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Preferred outcome measures for interventions to increase the earnings and productivity of rural women

My note focuses on impact-level outcomes that can be compared across multiple interventions targeted to poor rural women. These include: (1) household income, (2) household savings, and (3) female empowerment (focusing on household expenditure on medical care and education). Although I have limited my discussion to 5 pages, as requested, I have included several annexes with illustrative data from Cambodia.

Household income

Household income is useful as an impact indicator because, in principle, it reflects all income-earning activities of all household members. When income data are limited to a single activity (e.g., the activity targeted by an intervention), it is possible that an observed increase, for example, may partly reflect a shift of labor or other household resources to that activity from other income-earning activities so that the observed change may not be a reliable indicator of the total impact on household income. Similarly, a change in the income of a single household member (e.g., a female targeted by an intervention) is not only very difficult to measure in a rural setting (requiring separation of the woman's earnings from those of other household members in a family farm or business), but such a change may neglect possible spillover effects (positive or negative) of the individual's activities on the income-earning activities of other household members. Another important advantage of household income as an impact indicator is that it is applicable to a wide range of interventions (e.g., modern agricultural inputs, farming associations and networks, integrated services for subsistence farmers, rural electrification, and mobile phones for financial transactions and market information).

The main issue is how to measure household income cost-effectively. This is a topic discussed in a vast literature that draws on much useful experience over the years.[1] One important conclusion is that it depends on how the income measure will be used. Different possible uses include: (1) poverty measurement, (2) assessments of equity of access to education and health services, (3) targeting social subsidies to the poor, and (4) assessing the impact of interventions. This note focuses only on the issues relevant to their use in assessing impact. In this case, the most important considerations are: (1) cost, (2) and reliability (in this context, susceptibility to measurement error and short-term fluctuations unrelated to the intervention).[2]

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[1] See, for example, Deon Filmer and Kinnon Scott, "Assessing Asset Indices." *Demography* 49:359-392 (2012).

[2] For a discussion of other desirable properties of indicators, see James C. Knowles, Charlotte Leighton, and Wayne Stinson, "Measuring Results of Health Sector Reform for System Performance: A Handbook of Indicators." Special Initiatives Report No. 1, Partnerships for Health Reform, Abt Associates, Bethesda, MD (September 1997).

Another general conclusion from the literature is that the direct measurement of household income is usually impractical in a rural environment. Accordingly, there is a well-established tradition of using household consumption as an alternative measure of household income, particularly for poverty monitoring and for targeting social subsidies to the poor. However, collecting good-quality data on household consumption can be challenging and expensive in developing countries, particularly in rural areas. The World Bank has recently attempted to estimate the extent of measurement error in household consumption using eight alternative randomly assigned data collection methodologies in a field study conducted in Tanzania.[3] Although the study had no "gold standard" of error-free household consumption for comparison, one of the eight methodologies used in the study involved an individually-kept diary of household consumption over a 14-day period for frequently purchased items, supplemented by daily visits by a local assistant and visits every other day by the survey enumerator. The authors believe that the data collected by this method, which cost about ten times as much as the other methods, approximates a "gold standard." The study found that the less costly methods yielded estimates of household consumption with substantial measurement error.[4] Other assessments of the reliability of household consumption estimates in developing countries have reached similar conclusions and have pointed out additionally that household consumption (particularly in a rural environment) is subject to short-term fluctuations, due to variations in climate and other factors affecting agricultural output, seasonal factors (e.g., heaping of consumption around certain holidays), and large outlays in connection with illnesses or injuries.

Under these circumstances, a lot of attention has been given in recent years to possible alternative welfare measures to household income and consumption. Two of the most frequently used alternatives are asset indices (sometimes called "wealth indices") and indirect estimates of household consumption. Asset indices are usually calculated as the first principal component of a list of binary indicators referring to housing characteristics (e.g., the materials used to construct the walls, floor and roof of a dwelling) and the ownership of consumer durables.[5] Indirect estimates of household consumption are based on regression models estimated with data from a nationally representative household survey that includes data on household consumption. Instead of collecting data directly on household consumption, a smaller evaluation survey can then collect data on the right-hand side (explanatory) variables in the regression model to obtain estimates of household consumption.[6]

Asset indices are a promising alternative measure of household income. The data are easy and inexpensive to collect, relatively free of measurement error, and the asset indices themselves are easy to calculate.[7] However, at least two questions arise: (1) is an asset index a valid measure of

[3] John Gibson, Kathleen Beegle, Joachim De Weerdt and Jed Friedman,"What Does Variation in Survey Design Reveal about the Nature of Measurement Errors in Household Consumption?" Policy Research Working Paper 6372, Washington DC: The World Bank (February 2013).

[4] When the seven alternative measures were regressed on the benchmark measure, the estimated coefficients ranged from 0.422 (14-day household diary with infrequent follow-up visits) to 0.662 (58 food items, usual monthly values), with values less than one indicating the presence of measurement error.

[5] Asset indices have been most widely used to analyze inequities in social indicators, as in the Demographic and Health Surveys (DHS) and in the Multiple Indicator Cluster Surveys (MICS). Filmer and Scott, Op. cit. evaluates several different approaches to calculating an asset index.

[6] Indirect estimates of household consumption have been most widely used in preparing proxy means tests (PMT) to identify the poor. See, for example, Margaret E. Grosh and Judy L. Baker. "Proxy Means Tests for Targeting Social Programs: Simulations and Speculation." Living Standards Measurement Study Working Paper No. 118. Washington, DC: The World Bank (July 1995). However, they have also been used in some studies as a preferred alternative to measured household consumption. See, for example, Jere R. Behrman and James C. Knowles, "Household Income and Child Schooling in Vietnam," *The World Bank Economic Review* 13(2):211-56.

[7] In Stata, for example, once the binary indicators have been created, only two commands are needed, "pca" to calculate the first principal component of the indicators and "predict" to calculate the index itself.

household income? and (2) how sensitive is an asset index to *changes* in household welfare over time? In terms of the validity of an asset index as a measure of household income, it is currently believed that (1) asset indices (like household consumption) are a measure of longer-term household income, (2) they are closely correlated with household consumption measures, particularly if the denominator of the latter is adjusted for economies of scale in consumption, and (3) the degree to which household welfare rankings based on consumption and asset indices differ is related to urban versus rural residence.[8] Accordingly, when asset indices are used as a measure of rural household income, the index should be based on data from rural households only. Annex 1 compares annex indices calculated with Cambodian data for the period 2009-2011 to both measured and predicted levels of household consumption per capita for the same period and finds that the alternative measures are closely correlated and remain stable over time.

