Making the Demographic and Health Surveys Wealth Index Comparable

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Executive Summary

The Demographic and Health Surveys (DHS) and Multiple Indicator Cluster Surveys (MICS) contain a "wealth" of information on the health and demographic conditions of national populations in less developed countries. With the development of the DHS Wealth Index, a new avenue of analysis has been opened up to investigate economic status inequalities beyond those of educational attainment, residence and ethnic group membership. There has been a substantial limitation to this analysis in that the DHS Wealth Index is relative to the situation in each country at the time of the 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 between surveys and cannot be directly compared.

This paper describes a newly developed methodology for calculating wealth indexes comparable across country and time that allow for direct comparison of levels of economic status. The paper then proceeds to present inequality measures for a set of demographic and health indicators. Finally, the paper determines the contribution of relative and absolute measures of poverty to progress in these indicators.

Calculations of means and standard deviations for each survey as well as trends and regional averages show that the Comparative Wealth Index produces results in terms of ranking of countries and regions that generally comport with per capita income measures.

In the illustrative analyses undertaken for indicators of child mortality, fertility, maternal health care, and child nutritional status, the Comparative Wealth Index performs well and shows that absolute levels of wealth are important and usually more important than relative levels of wealth. However, one index does not completely replace the other and in most of the analyses both are related to the indicators of outcome. 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 economic status of the population.

By producing a Comparative Wealth Index for each survey, new avenues of analysis are opened up and questions of the value of poverty alleviation versus poverty eradication may be investigated.

1 Introduction

From the very beginning of the Demographic and Health Surveys project researchers and policymakers have been interested in creating a measure of economic status that is independent of demographic characteristics such as education and residence. Estimates of household income and expenditures in the Demographic and Health 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 (cf. Deaton 1997; Montgomery et al. 2000).

For a WHO meeting on Health for All in the Year 2000, Rutstein used a previously created index to illustrate differences in health equity that could be derived from existing DHS survey data, even though there were no data on income and expenditures. This index was based on assets and household amenities and services that had been included in the surveys because of their links to health, e.g. the association between diarrhea and dirt flooring, water supply and type of toilets. 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 (e.g. for vehicles, 0 for none to 3 for cars) was used. On the scale used, 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 from DHS surveys for use in evaluating education by economic status. As a result of the WHO meeting and a subsequent meeting at the Bank, a Bank-funded project was developed to produce a series of population and health indicators using a wealth index based on 42 existing DHS country datasets (1990 to 1998) with the Filmer-Pritchett principal component methodology for determining the item weights. A later second Bank funded project expanded the list of indicators and covered earlier and new surveys through 2001 (75 surveys in all). Subsequently, the DHS project decided to include the DHS Wealth Index (Rutstein and Johnson 2004) as a standard recode variable in all DHS survey datasets from then on.

Partly due to its success in determining differences in population and health indicators between the wealth quintiles, closer looks at the index suggested that more items be included in the DHS household questionnaires for newer surveys to increase the precision of the index and to correct for a possible urban bias. These items 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, computers and internet connections, etc. Later separate urban and rural wealth indexes were calculated and then combined into a national wealth index

(Rutstein 2008) to allow for differing item weightings in each area and for urban and rural specific analyses.

Currently, the DHS Wealth Index is calculated by using coefficients and sometimes items (assets, services, amenities) that are specific to urban and rural areas. The procedure is described in detail in Rutstein (2008) but briefly it involves first calculating a wealth index that uses items thought to be common and have common weightings in both urban and rural areas. Then area-specific wealth indexes are calculated for the urban and rural areas. These area specific indexes include additional items above those included in the common wealth index, such as number of farm animals, agricultural land size, and items not present in both areas, for example flush toilets to sewers. The urban and rural wealth indexes are then linearly regressed on the common wealth index. Then for each area, 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 are joined to make the combined wealth score at the national level. Quintiles for the urban, rural and national areas are then calculated using the de jure household populations of each of the areas and the urban, rural, and combined wealth indexes, respectively.

1.1 Need for a Comparative Wealth Index

To date the DHS Wealth Index is specific to each survey (i.e. to each country and date) with the exception of the Peru Continuous DHS where the wealth indexes for the five surveys done between 2004 and 2008 were constructed to be comparable to that of the 2000 DHS.[1] While the DHS Wealth Index is very useful for studying within country equity and relative economic poverty, it is constructed as a relative index within each country at the time of the survey. Each 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. In an extremely poor country, a household may appear in the highest wealth quintile but not necessarily be well-off in absolute terms.

Using external information where economic poverty is determined outside the DHS survey, poverty lines based on for example per capita income of less than $2.00 per day or a $1.00 per day (also $1.25 per person per day) or other definitions can be carried into the DHS data sets by determining cut points where the percent 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

[1] The 2004 through 2008 wealth indexes in Peru were made comparable by using the same items and, together with the same estimating equation (mean, standard deviation, and PCA coefficients) as in the 2000 DHS and by using the quintile cut points from that survey. Thus in 2008, the "quintiles" no longer represent 20% of the de jure household population as they did in 2000 but rather indicate the same level of economic status.

categories based on the cut points for the wealth index. While this procedure is useful if comparable economic poverty lines exist from external sources, it does not tell about comparability across the rest of the economic status spectrum nor reveal much about trends if the definition of economic poverty has changed over time.

To be able to judge whether the economic situation has improved over time, whether improvements in health and other indicators are due to general improvements in economic status or through the effects of government programs focused on the poorer sectors of the population, and whether international funding of health and development programs reaches the intended poorer sectors of the world population all require a DHS wealth index that is comparable across countries and time, the DHS Comparative Wealth Index (CWI).

1.2 Alternate measures of economic status and poverty

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

One 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 time and place. 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 others even when only a very small minority earns large incomes. Second, the accuracy of income data is difficult to ascertain, particularly in countries with large informal sectors.

World Health Survey and IHME Measures of Economic Status

Ferguson et al. (2003) describe a methodology for estimating permanent income using indicator variables, which is very similar to the relative DHS Wealth Index procedure. 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 the PCA gives scores that have a mean of zero and a standard deviation value of one, the authors claim 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 3 potential methods. One suggested method is to fix the level of two or more indicator variables such as is 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. That approach suggested the one used here, albeit with modifications that allow determining 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 to data from the Nicaragua Living Standards Measurement Surveys. She finds that the rescaled indexes perform 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 between the PCA and DIHOPIT methods.

International Wealth Index

The International Wealth Index 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 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: unlike the IHME methods described above (or the method used here), 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. Without any type of anchor to the relative wealth of a household, there is a loss of information produced by relative wealth computations about which assets are most salient to inequality in any given survey. The authors show high correlation between 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.

While universality and reproducibility are advantageous, one key drawback of this pooled method is that the computations were done at a single point in time and 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.

Other similar comparable wealth indexes were produced by Gakidou et al. (2007) to look at improving child survival using 42 DHS surveys and by Gakidou and Vayena (2007) for modern contraception use by the poor using 55 DHS surveys. 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" are similarly based on the weighted pooled datasets. As with the IWI, one drawback of this approach is that the "baseline" will change as new surveys are undertaken and pooled.

Unsatisfied Basic Needs (UBN)

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

According to Feres and Mancero (2001b), six key deprivations form the common denominator of these cross-national measurements of UBNs in Latin America: (1) overcrowding, (2) inadequate housing, (3) inadequate source of water, (4) lack or unsuitability of toilet facilities, (5) children not attending school, (6) lack of economic capacity. Countries generally use a subset of these indicators and measure them in slightly different ways.[2] The typical use of UBNs in poverty measurement is to set a threshold

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

cutpoint for each (for example: overcrowding is defined as three or more persons per room) and count the number of unsatisfied basic needs for each household. Some countries also transform these measures into a poverty index using a scoring system for each indicator (for example, number of persons per room), map these onto normalized scores, and weight 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 UBN 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 very sensitive to urban/rural residence, and measures of school attendance are not applicable to households without school-aged children.

