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Assessing Asset Indices

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Abstract

This paper compares how results using various methods to construct asset indices match results using per capita expenditures. The analysis shows that inferences about inequalities in education, health care use, fertility, child mortality, as well as labor market outcomes are quite robust to the specific economic status measure used. The measures—most significantly per capita expenditures versus the class of asset indices—do not, however, yield identical household rankings. Two factors stand out in predicting the degree of congruence in rankings between per capita expenditures and an asset index. First is the extent to which per capita expenditures can be explained by observed household and community characteristics. In settings with small transitory shocks to expenditure, or with little measurement error in expenditure, the rankings yielded by the alternative approaches are most similar. Second is the extent to which expenditures are dominated by individually consumed goods such as food. Asset indices are typically derived from indicators of goods which are effectively public at the household level, while expenditures are often dominated by food, an almost exclusively private good. In settings where private goods such as food are the main component of expenditures, asset indices and per capita consumption yield the least similar results, although adjusting for economies of scale in household expenditures reconciles the results somewhat.

This paper—a product of the Human Development and Public Services Team, Development Research Group—is part of a larger effort in the department to understand and measure inequalities in welfare and human development. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The author may be contacted at dfilmer@worldbank.org.

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Introduction

In this paper we revisit the potential for carrying out welfare analysis in the absence of the typically used measure of household economic status, per capita household expenditures. In many situations this preferred proxy for income is not available. While various solutions to overcoming this problem have been proposed, Filmer and Pritchett (1999, 2001) popularized an approach using an aggregate index based on consumer durable assets owned by household members, along with a set of housing characteristics, to rank households.

Filmer and Pritchett (1999, 2001) developed their index in the context of analyzing the associations between household economic status and schooling outcomes when using data sets without information on household expenditures. The approach has since been used for a variety of purposes. For example, researchers have used asset indices to explain inequalities in health outcomes and behaviors (Gwatkin et al. 2000; Bollen et al. 2002; Schellenberg et al. 2003), in particular those related to fever and malaria (Filmer 2005; Njau et al.. 2006), child nutrition (Sahn and Stifel 2003; Tarozzi and Mahajan 2005), child mortality (Fay et al 2005; Sastry 2004), and early child development (Ghuman et al.. 2005). The approach has also been used to analyze socio-economic inequalities in schooling in sub-populations, such as orphans (Ainsworth and Filmer 2006; Bicego, Rutstein and Johnston 2003; Case, Paxon, and Ableidinger 2004; Evans and Miguel 2004) and children with disabilities (Filmer 2008). Others have used asset indices to analyze poverty change (Sahn and Stifel 2000; Stifel and Christiaensen 2007), inequality (McKenzie 2005), or to control for economic status in program evaluation when expenditures data are not available (Rao and Ibanez 2005). The asset index approach has frequently been used to describe inequalities in health and education outcomes in international databases such as those in the World Bank's *World Development Reports* (World Bank 2003, 2005a, 2006).

A similar approach of using an index of observable household characteristics has been used in a different context for the purpose of targeting public programs. For example, Ecuador uses an index of assets and other household characteristics (based on a census of households) to target cash transfers to poor households (Schady and Araujo 2006). Analogous proxy-means targeting approaches have been applied in other countries such as Armenia, Brazil, Colombia and Indonesia (see discussion in Coady, Grosh and Hoddinott 2004).

The fact that expenditure data are expensive and time-consuming to collect makes it plausible that there will always be occasions when a proxy indicator of economic status is needed. Data used to construct asset indices are simple to collect and are frequently available. This paper takes an empirical approach to investigating the attributes of asset indices both in terms of how they correlate with household expenditures, as well as how they affect our understanding of the link between economic status and human development outcomes. Despite the existing literature on the issue (discussed in more detail below) there remain outstanding questions. By systematically comparing results across 11 surveys we address three main questions: *Are* alternative measures of economic status different? If so, *does it matter* for the types of analysis that they are typically used for? And, *when* are alternative approaches most likely to be different?

After an overview of some of the recent literature on methodological aspects of asset indices (Section 1) and a set of definitions for the different economic status measures and data used in our analysis (Section 2), we address each question in turn. First, we assess whether alternative approaches are different by analyzing how similarly they rank households—in so doing we not only compare expenditures against an asset index but also compare alternative asset indices (Section 3a). Second, we assess whether using alternative approaches matters for inferences about the economic gradients in education, health, fertility, mortality and labor force participation outcomes (Section 3b). We also assess whether the approach matters for inferences about the relative poverty status of urban versus rural households, or households of different demographic composition (Section 3c). Third, we explore the factors that lead to greater congruence and divergence in rankings, focusing on measurement error, transitory shocks, and household economies of scale (Section 4).

1) <u>Literature overview</u>

The motivation behind the use of asset indices is straightforward: in the absence of information on household expenditures (or income), can one use the information that is often collected in the context of surveys to characterize a household's economic status? The approach that has become popular in the past decade uses an "asset index" constructed from variables describing household ownership of durable goods and characteristics of housing. Asset indices typically follow the same basic form:

$$A_i = b_1 \cdot a_{1i} + b_2 \cdot a_{2i} + \ldots + b_k \cdot a_{ki} \quad (1)$$

where A_i is the asset index for household "i", (a_{1i}, a_{2i}, … ,a_{ki}) are k indicators of asset ownership and housing quality variables, and (b_1, b_2, … , b_k) are weights used to aggregate the indicators into an index.

By aggregating observed measures of a household's material living conditions, the asset index captures a dimension of economic status. While it is reasonable to think that assets and housing characteristics reflect a dimension of wealth it is clear that this is not wealth in the formal sense of the value of household assets owned minus liabilities.[1] Data on true household wealth are costly to collect and thus, like expenditures, are frequently unavailable.[2] Asset indices vary in terms of both the set of indicators included (i.e. a_{1i}, a_{2i}, … ,a_{ki}) and how weights used to aggregate the indicators are derived (i.e. b_1, b_2, … , b_k). How these attributes of indices affect household rankings and our understanding of inequalities in outcomes and welfare levels is the focus of this paper. In this section we first provide a literature overview of the main methodological findings to date.

a) Comparing asset indices to expenditure measures

Chief among the questions about how to interpret the results derived from asset indices is how a ranking by the index compares to one derived from household expenditures. Filmer and Pritchett (2001) compare rankings by household size-adjusted expenditures and an index using data from three household surveys from poor countries where both measures could be calculated. They find that the correlation coefficient between rankings based on the two measures ranges from 0.43 to 0.64 in the three countries. They find general agreement in the households classified in the poorest 40 percent by both measures: roughly 60 percent of households classified as being in the poorest 40 percent by per capita expenditures are also classified in the poorest 40 percent by the asset index. Moreover, they find that differences in schooling outcomes between the richest and poorest quintiles are typically the same or larger when using

[1] In previous papers (e.g. Filmer and Pritchett 2001) the index is often referred to as a *wealth* index. The term wealth in those papers was used to distinguish it from an expenditures based measure. In order to use a term that more accurately reflects the measure, it is referred to as an *asset* index in this paper.

[2] In addition, asset indices typically exclude productive assets which reflect household investments; assets that are not usually collected in the types of datasets for which analysts turn to an index approach.

the asset index as compared to expenditures. They conclude that "the asset index, as a proxy for economic status for use in predicting enrollments, is at least as reliable as conventionally measured expenditures".

Bollen et al. (2002) compare an asset index to per capita expenditures in a study of fertility using data from two countries and find that the estimated impact of economic status is larger when using the asset index. They also find that estimates of the impact of other variables on fertility differ somewhat depending on the measure of economic status used but conclude that "most of the changes in coefficients are not large."

Sahn and Stifel (2003) compare an asset index to reported expenditures using 12 different household survey datasets from 10 countries: the correlations between the household rankings using the two measures range between 0.39 and 0.50 in six of the datasets, between 0.51 and 0.70 in four of the datasets, and greater than 0.7 in two of the datasets. They also compare the two measures in terms of how they predict child height-for-age and draw two main conclusions. First, they cannot reject the null hypothesis that the coefficient on economic status is different across multivariate models that use different measures of welfare. Second, they find that the asset index does an "equal or better job at stratifying the population into well and poorly nourished individuals."

Wagstaff and Watanabe (2003) compare inequalities in child malnutrition using adult-equivalent expenditures and an asset index. They compare the concentration index (a summary measure of unequal distribution) based on these two measures using household survey data from 19 developing countries. The difference between the concentration indices is statistically significantly different from zero in only four countries for low weight-for-age, and in only four countries for low height-for-age. They conclude that "[…] it seems for the most part to make little difference to the measured degree of socioeconomic inequalities in malnutrition among under-five children whether one measures [socioeconomic status] by expenditures or by an asset-based wealth index."

In his study of the performance of asset indices using rural National Sample Survey data from India, Mukherjee (2006) analyzes the gradients in the fraction of five to 16 years olds who had ever attended school as well as in the fraction of the adult population who are literate. He finds that per capita expenditures and an asset index yield very similar gaps between those in the richest quintile and those in the poorest quintiles. For example, he reports that the fraction who have ever attended school in the richest quintile is 0.90 using both measures, and is 0.56 in the poorest quintile using per capita expenditures (for a gap of 0.34) and is 0.59 in the poorest quintile using the asset index (for a gap of 0.31). The difference for the fraction of illiterate adults is even smaller.

In contrast to these findings of similar results, Lindelow (2006) uses data from a large-scale household survey in Mozambique to compare inequalities in health service utilization. He calculates concentration indices derived from expenditures and an asset index for several health behaviors: hospital visits, health center visits, complete course of immunizations children, use of antenatal care, and giving birth in a medical facility. In all cases the concentration indices are statistically significantly different when using the two approaches to measuring welfare. In all cases except health center visits, inequality as measured by the asset index is higher than that measured by expenditures. The author interprets the results as stemming from the fact that urban households tend to rank higher when using the asset based measure. Since urban households also tend to have more access to health facilities, using the asset index tends to strengthen the relationship between economic status and the use of higher level health facilities.

b) Aggregation Methods

Much of the literature has followed Filmer and Pritchett (2001) and applied principal components to estimate the weights used to aggregate indicators into an index, that is to estimate (b_1, b_2, … , b_k) in equation (1). While principal components analysis is easy to implement, it remains a black box and various analysts have proposed alternative weighting schemes which are arguably better suited to the type of data typically available. The most similar alternative is factor analysis. Factor analysis has a theoretically attractive advantage in that the underlying model allows for a degree of error.[3] Despite relying on different mathematical models and computations, however, principal components and factor analysis yield asset indices that have virtually identical rankings and are therefore treated as the same approach in this paper.

One strand of the literature on aggregation methods focuses on finding a simple and straightforward approach. Two alternatives have been proposed. The first alternative is to use a count variable based on the number of assets owned. When assets have been aggregated in the demographic literature, this is typically the approach that has been taken (as described in the

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[3] For this reason, Sahn and Stifel (2000) favor factor analysis over principal components.

review of the literature to date in Montgomery et al. 2000). More recently Case, Paxon, and Ableidinger (2004) use the simple count approach when analyzing the relationship between orphan status, schooling, and household poverty. They use this approach in preference to principal components because the unit is well defined (it is simply "the number of assets owned") and, they argue, the resulting indices are therefore comparable across the several countries in their analysis.

Montgomery et al. (2000) analyze the properties of a simple count approach compared to per capita household expenditures in six countries. They find a positive association between the index and expenditures, but report that only a small share of the variation in expenditures is explained by the index. Nevertheless, they find that controlling for the index yields similar results to controlling for expenditures when interpreting the impact of their main variable of interest (women's education) on outcomes (fertility, child mortality, and children's schooling). They recommend, however, including the full set of dummy variables capturing ownership of each of the assets separately in these types of regressions.

Bollen et al. (2002) compare a count index to one derived from principal components in their analysis of the impact of economic status on fertility. They find similar estimates of the impact of economic status on fertility in two countries. They also find that the coefficient estimates for the other variables in their multivariate model of the determinants of fertility are virtually identical using either of these approaches. Paxson and Schady (2007), in a study of the relationship between an asset index and child cognitive development in Ecuador, report that an index derived using principal components yields similar results to one using the simple count method. Mukherjee (2006) compares principal components to a simple sum approach using data from rural India and also finds very small differences in rich-poor gaps in child schooling and in adult literacy.

A second simple approach is described by Morris et al. (2000) who aggregate assets into an index using weights for each item equal to the proportion of households who do not own at least one of the item. The justification for this approach is "based on the assumption that households would be progressively less likely to own a particular item the higher its monetary value." Using data from two household surveys from rural Africa, they compare this to the total value of those assets (based on the respondent-reported current value of each asset). They find that the index and the value of assets are fairly highly correlated: 0.74 and 0.83 (when both measures are transformed by their logs). When livestock is included in the set of assets considered the correlations are slightly lower (0.69 and 0.53 respectively).

A slightly more complicated approach uses a regression model to derive the aggregation weights. For instance, Stifel and Christiaensen (2007) use weights derived from a regression of per-capita expenditures on asset indicators in a dataset that includes expenditures, and apply these weights to the identically defined indicators in a dataset that does not include expenditures. They term this index an "economic asset index" since it is based on the economic measure of per capita household expenditures in contrast to the "statistical asset index" based on principal components or factor analysis. Applying this methodology to study poverty change in Kenya, they find similar overall results. Headcount poverty fell from 55.8 percent in 1993 to 45.0 percent in 2003—a 10.8 percentage point decline—when using the economic asset index, and from 57.9 to 45.1 when using the statistical asset index—a 12.8 percentage point decline.[4] There is a similar consistency when focusing on rural areas only (a decline in poverty of 9.2 versus 13.5 percentage points using the economic and statistical indices respectively) and urban areas other than Nairobi (an increase in poverty of 7.0 versus 5.1 percentage points). However, the two approaches yield changes of similar direction—but different magnitude—for Nairobi: the economic index yields a decline in poverty from 40.7 percent to 35.1 percent (a 5.6 percentage point fall) while the statistical index yields a decline from 49.8 to 28.2 percent (a 21.6 percentage point fall).[5]

A different strand of the literature has drawn on sophisticated modeling approaches which are well suited to the binary nature of most of the indicator data, and potentially incorporate or reveal more information about the mapping between indicators and underlying economic status. One approach is derived from the psychometric literature: Item Response Theory (IRT) analysis. This is an approach which attempts to uncover a latent trait, such as ability, based on a set of correct or incorrect answers to questions on a test. The intuitive analogy to asset indices is clear: the "latent trait" is household economic status and the "answers" are ownership or non-ownership of a set of assets. IRT analysis is well suited to the binary data typically available when asset indices are used. This approach was used to derive an

[4] The poverty line is benchmarked such that the poverty rate in 1997 using the economic index is equal to that in 1998 using the statistical index.
[5] The authors point out that results for Nairobi should be interpreted with caution as they appear to be driven by a single variable: ownership of refrigerators.

index of economic, social and cultural status in the multi-country analysis of data from the Organisation for Economic Cooperation and Development's (OECD) Programme for International Student Assessment (PISA) (OECD 2004). Das et al. (2004) use IRT analysis to derive economic status in their study of the determinants of education outcomes in Zambia. They report that the approach yielded similar results to principal components in simulation analysis. Mukherjee (2006) compares an asset index to the latent factor derived from IRT analysis of data from rural India and, once again, finds very small differences in rich-poor gaps in child schooling and in adult literacy.[6]

Montgomery and Hewett (2005) use a multiple-indicator multiple-cause (MIMIC) modeling approach in their analysis of the roles of poverty and neighborhood effects in the determination of health in urban areas in poor countries. They specify a structural model in which the latent factor ("living standard" in their terminology) determines the outcome of interest and the set of indicators, and is determined by a set of observed exogenous variables. They estimate the model using a two-step procedure, the first step of which (using maximum likelihood estimation) yields estimates of the parameters of the indicator equations. Under the assumptions of the model, these parameters determine the estimate of the latent factor.[7]

Ferguson et al. (2003) use an approach termed hierarchical ordered probit (DIHOPIT) which is similar to the first stage of the Montgomery and Hewett (2005) model. Unlike that approach, however, their parameterization allows for a household random effect. Nevertheless, the basic framework and estimation procedures follow a similar logic. Ferguson et al. (2003) compare the household rankings based on their index, and the ranking based on a principal components-based index, to rankings based on household income and household expenditures in three household survey datasets.[8] They find that the correlations between the indices and expenditures are extremely similar: for example in their dataset from Peru the rank correlation

[6] While Mukherjee (2006) uses IRT analysis, it is not primarily to extract the latent factor but rather to estimate what the IRT literature refers to as the "difficulty parameter" of each question. Under the conditions of the theoretical model he lays out, this parameter captures "[asset] specific attributes that determine relative ease of ownership over the entire population [which] is the logarithm of the user cost." Intuitively, the exponential of this parameter reflects the "price" of each asset and therefore aggregating using this exponential recovers a quantity he argues is related to the total value of the assets. While the asset index he derives using this approach differs, he finds that the economic status gradients in child schooling and adult literacy are, once again, similar.

[7] The authors do not report how this estimate of living standard compares with other approaches.

[8] However they do not compare the rankings derived from these different aggregation approaches to each other.

between the DIHOPIT index and household expenditures is 0.73, the exact same correlation as that between the principal components index and expenditures.

In a slightly different vein, another sophisticated approach integrates the estimation of indicator weights with the estimation of the determinants of outcomes. Lubosky and Wittenberg (2005) and Wittenberg (2005) build on the proposal of Montgomery et al. (2000) to enter each indicator variable separately, but add on a procedure to recombine the coefficient estimates in a way that allows interpreting their combined effect as the impact of the latent factor on the outcome. The authors argue the optimality of the approach in terms of minimizing the potential attenuation bias relative to alternative approaches—indeed since this is based on OLS estimates, their measure will be the linear combination of the indicators that best predicts the outcomes. However, the cost of the approach is that the estimate of the measure of the latent factor is dependent on the outcome of interest: a different outcome measure will imply a different measure of the latent factor. Lubotsky and Wittenberg (2005) and Wittenberg (2005) compare estimates of the impact of the latent factor on outcomes and find that, as expected, the principal components approach tends to understate the impact relative to their proposed measure, although the results are quite similar.