In terms of how well asset indices reflect *changes* in household income over time (as distinct from differences between households at a point in time), less is known. Annex 2 presents data from an earlier study in Cambodia showing that an asset index tracks quite well the changes in measured consumption per capita during the period 2004-2009, a period marked by rapid and relatively stable increases in per capita household income. However, Annex 3 presents new estimates for the subsequent two-year period (2009-2011) during which household incomes were unstable and finds that the asset index was slow to register the observed decrease in household incomes.

Indirect estimates of household consumption are also a promising alternative measure of household income. Like asset indices, they are relatively free of measurement error[9] and short-term fluctuations and are believed to be a proxy for longer-term household income. The main constraint to their use is that a fairly large household survey both with complete consumption data and data on suitable explanatory variables is required to estimate the regression function that is used to predict household consumption. Fortunately, this is unlikely to be a problem in most countries. Indirect estimates of household consumption are a valid indicator of household consumption and therefore most probably of longer-term household income. However, the extent to which indirect estimates of household consumption are sensitive to income *changes over time* depends on the explanatory variables used in the regression model. If the function's explanatory power (R-squared) derives mainly from indicators that change slowly or hardly at all over time (e.g., demographic characteristics, adult education, ethnicity) or indicators that are insensitive to changes in the household's expectations regarding its longer-term income, indirect estimates of household consumption will not be useful as an outcome measure in impact evaluation. In Annex 3, however, predicted household consumption is seen to have tracked quite well the observed changes in household incomes during a period of short-term income instability.

Household savings

Total household savings is defined as the difference between household income and household consumption during a given period (conventionally, one year). Total household savings is important as an impact indicator because (1) increased savings can increase household investment in productive assets, (2) increased savings can help households to smooth their consumption over time and to cope with emergency expenditures, and (3) increased savings may contribute to female

[8] Filmer and Scott, Op cit..

[9] If measurement error in household consumption is random, it will have no effect on the predicted values of household consumption. If it is non-random, however, it will bias the predicted values of household consumption. For example, if measurement error (defined as the predicted value minus the unobserved actual value) is negatively related to the actual value of household consumption, predicted levels will be under-estimated at higher levels of actual consumption. If predicted values of consumption are used as an outcome indicator in a project expected to increase household income, a comparison of baseline and follow-up values will then be biased toward zero. See Gibson et al., Op. cit..

empowerment if females have control over the asset in which additional savings are held. Savings in only one type of asset (e.g., an account at a single financial institution) or in a narrowly defined category of assets (e.g., bank accounts) or savings held by only one household member (e.g., a female targeted by an intervention) can be misleading as an impact indicator because of the possibility that an observed increase, for example, may reflect a shift of savings from other household assets such that there may be no overall impact on total household savings. That said, it may be both feasible and desirable to disaggregate some forms of savings by individual household members to reflect possible gender impacts. In other words, narrowly defined savings indicators may be more useful as proxies for female empowerment than as proxies for total household savings.

Household savings can be directly measured as the difference between measured household income and measured household consumption. However, it is very expensive and challenging to collect data on household income and expenditure that are sufficiently reliable to use as a measure of household savings impact.[10] Instead, the more common approach is to collect data on household assets and liabilities and assess how these are affected by a given intervention.[11] Household savings can be held in the form of either physical or financial assets. Physical assets include land, housing, livestock, productive assets (including trees and other perennial crops), consumer durables, or precious metals and other articles of value (e.g., gold, jewels). Financial assets include cash, accounts in different types of financial institutions (including microcredit institutions and informal savings clubs), some types of insurance products, equities and loans made to other households.[12] The main problem with existing studies is that the full range of assets and liabilities are seldom inventoried. Instead, asset inventories tend to focus narrowly on financial assets and consumer durables, which tend to account for relatively small shares of household assets in rural households. Annex 4 provides examples of more comprehensive asset inventories in Cambodia that track reasonably well the unstable economic conditions during the period 2009-2011.

Female empowerment

One frequently used set of indicators of women's empowerment is based on household expenditure on women's and children's medical care and both school enrollment and expenditure on children's education.

Expenditure on medical care

Collecting reliable data on household expenditure on medical care can be challenging. The resulting data tend to vary depending on the questions used to collect the data (see Annex 5, which compares recent estimates of household expenditure on medical care from Cambodia based on data collected using different methods). A few general conclusions have emerged from the literature. Firstly, more accurate data are obtained if questions about expenditure on medical care are asked separately for each individual household member. Collecting individual data also makes it easy to disaggregate the expenditure by age and sex. Asking a single question for the entire household (e.g., how much did

[10] For examples of analysis done with such data, see Angus Deaton, *The Analysis of Household Surveys: A Microeconometric Approach to Development Policy*. Published for the World Bank. Baltimore, MD: The Johns Hopkins University Press. 1997.

[11] Examples of this approach are Silvia Prina, "Do basic savings accounts help the poor to save? Evidence from a field experiment in Nepal." Processed, Case Western Reserve University, Cleveland OH (March 2012); and Nava Ashraf, Dean Karlan and Wesley Yin, "Household Decision Making and Savings Impacts: Further Evidence from a Commitment Savings Product in the Philippines." Discussion Paper No. 939, Economic Growth Center, Yale University, New Haven CT (June 2006).

[12] In addition, savings may be "invested" in reciprocal relationships with other households in an "affinity" group (e.g., a household may transfer funds to another household in the expectation of receiving an equivalent transfer in the future from the same household or a different household in the same affinity group).

the household spend on medical care for all household members during the past month?) tends to elicit responses (at least in Cambodia) that reflect "normal" levels of expenditure among households not incurring any actual expenditure on medical care during the reference period (Annex 5). Secondly, it is better *not* to link the question on expenditure to a reported illness (i.e., the expenditure should be "unconditional").[13] Thirdly, it is better to ask separate questions for different types of medical expenditure (e.g., outpatient visits for both curative and preventive care, inpatient care, purchase of medicines for self-treatment), to ensure that all expenditure is included. Fourthly, the recall period should not be longer than one month for outpatient care. Because inpatient care is relatively rare, questions on expenditure related to inpatient care are often asked for a longer recall period (e.g., one year, the most recent inpatient episode). Fifthly, more accurate data may be collected if questions are asked to all household members individually instead of to a single respondent. However, this is more expensive and may be problematic in settings where household members are frequently away from the household. Sixthly, more accurate data may be obtained in some cases by using a diary rather than collecting recall data. The usual procedure is to leave a diary form with the household at the beginning of the reference period, after explaining how it is to be completed, and to collect the completed form at the end of the reference period. However, collecting reliable diary data is more expensive and is not possible in all settings (Annex 5).