Multi-dimensional Poverty Index (MDPI)

The Multidimensional Poverty Index (MPI) was developed by the Oxford Poverty and Human Development Initiative for the UNDP Human Development Report (United Nations Development Programme 2010). As with UBN, it was inspired by Amartya Sen's seminal work on poverty, human capabilities and standards of living (Sen 1999; Sen and Hawthorn 1988). The MPI goes further than UBN to consider a larger set of human deprivations including educational attainment and nutrition.

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

The MPI is an aggregate-level population indicator derived from multiplying the prevalence of poverty with the average severity of poverty. As such, it is useful in a broad cross-national or historical perspective, but not intended to directly compare individual households in the same country or to assess inequalities in deprivation within countries. Households with school-aged children are the only ones 'at risk' of being deprived of half the education score.[3] The measure of child mortality extends over the

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

history of a woman's reproductive lifespan and this reduces comparability among women of different ages, or those living in countries with recent famine or conflict. Households are counted as malnourished if any member meets the anthropometric criteria; this measure is sensitive to whether there was subsampling of anthropometric data within a country and across countries whether the survey collected these data for women, men, and/or children. The MPI is a useful summary measure of population well-being, but not intended to be used in household-level analysis.

2 Methods

2.1 The procedure in brief

While it is possible to calculate comparable wealth indices by using the same set of variables and categories in each of the surveys, 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 way of categorizing these questions make this procedure difficult to use without discarding the majority of information used in each country for the wealth index.

Instead, the procedure to calculate the Comparative Wealth Index makes use of several techniques: comparison with a baseline, an idea similar to that used for price indexes, use poverty levels and other common items that are in each DHS survey (or at least the large majority of surveys since 1990) as "anchoring" points, use the proportion of households at given levels of the "anchors" to determine cut points and adjust the survey-specific DHS Wealth Indexes through regression on anchor cut points of the baseline wealth index. The anchoring points approach was originally developed to produce comparable cross-country estimates of self-reported health and mobility in work done for the World Health Survey (Murray et al. 2000; Murray et al. 2003; Salomon, Tandon, and Murray 2001; Tandon et al. 2003). The anchoring approach has also been applied to cross-survey metrics such as political freedom (King et al. 2004), job satisfaction (Kristensen and Johansson 2008), and to permanent income (Ferguson et al. 2003).

In order to develop a comparable wealth index using the anchoring approach, several decisions need to be made: 1) Which survey's wealth index should serve as the baseline wealth index; 2) How many and what types of anchoring points should be used; 3) How to calculate the wealth score values for the anchoring cut points; and 4) What to do about surveys with some missing items.

2.2 Selection of the baseline

Since the goal was to make the survey-specific wealth indexes comparable with each other rather than an absolute measure of economic status, the selection of the baseline is somewhat arbitrary (as is the base year in a price index). At the time of 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 PPP) at purchasing power parity (World Bank 2013) so it was decided to use this indicator with data from the year 2000. Among countries with DHS surveys, Vietnam turned out to have the median value. The nearest DHS survey for Vietnam was done in 2002 so this survey's wealth index

was chosen as the baseline, being 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 of the anchoring points and calculation of wealth score values at these points

To ensure comparability it is necessary to spread the anchoring points across the economic distribution, including some relevant at the poorer level and others at wealthier levels. The unsatisfied basic needs index [UBN / *Indice de Necesidades Básicas Insatisfechas*] developed by ECLAC is used as the basis for the anchoring points at the lowest level of the economic distribution. As discussed earlier, the 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 quite 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 Instituto Nacional de Estadistica e Informatica [Peru] 2000), gives points for:

- A dwelling with inadequate walls (natural or rustic materials) or dirt flooring
- Crowding (more than 3 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 don't attend school
- High Economic Dependency: Households whose head has less than a primary complete education and has more than 3 persons per worker.

These items are available in almost all DHS surveys. A couple of variations in the items were made. Crowding was calculated as more than 3 persons per sleeping room.[5] Sharing of a toilet with other households was also taken as inadequate. The number of household members divided by the number of earners[6] was used as persons depending on the household head's income. The fourth item, households whose children 6 to 12 years of age who don't attend school was dropped since not all households have

[4] A recent alternative considered was the Multidimensional Poverty Index. While it is designed as an aggregate measure of the prevalence and depth of poverty, items on the index can themselves 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, as they are sensitive to the presence of school-aged children and the age of the mother. Other items used to compute the MPI are quite similar to those used for measuring UBN.
[5] DHS generally does not count the number and type of rooms, but rather the number rooms used for sleeping.
[6] Determined through the individual interview for women and men in households with individual interviews. All households are assumed to have a minimum of one income earner.

children of that age. Therefore the wealth scores were determined for the percentages that had 4 points, 3 or more points, 2 or more points, and 1 or more points, and these scores were 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 was the dependent variable and the wealth score was the independent variable[7].

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

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 at a value of zero for the dependent variable, the logit of .5 being 0.[8] 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 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 having a motorcycle since possession 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 would not be appropriate for relative wealth comparisons over time. Note that it is not necessary that more than 50% of the highest quintile have the possession since the calculation is based on the score and not on the quintile.

[7] 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. The authors 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".

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

2.4 Transformation of country-specific wealth indexes

The procedure given above was performed for the baseline survey (the 2002 Vietnam DHS) and for each specific survey. There were therefore 8 wealth score values for the baseline and for the specific survey. A linear regression is then run with the baseline anchor cut point values as the dependent variable and the specific survey's anchor cut point values as the independent variable:

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

where cpb is the value of the cut point on the baseline wealth index of item i and cpc is the value on the specific 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. Then 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 cut points for the quintiles of the baseline wealth index are used on the CWI. (These comparative quintile cut point values are therefore the same for all surveys).

2.5 Survey inclusion and survey-specific adjustments

The CWI was calculated for 157 DHS9 surveys conducted between 1990 and 2011 in sixty-nine countries. It was not calculated for Jordan 1990 since most of the questions used in the procedure were not asked. DHS wealth indexes are not available for eleven surveys in the early 1990s: the Dominican Republic 1991, Egypt 1992, Indonesia 1991 and 1994, Madagascar 1992, Niger 1992, Philippines 1993, Senegal 1992-3, Tanzania 1991-2, Yemen 1991-2, and Zambia 1992.

Before 2000, many of the 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 dropped from the standard questionnaire although many surveys in this phase did ask the question (18 surveys without information). Questions on possession of a car or truck were left out of 11 surveys and on a fixed telephone were left out of 27 surveys, mostly during the 1990s (DHS phases 2 and 3). Five surveys did not have information on possession of a refrigerator, and two lack information on television sets. Instead of the full complement of 8 regression data points, 20 surveys had 7 data points, 7 had 6 data points, and 4 had 5 data points. Where the number of sleeping rooms was lacking, the surveys were regressed against a pecial baseline wealth index from Vietnam 2002 that excluded that item.

[9] Nonstandard DHS surveys such as Malaria Indicator Surveys (MIS), AIDS Indicator Surveys (AIS), surveys with restricted data, and region-specific surveys were excluded from the analysis. Nigeria 1999 was also excluded due to poor data quality.

Other surveys made use of the regression points that existed.

2.6 Illustration of the process

The process will be illustrated using the Benin 2006 DHS as the specific survey with the baseline Vietnam 2002 DHS. Columns 1 and 4 of Table 1 give the percentages of households by UBN point score and possessing a car or truck, a refrigerator, a fixed telephone and a television for Vietnam 2002 and Benin 2006, respectively. Columns 2 and 5 give the cumulative percentage of households by UBN score and Columns 3 and 6 give the wealth index cut point 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 -0.74984 and 0.85967, respectively, which represent the level and the dispersion of the CWI to be calculated for Benin 2006. Finally, the CWI score for each household is given by substituting the household's wealth score into the regression equation above.

