Inclusion in Asset Building: Research and Policy Symposium

Assets as a Measure of Household Welfare in Developing Countries

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INTRODUCTION

A variety of conceptual and technical problems with the use of money-metrics of welfare based on income and consumption expenditures motivate our pursuit of an alternative asset-based approach to defining poverty. In this paper, we therefore identify and explore the use of an asset-based metric of welfare that uses data on assets that are easy to collect and analyze, and is therefore particularly useful for less developed countries with severe budget constraints and limited technical capabilities. We will show that the asset index functions well in identifying and profiling the poor, in targeting transfers, and even in estimating demand or production functions for outcomes such as nutritional status of children that are useful for designing programs and policy.

Initially we present the logic of giving increased attention to an asset-based, rather than income-based framework to define the poor and promote poverty alleviation. In the following section of the paper, we will argue that assets are an appropriate alternative, both on conceptual grounds, as well as on the basis of ease of measurement. Next we will explain the derivation of the asset index based on the use of factor analysis.[1] We will then compare the asset index to expenditure data in terms of the ranking of individuals using household survey data in a number of countries. Then we will compare the basic parameters of a poverty profile using our asset-based index to a more tradition money-metric based poverty line. Although all these comparisons are interesting, they nonetheless beg a critical question: whether the asset index or consumption expenditures is a superior indicator of economic well-being. To the extent that the ordering of households based on the asset index and consumption expenditures is not consistent, we have little conceptual basis for arguing which is a more accurate representation of the ranking of individual welfare. Therefore, we seek a way to "verify" how well our asset index does relative to a more traditional money metric of well-being in explaining what is arguably one of the most crucial manifestations of poverty — child malnutrition. Finally, we conclude with a discussion of our findings and the implications of our empirical contribution for policymakers and further research.

WHY ASSETS INSTEAD OF INCOME?

The analysis of household survey data, and in particular, the measurement and the analysis of the characteristics and causes of poverty is important input into the design of economic policy and poverty alleviation programs in developing countries. Armed with a growing number of household income, consumption, and expenditure surveys, the construction of poverty lines and poverty profiles has become a major source of attention for development economists and international organizations such as the World Bank and International Monetary Fund. Considerable advances have been made, and increased rigor has been employed in defining poverty lines[2] and related indexes,[3] as well as exploring the use of other statistical methods for

[1] See Sahn and Stifel (2000) for an earlier paper in which they create an asset index based on a far more limited set of dichotomous variables available in the Demographic Health Surveys, and then use that asset to compare poverty inter-temporally and across countries in Africa.
[2] See Ravallion 1994; Ravallion 1996b.
[3] For example, the Foster, Greer, Thorbecke (1984) class of poverty measures has been widely adopted because of their desirable properties.

comparing poverty across populations, such as tests of stochastic dominance.[4] This information has been subsequently used to design and/or evaluate policies and targeted intervention schemes whose success is measured in terms of raising people above the poverty line.

Economists have relied on a money metric of utility – income or consumption expenditures – as the preferred indicator of poverty and living standards.[5] While income has generally been the measure of choice in developed countries, the preferred metric in developing countries has been an aggregate of a household's consumption expenditures. The choice of expenditures over income is attributable to a variety of difficulties involved in measuring income in developing countries.[6] [7]

The widespread acceptance and use of money metric expenditures to define the poor is consistent with a welfarist view of poverty that is concerned with raising utility levels. The important work of Amartya Sen (1985, 1987) has drawn into question whether a focus on commodities and utilities is the appropriate metric of poverty, and whether they instead should be viewed as a means to desired activities or states. He makes a strong argument that there are compelling reasons to adopt non-welfarist indicators that define poverty, in terms of the lack of basic capabilities to avoid hunger, malnutrition and poor health, and of being adequately clothed, partaking in the life of the community, and so forth. These functionings have the advantage of being direct measures of well-being. And unlike poverty defined in income or expenditure space, measures of poverty such as nutritional status and dietary adequacy have direct, and often powerful implications for the individual, household and community.[8,9]

Although the discussion of the causes of poverty (whether measured in income space or some more direct notion of functionings and capabilities) has often alluded to assets as underlying determinants, measurement of poverty in developing countries has rarely focused on the level of assets or distribution of assets as the objective of policy or programs. For the most part (with education being the possible exception), discussion of the measurement of poverty, and the related issue of inequality, has given relatively little attention to the asset ownership of individuals or households, or to the skewed distribution of assets across the population. This then may, in part, explain why the objectives of anti-poverty programs have been articulated in terms of raising people above the income-(or expenditure) determined poverty line, or raising

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[4] For a discussion of using stochastic dominance to compare poverty across populations, see Davidson and Duclos (1998).

[5] See Samuelson 1974.

[6] The choice between consumption and income, in theoretical terms, can be framed as the time period over which one is interested in measuring welfare. In practical terms, expenditures are preferred in a developing country setting for a number of reasons, including: agriculture is a prominent source of income, and seasonal variability in such earnings is often dramatic (Sahn 1989); households are often unaware of their earnings; and large shares of income in developing countries derive from self-employment, both in and outside of agriculture.

[7] For both income and expenditure, the value of leisure time is generally neglected in calculating welfare. Whereas the concept of full income is seemingly straightforward, there are a variety of conceptual and practical reasons for ignoring it, including the difficulty of defining the time endowment, and putting a price, and subsequently identifying a deflator for the price of leisure.

[8] Most obvious is the ability to achieve success in school and undertake productive work.

[9] Problems also exist in defining poverty in terms of capabilities. Most pronounced is the role that preferences play in the capabilities approach, including that being capable of realizing certain achievements, such as good nutrition, is certainly not a guarantee of success in doing so.

command over certain commodities. Since meaningful poverty alleviation is largely predicated on the individual's ability to accumulate productive assets, and income inequality will be reduced by addressing the unequal distribution of income generating assets, there is considerable merit in moving the process of poverty measurement away from expenditure-based measures, toward a more asset-based focus. Such a focus will, in turn, have implications for poverty reduction strategies. It implies more emphasis on economic and social forces that contribute to asset inequality, instead of anti-poverty measures that are targeted and evaluated based on expenditure levels.

Measurement Issues

Beyond the merits of focusing policy on asset accumulation, there are also a series of measurement problems with income and expenditures, particularly in developing countries, that commend consideration of an asset-based indicator as an alternative. First, unlike in developed countries, consumption and expenditure surveys are intermittent, at best, and with few exceptions, of low quality. The technical capacity within governmental agencies charged with conducting such surveys is limited, and the budget constraints under which these agencies operate are severe. Consequently, donor agencies such as the World Bank have often assumed charge for the design and implementation of surveys, at a very high financial cost. In addition, the commitment of donors to ensuring the availability of quality household data is wavering and unreliable, at best. This has led to a call for identifying more rapid, less costly, and less demanding alternative approaches to measuring poverty and ranking household welfare than the complex income and expenditure surveys that have been widely applied in developing countries. Since assets in poor countries are fewer and easier to measure, assets represents a potential alternative to more complex consumption and expenditure surveys.

Second, when consumption data is available from developing countries, it is collected on the basis of recall—usually 14 days, but sometimes one month. This recall data is prone to very large measurement errors. Some of this error is random – but not all. For example, the more commodities listed on the recall sheet, the higher the measured consumption (Pradhan 2000). Likewise, the longer the recall period, the lower the consumption that is reported (Scott and Amenuvegbe 1990).

Third, when constructing consumption aggregates, there is a need to derive the use value of those goods. To do so, we need data on the price of the good, the nominal interest rate, and the rate of depreciation, all of which are difficult to discern. A similar problem arises with housing, where the rental equivalent is almost impossible to determine, especially in rural areas where there is virtually no rental market for housing.

Fourth, in most poor countries, particularly in Africa, it is rare to find more than one household budget survey conducted during the past decade. Therefore inter-temporal comparisons are often not possible. Even more disconcerting is that more often than not, when there are two or more surveys, changes in the questionnaire design or survey procedures make comparisons less valid. In particular, the number of commodities listed and the recall period often are not consistent from one survey to the next. So, any inter-temporal comparisons are suspect.

A fifth problem with measuring consumption-based poverty is the choice of deflators: unlike in developed countries, where consumer price indexes are both readily available and reliable, in poor countries this is the exception rather than the rule , especially where inflation tends to be high and variable. It is also unusual to find regional price indexes. While this may not be of great importance in countries where markets are well integrated, and transportation and marketing costs are relatively small, in most poor countries regional and seasonal price variability is often dramatic.[10] Thus, the absence of reliable price deflators, at the national and regional levels, leads many researchers to employ unit prices derived from surveys to construct deflators, despite the obvious shortcomings in this approach. Thus, whether using flawed official prices, or derived price indexes from budget surveys, inter-temporal (and inter-regional) comparisons of poverty are highly subjective exercises.