School enrollment and expenditure on education

In the case of children's education, there is no problem in measuring changes in school enrollment in a household survey. However, it is important to include enrollment in preschool for children aged 3 and above as this is often provided by the private sector and both income gradients and gender differentials are often quite sharp with respect to preschool enrollment. Income gradients and gender differentials also tend to be sharper for higher levels of schooling (e.g., high school and post-secondary schooling). Questions on current school enrollment are best asked as part of a module that collects data on the age and sex of all household members. A follow-up question can then be asked about the household's expenditure related to schooling during the previous school year for each child reported to have been enrolled in school during the previous school year. Income gradients and gender differentials are usually sharper for household expenditure on schooling than on enrollment. Many surveys ask for detailed expenditure on education (e.g., school fees, uniforms, books and supplies, tutoring, contributions to schools, gifts to teachers, transportation, room and board, meals). Detailed data may be useful for some purposes, but the experience in Cambodia (Annex 5) suggests that a single question on total education expenditure provides reasonably accurate data. However, if gender-specific estimates are desired, it is better to ask for total expenditure on each individual child's schooling instead of asking for aggregate expenditure on "boys' schooling" and "girls' schooling."

[13] See William H. Dow, "Unconditional demand for health care in Cote D'Ivoire: Does selection on health status matter?" Living Standards Measurement Study Working Paper No. 127, Washington, DC: The World Bank (1996).

Annex 1. Relationship between alternative measures of household income in Cambodia

The purpose of this annex is to explore the relationships between alternative measures of household income using data from three rounds (2009, 2010, 2011) of the Cambodia Socio-Economic Survey (CSES). The three alternative measures are (1) household consumption as recorded in the survey, (2) predicted household consumption, and (3) an asset index. Predicted household consumption is obtained from the estimated regression function reported in Table 1. The dependent variable is the natural logarithm of reported (measured) household consumption divided by household size (HHS) adjusted to reflect economies of scale in consumption, i.e., adjusted HHS=reported HHS^0.35.[14] The regression model has 29 explanatory variables, including 8 demographic and social indicators, 4 housing indicators, 9 indicators of durables ownership, 5 indicators of weekly expenditure on specific food and beverage commodity groups, and 3 indicators of monthly expenditure on household utilities items.[15] The estimation sample includes all rural households (N=9,486) from the 2009 CSES round. The estimated regression model explains almost two-thirds of the total variation in the dependent variable (R-squared=0.65). The regression function estimated with 2009 data is used to obtain the predictions for 2010 and 2011 in order to test its robustness over a two-year period (if, for example, the coefficients are estimated using data from a larger national survey and then used to predict values in subsequent baseline and follow-up surveys).

Table 1. Linear regression models used to predict the log of household consumption per capita (adjusted for economies of scale), 2009

Explanatory variables	Dependent variable: Log of household consumption per capita (adjusted for economies of scale)
Household size (adjusted for economies of scale in consumption)	-0.019
	(6.54)**
Number of children aged 0-6 in household	-0.017
	(3.58)**
Number of children aged 12-17 in household	0.016
	(3.48)**
All adults (aged 18+) in household aged 60 plus	-0.086
	(4.57)**
Head of household is single parent	-0.070
	(3.77)**
At least one household member has chronic illness	0.047
	(4.45)**
At least one HH member incapacitated for 3+ days due to illness or injury during past 30 days	0.131
	(10.45)**
Number of weeks during the past 12 months in which household members did not have enough food	-0.0061
	(4.35)**
Dwelling owned (not rented)	0.068
	(3.57)**

[14] The value of the economies of scale parameter (0.35) was estimated as the value that maximized the correlation between the measured "per capita" household consumption and the asset index. For a discussion of the importance of adjusting for economies of scale in consumption, see Filmer and Scott, Op. cit.

[15] The explanatory variables were selected by Stata's stepwise least-squares procedure from a larger list of 131 indicators. The household expenditure items are limited to narrowly defined (fairly specific) commodity groups that are expected a priori to be closely related to household income but that do not account as a group for a large share of total household consumption.

Explanatory variables	Dependent variable: Log of household consumption per capita (adjusted for economies of scale)
Number of rooms in the HH's dwelling (excluding kitchens, bathrooms and toilets)	0.019
	(2.87)**
Floor area of dwelling (square meters)	0.00182
	(5.98)**
Walls of dwelling made of wood	0.061
	(6.67)**
Number of motorbikes owned	0.065
	(6.52)**
Number of televisions owned	0.054
	(7.47)**
Number of wardrobes/cabinets owned	0.030
	(4.23)**
Number of mobile phones owned	0.044
	(4.43)**
Number of radios owned	0.018
	(2.62)**
Number of motor boats owned	0.082
	(4.16)**
Number of row boats owned	0.050
	(3.34)**
No motorbike owned or value not more than 600,000 Riel (US$150)	-0.046
	(4.17)**
No mobile phone owned or value not more than 50,000 Riel ($US12.50)	-0.054
	(4.24)**
Expenditure on meat, fish and eggs during the past 7 days (thousands of Riel)	0.00597
	(15.74)**
Expenditure on fresh fruit during the past 7 days (thousands of Riel)	0.01134
	(11.44)**
Expenditure on tobacco products during the past 7 days (thousands of Riel)	0.00850
	(6.55)**
Expenditure on alcoholic beverages during the past 7 days (thousands of Riel)	0.00358
	(4.14)**
Expenditure on purchased meals during the past 7 days (thousands of Riel)	0.00485
	(11.38)**
Expenditure on sewage or waste water disposal during the past month (thousands of Riel)	0.00266
	(8.05)**
Expenditure on fuel for cooking (i.e., gas, charcoal and firewood) during the past month (thousands of Riel)	0.00152
	(8.32)**
Expenditure on water during the past month (thousands Riel)	0.00125
	(2.87)**
Constant	9.376
	(319.79)**
Observations	9486
R-squared	0.65

Source: 2009 Cambodia Socio-Economic Survey (CSES)
Robust t statistics in parentheses (adjusted for clustered sampling)
* significant at 5%; ** significant at 1%

The asset index is equal to scores calculated from the first principal component of 42 variables referring to the number of various durable goods owned by the household and 24 binary variables referring to different housing characteristics (e.g., materials used in the roof, walls, and floor). The estimation sample is again all rural households from the 2009 CSES round. The estimated weights obtained from the 2009 CSES are used to calculate comparable asset indices for 2010 and 2011

using a methodology that is similar to that described in Annex 2 to develop comparable asset indices for 2004 and 2009 (to illustrate the possible use of a comparable asset index in baseline and follow-up surveys).