Table 1 Example calculation of cut points

Thus for Benin 2006 on the baseline wealth index, the mean for the household members' wealth score is -0.7251 and the standard deviation is 0.8967 (Table 2). The comparative baseline quintile cut points are -0.9080, -0.3858, -0.1189, and +0.7416. (The original Benin 2006 wealth index has a mean = 0.0288, a standard deviation = 1.0431, and quintile cut points=-0.7095, -0.5129, -0.1932, and +0.6566.) From this calculation, it is clear that Benin in 2006 was generally poorer than Vietnam in 2002.

Table 2 Example results of comparative computations

2.7 Establishing a Monetary Equivalent

The Comparative Wealth Index is one that does not have a fixed absolute value, but is relative to the baseline survey so that an index score can be compared across DHS surveys. However, the cut points for the UBN estimate of poverty and extreme poverty for the baseline survey can be applied to the CWIs for all the surveys, giving comparable lines for poverty and extreme poverty across the surveys. From Table 1, the cut point between poor and not poor would be a value of -0.0810 and between poor and extremely poor would be -0.7464. In Vietnam in 2002, this means that 31 percent of the household population was poor but not extremely so, and 25 percent was extremely poor. For Benin in 2006 67% of the household population was extremely poor and another 15% were poor but not extremely so, and only 18% were 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 similar measure. Moreover, the DHS wealth index is a household measure while GNI includes income not distributed to households. Additionally, the DHS wealth index is not as affected by the very great distributional inequalities of income that form part of GNI.

Be that as it may, one way of proceeding 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 time against income per capita. 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.

3 Results

3.1 Levels of Wealth

The Comparative Wealth Index was computed for 157 DHS surveys conducted between 1990 and 2011. Of the 157 surveys, 79 were conducted in sub-Saharan Africa, 21 in North Africa / West Asia / Eastern Europe, 4 in Central Asia, 26 in South and Southeast Asia, and 27 in Latin America and the Caribbean. Table 3 presents the results of producing the comparative wealth index for these 157 DHS surveys. Figure 1 gives a visual picture of the results ordered by level of mean CWI score. Turkey in 2003 has the highest mean and Eritrea 1995 has the lowest. The greatest dispersion occurs in South Africa 1998 and Peru 1991-92, indicating higher levels of inequality, and the least dispersion in Kazakhstan 1999 and Malawi 1992, indicating more homogenous societies. However, these latter two countries have very different means.

Compared with the baseline, the unweighted average of the means of the CWI scores for all the 157 surveys is -0.260 and the unweighted average of the standard deviations is 0.930 (Table 4), while the average date is 2001. While given that median per capita income among DHS countries was used to choose the baseline so that one might expect the averages to be closer to 0 for the mean and 1 for the standard deviation, many countries have multiple surveys, and the average below 0 indicates that the relatively poorer countries are those with more surveys.[10]

By region, the 21 surveys in North Africa, West Asia and Eastern Europe have the highest average mean wealth scores. Sub-Saharan Africa has the lowest average of the means. Of the 79 surveys conducted in sub-Saharan Africa over the 21-year period, only 5 (Gabon 2000, Namibia 2006-07, Sao Tome 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 the standard deviations indicating greater dispersion in wealth than the other regions (Table 4).

Table 3 Values of comparative wealth index in relation to baseline
Figure 1 Comparative Wealth Indices, DHS Surveys 1990-2011
Table 4 Mean comparative wealth index by region

[10] Gross National Income per capita also includes non-household income so that countries may be ranked differently if only household income (not available) had been used to select the baseline.

3.2 Trends in Wealth

Using the countries with multiple DHS surveys[11], the average change between the first and the latest surveys' mean CWI is shown in Table 5. Of the 43 countries with more than one wealth index, 37 have had an increase in their mean CWI, five (Chad, Cote d'Ivoire, Kazakhstan, India, and Philippines) have had a decline and one has had no substantial change (Guinea).

Table 5 Trends in mean comparative wealth index score by country

Due to the fact that the number of years between surveys can vary, the five-year average change is a better indicator with which to compare the trends across countries in wealth. All 43 countries together had an increase of 0.166 in the CWI score as a five-year average change. The country with the greatest five-year average increase in mean CWI score is Armenia (+1.358) and Kazakhstan had the greatest decrease (-0.745). By region, the five-year average change in CWI score increased most in the North Africa, West Asia and Europe region (+0.470) and increased the least in Sub-Saharan Africa (+0.115), after the excluding Central Asia where only Kazakhstan had more than one survey (Table 6).

Table 6 Trends in mean comparative wealth index by region

3.3 Monetary Equivalents

Keeping in mind the caveats given above, Figure 2 shows the relationship between the means of the CWI and the natural logarithm of GNI/pop. There are several outliers, which are instructive as to the difference between the two types of values. Three former Soviet republics lie much above the trend line, Moldova, Armenia and the Ukraine, indicating that on average the population has a better economic status than that predicted by GNI/pop. This anomaly may be due to either a recent decline in Gross National Income or an underestimation of GNI. Similarly, Zimbabwe lies above the trend line most likely due to its deteriorating recent economic situation. In the opposite direction are Gabon, the country with the highest GNI/pop among the DHS countries, and Azerbaijan. Both have GNI/pop that are not reflected in the economic status of their populations, due to high levels of petroleum exports.

Figure 2 Wealth versus Income

Figure 2a Ln GNI/pop Line fit plot

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

$$\text{Ln (GNI/pop)} = 8.173 + 1.160 * \text{mean CWI}$$

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

(0.102) (0.121)
Adjusted r^2=.649

where the numbers in parentheses are the standard errors of the coefficients. These coefficients can be used to estimate the per capita income equivalent to each CWI score. As an example, the GNI/pop equivalents for the comparative wealth quintile cutpoints are:

cutpoint	value	ln		GNI/p
1	-0.9080	7.120	$	1,236
2	-0.3858	7.725	$	2,265
3	-0.1189	8.035	$	3,087
4	0.7416	9.033	$	8,375

4 Example applications

Beyond ranking countries on the basis of household wealth, the Comparative Wealth Index is useful in the cross-country and trend analysis of demographic and health outcomes. To illustrate a few of the analyses that can be done, the 47 most recent DHS surveys for each country (at the time of construction of the CWI) were pooled together to analyze fertility, maternal health care, young child mortality and young children's nutritional status. For each analysis topic, means and odds ratios or relative risks were calculated for the CWI and for the original DHS Wealth Index (called relative wealth index here since it is within survey relative) separately and with both indexes together. Unadjusted means and odds ratios or relative risks are presented as well as adjusted for principal confounding variables and then for country effects.

4.1 Child mortality

For young child mortality, the infant and under-five mortality rates were used based on children born 0-59 months and 0-179 months prior to the survey, respectively. Unadjusted mortality rates for each wealth index were calculated using a life table procedure[12]. Adjusted relative risks for mortality were calculated using Cox hazard regression[13] Table 7 shows the results. The Wald statistic is used to measure the explanatory power each wealth index. For each of the relative risk analyses, the CWI has a greater explanatory power as indicated by its greater Wald statistic. Indeed, the relative wealth index performs badly once control variables are introduced but before country effects are taken into account. Upon taking country effects into account, the relative wealth index improves its performance, indicating that the country effects are adjusting for differential levels in wealth. However, the CWI still has a greater explanatory power even after taking country effects into account.