A sixth and related problem with using a money-metric of utility to assess poverty in developing countries arises when trying to make inter-country comparisons. Exchange rate distortions make converting goods purchases into common prices perilous. Purchasing power parity numbers are widely available and often represent the best option for converting local currency into dollars. However, these numbers are rough approximations, and certainly are subject to considerable error.

In sum, there are myriad obstacles to reliable comparative analysis based on consumption and expenditure data surveys. Therefore, we propose the use of an asset index which has the advantages that: (a) assets in poor countries are few and generally easy to measure in contrast to a long-list of potential consumption goods, many of which are from home consumption and are in fact input/output of household enterprises; (b) the standardization of questionnaires is less of a problem (e.g., the issue of recall period is minimal); (c) the types of assets we will propose are likely to be subject to less reporting bias; and (d) as we will discuss below, since in most cases we rely on the use of actual physical assets such as land, human capital, or housing characteristics, we do not have to worry about problems of currency deflation.

ASSET INDEX

There are some major challenges in constructing an asset index. Most prominent is the difficulty involved in the aggregation of the various types of assets into a single number that represents the sum total of the value of assets. This is especially problematic in developing countries where markets are thin, and where it is difficult, if not impossible, to place a monetary value on many types of assets. We thus face the challenge of defining a set of weights for each asset. More specifically, we construct an index of the household assets that assumes the following form

$$A_i = \gamma_1 a_{i1} + \ldots + \gamma_K a_{iK}$$

where A_i is the asset index, the a_{iK}'s are the individual assets recorded in the survey, and the γ's are the weights, which we must estimate. Because neither the quantity nor the quality of all assets is collected, nor are prices available in the data, the natural welfarist choice of prices as weights is not possible. Rather than imposing arbitrary weights, we let the data determine them directly. Hammer (1998) and Filmer and Pritchett (1998) use a similar method that employs

[10] In many African countries, for example, it costs more to ship rice from the port to the interior, than from Bangkok to the port. Another manifestation of the high marketing costs is that the CIF and FOB prices often differ by 100 percent.

principal component analysis to construct an asset index. The weights for their indices are the standardized first principal component of the variance-covariance matrix of the observed household assets. We use factor analysis instead of principal component analysis because the latter forces all of the components to accurately and completely explain the correlation structure between the assets. Factor analysis, furthermore, accounts for the covariance of the assets in terms of a much smaller number of hypothetical common variates, or factors (Lawley and Maxwell, 1971). In addition, it allows for asset-specific influences to explain the variances. In other words, all of the common factors are not forced to explain the entire covariance matrix. In our case, we assume that the *one* common factor that explains the variance in the ownership of the set of assets is a measure of purchasing power, or "welfare." Finally, the assumptions necessary to identify the model using factor analysis are stated explicitly.[11]

While the structural details and related assumptions of the structural model that underlies our asset index are discussed elsewhere (Sahn and Stifel 2000), it is worth noting that the assets included in the index can be placed into two categories: household durables and household characteristics. The household durables consist of per capita values of radios, stereos, TVs, sewing machines, stoves, refrigerators, bicycles, and motorized transportation (motorcycle and/or cars), houses, and farming equipment or business assets owned by the household. The household characteristics include indicator variables for source of drinking water (piped or surface water relative to well water), toilet facilities (flush or no facilities relative to pit or latrine facilities), cooking fuel (gas or electricity), and household construction material (indicators for quality of walls, roofs, floors, and glass windows). Hectares of land and number of livestock are included in per capita terms. We also include the years of education of the household head to account for household's stock of human capital.

DATA

Living Standards Measurement Study (LSMS) household surveys for Côte d'Ivoire, Ghana and Vietnam are used in the paper. The purpose of these surveys is to collect individual, household, and community data to measure levels and changes in living standards of the populations sampled. The national statistical offices of each of the countries conducted the surveys with technical support from the World Bank. Multi-stage sampling techniques were used in selecting the samples of households, and sampling was done in a way to ensure self-weighting (i.e., each household has equal probability of being in the sample). The household surveys collect detailed information on expenditures, income, employment, assets, basic needs, and socio-economic characteristics of the households.

Analysts in the LSMS division of the World Bank constructed the expenditure variable used in the analysis. The aggregate measure of expenditures in the 12 months preceding the interview is a combination of food expenditures (market purchases and imputed value of home production), nonfood expenses (weekly expenses, annual expenses, depreciated consumer durables, utilities, housing rent or rental value, and educational expenses), and in-kind wages.

[11] Nonetheless, the two methods create indexes that rank households similarly. The Spearman rank correlation between the principal components and factor analysis asset indexes is about 0.98 for each of our samples.

The Côte d'Ivoire sample (CILSS) was collected between March 1986 and March 1987 (hereafter 1986), in two visits to households two weeks apart. The sample size of 1,600 households includes anthropometric measurements of 2,047 children under five years of age. Grootaert (1986) and Ainsworth and Munoz (1986) discuss this data in detail.

The Ghana sample was collected between October 1988 and August 1989 (hereafter 1988 or GLSS). The sample size is 3,192. Anthropometric measurements are available for 2,551 children under the age of five for GLSS.

The Vietnam Living Standards Study survey (VNLSS) was collected between October 1992 and October 1993 (hereafter 1993), in two visits to each household two-weeks apart. Expenditure data was collected during the second visit to the 4,800 households in the sample, and 2,813 children under age five were measured in the anthropometry section.

RESULTS

Comparison with Reported Consumption Expenditures

In this section we compare our asset index with consumption expenditures, the widely accepted measure of household welfare. When targeting the poor is an objective, we need to be able to identify them. Thus the consistency of ranking households by the asset index and predicted expenditures relative to reputed expenditures is important and examined.

There are several approaches to comparing household rankings. The first approach we employ is the use of Spearman rank correlations, which provide information on the overall rankings of individuals from poorest to richest. We look at the correlation coefficient between assets and expenditure per adult equivalent where the size elasticity is set to 0.5 (Table 1).[12] The rank correlations are reasonably high, 0.70 for Côte d'Ivoire, and 0.56 and 0.55 in the cases of Ghana and Vietnam, respectively. In all cases the Spearman tests of independence between the distributions of reported expenditures and estimated variables are rejected.

To give an idea of where along the distribution of household consumption expenditures the re-rankings occur, the rankings of the various welfare indicators are compared by means of transition matrices. The use of transition shares is borrowed from the labor economics literature on earnings and income mobility (Cox and Alm, 1995; Fields and Ok, 1996; and Leary, 1998), though the emphasis here is on immobility or fit (Hentschel and Lanjouw, 1995). The more households, for example, in the first quintile of reported expenditures placed in the first quintile of the alternative measure of welfare, the less "mobility" between the two distributions and the greater the fit. Those who are relatively poor, as measured by reported expenditures, will also be

[12] The choice of scaling for expenditures is subjective and not econometrically identifiable. In this paper, we define equivalent incomes as: $Y_i^{*} = Y_i/(A_i + cK_i)^{\theta}$, where θ represents the elasticity with respect to household size (i.e., the size or equivalence elasticity), Y_i is household income, and A_i and K_i are the number of adults and children in the household, respectively. We set $c = 1$ with $\theta = 0.5$. Elsewhere, we show that the results reported here are not very sensitive to the choice of the size elasticity. In addition, we have tried doing the factor analysis where the values of assets are scaled by different θs. The weights change only slightly, so that there is little re-ordering of households, unlike with the expenditure measures where the ordering of household well-being is sensitive to the choice of the size elasticity (Sahn and Stifel 2000).

considered relatively poor under the alternative measure. If significant re-rankings of households occur, then the identification of the poor differs across the measures.

The transition share matrices (Table 2) indicate considerable re-ranking between assets and expenditures. More specifically, an examination of the diagonal elements of these matrixes, which represents the proportion of the population that is in the same expenditure and asset quintiles of the distribution, shows that the proportions are highest for the uppermost quintile. For example, in Cote d'Ivoire, three-quarters of the population that is in the uppermost quintile for the expenditure (asset) distribution is also in the uppermost quintile for the asset (expenditure) distribution. In the bottom quintile of the asset distribution, 52 percent of the households are also in the bottom quintile of the expenditure distribution. However, in Cote d'Ivoire and Ghana, more than one-quarter of the population in the bottom quintile of the asset distribution is found in the second quintile of the expenditure distribution. Thus, it is clear that while the correlation between these two variables is reasonably high, the re-ranking is also substantial.

