		.053	1,317,258	.097			.097		.097		.097

Note: Other variables include mother's level of education, multiplicity of birth, sex, preceding interpregnancy interval, birth order, mother's age at birth, and type of residence (urban/rural).

Odds ratios in **bold** are significant at the 5% level

[1] Includes country dummy variable

[2] Includes both wealth index variables and country dummy variables

4.2 Fertility

The indicator used for fertility level is whether or not a woman had a birth in the past year. For the means this indicator gives the proportions of women who had a birth and is akin to the general fertility rate (GFR) for women 15 to 49 years of age.[19] Logistic regression is used to analyze the effects of the wealth indexes, producing adjusted odds ratios as the output.[20] The unadjusted means and odds ratios indicate that both the CWI and the relative wealth index show important differences in fertility level by wealth quintile, and indicate that fertility declines as wealth increases (Table 4.2). Additionally, the Wald statistic shows that the CWI has the greater explanatory power. These results hold as control variables for age, education, marital status, and urban-rural residence are included in the regressions. However, after adding country effects, the explanatory advantage of the CWI is only slightly greater than that of the relative wealth index. When both indexes are included in the regression analysis, the results indicate that both absolute and relative wealth are important in determining fertility level.

Table 4.2 Fertility: Whether women 15-49 had a birth in the year preceding the survey, 52 latest DHS surveys since 2003

		Births per woman in 12 months preceding survey (General Fertility Rate)							
Wealth quintile	**N**	**Mean**	**Odds ratio**	**Adj. odds ratio**	**Adj. mean**	**Adj. odds ratio[1]**	**Adj. mean [1]**	**Adj. odds ratio[2]**	**Adj. mean [2]**
Comparative wealth quintile									
Wald statistic			12,872	2,470		1,269		261	
p-value			0.000	0.000		0.000		0.000	
Poorest (Ref.)	*215,788*	*.187*	*1.000*	*1.000*	*.187*	*1.000*	*.187*	*1.000*	*.187*
Second	116,842	.148	**0.755**	**0.883**	.169	**0.849**	.163	**0.915**	.174
Middle	67,567	.129	**0.645**	**0.780**	.152	**0.786**	.153	**0.864**	.166
Fourth	136,587	.110	**0.539**	**0.665**	.133	**0.687**	.136	**0.776**	.151
Wealthiest	264,911	.078	**0.370**	**0.534**	.109	**0.595**	.120	**0.717**	.142
Total	801,695	.128			.128		.128		.128
Relative wealth quintile									
Wald statistic			5,579	523		1,175		164	
p-value			0.000	0.000		0.000		0.000	
Poorest (Ref.)	*151,977*	*.169*	*1.000*	*1.000*	*.169*	*1.000*	*.169*	*1.000*	*.169*
Second	152,139	.146	**0.838**	**0.905**	.155	**0.877**	.151	**0.920**	.158
Middle	156,772	.129	**0.724**	**0.846**	.147	**0.791**	.139	**0.864**	.149
Fourth	162,364	.114	**0.633**	**0.823**	.143	**0.732**	.130	**0.855**	.148
Wealthiest	178,443	.087	**0.470**	**0.754**	.133	**0.613**	.111	**0.775**	.136
Total	801,695	.128			.128		.128		.128

Note: Other variables include: five-year age group, level of education, current marital status, and type of residence (urban/rural).

Odds ratios in **bold** are significant at the 5%

[1]Includes country dummy variable

[2] Includes both wealth index variables and country dummy variables level

[19] Among all these women, only one had more than 1 birth in the year preceding the interview; it was a multiple birth of four children.

[20] Logistic Regression procedure of IBM SPSS Statistics version 20.0.

4.3 Maternal Health Care

Two indicators of maternal health care are analyzed here for live births that occurred in the five years preceding the survey: 1) whether the mother received recommended minimum prenatal care (four or more visits, with the first beginning in the first trimester of the pregnancy) and 2) whether the delivery took place in a health facility. In addition to the two wealth indexes, control variables were the mother's age at interview, the mother's level of education, the husband's level of education (if married), and residence (urban or rural). An additional variable for facility deliveries was whether the mother had received the recommended minimum prenatal care. Logistic regression was used for analysis of both indicators.