An alternative index is the actual value of assets owned: it is not unreasonable to think that the gold standard against which the validity of an asset index should be measured is the underlying value of the assets.[9] As described above Morriss et al. (2000) compare their index to the total reported current value of assets and find fairly high correlations. Mukherjee (2006) compares his preferred asset index to the value of assets using the median unit values (as derived from all recent purchases of that asset in the data) as an estimate of the price of each asset. He finds that the two are highly related, with a correlation of 0.82 in urban areas and of 0.89 in rural areas.

c) Indicators used in asset index

The last set of issues raised in the literature relates to which indicators, or types of indicators, should be included in the asset index. Filmer and Pritchett (2001) experiment with excluding water and sanitation variables, housing and land ownership, and both of these sets of variables in their derivation of economic status ranking using data from India. They find that

[9] However, as mentioned above this ignores the liabilities side of the net household wealth equation.

while the household rankings are not the same when using these different subsets of variables, there is a large amount of overlap. The correlation in household rankings across these variants does not fall below 0.79.

Houweling et al. (2003) assess the sensitivity of analyzing inequalities in child survival and in measles immunization coverage using three variants of the full set of indicators available: first, excluding water and sanitation variables that they argue have a direct effect on morbidity; second, additionally excluding housing characteristics; and third, additionally excluding the indicator of whether the household had access to electricity. Analyzing data from 10 Demographic and Health Surveys they argue that the choice of the set of assets makes a difference. Indeed, they find that households are not always ranked in the same quintile when different subsets of the indicators are used. Nevertheless, fewer than 10 percent of households are ranked in a quintile more than one quintile away from the one they were assigned to on the basis of the full set of indicators. The authors also argue that statements about inequalities in outcomes differ by choice of the subset of indicators used. Again, their results do show some differences. However, they report remarkable consistency in the gaps they consider. For example, the ratio of under-5 mortality in the richest quintile to that in the poorest quintile differs by no more than 5 percentage points in the six out of the seven countries for which it is reported.[10] The ratio of measles immunization coverage between richest and poorest quintiles differs by no more than 10 percentage points in five of the seven countries for which it is reported.

Mukherjee (2006) compares an asset index approach that uses all indicators versus one that excludes non-durables such as the main sources of energy used for cooking and lighting, and the amount of land owned. He finds very small differences in the gaps in the fraction of children who had ever been to school (gaps of 0.31 versus 0.24) and in the fraction of adults who are literate (gaps of 0.40 versus 0.35).

In sum, the literature to date suggests that economic gradients in education and health outcomes are similar when these are based on per capita expenditures or on an asset index. On the other hand, the evidence suggests less than perfect agreement in ranking households—and thereby in identifying the poorest. In the remainder of this paper we add to this literature by

[10] For example in Kenya, whereas the rich/poor differential is 42 percent using the full index, it is 47 percent using the reduced index—a difference of 5 percentage points.

systematically assessing the effect of using different measures and aggregation methods in: identifying the poor; analyzing inequalities in a variety of human development outcomes; assessing the correlation with other household attributes such demographic characteristics and urban or rural residence; and by analyzing the factors that lead to more or less congruence in the different economic status rankings.

2) Definitions and data

Before turning to a discussion of results, in this section we define the different measures of economic status and describe the data on which our analysis is based.

a) Defining welfare indices

Filmer and Pritchett (2001), Bollen et al. (2002), and Sahn and Stifel (2003) all argue that per capita household expenditures should not necessarily be considered the "gold standard" against which asset indices are judged. Nevertheless, we take a practical approach: given that the main variable used in the poverty analysis literature is per capita expenditures, we assess the performance of asset indices relative to that benchmark (we discuss in section 4 how adjusting expenditures for household economies of scale affects the results).

In principle, calculating **reported per capita household expenditure** is straightforward: add all the responses to items on the survey questionnaire relating to expenditures, add the imputed value of home produced goods that were consumed (for example, home-grown food consumed by the household), and impute the "flow" values for items that are consumed in bulk and have long depreciation periods (such as expensive consumer durables or housing) or are provided free (such as water or other utilities that are provided without charge from government sources).[11] The basic guidelines for constructing per capita household expenditures are fairly well established (see Deaton and Zaidi 2002), but the practice still depends on the exact questions asked in each questionnaire (for example, the range of items asked about, the time

[11] We use the term expenditures to refer to what is sometimes more precisely called consumption expenditures, the value of household consumption regardless of whether purchased or home-produced excluding expenditures for non-consumption purposes such as investment. This is also sometimes just called consumption. For consistency and compactness, we use the term expenditures throughout.

scale for certain types of purchases), the way durables are depreciated and how their flow value is calculated, as well as a series of judgments about how to deflate values across space and time.

For five of the surveys analyzed here, we use the expenditure aggregates described in Deaton and Zaidi (2002)[12], and for the remaining six surveys we use the expenditure aggregate that was constructed for the main poverty report that resulted from the survey.[13] All expenditure aggregates are spatially deflated to adjust for regional price differences within countries.

The first asset index we consider is based on **predicted per capita household expenditures**. The weights for this index are derived from an OLS regression of per capita expenditures on the asset and housing indicators, that is, the estimates of the βs in:

$$Y_i = \beta_1 \cdot a_{1i} + \beta_2 \cdot a_{2i} + \ldots + \beta_k \cdot a_{ki} + \varepsilon_i \quad (2)$$

These estimates of β_1 to β_k are then substituted for b_1 to b_k in equation 1. While asset indices are typically used in situations where expenditures are unavailable, predicted expenditures is an interesting variable for our analysis. First, it represents the linear combination of these assets and housing characteristics that best predicts per capita expenditures. No other linear aggregation of the same indicators will come as close to giving the same ranking of households and, therefore, come as close to giving similar results to per capita expenditures. Second, this regression-based prediction is consistent with what is sometimes used in proxy-means tested approaches to targeting populations for social programs. As discussed above, principal components analysis has sometimes been used for this purpose but using predicted expenditures is probably more common (Coady, Grosh and Hoddinott 2004). In addition, predicted expenditure mimics the "best possible" linear prediction for situations where indicators are available in one dataset, but they can only be related to expenditures in another.[14] It is therefore the best possible "economic" asset index in the terminology of Stifel and Christiaensen (2007) that can be constructed from this set of assets. Third, under some interpretations, predicted expenditures capture a stable component of expenditures. This argument has two variants. If expenditures are measured with substantial error, then using the prediction is a way

[12] These aggregates were graciously made available by those authors for Brazil 1996-97; Nepal 1996; Panama 1997; South Africa 1993; Vietnam 1992-93. The other datasets we use were not available to those authors at the time of their analysis .

[13] Albania 2002, Ghana 1991/92, Nicaragua 2001, PNG 1996 are available at http://www.worldbank.org/lsms. Uganda 2000 and Zambia 2004 were made available by the agencies responsible for data collection or analysis.

[14] Note that this is consistent with the way this is often carried out (such as in Stifel and Christiansen 2007)—although not with the "Poverty Mapping" approach which includes area-level aggregates (in Elbers, Lanouw and Lanjouw 2002, 2003 and Alderman, Babita, Demombynes, Makhatha and Özler 2002).

of purging this measurement error. Alternatively, if asset ownership and housing characteristics relate to the permanent component of expenditures (as a proxy for permanent income), using the prediction is a way of purging out transitory shocks to income. Fourth, in the context of regression analysis, using an instrumental variables approach to estimating the impact of expenditures on an outcome is sometimes used as a way of purging out the effects of endogeneity: using predicted per capita expenditures mimics such an approach. For example, in order to ensure that their estimates of the impact of household per capita expenditures (as a proxy for income) on school participation in Vietnam is not biased due to measurement error, reverse causation or other sources of endogeneity Behrman and Knowles (1999) use a set of consumer durables and other longer-run characteristics of households as instruments for expenditures. Benefo and Schultz (1996) use a similar approach when studying the impact of household per capita expenditures on fertility and child mortality in Cote d'Ivoire.

The second asset index we consider uses principal components analysis to derive weights: the **principal components index using all indicators** (sometimes shortened below to principal components index). This method, along with factor analysis, has been used in much of the recent literature. Principal components analysis posits an underlying structure relating the indicator variables to a set of latent factors:

$$\begin{aligned} \tilde{a}_{1i} &= v_{11}\cdot A_{1i} + v_{12}\cdot A_{2i} + \ldots + v_{1k}\cdot A_{ki} \\ &\ldots \\ \tilde{a}_{ki} &= v_{k1}\cdot A_{1i} + v_{k2}\cdot A_{2i} + \ldots + v_{kk}\cdot A_{ki} \end{aligned} \qquad (3)$$

where ã are the k asset indicators (a in equation 1) normalized by their means and standard deviations, A are the k principal components, and v are the weights that relate the principal components to the ownership of the assets.[15] Since only the left hand side of these equations is observed, principal components imposes a set of restrictions on the relationship between the components (they are orthogonal to one-another) and on the vs (the sum of their squares adds up to one) to solve the system. Once the vs have been estimated, inverting the system (3) yields the following set of equations:

$$\begin{aligned} A_{1i} &= b_{11}\cdot\tilde{a}_{1i} + b_{21}\cdot \tilde{a}_{2i} + \ldots + b_{k1}\cdot\tilde{a}_{ki} \\ &\ldots \\ A_{ki} &= b_{1k}\cdot\tilde{a}_{1i} + b_{2k}\cdot \tilde{a}_{2i} + \ldots + b_{kk}\cdot\tilde{a}_{ki} \end{aligned} \qquad (3')$$

[15] Factor analysis allows for an indicator- and household-specific error term in these equations.

The equation for the first principal component is the one with maximal variance. The weights used to aggregate the asset indicators are therefore the set (b_{11},b_{21}, ... , b_{k1}).

The next asset index we consider is also based on principal components but uses only the indicators that reflect ownership of household consumer durables: **principal components using only assets**. As discussed in the previous section, there has been some discussion in the literature about which of the indicators should be included. Some authors have expressed concern about variables that affect outcomes directly (such as water source in health outcome analysis) as well as variables that reflect availability of publicly provided utilities (such as use of electricity for lighting). This variant of the principal components index explores the implications of excluding all indicators measuring housing quality, drinking water source, type of toilet, as well as availability of electricity and source of cooking fuel.

The next index is that derived from an Item Response Theory analysis of the data, the **IRT index**. The underlying model assumes that each of the k indicators is determined through the following relationship:

$$\Pr(a_{ki} = 1 | A_i) = \frac{\exp(\alpha_k (A_i - \beta_k))}{1 + \exp(\alpha_k (A_i - \beta_k))} \tag{4}$$

where, in the IRT literature, α_k is the called the "discrimination" parameter for the k'th indicator, β_k is the "difficulty" parameter, and A_i is the latent factor (or "θ") for the i'th household. The IRT methodology estimates the αs and βs after conditioning on A_i, and then derives an estimate of A_i *ex-post*.[16]

The next index is the sum of the asset indicators where each asset is weighted by the share of the population that does not own the asset, the **share weighted average**. More formally:

$$A_i = w_1 \cdot a_{1i} + w_2 \cdot a_{2i} + \ldots + w_k \cdot a_{ki} \tag{5}$$

where $w_k = \frac{1}{N} \sum_{i=1,N} (1 - a_{ki})$

[16] The open source software ICL was used for estimating the IRT model. It is available at http://www.b-a-h.com/software/irt/icl/. Note that only binary variables can be included, which means that rooms per person is dropped. Moreover, only assets whose ownership increases with the latent factor can be considered in this index. Some assets or housing characteristics are therefore dropped in the construction of the IRT index.

that is, if a_k is a binary indicator of the ownership of indicator k, then w_k is the share of the population who does not own that asset.[17]

Next is the index created by simply summing the number of assets owned and housing characteristics, the **count index**. In this index, all of the bs of equation (1) are equal to one:

$$A_i = a_{1i} + a_{2i} + \dots + a_{ki} \quad (6)$$

The last index we consider captures the value of assets owned divided by the number of household members: **per capita value of durable goods**. Since only durable goods have a readily defined resale value this index includes only consumer durables and excludes the housing characteristic indicators. The value of each asset is defined as the current resale value reported by the household respondent in the questionnaire. The index is therefore:

$$A_i = (p_{1i} \cdot a_{1i} + p_{2i} \cdot a_{2i} + \dots + p_{ki} \cdot a_{ki})/H \quad (7)$$

where ps are the reported resale value (the "price") of each asset and H is household size. Note that the resale value is household specific—and subject to the measurement error that it is reported by a respondent who has not actually tried to sell the item at the reported price.

b) Data

The datasets we use are from the Living Standards Measurement Study program (www.worldbank.org/lsms) or from similarly designed large-scale household surveys (details are in Appendix 1). The data are from 11 countries: four datasets are from Sub-Saharan Africa (Ghana, South Africa, Uganda, and Zambia), three are from Latin America (Brazil, Nicaragua, Panama), three are from Asia/Pacific (Nepal, Papua New Guinea, Vietnam), and one is from Europe (Albania). The percentage of the population living on less than $1 a day ranges widely: six of the surveys are from countries with a very high share of the population living in extreme poverty (over 30 percent live under $1 a day in Ghana, Nepal, Nicaragua, Papua New Guinea, Uganda, and Zambia), two are from countries with a high share in extreme poverty (between 10 and 18 percent in South Africa, and Vietnam), and three are from countries with a relatively small share of the population living in extreme poverty (less than ten percent in Albania, Brazil and Panama).

[17] This index, like the count index, uses the same reduced set of indicators as the IRT index because only binary assets or characteristics whose ownership increases with the index can be included.

The data are all from surveys that were designed to be nationally representative (typically with sampling weights—which are used throughout this analysis) with sample sizes ranging from 1,141 households in Papua New Guinea to over 10,500 in Uganda.[18] Most of the surveys were carried out in the 1990s but four of them were fielded after 2000.

The asset indicators used in each of these datasets are similar to that in situations in which the asset index approach is typically used, for example the analysis of Demographic and Health Survey data. The indicators cover household ownership of consumer durables such as a radio, a television, a bicycle, a car; and characteristics of the dwelling in which the household lives such as characteristics of the flooring, the roofing, main source of drinking water, type of toilet facilities, main source of lighting and cooking fuel. The datasets contain between 12 (Uganda) and 29 (Nicaragua) indicators of asset ownership and between 4 (Ghana) and 12 (Albania) indicators of housing characteristics (Zambia is an exception at 37). The full list of indicators for each dataset is in Appendix 2.

3) Results

In this section we begin by assessing how household rankings differ when using the alternative approaches to measuring economic status; we then assess how gradients in outcomes differ; and we end by assessing the variation in household attributes such as rural/urban location, size and composition.

a) Relative rankings

We use two approaches to compare household rankings. The first compares the simple correlation of household rankings across the different measures. This gives an indication of the difference across the entire population. The second estimates the share of households that are simultaneously ranked in the poorest quintile by different measures. This focuses on the way in which these types of aggregations are often used, namely identifying households in the poorest tail of the economic status distribution.

[18] In rare cases, parts of the country were excluded. For example the Brazilian survey only covers the Southeast and Northeast regions of the country. In Uganda one region of the country was not sampled because of security reasons. Surveys typically used cluster sampling: robust standard errors are used for inference in this paper.

Household Rankings   The various measures yield statistically significantly related household rankings. The rank correlation between per capita expenditures and all the asset indices is typically greater than 0.5 (top panel of Table 1). Unsurprisingly, predicted per capita expenditures yields the most similar household rankings to per capita expenditures: the rank correlation coefficients range from 0.42 in Zambia to 0.84 in Brazil with a mean of 0.66 across the 11 countries (table 1 column 2). The rank correlation of per capita expenditures with the other indices averages about 0.5. For the principal components index that uses all indicators, the rank correlation with per capita expenditures ranges from 0.39 in Zambia to 0.72 in Brazil (table 1 column 3). The range is similar for the other indices, and it is always Ghana and Zambia that have the lowest rank correlation and Brazil the highest. While these rankings are related, and always statistically significant, the correlations are not systematically high.

The rank correlation among the various asset indices is very high. The correlation between the ranking derived from principal components using all indicators and the other asset indices is typically greater than 0.8 (bottom panel of table 1). Even predicted per capita expenditures is highly related to the principal components index: the correlation ranges from 0.77 (Papua New Guinea) to 0.94 (Nicaragua) and has an average of 0.86 across the countries. The correlation between the principal components index and the other asset indices is typically even higher.

The per capita value of durable goods is not closely correlated to the other asset indices. While it has about the same rank correlation with per capita expenditures as the other indices, its correlation with the principal components index using all indicators is quite a bit lower (0.66 versus more than 0.90 for the others). However, the mean rank correlation is higher between the per capita value of durables and the principal components index (0.68) than between the per capita value of durables and per capita expenditures (0.57)—and this is true for every country. The asset indices are therefore more closely related to the per capita value of durables than they are to per capita expenditures.

Overlap in classifications   Not quite half of the people categorized as being in the poorest quintile by per capita expenditures are also in the poorest quintile according to the other welfare measures (top panel of Table 2). The overlap for per capita expenditures and predicted per capita expenditures—the benchmark for the "best" linear prediction of per capita expenditures given the asset indicators—ranges from 42 percent (Zambia) to 72 percent

(Panama) with a mean of 0.5. The overlap for the principal components index using all indicators is only slightly lower with a range of 40 percent (Zambia) to 71 percent (Panama): a pattern which holds across all the other asset indices. The overlap is bigger within the class of asset indices: typically around 70 percent of people classified as being in the poorest quintile by one asset index are also so classified by another asset index (bottom panel of table 2). The exception, again, is the measure of the per capita value of durable goods. Among asset indices, the principal components ranking is most closely related to the IRT index ranking (85 percent overlap on average—with over 95 percent overlap in Brazil, Panama, and Vietnam).