Poverty Profile

One of the most important components of any poverty alleviation strategy, and therefore of household level data collection, is developing a poverty profile that characterizes the poor and distinguishes their attributes from the non-poor. The question arises as to whether in fact the classification and characterization of the poor differs when using a definition of poverty that is based on expenditures and assets. To explore this question, we present some a basic poverty profile for our three countries, using both expenditures per capita and asset-based poverty indicators. More specifically, we set the poverty line equal to the 25th percentile of the population distribution. Thus, one quarter of the population is defined as poor in either case. The question arises, however, as to whether the characteristics of the population that falls in the bottom quartile of the expenditure and asset distribution differ. The extent to which they differ will determine whether or not our poverty profile based on these indicators will be consistent.[13]

To begin, in Table 3, we show a breakdown of poverty by rural versus urban areas. This and the following tables present both the share of the poor that are in a given category (in this case, the share of the rural and urban population that are poor), as well as the overall contribution of the category to national poverty (in this case, the share of the total poor that reside in rural and urban areas). Results indicate that in all three countries urban poverty is less relative to rural poverty when relying on the asset index than on expenditures. The difference between assets and expenditure-based poverty measures is particularly pronounced for Côte d'Ivoire where 7 percent of the urban population is classified as poor based on an expenditure-based definition, while only 2 percent are characterized as poor when relying on our asset-based measure. This undoubtedly reflects the far better position of urban households in terms of asset ownership, for comparable levels of total expenditures. In fact, the greater level of asset-based poverty in rural than urban areas may help explain the allure of urbanization, despite that the fact that, at least in the short-term, migration may not bring higher earnings. In addition, the differences between the

[13] There is considerable evidence that poverty profiles are robust to subjective decision regarding poverty lines. Thus, whether we set the poverty line at the 25th or some other share of the distribution is not expected to alter the results of our comparison of poverty profiles based on incomes vs. assets.

results of the two measures may reflect differences in preferences for asset ownership between urban and rural areas.

Table 4 shows the poverty according to the gender of the household head. The percent of poor in male-headed households is virtually the same across measures for the Ghana and Vietnam surveys. However, again in the case of Cote d'Ivoire, an important difference is noted: female-headed households are far more likely to be poor when evaluated on the basis of expenditures than asset poverty. No such difference, however, exists for male-headed households in Cote d'Ivoire.

Poverty by educational attainment of the household head is shown in Table 5. The results between the educational profile of the poor, based on the use of the asset index and the traditional expenditure-determined poverty line, differ substantially only in the cases of Cote d'Ivoire for heads with primary and secondary education. For example, among households where the head has primary education, 17 percent are characterized as poor when using the expenditure measures, while the figure is only 4 percent when using assets. In fact, the decline in probability of being poor as education increases is much steeper in the case of the asset-based indicator than the expenditure measure. And similarly, the poor are much more concentrated among the uneducated when relying on the asset-based measure than expenditure-based population ordering and poverty line.

Finally, in Table 6, we show poverty by the size of the household. In this case, the characteristics of the poor, stratified by household size, differ most markedly in the case of Vietnam. In particular, we do not observe the large increase in poverty with increasing household size when relying on asset poverty, unlike the use of our expenditure measure. This finds explanation in the fact that our poverty profile using assets is based on household ownership of assets, without any discount for more people in the household. While some degree of discounting may be appropriate, as discussed above, most of the assets in our measure are not easily divisible.

Evaluation through Nutrition Models

By comparing the ordering of household welfare using asset indexes and expenditures, as well as the poverty profiles based on these two indicators, we implicitly assume that the latter represents the true measure of welfare. However, we must keep in mind that consumption expenditures are a proxy for welfare and measures long-term wealth with error. Furthermore, it is not entirely clear that expenditures are better measure of economic welfare, especially considering that the choice of regional price indexes can considerably alter the distribution of reported expenditures, as can changes in survey instruments. We thus turn to an indirect means of evaluating the asset index and predicted expenditures variables, one that is more in the spirit of the capabilities approach to measuring welfare – modeling child nutrition outcomes.

While the preceding comparisons make it clear that the correspondence between the asset ordering and expenditures is far from perfect, it begs the question as to which is a better metric of household welfare. In this section we attempt to address that question. We do so by comparing the ability of the two metrics of economic well-being, our asset index and consumption expenditures, to explain nutrition outcomes. Appendix B discusses the theoretical foundations and estimation strategies for modeling nutrition outcomes of children under five years of age. The dependent variable is the standardized anthropometric height-for-age Z (HAZ) score (see Appendix A), a indicator of long-term nutritional status, or chronic malnutrition. The set of predictors consists of characteristics of the child (e.g., age, gender, birth order), household demographic variables such as household size and age-sex composition, characteristics of the parents (e.g., educational attainment, age, and height), community characteristics where available (e.g., distance to nurse and doctor, vaccination prevalence), month of the measurement (to control for seasonality), and region dummies.

Separate quasi-reduced form models conditioned on (a) the log of household asset indexes, (b) the log of household expenditures,[14] and (c) both the log of asset indexes and the log of per capita household expenditures. Standard errors were estimated using bootstrapping methods for the models. The logic for estimating the latter model (c) is that while collinearity between the asset index and consumption expenditures will bias the coefficient estimates, it does not bias the predicted values of the dependent variable, the child's nutritional outcome. Further, if the predicted outcomes from the models that include both asset indexes and consumption expenditures perform better than those with either one or the other, we could reasonably conclude that each has more to add to the model. When this is not the case, then the asset index and household consumption expenditures can be viewed as practical substitutes for explanatory variables in models of child nutritional outcomes.

Table 7 reports the mean bootstrapped parameter estimates on expenditures and the ordinary least squares (OLS) R^2 for each of the models.[15] The signs are all as expected. The asset index coefficients are positive and significant in urban and rural areas for all three countries. In contrast, the expenditure coefficient is not significant in urban and rural Ghana and in rural Cote d'Ivoire. Because the scale of the asset index is different from that of expenditures, the coefficients of the former cannot be compared directly with those of the latter. However, for both urban and rural areas, the parameter estimates are largest for Côte d'Ivoire and smallest for Ghana.[16] In every sample, the explanatory power of the models conditioned on asset indexes is comparable to those conditioned on expenditures.

Spearman rank correlations between measured and predicted HAZ scores (Table 8) indicate that in terms of predictive capabilities, it does not matter which alternative welfare measure is used.[17] Specifically, the correlations between the predicted nutritional status from the models using assets and expenditures are nearly identical in all cases.[18] Furthermore, the rank correlations do

[14] We have experimented with instrumenting expenditures, and the parameter estimates only differ in a trivial fashion than using reported expenditures (Sahn and Stifel 2000).
[15] For ease of exposition, the other parameters in the model are not presented but are available from the authors upon request.
[16] Elasticities are equally uninformative because a one percent change in the asset index does not represent the same magnitude of change as does a one percent change in expenditures.
[17] Elsewhere where we instrument expenditures using two-stage least squares, we also find that the correlations between predicted expenditures and height-for-age are nearly the same (Sahn and Stifel 2000).
[18] We have also calculated transition matrices where we examine how well the model predicts the quantiles of the height-for-age distribution relative to that actually reported. Here too, they are also extremely similar across the expenditure and asset indexes (Sahn and Stifel 2000).

not improve in any significant way when the asset index is added into the model with expenditures. This suggests that analysts are no worse off conditioning child nutrition models on the asset index rather than reported expenditures in their effort to predict nutritional outcomes and target programs.

Further insight into the relative merits of the alternative measures can be gained when we consider that each variable is a proxy for the same thing—long-term wealth—but is measured with error. We employ the logic behind the Hausman test of measurement error here to construct a relative indicator of measurement error between predicted expenditures and the asset index (Filmer and Pritchett, 1998). The preferred measure is the one that has a level of measurement error lower than the other to which it is being compared.

If we assume that the measurement error for predicted expenditures and for the asset index are not perfectly correlated, then each can be used as an instrument for the other to alleviate (though not eliminate) the attenuation bias in the OLS parameter estimate. The ratio of the OLS estimator to the instrumental variable (IV) estimator is a relative measure of measurement error, which as Filmer and Pritchett (1998) point out, is an estimate of the relative signal to signal plus noise of the two variables. In other words, the lower the ratio (the more noise or measurement error), the worse the variable is as a proxy for long-term wealth in predicting nutritional outcomes.

Although instruments are valid only when they are uncorrelated with the error term in the estimating equation, Appendix C shows that this approach is still valid as a means of indicating *relative* measurement error because the IV estimates for both expenditures and assets will converge to the same constant.