For the recommended minimum prenatal care, the explanatory power of the CWI is much greater than that of the relative wealth index for unadjusted odds ratios and for adjusted odds ratios, without including country effects. For the adjusted odds ratios with the control variables, the CWI has significant results showing an increase in the prenatal care indicator with wealth (Table 4.3, first panel). At the same time, the effect of the relative wealth index is small and inconsistent; however, after country effects were introduced, the relative wealth index regains explanatory power such that the results for each index are similar. Including both indexes in the analysis indicates that absolute and relative wealth are about equally important in explaining recommended minimum prenatal care, with relative wealth having a little stronger relationship.

For delivery in a health facility, the results are similar to those for prenatal care, with the exception that relative wealth is still quite important even after control variables were introduced into the regression analysis. Indeed, the final columns of Table 4.3 show that, after including country effects, both relative and absolute wealth are equally important in explaining differences in health facility deliveries.

Table 4.3 Maternal health: Proper prenatal care (four or more visits starting in the first trimester of pregnancy) and delivery in a health facility, last birth in the five years preceding survey

		Proper prenatal care (4 or more visits starting in the first trimester of pregnancy)								Delivery in a health facility							
Wealth quintile	**N**	**Mean**	**Odds ratio**	**Adj. odds ratio**	**Adj. mean**	**Adj. odds ratio[1]**	**Adj. mean[1]**	**Adj. odds ratio[2]**	**Adj. mean[2]**	**Mean**	**Odds ratio**	**Adj. odds ratio**	**Adj. mean**	**Adj. odds ratio[1]**	**Adj. mean[1]**	**Adj. odds ratio[2]**	**Adj. mean[2]**
Comparative wealth quintile																	
Wald statistic			43,451	8,129		3,206		489			45,681	5,485		6,899		1,468	
p-value			0.000	0.000		0.000		0.000			0.000	0.000		0.000		0.000	
Poorest (Ref.)	*115,504*	*.181*	*1.000*	*1.000*	*.181*	*1.000*	*.181*	*1.000*	*.181*	*.348*	*1.000*	*1.000*	*.348*	*1.000*	*.348*	*1.000*	*.348*
Second	52,322	.294	**1.883**	**1.495**	.248	**1.360**	.231	**1.190**	.208	.526	**2.083**	**1.479**	.441	**1.918**	.506	**1.558**	.454
Middle	26,738	.390	**2.880**	**1.959**	.302	**1.532**	.253	**1.240**	.215	.641	**3.356**	**1.780**	.487	**2.648**	.586	**2.017**	.518
Fourth	47,054	.488	**4.296**	**2.494**	.355	**1.850**	.290	**1.379**	.234	.736	**5.241**	**2.264**	.547	**3.386**	.644	**2.317**	.553
Wealthiest	68,641	.671	**9.193**	**3.854**	.460	**2.793**	.382	**1.783**	.283	.852	**10.828**	**3.105**	.624	**4.556**	.709	**2.490**	.571
Total	310,259	.373			.373		.373		.373	.574			.574		.574		.574
Relative wealth quintile																	
Wald statistic			10,173	94		3,261		562			26,933	4,636		6,316		903	
p-value			0.000	0.000		0.000		0.000			0.000	0.000		0.000		0.000	
Poorest (Ref.)	*74,423*	*.272*	*1.000*	*1.000*	*.272*	*1.000*	*.272*	*1.000*	*.272*	*.328*	*1.000*	*1.000*	*.328*	*1.000*	*.328*	*1.000*	*.328*
Second	65,228	.323	**1.276**	.979	.268	**1.252**	.319	**1.124**	.296	.494	**1.590**	**1.338**	.395	**1.543**	.430	**1.335**	.395
Middle	61,861	.367	**1.546**	**.950**	.262	**1.530**	.364	**1.265**	.321	.575	**2.212**	**1.556**	.432	**1.981**	.492	**1.435**	.412
Fourth	57,331	.420	**1.934**	**.895**	.251	**1.910**	.416	**1.445**	.351	.677	**3.451**	**1.904**	.482	**2.710**	.569	**1.571**	.434
Wealthiest	51,416	.538	**3.115**	**.889**	.249	**2.859**	.516	**1.873**	.412	.830	**8.201**	**2.894**	.586	**4.863**	.704	**2.387**	.538
Total	310,259	.373			.373		.373		.373	.574			.574		.574		.574

Note: Other variables include mother's level of education, husband's level of education, birth order, mother's age, type of residence (urban/rural), and proper prenatal care for health facility delivery.