Table 7 Infant and Under-Five Mortality: Deaths per 1000 live births, 47 latest DHS surveys

When both indexes are considered together, the CWI has the greater explanatory power but for under-five mortality, indicating that absolute is more important than relative economic status but that both are related to level of mortality. For infant mortality, the relative wealth index becomes non-significant, indicating little relation to infant mortality once absolute economic status is taken into account. Upon using the wealth scores for each index rather than the quintiles in the analysis 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-five or infant

[12] Survival procedure of IBM SPSS Statistics version 20.0.
[13] Cox procedure of IBM SPSS Statistics version 20.0.

mortality. The CWI has an adjusted relative risk for under-five mortality of 0.834 and for infant mortality of 0.884, given each standard deviation increase in the CWI.

4.2 Fertility

The indicator used for fertility level is whether or not a woman had a birth in the last year. For the means this indicator gives the proportions of women who had a birth and is akin to the general fertility rate for women 15 to 49 years of age.[14] Logistic regression is used to analyze the effects of the wealth indexes, producing adjusted odds ratios as the output.[15] The unadjusted means and odds ratios indicate that both the comparative and relative wealth indexes show important differences in fertility level by wealth quintile, and indicate that fertility declines as wealth increases (Table 8). As shown by the Wald statistic, the CWI has the greater explanatory power. These results hold as control variables for age, education, marital status and urban-rural area 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 8 Fertility: Whether Woman 15-49 had a birth in the year preceding the survey

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 had had recommended minimum prenatal care (four or more visits with 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 education level, husband's education level (if married), and urban-rural area of residence. Additionally for facility deliveries, whether the mother had had recommended minimum prenatal care. Logistic regression is used for the 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 that show an increase in the prenatal care indicator with wealth (Table 9, first panel). However, the effect of the relative wealth index is very small and inconsistent. Once country effects are introduced,

[14] Among all these women, only one had more than 1 birth in the year preceding the interview, and it was multiple with four children born!
[15] Logistic Regression procedure of IBM SPSS Statistics version 20.0.

though, the relative wealth index regains explanatory power such that the results for each index are very similar. Including both indexes in the analysis indicates that both absolute and relative wealth are almost 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 very similar to those for prenatal care, with the exception that relative wealth is still quite important even after control variables are introduced into the regression analysis. Indeed, the final columns of Table 9 indicate that after including country effects, both relative and absolute wealth are equally important in explaining differences in health facility deliveries.

Table 9 Maternal Health: Proper Prenatal Care--4 or more visits starting in the first trimester of pregnancy and Delivery in a Health Facility, Last Birth in the Five Years Preceding Survey

4.4 Children's Nutritional Status

For this illustrative use of the comparative and relative wealth indexes, the proportions of children under age five who were stunted (less than -2 sd for height for age—chronic malnutrition) and who were wasted (less than -2 sd for weight for height—acute malnutrition) were chosen as indicators of the nutritional status of young children[16]. The CWI is related to the levels of both indicators, even after including both control variables and country effects but the relationship is stronger for chronic malnutrition than for acute malnutrition, an expected result (Table 10). The relative wealth index is less strongly related to stunting than the CWI but once country effects are taken into account 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, though, for acute malnutrition since the relationship of the relative wealth index turns non-significant but that of absolute wealth remains significant even though its power is reduced.

Table 10 Nutritional Status Indicators for Children 0-59 months of age: Stunting and Wasting

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

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 of linking (or anchoring) items that are present in almost all DHS surveys since the 1990s. While the selection of linking items is somewhat arbitrary, we feel that they generally cover the range of economic status encountered for the large majority of the populations in countries with DHS surveys. The Comparative Wealth Index 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.

Calculations of means and standard deviations for each survey as well as trends and regional averages show that the Comparative Wealth Index produces results in terms of ranking of countries and regions that generally comport with per capita income measures.

In the illustrative analyses undertaken for indicators of child mortality, fertility, maternal health care, and child nutritional status, the CWI performs well and shows that absolute levels of wealth are important and usually more important than relative levels of wealth. However, one index does not completely replace the other and in most of the analyses both are related to the indicators of outcome. 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 economic status of the population.

By producing a CWI for each survey, new avenues of analysis are opened up and questions of the value of poverty alleviation versus poverty eradication may be investigated.

5.2 Limitations

The methods described here are an initial approach. The selections of the anchoring point criteria are somewhat arbitrary and the results may vary if other criteria had been used. Indeed not all surveys have all the selected criteria, most notably absent being information on 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 possession of fixed telephones. Within each survey, the number of workers in a household, used in the high economic dependency point of the UBM, is not available if there were no individual interviews in that household (which was then assumed to have one worker). The head of household in DHS is defined by respondents and likely, but not necessarily, to be the economic provider. The quantity and quality of assets, for example number or type of cars and trucks, are not captured by DHS. 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 in the UBN anchoring scores.

5.3 Further Research

A variation on the calculation of the UBN point for high economic dependency can be made by using the highest level of education of any of the adult members of the household or of the workers in the household instead of using the head's education level. Sensitivity analysis is therefore in order to test how robust the current methodology is to possible variations in the anchoring criteria. Sensitivity analyses should also be done to determine the effects of using fewer anchoring points where survey-missing items are present.

Linear regression was used to determine the coefficients to calculate the Comparative Wealth Indexes from the relative survey-specific indexes. Non-linear regressions should be investigated to find out if a specific functional form would work better. Separate urban and rural Comparative Wealth Indexes could also be calculated following the procedures described above and then combined into a composite comparative wealth index along the same lines that the country-specific composite wealth index is calculated

The determination of comparable poverty lines as applicable to the Comparative Wealth Index should be investigated, using the UBN, World Bank dollars per day, or other criteria, as applied to the baseline survey.

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Figure 1: Mean and Standard Deviation of the Comparative Wealth Index, DHS Surveys 1990-2011