Table 9 presents the estimated ratios of OLS to IV estimates from regressions of height-for-age z-scores on predicted expenditures using the asset index as an instrument, and from regression on the asset index using expenditures as an instrument.[19] In each case except rural Vietnam, the ratio of OLS to IV estimators is higher for the asset index than for expenditures, suggesting that measurement error is larger for the latter. In instances such as urban Côte d'Ivoire and Vietnam, the ratios are relatively close. At the opposite extreme is urban Ghana where the ratio is 0.276 for expenditures, and 0.889 for the asset index.

Concluding Remarks

This paper evaluates the potential of our index of household assets to act as a measure of the economic welfare of the household. Our motivation is to see if there exist simpler and less demanding alternatives to collecting data on expenditures to measure economic welfare and to rank households.

The first form of evaluation, comparison of the asset index and expenditures, indicates that the ranking of household welfare according to the asset index is quite dissimilar, both based on the

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[19] The exercise was also carried out for reported expenditures and expenditures predicted from the DHS-restricted models. The results do not differ substantially from those in Table 8, and consequently are not reported.

correlation coefficients and the transition matrices. Regarding our comparison of the poverty profile using the asset index and expenditures, we find that while they are similar, the two measurement tools do paint a somewhat different picture. The important differences in magnitudes are noted in the cases where we compare rural versus urban poverty. Poverty appears to be a relatively greater problem in rural areas when we use the asset index. This is likely explained by the fact that asset ownership is greater in the cities. While present consumption may not be much higher, there is the implication that urban households are more effective at accumulating assets, which may portend greater improvements in welfare for households in the cities.

While these comparisons are informative, it begs the question of whether direct comparisons to household consumption expenditures are the appropriate means of evaluation. Household expenditures are a proxy for welfare (and notionally, utility). They are, however, measured with large errors. The reliance on recall data, the large share of goods consumed from home production, poorly trained and supervised enumerators and field staff, inconsistencies in survey instruments, and suspect price deflators are the types of factors that make rankings and analyses of poverty dynamics based on expenditure data suspect and problematic.

We therefore resort to a second form of evaluation that involves testing the power of the asset index and expenditures, both instrumented and reported, to predict a basic capability—adequate nutrition. Our findings show that the asset index is a perfectly valid predictor of child nutrition outcomes. In the context of estimating models of nutrition, we find no compelling reason to believe that expenditures serves as a better proxy for economic welfare than does the asset index. In fact, for the three samples included in this paper, the asset index performs as well, if not better than expenditures in predicting children's height-for-age Z-scores. Further, indicators of relative measurement error estimated in the nutrition models show that expenditures are measured as a proxy for long-term wealth or welfare with more error than is the asset index.

Despite the ambiguous results from direct comparison of the asset index and expenditures to reported household expenditures, this paper finds no reason to abandon the use of the asset index as a measure of economic welfare in the absence of expenditure data. In addition, even when expenditure data are available, our results suggest that analysts may prefer to use the asset index as an explanatory variable, or in an effort to map a metric in permanent income space to other living standards and capabilities, such as nutrition. In fact, while further empirical testing is required, our research raises the prospect of relying on assets as an alternative to the collection of expensive expenditure data that is ridden with large measurement errors.

Appendix A

Anthropometric Nutrition Measures

The indicators of nutritional status used in this paper (and available in the DHS) are anthropometric measurements of children under age five. From these measures, along with reported ages of children, normalized measures of weight-for-height, height-for-age, and weight-for-age can be constructed as follows

$$z\text{-}score = \frac{x_i - x_{median}}{\sigma_x},$$

where x_i is a given measurement such as height or weight for child i, x_{median} is the median of that measurement for a healthy and well-nourished child from a reference population of the same age or height and of the same gender, and σ_x is the standard deviation from the mean of the reference population. Note that the z-score for the reference population has a standard normal distribution in the limit. Thus, a child has a probability distribution on the expected value of a z-score. If more that 2.5 percent of a given population have z-scores that fall two standard deviations below the mean of the normal population (zero), then there is said to be malnutrition in the country.

As recommended by the World Health Organization (WHO, 1983), the standard reference population used here is that of the United States National Center for Health Statistics. Studies, such as Martorell and Habicht (1986) that found that less than 10 percent of worldwide variance in height is due to differences in genetics or race among children of the same sex under the age of ten, help to establish the appropriateness of using such a reference population.

The height-for-age z-score (HAZ) is an indicator of a child's long-term nutritional status. Children who are "stunted" are those whose past chronic nutritional deprivations leave them shorter than expected for their age and gender cohorts in the reference population. The weight-for-height z-score (WHZ), on the other hand, reflects short-term nutritional status. Current nutritional stress manifests itself in acute "wasting" of children independent of chronic malnutrition. The third measure, the weight-for-age z-score (WAZ), captures a combination of "stunting" and "wasting." We limit ourselves to modeling only the HAZ scores.

Appendix B

Nutrition Models

The theoretical foundations for modeling household expenditures and child nutrition must be considered concurrently given the simultaneity of choices that govern the levels and patterns of consumption with those of 'inputs' into child nutrition. We thus follow Behrman and Deolalikar (1989), Horton (1988), Sahn (1990) and Thomas, Lavy and Strauss (1996) in estimating reduced form equations. Further, since we are interested in the role of our proxies for wealth, we follow the method of Sahn (1990) in estimating these reduced-form equations conditional on consumption expenditures. The appropriate means of doing so would be to instrument per capita expenditures to ensure that they are not jointly determined by the nutritional outcomes that they are meant to explain. This provides an opportunity to test our asset index and DHS-limited predicted household expenditures against the instrumented variable typically used in nutrition models.

The models of household per capita consumption expenditures and child nutritional status are derived from a household model in the tradition of Becker (1981). Assume that the household maximizes a quasi-concave utility function that takes as its arguments consumption of commodities and services, x, the leisure, l, and health status, θ (of which a child's anthropometric measurement, h, is one dimension) of each household member. Without considering how household decisions are made, the household solves the following problem, $\max_{x,l,\theta} u(x,l,\theta;A,Z)$,

where A and Z respectively represent household and community characteristics, some of which are not observed. Allocation choices are conditional to the budget constraint:

$$px = w(T-l) + y\,,$$

where p is a vector of prices, w is a vector of household members' wages, T is a vector of the household members' maximum number of work hours, and y is household non-wage income.

The nutritional status of children, h, is determined by a biological health production technology:

$$h_i = h(I, A, Z, \mu_i)\,,$$

where I are health inputs and μ_i represents the unobservable individual, family, and community characteristics that affect the child's nutritional outcomes. Household characteristics (e.g., demographics, educational levels, etc.), A, can have an impact on health by affecting household allocation decisions. Community characteristics, Z, such as vaccination rates and access to clean water, can also have direct impacts on nutritional outcomes. Note that the input vector, I, includes consumption goods which contribute positively to household welfare both directly through x, and indirectly through h. This represents the simultaneous choice of consumption goods and health inputs.

Solving the household's optimization problem leads to reduced-form demand equations including those for consumption, nutrition inputs, and child nutrition. The nutrition functions for each child conditional on per capita expenditures (quasi-reduced form) can be represented as follows:

$$h_i = \widetilde{h}(x, A, Z, \varepsilon_i)\,,$$

where ε_i is the child-specific random disturbance term, which as such is assumed to be uncorrelated with the other elements of the demand function. Since consumption, x, is a choice variable, it is unlikely to be uncorrelated with the disturbance term, and instrumental variables approaches are typically employed.

This is the model that we estimate, substituting our asset index and DHS-restricted predicted consumption expenditures for x as instruments. Because we are predicting expenditures at the household level (instead of the level of the individual), we cannot use two-stage least squares. Further, since the asset index is constructed using factor analysis, other means of correcting the standard errors must be found. For these reasons, the models were bootstrapped to estimate standard errors and to test parameter differences across models.

Appendix C

Indicator of Relative Measurement Error

To illustrate that the ratio of the OLS to IV estimators is a valid indicator of *relative* measurement error, we first set up the model and briefly review the basis of the Hausman test. We simplify notation by assuming that there is only one explanatory variable, though this can be easily generalized to multivariate regression.