Odds ratios in **bold** are significant at the 5% level

[1] Includes country dummy variable

[2] Includes both wealth index variables and country dummy variables

4.4 Children's Nutritional Status

This illustrative use of the CWI and relative wealth indexes looks at children's nutritional status, as measured by stunting (chronic malnutrition) and wasting (acute malnutrition). The proportions of children under age 5 who were stunted (below -2 SD for height-for-age) and who were wasted (below -2 SD for weight-for-height) were chosen as indicators of the nutritional status of young children.[21] The CWI is related to the levels of both indicators, even after including control variables and country effects; as expected, the relationship is stronger for stunting than for wasting (Table 4.4). The relative wealth index is less strongly related to stunting than the CWI, but once country effects are taken into account the relative wealth index has about the same strength of relationship with wasting as the CWI. Including both indexes together in the analysis of stunting shows that both absolute wealth and relative wealth affect chronic malnutrition. Such is not the case for acute malnutrition though because the relationship of the relative wealth index turns nonsignificant (in the analysis of wasting), while that of the CWI remains significant even though its power is reduced.

[21] The proportions stunted and wasted are based on the CDC/NCHS/WHO reference population nutritional standard.

Table 4.4 Nutritional status indicators (stunting and wasting) for children age 0-59 months, 52 latest DHS surveys since 2003

	Stunting: Children age 0-59 months									Wasting: Children age 0-59 months								
Wealth quintile	**N**	**Mean**	**Odds ratio**	**Adj. Odds ratio**	**Adj. mean**	**Adj. Odds ratio[1]**	**Adj. mean[1]**	**Adj. Odds ratio[2]**	**Adj. mean[2]**	**N**	**Mean**	**Odds ratio**	**Adj. Odds ratio**	**Adj. mean**	**Adj. Odds ratio[1]**	**Adj. mean[1]**	**Adj. Odds ratio[2]**	**Adj. mean[2]**
Comparative wealth quintile																		
Wald statistic			14498	4489		3131		1031				1923	468		189		42	
p-value			0.000	0.000		0.000		0.000				0.000	0.000		0.000		0.000	
Poorest (Ref.)	*113,419*	*.406*	*1.000*	*1.000*	*.406*	*1.000*	*.406*	*1.000*	*.406*	*113,798*	*.108*	*1.000*	*1.000*	*.108*	*1.000*	*.108*	*1.000*	*.108*
Second	48,497	.351	**0.791**	**.871**	.373	**.749**	.339	**.808**	.356	48,589	.094	**.856**	**.970**	.105	**.853**	.093	**.898**	.098
Middle	24,165	.273	**0.549**	**.653**	.309	**.610**	.294	**.666**	.313	24,213	.078	**.702**	**.834**	.091	**.782**	.086	**.830**	.091
Fourth	41,273	.214	**0.405**	**.509**	.258	**.497**	.254	**.554**	.275	41,326	.067	**.603**	**.746**	.083	**.748**	.083	**.803**	.088
Wealthiest	59,657	.133	**0.233**	**.337**	.187	**.351**	.193	**.418**	.222	59,673	.047	**.423**	**.561**	.063	**.689**	.077	**.769**	.085
Total	287,011	.299			.299		.299		.299	287,599	.084			.084		.084		.084
Relative wealth quintile																		
Wald statistic			4850	288		2302		159				125	125		182		34	
p-value			0.000	0.000		0.000		0.000				0.000	0.000		0.000		0.135	
Poorest (Ref.)	*70,832*	*.367*	*1.000*	*1.000*	*.367*	*1.000*	*.367*	*1.000*	*.367*	*71,039*	*.090*	*1.000*	*1.000*	*.090*	*1.000*	*.090*	*1.000*	*.090*
Second	60,952	.327	**0.836**	**0.927**	.350	**.811**	.320	**.893**	.341	61,095	.085	**0.938**	1.014	.091	**.886**	.081	.901	.082
Middle	57,784	.301	**0.735**	**0.907**	.345	**.706**	.290	**.850**	.330	57,916	.085	**0.933**	**1.098**	.098	**.840**	.077	.896	.081
Fourth	52,653	.265	**0.613**	**0.884**	.339	**.600**	.258	**.864**	.334	52,724	.081	**0.881**	**1.167**	.104	**.780**	.072	.891	.081
Wealthiest	44,790	.188	**0.391**	**0.753**	.304	**.420**	.196	**.768**	.308	44,825	.073	**0.788**	**1.299**	.114	**.692**	.064	.842	.077
Total	287,011	.299			.299		.299		.299	287,599	.084			.084		.084		.084