Table 2 (columns 1-3) and Figure 1 (first two sets of bars) show the product-moment (Pearson) correlation coefficients between the three alternative income measures. The estimated standard errors reported in parentheses below each correlation coefficient in Table 2 are bootstrapped using 200 repetitions.[16] Table 2 (columns 4-6) and Figure 1 (last two sets of bars) provide the corresponding Spearman rank correlation coefficients. Both the actual and predicted levels of household consumption are again divided by household size (HHS) adjusted for the assumed effects of economies of scale in consumption (i.e., adjusted HHS=reported HHS^0.35). The results indicate that predicted household consumption is highly correlated with measured household consumption, as expected.[17] However, the asset index is also highly correlated with measured household consumption (the correlation coefficients for 2010 and 2011 vary only from 0.66 to 0.68), despite the fact that the asset index weights are estimated with data from the 2009 CSES. The asset index is also closely correlated with the predicted level of consumption (with correlation coefficients of 0.77-0.78). However, this is partly due to the inclusion of several asset and housing indicators among the explanatory variables in Table 1. If these are omitted from the list of variables that are specified in the regression model, the R-squared decreases from 0.65 to 0.58, the correlations between predicted and measured consumption decrease to 0.63-0.79 (from 0.79-0.82), the correlations between predicted consumption and the asset index decrease to 0.53-0.64 (from 0.77-0.78). Still, correlations of 0.53-0.64 are highly significant, suggesting that even under such restricted conditions there is a strong common element to both of these alternative household income measures.

[16] Because the sample is clustered, the re-sampling is done at the level of clusters rather than at the level of individual households.

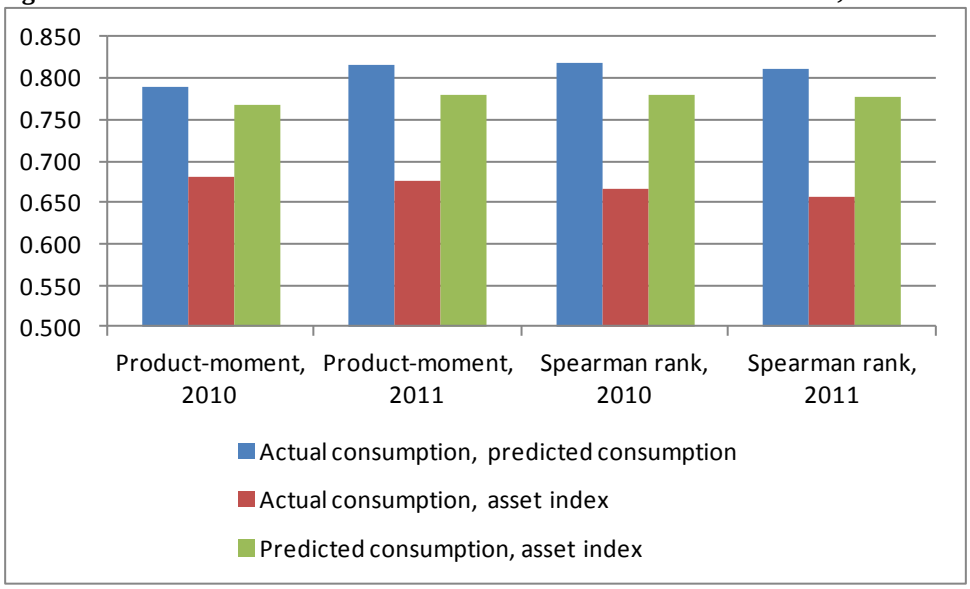
[17] The product-moment correlation coefficient in this case is equal to the square root of the R-squared in Table 1.

Table 2. Correlations between alternative measures of household income, Cambodia 2010 and 2011 (bootstrapped standard errors)

	Product-moment correlation coefficients			Spearman rank correlation coefficients		
	Measured household consumption per capita*	Predicted household consumption per capita	Asset index	Measured household consumption per capita*	Predicted household consumption per capita	Asset index
2010 (N=2,235)						
Measured household consumption per capita*	**1.000**			**1.000**		
	(0.000)			**(0.000)**		
Predicted household consumption per capita	0.790	**1.000**		0.819	**1.000**	
	(0.015)	**(0.000)**		(0.011)	**(0.000)**	
Asset index	0.681	0.767	**1.000**	0.665	0.779	**1.000**
	(0.024)	(0.027)	**(0.000)**	(0.022)	(0.013)	**(0.000)**
2011 (N=2,235)						
Measured household consumption per capita*	**1.000**			**1.000**		
	(0.000)			**(0.000)**		
Predicted household consumption per capita	0.815	**1.000**		0.810	**1.000**	
	(0.012)	**(0.000)**		(0.012)	**(0.000)**	
Asset index	0.675	0.780	**1.000**	0.656	0.777	**1.000**
	(0.022)	(0.017)	**(0.000)**	(0.020)	(0.013)	**(0.000)**

Source: 2010 and 2011 Cambodia Socio-Economic Surveys (author's calculations)
* "Measured per capita household consumption" is the natural logarithm of household consumption in constant 2009 Phnom Penh prices divided by household size (HHS) adjusted for economies of scale (i.e., adjusted HHS=reported HHS^0.35).

Figure 1. Correlations between alternative welfare measures in Cambodia, 2010 and 2011



Source: Table 2

Annex 2. Relationship between changes in an asset index and changes in real per capita consumption in Cambodia during the period 2004-2009

This annex compares changes over time in measured per capita household consumption in constant prices to changes over time in a comparable asset index. An asset index (A) for the jth household can be written in general form as:

$$A_j = f_1 * z_{1j} + f_2 * z_{2j} + \ldots + f_N * z_{Nj} \quad (1)$$

Where A_j is the asset index for household j, f are the scoring coefficients (i.e., elements of the normalized eigenvector of the first principal component) and z_{nj} are the standardized asset indicators of durable ownership and housing characteristics (i.e., the indicators transformed to have zero means and standard deviations equal to one), N is the number of asset indicators (78 in this example), and the symbol * indicates multiplication. A comparable asset index is one in which the scoring coefficients (f) and the baseline sample means and standard deviations remain constant so that changes in the asset index over time reflect only changes in the non-standardized values of the asset indicators. A comparable asset index for the base period (2004) can be expressed in terms of the original (i.e., non-standardized) values of the asset indicators (x) as follows:

$$A_{j,2004} = f_{1,2004} * (x_{1j,2004} - m_{X1,2004})/(s_{X1,2004}) + \ldots + f_{N,2004} * (x_{Nj,2004} - m_{XN,2004})/(s_{XN,2004}) \quad (2)$$

where $f_{n,2004}$ refers to the scoring coefficient for the nth indicator obtained using the data for 2004 only, $m_{Xn,2004}$ and $s_{Xn,2004}$ refer respectively to the 2004 sample mean and sample standard deviation of the nth asset indicator.

