Has World Poverty *Really* Fallen?[1]

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We evaluate the claim that world consumption poverty has fallen since 1990 in light of alternative assumptions about the extent of initial poverty and the rate of subsequent poverty reduction in China, India, and the rest of the developing world. We use two poverty indicators: the aggregate headcount and the headcount ratio, and consider two widely-used international poverty lines ($1/day and $2/day). We conclude that, because of uncertainties in relation to the extent and trend of poverty in China, India, and the rest of the developing world, global poverty may or may not have increased. The extent of the estimated increase or decrease in world poverty is critically dependent on the assumptions made. Our conclusions highlight the importance of improving the quality of global poverty statistics.

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1. Introduction

Many studies have recently advanced the conclusion that world poverty has fallen substantially since the early 1990s (see, e.g., Bhalla, 2002; Chen and Ravallion, 2001, 2004; Sala-i-Martin, 2006; Berry and Serieux, 2004). A central basis for this conclusion is the view that poverty fell in India and China in the 1990s. However, the extent of recent poverty reduction and the current levels of poverty in these two countries are debated. Moreover, there is reason to believe that poverty reduction has been less rapid elsewhere in the world (in particular, in Latin America and sub-Saharan Africa) than it may have been in India and in China. As a result, there is reason to question whether world poverty has actually fallen, and if so to what extent.

This question takes on special importance in light of the United Nations' first Millennium Development Goal, which calls for the halving of the percentage of the developing country population living under the $1/day international poverty line between 1990 and 2015.[4] Whether this goal is likely to be achieved has been a central concern in recent debates. Some have claimed that it has already been achieved. For example, Bhalla (2002) argues that "Toward that goal…15 years *hence*, and *already achieved today*, resources are used to fight the non-existent poverty of tomorrow." (p. 92-93, italics added). Chen and Ravallion (2004, p. 141) conclude that "if the trends over 1980-2001 continue then the aggregate $1 per day poverty rate for 1990 will be almost halved by 2015, though East and South Asia will be the only regions to more than halve their 1990 poverty rates." However, they also find a low rate of reduction in the $1/day headcount ratio measure of poverty in Latin America between 1990 and 2001 (from 11.3 percent to 10.5 percent) and increases in the same measure of poverty in Sub-Saharan Africa during the period (from 44.6 percent to 45.7 percent). Deaton (2002), Pogge and Reddy (2006) and Reddy and Pogge (2006) highlight the uncertainties surrounding global poverty estimates.

The recent debate on whether the world is on the right track in regard to poverty has centered on whether the poverty reduction thought to have taken place in China and India in the 1990s has been sufficient to have caused a decrease in poverty worldwide, despite the apparently less impressive record of poverty reduction elsewhere.[5] In order to assess this question, we undertake a sensitivity analysis. Specifically, we examine whether the conclusion that world poverty has fallen between 1990 and 2001 is robust to alternative assumptions concerning the extent of initial poverty and the rate of subsequent poverty reduction in China, India, and the developing world outside China and India (henceforth, 'non-China-India').

We draw on the literature estimating poverty in China, India and world as a whole to identify alternative estimates of initial poverty and subsequent poverty reduction. In presenting multiple poverty scenarios, we are recognizing that there are fundamental uncertainties surrounding the appropriate estimates to employ for different countries and

[4] The most widely used international poverty lines are $1.08/day and $2.15 day at 1993 PPP (for details on their construction, see Chen and Ravallion, 2001). For simplicity, we refer to these as $1/day and $2/day throughout the paper.

[5] See, for example, Wade and Wolf (2002).

regions (see, for example, Riskin, 2004, and Reddy and Minoiu, 2006 on China; Deaton and Kozel, 2005, and Sen and Himanshu, 2004 on India). We do not view any one estimate as authoritative and use them together to construct bounds for the sensitivity analysis. These bounds can be viewed as relating to conceptual disputes concerning the appropriate identification criteria to employ in assessing poverty, to methodological disputes concerning how best to estimate the number of poor persons, or to statistical uncertainties which are inherent in such assessment. Further, the estimates employed in individual countries must not only be meaningful but must be comparable across countries if they are to permit international comparison and aggregation. Existing poverty estimates for major countries are not constructed with these ends in mind, raising questions about their use without additional adjustment in global poverty analysis.

The extent of poverty is assessed using two indicators: the poverty headcount ratio (the share of poor) and the aggregate poverty headcount (the number of poor). The merits and demerits of these indicators are examined by Subramanian (2002) who presents relevant axioms for their assessment. As a starting point for our analysis, we focus on two international poverty lines: $1/day and $2/day which have been widely used in the 'money-metric' approach to poverty analysis (Chen and Ravallion, 2001, 2004; Bhalla, 2002; Sala-i-Martin 2006; and critically assessed in Reddy and Pogge, 2006) and identify bounds for poverty estimates in individual countries and regions which fulfill the requirement that they are notionally comparable in the sense that they "correspond" to these poverty lines.

We find that under at least some assumptions considered, world poverty must be concluded to have increased in the 1990s. The analysis draws attention to the need to reduce uncertainties concerning poverty in individual countries and region and to assess claims regarding the extent and trend of global poverty in light of their robustness to alternative assumptions.

The assumptions made about initial and final poverty in each country influence the estimated global poverty trend in two ways. When assessing the global poverty trend, the proportion of the world's poor accounted for by the poor in a given country at the beginning of the time period analyzed determines the weight attached to subsequent poverty reduction in that country. Further, the pace of poverty reduction in each country influences its contribution to global poverty reduction.