Note: Other variables include mother's level of education, mother's work status, type of residence (urban/rural), and child's age.

Odds ratios in **bold** are significant at the 5% level

[1] Includes country dummy variable

[2] Includes both wealth index variables and country dummy variables

5 Conclusions and Limitations

5.1 Summary

This document outlines a procedure for making the country-specific DHS Wealth Indexes comparable to one another through the use of a baseline survey and linking (or anchoring) items that are present in almost all DHS surveys carried out since the 1990s. The selection of linking items was designed to include salient assets that cover the range of economic status indicators seen in the populations surveyed by the Demographic and Health Surveys program. The experimental Comparative Wealth Index (CWI) procedure makes full use of the information available in each of the surveys and allows for both level and dispersion adjustments to the baseline. It also allows for the addition of new surveys as they occur.

The Comparative Wealth Index produces results in the form of rankings of countries and regions—based on the calculation of means and standard deviations for each survey—as well as trends and regional averages that generally comport with per capita income measures.

In the illustrative analyses undertaken here for indicators of young child mortality, fertility, maternal health care, and child nutritional status, the CWI performed well, indicating that absolute levels of wealth are as important and usually more important than relative levels of wealth. However, the CWI does not completely replace the DHS Wealth Index and, in most of the analyses, both were found to be related to the outcome indicators. Using the CWI in trend analysis within countries may help to sort out the effects due to health programs focused on the poor versus the effects due to changes in the economic status of the population. Overall, the experimental CWI provides new options for analysis and investigation of health disparities across countries and over time.

5.2 Limitations

The methods described here are an initial approach to the development of a more widely applicable wealth index. Selection of the anchoring point criteria was limited here for purposes of illustration, and the results of the analyses could vary if other criteria were used. Indeed, not all surveys have all of the selected criteria. Most notably absent was information on the number of sleeping rooms (used for the household crowding point in the Unsatisfied Basic Needs scale), information on the sharing of toilet facilities with other households (used for the sanitation point), and information on possession of a fixed telephone. Within each survey, the number of workers in a household (used in the economic dependency point of the UBN) is not available if there were no individual interviews conducted in that household (which was then assumed to have one worker). The head of household in DHS surveys is defined by respondents and is likely, but not necessarily, the economic provider. The quantity and quality of assets, for example, number or type of cars and trucks, are not captured by DHS surveys. While the original purpose of the wealth index was to develop a measure of economic status independent of education or health, the approach here indirectly includes data on education in the assessment of a point for economic dependency in the UBN anchoring scores.

Because the DHS Wealth Index is country-specific and time-specific, it can function as a type of estimate of permanent income of the kind espoused by Milton Friedman (1957) that is somewhat independent of transient fluctuations in monetary income. Assets provide a more stable picture of household economic status than income, particularly in less developed countries where many workers earn seasonal or variable incomes. However, the concept of permanent income becomes more difficult to capture with assets and service amenities compared across countries and time. Prices of assets and the ability to purchase them may vary widely across countries; for example, as previously discussed, the availability of fixed (landline) phone service depends on a number of factors, such as 1) the time period of the survey, 2) the

infrastructure capacity of the country, and 3) the geographic location of the household. However, these assets were chosen to represent the upper portion of the wealth continuum since the UBN represents the lower portion. Given that mobile phone ownership was rare in the 1990s and is now widespread, even among the poor, it is not a useful anchoring point. The monetary cost of the assets, services, and amenities themselves tend to vary, even after controlling for purchasing power parity. However, the selection of a baseline has only a small effect on the overall ranking. Still, the results presented here should be interpreted with caution.