Define the following variables (individual subscripts are dropped for simplicity) as:

y = HAZ score of the child

x^* = True value of wealth (not observed)

x_e = Expenditures

x_a = Asset Index

Suppose that the underlying model is

$$y = \beta x^* + \varepsilon,$$

and our proxies for wealth are measured with error as follows,

$$x_e = x^* + u_e \qquad u_e \sim N(0, \sigma_e^2), \text{ and}$$

$$x_a = x^* + u_a \qquad u_a \sim N(0, \sigma_a^2).$$

Starting with the model in which we regress y on expenditures, x_e, we have

$$y = \beta x_e + (\varepsilon - \beta u_e).$$

If the asset index were a valid instrument for expenditures, then

$$\text{cov}(x_a, x_e) \neq 0, \text{ and}$$

$$\text{cov}(x_a, u_e) = 0.$$

The first condition is clearly the case given the rank correlations between the asset index and reported and predicted household consumption expenditures reported in Table 1. The second condition is unlikely to hold since there is sure to be some component of the measurement error common to both expenditures and the asset index. Note first that if both conditions hold, then

$$p\lim \hat{\beta}_{e,IV} = \beta \geq p\lim \hat{\beta}_{e,OLS},$$

where $\hat{\beta}_{e,IV}$ is the IV estimator when the asset index is used as an instrument for expenditures. This follows from the fact that in the presence of measurement error, the OLS estimator suffers from attenuation bias, and implies that

$$\frac{\hat{\beta}_{e,OLS}}{\hat{\beta}_{e,IV}} \leq 1$$

in the limit. The same would be the case for the model in which y is regressed on the asset index. Thus if each of the wealth proxies were valid instruments for each other, then the proxy for wealth in the model with the higher ratio of OLS to IV estimators in the limit, is the proxy that suffers from relatively less measurement error.

The consistency of the IV estimator follows from the orthogonality between the instrument and the error term. This is not likely to be the case for expenditures and the asset index. In other words,

$$\operatorname{cov}(x_a, u_e) \neq 0 \text{, and}$$

$$\operatorname{cov}(x_e, u_a) \neq 0 .$$

Nonetheless, provided that the measurement error of the asset index and expenditures is not perfectly correlated, comparison of the ratios of OLS to IV estimators remains a valid indicator of *relative* measurement error. This is apparent if we rewrite the measurement error as

$$x_e = x^* + \tilde{u} + \tilde{u}_e, \text{ and}$$

$$x_a = x^* + \tilde{u} + \tilde{u}_a,$$

where $\tilde{u}$ is the component of the measurement error common to both the asset index and expenditures, and $\tilde{u}_e$ and $\tilde{u}_a$ are the idiosyncratic measurement error terms for expenditures and the asset index, respectively. The covariance between the instrument and the error for nutrition regressed on expenditures can now be written as

$$\operatorname{cov}(x_a, u_e) = \operatorname{cov}(x_a, \tilde{u})$$

since

$$\operatorname{cov}(x_e, \tilde{u}_a) = 0 .$$

Using this information, it follows from the definition of the IV estimator that

$$p\lim \hat{\beta}_{e,IV} = p\lim \hat{\beta}_{a,IV} = \left(\frac{\operatorname{var}(x^*)}{\operatorname{var}(x^*) + \operatorname{var}(\tilde{u})} \right) \beta .$$

Thus, although the IV estimators are not consistent, they converge to the same constant and

$$\frac{\hat{\beta}_{i,OLS}}{\hat{\beta}_{i,IV}} \leq \left(\frac{\operatorname{var}(x^*)}{\operatorname{var}(x^*) + \operatorname{var}(\tilde{u})} \right) \qquad \text{for} \qquad i = e, a.$$

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Table 1. Spearman Rank Correlations between Reported Expenditures and Alternative Measures of Welfare

	Predicted expenditures	Asset Index
Côte d'Ivoire		
Log per capita household expenditure	0.73	0.61
Asset Index	0.75	
Ghana		
Log per capita household expenditure	0.50	0.57
Asset Index	0.47	
Vietnam		
Log per capita household expenditure	0.76	0.57
Asset Index	0.64	

Table 2a. Matrices of Transition Shares for Côte d'Ivoire (CILSS), 1986

		Predicted Per Capita Expenditures					
	Quintiles	1	2	3	4	5	Row Sum
Per Capita Expenditures	1	**53.8**	24.9	17.4	3.9	0.1	100.0
	2	23.8	**35.7**	25.5	13.6	1.3	100.0
	3	13.2	24.1	**28.9**	25.3	8.6	100.0
	4	6.7	12.5	22.5	**34.6**	23.7	100.0
	5	2.5	3.3	5.3	22.6	**66.4**	100.0

		Asset Index					
	Quintiles	1	2	3	4	5	Row Sum
Per Capita Expenditures	1	**40.4**	32.9	20.7	4.9	1.1	100.0
	2	28.6	**22.4**	33.9	13.5	1.7	100.0
	3	18.8	25.3	**19.8**	29.5	6.6	100.0
	4	9.5	14.4	18.9	**33.6**	23.6	100.0
	5	2.9	4.8	6.7	18.8	**66.8**	100.0

Table 2b. Matrices of Transition Shares for Ghana (GLSS), 1988

		Predicted Per Capita Expenditures					
	Quintiles	1	2	3	4	5	Row Sum
Per Capita Expenditures	1	**47.1**	27.2	15.1	7.4	3.3	100.0
	2	26.6	**31.0**	21.2	14.6	6.6	100.0
	3	13.8	18.8	**27.0**	23.8	16.6	100.0
	4	9.1	13.2	24.0	**29.5**	24.2	100.0
	5	3.4	9.9	12.6	24.8	**49.3**	100.0

		Asset Index					
	Quintiles	1	2	3	4	5	Row Sum
Per Capita Expenditures	1	**40.7**	32.2	17.1	6.4	3.6	100.0
	2	29.5	**26.6**	19.9	16.5	7.6	100.0
	3	18.1	17.1	**28.2**	24.4	12.4	100.0
	4	9.1	16.7	22.7	**27.3**	24.3	100.0
	5	2.8	7.4	12.2	25.7	**52.0**	100.0

Table 2c. Matrices of Transition Shares for Vietnam (VNLSS), 1993

		Predicted Per Capita Expenditures					
	Quintiles	1	2	3	4	5	Row Sum
Per Capita Expenditures	1	**57.6**	27.0	11.5	3.6	0.3	100.0
	2	24.5	**33.7**	27.6	12.3	2.0	100.0
	3	14.2	25.2	**30.4**	23.6	6.5	100.0
	4	3.4	11.9	23.6	**36.9**	24.2	100.0
	5	0.4	2.4	6.6	23.7	**67.0**	100.0

		Asset Index					
	Quintiles	1	2	3	4	5	Row Sum
Per Capita Expenditures	1	**39.7**	30.6	21.2	7.5	1.0	100.0
	2	22.9	**25.4**	29.0	20.5	2.2	100.0
	3	19.4	21.5	**23.9**	27.3	7.9	100.0
	4	13.5	15.4	17.6	**29.1**	24.5	100.0
	5	4.7	7.0	8.3	15.6	**64.4**	100.0

Table 3. Fit Indexes between Reported Expenditures and Alternative Measures of Welfare

	Predicted expenditures	Asset Index
Ghana		
Log per capita household expenditure	0.58	0.59
Asset Index	0.65	
Cote d'Ivoire		
Log per capita household expenditure	0.40	0.49
Asset Index	0.37	
Vietnam		
Log per capita household expenditure	0.35	0.57
Asset Index	0.47	

Table 4. National, Urban & Rural Relative Poverty by Welfare Measure

Poverty line is the 25th Percentile	Levels		Percent of National Level		Percent of Population
	Reported Expenditures	Asset Index	Reported Expenditures	Asset Index	
National Poverty					
Côte d'Ivoire (CILSS 1986)	25.04	25.00	100.00	100.00	100.0
Ghana (GLSS 1988)	25.01	25.01	100.00	100.00	100.0
Vietnam (VNLSS 1993)	25.01	25.01	100.00	100.00	100.0
Urban Poverty					
Côte d'Ivoire (CILSS 1986)	8.45	1.66	14.27	2.80	42.3
Ghana (GLSS 1988)	10.19	7.90	12.53	9.71	34.5
Vietnam (VNLSS 1993)	7.40	6.83	5.89	5.44	19.9
Rural Poverty					
Côte d'Ivoire (CILSS 1986)	37.19	42.10	85.73	97.20	57.7
Ghana (GLSS 1988)	31.60	32.62	87.47	90.29	65.6
Vietnam (VNLSS 1993)	29.38	29.52	94.11	94.56	80.1