When people are classified as being in a different quintile, how much of a mismatch is there? Of the people in the poorest quintile by per capita expenditures, the asset indices classify on average about 75 percent in the poorest two quintiles (top panel of table 3). Virtually all of those classified in the poorest quintile by the principal components index using all indicators are classified as being in the poorest two quintiles by the other indices (bottom panel of Table 3).

In sum, people are certainly re-ranked by different measures of economic status. There is a fairly tight matching, however, among the various asset indices—including predicted per capita expenditures. But between per capita expenditures and all other asset indices, the reclassification is by more than one quintile for a quarter of all individuals. If one believes that transitory shocks or measurement error are large, one might argue that asset indices capture permanent income (as argued in Filmer and Pritchett 2001 and Sahn and Stifel 2001) and might therefore be preferable for identifying the more permanently-poor. Without panel data it is hard to conclusively address this issue. In this paper we limit ourselves to the less ambitious goal of documenting data regularities and exploring correlates of differences.

b) Differences in education, health and labor market outcomes

The previous discussion focused on how household rankings changed with the use of different economic status measures. A frequent concern, however, is the extent to which findings or inferences about inequalities in outcomes or behaviors might differ by the economic status measure used. To shed light on this issue, we look at a set of outcome and behavioral indicators in the areas of education, health, and labor markets. The specific indicators used—enrollment rate and primary school completion, medical care use, fertility, child mortality and labor market participation—were chosen as being typical to the analyses of social sector outcomes, as well as being possible to define systematically across the data sets used here. In each case the variable of interest is regressed on dummy variables for quintiles (with the poorest quintile as the reference group) and dummy variables for age and gender. Figures 1 to 5 display, for each country and for each economic status measure, the predicted average outcome for each quintile at the means of the other correlates.

Figure 1 displays inequalities in the school participation rate among youths seven to 19 years of age and in the completion of grade six among youths 15 to 19 years of age.[19] In Brazil, for example, 67 percent of seven to 19 year olds in the poorest per capita expenditure quintile are in school as compared to 97 percent in the richest quintile—as predicted from the multivariate regression that controls for age and gender. In contrast, 64 percent of youths in the poorest principal component quintile (using all indicators) are in school, as compared to 98 percent in the richest quintile.

In general for the two education outcomes, the pattern is similar across all countries: the different economic status measures yield extremely similar rich-poor gaps in outcomes. The difference between the richest and poorest quintiles in school participation and sixth-grade completion are statistically significantly different from zero for all countries and for all economic status measures. The rich-poor gaps tend to be larger when using the asset indices than when using per capita expenditures.

Figures 2 and 3 display inequalities in the use of health services—figure 2 is limited to children under five years of age while figure 3 is limited to people 16 and older. The top panel refers to the proportion in each quintile that has visited a medical provider in the past month, and the bottom panel refers to the proportion that has visited a private sector provider.[20] The results are more variable than those for education. Economic status gradients are similar regardless of the asset index used, but there is less of a systematic pattern in the comparison between per capita expenditures and the asset indices. For example, the rich-poor gap in the proportion of children obtaining medical care is smaller using asset index quintiles than per capita expenditure ones. This difference is statistically significant in Brazil, South Africa, Uganda, and Vietnam.

[19] Statistical significances for the estimates underlying figures 1 to 5 are in the tables in Appendix 3.
[20] Consistent with Dow (1996) these estimates do not condition on self-reported health status which may be systematically related to socio-economic status. We do not study self-reported illness directly because of the potential problem of biased self-reporting: if the poor are less likely to recognize illness—perhaps because the implicit cost of doing so is high—then it is unclear what the economic status gradient in self-reported illness actually represents. This issue is discussed in Butler, Burkhauser, Mitchell, and Pincus (1987); Deolalikar (1998), Sindelar and Thomas (1991), and Strauss and Thomas (1996).

In two countries, different measures yield statistically significantly different implications about the importance of economic status as a correlate of medical care visits. In Brazil being in the richest per capita expenditure quintile is associated with an 8.7 percentage point higher likelihood of having consulted a medical provider compared to the poorest quintile; but the gap derived from the principal components index is only 1.2 percentage points and is statistically insignificant. In Zambia the sign of the gap switches: poor children are more likely to have been taken to a medical provider when the asset indices are used to derive quintiles. These results are driven by the fact that, in both surveys, poor people—as measured by the asset index—are more likely to have been reported ill (the share is roughly equal across quintiles when using per capita expenditures). Therefore, even though fewer seek care conditional on illness, they are more likely to have sought care when one does not condition on illness.

The results for seeking private care are qualitatively similar. In most cases the different measures yield the same conclusion about the importance of economic status on medical care seeking behavior—and in only one case (Zambia) is the size of the rich-poor differential statistically significantly different. For care-seeking behavior among adults, the magnitudes of the gaps are typically smaller using the asset index, but the results would not be misleading about the statistical significance of economic status as a correlate of behavior (again, with the exception of Zambia).

Figure 4 shows results for the number of children ever born to women currently aged 20 to 35 (top panel), and for the proportion of those children who are no longer alive (bottom panel). Differences in (and levels of) the number of births born to women are very consistent, regardless of the economic status measure used. Nepal is the only country where the measure makes a large and statistically significant difference: the gap between the richest and poorest quintiles in the average number of children born is slightly more than 1 child using per capita expenditures, but it is closer to half a child when using the asset index (although both of these gaps are statistically significantly different from zero). In general, however, the asset indices all produce similar gaps across quintiles. In some cases per capita expenditure quintiles yield smaller differences between child mortality in rich and poor households (this difference is statistically significant in Albania, Nepal, South Africa and Vietnam). In four of the countries (Albania, Nepal, Vietnam and Zambia) the highest level of mortality is not in the poorest quintile when using per capita expenditures. On the other hand, in all countries, all of the asset indices (including predicted per capita expenditures) suggest that the highest level of mortality is in the poorest (or next to poorest) quintile.

Figure 5 shows results for female labor participation and for the proportion of the labor force that is self-employed. Once again, the rich-poor gap is fairly insensitive to the economic status measure used. Per capita expenditure quintiles tend to suggest flatter rich-poor gradients in several countries, especially for self employment. But conclusions about the statistical significance of the rich-poor gap are the same regardless of whether per capita expenditures or asset indices are used to derive quintiles.

c) Household location, size and composition

The results so far suggest that despite household re-rankings, conclusions about inequalities across quintiles in education outcomes, health care seeking behavior, fertility and child mortality, as well as labor market outcomes are not very sensitive to the particular economic status measure used to classify households. Two indicators are potentially more sensitive. First, Lindelow (2006) argues that an asset index in Mozambique is more likely to identify rich households as being urban than is per capita household expenditures—suggesting that urban/rural residence might differ systematically across economic status measures. Second, per capita expenditures is, by construction, scaled by household size whereas the asset indices incorporate no such adjustment—suggesting that household size (and as discussed below, household composition) may differ systematically as well.

The top panel of figure 6 shows, for each country, economic status measure, and quintile, the proportion of the population that is urban.[21] The difference in urbanization between the poorest and richest quintiles is indeed always statistically significantly larger when using the principal components asset index compared to per capita expenditures. The largest difference in the rich-poor gap in urbanization is Albania where it is 75 percentage points by the principal components index but only 22 percentage points by per capita expenditures—or a difference-in-difference of over 53 percentage points. The difference-in-difference is 50 percentage points in Zambia, on the order of 20 percentage points in Ghana and Nicaragua, and smaller in the other

[21] The definition of urban differs across countries. For the purpose of this analysis we use the definition as described in the context of each dataset.

countries. Importantly, the urbanization gap between rich and poor is always statistically significantly different from zero, regardless of country or economic status measure.

Rich-poor differences in household composition are also substantively different when using the different economic status measures. The bottom panel of figure 6 shows that differences in household size are much larger when using per capita expenditures. Moreover, the poorest quintile has the largest household size in all countries when using per capita expenditures. The difference relative to the richest quintile can be quite large: up to almost 4.5 household members in South Africa. On the other hand, the principal components index typically yields a smaller rich poor gap which never exceeds 1.6 household members (also South Africa). More importantly, rankings by asset indices do not always imply that the poorest households are the largest. In Nepal, Uganda, Vietnam and Zambia the asset indices suggest that the poorest households have the fewest household members.

Figure 7 shows differences across quintiles and economic status measures of two variables characterizing household composition: female headship (top panel) and the dependency ratio (bottom panel).[22] It is hard to discern a pattern across countries or indices in the extent of female headship. The rich-poor gap tends to be larger for the asset indices than expenditures, and this happens both in places where female-headed households are concentrated in the poorest (for example Nicaragua) and in the richest (for example Zambia) quintiles. On the other hand: the dependency ratio is always larger in the poorest households, regardless of the economic status measure used, and the dependency ratio is virtually always larger for per capita expenditures than the asset indices.

In sum, while the gradients in human development outcomes are largely consistent across the difference economic status measures, gaps in urbanization and household demographic composition are substantially different. In particular, the poor according to asset indices are more likely to be in rural areas than the poor according to expenditures. At the same time, while the poor according to expenditures are systematically in larger households, the rich-poor gap in household size is much less pronounced when using an asset index.

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[22] The dependency ratio is defined here as the ratio of the number of household members less than 16 years old plus those aged 60 or more, divided by total household size.

4) **Congruence and divergence in rankings**

When are alternative approaches most likely to be different? This section describes two main potential factors that are associated with congruence household rankings: the predictability of expenditures; and the treatment of economies of scale within households.[23] Because the various asset indices yielded extremely similar rankings, we focus in this section on the correlation in rankings by expenditures by the principal components index.

a) The predictability of expenditures

There is a mildly positive association between the variability of per capita expenditures and the rank correlation between per capita expenditures and the asset index. Across the 11 countries the correlation between the rank correlation of per capita expenditures and the principal components asset index, and the standard deviation of log per capita expenditures, is 0.110 (column 2 of table 4). The result is somewhat intuitive: when there is more inequality in a society, this manifests itself similarly in the expenditure and asset dimensions.

However, this association is weak. There is a much stronger association with the extent to which the variation in per capita expenditures is *explained* by observed household characteristics. This result is predicted by Montgomery et al. (2000) who show that asset indicators and asset indices will be better proxies for per capita expenditures the higher the R-squared of the regression of expenditures on the indicators. Indeed, in this set of 11 countries the correlation between the ranking of households based on per capita expenditures and based on the asset index is higher when the R-squared of the regression is higher (column 3 of table 4). This result is quite intuitive: rankings derived from the two approaches will be most similar when assets and expenditures "move together" and therefore assets are able to explain the variation in expenditures.

But it is not just when the explanatory power of the asset indicators themselves is high that there is congruence: the correlation between expenditures and asset index rankings is also higher when the explanatory power of an alternative non-overlapping set of variables is higher.

[23] We also explored the relationship with other potential countries and dataset characteristics that one might expect to be associated with congruence: the number of assets and the share of their covariance explained by the first principal component; overall poverty in the country; and whether or not education or health expenditures are included in expenditure aggregate. None of these are significant correlates of congruence. The results are described in Appendix 4.

Column 4 of table 4 reports the share of the variation in per capita expenditures explained by a set of household and cluster social and demographic characteristics that excludes the asset indicators. The approach follows that of the first stage of the "poverty mapping" methodology described in Elbers, Lanjouw and Lanjouw (2002, 2003) and Alderman et al. (2002) in which per capita expenditures is regressed, administrative region by administrative region in each country, on urban location, age and sex of the head of household, employment indicators of the head of the household; highest education attained by male and female household members; demographic composition of household, and cluster means of all these variables.[24] The share of the variation explained by these models is similar, or higher, than that in the models that simply include indicators. This share is highly correlated with the rank correlation between the asset index and per capita expenditures with a correlation of 0.694 across datasets.[25]

The intuition for this result is somewhat less clear. One possible explanation is that a high explanatory power, either by the asset indices or the alternative set of household characteristics, indicates less measurement error in reported expenditures. By this logic, when measurement error is low, per capita expenditures and an asset index yield similar rankings and *vice versa*. This is consistent with earlier studies that have argued that one advantage of an asset index is less measurement error in identifying the long-run "wealth" or "income" that is associated with inequalities in education (Filmer and Pritchett 2001) or child nutritional outcomes (Sahn and Stifel 2003). Those papers argue, on the basis of results consistent with attenuation bias as well as instrumental variables regressions, that the evidence is consistent with more measurement error in per capita expenditures than in an asset index. The results here are typically consistent with attenuation associated with measurement error: in most of the outcomes considered in figures 1 to 7 the rich-poor gap is larger when using an asset index than when using per capita expenditures (the exception being health care seeking behavior).

Per capita expenditures are certainly measured with error. The literature suggests that the level of aggregation at which consumption and expenditure data are collected affects accuracy (Hentshel and Lanjouw 1996; see Deaton and Grosh 2000 for an overview). It is also

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[24] The share reported in table 4 is the total sum of squares explained in these regressions divided by the overall sum of squares. Clusters are the lowest sampling unit used in the survey: they are typically the primary sampling unit (PSU) from which on the order of 15-30 households are randomly selected.

[25] When asset indicators are included in the set of household characteristics the share of variance in each country increases by a small amount, but the association with the rank correlation between the assets index and expenditures is similar: the correlation coefficient 0.710.

hypothesized that the reference periods, use of diaries instead of recall, item and unit non response and even the assumptions made in the construction of the expenditures aggregate are all potential sources of measurement errors—although there is less evidence on these issues. But high explanatory power of observed characteristics also potentially indicates a country with a lower share of transitory shocks in expenditures. In such a situation asset indicators and per capita expenditures are both closely related to the concept of permanent income and therefore are highly related. Indeed, if the research question is the impact of shocks (for example health shocks or weather shocks) on human development outcomes then asset indices would clearly fall short in their ability to shed light on the issue.

While measurement error and transitory shocks are conceptually very different entities, it is virtually impossible to distinguish between them in a cross-sectional dataset (or even a panel dataset) without additional assumptions. Therefore resolving which of these is a better explanation for congruence is probably unfeasible. But one (modest) conclusion consistent with these findings is that when household expenditures are more predictable (due either to low measurement error or low transitory shocks) that an asset index and per capita expenditures will yield a more similar household rankings.

b) Economies of scale within households

The fact that expenditures and asset indices yield vastly different economic gradients in household composition (figures 6 and 7) suggests an additional explanation for divergence in rankings: per capita expenditures adjust for household size, whereas asset indices do not. In most welfare analyses, expenditures are scaled by the total number of household members before deriving poverty profiles. Deaton and Zaidi (2002) describe this as the best benchmark, but they also describe various approaches to adjust for household composition and size in order to account for the age of household members as well as for economies of scale within households. We follow what they describe as the *ad hoc* approach by varying the parameters characterizing the equivalence between children and adults and the extent of economies of scale within households, and assessing the sensitivity of our results to the choice of these parameters. Specifically we calculate:

$$\text{Adj. Expenditures} = (\text{Total Expenditures}) / (\alpha * \text{No. of Children} + \text{No. of Adults})^{\theta} \quad (8)$$

where α is the equivalence between children and adults, and θ accounts for economies of scale (using values of α and θ both equal to 1 is therefore equivalent to scaling by total household size and yields per capita household expenditures). We then estimate the congruence in rankings at different values of α and θ.

Figure 8 plots, for each country, the rank correlation between per capita expenditures and the principal components index against the economies of scale parameter θ at four different values of the adult equivalence parameter α (for example the top left panel sets α equal to one, the top right panel sets α equal to 0.75 and so on). Adult equivalence does not generally affect the results. There is an appreciable difference in the congruence between per capita expenditures and the asset index as α changes in Albania, but in all the other countries, treating children differently from adults barely affects the rank correlation between expenditures and the asset index.[26]

The congruence is, however, affected by the economies of scale parameter. The general pattern is that of an inverse-U shape with low rank correlations when the scaling parameter is equal to 0 and 1, and higher in-between. In most cases the lowest rank correlation is when θ equals 1. The highest degree of congruence is at a scaling parameter of 0.7 or higher in two countries (Albania and Vietnam); between 0.5 and 0.4 in most countries; and at 0.3 or lower in two countries (PNG and Zambia). This suggests that part of the divergence in rankings is indeed due to different degrees of accounting for economies of scale, and that the asset index ranking is typically closer to that of expenditures when the latter is adjusted for economies of scale than when it is not.

Based on their analysis of the relationship between the food budget share and household size in Pakistan, Lanjouw and Ravallion (1995) argue that a value of 0.6 might be defensible. They caveat this argument since this values implies a relatively high share of public-goods in household consumption (on the order of 20 percent). Drèze and Srinivasan (1997) argue that in a household of only adults the economies of scale parameter should, theoretically, equal the share of private goods in household expenditures. In their analysis of rural India they find that this implies a value of around 0.85 for θ. In their empirical analysis they find that poverty

[26] Dreze and Srinivasan (1997) similarly find that poverty rankings across groups of households (such as male-headed, female-headed, single widow, etc… are not substantively affected by adjusting for equivalence scales.

comparisons using per capita expenditures do not suggest that widows are an especially poor group in India. However, rankings are reversed at a value of 0.8 and at that economies of scale parameter widows are identified as an especially poor group—in line with the author's priors based on sociological and anthropological research. Similarly, Lanjouw et al. (2004) show how estimates of the incidence of poverty in different groups in transition economies in the early 1990s are sensitive to assumptions about θ. For example in one of the countries they study, Bulgaria, the elderly are better off than households with many children when assessed on the basis of per capita expenditures—but for any value of θ less than 0.9 they are worse off.[27] All of this research suggests that some adjustment to expenditures for economies of scale is in order, which would bring the asset index and expenditure based rankings in closer alignment, although there is little agreement on what the appropriate value of θ is.

While the theoretical discussion of economies of scale is framed in terms of public and private goods, empirical analyses typically single out food as the quintessential private good (see the discussion in Deaton and Paxson 1998).[28] Our data strongly support the notion that asset indices are more closely associated with the non-food component of expenditures. First, in countries where the average share of food in total expenditures is high, the correlation between per capita expenditures and the principal components asset index is low: the correlation is -0.84 across the 10 countries with available data (column 5 of table 4). Second, the rank correlation of the asset index and per capita food expenditures within countries is substantially lower than that of the asset index and per capita non-food expenditures: the former averages 0.38 across the countries while the latter averages 0.66 (columns 4 and 5 of the bottom panel of table 5). If non-food expenditures are not adjusted for household size, the rank correlation increases further, and in four countries exceeds 0.75 (Brazil, Panama, South Africa, Zambia).