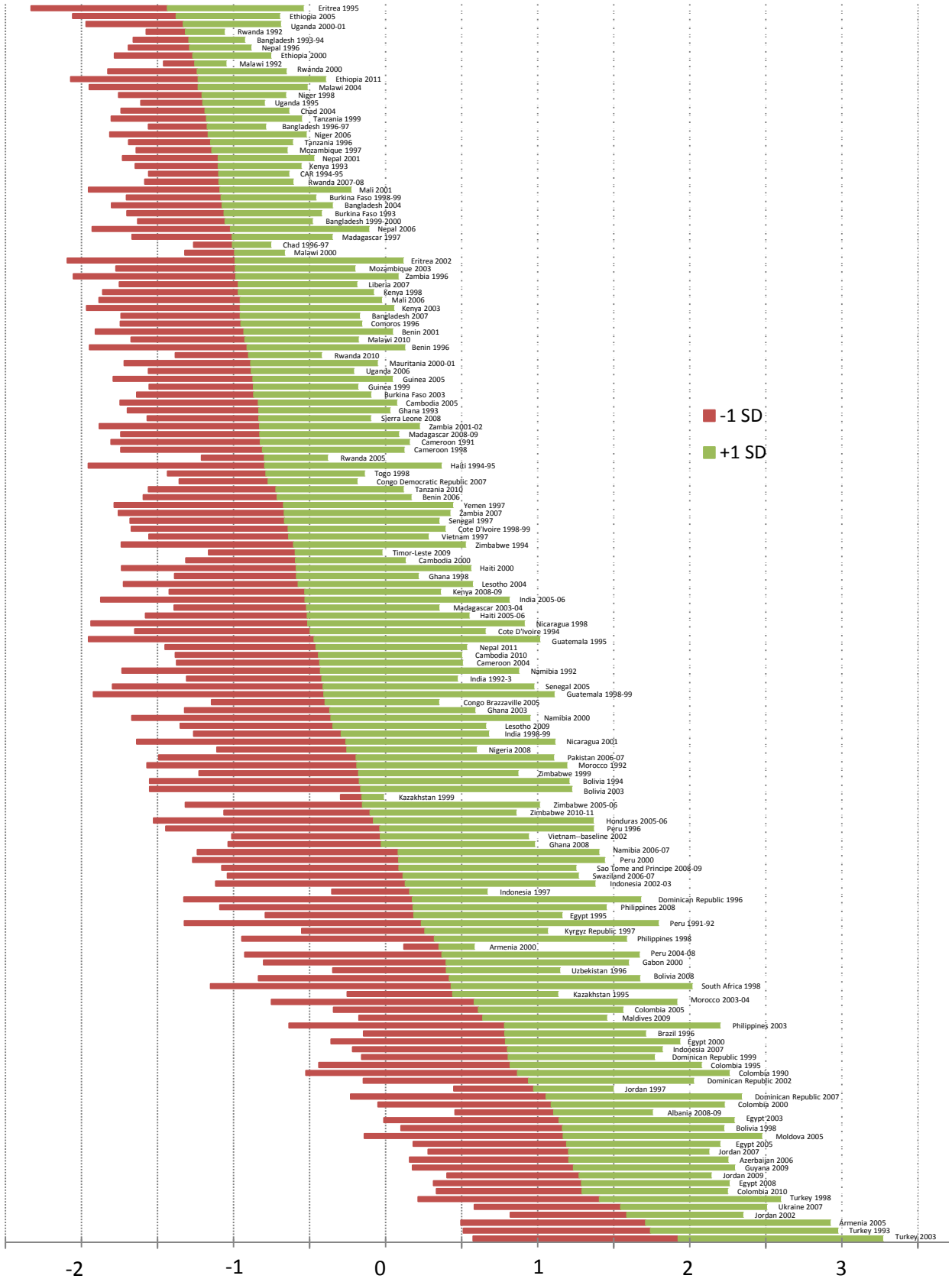

Table 1. Example calculation of cut points

Items	Baseline (Vietnam 2002) % of households with item	Cumulative % of households by UBN score	Cut points for median or cumulative %	Benin 2006 % of households with item	Cumulative % of households by UBN score	Cut points 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		0.6721
UBN score						
0	43.9	100.0		25.3	100.0	
1	31.4	56.1	-0.0810	38.8	74.7	0.4091
2	15.8	24.7	-0.7464	20.8	35.9	-0.5503
3	7.3	8.9	-1.2260	11.6	15.1	-0.7460
4	1.6	1.6	-1.5885	3.5	3.5	-0.8675

Regression of column 6 on column 3:

α	-0.74984
β	0.85967

Table 2. Example results of comparative computations

Household population wealth index scores	Baseline (Vietnam 2002) Country-specific	Comparative	Benin 2006 Country-specific	Comparative
Mean	-0.04814	-0.04814	0.0288	-0.7251
Standard deviation	0.98334	0.98334	1.0431	0.8967
Minimum	-1.93391	-1.93391	-1.03	-1.63665
Maximum	2.79952	2.79952	7.57	5.75444

Wealth quintiles		Country-specific cut point with next highest quintile	Comparative cut point with next highest quintile	Percent of household population	Country-specific cut point with next highest quintile	Comparative cut point with next highest quintile	Percent of household population
	1	-0.9080	-0.9080	20	-0.7095	-0.9080	60.4
	2	-0.3858	-0.3858	20	-0.5129	-0.3858	15.8
	3	-0.1189	-0.1189	20	-0.1932	-0.1189	6.7
	4	0.7416	0.7416	20	0.6566	0.7416	9.2
	5	na	na	20	na	na	7.9

Table 3. Values of comparative wealth index in relation to baseline (as currently computed)

Region and Country	Year	Mean	Standard Deviation
Sub-Saharan Africa			
Benin	1996	-0.910	1.038
Benin	2001	-0.931	0.979
Benin	2006	-0.713	0.882
Burkina Faso	1993	-1.061	0.640
Burkina Faso	1998-99	-1.081	0.624
Burkina Faso	2003	-0.866	0.771
Cameroon	1991	-0.824	0.982
Cameroon	1998	-0.809	0.932
Cameroon	2004	-0.433	0.941
CAR	1994-95	-1.097	0.462
Chad	1996-97	-1.008	0.255
Chad	2004	-1.187	0.553
Comoros	1996	-0.950	0.795
Congo Brazzaville	2005	-0.397	0.748
Congo Democratic Republic	2007	-0.772	0.586
Cote D'Ivoire	1994	-0.496	1.154
Cote D'Ivoire	1998-99	-0.640	1.033
Eritrea	1995	-1.435	0.896
Eritrea	2002	-0.989	1.106
Ethiopia	2000	-1.268	0.515
Ethiopia	2005	-1.377	0.681
Ethiopia	2011	-1.232	0.839
Gabon	2000	0.398	1.201
Ghana	1993	-0.834	0.864
Ghana	1998	-0.586	0.802
Ghana	2003	-0.367	0.956
Ghana	2008	-0.027	1.009
Guinea	1999	-0.868	0.687
Guinea	2005	-0.872	0.919
Kenya	1993	-1.100	0.547
Kenya	1998	-0.969	0.892
Kenya	2003	-0.955	1.012
Kenya	2008-09	-0.530	0.893
Lesotho	2004	-0.575	1.149
Lesotho	2009	-0.346	1.006
Liberia	2007	-0.969	0.782
Madagascar	1997	-1.009	0.659
Madagascar	2003-04	-0.519	0.872
Madagascar	2008-09	-0.827	0.915
Malawi	1992	-1.254	0.206
Malawi	2000	-0.992	0.329
Malawi	2004	-1.231	0.719

Region and Country	Year	Mean	Standard Deviation
Malawi	2010	-0.925	0.748
Mali	2001	-1.089	0.864
Mali	2006	-0.955	0.930
Mauritania	2000-01	-0.886	0.834
Mozambique	1997	-1.143	0.498
Mozambique	2003	-0.987	0.787
Namibia	1992	-0.428	1.306
Namibia	2000	-0.359	1.311
Namibia	2006-07	0.083	1.322
Niger	1998	-1.206	0.551
Niger	2006	-1.167	0.647
Nigeria	2008	-0.255	0.854
Rwanda	1992	-1.316	0.258
Rwanda	2000	-1.239	0.588
Rwanda	2005	-0.796	0.416
Rwanda	2007-08	-1.096	0.489
Rwanda	2010	-0.901	0.481
Sao Tome and Principe	2008-09	0.087	1.166
Senegal	1997	-0.664	1.017
Senegal	2005	-0.410	1.387
Sierra Leone	2008	-0.833	0.735
South Africa	1998	0.433	1.584
Swaziland	2006-07	0.115	1.155
Tanzania	1996	-1.149	0.540
Tanzania	1999	-1.178	0.627
Tanzania	2010	-0.721	0.839
Togo	1998	-0.786	0.649
Uganda	1995	-1.202	0.408
Uganda	2000-01	-1.329	0.640
Uganda	2006	-0.884	0.676
Zambia	1996	-0.985	1.069
Zambia	2001-02	-0.829	1.054
Zambia	2007	-0.666	1.091
Zimbabwe	1994	-0.606	1.133
Zimbabwe	1999	-0.177	1.050
Zimbabwe	2005-06	-0.151	1.166
Zimbabwe	2010-11	-0.101	0.961
North Africa-West Asia-Europe			
Albania	2008-09	1.106	0.651
Armenia	2000	0.352	0.232
Armenia	2005	1.710	1.215
Azerbaijan	2006	1.205	1.048
Egypt	1995	0.186	0.977

