Dollar a Day Revisited

Martin Ravallion, Shaohua Chen, and Prem Sangraula

The article presents the first major update of the international $1 a day poverty line, proposed in *World Development Report 1990: Poverty* for measuring absolute poverty by the standards of the world's poorest countries. In a new and more representative data set of national poverty lines, a marked economic gradient emerges only when consumption per person is above about $2.00 a day at 2005 purchasing power parity. Below this, the average poverty line is $1.25, which is proposed as the new international poverty line. The article tests the robustness of this line to alternative estimation methods and explains how it differs from the old $1 a day line. JEL codes: I32, E31, O10

The widely used $1 a day poverty line was set for *World Development Report 1990: Poverty* (World Bank 1990) based on research for that report documented in Ravallion, Datt, and van de Walle (1991). The aim was to set a global poverty line that defined poverty in the developing world as a whole by the standards of what "poverty" means in the world's poorest countries, recognizing that richer countries naturally have higher standards. This (intentionally) frugal basis for measuring global poverty gives the $1 a day line a salience in focusing international attention on the world's poorest—a salience that a higher line would not have.[1] A consensus emerged in the international development community on this standard for measuring extreme poverty in the world, and it became the basis of the first Millennium Development Goal, to halve the 1990s $1 a day poverty rate by 2015.

This article provides the first major revision of the original $1 a day line. Understanding why this revision is necessary requires understanding how the original international poverty line was set in 1990 and what new data have become available since then.

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1. For example, Pritchett (2006) proposes a poverty line of around $10 a day. Calculations using the World Bank's *PovcalNet* (http://econ.worldbank.org/povcalnet) indicate that 95 percent of people in developing countries live below this line.

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Ravallion, Datt, and van de Walle (1991) studied how poverty lines varied with mean consumption when both were converted to a common currency at purchasing power parity (PPP, meaning a currency conversion rate that is intended to ensure a common purchasing power over commodities). They found that national poverty lines have a positive economic gradient above some critical level. The elasticity rises with average consumption, approaching unity in rich countries. It can thus be argued that absolute poverty (measured using a poverty line with a constant real value) is the more relevant concept in poor countries, while relative poverty (in which the poverty line rises with the mean) is more salient in middle- and high-income countries.

The poverty lines that prevail in each country (or that would be expected given the country's mean consumption) could be used in assessing global poverty. But then the resulting aggregate poverty measures would not be treating people at the same level of real consumption the same way. And by treating absolutely poor people similarly to relatively poor people such a measure of global poverty would risk diverting the focus from what is surely the highest priority: raising the living standards of the poorest people in the world.

But what absolute line should be used? Ravallion, Datt, and van de Walle (1991) proposed measuring global poverty by the standards of the poorest countries, based on a survey of national poverty lines.[2] Drawing on 33 national poverty lines for the 1970s and 1980s (for both developed and developing economies), Ravallion, Datt, and van de Walle proposed a line of $23 a month ($0.76 a day) at 1985 consumption PPP. That value was the predicted poverty line for the poorest country in the sample, based on a regression model. A higher line of $31 a month ($1.02 a day) that was more representative of the poverty lines in low-income countries. Subsequently, the higher line became more accepted in the World Bank and internationally, and it became known as the "$1 a day" line.

The PPPs used by Ravallion, Datt, and van de Walle were from the Penn World Table (Summers and Heston 1991) and were based on the price surveys for 1985 done by the International Comparison Program (ICP). New price surveys were done in 1993, and the World Bank started estimating its own PPPs, using methods that were considered more appropriate for measuring poverty.[3] The changes in ICP benchmark years create comparability problems, due to differing estimation methods for the PPPs and differences in the ICP price surveys. Recognizing these problems, Chen and Ravallion (2001) revised past estimates of poverty measures to ensure consistency with new data available when the ICP benchmark round changed from 1985 to 1993. Chen and Ravallion (2001) applied the new PPPs to the original Ravallion, Datt, and

2. Prior to Ravallion, Datt, and van de Walle (1991), the World Bank had used explicitly arbitrary lines; see Ahluwalia (1974).

3. Ackland, Dowrick, and Freyens (2006) and Deaton and Heston (2008) discuss alternative approaches to measuring PPPs and their appropriateness for different applications.

van de Walle (1991) data set of 33 national lines in local currency units. Employing the same regression method as in Ravallion, Datt, and van de Walle, Chen and Ravallion found the predicted poverty line for the poorest country to be $31.96 a month ($1.05 a day). However, a slightly higher line was considered more representative; the new $1 a day line was set at $32.74 a month, or $1.08 a day, at 1993 PPPs. In 2004, about one in five people in the developing world (1 billion people) were deemed to be poor by this standard (Chen and Ravallion 2007).

These estimates all relied on the original Ravallion, Datt, and van de Walle (1991) compilation of poverty lines. However, much new analytic work on poverty at the country level has been done since 1990, notably under the World Bank's program of country poverty assessments and the Poverty Reduction Strategy Papers prepared by national governments, often with assistance from the World Bank, other governments, or international agencies. Few of these studies were available in 1990, but they have since been completed for about 100 developing economies. They provide a rich source of data on poverty at the country level, and almost all include estimates of national poverty lines. The poverty studies done since 1990 also allow us to correct for the sampling biases in the original Ravallion, Datt, and van de Walle (1991) compilation of national poverty lines—biases that could not be avoided in the original compilation given the data available at the time. Another important new source of data is the 2005 round of the ICP (World Bank 2008). As the most ambitious round of the ICP (which began in 1968), it is expected to entail substantial improvements in data quality for estimating PPPs.

These new data prompt a reassessment of the international poverty line. The analysis in this article leads to a proposed new international poverty line of $1.25 a day at 2005 PPP for household consumption. Section I presents the new compilation of national poverty lines, which are shown to rise with mean consumption but with a low elasticity at low consumption. Based on these empirical results, section II discusses the proposed new international poverty line. Section III compares the proposed new line to the old $1 a day line. Section IV concludes.