Asset indices, as they are typically implemented, consist almost entirely of household public goods: consumer durables such as radios or televisions, housing quality such as type of

[27] Other studies use subjectively reported measures of welfare to document the existence of economies of scale (Pradhan and Ravallion 2000). However, as discussed in Deaton and Zaidi (2002) a formal comparison of measured and subjective welfare often yields unbelievably small values of θ.

[28] Deaton and Paxson (1998) show how one would expect that, holding per capita total expenditures constant, larger household size should be associated with higher per capita food expenditures. This is because households would be able to exploit the economies of scale aspect of the public goods (i.e. non-food) portion of expenditures which would effectively leave more money per person to be allocated to food. If true, this would allow estimation of the economies of scale parameter. However, they find exactly the opposite result: larger households are associated with lower per capita spending on food: a puzzle that they are unable to resolve.

flooring, or the availability of electricity. Household expenditures on the other hand are typically dominated by expenditures on private goods, with food making up a substantial share of expenditures in the data from the developing countries we analyze. It should therefore perhaps not come as a surprise that asset indices are more closely related to non-food expenditures than to food expenditures, or to economies of scale-adjusted expenditures than per capita expenditures. It does suggest, however, that in the poorest settings where food dominates expenditure aggregates, results derived from asset indices and from expenditures-based measures are likely to differ most.[29]

Conclusions

The use of asset indices in welfare analysis in developing countries—instead of per capita expenditures—has been growing in the past few years in situations when data on expenditures are missing or too costly to collect well. Many applications of this alternative approach have derived an asset index on the basis of principal components analysis of a set of asset and housing quality indicators, but some applications have used simpler methods such as count measures of the number of assets owned, or more sophisticated methods such as the application of formulae derived from Item Response Theory.

The results in this paper suggest that inferences about inequalities in education, health care use, fertility, child mortality and labor market outcomes are remarkably robust to the specific economic status measure used. First, within the class of asset indices, results are systematically consistent across aggregation approaches. Second, the economic gradients in outcomes based on asset indices are similar to those based on per capita expenditures. There are some differences, in particular with regards to health care seeking behavior, but inferences about the importance of economic status are not typically affected.

Despite these similarities, the results suggest that the different measures—but most importantly per capita expenditures versus the class of asset indices—do not yield the same ranking of households. Therefore, targeting a social program to the poorest 20 percent of the

[29] One might be worried that the results on the predictability of expenditures are also being driven by the share of food in expenditures since both approaches to prediction use non-food related variables to predict overall expenditures (columns 3 and 4 of table 4). However, the results are barely affected if the prediction models are estimated for non-food expenditures only (columns 6 and 7 of table 4) indicating that predictability and household public goods are indeed separate issues.

population on the basis of an asset index, for example, would reach an overlapping, but different, set of households than targeting the poorest 20 percent on the basis of per capita expenditures. In particular, using an asset index would identify more rural, smaller households with a larger share of working-age members than per capita expenditures would. But the fact that economic status gradients are similar (often larger) when using an asset index suggests that these programs would not necessarily be "mis-targeted": they might in fact do a better job of identifying the populations with the lowest levels of education, worst health outcomes, or lowest labor force attachment which may, in some cases, be the appropriate targeting criterion.

We identify two important predictors of the congruence of rankings by per capita expenditures and an asset index: (i) the extent to which per capita expenditures can be explained by observed household and community characteristics and (ii) the share of household public goods in aggregate expenditures. This suggests that in settings with large transitory shocks to expenditures, or a large amount of measurement error in expenditures, or a large share of private goods—in particular food—in aggregate expenditures, the rankings yielded by expenditures and by an asset index are likely to differ substantially.

In sum, using asset indices for targeting is feasible, and may be desirable, but potentially identifies different households than expenditures would as being in the poorest group. Using asset indices to carry out welfare analysis also clearly has a place. When per capita expenditure data are missing, the use of an asset index can clearly provide useful guidance to the order of magnitude of rich-poor differentials, however analysts should be aware that there are settings where the two approaches are likely to yield similar results, but others where they are more likely to differ.

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Table 1. Rank correlation coefficients between welfare indices across households

	Per capita HH expend. (1)	Predicted per capita HH expend. (2)	PC index, all indicators (3)	PC index, assets only (4)	IRT index (5)	Share weighted average (6)	Count index (7)	Per capita value of durable goods (8)
Correlation with ranking by per capita household expenditures								
Albania	1	0.64	0.47	0.45	0.45	0.45	0.44	0.63
Brazil	1	0.84	0.72	0.71	0.72	0.68	0.68	
Ghana	1	0.47	0.43	0.37	0.44	0.30	0.34	0.33
Nepal	1	0.60	0.48	0.41	0.43	0.42	0.44	0.53
Nicaragua	1	0.77	0.71	0.67	0.69	0.64	0.66	0.71
Panama	1	0.79	0.70	0.67	0.68	0.65	0.66	0.65
Papua New Guinea	1	0.57	0.47	0.46	0.47	0.48	0.49	0.53
South Africa	1	0.79	0.67	0.60	0.66	0.59	0.58	
Uganda	1	0.68	0.55	0.39	0.53	0.45	0.41	
Vietnam	1	0.71	0.61	0.62	0.59	0.61	0.59	0.62
Zambia	1	0.42	0.39	0.37	0.38	0.40	0.40	0.53
Average	*1*	*0.66*	*0.56*	*0.52*	*0.55*	*0.52*	*0.52*	*0.57*
Correlation with ranking by principal components index which uses all indicators								
Albania	0.47	0.81	1	0.95	0.99	0.94	0.96	0.73
Brazil	0.72	0.85	1	0.99	0.99	0.97	0.99	
Ghana	0.43	0.89	1	0.89	0.98	0.79	0.86	0.44
Nepal	0.48	0.86	1	0.81	0.95	0.96	0.94	0.58
Nicaragua	0.71	0.94	1	0.96	0.99	0.88	0.93	0.82
Panama	0.70	0.90	1	0.98	1.00	0.95	0.97	0.70
Papua New Guinea	0.47	0.77	1	0.92	0.96	0.92	0.88	0.73
South Africa	0.67	0.84	1	0.93	0.98	0.93	0.93	
Uganda	0.55	0.86	1	0.76	0.96	0.87	0.80	
Vietnam	0.61	0.84	1	0.89	1.00	0.97	0.98	0.73
Zambia	0.39	0.92	1	0.89	0.95	0.96	0.95	0.74
Average	*0.56*	*0.86*	*1*	*0.91*	*0.98*	*0.92*	*0.93*	*0.68*

Note: Blank entry indicates that data are not available. Cross-country averages are unweighted.

Table 2. Overlap in the classification in the *poorest quintiles*

	Per capita HH expend. (1)	Predicted per capita HH expend. (2)	PC index, all indicators (3)	PC index, assets only (4)	IRT index (5)	Share weighted average (6)	Count index (7)	Per capita value of durable goods (8)
Proportion of the population classified in the poorest 20 percent by per capita household expenditures who are in the poorest 20 percent according to other welfare indices								
Albania	1	0.47	0.42	0.41	0.41	0.37	0.38	0.47
Brazil	1	0.68	0.64	0.62	0.63	0.57	0.63	
Ghana	1	0.37	0.42	0.39	0.40	0.33	0.38	0.32
Nepal	1	0.36	0.34	0.32	0.30	0.32	0.30	0.35
Nicaragua	1	0.56	0.51	0.46	0.50	0.48	0.49	0.52
Panama	1	0.72	0.71	0.69	0.70	0.65	0.70	0.65
Papua New Guinea	1	0.36	0.34	0.27	0.32	0.32	0.33	0.34
South Africa	1	0.48	0.43	0.38	0.43	0.43	0.42	
Uganda	1	0.52	0.48	0.43	0.51	0.47	0.48	
Vietnam	1	0.54	0.49	0.50	0.47	0.49	0.48	0.49
Zambia	1	0.42	0.40	0.40	0.40	0.41	0.42	0.40
Average	*1*	*0.50*	*0.47*	*0.44*	*0.46*	*0.44*	*0.46*	*0.44*
Proportion of the population classified in the poorest 20 percent by the principal components index using all indicators who are in the poorest 20 percent according to other welfare indices								
Albania	0.42	0.74	1	0.83	0.91	0.70	0.83	0.68
Brazil	0.64	0.82	1	0.93	0.96	0.81	0.93	
Ghana	0.42	0.71	1	0.68	0.78	0.38	0.50	0.26
Nepal	0.34	0.71	1	0.58	0.81	0.86	0.81	0.46
Nicaragua	0.51	0.81	1	0.80	0.85	0.50	0.63	0.53
Panama	0.71	0.91	1	0.87	0.96	0.81	0.88	0.72
Papua New Guinea	0.33	0.46	1	0.77	0.61	0.39	0.38	0.24
South Africa	0.44	0.54	1	0.57	0.85	0.73	0.66	
Uganda	0.48	0.74	1	0.66	0.85	0.78	0.72	
Vietnam	0.49	0.67	1	0.71	0.95	0.84	0.88	0.63
Zambia	0.40	0.77	1	0.76	0.80	0.79	0.80	0.62
Average	*0.47*	*0.72*	*1*	*0.74*	*0.85*	*0.69*	*0.73*	*0.52*

Note: Blank entry indicates that data are not available. Cross-country averages are unweighted.

Table 3. Overlap in the classification in the *poorest quintile* by one measure and the *poorest two quintiles* by another

	Per capita HH expend. (1)	Predicted per capita HH expend. (2)	PC index, all indicators (3)	PC index, assets only (4)	IRT index (5)	Share weighted average (6)	Count index (7)	Per capita value of durable goods (8)
Proportion of the population classified in the poorest **20** percent by per capita household expenditures who are in the poorest **40** percent according to other welfare indices								
Albania	1	0.73	0.68	0.68	0.68	0.65	0.66	0.78
Brazil	1	0.93	0.90	0.90	0.90	0.87	0.88	
Ghana	1	0.65	0.69	0.65	0.69	0.63	0.64	0.61
Nepal	1	0.63	0.59	0.60	0.50	0.55	0.54	0.65
Nicaragua	1	0.88	0.87	0.84	0.86	0.80	0.82	0.86
Panama	1	0.93	0.91	0.91	0.92	0.90	0.90	0.89
Papua New Guinea	1	0.63	0.65	0.64	0.65	0.65	0.68	0.63
South Africa	1	0.79	0.76	0.74	0.77	0.75	0.75	
Uganda	1	0.78	0.73	0.69	0.75	0.73	0.72	
Vietnam	1	0.81	0.77	0.79	0.75	0.76	0.75	0.78
Zambia	1	0.73	0.71	0.68	0.70	0.72	0.72	0.70
Average	*1*	*0.77*	*0.75*	*0.74*	*0.74*	*0.73*	*0.73*	*0.54*
Proportion of the population classified in the poorest **20** percent by the principal components index using all indicators who are in the poorest **40** percent according to other welfare indices								
Albania	0.68	0.95	1	1.00	1.00	0.95	1.00	0.91
Brazil	0.88	0.97	1	1.00	1.00	0.99	1.00	
Ghana	0.66	0.97	1	0.94	1.00	0.72	0.83	0.50
Nepal	0.60	0.92	1	0.90	1.00	1.00	0.97	0.70
Nicaragua	0.79	0.99	1	1.00	1.00	0.91	0.96	0.87
Panama	0.91	0.99	1	1.00	1.00	0.99	1.00	0.93
Papua New Guinea	0.60	0.88	1	0.96	1.00	0.97	0.96	0.87
South Africa	0.71	0.87	1	0.99	1.00	0.95	1.00	
Uganda	0.71	0.94	1	0.97	1.00	0.96	0.99	
Vietnam	0.73	0.91	1	1.00	1.00	0.99	1.00	0.89
Zambia	0.65	1.00	1	0.99	1.00	1.00	1.00	0.87
Average	*0.72*	*0.94*	*1.00*	*0.98*	*1.00*	*0.95*	*0.97*	*0.59*

Note: Blank entry indicates that data are not available. Cross-country averages are unweighted.

Table 4. Correlates of similarity between per capita expenditures and asset index rankings							
	Rank correlation between PCE and PC index, all indicators	Standard deviation of log PCE	Proportion of variation in ln(PCE) explained by indicators (R^2)	Proportion of variation in ln(PCE) explained by non-indicators	Share of food in total household expenditures	Proportion of variation in ln(non-food PCE) explained by indicators (R^2)	Proportion of variation in ln(non-food PCE) explained by non-indicators
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Albania	0.47	0.52	0.41	0.40	0.64	0.48	0.35
Brazil	0.72	0.91	0.72	0.68	0.35	0.72	0.68
Ghana	0.43	0.74	0.25	0.50	0.60	0.37	0.49
Nepal	0.48	0.70	0.43	0.49	0.69	0.50	0.47
Nicaragua	0.71	0.76	0.64	0.54	-	-	-
Panama	0.70	0.96	0.63	0.57	0.56	0.68	0.56
PNG	0.47	0.87	0.36	0.56	0.64	0.41	0.61
South Africa	0.67	1.09	0.65	0.69	0.44	0.66	0.70
Uganda	0.55	0.72	0.49	0.45	0.55	0.50	0.43
Vietnam	0.61	0.59	0.57	0.48	0.57	0.60	0.49
Zambia	0.39	1.17	0.19	0.43	0.69	0.46	0.45
Correlation with (1)	*1*	*0.110*	*0.970*	*0.694*	*-0.837*	*0.945*	*0.643*

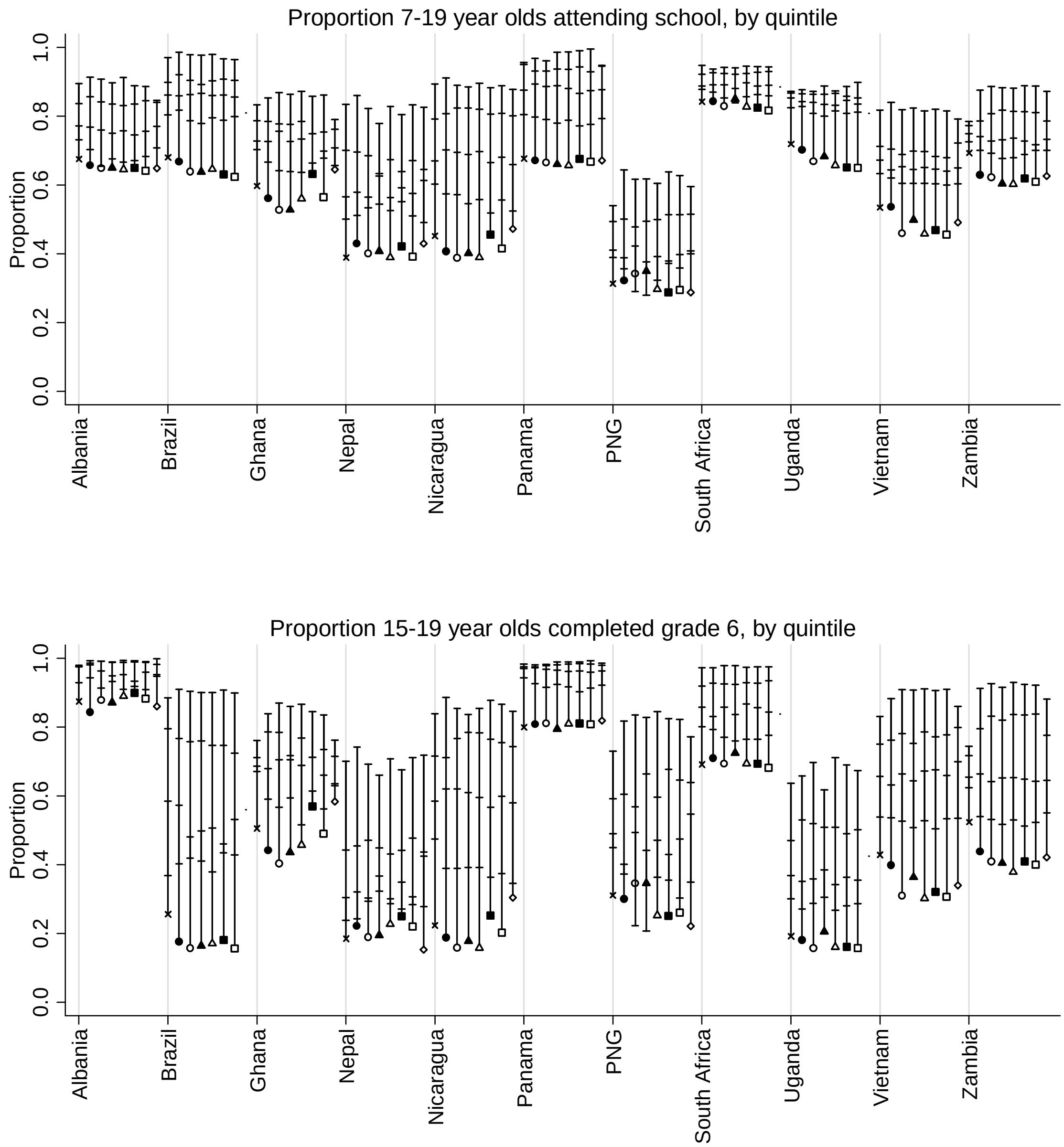
Note: (1) repeats the third column of Table 1; (3) is the standard deviation of ln(PCE); (3) is the R-squared of the regression of ln(PCE) on all the variables that make up the “all indicators asset index”; (4) is the explained divided by total sum of squares in region-by-region regressions of ln(PCE) on a set of explanatory variables (urban location, age and sex of the head of household, employment indicators of the head of the household; highest education attained by male and female household members; and demographic composition of household) and their cluster means; (5) is the number of asset indicators used in the construction of the all indicators asset index; (6) repeats column (3) but with the non-food share of expenditure only; (7) repeats column (4) but with the non-food share of expenditures only.