Region and Country	Year	Mean	Standard Deviation
Egypt	2000	0.789	1.148
Egypt	2003	1.142	1.153
Egypt	2005	1.191	1.010
Egypt	2008	1.288	0.973
Jordan	1997	0.974	0.525
Jordan	2002	1.586	0.766
Jordan	2007	1.204	0.925
Jordan	2009	1.273	0.870
Moldova	2005	1.168	1.308
Morocco	1992	-0.188	1.382
Morocco	2003-04	0.583	1.335
Turkey	1993	1.743	1.233
Turkey	1998	1.406	1.193
Turkey	2003	1.924	1.348
Ukraine	2007	1.546	0.962
Yemen	1997	-0.671	1.114
Central Asia			
Kazakhstan	1995	0.441	0.694
Kazakhstan	1999	-0.155	0.142
Kyrgyz Republic	1997	0.258	0.809
Uzbekistan	1996	0.400	0.747
South and Southeast Asia			
Bangladesh	1993-94	-1.292	0.367
Bangladesh	1996-97	-1.173	0.387
Bangladesh	1999-2000	-1.055	0.576
Bangladesh	2004	-1.075	0.727
Bangladesh	2007	-0.955	0.785
Cambodia	2000	-0.592	0.723
Cambodia	2005	-0.836	0.911
Cambodia	2010	-0.440	0.943
India	1992-3	-0.418	0.891
India	1998-99	-0.292	0.971
India	2005-06	-0.530	1.344
Indonesia	1997	0.158	0.512
Indonesia	2002-03	0.130	1.249
Indonesia	2007	0.802	1.020
Maldives	2009	0.640	0.815
Nepal	1996	-1.288	0.405
Nepal	2001	-1.100	0.630
Nepal	2006	-1.019	0.911
Nepal	2011	-0.458	0.993
Pakistan	2006-07	-0.193	1.300

Region and Country	Year	Mean	Standard Deviation
Philippines	1998	0.321	1.266
Philippines	2003	0.783	1.418
Philippines	2008	0.181	1.271
Timor-Leste	2009	-0.594	0.572
Vietnam	1997	-0.637	0.920
Vietnam--baseline	2002	-0.035	0.977
Latin America and Caribbean			
Bolivia	1994	-0.172	1.380
Bolivia	1998	1.164	1.063
Bolivia	2003	-0.163	1.389
Bolivia	2008	0.418	1.254
Brazil	1996	0.783	0.928
Colombia	1990	0.868	1.393
Colombia	1995	0.819	1.259
Colombia	2000	1.089	1.140
Colombia	2005	0.610	0.953
Colombia	2010	1.292	0.959
Dominican Republic	1996	0.176	1.503
Dominican Republic	1999	0.806	0.964
Dominican Republic	2002	0.940	1.087
Dominican Republic	2007	1.056	1.287
Guatemala	1995	-0.470	1.485
Guatemala	1998-99	-0.406	1.517
Guyana	2009	1.236	1.060
Haiti	1994-95	-0.794	1.162
Haiti	2000	-0.587	1.149
Haiti	2005-06	-0.514	1.064
Honduras	2005-06	-0.079	1.447
Nicaragua	1998	-0.511	1.426
Nicaragua	2001	-0.261	1.376
Peru	1991-92	0.236	1.559
Peru	1996	-0.038	1.407
Peru	2000	0.086	1.355
Peru	2004-08	0.372	1.298


Wealth versus Income
Mean of Comparative Wealth Index
Ln of GNI/p at PPP
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
5.0
5.5
6.0
6.5
7.0
7.5
8.0
8.5
9.0
9.5
10.0
Ukraine
Armenia
Moldova
Zimbabwe
Gabon
Azerbaijan

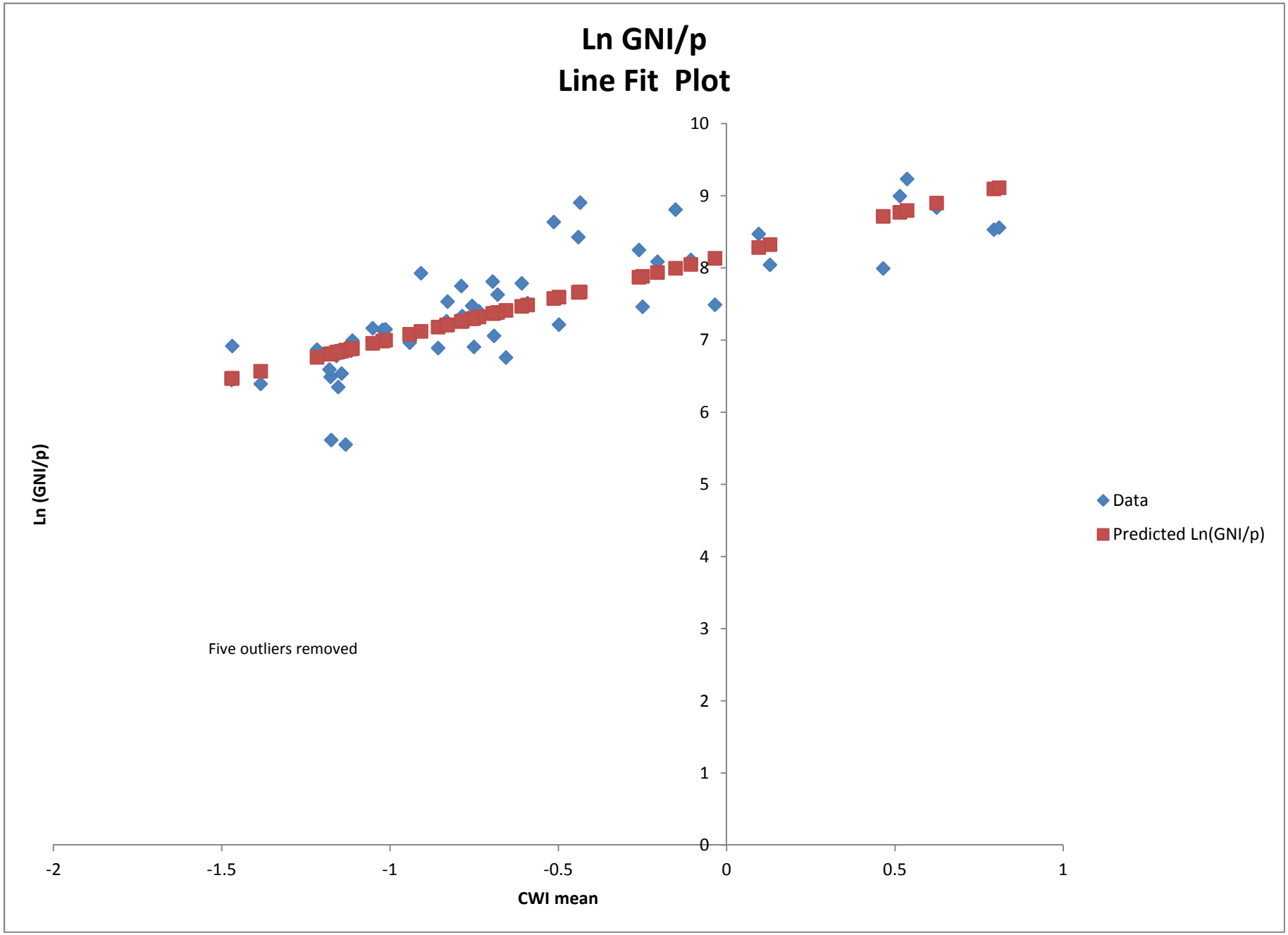
Ln GNI/p
Line Fit Plot
Ln (GNI/p)
CWI mean
10
9
8
7
6
5
4
3
2
1
0
-2
-1.5
-1
-0.5
0
0.5
1
Data
Predicted Ln(GNI/p)
Five outliers removed

Table 4. Mean comparative wealth index by region

	Date	Average of Means	Average of Standard Deviation
All	**2001.3**	**-0.260**	**0.930**
Regions			
Sub-Saharan Africa	2001.4	-0.780	0.831
North Africa-West Asia-Europe	2002.0	1.025	1.017
Central Asia	1996.8	0.236	0.598
South and Southeast Asia	2002.3	-0.422	0.880
Latin America and Caribbean	2000.0	0.295	1.254