Table 5. Poverty According to Gender of Household Head by Welfare Measure					
Poverty line is the 25th Percentile					
	Levels		Percent of National Level		Percent of Population
	Reported Expenditures	Asset Index	Reported Expenditures	Asset Index	
Male Household Head					
Côte d'Ivoire (CILSS 1986)	25.55	25.65	96.05	96.61	94.2
Ghana (GLSS 1988)	26.81	26.64	74.43	73.95	67.5
Vietnam (VNLSS 1993)	26.26	26.09	81.35	80.83	77.5
Female Household Head					
Côte d'Ivoire (CILSS 1986)	16.93	14.53	3.95	3.39	5.7
Ghana (GLSS 1988)	20.93	21.32	25.57	26.05	32.4
Vietnam (VNLSS 1993)	20.69	21.27	18.65	19.17	22.5

Table 6. Poverty According to Education of Household Head by Welfare Measure					
Poverty line is the 25th Percentile					
	Levels		Percent of National Level		Percent of Population
	Reported Expenditures	Asset Index	Reported Expenditures	Asset Index	
Head with No Education					
Côte d'Ivoire (CILSS 1986)	31.85	36.43	83.77	95.98	65.9
Ghana (GLSS 1988)	36.37	38.61	62.70	66.57	43.1
Vietnam (VNLSS 1993)	39.18	46.29	18.69	22.08	11.9
Head with Only Primary Education					
Côte d'Ivoire (CILSS 1986)	19.10	4.45	13.50	3.15	17.7
Ghana (GLSS 1988)	22.59	24.23	14.98	16.07	16.6
Vietnam (VNLSS 1993)	24.76	28.53	52.68	60.71	53.2
Head with Only Secondary Education					
Côte d'Ivoire (CILSS 1986)	4.87	1.55	2.74	0.87	14.1
Ghana (GLSS 1988)	15.16	12.57	19.81	16.43	32.7
Vietnam (VNLSS 1993)	23.86	14.26	25.13	15.01	26.3
Head with Post Secondary Education					
Côte d'Ivoire (CILSS 1986)	0.00	0.00	0.00	0.00	2.3
Ghana (GLSS 1988)	8.37	3.59	2.54	1.09	7.6
Vietnam (VNLSS 1993)	1.05	0.76	4.21	3.04	9.6

Table 7. Poverty According to Number of Household Members					
Poverty line is the 25th Percentile					
	Levels		Percent of National Level		Percent of Population
Household Size	Reported Expenditures	Asset Index	Reported Expenditures	Asset Index	
1 to 2 members					
Côte d'Ivoire (CILSS 1986)	7.59	30.38	3.00	12.04	9.9
Ghana (GLSS 1988)	19.54	20.93	22.32	23.91	28.6
Vietnam (VNLSS 1993)	12.20	24.97	1.76	3.61	3.6
3 to 5 members					
Côte d'Ivoire (CILSS 1986)	12.07	30.97	11.52	29.59	23.9
Ghana (GLSS 1988)	24.52	23.77	37.75	36.60	38.5
Vietnam (VNLSS 1993)	21.28	23.87	38.27	42.93	45.0
6 to 10 members					
Côte d'Ivoire (CILSS 1986)	26.23	25.46	42.56	41.37	40.6
Ghana (GLSS 1988)	31.10	29.41	35.07	33.16	28.2
Vietnam (VNLSS 1993)	29.65	26.18	56.42	49.82	47.6
More than 10 members					
Côte d'Ivoire (CILSS 1986)	41.91	16.67	42.81	17.05	25.6
Ghana (GLSS 1988)	25.75	33.57	4.86	6.33	4.7
Vietnam (VNLSS 1993)	23.17	23.72	3.56	3.64	3.8

Table 8. Poverty According to Number of Household Members					
Poverty line is the 25th Percentile					
Theta = 0.5					**Percent of**
	Levels		**Percent of National Level**		**Population**
Household Size	Reported Expenditures	Asset Index	Reported Expenditures	Asset Index	
1 to 2 members					
Côte d'Ivoire (CILSS 1986)	24.68	29.75	9.77	11.76	9.9
Ghana (GLSS 1988)	20.50	21.61	24.64	25.97	30.1
Vietnam (VNLSS 1993)	43.55	24.85	6.29	3.59	3.6
3 to 5 members					
Côte d'Ivoire (CILSS 1986)	27.56	32.02	26.31	30.51	23.9
Ghana (GLSS 1988)	25.17	23.95	39.73	37.80	39.5
Vietnam (VNLSS 1993)	30.52	24.25	54.88	43.56	45.0
6 to 10 members					
Côte d'Ivoire (CILSS 1986)	25.15	25.15	40.85	40.77	40.6
Ghana (GLSS 1988)	29.41	29.41	31.40	31.40	26.7
Vietnam (VNLSS 1993)	19.98	25.99	38.02	49.41	47.6
More than 10 members					
Côte d'Ivoire (CILSS 1986)	22.55	16.42	23.05	16.76	25.6
Ghana (GLSS 1988)	28.46	32.52	4.23	4.83	3.7
Vietnam (VNLSS 1993)	5.25	22.51	0.81	3.45	3.8

Table 9. Bootstrapped Wealth Coefficients from Height-for-Age Quasi-Reduced Form Models

	Côte d'Ivoire			Ghana			Vietnam		
	CILSS 1986			GLSS 1988			VNLSS 1993		
	Mean Coefficient	t statistic	OLS R-squared	Mean Coefficient	t statistic	OLS R-squared	Mean Coefficient	t statistic	OLS R-squared
Urban									
Predicted Expenditures	0.520 **	3.00	0.196	0.076	0.34	0.299	0.502 **	3.03	0.264
Asset Index	3.826 **	4.96	0.206	1.844 **	2.95	0.280	2.732 **	3.47	0.278
Reported Expenditures	0.523 **	4.03	0.208	0.115	1.57	0.280	0.476 **	3.71	0.274
Rural									
Predicted Expenditures	0.778 **	3.28	0.098	0.325 +	1.91	0.256	0.414 **	3.34	0.227
Asset Index	9.053 **	2.63	0.097	2.373 *	2.07	0.255	3.153 **	3.43	0.227
Reported Expenditures	0.032	0.28	0.085	0.069	0.98	0.255	0.476 **	3.71	0.230

Table 10. Performance of Predicted HAZ Scores Using Predicted Expenditures and Asset Index

Spearman Rank Correlations

Reported HAZ	Predicted Expenditures	Asset Index	Predicted Expenditures & Asset Index	Reported Expenditures
Côte d'Ivoire				
CILSS (1986)	0.387	0.394	0.399	0.382
Ghana				
GLSS2 (1988)	0.525	0.520	0.525	0.521
Vietnam				
VNLSS (1993)	0.490	0.491	0.493	0.495

Fit Indexes

Reported HAZ	Predicted Expenditures	Asset Index	Predicted Expenditures & Asset Index	Reported Expenditures
Cote d'Ivoire				
CILSS (1986)	0.49	0.48	0.49	0.49
Ghana				
GLSS2 (1988)	0.48	0.49	0.48	0.49
Vietnam				
VNLSS (1993)	0.51	0.51	0.51	0.51

Table 11a. Matrices of Transition Shares for HAZ for Côte d'Ivoire 1986 (CILSS)

		Predicted HAZ (predicted expenditures)					
	Quintiles	*1*	*2*	*3*	*4*	*5*	*Row Sum*
	1	**39.2**	22.1	18.0	15.2	5.5	*100*
Reported	*2*	23.8	**27.1**	18.1	20.5	10.6	*100*
HAZ	*3*	18.2	21.6	**22.7**	18.9	18.6	*100*
	4	10.1	16.9	20.7	**24.1**	28.3	*100*
	5	8.7	12.3	20.6	21.2	**37.3**	*100*

		Predicted HAZ (asset index)					
	Quintiles	*1*	*2*	*3*	*4*	*5*	*Row Sum*
	1	**39.1**	23.1	19.1	12.8	5.9	*100*
Reported	*2*	24.7	**24.3**	20.7	20.4	9.9	*100*
HAZ	*3*	18.0	23.0	**22.9**	19.0	17.0	*100*
	4	10.4	17.4	19.5	**22.8**	30.0	*100*
	5	7.6	12.1	17.8	25.2	**37.5**	*100*

		Predicted HAZ (predicted expenditures & asset index)					
	Quintiles	*1*	*2*	*3*	*4*	*5*	*Row Sum*
	1	**39.8**	21.8	20.6	11.3	6.4	*100*
Reported	*2*	23.9	**26.9**	18.9	18.7	11.6	*100*
HAZ	*3*	17.0	22.3	**23.5**	20.1	17.2	*100*
	4	10.9	17.1	17.7	**25.8**	28.4	*100*
	5	8.2	11.7	19.1	24.1	**36.8**	*100*