I. National Poverty Lines across Developing Economies

The two most obvious ways of updating the old $1 a day poverty line have serious drawbacks. First, one might simply apply the U.S. consumer price index (CPI). This assumes that the old $1 a day line, based on an old sample of national poverty lines and an old set of PPPs, is still valid; that assumption ignores possible biases in past data sets—biases the new data can go at least some way toward addressing. Second, one might keep the ratio of the poverty line to (say) the developing world's mean income the same. With growth, this would imply a higher real poverty line over time. Indeed, the poverty line would have an elasticity of unity with respect to mean income, implying that

distribution-neutral growth (all incomes grow at the same rate) would leave poverty measures unchanged, even though the poor gained in absolute terms. An elasticity of unity would seem hard to defend, especially for poor countries.[4]

The approach taken here returns to the logic of the original $1 a day line, armed with new data. The set of national poverty lines collected by Ravallion, Datt, and van de Walle (1991) covered 33 countries and drew on specialized, country-specific, mostly academic studies of poverty spanning 1971–90. Clearly, this data set is now rather old. Since then there has been considerable expansion in research and analysis on poverty in developing economies, notably through the World Bank's country-level poverty assessments, which have now been completed for many developing economies. These are core reports within the World Bank's program of analytic work at the country level; each report describes the extent of poverty and its causes in a given country. The poverty assessment is conducted in consultation with the government, and most poverty assessments claim government ownership. Most low-income countries have also prepared Poverty Reduction Strategy Papers, which are prepared by the government, often with some financial support from aid donors. A large share of the work on poverty assessments and Poverty Reduction Strategy Papers typically goes into poverty measurement and both typically lay out what is known about poverty in each country, including a detailed poverty profile as well as aggregate poverty statistics and how they have changed over time. Both reports are important sources of information on the accepted national poverty lines.

For the purpose of this article, a new data set of 88 national poverty lines was compiled from the most recent poverty assessments and Poverty Reduction Strategy Papers over 1988–2005. In the source documents, each poverty line is given in the prices for a specific survey year (for which the subsequent poverty measures are calculated). In most cases, the poverty line was also calculated from the same survey (though there are some exceptions, for which pre-existing national poverty lines were updated using the CPI).

Sometimes the national poverty lines were old lines updated over time for inflation, and sometimes the poverty line was calculated afresh at each survey, though typically anchored to a common food bundle. Such recalculated poverty lines would not generally have the same real value over time when assessed according to a reasonable price index, since the Engel curve may shift for other reasons and thus change the real value of the nonfood component of the poverty line. When a choice had to be made, the most recent national poverty line available was selected.

The new data set on national poverty lines differs from the old (Ravallion, Datt, and van de Walle 1991) data set in four main respects. First, while the old data were drawn from sources for the 1980s (with a mean year of 1984),

4. For further discussion, see Ravallion (2008b) and Ravallion and Chen (2009).

the new data are all post-1990 (mean of 1999), such that in no case do the proximate sources overlap. Second, the new data set covers 88 developing economies (74 with complete data for the subsequent analysis), while the old data set included only 22 developing economies (plus 11 developed countries). Third, the old data set used rural poverty lines when there was a choice, whereas the new one estimates national average lines. Fourth, the old data set was unrepresentative of Sub-Saharan Africa, with only five countries from that region (Burundi, Kenya, South Africa, Tanzania, and Zambia), whereas the new data set has a good spread across regions, including 25 countries in Sub-Saharan Africa. The proportion of African countries in the old sample was about half what it should have been to be considered representative of poor countries. The sample bias in the Ravallion, Datt, and van de Walle data set was unavoidable at the time (1990), but it can now be corrected.

The fact that the poverty assessments are World Bank reports raises two concerns. First, it might be conjectured that these are external poverty lines, rather than poverty lines accepted by the country. However, the process of producing a poverty assessment entails (often extensive) consultation with the government, including discussion about the most appropriate poverty line. Thus, this new set of poverty lines has a stronger claim to being national poverty lines than those used by Ravallion, Datt, and van de Walle (1991), which were based largely on academic studies.

Second, it might be thought that the poverty lines used in the World Bank poverty assessments reports and in governments' Poverty Reduction Strategy Papers are biased toward the World Bank's old international poverty line. This does not appear to be a serious concern. The poverty assessments (and the Poverty Reduction Strategy Papers) typically either use a pre-existing national poverty line or derive a new line, and in both cases the line has no obvious origins in the World Bank's $1 a day poverty line. The aim is to use a poverty line appropriate to the country. Some 80 percent of these reports use a version of the cost of basic needs method in which the food component of the poverty line is the expenditure needed to purchase a food bundle specific to each country (or region) that yields a stipulated food energy requirement.[5] To this amount an allowance is added for nonfood spending, which is typically anchored to the nonfood spending of people whose food spending (or sometimes total spending) is near the food poverty line.

There is considerable scope for discretion in setting such a poverty line. Although the stipulated food-energy requirements are similar, the food bundles that can yield a given food energy intake can vary enormously, and some will be preferable to others in any given context. The nonfood spending that is deemed adequate will also vary. The judgments made in setting the various parameters of a poverty line are likely to reflect prevailing notions of what poverty means in each country setting.

5. This method, and alternatives, are discussed in detail in Ravallion (1994, 1998, 2008a).

These poverty lines are converted to a common currency using the PPP for individual consumption expenditure by households from the 2005 ICP, as documented in World Bank (2008).[6] The 2005 ICP is clearly the most complete assessment to date of how the cost of living varies across countries. The ICP collected primary data on a region-specific list of prices for 600–1,000 (depending on the region) goods and services. The prices were obtained from a large sample of outlets in each country. All regions participated, but the participation rate was markedly lower for Latin America.

The 2005 ICP introduced several improvements over previous ICP rounds. The number of countries participating rose from 117 in 1993 to 146 countries. The new countries include China, which had not previously participated in the ICP. The surveys have been implemented on a more scientific basis. New methods were used for measuring government compensation and housing. Adjustments were made for the lower average productivity of public sector workers in developing economies (lowering the imputed value of the services derived from public administration, education, and health). Ring comparisons (linking regional PPP estimates through global prices) were done for more countries (18 in all). The 2005 data were also subject to more rigorous supervision and validation methods than was the 1993 round, including stricter standards in defining internationally comparable quality standards for the goods identified in the ICP price surveys. Otherwise, the PPPs calculated from the ICP data (and in World Bank 2008) follow standard methods; as in the past, the World Bank uses a multilateral extension of the bilateral Fisher price index.[7]

While these are clearly improvements, the new PPPs still have some limitations. The ICP aimed to survey prices that were nationally representative. This was not the case in China, where the ICP survey was confined to 11 cities. Although the survey included some surrounding rural areas, it cannot be considered representative of rural China, where the cost of living is lower than in urban areas. The correction method described in Chen and Ravallion (2008a) was used to derive a PPP for rural areas based on a prior estimate of the

6. The ICP started in 1968. Before 2000, the Penn World Table (Summers and Heston 1991) was the main source of the PPP rates for consumption derived from the ICP, as used in the Bank's global poverty measures. In 2000, there was a switch to the 1993 PPPs estimated by the World Bank's Development Data Group; the most recent results are reported in World Bank (2008). There are methodological differences in these two sets of PPPs. The Penn World Table used the Geary-Khamis (GK) method, while the Bank used the Elteto-Koves-Szulc (EKS) method, which is the multilateral extension of the bilateral Fisher index. On the differences between the GK and EKS methods and implications for global poverty measures, see Ackland, Dowrick, and Freyens (2006). There were also improvements in country coverage and data quality in the 1993 PPPs as compared with the Penn World Table.