Table 5. Rank correlation coefficients between welfare indices across households

	Per capita HH expend. (1)	PC index, all indicators (2)	Per capita HH food expend. (3)	Per capita HH non-food expend. (4)	Total HH non-food expend. (5)
Correlation with ranking by per capita household expenditures					
Albania	1	0.47	0.91	0.83	0.48
Brazil	1	0.72	0.69	0.97	0.84
Ghana	1	0.43	0.92	0.88	0.44
Nepal	1	0.49	0.91	0.85	0.61
Nicaragua	1	0.71			
Panama	1	0.70	0.91	0.94	0.74
Papua New Guinea	1	0.47	0.91	0.84	0.70
South Africa	1	0.67	0.88	0.97	0.78
Uganda	1	0.55	0.93	0.91	0.49
Vietnam	1	0.61	0.87	0.93	0.75
Zambia	1	0.39	0.91	0.72	0.49
Average	*1*	*0.56*	*0.88*	*0.88*	*0.63*
Correlation with ranking by principal components index which uses all indicators					
Albania	0.47	1	0.31	0.58	0.51
Brazil	0.72	1	0.42	0.75	0.84
Ghana	0.43	1	0.24	0.57	0.59
Nepal	0.49	1	0.34	0.56	0.59
Nicaragua	0.71	1			
Panama	0.70	1	0.54	0.77	0.80
Papua New Guinea	0.47	1	0.34	0.54	0.58
South Africa	0.67	1	0.49	0.71	0.76
Uganda	0.55	1	0.46	0.57	0.56
Vietnam	0.61	1	0.45	0.66	0.65
Zambia	0.39	1	0.16	0.67	0.75
Average	*0.56*	*1*	*0.38*	*0.64*	*0.66*

Note: Blank entry indicates that data are not available. Cross-country averages are unweighted.

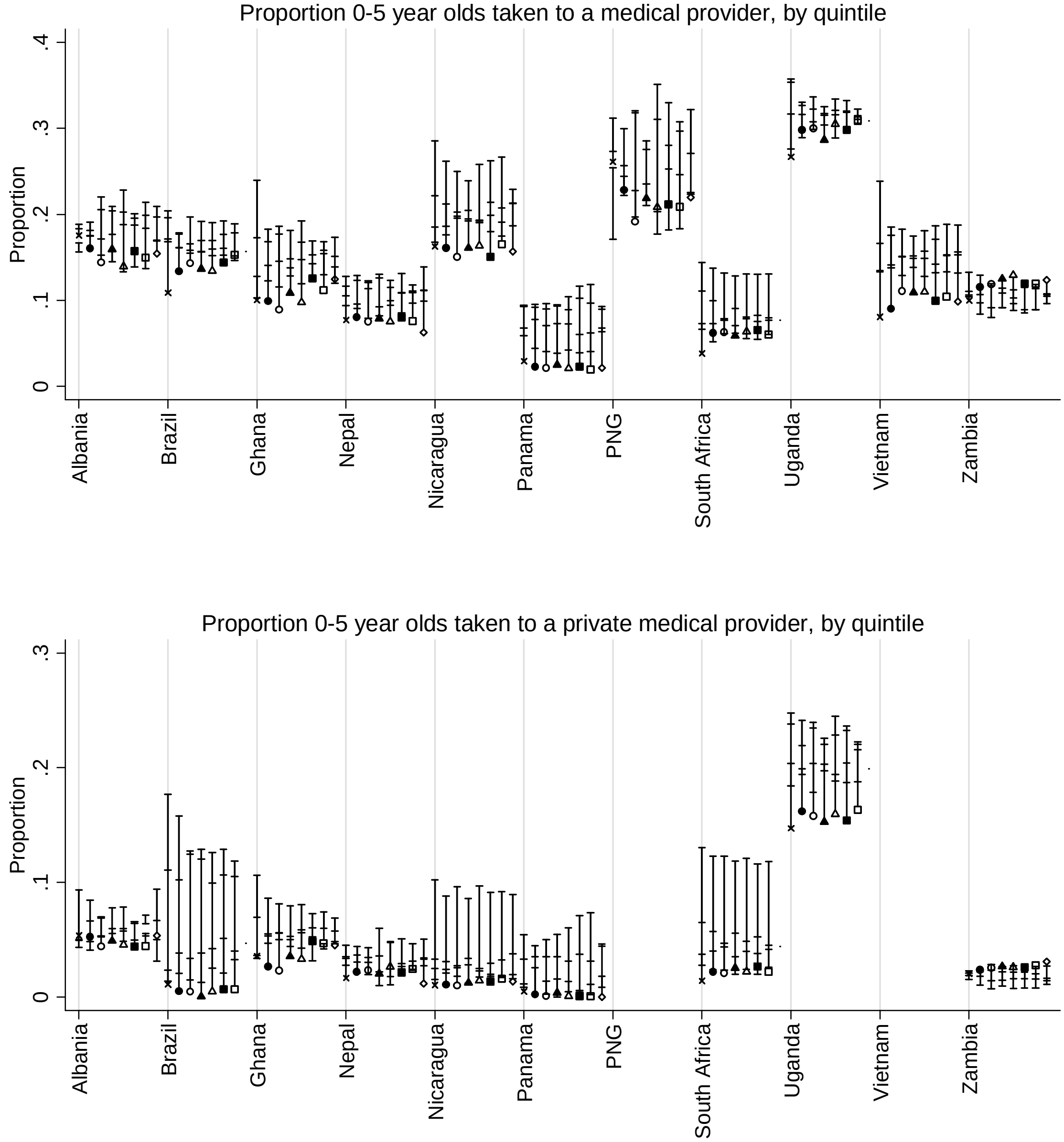
Figure 1: Differences in education outcomes by quintile using various welfare measures



×	Per capita HH expenditures	△	IRT index
●	Predicted per capita HH expenditures	■	Share weighted average
○	PC index, all indicators	□	Count index
▲	PC index, assets only	◇	Per capita value of durable goods

Note: Symbols indicate the poorest quintile. Each marking shows the predicted gap from the previous quintile after controlling for dummy variables for age and gender.

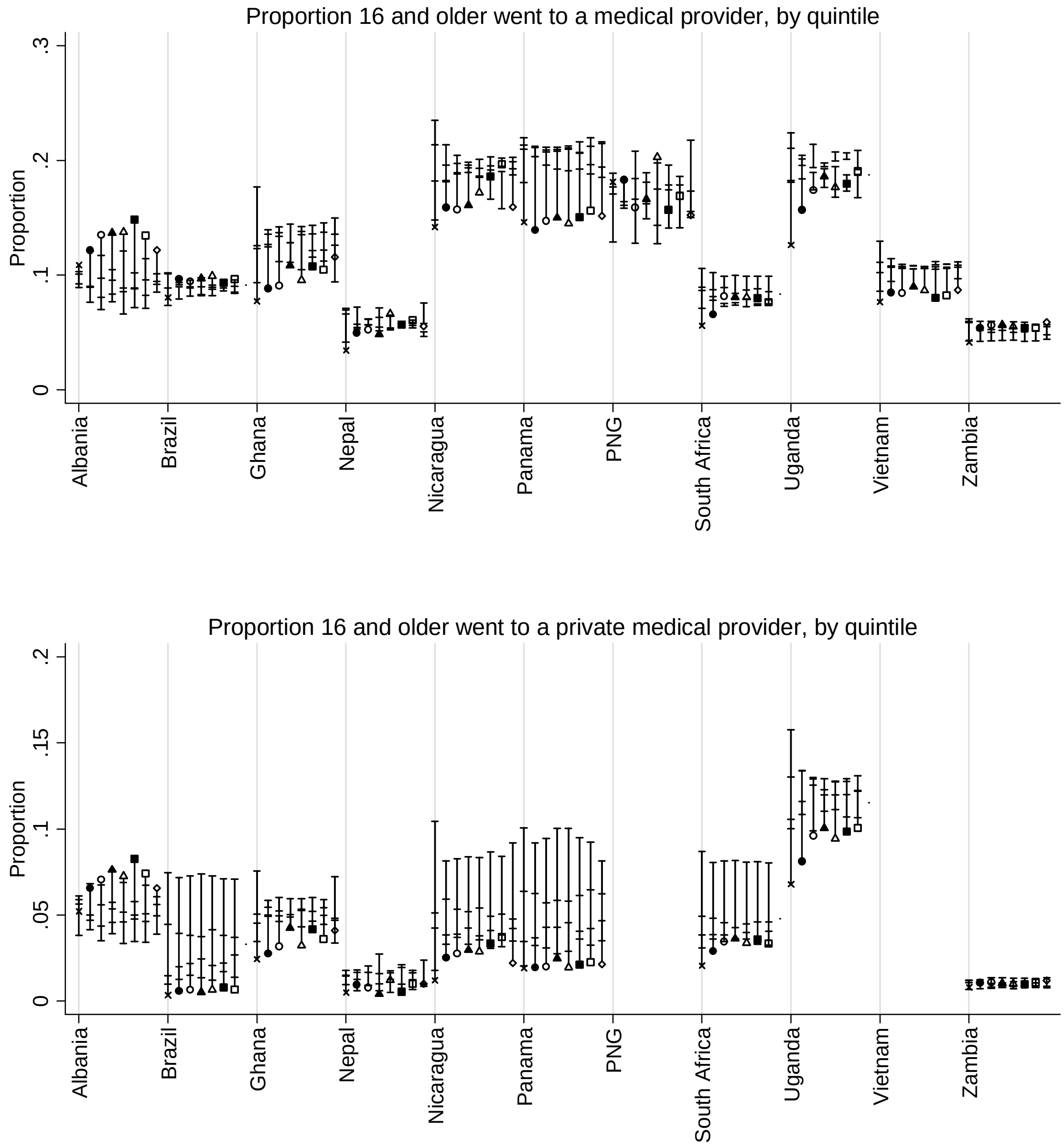
Figure 2: Differences in child medical provider usage by quintile using various welfare measures



×	Per capita HH expenditures	△	IRT index
●	Predicted per capita HH expenditures	■	Share weighted average
○	PC index, all indicators	□	Count index
▲	PC index, assets only	◇	Per capita value of durable goods

Note: Symbols indicate the poorest quintile. Each marking shows the predicted gap from the previous quintile after controlling for dummy variables for age and gender.

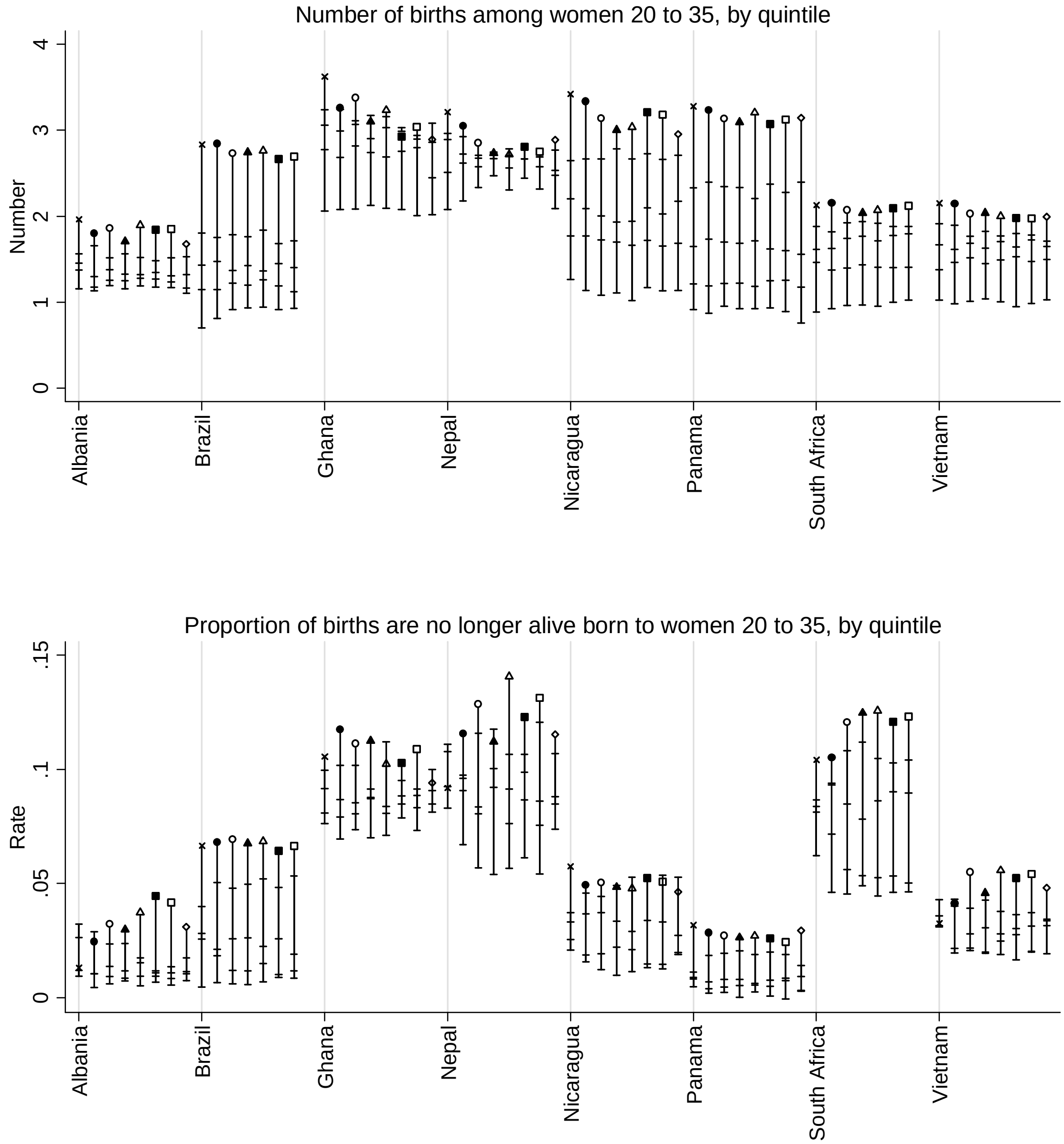
Figure 3: Differences in adult medical provider usage by quintile using various welfare measures



×	Per capita HH expenditures	△	IRT index
●	Predicted per capita HH expenditures	■	Share weighted average
○	PC index, all indicators	□	Count index
▲	PC index, assets only	◇	Per capita value of durable goods

Note: Symbols indicate the poorest quintile. Each marking shows the predicted gap from the previous quintile after controlling for dummy variables for age and gender.

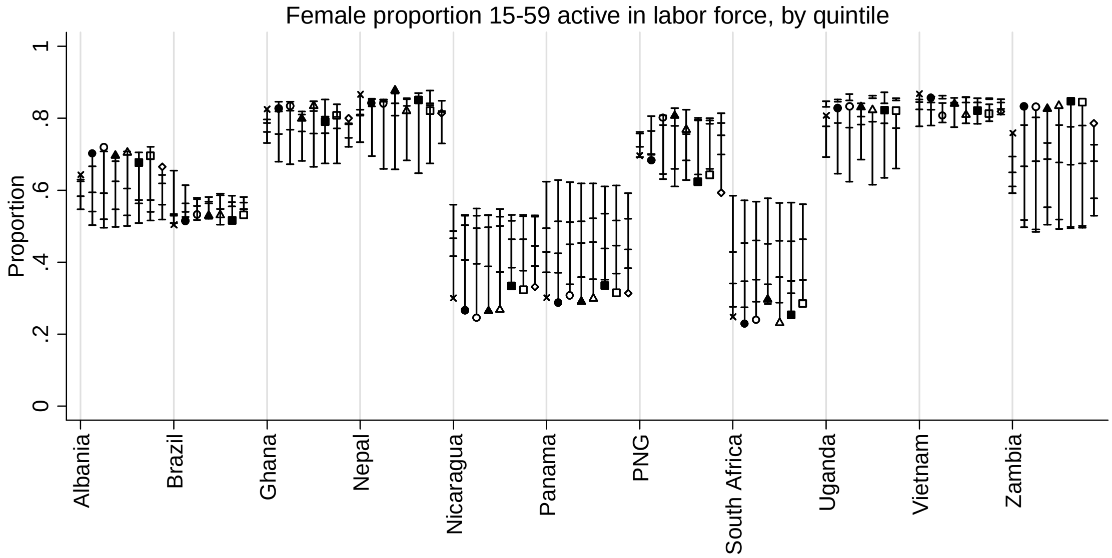
Figure 4: Differences in fertility and child mortality quintile using various welfare measures

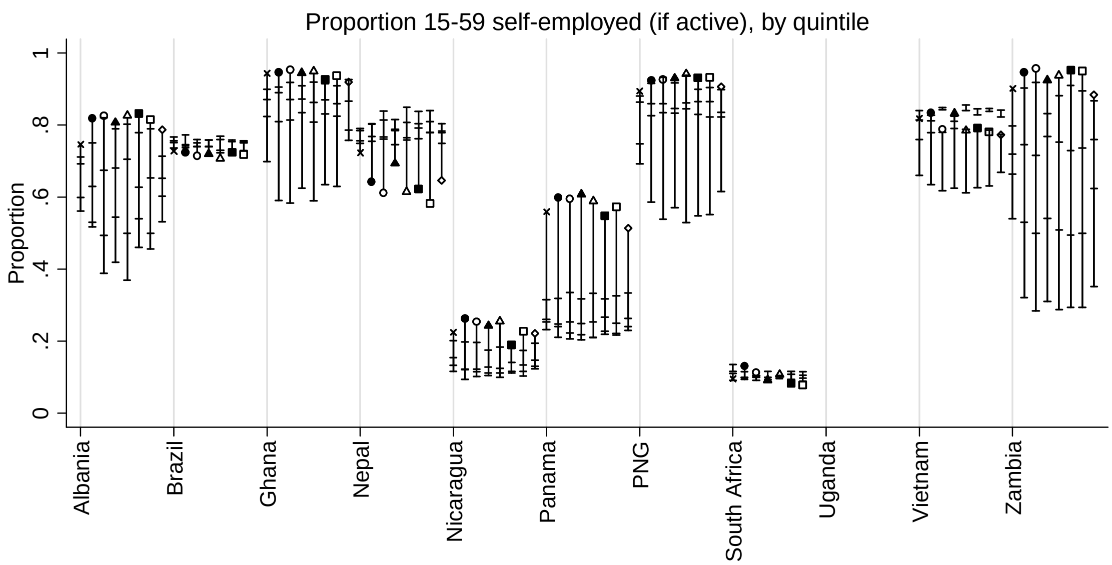


×	Per capita HH expenditures	△	IRT index
●	Predicted per capita HH expenditures	■	Share weighted average
○	PC index, all indicators	□	Count index
▲	PC index, assets only	◇	Per capita value of durable goods

Note: Symbols indicate the poorest quintile. Each marking shows the predicted gap from the previous quintile after controlling for dummy variables for women's age.