Using the same notation, a comparable asset index for 2009 can be obtained from equation (2) by substituting the non-standardized 2009 values of the indicators ($x_{nj,2009}$) for the corresponding 2004 values ($x_{nj,2004}$):

$$A_{j,2009} = f_{1,2004} * (x_{1j,2009} - m_{X1,2004})/(s_{X1,2004}) + \ldots + f_{N,2004} * (x_{Nj,2009} - m_{XN,2004})/(s_{XN,2004}) \quad (3)$$

The asset index includes both positive and negative values, and this complicates a direct comparison of percentage changes in the wealth index between 2004 and 2009 with the corresponding changes in real per capita consumption. However, this problem can be effectively addressed by subtracting the smallest observed value of the asset index from the asset index in its original metric to obtain a transformed asset index that is perfectly correlated with the original but is limited to non-negative values. Table 3 presents the 2004 and 2009 sample mean values of the transformed asset index by main region and by per capita consumption quintile[18] together with the corresponding measured values of real per capita consumption. These data indicate that the percentage changes in the asset index by main region and by per capita consumption quintile in column 3 are similar to the corresponding percentage changes in the measured values of real per capita consumption in column 6 (Figure 2). In particular, the pattern observed with the measured values of real per capita consumption that the percentage increase is larger in the Other Urban and Rural areas than in Phnom Penh and is larger in the poorest four quintiles than in the richest quintile is also observed with the comparable asset index.

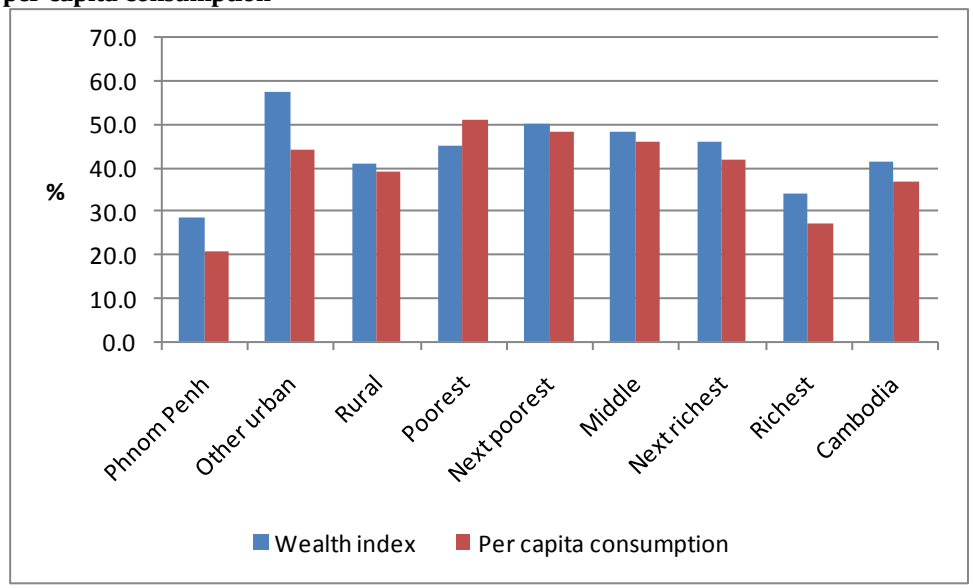
[18] The population-weighted per capita consumption quintiles in Table 3 are formed separately in each year using the 2004 and 2009 values of real per capita consumption.

Table 3. Comparable asset index and measured real per capita consumption by main region and by per capita consumption quintile, 2004 and 2009

	Asset index (transformed as described in text)			Observed values of real per capita consumption		
	2004	2009	% change	2004	2009	% change
Main region						
Phnom Penh	10.23	13.13	28.3	8,067	9,724	20.5
Other urban	5.00	7.89	57.8	4,995	7,213	44.4
Rural	2.29	3.24	41.5	3,214	4,473	39.2
Quintile						
Poorest	1.62	2.35	45.1	1,378	2,083	51.2
Next poorest	1.96	2.94	50.0	2,062	3,055	48.2
Middle	2.43	3.60	48.1	2,749	4,017	46.1
Next richest	3.42	4.98	45.6	3,860	5,485	42.1
Richest	6.86	9.21	34.3	9,046	11,512	27.3
Cambodia	3.26	4.60	41.1	3,819	5,230	37.0

Source: James C. Knowles, "Poverty Profile for Cambodia, 2009." Draft report to the EAS Country Units of the World Bank, Washington DC (January 2012).

Figure 2. Comparison of percentage changes between 2004 and 2009 in a comparable asset index and in real per capita consumption



Source: Table 3

Annex 3. Relationships between changes in measured consumption, predicted consumption and an asset index during a period of economic instability (2009-2011)

Whereas the period 2004-2009 in Cambodia was a period of rapid and fairly stable income growth, the period 2009-2011 was one of very slow or even negative income growth, reflecting the effects of the global financial crisis. Table 4 reports the percentage changes over time in measured per capita consumption (row 1), predicted per capita consumption (row 2) and an asset index (row 3) during the period 2009-2011, while Figure 3 shows them graphically (including 95% confidence intervals based on the bootstrapped standard errors reported in Table 4). The predicted levels of consumption per capita in all three years are calculated from the regression model estimated with data from the 2009 CSES that is reported in Table 1. The asset index values in all three years are calculated using the coefficients (weights) based on the 2009 CSES data (using the methods described in Annex 2). The data in Table 4 indicate that the asset index did not register the slowdown in growth in the first year (2009-2010) but began to register it in the second year (2010-2011), whereas the predicted level of consumption per capita reflected the actual slowdown even in the first year and also registered the return to positive growth in the second year, as indicated by the estimated growth rates in per capita GNP (from the national accounts) in the bottom row of Table 4. The data in Table 4 suggest that an asset index may not be a reliable indicator of short-term income change, whereas predicted consumption may be a reliable indicator even of short-term income change.

One might expect that the housing indicators in an asset index would be less sensitive to short-term income changes than the indicators referring to durables ownership because households have the option of selling some types of durables (e.g., motorbikes, cell phones, TVs, boats) to obtain additional cash, whereas such a response is less likely in the case of housing assets. However, it turns out in this case that an asset index limited to indicators of durables ownership is even less responsive to short-term income change than an asset index limited to indicators of housing characteristics, i.e., an asset index limited to durables increases by 15.6% in 2009-2010 and by 5.3% in 2010-2011, whereas an asset index limited to housing increases by only 7.1% in 2009-2010 and by 3.0% in 2010-2011.