7. As argued in Ravallion, Datt, and de Walle (1991), the weights attached to different commodities in the conventional PPP rate may not be appropriate for the poor. Results reported in Deaton and Dupriez (2008) do not suggest that the reweighting needed to derive a "PPP for the poor" will have much impact on the aggregate consumption PPP. The working paper version of this article reports tests of sensitivity to using the Deaton-Dupriez PPP (Ravallion, Chen, and Sangraula 2008).

urban–rural differential in absolute poverty lines. However, there are other concerns that were not addressed. The weights attached to different commodities in the conventional PPP rate are not appropriate for the poor (Ravallion, Datt, and van de Walle 1991), though it is not clear that using those weights entails a significant bias.[8] Yet another limitation is that the PPP is a national average; just as the cost of living tends to be lower in poorer countries, the PPP can be expected to be lower in poorer regions within a country, especially in rural areas.[9]

For each country, the national poverty line was converted to 2005 international dollars using the individual consumption PPP from World Bank (2008). The 2005 PPP was not available for 11 of the 88 countries (mainly due to the poor ICP coverage in Latin America) and was deemed unreliable for one country (Zimbabwe).[10] Allowing for missing PPPs and other data problems gave 75 lines.[11] Appendix table A-1 gives the precise poverty lines for each country; details on the sources are in the working paper version of this article (Ravallion, Chen, and Sangraula 2008). In no case do the sources overlap with Ravallion, Datt, and van de Walle (1991).

The density function is given in figure 1. The poverty lines range from $19.05 to $275.71 a month, with a mean of $87.59 and median of $60.81 (figure 1). (The standard deviation is $66.22.) The mode is slightly under $50 a month.

This article follows Ravallion, Datt, and van de Walle (1991) in using private consumption expenditure per capita from the national accounts as the measure of economic welfare (or, more precisely, household final consumption expenditure). The sample mean for private consumption expenditure is $209.40 a month ($6.89 a day) at 2005 PPP; 15 of the sample countries have consumption per capita of less than $60 per month, or about $2.00 a day. The poorest country by this measure is Malawi, at $1.03 a day. The mode of the national poverty lines is quite close to the mode of private consumption

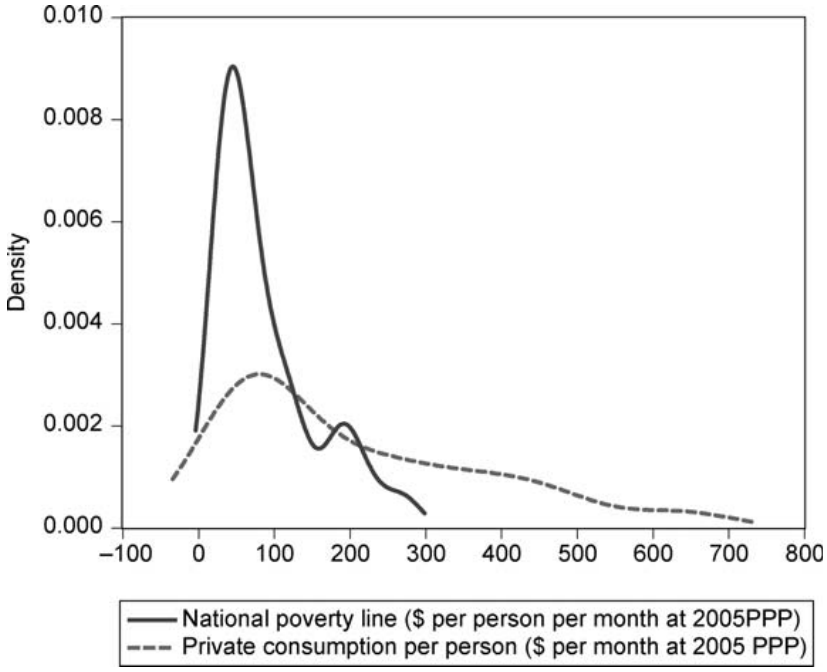
8. Deaton and Dupriez (2009) estimated PPPs for the poor for a subset of countries with the required data. The results do not suggest that the implied reweighting has much impact on the consumption PPP. The working paper version discusses sensitivity of the international poverty line to the choice of PPPs (Ravallion, Chen, and Sangraula 2008). The Asian Development Bank (2008) has taken the further step of implementing special price surveys for Asian countries to collect prices on explicitly lower qualities of selected items than those identified in the standard ICP. Using lower quality goods essentially means lowering the poverty line. In terms of the impact on the poverty counts for Asia in 2005, the Asian Development Bank's method is equivalent to using a poverty line of about $1.20 a day by the methods described here; this calculation is based on a log-linear interpolation between the relevant poverty lines.

9. Ravallion, Chen, and Sangraula (2007) allow for urban–rural cost of living differences facing the poor and provide an urban–rural breakdown of the prior global poverty measures using the 1993 PPP. These estimates will be updated in the future work.

10. The 2005 consumption PPP implies a poverty line of $6 a month, which is very hard to believe.

11. One country, Madagascar, was dropped because of large inconsistencies in the data from various sources (national accounts aggregates reported by the World Bank and the International Monetary Fund). Using the World Bank's estimate of private consumption expenditure gives a poverty line almost three times mean consumption.