Figure 5: Differences in labor force outcomes by quintile using various welfare measures

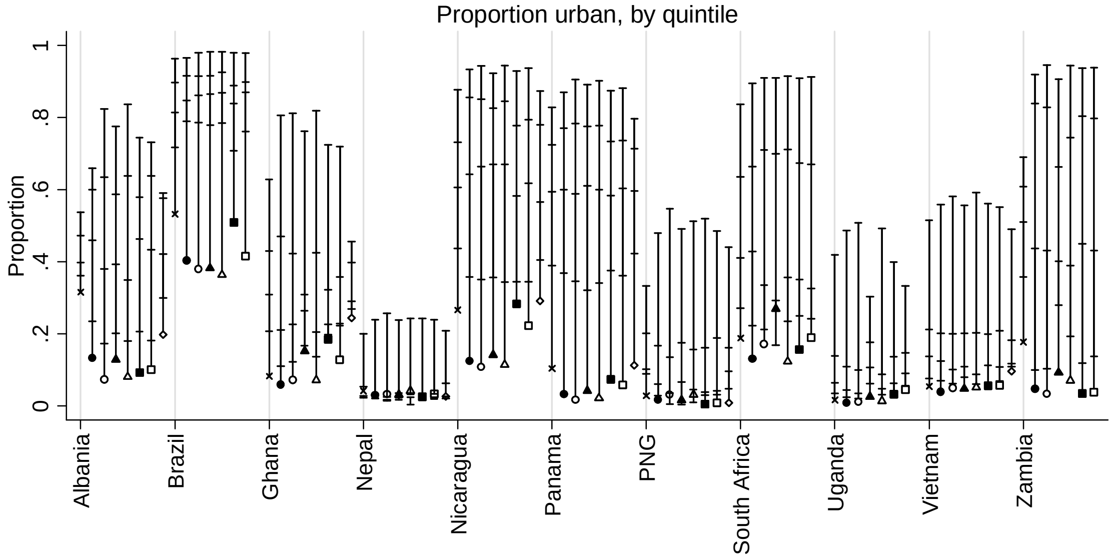


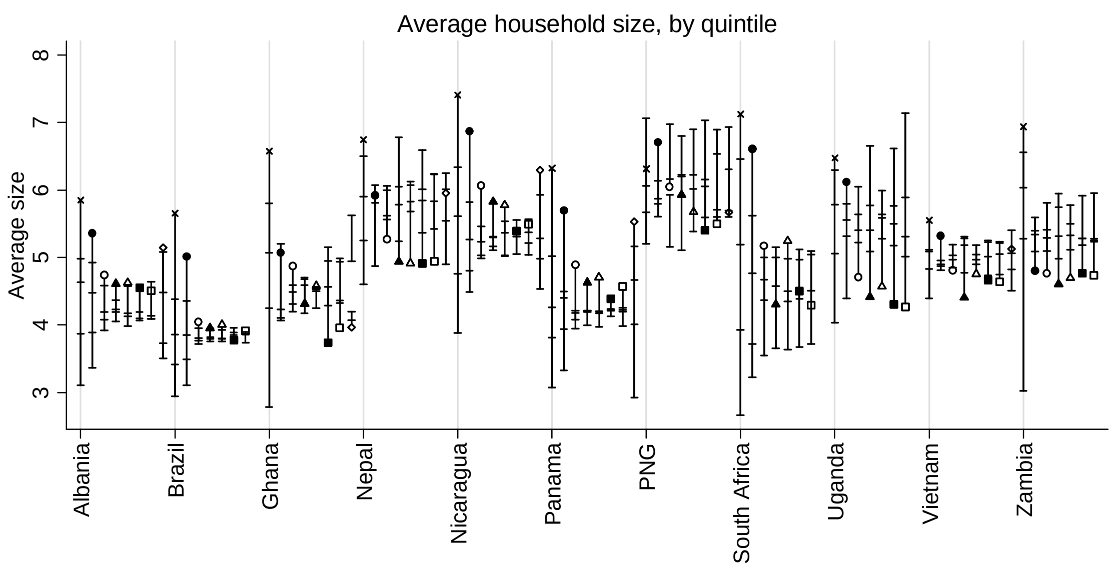


×	Per capita HH expenditures	△	IRT index
●	Predicted per capita HH expenditures	■	Share weighted average
○	PC index, all indicators	□	Count index
▲	PC index, assets only	◇	Per capita value of durable goods

Note: Symbols indicate the poorest quintile. Each marking shows the predicted gap from the previous quintile after controlling for dummy variables for age and, in the bottom panel, gender.

Figure 6: Differences in urban location and in household size by quintile using various welfare measures

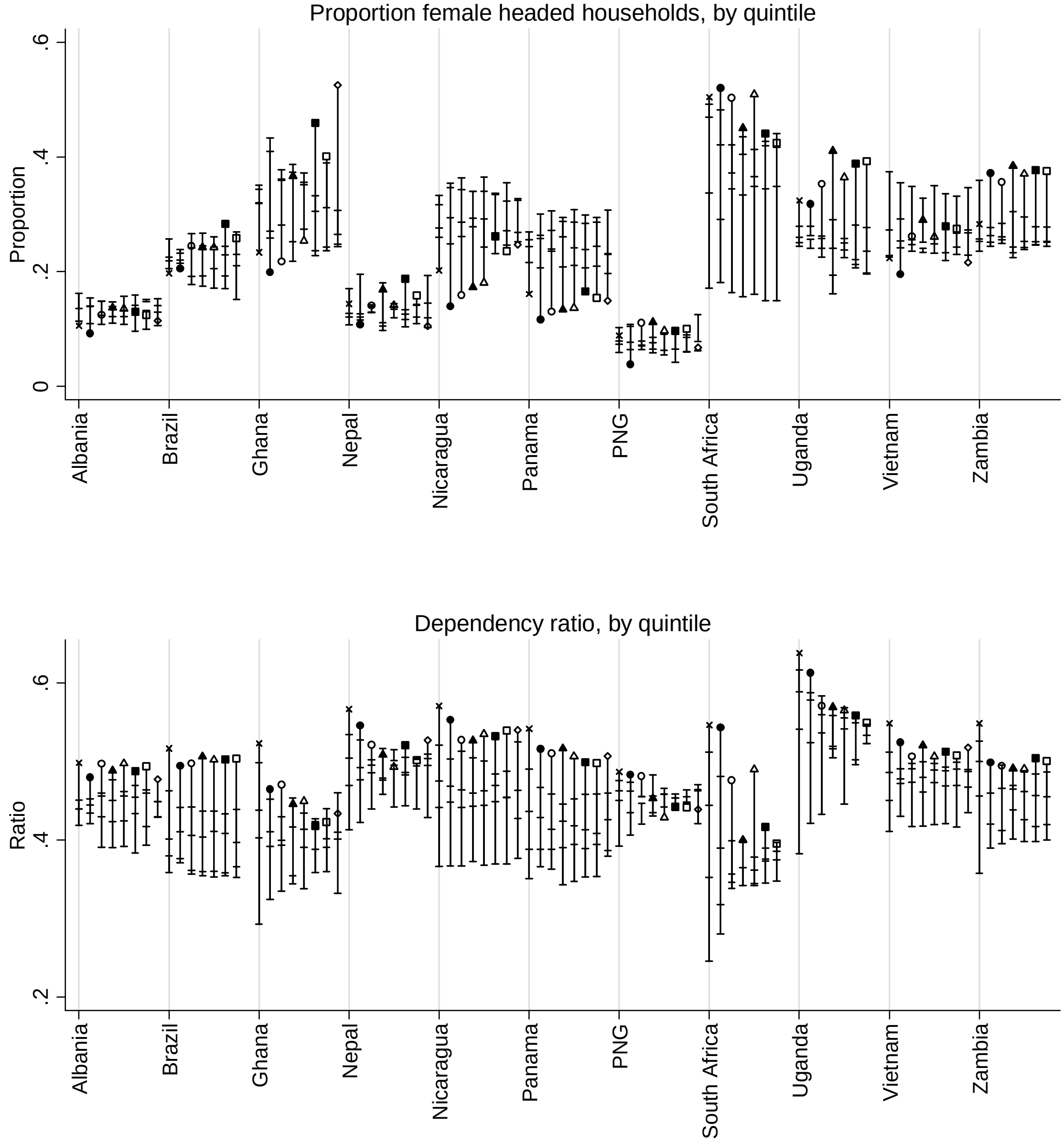




×	Per capita HH expenditures	△	IRT index
●	Predicted per capita HH expenditures	■	Share weighted average
○	PC index, all indicators	□	Count index
▲	PC index, assets only	◇	Per capita value of durable goods

Note: Symbols indicate the poorest quintile. Each marking shows the predicted gap from the previous quintile.

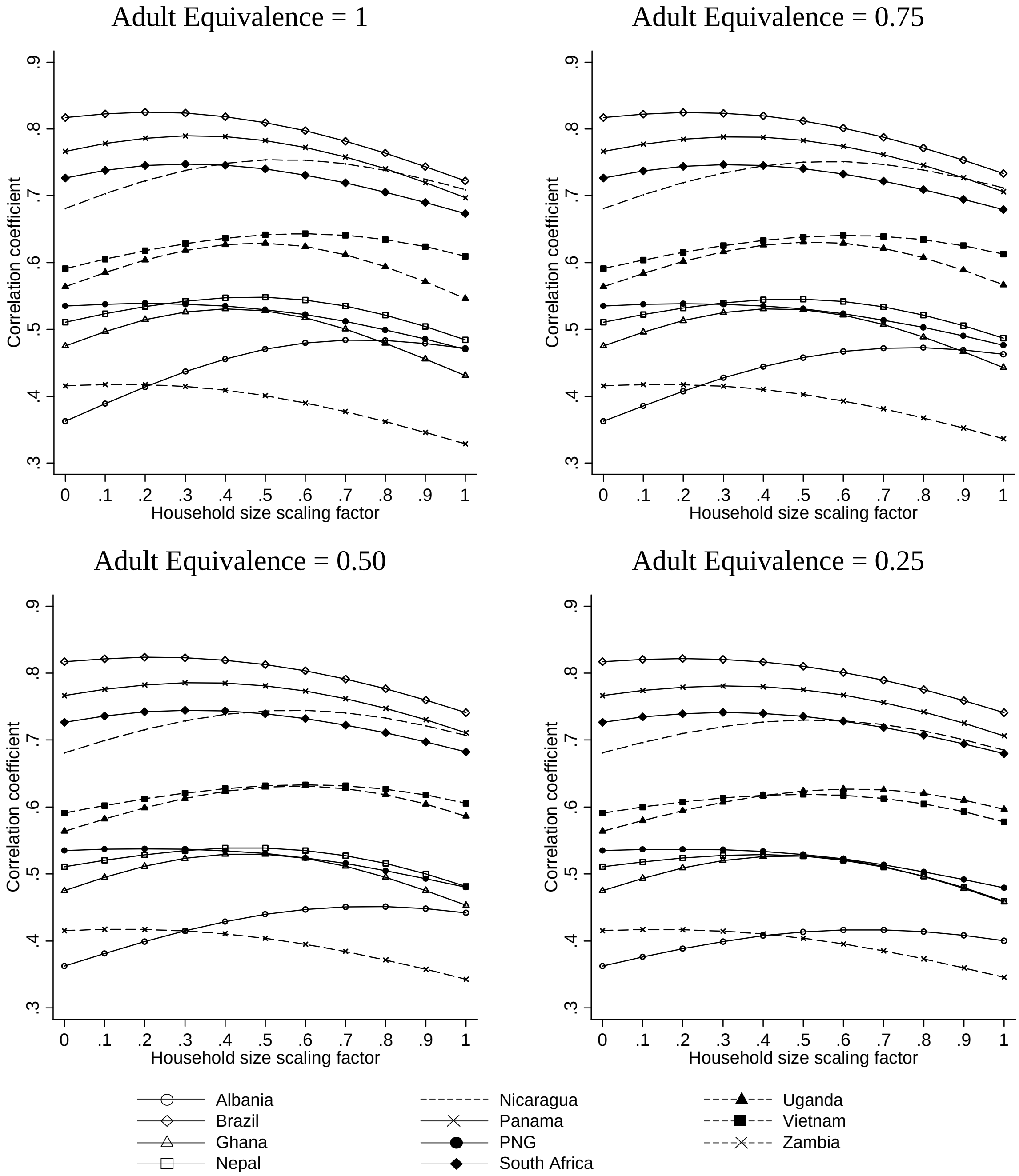
Figure 7: Differences in female headship and the dependency ratio by quintile using various welfare measures



×	Per capita HH expenditures	△	IRT index
●	Predicted per capita HH expenditures	■	Share weighted average
○	PC index, all indicators	□	Count index
▲	PC index, assets only	◇	Per capita value of durable goods

Note: Symbols indicate the poorest quintile. Each marking shows the predicted gap from the previous quintile.

Figure 8: Rank correlation between asset index using all indicators and household expenditures per adjusted household size, with various scaling factors used for adjustment and adult equivalence values.



Note: Scaling factor is parameter α, and adult equivalence is parameter θ, in the following adjustment to household expenditures:

(household expenditures)/(α × Number of HH members <= 15 + Number of HH members>= 16)$^{\theta}$.

When α = 1 and θ=1 this is just per capita household expenditures.

Appendix 1

Summary information on countries and datasets in study

	Date of survey	Number of households in analysis	Number of indicators of asset ownership	Number of indicators of housing characteristics
Albania (ALSMS)	2002	3598	28	12
Brazil (BPPV)	1996/97	4940	26	6
Ghana (GLSS)	1991/92	4522	27	4
Nepal (NLSS)	1996	3373	18	6
Nicaragua (EMNV)	2001	4191	29	9
Panama (PENV)	1997	4945	28	6
PNG (PNGHS)	1996	1144	20	10
South Africa (SAIHS)	1993	8791	15	5
Uganda (UNHS)	2000	10696	13	7
Vietnam (VLSS)	1992/93	4800	29	9
Zambia (LCMS)	2004	19247	62	37

Appendix 2: Variables used in the calculation of the asset indices.

Albania	Brazil	Ghana	Nepal	Nicaragua	Panama
Assets					
Bicycle	Motorbike	Bicycle	Bicycle	Car	Bicycle
Motorcycle	Car	Car	Motorbike	Boat	Car
Car	Bicycle	Boat	Car	Bicycle	Boat
Truck	Any TV	Canoes	Radio/Cassette	Motorcycle	Outboard Motor
Dumdum tractor	Radio	Outboard Motor	Camera	Radio	Motorbike
Colour TV	Tape Recorder	Radio	Any TV	Television BW	BW TV
B&W TV	Audio System	Radio Cassettes	Fridge/Freezer	Television Color	Color TV
Video Player	Personal Computer	Record Player	Electric Fan	Radiograbadora	Audio Equip
Tape/CD Player	Video Player	3 in 1 RCP	Heater	Stereo	VCR
Camara, Video Camera	Stove	Video	Lamp pressured	VHS/Betamax	Typewriter
Computer	Blender	Any TV	Telephone	Typewriter	Computer
Satellite dish	Microwave	Camera	Sewing Machine	Computer	Blender
Refrigerator	Freezer	Stove	Furniture	Refrigerator	Toaster
Freezer	Sewing Machine	Refrigerator / Freezer	Jewelry	Stove	Oven
Washing Machine	Fan	Iron Electric		Plancha	Stove
Dishwasher	Iron	Sewing Machine		Grinder	Iron
Electri/gas stove	Floor Waxing Machine	Washing Machine		Fan	Grinder
Kerosene stove	Vacuum Cleaner	Air conditioner		Mixer	Radio
Wood stove	Air conditioner	Fans		Toaster	Fridge
Electri radiator	Washing Machine	Furniture		Oven	Washing Machine
Generator	Dish Washing Machine	House		Microwave oven	Phone
Sewing/knitting machine	Clothes Dryer	Land / Plot		Ricer	Sewing Machine
Air Conditioner		Share dwelling		Washing machine	Fan
Water boiler				Air conditioner	Air conditioner
Telephone				Sewing machine	
				Telephone	
Housing characteristics					
Brick/Stone walls	Permanent house	Concrete brick stone walls	Concrete or fired brick or stone outer walls	Brick, stone, concrete, cement, adobe walls	Permanent housing
Plastered exterior	Concrete or brick walls	Wood, stone, brick, cement, concrete floors	Marble brick cement or wood floors	Wood, tile, brick floors	Concrete or fired brick or stone outer walls
Interior WC	Finished wood, carpeted, tiled, cement floors	Concrete or tiled roof	Concrete or tiled roof	Tiled roof	Concrete or tiled roof
Separate kitchen	Concrete or tiled roof	Flush toilet	Shutter, screen or glass windows	Flush toilet	Concrete/cement, brick, wood floor
Separate bath/shower	Have toilet		Flush toilet	Piped water	Flush toilet
Balcony/terrace	Rooms per person		Rooms per person	Main source of light electric	Rooms per person
Pantry				Source of cooking fuel gas or electric	
Running water inside or outside dwelling				Rooms per person	
Electric heating					
Main cooking fuel is electricity					
Rooms per person					