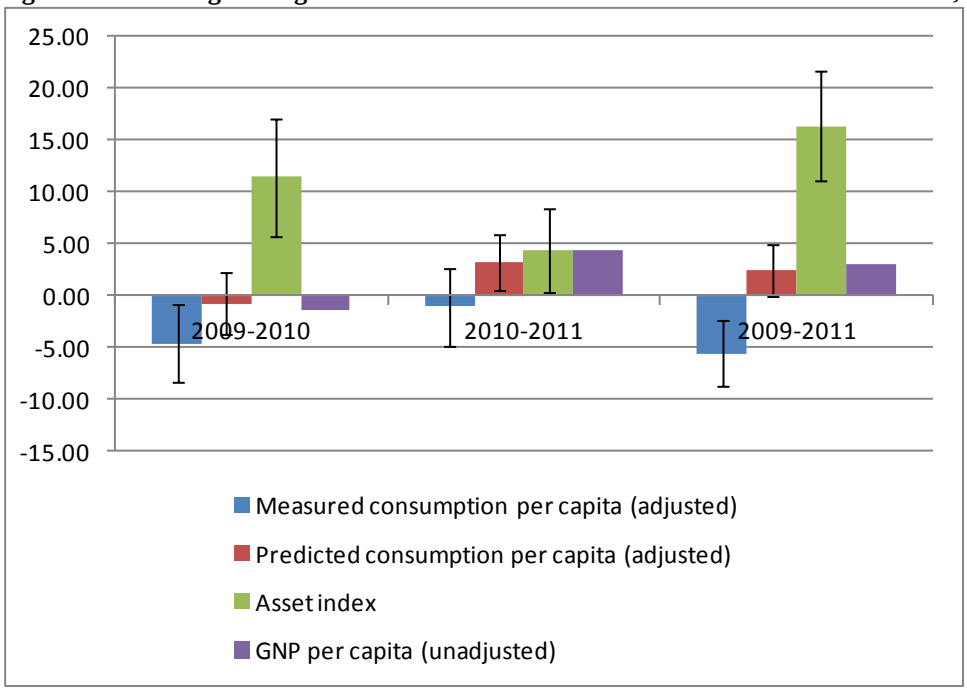
Table 4. Percentage changes in alternative measures of household income over time, Cambodia 2009-2011 (bootstrapped standard errors are reported in parentheses below the corresponding estimates)

Income indicator	2009-2010	2010-2011	2009-2011
Measured household consumption per capita (adjusted for economies of scale)* in constant prices	-4.57	-1.05	-5.57
	(1.87)	(1.92)	(1.63)
Predicted household consumption per capita (adjusted for economies of scale)* in constant prices	-0.72	3.23	2.48
	(1.50)	(1.40)	(1.31)
Asset index	11.42	4.44	16.36
	(2.92)	(2.05)	(2.71)
Household consumption per capita (unadjusted) in constant prices	-4.42	-1.23	-5.60
	(1.96)	(2.10)	(1.76)
Household income per capita (unadjusted) in constant prices	NA	NA	4.42
GNP per capita in constant prices	-1.4	4.4	2.9

Sources: Household consumption per capita and asset index (CSES); predicted household consumption per capita (Table 1); household income per capita and GNP per capita (World Bank, *Where Have All the Poor Gone? Cambodia Poverty Assessment*, 2013).

* Adjusted HHS = reported HHS^0.35.

Figure 3. Percentage changes in alternative measures of household income over time, Cambodia 2009-2011



Source: Table 4

Annex 4. Household asset inventories in Cambodia

Table 5 and Figure 4 present inventories of household assets in Cambodia by region (urban-rural) for three years (2009, 2010, and 2011) based on data from the corresponding rounds of the Cambodia Socio-Economic Survey (CSES). These three years were selected because, as discussed in Annex 3, this was a period of economic instability in Cambodia (as the result of the global financial crisis), and it is interesting to see whether the asset inventories reflect this economic instability.

The asset inventories themselves are relatively complete, compared to those that are typically estimated in connection with assessments of the savings impact of financial interventions. However, they omit both cash in hand (or cash hidden under the mattress) and wealth held in the form of gold and jewelry because there are no data on these items in the CSES. In addition, the estimates of financial assets (i.e., bank accounts, equities and loans made to others) are reported only as income flows (i.e., interest and dividends) and are estimated (crudely) on the basis of the following assumed annual rates of return: bank accounts (5%), equities (10%) and loans made to others (30%).[19] However, these items account for a relatively small share of total assets (Table 6). All assets are in current Riel as valued by respondents.[20] The implied annual saving (or dissaving) rates, expressed as a percentage of the previous year's net assets, are displayed in the last row of the table.

The data in Table 5 indicate that the composition of household assets varies markedly between urban and rural households. In urban areas, household assets are heavily concentrated in buildings (mostly residences), with smaller shares of assets held in the form of agricultural land and consumer durables. In the rural areas, most assets are held in the form of agricultural land and buildings, but with significant shares as well in consumer durables, livestock, crop inventories and producer durables. The changes over time in the household asset inventories (and the implied savings rates) are broadly consistent with the income trends observed during this three-year period (cf Table 4). According to the asset inventories, the negative growth rate in real per capita GDP between 2009 and 2010 was accompanied by substantial dissaving in the urban areas (-36%) and by more modest dissaving in the rural areas (-11%). The economic recovery that occurred from 2010-2011 was accompanied by only modest dissaving in the urban areas (-8%) and modest positive savings in the rural areas (+7%). The asset values that contracted most in the urban areas were those for agricultural land and buildings (-31% and -40% respectively between 2009 and 2010 and -7% for both items between 2010 and 2011). In the rural areas, the change was confined mainly to agricultural land, which decreased in value by 33% between 2009 and 2010 before recovering by 13% between 2010 and 2011. Much of the observed decrease in the value of agricultural land and buildings depicted in Table 5 and Figure 4 is probably due to deflation in property prices rather than the sale of assets. The reported revenue received by households from land sales was much smaller (i.e., only 577 thousand Riel in urban areas in and only 115 thousand Riel in rural areas in 2010).

[19] The mean reported *monthly* interest rate on non-institutional debt is 3.00% in 2009, 3.23% in 2010 and 2.64% in 2011.

[20] There is sufficient information in the CSES on the characteristics of agricultural land and buildings to permit more refined estimates, but this has not done for the data in Table 5.