FIGURE 1. Density Functions of Poverty Lines and Private Consumption per Capita at 2005 PPP



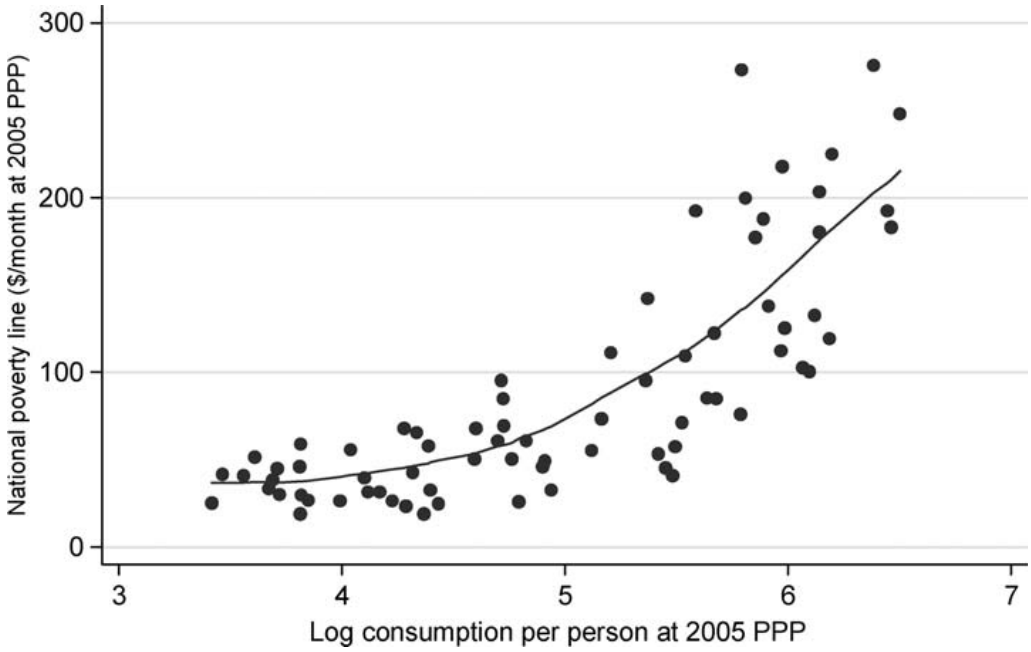
Source: Authors' analysis based on data in appendix table A-1.

expenditure per capita, but otherwise the distributions are very different, with consumption showing a far greater spread (figure 1).

The alternative to private consumption expenditure from the national accounts is mean household consumption or income from household surveys. However, in many cases the poverty line was calculated from such surveys, so any relationships between the national poverty lines and the survey means may well be spurious, being driven by common measurement errors. Consider, for example, the most popular method of setting a national poverty line, which values a predetermined food bundle and adds an allowance for nonfood spending based on the food Engel curve. Underestimation of nonfood spending in the survey will shift the Engel curve and automatically adjust the poverty line downward. The measurement error alone will generate a positive correlation between the poverty line and the survey mean.[12] (The overall direction of bias is ambiguous in theory, given that there will also be the usual attenuation bias when a regressor is measured with error.) Under the assumption that the measurement errors in the national accounts are largely independent of those in the surveys, private consumption expenditure is probably a better indicator.

12. The same would happen if the poverty line were derived by the alternative method of finding the total consumption expenditure level at which predetermined food-energy requirements are met on average. If nonfood spending is underestimated by the survey, the poverty line is automatically adjusted downward, reflecting the measurement error. A spurious correlation results.

FIGURE 2. National Poverty Lines and Log Private Consumption per Person for the Survey Year



Note: Fitted values use a lowess smoother with bandwidth = 0.8.
Source: Authors' analysis based on data in appendix table A-1.

Figure 2 plots the poverty lines against log consumption for the survey year. The least squares estimate of the elasticity of the poverty line to private consumption expenditure is 0.655 (with a *t*-ratio of 13.68, based on a robust standard error).[13] This elasticity estimate is significantly less than unity ($t = 7.21$), as used in relative poverty lines for many developed countries (see, for example, Eurostat 2005), although it is similar to some past estimates based on subjective poverty lines for developed countries.[14] However, figure 2 suggests that the economic gradient emerges strongly only once mean consumption is above a critical level. In a nonparametric regression of the national poverty lines against log mean consumption,[15] the elasticity of the poverty line to mean consumption rises from zero to around 0.7 at the highest level of mean consumption (see figure 2).[16]

13. The estimate is quite robust to outliers; a median quantile regression gives 0.647 ($t = 9.57$).

14. Hagenaars and van Praag (1985) estimated an elasticity of 0.51 for eight European countries. Kilpatrick (1973) estimated an elasticity of about 0.6 for subjective poverty lines in the United States.

15. The nonparametric regression is Stata's locally weighted scatter plot smoothing method with the default bandwidth (0.8). Alternative bandwidths in the interval (0.2, 0.9) were also tested. The mean of the predicted values in the poorest 15 countries ranged from $37.52 to $38.11 (although the regression line was clearly undersmoothed at bandwidths below about 0.5).

16. This elasticity was estimated by taking a simple moving average of the left- and right-side discrete differentials in logs at each data point along the nonparametric regression function in figure 2.

The same pattern found by Ravallion, Datt, and van de Walle (1991) using the older compilations of national poverty lines is evident in figure 2, with the poverty line rising with mean consumption, but with a low initial elasticity. By interpretation, absolute poverty appears to be the dominant concern in poor countries, with relative poverty emerging at higher consumption levels. However, it is notable how high the overall elasticity is for developing economies.

The economic gradient in the poverty lines comprises a component for food needs and one for nonfood needs, although this difference can be quantified only for a subset of the national poverty lines. For a subsample of 28 countries, complete data are also available for separating the food and nonfood components of the national poverty lines. The mean food share at the poverty line is 0.564 (with a range of 0.260–0.794). The elasticity of the food component of the poverty line to mean consumption is 0.471 ($t = 9.55$), whereas the elasticity of the nonfood component is almost twice as high, at 0.910 ($t = 8.97$). (The overall elasticity is 0.679 ($t = 11.02$) for this subsample and 0.655 for the full sample.)

So, the economic gradient in national poverty lines evident in figure 2 is driven more by the gradient in the nonfood component of the poverty lines (which accounts for about 60 percent of the overall elasticity), although an appreciable share is attributable to the economic gradient in food poverty lines.

II. Setting an International Poverty Line Based on the National Lines

Armed with the new compilation of national poverty lines, consider again the basic idea behind the $1 a day poverty line, which was chosen to be representative of poverty lines in poor countries. There are several ways of setting a new international poverty line consistent with this idea.

The sample median poverty line is $60.81 a month, or almost exactly $2.00 a day; the sample mean is higher, at about $2.90 a day. However, the marked economic gradient shown in figure 2 implies that the mean or median will be well above the poverty lines found for the poorest countries.