5.3 Further Research

A variation on calculation of the UBN point for economic dependency would be using the highest level of education of any of the adult members of the household rather than number of workers plus education. Some sensitivity analysis has been conducted to test how robust the current methodology is to possible variations in the anchoring criteria, but further sensitivity analysis should be done to determine the effects of using fewer anchoring points where survey-missing items are present. Alternative ways of determining the baseline survey could also be tested.

Linear regression was used to determine the coefficients for calculating Comparative Wealth Indexes from the relative, survey-specific DHS Wealth Indexes. Non-linear regressions should be investigated to find out if a specific functional form would work better. CWI could also be calculated separately for urban and rural areas within countries. These separate urban and rural values would then be combined into a Composite Comparative Wealth Index (CCWI) using calculations similar to those used for the country-specific composite Wealth Index.

Alternative monetary equivalents and comparable poverty lines applicable to the Comparative Wealth Index should be investigated—using the UBN scale, World Bank dollars per day, or other criteria—as applied to the baseline survey.

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Appendix A: Summary of Information from DHS Surveys

Appendix Table A.1 Surveys completed for comparative wealth index, number of anchoring regression points used, and missing variables, DHS surveys 1991 - 2012

Country	Year	Number of anchoring regression points	Missing variables				Codes used for HV205 (improved unshared toilet)
			HV212-car/truck	HV221-(fixed) telephone	HV216-sleeping rooms	Others	
Albania	2008-09	8					
Armenia	2000	6	x		x	don't use hv212-car	
Armenia	2005	8					
Azerbaijan	2006	8					
Bangladesh	1993-94	5	x	x		HV209	
Bangladesh	1996-97	5	x	x		HV209	
Bangladesh	1999-2000	6	x	x			
Bangladesh	2004	6	x	x			
Bangladesh	2007	8					
Bangladesh	2011	7					
Benin	1996	6		x			No improved unshared
Benin	2001	7			x		
Benin	2006	8					
Bolivia	1994	6	x	x			
Bolivia	1998	7	x				
Bolivia	2003	8					
Bolivia	2008	8					
Brazil	1996	7		x			
Burkina Faso	1993	7		x			
Burkina Faso	1998-99	7					
Burkina Faso	2003	7			x		
Cambodia	2000	7			x		
Cambodia	2005	7		x			
Cambodia	2010	8					
Cameroon	1991	7		x			
Cameroon	1998	7					
Cameroon	2004	8					
Cameroon	2011	8					
CAR	1994-95	8					
Chad	1996-97	8					
Chad	2004	8					
Colombia	1990	7					
Colombia	1995	8					
Colombia	2000	7					
Colombia	2005	7	x				

(Continued...)

App. Table A.1 – *Continued*

Country	Year	Number of anchoring regression points	Missing variables				Codes used for HV205 (improved unshared toilet)
			HV212-car/truck	HV221-(fixed) telephone	HV216-sleeping rooms	Others	
Colombia	2010	8					
Comoros	1996	7					
Congo Brazzaville	2005	8					
Congo Democratic Republic	2007	8					
Côte D'Ivoire	1994	7		x			
Côte D'Ivoire	1998-99	7					
Côte d'Ivoire	2011-12	8					
Dominican Republic	1996	8					
Dominican Republic	1999	8					
Dominican Republic	2002	8					
Dominican Republic	2007	8					
Egypt	1995	6	x	x			
Egypt	2000	8					
Egypt	2003	8					
Egypt	2005	8					
Egypt	2008	8					
Eritrea	1995	8					
Eritrea	2002	8					
Ethiopia	2000	7				hv209	hv214
Ethiopia	2005	8					
Ethiopia	2011	8					
Gabon	2000	8					
Gabon	2012	8					
Ghana	1993	7	x	x			
Ghana	1998	8					
Ghana	2003	7			x		
Ghana	2008	8					
Guatemala	1995	8					
Guatemala	1998-99	7					
Guinea	1999	7					
Guinea	2005	8					
Guyana	2009	8					
Haiti	1994-95	7	x	x			
Haiti	2000	7			x		
Haiti	2005-06	8					
Haiti	2012	8					

(Continued...)