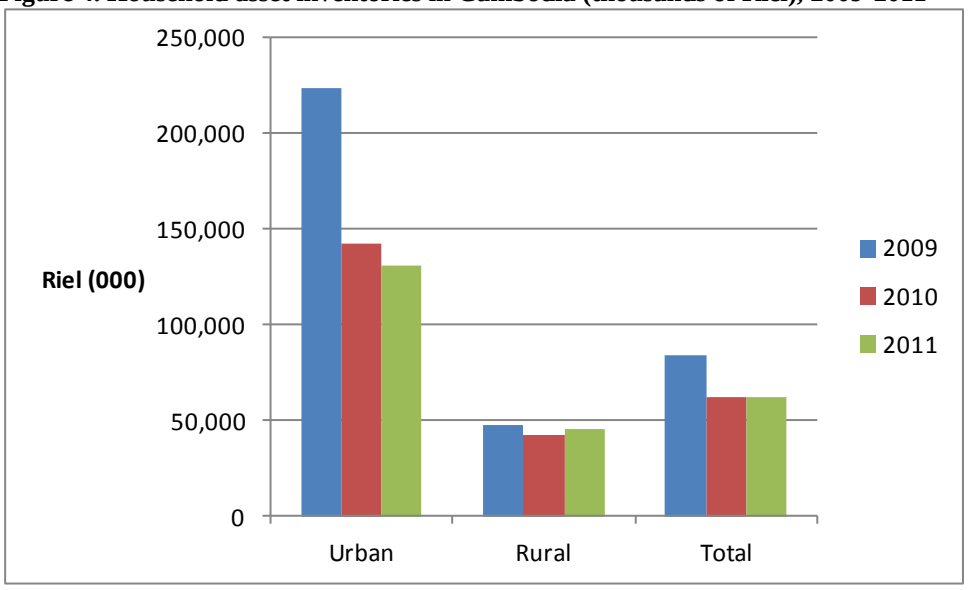
Table 5. Household asset inventories in Cambodia (thousands of current Riel), 2009-2011

	Urban			Rural			Cambodia		
Asset	2009	2010	2011	2009	2010	2011	2009	2010	2011
Agricultural land	19,500	13,500	12,500	22,100	14,900	16,800	21,500	14,600	15,900
Buildings (mainly dwellings)	191,000	115,000	107,000	19,000	21,200	21,600	54,400	39,500	38,900
Consumer durables	12,893	13,748	12,340	2,845	2,944	2,966	4,915	5,040	4,880
Producer durables*	207	852	160	863	867	1,101	728	864	909
Livestock	236	406	357	2,507	2,115	2,417	2,038	1,783	1,997
Crop inventories	62	99	149	814	864	1,026	659	715	847
Fish ponds	201	14	41	128	60	143	143	51	122
Bank accounts	192	67	0	10	16	0	48	26	0
Equities	27	0	0	0	24	0	6	19	0
Loans made to others	182	57	43	60	79	22	85	75	27
Subtotal: Assets	224,500	143,744	132,591	48,327	43,069	46,075	84,521	62,673	63,583
Liabilities (outstanding debt)	1,117	1,157	1,178	715	779	938	798	852	987
Net assets	223,383	142,586	131,412	47,612	42,290	45,137	83,723	61,821	62,596
Total savings		-80,797	-11,174		-5,322	2,847		-21,902	774
As % of net assets		-36.2%	-7.8%		-11.2%	6.7%		-26.2%	1.3%

Source: CSES (author's calculations)

*includes row boats, motor boats, animal carts, tractors, bulldozer/rollers, ploughs, threshing machines, hand tools, hand tractors and water pumps.

Figure 4. Household asset inventories in Cambodia (thousands of Riel), 2009-2011



Source: Table 5

Table 6. Composition of household assets in Cambodia (%), 2009-2011

	Urban			Rural			Total		
Asset	2009	2010	2011	2009	2010	2011	2009	2010	2011
Agricultural land	8.7	9.4	9.4	45.7	34.6	36.5	25.4	23.3	25.0
Buildings (mainly dwellings)	85.1	80.0	80.7	39.3	49.2	46.9	64.4	63.0	61.2
Consumer durables	5.7	9.6	9.3	5.9	6.8	6.4	5.8	8.0	7.7
Producer durables*	0.1	0.6	0.1	1.8	2.0	2.4	0.9	1.4	1.4
Livestock	0.1	0.3	0.3	5.2	4.9	5.2	2.4	2.8	3.1
Crop inventories	0.0	0.1	0.1	1.7	2.0	2.2	0.8	1.1	1.3
Fish ponds	0.1	0.0	0.0	0.3	0.1	0.3	0.2	0.1	0.2
Bank accounts	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
Equities	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
Loans to others	0.1	0.0	0.0	0.1	0.2	0.0	0.1	0.1	0.0
Totals	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Table 5.

*includes row boats, motor boats, animal carts, tractors, bulldozer/rollers, ploughs, threshing machines, hand tools, hand tractors and water pumps.

Annex 5. Comparison of household expenditure on education and medical care based on data collected using different methods

Expenditure on education

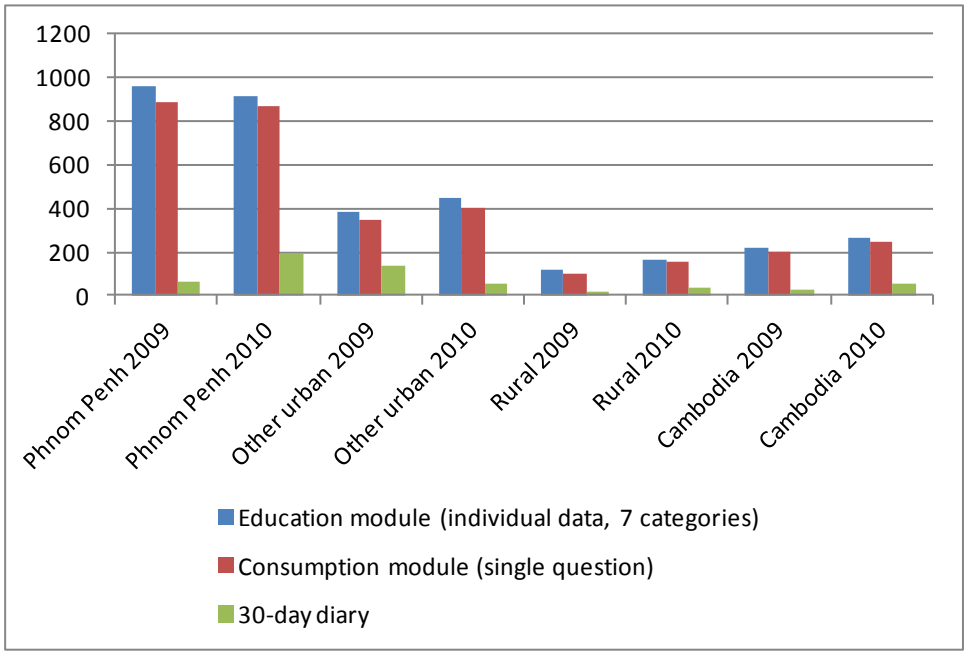
Table 7 and Figure 5 present data on household expenditure on education from the 2009 and 2010 rounds of the Cambodia Socio-Economic Survey (CSES) collected using three different data collection methods. The first methodology (rows 1 and 4) involves asking a single question to a single household member ("who knows most about the household's non-food expenditure") about household expenditure on "education (school fees, textbooks, private tutoring charges)" during the last 12 months as one of 13 non-food commodity groups. The second data collection method (rows 2 and 5) asked for household expenditure "during the past school year" on seven different education expenditure items (i.e., school fees, tuition and private lessons, text books, other school supplies, allowances for children studying away from home, transportation, and gifts to teachers, school building funds, etc.), as well as the total, for *each* household member aged 3 and above who was reported to have been enrolled in school during the previous school year (including nonformal classes). The third data collection method (rows 3 and 6) used a 30-day diary in which a literate adult household member (or the interviewer, in the absence of such a household member) was asked to list daily household expenditures on all items, including education. The diary codes for education identified education expenditure only by level of schooling (e.g., pre-primary, primary, etc.), public or private. The data indicate that collecting detailed recall data on different types of expenditure for each individual separately leads to higher (and probably more accurate) estimates, as expected, but that the additional accuracy may not be worth the additional cost. The single household-level question does practically as well. However, the data also indicate that collecting data using a diary in a country like Cambodia with limited education may not be a practical option.