The poverty line for Malawi—with the lowest personal consumption expenditure per capita in the sample—is $26.11 a month. However, like all specific data points in a sample, this one is susceptible to measurement error, and the country-specific error term could be large. It is notable that even though the relationship in figure 2 is quite flat at low consumption, there is still a sizable variance. No doubt, idiosyncratic differences in the data and methods used in setting national poverty lines have a role; there are measurement errors and methodological differences between countries in how poverty lines are constructed, which can be interpreted as noise in the mapping from the underlying welfare space into the income space. Some averaging is clearly called for, as is normal in economic measurement. A better method is to use the expected

TABLE 1. Estimated Poverty Line for the Poorest Country for Various Parametric Models

Specification	Predicted poverty line for the poorest country in 2005 PPP dollars per month (C^{min} = \$31.34 for Malawi)
$Z_i = \alpha + \beta C_i + \varepsilon_i$	\$31.04 (8.53)
$Z_i = \alpha + \beta_1 C_i + \beta_1 C_i^2 + \varepsilon_i$	\$29.32 (6.59)
$Z_i = \alpha + \beta_1 \ln C_i + \beta_1 \ln C_i^2 + \varepsilon_i$	\$44.22 (6.89)[a]
$\ln Z_i = \alpha + \beta_1 \ln C_i + \beta_1 \ln C_i^2 + \varepsilon_i$	\$33.76; $\ln \hat{Z} = 3.52$ (33.51)
$\ln Z_i = \alpha + \beta_1 C_i + \beta_1 C_i^2 + \varepsilon_i$	\$32.63; $\ln \hat{Z} = 3.49$ (47.16)

Note: Numbers in parentheses are *t*-ratios based on robust standard errors.

[a]The turning point $\ln C = 4.04$—above the lowest consumption. The predicted value of Z_i at the turning point is \$36.05 ($t = 13.61$).

Source: Authors' analysis based on sources described in Ravallion, Chen, and Sangraula (2008).

value of the poverty line in the poorest country, based on how the poverty lines vary with mean consumption. Table 1 gives a number of parametric specifications (including those used by Ravallion, Datt, and van de Walle 1991; Ravallion 1994; Chen and Ravallion 2001) and the implied estimates of the poverty line for the poorest country.

The estimates in table 1 raise three concerns. First, the results may be driven by the specific parametric form. Signs of this possibility include the much higher predicted national poverty line Z for the poorest country in the semi-log model—poverty line Z_i regressed on a quadratic function of the log of personal consumption expenditure ($\ln C_i$). But this is deceptive, since the turning point of the quadratic function is above the lowest consumption. This is clearly an artifact of the parametric form, since there is no sign in figure 2 of a negatively sloped segment at low private consumption expenditure per capita. If this specification is ignored, the results in table 1 suggest that a poverty line of around \$1 a day at 2005 PPP is defensible if poverty in the world is measured by the standards of the poorest country in the world.

Second, a parametric model need not estimate well at all levels of consumption. For example, the linear regression of Z_i on C_i has a very good overall fit, with a correlation of 0.995 with the fitted values in figure 2 and a correlation of 0.836 with the data. However, the linear projection based on this regression underpredicts the poverty lines for the poorest dozen or so countries.[17] The nonparametric regression in figure 2 provides a more flexible method of averaging, given that the regression is ensured to have reasonably good fit over the full range of the data, including among the poorest countries. The predicted value of Malawi's private consumption expenditure per capita is \$37.16 a month (\$1.22 a day).

17. Based on the linear projection, the mean predicted Z for the poorest 15 countries (ranked by C) is \$34.61. By contrast, the mean poverty line for the poorest 15 countries is \$37.98, while the mean of the predicted values from the nonparametric regression is \$37.89.

The third concern is that focusing exclusively on the poorest single country in the sample could make the result vulnerable to measurement errors in consumption. Arguably, it would be better to focus on a reference group of poor countries, with that reference group be defined as countries with personal consumption expenditure per capita of less than some amount C^*, say.

The following empirical model of the national poverty lines in figure 2 takes these observations into account and allows for measurement errors and idiosyncratic differences in the data and methods used in setting national poverty lines:

$$Z_i = Z^* I_i + f(C_i)(1 - I_i) + \varepsilon_i \tag{1}$$

where Z^* is the mean poverty line for the reference group (countries with $C_i \leq C^*$), I_i takes the value one if i is a member of the reference group and zero otherwise, $f(C_i) \equiv E[Z|C = C_i]$ and $E[\varepsilon_i \mid C = C_i] = 0$. For continuity, $Z^* = f(C^*)$. For internal consistency, the reference group must comprise countries for which $C_i \leq C^*$. When this holds, the reference group can be said to be consistent.

The reference group is the sampled countries with personal consumption expenditure per capita of less than \$60 a month; in ascending order in terms of C_i, those countries are Malawi, Mali, Ethiopia, Sierra Leone, Niger, Uganda, Gambia, Rwanda, Guinea-Bissau, Tanzania, Tajikistan, Mozambique, Chad, Nepal and Ghana. Personal consumption expenditure for this group ranges from \$31.34 to \$56.90 a month, with a mean of \$42.46 (or about \$1.40 a day) and a median of \$41.33. The mean poverty line is \$37.98, or \$1.25 a day (the median is \$38.51).

Under various parametric forms, the linear specification for $f(C_i)$ was as good as, or better than, others in terms of fit.[18] The estimated regression corresponding to equation (1) is then (with t-ratios in parentheses based on robust standard errors):

$$\begin{aligned} Z_i &= \underset{(12.55)}{37.983}\, I_i + (\underset{(2.99)}{19.388} + \underset{(11.15)}{0.326}\, C_i)(1 - I_i) + \hat{\varepsilon}_i \\ R^2 &= 0.890, \quad n = 74. \end{aligned} \tag{2}$$

The rising segment has a slope of about one-third.[19] The previously mentioned underprediction of the linear regression at low consumption is corrected for by using the \$1.25 line as the lower bound.

18. The coefficient on a squared term in private consumption expenditure per capita was not significantly different from zero ($t = 0.71$). Regressing Z on a quadratic function of log consumption performed as well as the linear model in terms of R^2 and gave a very similar estimate of Z^*. The parsimonious linear model was therefore selected.

19. Because a common measurement error term appears in both variables, the use of the same PPP for converting both the poverty line and private consumption expenditure could create a spurious correlation. To check this, private consumption expenditure at 1993 PPP was used as the instrumental variable for private consumption expenditure at 2005 PPP (assuming the measurement errors are uncorrelated). This gave a slope of 0.347 ($t = 8.42$) with a slightly smaller sample ($n = 70$); the corresponding poverty line was \$37.41 a month ($t = 11.73$).