Papua New Guinea	South Africa	Uganda	Vietnam	Zambia
Assets				
Bicycle	Car	Bicycle	Car	Bicycle
Motorcycle	Bicycle	Other transportation	Motorbike	Motorcycle
Car	Radio	Electronic appliances	Bicyle	Motor Vehicle
Outboard motor	Any TV	HH Furnishings	Boat	Tractor
Camera	Electric Stove	HH appliances	Push Cart	Tv
Radios/cassette	Gas Stove	Other buildings	VCR	Video Player
Tv or video equipment	Primus Cooker	Furniture	Col TV	Radio
Chairs and tables	Fridge	Jewelry and watch	BW TV	Hammer/Grinding Mill
Kerosene lamp	Geyser	Houses	Stereo	Electric Iron
Primus/portable stove	Electric Kettle		Radio Cassette player	Non Electric Iron
Generator	Telephone		Radio	Refrigerator
Refrigerator of freezer			Elec. Equip.	Deep Freezer
Sewing machine			Phonograph	Land Telephone Line
Gun			Camera	Cellular Phone
Traditional canoe			Stove/Cooker, Gas/Elec	Internet Connection
Metal/fibreglass dinghie			Fridge/Freezer	Satellite Dish/Decoder
			Air Cond	Sewing Machine
			Washing Machine	Knitting Machine
			E. Fan	Brazier
			Pump/Heater	Electric Stove
			Sewing/Knitting Machine	Gas Stove
			Wardroab/cupboard	Table (Dining)
			Bed	Sofa
			Table/Chair	Bed
			Clock	Mattress
Housing characteristics				
Electricity from public grid	Live in house or a flat	Own dwelling	Permanent house	Dwelling is a hut
Flush or pit toilet	Concrete, cement, brick prefab walls	Bricks, timber, cement, stone walls	Don't share housing	Roof is asbestos sheets
Separate cook house	Brick, cement, wood, tile, linoleium, carpet floor	Cement, tile, brick, stone, wood floor	Concrete, brick, stone walls	Roof is tiles
Main cooking source is wood/coconut	Cement or tile roof	Iron sheets, asbestos, tiles, tin, cement roof	Marble, brick, cement or wood floors	Roof is iron sheets.
Main cooking source is kerosene	Rooms per person	Flush toilet or covered pit latrine	Concrete or tile roof	Roof is concrete
Main cooking source is electricity		Main source of lighting is electric	Wooden door	Pan brick walls
Brick walls		Rooms per person	Layered or sliding window	Concrete brick walls
Cement/ceramic/carpet floors			Flush or compost toilet	Floor is covered concrete
Corrugated iron/sheet metal/fibro cement/tile roof			Rooms per person	Floor is concrete
Rooms per person				Floor is mud
				Drinking water from public tap
				Drinking water from own tap
				Main source of lighting is electric
				Main cooking fuel is purchased firewood
				Main cooking fuel is purchased charcoal
				Main cooking fuel is electricity
				Cooking device is a stove
				Cooking device is a brazier
				Own flush toilet
				Shared flush toilet

Appendix 3

Appendix 3: Table 1: Difference in education outcomes between richest and poorest quintile (conditional on age and gender) by various welfare indices

	Per capita HH expend.	Predicted per capita HH expend.	PC index, all indicators	PC index, assets only	IRT index	Share weighted average	Count index	Per capita value of durable goods
Currently in school, ages 7 to 19								
Albania	0.220 s	0.257 s	0.259 s	0.246 s	0.267 s *	0.239 s	0.245 s	0.192 s ^
Brazil	0.290 s ^	0.318 s	0.340 s *	0.338 s *	0.334 s *	0.336 s *	0.341 s *	*^
Ghana	0.235 s ^	0.292 s *^	0.341 s *	0.336 s *	0.312 s *	0.226 s ^	0.296 s *	0.145 s *^
Nepal	0.445 s	0.430 s	0.421 s	0.370 s *	0.439 s	0.383 s *^	0.442 s	0.396 s
Nicaragua	0.441 s ^	0.504 s *	0.501 s *	0.483 s	0.506 s *	0.426 s ^	0.473 s	0.405 s ^
Panama	0.273 s ^	0.297 s *	0.296 s *	0.326 s *^	0.330 s *^	0.314 s *	0.328 s *^	0.277 s
PNG	0.227 s	0.321 s *	0.274 s	0.268 s	0.308 s	0.350 s *	0.333 s *	0.308 s
South Africa	0.106 s	0.094 s ^	0.113 s	0.090 s ^	0.117 s	0.119 s	0.127 s	*^
Uganda	0.152 s ^	0.176 s ^	0.203 s *	0.205 s *	0.216 s *	0.235 s *^	0.248 s *^	*^
Vietnam	0.283 s ^	0.305 s ^	0.359 s *	0.325 s *^	0.357 s *	0.351 s *	0.360 s *	0.300 s ^
Zambia	0.092 s ^	0.246 s *^	0.263 s *	0.279 s *^	0.279 s *^	0.27 s *	0.278 s *^	0.246 s *
Completed grade 6, ages 15 to 19								
Albania	0.100 s	0.149 s *	0.113 s	0.116 s	0.098 s	0.093 s	0.108 s	0.122 s
Brazil	0.629 s ^	0.733 s *	0.745 s *	0.737 s *	0.729 s *	0.727 s *	0.742 s *	*^
Ghana	0.256 s ^	0.397 s *^	0.466 s *	0.424 s *	0.408 s *^	0.275 s ^	0.345 s ^	0.178 s ^
Nepal	0.516 s	0.520 s	0.502 s	0.466 s	0.480 s	0.425 s ^	0.491 s	0.565 s
Nicaragua	0.616 s ^	0.697 s *	0.696 s *	0.658 s ^	0.696 s *	0.626 s	0.663 s	0.541 s ^
Panama	0.176 s	0.173 s	0.172 s	0.195 s ^	0.179 s	0.178 s	0.175 s	0.161 s
PNG	0.419 s	0.517 s	0.490 s	0.482 s	0.592 s *^	0.574 s	0.562 s	0.549 s
South Africa	0.281 s	0.263 s	0.284 s	0.253 s	0.280 s	0.281 s	0.293 s	*^
Uganda	0.445 s ^	0.476 s ^	0.539 s *	0.413 s ^	0.550 s *	0.529 s *	0.516 s *	*^
Vietnam	0.402 s ^	0.484 s *^	0.599 s *	0.544 s *^	0.609 s *	0.585 s *	0.602 s *	0.520 s *^
Zambia	0.220 s ^	0.475 s *^	0.517 s *	0.511 s *	0.551 s *^	0.514 s *	0.522 s *	0.459 s *^

Note: "S" indicates that the average difference between the richest and poorest quintiles is statistically significant at the 5 percent level. * indicates that the estimate is different from that for per capita household expenditures at the 5 percent level. ^ indicates that the estimate is different from that for principal components at the 5 percent level. Blank entry indicates that data are not available.

Appendix 3: Table 2: Difference in child health care seeking behavior between richest and poorest quintile (conditional on age and gender) by various welfare indices

	Per capita HH expend.	Predicted per capita HH expend.	PC index, all indicators	PC index, assets only	IRT index	Share weighted average	Count index	Per capita value of durable goods
Visited medical outlet - ages 0 - 5 (unconditional on illness)								
Albania	0.008	0.030	0.009	-0.014	-0.006	-0.019	-0.013	0.055
Brazil	0.087 s ^	0.028 *	0.012 *	0.020 *	0.018 *	0.017 *	-0.001 *	*
Ghana	0.139 s	0.084 s *	0.097 s	0.073 s *	0.095 s	0.043 s *^	0.057 s *^	0.026 *^
Nepal	0.017	0.049 s	0.038 s	0.047 s	0.040 s	0.051 s	0.042 s	0.077 s *
Nicaragua	0.122 s	0.101 s	0.099 s	0.078 s	0.094 s	0.112 s	0.101 s	0.072 s
Panama	0.065 s	0.055 s	0.068 s	0.068 s	0.083 s ^	0.094 s ^	0.099 s *^	0.071 s
PNG	0.051	0.029	0.036	0.067	-0.005	0.041	0.037	0.103 s
South Africa	0.106 s ^	0.075 s *	0.068 s *	0.070 s *	0.067 s *	0.065 s *	0.070 s *	*^
Uganda	0.090 s ^	0.032 s *	0.037 s *	0.039 s *	0.029 s *	0.034 s *	0.013 *	*
Vietnam	0.158 s ^	0.095 s *	0.072 s *	0.066 s *	0.071 s *	0.087 s *	0.084 s *	0.089 s *
Zambia	0.033 s ^	-0.032 s *	-0.028 s *	-0.034 s *	-0.041 s *^	-0.031 s *	-0.03 s *	-0.028 s *
Visited private medical provider - ages 0 to 5 (unconditional on illness)								
Albania	0.040 s	0.014	0.008	0.011	0.003	0.006	0.011	0.040 s
Brazil	0.166 s	0.153 s	0.123 s	0.129 s	0.121 s	0.122 s	0.112 s *	*^
Ghana	0.070 s	0.060 s	0.058 s	0.044 s	0.047 s	0.024 s *^	0.028 s *^	0.024 s *^
Nepal	0.029 s	0.022 s	0.020 s	0.015	0.021 s	0.029 s	0.022 s	0.039 s
Nicaragua	0.092 s	0.077 s	0.086 s	0.074 s	0.083 s	0.077 s	0.076 s	0.076 s
Panama	0.050 s	0.042 s	0.049 s	0.051 s	0.060 s ^	0.070 s ^	0.073 s ^	0.044 s
PNG								
South Africa	0.116 s	0.101 s	0.102 s	0.093 s *	0.099 s *	0.089 s *^	0.096 s *	*^
Uganda	0.101 s	0.080 s	0.076 s	0.073 s	0.085 s	0.079 s	0.057 s *	*^
Vietnam	0.010 s	0.006	0.005	0.005	0.005	0.007 s	0.006 s	0.007 s
Zambia	0.002	-0.001	0.003	0.000	0.001	0.001	-0.001	-0.004

Note: “S” indicates that the average difference between the richest and poorest quintiles is statistically significant at the 5 percent level. * indicates that the estimate is different from that for per capita household expenditures at the 5 percent level. ^ indicates that the estimate is different from that for principal components at the 5 percent level. Blank entry indicates that data are not available.

Appendix 3: Table 3: Difference in adult health care seeking behavior between richest and poorest quintile (conditional on age and gender) by various welfare indices

	Per capita HH expend.	Predicted per capita HH expend.	PC index, all indicators	PC index, assets only	IRT index	Share weighted average	Count index	Per capita value of durable goods
Visited medical outlet - ages 16 and over (unconditional on illness)								
Albania	-0.027 s ^	-0.053 s ^	-0.075 s *	-0.068 s *	-0.080 s *	-0.083 s *	-0.071 s *	-0.041 s ^
Brazil	0.014	-0.013 *	-0.008	-0.009 *	-0.013 *	-0.006	-0.008 *	
Ghana	0.100 s ^	0.055 s *	0.060 s *	0.043 s *^	0.055 s *	0.043 s *	0.049 s *	0.033 s *^
Nepal	0.035 s ^	0.022 s ^	0.005 *	0.008 *	-0.013 *^	0.004 *	-0.006 *	0.020 s
Nicaragua	0.079 s ^	0.023 s *	0.027 s *	0.034 s *	0.020 *	0.018 *	0.001 *^	0.035 s *
Panama	0.055 s	0.053 s	0.047 s	0.045 s	0.046 s	0.042 s	0.029 s *^	0.043 s
PNG	-0.001	-0.010	-0.019	-0.010	-0.064 s	-0.001	-0.012	0.015
South Africa	0.042 s ^	0.027 s *^	0.011 s *	0.013 s *	0.014 s *	0.013 s *	0.017 s *	*
Uganda	0.104 s ^	0.033 s *^	0.018 s *	0.009 *	0.009 *	0.011 *	-0.007 *^	*
Vietnam	0.049 s ^	0.024 s *	0.019 s *	0.013 *	0.017 s *	0.022 s *	0.019 s *	0.017 s *
Zambia	0.021 s ^	-0.007 s *	-0.010 s *	-0.009 s *	-0.008 s *	-0.007 s *	-0.007 s *	-0.011 s *
Visited private medical provider - ages 16 and over (unconditional on illness)								
Albania	-0.002 ^	-0.031 s *	-0.042 s *	-0.043 s *	-0.045 s *	-0.053 s *	-0.045 s *	-0.018 s ^
Brazil	0.070 s	0.065 s	0.066 s	0.069 s ^	0.066 s	0.063 s	0.064 s	*^
Ghana	0.050 s ^	0.034 s	0.032 s *	0.020 s *^	0.030 s *	0.021 s *	0.026 s *	0.030 s
Nepal	0.014 s	0.008 s	0.010 s	0.013 s	0.002 ^	0.015 s ^	0.009 s	0.015 s
Nicaragua	0.087 s ^	0.052 s *	0.054 s *	0.056 s *	0.054 s *	0.054 s *	0.049 s *	0.070 s *^
Panama	0.079 s	0.070 s *	0.074 s	0.076 s	0.080 s ^	0.073 s	0.069 s	0.056 s *^
PNG								
South Africa	0.062 s ^	0.046 s *	0.043 s *	0.041 s *	0.043 s *	0.042 s *	0.043 s *	*^
Uganda	0.093 s ^	0.056 s *^	0.041 s *	0.031 s *	0.041 s *	0.039 s *	0.031 s *	*^
Vietnam	0.009 s	0.008 s	0.008 s	0.009 s	0.008 s	0.008 s	0.008 s	0.005 s *
Zambia	0.004 s	0.003	0.003 s	0.004 s	0.004 s	0.004 s	0.003 s	0.003

Note: “S” indicates that the average difference between the richest and poorest quintiles is statistically significant at the 5 percent level. * indicates that the estimate is different from that for per capita household expenditures at the 5 percent level. ^ indicates that the estimate is different from that for principal components at the 5 percent level. Blank entry indicates that data are not available.

Appendix 3: Table 4: Difference in fertility and child mortality between richest and poorest quintile (conditional on women's age) by various welfare indices

	Per capita HH expend.	Predicted per capita HH expend.	PC index, all indicators	PC index, assets only	IRT index	Share weighted average	Count index	Per capita value of durable goods
Number of births to women currently 20 to 35								
Albania	-0.805 s	-0.624 s	-0.669 s	-0.551 s *^	-0.707 s	-0.665 s	-0.618 s	-0.512 s *^
Brazil	-2.130 s ^	-2.032 s ^	-1.813 s *	-1.807 s *	-1.819 s *	-1.749 s *	-1.762 s *	*^
Ghana	-1.562 s ^	-1.185 s *	-1.296 s *	-0.975 s *^	-1.141 s *^	-0.849 s *^	-1.030 s *^	-0.873 s *^
Nepal	-1.131 s ^	-0.872 s *^	-0.520 s *	-0.262 s *^	-0.409 s *	-0.366 s *^	-0.433 s *	-0.800 s *^
Nicaragua	-2.154 s	-2.202 s ^	-2.055 s	-1.893 s *^	-2.015 s	-2.039 s	-2.050 s	-1.819 s
Panama	-2.366 s ^	-2.361 s ^	-2.179 s *	-2.169 s *	-2.279 s ^	-2.138 s *	-2.233 s	-2.387 s ^
PNG	-1.240 s	-1.229 s ^	-1.113 s	-1.068 s *	-1.118 s	-1.092 s *	-1.100 s *	*^
South Africa	-1.129 s	-1.161 s ^	-1.021 s	-0.998 s	-0.996 s	-1.032 s	-0.984 s	-0.967 s *
Mortality rate of children born to women currently 20 to 35								
Albania	-0.004 ^	-0.014	-0.023 s *	-0.023 s *	-0.028 s *	-0.038 s *^	-0.033 s *^	-0.023 s *
Brazil	-0.062 s	-0.061 s	-0.063 s	-0.062 s	-0.062 s	-0.055 s	-0.058 s	*^
Ghana	-0.014	-0.048 s *	-0.038 s	-0.043 s	-0.031 s	-0.024	-0.036 s	-0.003
Nepal	0.001 ^	-0.049 s *	-0.072 s *	-0.058 s *	-0.084 s *	-0.062 s *	-0.077 s *	-0.027 s ^
Nicaragua	-0.037 s	-0.034 s	-0.038 s	-0.039 s	-0.036 s	-0.038 s	-0.038 s	-0.027 s
Panama	-0.027 s	-0.026 s	-0.025 s	-0.026 s	-0.025 s	-0.025 s	-0.025 s	-0.026 s
PNG	-0.042 s ^	-0.059 s	-0.075 s *	-0.076 s *	-0.081 s *	-0.075 s *	-0.073 s *	*^
South Africa	0.003 ^	-0.022 s *^	-0.033 s *	-0.027 s *	-0.037 s *	-0.036 s *	-0.034 s *	-0.029 s *

Note: "S" indicates that the average difference between the richest and poorest quintiles is statistically significant at the 5 percent level. * indicates that the estimate is different from that for per capita household expenditures at the 5 percent level. ^ indicates that the estimate is different from that for principal components at the 5 percent level. Blank entry indicates that data are not available.