App. Table A.1 – *Continued*

Country	Year	Number of anchoring regression points	Missing variables				Codes used for HV205 (improved unshared toilet)
			HV212-car/truck	HV221-(fixed) telephone	HV216-sleeping rooms	Others	
Honduras	2005-06	8					
Honduras	2011-2012	8					
India	1992-3	7		x			
India	1998-99	8					
India	2005-06	8					
Indonesia	1997	6		x	used area	hv208 not usable	
Indonesia	2002-03	7			used area		
Indonesia	2007	8			used area		
Indonesia	2012	8			used area		
Jordan	1997	8					
Jordan	2002	8					
Jordan	2007	8					
Jordan	2009	8					
Kazakhstan	1995	8					
Kazakhstan	1999	7	x			don't use hv212-car	
Kenya	1993	6	x	x			
Kenya	1998	8					
Kenya	2003	8					
Kenya	2008-09	8					
Kyrgyz Republic	1997	8					
Lesotho	2004	7			x		
Lesotho	2009	8					
Liberia	2007	7		x			
Madagascar	1997	8					
Madagascar	2003-04	7			x		
Madagascar	2008-09	8					
Malawi	1992	5		x		hv208, hv209	
Malawi	2000	5		x	x	hv209	
Malawi	2004	8					
Malawi	2010	8					
Maldives	2009	8					
Mali	1995-96	8					
Mali	2001	7					
Mali	2006	8					
Mauritania	2000-01	8					
Moldova	2005	8					
Morocco	1992	7					

(Continued...)

App. Table A.1 – *Continued*

Country	Year	Number of anchoring regression points	Missing variables				Codes used for HV205 (improved unshared toilet)
			HV212-car/truck	HV221-(fixed) telephone	HV216-sleeping rooms	Others	
Morocco	2003-04	8					
Mozambique	1997	8					
Mozambique	2003	8					
Mozambique	2011	8					
Namibia	1992	7		x			
Namibia	2000	8					
Namibia	2006-07	8					
Nepal	1996	5	x	x		hv209	
Nepal	2001	5	x		x	hv209	
Nepal	2006	8					
Nepal	2011	9					
Nicaragua	1998	8					
Nicaragua	2001	8					
Niger	1998	8					
Niger	2006	8					
Nigeria	2003	8					
Nigeria	2008	8					
Pakistan	2006-07	8					
Peru	1991-92	7		x			
Peru	1996	8					
Peru	2000	8					
Peru	2004-08	8					
Peru	2009	8					
Peru	2010	8					
Peru	2011	8					
Philippines	1998	8					
Philippines	2003	7			x		
Philippines	2008	8					
Rwanda	1992	6		x		hv208	no improved unshared toilet
Rwanda	2000	7			x		
Rwanda	2005	7			x		
Rwanda	2007-08	7					
Rwanda	2010	8					
Sao Tome and Principe	2008-09	8					
Senegal	1997	7		used sh22f			
Senegal	2005	8					
Senegal	2010-11	8					
Sierra Leone	2008	8					
South Africa	1998	8					

(Continued...)

App. Table A.1 – *Continued*

Country	Year	Number of anchoring regression points	Missing variables				Codes used for HV205 (improved unshared toilet)
			HV212-car/truck	HV221-(fixed) telephone	HV216-sleeping rooms	Others	
Swaziland	2006-07	8					
Tanzania	1996	7		x			
Tanzania	1999	7		x			
Tanzania	2003-04	8					
Tanzania	2010	8					
Timor-Leste	2009	8					
Togo	1998	7		x			no improved unshared toilet
Turkey	1993	8		used sh50j			
Turkey	1998	8					
Turkey	2003	8					
Uganda	1995	8					
Uganda	2000-01	7			x		
Uganda	2006	8					
Ukraine	2007	8					
Uzbekistan	1996	8					
Vietnam	1997	8					
Vietnam--baseline	2002	8					
Yemen	1997	7					
Zambia	1996	7		x			
Zambia	2001-02	7			x		
Zambia	2007	8					
Zimbabwe	1994	7		x			
Zimbabwe	1999	7			x		
Zimbabwe	2005-06	8					
Zimbabwe	2010-11	8					