To check whether the reference group is consistent, the estimated value of $\hat{C}^*$ is calculated, such that $\hat{Z}^* = \hat{f}(\hat{C}^*)$, which gives $\hat{C}^* = 59.50$ ($t = 3.26$). So the choice of all countries with $C_i < \$60$ as the reference group is internally consistent with the estimate of equation (2).

This estimation method is computationally convenient but has the econometric drawback of treating the regressor I_i as data, which is incorrect since I_i is a function of C^*, which depends on the parameters. A better way would be to use a suitably constrained version of Hansen's (2002) method for estimating a piecewise linear ("threshold") model.[20] This method gives $\hat{Z}^* = 37.464$ ($t = 6.36$) and a slope coefficient on C_i of 0.325 ($t = 12.70$) and $\hat{C}^* = 59.31$ ($t = 1.82$). These parameter estimates are very close to those in equation (2).

The \$1.25 line is also fairly robust to changes in the reference group. Taking the poorest 10 countries instead of the poorest 15 yields a mean poverty line of \$37.27 a month (\$1.22 a day) and taking the poorest 20 yields a mean poverty line of \$38.33 (\$1.26). However, these were not consistent reference groups, unlike that defined by the poorest 15 countries.

While this article focuses on absolute poverty, the new data set on national poverty lines also points to a new schedule of relative poverty lines. With a little rounding off, Ravallion and Chen (2009) proposed a parsimonious schedule of relative poverty lines based on the data in figure 2, with a lower bound of \$1.25 a day but rising above a critical consumption level with a gradient of \$1 in \$3. More precisely, the Ravallion and Chen schedule of relative poverty lines (in dollars per day) is:

$$Z_i^R \equiv \max\left[\$1.25, \$0.60 + \frac{C_i}{3}\right] = \$0.60 + \max\left[\$0.65, \frac{C_i}{3}\right]. \tag{3}$$

The lower bound of \$1.25 is binding for the same 15 poorest countries used in setting the absolute line. The point at which the poverty line rises is at $C =$ \$1.95 per day. Ravallion and Chen (2009) discuss the theoretical rationale for relative poverty lines based on equation (3). This schedule of relative poverty lines has a high correlation with the fitted values in figure 2 ($r = 0.994$) as well as with the data on national poverty lines ($r = 0.836$). Indeed, the precision in predicting the national poverty lines is slightly greater using equation (3) rather than the nonparametric regression in figure 2 (using the Stata program's default smoothing parameter).[21] Furthermore, neither the fitted values from the

20. By this method, one essentially estimates equation (1) for each possible value of consumption in the data and picks the value that minimizes the residual sum of squares The variation on Hansen's model is that, in this case, the slope of the lower linear segment is constrained to be zero and there is no potential discontinuity at the threshold. We are grateful to Michael Lokshin for programming Hansen's method.

21. The standard deviation of the error is \$36.13 for the relative poverty lines and \$36.55 for the fitted values from figure 1. Note that a (sufficiently) less smoothed nonparametric regression would do better than the piecewise linear model used here.

nonparametric regression nor a cubic polynomial in C is significant when added to a regression of Z on Z^R.[22]

III. Comparisons with the Old "$1 a Day" Line

The proposed new international poverty line has a lower value in the United States than the old line of Ravallion, Datt, and van de Walle (1991). The U.S. dollar value in 1993 of the new international poverty line of $1.25 a day is $0.92 a day—15 percent lower than the Chen and Ravallion (2001, 2004) poverty line of $1.08 a day at 1993 PPP. The $1.25 line in 2005 is equivalent to exactly $1.00 a day in the United States in 1996. Put another way, simply updating the old 1993 line for inflation in the United States would give a line of $1.45 a day in 2005,[23] which is well above the poverty lines found in the poorest countries and significantly higher than the $1.25 line ($t = 2.08$; prob. = 4 percent).

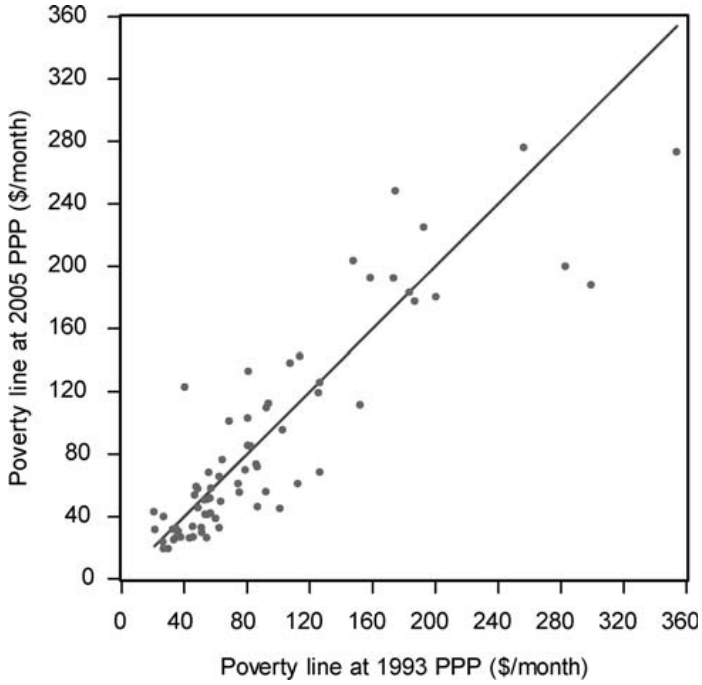
As the following discussion will make clear, these calculations are deceptive for two reasons. First, the underlying data on national poverty lines has improved, enabling use of a more representative sample of national lines than that used to set the $1.08 line at 1993 PPP. Second, the PPPs from different ICP rounds are not strictly comparable, and the new PPPs are likely to be a better guide to the cost of living in poor countries. As will be shown, these two effects work in opposite directions: the first raises the international poverty line whereas the second lowers it.

The first difference between the proposed new international poverty line and the old one is in the underlying sample of national poverty lines. The effect of the new sample is to raise the international poverty line when assessed at a common set of PPPs. For the poorest 15 countries ranked by consumption per capita at 1993 PPP, the mean poverty line in the new sample is $44.19 ($1.45 a day). This compares to $33.51 ($1.10 a day), which is the mean for the eight countries in the old sample with consumption per capita below the upper bound of consumption for the poorest 15 countries in the new sample. This might be taken to suggest that there was an upward drift in the national poverty lines of poor countries over this period. This would seem implausible, however, as it appears to be quite rare for developing economies to increase the real value of their poverty lines over time. The more plausible explanation lies with the aforementioned differences between the old and new samples of national poverty lines. Making the sample more representative—with a much larger and more regionally balanced sample of developing economies and with both urban and rural lines for almost all countries—appears to have raised the

22. The joint F-test of the null hypothesis that the three parameters in the cubic function of C are all zero in the regression of Z on Z^R gave $F(3,69) = 0.14$ (prob. = 0.93), while the t-test on the coefficient on the fitted values when added to the same regression was 0.44.