Table 5: Trends in mean Comparative Wealth Index score by country

			Change from earliest to latest		
Region and Country	**Year of latest survey**	**Mean comparative score**	**Years**	**Mean**	**Per 5-years**
Sub-Saharan Africa					
Benin	2006	-0.713	10	0.198	0.099
Burkina Faso	2003	-0.866	10	0.195	0.097
Cameroon	2004	-0.433	13	0.390	0.150
Chad	2004	-1.187	8	-0.179	-0.112
Cote D'Ivoire	1998	-0.640	4	-0.144	-0.180
Eritrea	2002	-0.989	7	0.447	0.319
Ethiopia	2011	-1.232	11	0.036	0.016
Ghana	2008	-0.027	15	0.807	0.269
Guinea	2005	-0.872	6	-0.004	-0.004
Kenya	2008	-0.530	15	0.570	0.190
Lesotho	2009	-0.346	5	0.230	0.230
Madagascar	2008	-0.827	11	0.181	0.082
Malawi	2010	-0.925	18	0.329	0.091
Mali	2006	-0.955	5	0.134	0.134
Mozambique	2003	-0.987	6	0.155	0.129
Namibia	2006	0.083	14	0.511	0.182
Niger	2006	-1.167	8	0.039	0.025
Rwanda	2010	-0.901	10	0.338	0.169
Senegal	2005	-0.410	8	0.254	0.159
Tanzania	2010	-0.721	14	0.429	0.153
Uganda	2006	-0.884	11	0.318	0.145
Zambia	2007	-0.666	11	0.318	0.145
Zimbabwe	2010	-0.101	16	0.504	0.158
North Africa-West Asia-Europe					
Armenia	2005	1.710	5	1.358	1.358
Egypt	2008	1.288	13	1.103	0.424
Jordan	2009	1.273	12	0.299	0.124
Morocco	2003	0.583	11	0.771	0.350
Turkey	2003	1.924	10	0.181	0.090
Central Asia					
Kazakhstan	1999	-0.155	4	-0.596	-0.745
South and Southeast Asia					
Bangladesh	2007	-0.955	14	0.338	0.121
Cambodia	2010	-0.440	10	0.151	0.076
India	2005	-0.530	13	-0.112	-0.043
Indonesia	2007	0.802	10	0.644	0.322

Nepal	2011	-0.458	15	0.830	0.277
Philippines	2008	0.181	10	-0.140	-0.070
Vietnam	2002	-0.035	5	0.603	0.603
Latin America and Caribbean					
Bolivia	2008	0.418	14	0.591	0.211
Colombia	2010	1.292	20	0.424	0.106
Dominican Republic	2007	1.056	11	0.880	0.400
Guatemala	1998	-0.406	3	0.064	0.107
Haiti	2005	-0.514	11	0.280	0.127
Nicaragua	2001	-0.261	3	0.250	0.416
Peru	2004	0.372	8	0.410	0.256

Table 6. Trend in mean comparative wealth index

	Years between first and last surveys	Change	Five-year average change
All	**10.186**	**0.334**	**0.166**
Regions			
Sub-Saharan Africa	10.261	0.263	0.115
North Africa-West Asia-Europe	10.200	0.742	0.470
Central Asia (Kazakhstan only)	4.000	-0.596	-0.745
South and Southeast Asia	11.000	0.330	0.183
Latin America and Caribbean	10.000	0.414	0.232

Table 7. Infant and Under-Five Mortality: Deaths per 1000 live births, 47 latest DHS surveys

		Under-Five Mortality Rate for children born 0-179 months prior to survey									Infant Mortality Rate for children born 0-59 months prior to survey								
		N	Mean	Relative Risk	Adj. Relative Risk	Adj mean	Adj. Relative Risk [2]	Adj mean [2]	Adj. Relative Risk [3]	Adj mean [3]	N	Mean	Relative Risk	Adj. Relative Risk	Adj mean	Adj. Relative Risk [2]	Adj mean [2]	Adj. Relative Risk [3]	Adj mean [3]
Comparative Wealth Quintile																			
Wald Statistic				17031	4224		1186		387				1864	458		133		49	
p-value				0.000	0.000		0.000		0.000				0.000	0.000		0.000		0.000	
Poorest	*Reference*	*554,557*	*.135*	*1.000*	*1.000*	*.135*	*1.000*	*.135*	*1.000*	*.135*	*197,249*	*.067*	*1.000*	*1.000*	*.067*	*1.000*	*.067*	*1.000*	*.067*
Second		171,566	.106	**.783**	**.870**	.117	**.893**	.121	**.929**	.125	60,319	.058	**.856**	**.916**	.061	**.924**	.062	**.949**	.064
Middle		92,470	.083	**.615**	**.726**	.098	**.813**	.110	**.859**	.116	31,941	.048	**.711**	**.793**	.053	**.840**	.057	**.867**	.058
Fourth		174,609	.063	**.468**	**.600**	.081	**.739**	.100	**.786**	.106	60,675	.040	**.602**	**.707**	.047	**.811**	.055	**.837**	.056
Wealthiest		257,372	.039	**.285**	**.446**	.060	**.615**	.083	**.678**	.092	85,722	.027	**.408**	**.550**	.037	**.701**	.048	**.736**	.049
Total		1,250,574	.097			.097		.097		.097	435,906	.053			.053		.053		.053
Relative Wealth Quintile																			
Wald Statistic				3341	53		874		63				296	16		92		7	
p-value				0.000	0.000		0.000		0.000				0.000	0.003		0.000		0.135	
Poorest	*Reference*	*309,627*	*.114*	*1.000*	*1.000*	*.114*	*1.000*	*.114*	*1.000*	*.114*	*108,335*	*.059*	*1.000*	*1.000*	*.059*	*1.000*	*.059*	*1.000*	*.059*
Second		271,352	.107	**0.938**	**1.032**	.118	**.958**	.109	**.978**	.111	93,856	.057	0.974	**1.048**	.062	.982	.058	.998	.059
Middle		250,383	.098	**0.860**	**1.043**	.119	**.890**	.101	**.939**	.107	87,269	.053	**0.898**	1.037	.061	**.905**	.053	.947	.056
Fourth		225,355	.088	**0.768**	**1.069**	.122	**.830**	.095	**.938**	.107	78,719	.049	**0.845**	**1.078**	.064	**.869**	.051	.963	.057
Wealthiest		193,857	.065	**0.561**	**1.045**	.119	**.690**	.079	**.875**	.100	67,727	.041	**0.692**	**1.089**	.064	**.774**	.046	.941	.056
Total		1,250,574	.097			.097		.097		.097	435,906	.053			.053		.053		.053

Other included variables: Level of Mother's Education, Multiplicity of Birth, Sex, Preceding Interpregnancy Interval, Birth Order, Mother's Age at Birth, Type of Area of Residence

[2] Includes country dummy variable

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

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

Table 8. Fertility: Whether Woman 15-49 had a birth in the year preceding the survey