Table 7. Comparison of data on annual household expenditure on education (thousands of Riel) collected using different methods, 2009 and 2010

Data collection method	Phnom Penh	Other urban	Rural	Cambodia
2009				
Consumption module (single question)	960	386	115	220
Education module (individual data, 7 categories)	884	347	99	196
30-day diary (annualized)	64	132	14	30
2010				
Consumption module (single question)	916	449	163	266
Education module (individual data, 7 categories)	870	404	154	250
30-day diary (annualized)	194	53	36	53

Source: 2009 and 2010 CSES (author's calculations).

Figure 5. Comparison of data on household expenditure on education (thousands of Riel) collected using different methods, 2009 and 2010



Source: Table 7.

Expenditure on medical care

Table 8 and Figure 6 present data on household expenditure on medical care from the 2009 and 2010 rounds of the Cambodia Socio-Economic Survey (CSES) collected using three different data collection methods. The first methodology (rows 1 and 4) involves asking a single question to a single household member ("who knows most about the household's non-food expenditure") about household expenditure on "medical care (doctor's fees, other medical services, drugs, hospital charges, other medical supplies etc.)" during the last month as one of 13 non-food commodity groups. The second data collection method (rows 2 and 5) asked for household expenditure during the past 30 days on "treatment at any health provider" and on "transport to go to or return from any health provider" for *each* household member who was reported to have consulted any type of health provider during the past 30 days (independent of illness or injury). The third data collection method (rows 3 and 6) used a 30-day diary in which a literate adult household member (or the interviewer, in the absence of such a household member) was asked to list daily household expenditures on all items, including medical care. The diary codes for medical care were quite detailed, i.e., prescription drugs, non-prescription drugs (modern), other medical products, eyeglasses, other therapeutic appliances and equipment, doctor's fees, traditional healer's fees, traditional birth attendant's fees, freelance nurses and midwives, massage fees, paramedical services, and hospital services. The data indicate that there were substantial and consistent differences in the data yielded by all three methods, with the highest estimates obtained from the single household-level question and the lowest estimates provided by the diary method. Detailed analysis of data from the 2007 CSES, which encountered a similar pattern, found consistent evidence suggesting that households that did not incur any expenditure on medical care during the past month tended to report their "normal" monthly expenditure on medical care, instead of zero expenditure, producing the upward bias.[21]

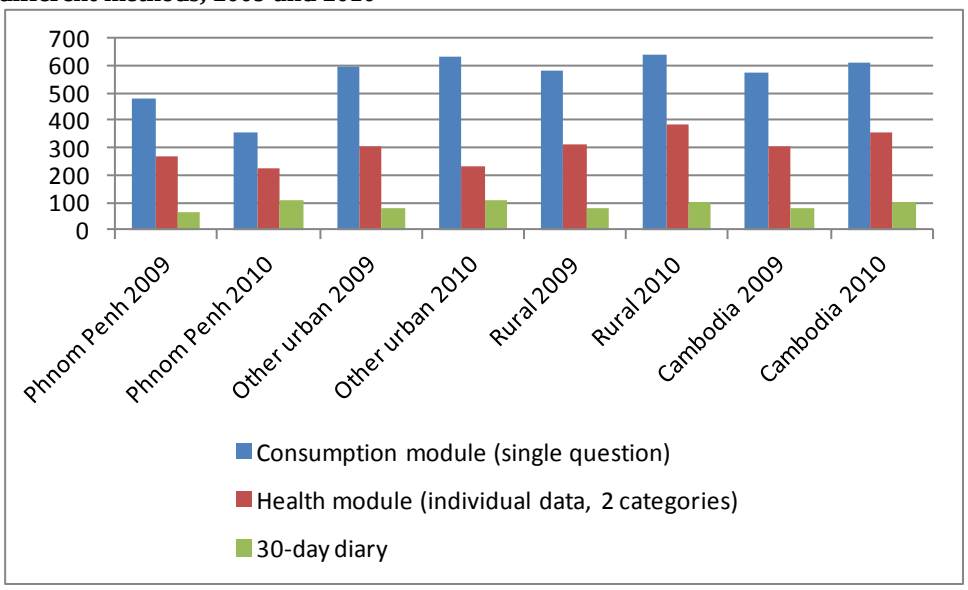
[21] James C. Knowles, "Poverty Estimates for Cambodia, 2007." Report to the EAS Country Units of the World Bank. Washinton, DC (December 2008).

Table 8. Comparison of data on monthly household expenditure on medical care (thousands of Riel) collected using different methods, 2009 and 2010

Data collection method	Phnom Penh	Other urban	Rural	Cambodia
2009				
Consumption module (single question)	481	596	579	572
Health module (individual data, 2 categories)	271	308	309	305
30-day diary	66	77	78	77
2010				
Consumption module (single question)	359	635	640	612
Health module (individual data, 2 categories)	224	235	386	354
30-day diary	112	105	100	102

Source: 2009 and 2010 CSES (author's calculations).

Figure 6. Comparison of data on household expenditure (thousands of Riel) on medical care collected using different methods, 2009 and 2010



Source: Table 8.