		Predicted HAZ (reported expenditures)					
	Quintiles	*1*	*2*	*3*	*4*	*5*	*Row Sum*
	1	**35.8**	25.4	18.6	14.2	5.9	*100*
Reported	*2*	21.1	**27.0**	22.6	18.2	10.6	*99*
HAZ	*3*	18.9	23.8	**21.7**	18.3	16.5	*99*
	4	14.0	12.5	19.6	**22.6**	31.2	*100*
	5	9.9	10.8	17.1	26.4	**35.7**	*100*

Table 11b. Matrices of Transition Shares for HAZ for Ghana 1988 (GLSS2)

		Predicted HAZ (predicted expenditures)					
	Quintiles	*1*	*2*	*3*	*4*	*5*	*Row Sum*
	1	**42.6**	28.5	17.0	8.7	3.3	*100*
Reported	*2*	24.0	**25.7**	22.1	19.2	9.1	*100*
HAZ	*3*	17.6	24.0	**22.1**	19.6	16.8	*100*
	4	10.3	13.6	25.2	**28.4**	22.6	*100*
	5	5.6	7.7	13.8	24.6	**48.4**	*100*

		Predicted HAZ (asset index)					
	Quintiles	*1*	*2*	*3*	*4*	*5*	*Row Sum*
	1	**40.1**	29.5	20.4	6.7	3.3	*100*
Reported	*2*	24.0	**25.0**	22.8	19.5	8.7	*100*
HAZ	*3*	18.6	21.2	**22.2**	24.1	13.8	*100*
	4	11.5	16.4	21.0	**27.9**	23.2	*100*
	5	5.5	7.7	13.5	22.1	**51.2**	*100*

		Predicted HAZ (predicted expenditures & asset index)					
	Quintiles	*1*	*2*	*3*	*4*	*5*	*Row Sum*
	1	**40.9**	31.1	17.8	7.1	3.1	*100*
Reported	*2*	25.7	**22.8**	24.0	18.5	8.9	*100*
HAZ	*3*	17.0	22.0	**22.0**	26.5	12.7	*100*
	4	11.5	15.2	22.3	**25.4**	25.7	*100*
	5	4.8	8.7	13.9	22.6	**50.0**	*100*

		Predicted HAZ (reported expenditures)					
	Deciles	*1*	*2*	*3*	*4*	*5*	*Row Sum*
	1	**40.3**	30.9	16.7	8.8	3.4	*100*
Reported	*2*	26.6	**23.2**	24.5	15.4	10.3	*100*
HAZ	*3*	18.8	20.6	**23.8**	24.7	12.0	*100*
	4	9.1	17.1	21.0	**28.3**	24.4	*100*
	5	5.0	8.0	14.2	22.8	**50.0**	*100*

Table 11c. Matrices of Transition Shares for HAZ for Vietnam 1993 (VNLSS)

		Predicted HAZ (predicted expenditures)					
	Quintiles	*1*	*2*	*3*	*4*	*5*	*Row Sum*
	1	**37.4**	26.9	18.0	13.7	4.1	*100*
Reported	*2*	27.7	**26.9**	23.0	17.2	5.2	*100*
HAZ	*3*	20.8	21.9	**23.4**	20.3	13.6	*100*
	4	10.6	15.9	20.2	**26.9**	26.5	*100*
	5	3.5	8.4	15.5	22.0	**50.7**	*100*

		Predicted HAZ (asset index)					
	Quintiles	*1*	*2*	*3*	*4*	*5*	*Row Sum*
	1	**36.9**	26.1	18.2	14.8	4.1	*100*
Reported	*2*	27.9	**28.0**	20.9	17.2	6.0	*100*
HAZ	*3*	21.4	22.1	**23.4**	19.7	13.4	*100*
	4	10.6	14.6	22.6	**26.3**	25.9	*100*
	5	3.4	9.1	14.9	22.0	**50.7**	*100*

		Predicted HAZ (predicted expenditures & asset index)					
	Quintiles	*1*	*2*	*3*	*4*	*5*	*Row Sum*
	1	**36.7**	26.5	18.2	14.6	4.1	*100*
Reported	*2*	28.0	**27.3**	21.5	17.4	5.8	*100*
HAZ	*3*	21.0	23.6	**21.9**	19.7	13.8	*100*
	4	11.0	13.8	23.0	**26.1**	26.1	*100*
	5	3.4	8.8	15.5	22.2	**50.3**	*100*

		Predicted HAZ (Reported Expenditures)					
	Deciles	*1*	*2*	*3*	*4*	*5*	*Row Sum*
	1	**34.6**	23.5	18.5	15.9	7.4	*100*
Reported	*2*	28.4	**25.2**	22.6	18.1	5.6	*100*
HAZ	*3*	18.8	23.6	**24.2**	17.3	16.2	*100*
	4	12.5	18.5	19.6	**26.7**	22.8	*100*
	5	5.8	9.1	15.1	22.0	**48.0**	*100*

Table 12. Test of Measurment Error between Predicted Expenditures and Asset Index

Parameter Estimates on Wealth Proxy

	Urban		*Rural*	
	Expenditures	Asset Index	Expenditures	Asset Index
Côte d'Ivoire *CILSS (1986)*				
OLS estimator	0.581	4.140	0.783	9.271
IV estimator	1.265	5.392	1.537	23.560
OLS / IV	*0.460*	*0.768*	*0.510*	*0.394*
Ghana *GLSS2 (1988)*				
OLS estimator	0.205	1.858	0.437	2.563
IV estimator	8.334	1.870	3.393	9.910
OLS / IV	*0.009*	*0.993*	*0.129*	*0.259*
Vietnam *VNLSS (1993)*				
OLS estimator	0.498	2.720	0.360	3.063
IV estimator	0.964	2.838	0.508	3.781
OLS / IV	*0.517*	*0.958*	*0.709*	*0.810*

Appendix Table 1a. Reduced-Form Models for Log Per Capita Expenditures for Côte d'Ivoire 1986 (CILSS)

	Urban			*Rural*		
	Coefficient		t statistic	Coefficient		t statistic
No. of HH members age < 5	-0.251	**	-6.15	-0.137	**	-3.70
Sq. no. of HH members age < 5	0.030	**	3.75	0.012		1.60
No. of HH boys age 5-15	-0.128	**	-3.55	-0.119	**	-3.58
Sq. no. of HH boys age 5-15	0.014	*	1.98	0.016	*	2.46
No. of HH girls age 5-15	-0.171	**	-5.45	-0.141	**	-4.81
Sq. no. of HH girls age 5-15	0.019	**	4.20	0.021	**	3.60
No. of HH women age 15-49	-0.080		-1.08	-0.147	+	-1.74
Sq. no. of HH women age 15-49	0.012		1.56	0.014	*	2.36
No. of HH men age 15-49	-0.086		-1.31	0.023		0.39
Sq. no. of HH men age 15-49	0.016	**	3.49	0.002		0.29
No. of HH members age > 49	-0.644	**	-3.26	0.003		0.03
Sq. no. of HH members age > 49	0.042	*	2.26	0.017	+	1.65
Education of HH head (years)						
Squared education of HH head						
No. male HH memb (15-49) some primary	-0.027		-0.40	-0.092		-1.61
No. male HH memb (15-49) primary	-0.092		-1.36	-0.106	+	-1.83
No. male HH memb (15-49) some secondary	-0.046		-0.68	0.026		0.45
No. male HH memb (15-49) secondary	0.161	+	1.70	0.389		1.53
No. male HH memb (15-49) post secondary	-0.053		-0.76	-0.099	+	-1.92
No. male HH memb (50+) some primary	0.584	**	2.61	-0.249	+	-1.76
No. male HH memb (50+) primary	0.511	*	2.41	-0.142		-0.75
No. male HH memb (50+) some secondary	0.182		0.90	-0.318		-1.26
No. male HH memb (50+) secondary	0.000		0.00	0.000		0.00
No. male HH memb (50+) post secondary	0.429	*	2.22	-0.144		-1.31
No. female HH memb (15-49) some primary	-0.003		-0.04	-0.017		-0.21
No. female HH memb (15-49) primary	-0.073		-1.07	0.041		0.40
No. female HH memb (15-49) some secondary	0.045		0.77	0.178	+	1.81
No. female HH memb (15-49) secondary	0.399	**	2.77	0.000		0.00
No. female HH memb (15-49) post secondary	-0.039		-0.63	-0.003		-0.05
No. female HH memb (50+) some primary	0.733	**	3.24	0.000		0.00
No. female HH memb (50+) primary	-0.582	*	-2.28	0.000		0.00
No. female HH memb (50+) some secondary	1.311	**	3.56	0.000		0.00
No. female HH memb (50+) secondary	0.000		0.00	0.000		0.00
No. female HH memb (50+) post secondary	0.413	*	1.98	-0.165		-1.41
Own house	-0.516	*	-2.18	-0.124	**	-3.15
HH floor material -- sand, dirt	0.613	**	10.15	0.289		1.61
Access to piped drinking water	0.304	**	5.14	0.230	**	2.81
Access to electricity	-0.022		-0.35	-0.177	*	-2.03
Financial Assets	0.257	**	3.52	0.257	**	3.99
Log of value of land				0.020	**	3.06
Log of value of equipment				0.023	**	4.87
Log of value of business assets	0.001		0.29	0.012	*	2.40
Abidjan	0.174	**	3.24			
East Forest				0.067		1.41
West Forest				0.141	**	2.87
Constant	12.602	**	121.68	11.981	**	103.10
Number of Observations	685			909		
R-Squared	0.569			0.321		

+, * and ** indicate significance at the 90%, 95% and 99% levels of confidence, respectively.