23. The ratio of the 2005 CPI for the United States to the 1993 CPI is 1.352.

FIGURE 3. National Poverty Line in Local Currency Units Converted into Dollars for 1993 and 2005 for the 72 Countries with PPP Available for Both Years



Source: Authors' analysis based on sources described in the text.

poverty line. Conversely, one can conjecture that had the old sample had been more representative, the old international line would have been appreciably higher.

The second difference between the new international poverty line and the old one is in the PPPs. There were substantial revisions to the PPPs in the 2005 ICP round relative to the 1993 round. Probably the most important difference for current purposes is that the 1993 ICP for developing economies used less rigorous standards for specifying the quality of goods and weaker supervision in poor countries, so that lower quality goods were priced than would have been found in the U.S. market. The following discussion focuses on this second difference using the new sample of national poverty lines.

Some large changes in the PPPs are evident if the same national poverty line in local currency units is converted into dollars for both 1993 and 2005 and the results are then compared, as in figure 3 for the 72 countries in the data set with PPPs available for both years. It is notable that the 2005 ICP has tended to entail a downward revision in the dollar value of the lowest stratum of poverty lines.

The implied revisions are substantial for poor countries. To see this, let $PPP_i^{t^*}$ denote the true PPP exchange rate derived from the ICP round for date t. If the data were internally consistent, the PPP rate for a given country would

change over time according to differences in the country's rate of inflation and that for the numeraire country, the United States, so that

$$\frac{PPP_i^{05*}}{PPP_i^{93*}} = \frac{D_i^{05*}/D_i^{93*}}{D_{\text{US}}^{05*}/D_{\text{US}}^{93*}} \tag{4}$$

where D_i^{t*} is the true deflator for converting the country-specific poverty line to the PPP reference date, t. While equation (4) holds for the true values of all variables, the measurements are based instead on the observed values, PPP_i^t and D_i^t. To focus on the implications for the errors in the historical PPP data for developing economies, the 2005 PPP and the deflators are assumed to be accurate. The poverty lines are converted to a common currency using these observed data. Let $Z_i^t \equiv Z_i\ D_i^t/PPP_i^t$ denote the calculated poverty line in PPP dollars in country i at date t where Z_i is the poverty line in local currency for country i (at some country-specific date, which is implicit). Under these assumptions, the revision to the PPP for 1993 that is implied by the observed data can be readily derived as follows:

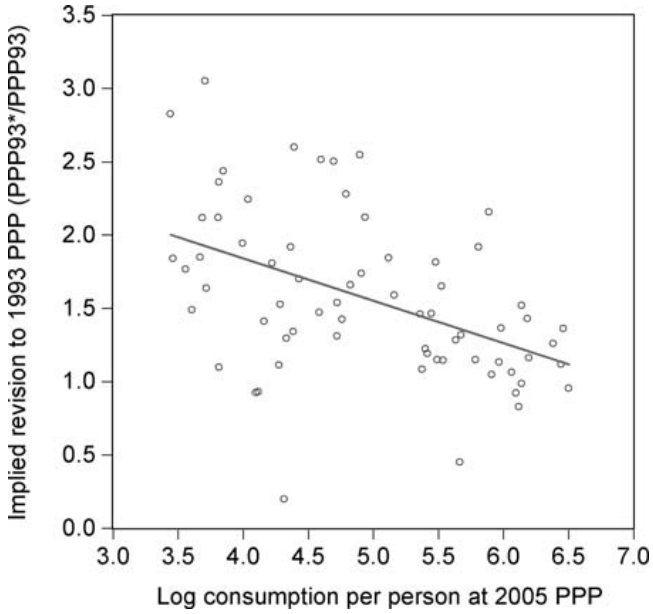
$$\frac{PPP_i^{93*}}{PPP_i^{93}} = \left(\frac{D_{\text{US}}^{05}/D_{\text{US}}^{93}}{D_i^{05}/D_i^{93}}\right)\frac{PPP_i^{05}}{PPP_i^{93}} = \frac{D_{\text{US}}^{05}/D_{\text{US}}^{93}}{Z_i^{05}/Z_i^{93}}. \tag{5}$$

The sample mean of this variable is 1.578 (with a standard error of 0.062; $n = 72$). Thus, a sizable underestimation of the 1993 PPP is implied by the new PPPs and inflation data. Furthermore, the extent of this underestimation tends to be greater for poorer countries. The implied values of PPP_i^{93*}/PPP_i^{93} plotted against log consumption per capita at 2005 PPP show a marked negative gradient (figure 4). The correlation coefficient is -0.47, which is significant at the 1 percent level ($t = -4.70$). Among the poorest countries in personal consumption expenditure, the data suggest that a marked upward revision is required to the 1993 PPPs. In other words, the 1993 ICP round underestimated the price level in these countries relative to that in the United States. This is consistent with the view that the 1993 ICP used a lower quality of goods in poor countries than would have been found in the U.S. market (say) because of looser standards of specifying the quality of goods and weaker supervision in poor countries, particularly the poorest countries.

These observations are suggestive at best. The data problems are unlikely to be confined to the 1993 PPPs; errors are no doubt also present in the 2005 PPPs and the inflation rates. But these results are at least consistent with the interpretation that less rigorous specification and monitoring of quality standards in the 1993 ICP resulted in lower quality goods being priced in poor countries, leading to an underestimation of the PPP for many of the poorest countries or (equivalently) to underestimation of the true cost of living.

Clearly, there are serious comparability problems across ICP rounds. Note, however, that the method of measuring global poverty used by Chen and

FIGURE 4. Implied Revisions to 1993 PPP Plotted against Log Private Consumption per Person at 2005 PPP



Note: Implied revisions to the 1993 PPP values (PPP93*) are calculated using the 2005 round and differential rates of inflation between 1993 and 2005; PPP93* is then normalized by the original estimate of the 1993 PPP rates (PPP93).

Source: Authors' analysis based on sources and methods described in the text.