			Births per woman in 12 months preceding survey (General Fertility Rate)							
		N	Mean	Odds ratio	Adj. Odds ratio	Adj mean	Adj. Odds ratio [2]	Adj mean [2]	Adj. Odds ratio [3]	Adj mean [3]
Comparative Wealth Quintile										
Wald Statistic				11450	1759		1176		241	
p-value				0.000	0.000		0.000		0.000	
Poorest	*Reference*	*239,752*	*.180*	*1.000*	*1.000*	*.180*	*1.000*	*.180*	*1.000*	*.180*
Second		92,976	.142	**0.756**	**0.865**	.160	**0.847**	.157	**0.922**	.168
Middle		57,405	.123	**0.641**	**0.756**	.142	**0.773**	.145	**0.853**	.158
Fourth		121,268	.110	**0.564**	**0.690**	.132	**0.690**	.132	**0.778**	.146
Wealthiest		241,076	.078	**0.383**	**0.567**	.111	**0.601**	.117	**0.726**	.138
Total		752,477	.127			.127		.127		.127
Relative Wealth Quintile										
Wald Statistic				5603	531		1141		201	
p-value				0.000	0.000		0.000		0.000	
Poorest	*Reference*	*137,430*	*.172*	*1.000*	*1.000*	*.172*	*1.000*	*.172*	*1.000*	*.172*
Second		141,911	.146	**0.822**	**0.885**	.155	**0.869**	.153	**0.901**	.158
Middle		148,346	.128	**0.703**	**0.824**	.146	**0.776**	.139	**0.839**	.149
Fourth		154,088	.113	**0.613**	**0.803**	.143	**0.719**	.130	**0.834**	.148
Wealthiest		170,702	.087	**0.458**	**0.741**	.134	**0.609**	.112	**0.764**	.137
Total		752,477	.127			.127		.127		.127

Other included variables: Five-Year Age Group, Level of Education, Current Marital Status, and Type of Area of Residence

[2] Includes country dummy variable

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

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

Table 9. Maternal Health: Proper Prenatal Care--4 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								Health Facility Delivery							
		N	Mean	Odds ratio	Adj. Odds ratio	Adj mean	Adj. Odds ratio [2]	Adj mean [2]	Adj. Odds ratio [3]	Adj mean [3]	Mean	Odds ratio	Adj. Odds ratio	Adj mean	Adj. Odds ratio [2]	Adj mean [2]	Adj. Odds ratio [3]	Adj mean [3]
Comparative Wealth Quintile																		
Wald Statistic				35976	5592		2998		407			39523	4063		5535		1033	
p-value				0.000	0.000		0.000		0.000			0.000	0.000		0.000		0.000	
Poorest	*Reference*	*117,033*	*.199*	*1.000*	*1.000*	*.199*	*1.000*	*.199*	*1.000*	*.199*	*.336*	*1.000*	*1.000*	*.336*	*1.000*	*.336*	*1.000*	*.336*
Second		36,968	.328	**1.965**	**1.490**	.270	**1.428**	.262	**1.173**	.226	.503	**1.997**	**1.352**	.406	**1.825**	.480	**1.461**	.425
Middle		20,194	.398	**2.661**	**1.741**	.302	**1.561**	.280	**1.188**	.228	.608	**3.063**	**1.689**	.461	**2.402**	.549	**1.770**	.473
Fourth		37,283	.475	**3.638**	**2.032**	.336	**1.819**	.312	**1.300**	.244	.699	**4.543**	**2.060**	.510	**3.046**	.607	**2.085**	.514
Wealthiest		59,672	.670	**8.172**	**3.273**	.449	**2.879**	.417	**1.702**	.297	.836	**9.958**	**2.712**	.579	**4.565**	.698	**2.439**	.553
Total		271,150	.373			.373		.373		.373	.540			.540		.540		.540
Relative Wealth Quintile																		
Wald Statistic				11947	52		3124		571			27147	4245		5464		973	
p-value				0.000	0.000		0.000		0.000			0.000	0.000		0.000		0.000	
Poorest	*Reference*	*62,631*	*.249*	*1.000*	*1.000*	*.249*	*1.000*	*.249*	*1.000*	*.249*	*.326*	*1.000*	*1.000*	*.326*	*1.000*	*.326*	*1.000*	*.326*
Second		57,002	.317	**1.399**	**1.078**	.263	**1.265**	.295	**1.171**	.279	.444	**1.650**	**1.331**	.392	**1.470**	.416	**1.347**	.395
Middle		54,058	.368	**1.759**	**1.063**	.260	**1.542**	.338	**1.315**	.303	.547	**2.499**	**1.652**	.445	**1.998**	.492	**1.561**	.431
Fourth		50,795	.427	**2.247**	1.026	.253	**1.935**	.390	**1.500**	.332	.652	**3.879**	**1.999**	.492	**2.721**	.569	**1.708**	.453
Wealthiest		46,664	.558	**3.822**	**1.096**	.266	**2.982**	.497	**1.981**	.396	.809	**8.823**	**2.848**	.580	**4.748**	.697	**2.483**	.546
Total		271,150	.373			.373		.373		.373	.540			.540		.540		.540

Other included variables: Level of Mother's Education, Level of Husband's Education, Birth Order, Mother's Age, Type of Area of Residence, Proper prenatal care for health facility delivery

[2] Includes country dummy variable

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

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

Table 10. Nutritional Status Indicators for Children 0-59 months of age: Stunting and Wasting

		Stunting for children 0-59 months of age									Wasting for children 0-59 months of age								
		N	Mean	Odds ratio	Adj. Odds ratio	Adj mean	Adj. Odds ratio [2]	Adj mean [2]	Adj. Odds ratio [3]	Adj mean [3]	N	Mean	Odds ratio	Adj. Odds ratio	Adj mean	Adj. Odds ratio [2]	Adj mean [2]	Adj. Odds ratio [3]	Adj mean [3]
Comparative Wealth Quintile																			
Wald Statistic				13781	4432		2431		803				1933	542		167		35	
p-value				0.000	0.000		0.000		0.000				0.000	0.000		0.000		0.000	
Poorest	*Reference*	*135,584*	*.367*	*1.000*	*1.000*	*.367*	*1.000*	*.367*	*1.000*	*.367*	*120,595*	*.110*	*1.000*	*1.000*	*.110*	*1.000*	*.110*	*1.000*	*.110*
Second		42,076	.297	**0.729**	**.797**	.316	**.782**	.312	**.834**	.326	37,296	.094	**.846**	**.943**	.104	**.862**	.096	**.914**	.101
Middle		22,486	.235	**0.531**	**.612**	.262	**.658**	.276	**.710**	.292	19,885	.078	**.684**	**.792**	.089	**.801**	.090	**.847**	.094
Fourth		40,916	.185	**0.405**	**.492**	.222	**.549**	.242	**.602**	.259	35,968	.067	**.606**	**.727**	.082	**.775**	.087	**.828**	.092
Wealthiest		59,909	.117	**0.234**	**.328**	.160	**.392**	.185	**.457**	.210	52,784	.046	**.402**	**.512**	.059	**.682**	.077	**.752**	.085
Total		300,971	.271			.271		.271		.271	266,528	.086			.086		.086		.086
Relative Wealth Quintile																			
Wald Statistic				4840	270		1768		111				133	125		175		42	
p-value				0.000	0.000		0.000		0.000				0.000	0.003		0.000		0.135	
Poorest	*Reference*	*72,228*	*.333*	*1.000*	*1.000*	*.333*	*1.000*	*.333*	*1.000*	*.333*	*63,984*	*.094*	*1.000*	*1.000*	*.094*	*1.000*	*.094*	*1.000*	*.094*
Second		64,297	.302	**0.866**	**0.957**	.323	**.865**	.302	**.910**	.312	57,216	.086	**0.909**	.995	.093	**.882**	.084	.891	.085
Middle		60,923	.276	**0.759**	**0.937**	.319	**.769**	.278	**.881**	.306	54,256	.087	**0.908**	**1.080**	.101	**.836**	.080	.876	.083
Fourth		55,139	.238	**0.619**	**0.897**	.309	**.654**	.246	**.883**	.306	48,941	.084	**0.877**	**1.173**	.108	**.786**	.075	.882	.084
Wealthiest		48,384	.166	**0.391**	**0.758**	.275	**.465**	.188	**.791**	.283	42,131	.075	**0.773**	**1.290**	.118	**.686**	.066	.840	.080
Total		300,971	.271			.271		.271		.271	266,528	.086			.086		.086		.086

Other included variables: Level of Mother's Education, Mother's Work Status,Type of Area of Residence

[2] Includes country dummy variable

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