Appendix 3: Table 5: Difference in labor force outcomes between richest and poorest quintile (conditional on age and gender) by various welfare indices

	Per capita HH expend.	Predicted per capita HH expend.	PC index, all indicators	PC index, assets only	IRT index	Share weighted average	Count index	Per capita value of durable goods
Female labor force participation								
Albania	-0.097 s ^	-0.199 s *	-0.223 s *	-0.198 s *	-0.204 s *	-0.168 s ^	-0.179 s *^	-0.146 s ^
Brazil	0.150 s ^	0.099 s *^	0.046 s *	0.051 s *	0.055 s *	0.068 s *	0.049 s *	*
Ghana	-0.095 s ^	-0.148 s	-0.161 s *	-0.117 s ^	-0.170 s *	-0.116 s ^	-0.134 s	-0.079 s ^
Nepal	-0.132 s	-0.148 s	-0.182 s	-0.220 s *^	-0.137 s ^	-0.203 s *	-0.146 s ^	-0.084 s ^
Nicaragua	0.259 s	0.263 s	0.284 s	0.266 s	0.259 s	0.197 s *^	0.208 s *^	0.194 s *^
Panama	0.322 s	0.340 s ^	0.314 s	0.329 s	0.319 s	0.275 s *^	0.298 s	0.279 s *
PNG	-0.004 ^	0.016	-0.156 s *	-0.148 s *	-0.139 s *	0.020	0.017	0.106 s ^
South Africa	0.336 s	0.343 s	0.330 s	0.281 s *^	0.333 s	0.312 s	0.276 s *^	*^
Uganda	-0.116 s ^	-0.182 s *^	-0.209 s *	-0.146 s ^	-0.208 s *	-0.188 s *^	-0.161 s *^	*^
Vietnam	-0.090 s ^	-0.077 s ^	-0.019 *	-0.065 s ^	-0.023 *	-0.036 s *^	-0.021 *	-0.008 *
Zambia	-0.167 s ^	-0.336 s *	-0.34 s *	-0.321 s *	-0.342 s *	-0.35 s *	-0.349 s *	-0.257 s *^
Proportion of labor force who are self-employed								
Albania	-0.185 s ^	-0.302 s *^	-0.439 s *	-0.388 s *^	-0.457 s *	-0.372 s *^	-0.360 s *^	-0.184 s ^
Brazil	0.009	0.013	0.025	0.020	0.017	0.000 ^	0.011	
Ghana	-0.246 s ^	-0.356 s *	-0.370 s *	-0.320 s *^	-0.359 s *	-0.292 s *^	-0.308 s *^	-0.162 s *^
Nepal	0.067 s ^	0.125 s *	0.156 s *	0.091 s ^	0.150 s *	0.169 s *	0.197 s *^	0.157 s *
Nicaragua	-0.108 s	-0.140 s	-0.138 s	-0.132 s	-0.143 s	-0.079 s ^	-0.111 s	-0.091 s ^
Panama	-0.327 s ^	-0.388 s *	-0.389 s *	-0.404 s *	-0.377 s *	-0.329 s ^	-0.350 s ^	-0.283 s ^
PNG	-0.201 s ^	-0.338 s *	-0.388 s *	-0.359 s *	-0.412 s *	-0.383 s *	-0.380 s *	-0.291 s *^
South Africa	-0.004	-0.036 s	-0.021	0.001	-0.012	0.006 ^	0.011 ^	
Uganda								
Vietnam	-0.159 s	-0.200 s *^	-0.169 s	-0.208 s *^	-0.172 s	-0.165 s	-0.150 s ^	-0.104 s *^
Zambia	-0.362 s ^	-0.626 s *^	-0.672 s *	-0.614 s *^	-0.650 s *^	-0.658 s *^	-0.656 s *^	-0.532 s *^

Note: “S” indicates that the average difference between the richest and poorest quintiles is statistically significant at the 5 percent level. * indicates that the estimate is different from that for per capita household expenditures at the 5 percent level. ^ indicates that the estimate is different from that for principal components at the 5 percent level. Blank entry indicates that data are not available.

Appendix 3: Table 6: Difference between the richest and poorest quintile in household characteristic by various welfare indices

	Per capita HH expend.	Predicted per capita HH expend.	PC index, all indicators	PC index, assets only	IRT index	Share weighted average	Count index	Per capita value of durable goods
Urban								
Albania	0.222 S ^	0.526 S *^	0.750 S *	0.646 S *^	0.756 S *	0.651 S *^	0.631 S *^	0.378 S *^
Brazil	0.431 S ^	0.562 S *^	0.600 S *	0.599 S *	0.618 S *^	0.470 S ^	0.563 S *^	*^
Ghana	0.546 S ^	0.747 S *	0.739 S *	0.610 S ^	0.747 S *	0.539 S ^	0.591 S ^	0.211 S *^
Nepal	0.158 S ^	0.208 S	0.224 S *	0.206 S	0.200 S	0.217 S	0.205 S	0.182 S
Nicaragua	0.611 S ^	0.809 S *	0.835 S *	0.781 S *^	0.830 S *	0.646 S ^	0.714 S *^	0.582 S ^
Panama	0.723 S ^	0.837 S *^	0.887 S *	0.848 S *^	0.879 S *	0.800 S *^	0.823 S *^	0.683 S ^
PNG	0.304 S ^	0.462 S *	0.515 S *	0.474 S *	0.480 S *	0.514 S *	0.477 S *	0.432 S *
South Africa	0.649 S ^	0.763 S *	0.738 S *	0.640 S ^	0.791 S *^	0.751 S *	0.723 S *	*^
Uganda	0.403 S ^	0.477 S *^	0.496 S *	0.277 S *^	0.478 S *^	0.367 S *^	0.288 S *^	*^
Vietnam	0.460 S ^	0.519 S *	0.530 S *	0.508 S	0.539 S *	0.505 S ^	0.494 S ^	0.393 S *^
Zambia	0.512 S ^	0.872 S *^	0.911 S *	0.814 S *^	0.874 S *^	0.903 S *	0.899 S *^	0.670 S *^
Household size								
Albania	-2.737 S ^	-1.998 S *^	-0.817 S *	-0.558 S *^	-0.645 S *^	-0.486 S *^	-0.415 S *^	-1.638 S *^
Brazil	-2.708 S ^	-1.913 S *^	-0.277 S *	-0.157 *^	-0.211 S *	0.027 *^	-0.040 *^	*
Ghana	-3.786 S ^	-0.841 S *^	-0.388 S *	0.386 S *^	-0.082 *^	1.207 S *^	0.979 S *^	0.108 *^
Nepal	-2.140 S ^	-1.049 S *^	0.728 S *	1.838 S *^	1.155 S *^	1.681 S *^	1.295 S *^	-1.059 S *^
Nicaragua	-3.523 S ^	-2.381 S *^	-1.037 S *	-0.720 S *^	-0.743 S *^	-0.344 S *^	-0.453 S *^	-1.763 S *^
Panama	-3.249 S ^	-2.367 S *^	-0.815 S *	-0.421 S *^	-0.500 S *^	-0.154 *^	-0.318 S *^	-2.608 S *^
PNG	-1.109 S ^	-1.100 S ^	0.926 S *	0.869 S *	1.226 S *	1.631 S *^	1.398 S *^	0.026 *^
South Africa	-4.461 S ^	-3.380 S *^	-1.628 S *	-0.652 S *^	-1.609 S *	-0.822 S *^	-0.576 S *^	*^
Uganda	-2.440 S ^	-1.724 S *^	0.515 S *	2.238 S *^	1.064 S *^	2.308 S *^	2.866 S *^	*^
Vietnam	-1.158 S ^	-0.510 S *^	0.375 S *	0.881 S *^	0.430 S *	0.589 S *^	0.598 S *^	-0.615 S *^
Zambia	-3.914 S ^	0.791 S *^	1.04 S *	1.342 S *^	1.082 S *	1.149 S *^	1.221 S *^	-0.769 S *^

Note: "S" indicates that the average difference between the richest and poorest quintiles is statistically significant at the 5 percent level. * indicates that the estimate is different from that for per capita household expenditures at the 5 percent level. ^ indicates that the estimate is different from that for principal components at the 5 percent level. Blank entry indicates that data are not available.

Appendix 3: Table 7: Difference between the richest and poorest quintile in household characteristic by various welfare indices, continued

	Per capita HH expend.	Predicted per capita HH expend.	PC index, all indicators	PC index, assets only	IRT index	Share weighted average	Count index	Per capita value of durable goods
Female headed household								
Albania	0.057 s ^	0.062 s ^	-0.017 *	-0.027 *	-0.027 *	-0.033 *	-0.025 *	0.026 ^
Brazil	0.059 s ^	0.033 ^	-0.067 s *	-0.068 s *	-0.071 s *	-0.113 s *^	-0.107 s *^	*^
Ghana	0.110 s	0.071 s	0.064 s	-0.114 s *^	0.021 *^	-0.222 s *^	-0.165 s *^	-0.277 s *^
Nepal	0.026	0.087 s *^	-0.001	-0.072 s *^	-0.003	-0.084 s *^	-0.049 s *^	0.088 s *^
Nicaragua	0.131 s ^	0.215 s *^	0.184 s *	0.167 s	0.159 s ^	0.073 s *^	0.087 s ^	0.077 s *^
Panama	0.108 s	0.147 s *^	0.106 s	0.074 s ^	0.074 s ^	0.042 s *^	0.056 s *^	0.158 s *^
PNG	-0.010	0.038 ^	-0.047	-0.047	-0.006	-0.032	-0.040	-0.006
South Africa	-0.333 s	-0.339 s	-0.340 s	-0.294 s ^	-0.348 s	-0.292 s ^	-0.275 s ^	*^
Uganda	-0.045 s ^	-0.039 s ^	-0.091 s *	-0.249 s *^	-0.107 s *	-0.176 s *^	-0.196 s *^	^
Vietnam	0.150 s ^	0.159 s ^	0.087 s *	0.038 *^	0.089 s *	0.057 s *^	0.057 s *^	0.130 s ^
Zambia	0.077 S ^	-0.127 S *	-0.107 S *	-0.141 S *^	-0.128 S *^	-0.125 S *^	-0.122 S *^	-0.111 S *
Dependency ratio								
Albania	-0.080 s	-0.035 s *^	-0.106 s	-0.098 s	-0.106 s	-0.104 s	-0.100 s	-0.048 s ^
Brazil	-0.158 s	-0.118 s *	-0.141 s	-0.147 s	-0.149 s	-0.148 s	-0.151 s	*^
Ghana	-0.230 s ^	-0.140 s *	-0.136 s *	-0.101 s *^	-0.111 s *^	-0.059 s *^	-0.064 s *^	-0.032 s *^
Nepal	-0.154 s ^	-0.123 s *^	-0.082 s *	-0.050 s *^	-0.051 s *^	-0.077 s *	-0.062 s *^	-0.099 s *
Nicaragua	-0.204 s ^	-0.186 s ^	-0.160 s *	-0.154 s *	-0.167 s *	-0.163 s *	-0.170 s *	-0.164 s *
Panama	-0.191 s ^	-0.150 s *	-0.147 s *	-0.174 s ^	-0.159 s *	-0.146 s *	-0.144 s *	-0.120 s *^
PNG	-0.095 s ^	-0.077 s ^	-0.026 *	0.003 *	0.029 *^	0.011 *	0.013 *	-0.018 *
South Africa	-0.301 s ^	-0.225 s *^	-0.138 s *	-0.058 s *^	-0.148 s *	-0.071 s *^	-0.047 s *^	*^
Uganda	-0.255 s ^	-0.192 s *^	-0.138 s *	-0.064 s *^	-0.119 s *^	-0.063 s *^	-0.026 s *^	*^
Vietnam	-0.138 s ^	-0.094 s *	-0.089 s *	-0.103 s *^	-0.087 s *	-0.092 s *	-0.091 s *	-0.083 s *
Zambia	-0.191 S ^	-0.109 S *	-0.099 S *	-0.09 S *	-0.093 S *	-0.106 S *	-0.101 S *	-0.147 S *^

Note: "S" indicates that the average difference between the richest and poorest quintiles is statistically significant at the 5 percent level. * indicates that the estimate is different from that for per capita household expenditures at the 5 percent level. ^ indicates that the estimate is different from that for principal components at the 5 percent level. Blank entry indicates that data are not available.

Appendix 4: Additional potential correlates of congruence.

A) Number of assets and share of variance explained by first principal component

As discussed in the main text of the paper, excluding some indicators from the set of assets used in the construction of the asset index (namely indicators of water and sanitation, and indicators of housing characteristics) yields a very similar rank correlation between an asset index and per capita expenditures (see the third and fourth columns of table 1). This suggests that, within countries, the number of assets is not a major factor in determining congruence between asset index and expenditures rankings. This result is consistent with the variation across countries: there is only a weak association between the number of assets used to construct the asset index and the congruence between rankings (across countries the correlation is only 0.324; column 6 of table 4).

There is a mildly positive association between the extent to which the first principal component (i.e. the asset index) captures the covariation among the asset indicators (column 7 of table 4). The cross-country correlation, at 0.460, suggests that the more closely related the asset indicators are to each other (and by implication the aggregated index), the more closely they track expenditures.

B) Headcount extreme poverty rate

Another potential correlate of the congruence in rankings is a country's overall poverty rate. Column 8 of table 4 reports the percentage of the population living under $1 a day based on expenditures as reported in World Bank sources. There is a modest negative association between the share of the population in extreme poverty and the degree of congruence in rankings. The fact that this is negative suggests that the more people in extreme poverty the lower the rank correlation between the asset index and per capita expenditures. One explanation for this could be that asset indices, as implemented in these 11 countries, are not good at capturing variation among the poorest of the poor. If a large group of poor households share a similar lack of ownership of the consumer durables collected in the surveys, and a similar low quality of housing facilities, then an asset index might do a poor job of distinguishing across these households. In such a situation per capita expenditures might distinguish well between the poor and the very poor while an asset index might not. A practical implication of this would be that surveys that collect asset information should include assets that distinguish the extreme poor from the moderately poor (such as ownership of pots and pans, or shoes, for example). While this is a potential issue, and collecting asset information that allows finer distinction at the lower end of the asset distribution is likely to be a good idea in any case, the cross-country correlation in the poverty rate and the congruence between assets and expenditures is low (0.406) and this is therefore not likely one of the main determinants of the congruence in rankings.

C) Individual components of expenditures

The factors described above all address the congruence in the ranking of households. But this is only a sufficient condition for two welfare measures to yield similar economic status gaps in outcomes across quintiles: a large amount of re-ranking could still yield similar outcome-gradients if outcomes are not highly correlated with that re-ranking (Wagstaff and Watanabe 2003). But there is a potential for such a correlation to be built into the expenditure aggregate. This is most obvious in the case of health seeking behavior. If health expenditures enter the expenditure aggregate, then households who have a health shock and seek costly care will appear as being in a higher quintile. It would therefore not be surprising to find that the rich-poor gaps in child (figure 2) and adult (figure 3) medical care are higher when using expenditures than an asset index: this is indeed the case in some of the countries.

Deaton and Zaidi (2002) discuss whether health expenditures should be included in an expenditure aggregate at all. As they describe:

By including health expenditures for someone who has fallen sick, we register an increase in welfare when, in fact, the opposite has occurred. The fundamental problem here is our inability to measure the loss of welfare associated with being sick, and which is (presumably) ameliorated to some extent by health expenditures. Including the latter without allowing for the former is clearly incorrect, though excluding health expenditures altogether means that we miss the difference between two people, both of whom are sick, but only one of which pays for treatment. It is also true that some health expenditures—for example cosmetic expenditures—are discretionary and welfare enhancing, and that it is difficult to separate "necessary" from "unnecessary" expenditures, even if we could agree on which is which. (Deaton and Zaidi 2002:p. 33).

On balance, the authors conclude that there is a good case for excluding health expenditures from the aggregate, primarily on the grounds that the elasticity of health expenditures with respect to overall expenditures is low. Nevertheless, in practice, health expenditures are often included in the aggregate: among the 11 countries we review, they were only excluded in Albania and Panama suggesting that analyses that report health seeking behavior by per capita expenditure quintiles are typically inducing some degree of spuriousness into the association.

Based on the countries analyzed here, however, the magnitude of the bias is not large. For example, the four countries with largest expenditures-based rich-poor gap in adults seeking any medical care are Ghana, Nicaragua, Uganda and Vietnam where the gaps are 10, 7.9, 10.4 and 4.9 percentage points respectively. Deriving quintiles after excluding health expenditures from the expenditure aggregates yields only slightly smaller rich-poor gaps (9.8, 5.1, 9.3 and 4.0 percentage points respectively). Health expenditures therefore only explain a small part of the difference with gaps based on the asset index in these countries (6.0, 2.7, 1.8 and 1.9 percentage points respectively). The results are qualitatively similar in the other countries, and for adults seeking private medical care, or medical care seeking behaviors among children.

This potential problem is not limited to health expenditures, nor to the expenditure aggregate. Educational expenditures are also related to current school participation and past attainment. Nevertheless, as recommended by Deaton and Zaidi (2002), these are always included in the expenditure aggregate. Similarly, specific assets included in the asset index might have a direct relationship to outcomes. For example, if some form of transport is necessary for work, then an asset index that includes ownership of transport modalities might be inducing a positive association that is not simply reflecting the variation of labor force status across the economic status distribution. These are clearly issues with both classes of welfare measures, and suggest that care needs to be taken in which variables are included in the construction of both—and that the "right" variables might be context dependent.

Appendix 4 Table: Additional potential correlates of similarity between per capita expenditures and asset index rankings

	Rank correlation between PCE and PC index, all indicators (1)	Headcount poverty rate (2)	Gini coefficient (3)	Number of indicators used in asset index (4)	Share of variance explained by first principal component (5)
Albania	0.47	0.24	0.29	40	0.16
Brazil	0.72	6.89	0.51	32	0.23
Ghana	0.43	47.2	0.42	31	0.18
Nepal	0.48	34.4	0.42	24	0.22
Nicaragua	0.71	47.7	0.43	38	0.25
Panama	0.70	3.21	0.46	34	0.24
PNG	0.47	31.0	0.49	30	0.21
South Africa	0.67	10.0	0.57	20	0.42
Uganda	0.55	84.9	0.43	20	0.24
Vietnam	0.61	14.6	0.35	38	0.17
Zambia	0.39	60.0	0.63	62	0.22
Correl. with (1)	1	-0.406	0.023	-0.324	0.460

Note: (1) repeats the third column of Table 1; (2) is the headcount poverty ratio derived from expenditures as reported in the World Bank's PovCalNet (http://iresearch.worldbank.org/PovcalNet/) as of 13 July 2007, except PNG which is from World Bank (2000) and Brazil with is from Leite (personal communication following methodologies described in Elbers, Lanjouw, Lanjouw and Leite, 2004); (3) is the Gini index of PCE; (4) is the number of asset indicators used in the construction of the all indicators asset index; (5) is the share of the variance of the assets explained by the first principal component.