Appendix Table 1b. Reduced-Form Models for Log Per Capita Expenditures for Ghana 1988 (GLSS)

	Urban		*Rural*	
	Coefficient	t statistic	Coefficient	t statistic
No. of HH members age < 5	-0.331 **	-6.27	-0.262 **	-9.69
Sq. no. of HH members age < 5	0.032	1.51	0.032 **	4.28
No. of HH boys age 5-15	-0.250 **	-4.82	-0.176 **	-7.19
Sq. no. of HH boys age 5-15	0.042 *	2.31	0.013 *	2.11
No. of HH girls age 5-15	-0.226 **	-4.01	-0.221 **	-9.17
Sq. no. of HH girls age 5-15	0.029	1.57	0.034 **	4.78
No. of HH women age 15-49	-0.213 **	-2.97	-0.262 **	-5.70
Sq. no. of HH women age 15-49	0.033	1.57	0.047 **	3.36
No. of HH men age 15-49	-0.006	-0.07	0.043	0.89
Sq. no. of HH men age 15-49	-0.012	-0.67	-0.032 **	-3.14
No. of HH members age > 49	-0.265 **	-7.86	-0.195 **	-3.48
Sq. no. of HH members age > 49	0.014 **	5.44	0.021	1.49
Education of HH head (years)				
Squared education of HH head				
No. male HH memb (15-49) some primary	-0.140 +	-1.75	0.039	0.81
No. male HH memb (15-49) primary	-0.110	-0.90	-0.023	-0.38
No. male HH memb (15-49) some secondary	-0.055	-0.74	0.075	1.54
No. male HH memb (15-49) secondary	-0.053	-0.35	0.034	0.26
No. male HH memb (15-49) post secondary	0.036	0.43	0.038	0.80
No. male HH memb (50+) some primary	0.255 *	2.52	0.263 **	2.72
No. male HH memb (50+) primary	-0.153	-0.69	0.412 **	2.81
No. male HH memb (50+) some secondary	0.315 **	3.60	0.242 **	3.61
No. male HH memb (50+) secondary	-0.481 **	-3.93	-0.012	-0.07
No. male HH memb (50+) post secondary	0.091	1.04	0.066	1.32
No. female HH memb (15-49) some primary	-0.034	-0.75	-0.004	-0.13
No. female HH memb (15-49) primary	-0.064	-0.64	0.108 +	1.91
No. female HH memb (15-49) some secondary	0.018	0.39	0.124 **	3.50
No. female HH memb (15-49) secondary	-0.031	-0.23	0.787 **	6.31
No. female HH memb (15-49) post secondary	0.072	1.53	0.046	1.33
No. female HH memb (50+) some primary	-0.267 +	-1.94	-0.039	-0.32
No. female HH memb (50+) primary	0.185	1.02	0.041	0.43
No. female HH memb (50+) some secondary	-0.020	-0.12	0.153	0.97
No. female HH memb (50+) secondary	0.000	0.00	0.000	0.00
No. female HH memb (50+) post secondary	-0.125 +	-1.78	-0.081 +	-1.87
Own house	-0.074	-0.54	-0.102 *	-2.40
HH floor material -- sand, dirt	0.110 *	2.00	0.132	1.60
Access to piped drinking water	0.279 **	4.67	0.181 *	1.98
Access to electricity	0.080	1.25	-0.013	-0.46
Financial Assets	0.096	1.47	0.074	1.57
Log of value of land			0.001	0.50
Log of value of equipment			-0.002	-0.31
Log of value of business assets	0.000	0.13	0.003	0.77
Constant	11.134 **	56.67	10.949 **	103.95
Number of Observations	1,242		2,188	
R-Squared	0.484		0.409	

+, * and ** indicate significance at the 90%, 95% and 99% levels of confidence, respectively.
Note: Regional dummies are not reported

Appendix Table 1c. Reduced-Form Models for Log Per Capita Expenditures for VNLSS (1993)

	Urban		*Rural*	
	Coefficient	t statistic	Coefficient	t statistic
No. of HH members age < 5	-0.075 +	-1.67	-0.160 **	-8.91
Sq. no. of HH members age < 5	0.001	0.06	0.027 **	5.77
No. of HH boys age 5-15	-0.091 *	-1.98	-0.039 *	-2.09
Sq. no. of HH boys age 5-15	0.010	0.54	-0.003	-0.55
No. of HH girls age 5-15	0.008	0.17	-0.049 **	-2.71
Sq. no. of HH girls age 5-15	-0.037 *	-2.35	0.001	0.12
No. of HH women age 15-49	-0.154 **	-3.14	-0.112 **	-3.42
Sq. no. of HH women age 15-49	0.011	1.28	0.015 *	2.04
No. of HH men age 15-49	-0.149 **	-2.62	-0.065 *	-2.24
Sq. no. of HH men age 15-49	0.023 *	2.35	0.007	0.96
No. of HH members age > 49	-0.158 **	-3.21	-0.040	-1.44
Sq. no. of HH members age > 49	0.017	1.03	-0.018 +	-1.75
HH head primary				
HH head secondary				
HH head post secondary				
No. male HH memb (15-49) some primary	0.247	1.17	0.372 **	3.90
No. male HH memb (15-49) primary	0.358	1.38	0.429 **	3.78
No. male HH memb (15-49) some secondary	0.286	1.47	0.534 **	5.49
No. male HH memb (15-49) secondary	0.561 *	2.53	0.744 **	6.74
No. male HH memb (15-49) post secondary	0.273 +	1.83	0.002	0.02
No. male HH memb (50+) some primary	0.563 **	2.74	0.432 **	3.99
No. male HH memb (50+) primary	-0.046	-0.07	1.094 *	2.50
No. male HH memb (50+) some secondary	0.561 *	2.07	0.610 **	4.40
No. male HH memb (50+) secondary	0.685 *	2.09	0.342 +	1.91
No. male HH memb (50+) post secondary	-0.195	-0.66	0.223 +	1.75
No. female HH memb (15-49) some primary	0.431 **	2.88	0.453 **	4.95
No. female HH memb (15-49) primary	0.541 *	2.49	0.309 **	2.92
No. female HH memb (15-49) some secondary	0.732 **	4.55	0.549 **	5.36
No. female HH memb (15-49) secondary	0.579 **	3.45	0.801 **	7.53
No. female HH memb (15-49) post secondary	0.287 *	2.12	-0.072	-0.72
No. female HH memb (50+) some primary	0.369 +	1.96	0.379 **	4.02
No. female HH memb (50+) primary	1.923 **	4.19	-0.378	-1.08
No. female HH memb (50+) some secondary	0.414	1.53	0.814 **	5.17
No. female HH memb (50+) secondary	0.668	1.65	0.884	0.77
No. female HH memb (50+) post secondary	0.221	1.47	0.230 **	2.85
Own house	-0.012	-0.33	0.130 **	3.89
HH floor material -- sand, dirt	-0.043	-1.03	-0.127 **	-9.04
Access to piped drinking water	0.142 **	4.24	0.301 **	4.30
Access to electricity	0.097 *	2.03	0.061 **	4.41
Financial Assets	0.190 **	6.62	0.180 **	12.76
Log of value of house	0.166 **	12.86	0.111 **	15.68
Log of value of equipment			0.029 **	5.18
Log of value of business assets	0.015 **	3.91		
Constant	6.746 **	57.45	6.559 **	98.87
Number of Observations	960		3,840	
R-Squared	0.635		0.485	

+, * and ** indicate significance at the 90%, 95% and 99% levels of confidence, respectively.
Note: Regional dummies are not reported