Ravallion (2001, 2004, 2007) does not assume comparability of ICP rounds. The salient features of the method are that the international poverty line is converted to local currency units in the ICP base year (using the same consumption PPP as was used for the national poverty lines) and is then converted to the prices prevailing in the relevant survey year using the best available CPI for that country. The PPP conversion is done only once, and all estimates are revised back in time.

IV. CONCLUSIONS

The original $1 a day poverty line aimed to assess poverty in the world as a whole by the standards of what poverty means in the world's poorest countries. This article has revisited this idea armed with a new set of national poverty lines for low- and middle-income countries, drawing on the World Bank's country-specific poverty assessments and the Poverty Reduction Strategy Papers prepared by the governments of the countries concerned. The new set of national poverty lines is both more up to date and more representative of developing economies, notably in Sub-Saharan Africa. These national poverty lines were converted to a common currency using the new set of household consumption PPP's estimated from the 2005 round of ICP price surveys.

Because the 2005 ICP round implied substantial upward revisions to the PPPs of the poorest countries, simply updating the old international poverty line for inflation in the United States gives a poverty line that is well above the lines found among the poorest countries at 2005 PPPs. Instead, a new international poverty line of $1.25 a day is proposed for 2005 (equivalent to $1.00 a day in 1996 U.S. prices), which is the mean of the lines in the poorest 15 countries in consumption per capita, based on the new compilation of national poverty lines. This new poverty line is fairly robust to different estimation methods.

Using the new international poverty line proposed in this article, Chen and Ravallion (2008b) find that 1.4 billion people in 2005—25 percent of the population of the developing world—lived in poverty. That share was 52 percent 25 years earlier (in 1981) and 42 percent in 1990.[24] However, Chen and Ravallion find that progress was highly uneven, both over time and across regions. If the trend is extrapolated forward, the developing world as a whole appears to be on track for attaining the first Millennium Development Goal. That is not the case, however, for developing economies excluding China. For those countries, the losses to the poor have roughly cancelled the gains, so that the number of people living below $1.25 a day stays at around 1.1–1.2 billion over 1981–2005.

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24. The set of countries is held constant over time at the number of countries that have at least one household survey satisfying the quality conditions. The estimation method provides an estimate for each of these countries at each reference data point; for detail, see Chen and Ravallion (2008b).

Appendix

Table A-1. National Poverty Lines

Country	Survey year	2005 PPP dollars	
		Consumption per capita per month for survey year	Poverty line per capita per month
Albania	2002	280.71	85.18
Argentina[a]	1999	641.90	183.07
Armenia	1998–99	174.84	73.36
Azerbaijan	2001	292.23	84.80
Bangladesh	2000	64.34	31.46
Belarus	2002	362.04	187.73
Benin	1999–2000	72.82	23.57
Bolivia[a]	2001	216.66	142.39
Bosnia and Herzegovina	2001	393.95	217.65
Brazil[a]	2002–03	465.45	180.14
Bulgaria	2001	445.70	100.77
Burkina Faso	2003	68.54	26.27
Cambodia[a]	2004	75.06	42.80
Cameroon	2001	112.96	69.62
Chad	1995–96	47.04	26.60
Chile[a]	2000	487.08	119.00
China	2002	120.78	25.89
Colombia[a]	1999	334.47	199.56
Congo Republic	2005	72.13	67.99
Cote d'Ivoire	1998	117.07	50.36
Djibouti	2002	111.70	95.61
Ecuador	2001	289.72	122.62
Egypt	1999–2000	225.68	53.43
Estonia	1995	431.16	102.78
Ethiopia	1999–2000	35.22	41.04
The Gambia	1998	40.88	44.92
Georgia	1997	182.79	111.24
Ghana	1998–99	56.90	55.65
Guinea Bissau	1991	45.12.	45.96
Hungary	1997	668.31	247.87
India	1999–2000	84.24	27.40[b]
Indonesia	1999	139.96	32.63
Jordan	2002–03	251.59	71.47
Kazakhstan	1996	213.41	95.32
Kenya	1997	112.80	84.71
Kyrgyz Republic	2003	109.85	60.81
Lao PDR	1997–98	—	32.10
Latvia	1995	370.11	137.91
Lesotho	1994–95	135.84	49.37
Macedonia FYR	1994	348.96	177.25
Malawi	2004–05	31.34	26.11
Mali	1988–89	31.96	41.89

(Continued)

TABLE A-1. Continued

Country	Survey year	2005 PPP dollars: Consumption per capita per month for survey year	2005 PPP dollars: Poverty line per capita per month
Mauritania	2000	99.63	68.16
Mauritius	1991–92	328.33	272.99
Mexico	2002	630.73	192.22
Moldova	2001	124.89	60.81
Mongolia	2002–03	80.55	57.88
Morocco	1998–99	167.73	55.33
Mozambique	2002–03	45.52	29.54
Nepal	2003–04	54.55	26.43
Niger	1993	39.34	33.35
Nigeria	1985	61.49	31.38
Pakistan[a]	1998–99	98.31	50.67
Paraguay	2002	222.27	192.14
Peru[a]	2000	326.61	76.10
Philippines	1988	134.17	46.02
Poland	1993	465.05	203.23
Romania	2001	397.77	125.57
Russian Federation	2002	455.72	132.67
Rwanda	1999–2001	41.33	30.17
Senegal	1991	78.92	19.05
Sierra Leone	2003–04	36.94	51.54
Sri Lanka	2002	233.05	45.38
Tajikistan	1999	45.49	58.83
Tanzania	2000–01	45.26	19.20
Thailand[a]	1992	243.52	57.58
Tunisia	1995	240.63	41.17
Turkey	2002	391.42	112.26
Uganda	1993–98	40.01	38.51
Ukraine	2002	254.62	109.43
Uruguay	1998	593.71	275.71
Venezuela RB	1989	492.30	224.73
Vietnam	2002	81.18	32.52
Yemen	1998	76.37	65.37
Zambia	2002–03	60.40	39.69

— is not available.

Note: For a summary of the methods used for each country and other details on the individual country estimates, see Ravallion Chen, and Sangraula (2008). The national poverty line is calculated as the weighted mean of the urban and rural poverty lines, using urban and rural real consumption (or income) shares as the weights and the poverty lines as the deflators.

[a]The poverty line is an urban poverty line since the 2005 PPP is based on urban prices for that country.

[b]This rises to $31.25 using the adjustment for urban–rural cost of living differences in India used by Chen and Ravallion (2008b).

Source: Authors' analysis based on sources described in Ravallion, Chen, and Sangraula (2008).

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