The paper is structured as follows: in the next section, we describe the literature and data sources used to identify alternative assumptions concerning the extent of initial poverty and the pace of poverty reduction in China, India and non-China-India. In section 3 we present and discuss, for each poverty scenario for China and India, the lowest poverty rate in the developing world outside China and India in 2001 which is consistent with the conclusion that world poverty has increased. We consider the implications of this analysis in light of our question. Section 4 summarizes our conclusions.

2. Poverty in China, India and the rest of the developing world

Poverty in China

There is substantial uncertainty concerning the extent and recent trend of Chinese poverty, despite a wealth of studies on this topic. Some of these uncertainties are data-related. For example, nationally representative household consumption surveys are not publicly available for China at multiple points in time and poverty analysis is therefore often undertaken on grouped data (Chen and Ravallion 2001, 2004, 2007; Chen and Wang, 2001; Fang, Zhang, and Fan, 2002; Berry and Serieux, 2004) or on unit data from surveys with limited spatial or temporal coverage (Khan and Riskin, 2001; Gibson, Huang, and Rozelle, 2003; Xue and Zhong, 2003; Meng, Gregory, and Wan, 2007). Other uncertainties relate to methodology: for example, there is no official national poverty line for China (National Statistical Bureau, 2004). Furthermore, the country's non-participation in the International Comparison Program precludes the use of purchasing power parity (PPP) conversion factors derived from an official benchmark survey to translate international poverty lines into local currency units, as is required if the resulting poverty estimates are to be viewed as notionally comparable to poverty estimates elsewhere and to be employed in international comparison and aggregation.

Our estimates of national consumption poverty for China in the 1990s come from two studies: Chen and Ravallion (2004) and Reddy and Minoiu (2006). Using grouped data from underlying household surveys, Chen and Ravallion (2004) (henceforth, 'CR') find that the $1/day poverty headcount ratio has fallen in China from 33 percent (374.8 million) in 1990 to 16.6 percent (211.6 million) in 2001. Their estimates are obtained by (1) translating the international poverty lines into local currency units using a 1993 consumption PPP of 1.4185 Yuan/$, (2) converting the resulting poverty line into the current Yuan of each year in which consumption poverty was estimated, using official rural and urban consumer price indices, and (3) using grouped data on consumption to arrive at a poverty estimate.[6]

Reddy and Minoiu (2006) (henceforth, 'RM') propose several sets of consumption poverty estimates for China in the 1990s, based on alternative assumptions concerning: (a) the choice of purchasing power parity conversion factor used to translate the international consumption poverty lines into local currency units; (b) alternative estimates of the level and distribution of private incomes; (c) alternative estimates of the propensity to consume of lower income groups, and (d) alternative consumer price indices. The authors use the consumption profiles and poverty lines that they derive on the basis of these assumptions to estimate poverty for different years in the 1990s.[7]

[6] To estimate poverty from grouped data, the authors use the World Bank's POVCAL software. For an evaluation of the accuracy of POVCAL for a range of income distributions, see Minoiu and Reddy (2007).
[7] For details on the choice of parameters, see Reddy and Minoiu (2006, Appendix). The purchasing power parity conversion factors considered by the authors are GDP consumption PPPs implied by 1991 GDP estimates for China contained in the IMF World Economic Outlook and the Penn World Tables Mark 5.5 (see Gulde and Schulze-Ghattas, 1993). The low and the high value of the consumption 1993 PPPs

To summarize the process through which the incomes shares are transformed into a consumption profile and a consumption poverty line is identified we employ a methodological vector of four parameters: $\left[PL, \hat{Y}, \theta, \pi\right]$, where PL represents the national currency equivalent of the \$1/day poverty line; $\hat{Y}$ refers to the estimate of per capita private income (either from the national accounts, $\hat{Y}_{NA}$ or from surveys, $\hat{Y}_S$); θ refers to the method of arriving at estimates of the fractions of per capita private income devoted to consumption by each income group (and deriving either from the national accounts, θ_{NA} or from surveys, θ_S); and π is the consumer price index (CPI) used to express consumption levels in constant prices (and can be either the official CPI, π_{off}, or an adjusted CPI, π_{adj}, that may be viewed as more appropriate for poverty assessment).

Since the analysis becomes increasingly complex as the number of values of possible parameters increases, we simplify the presentation of the results using a shortcut. First, we note that for any approach to estimating the per-capita private income level (that is, either $\hat{Y}_{NA}$ or $\hat{Y}_S$), four scenarios are now possible for the first two parameters of the methodological vector: $\left(PL_{LOW}, \hat{Y}_{NA}\right)$, $\left(PL_{HIGH}, \hat{Y}_{NA}\right)$ $\left(PL_{LOW}, \hat{Y}_S\right)$ and $\left(PL_{HIGH}, \hat{Y}_S\right)$. Based on supporting evidence regarding the discrepancy between survey and national income during the 1990s, we make the further assumption that $\hat{Y}_{NA}$ and $\hat{Y}_S$ are in the proportion of 2.07:1 throughout the decade.[8] We note that scaling up (down) all individuals' income by a fixed factor and raising (lowering) the poverty line by the same factor leaves the headcount ratio unchanged (for a given propensity to consume). It conveniently follows that there is an equivalence between computing the poverty headcount ratio from data given by the methodological vectors $\left(PL_{LOW}, \hat{Y}_S\right)$ and $\left(2.07 \times PL_{LOW}, 2.07 \times \hat{Y}_S\right)$, that is $\left(PL_{HIGH}, \hat{Y}_{NA}\right)$. We use this equivalence to reduce the number of calculations conducted and to report the data more economically in what follows.

We present the resulting range of \$1/day poverty estimates for China in Table 1. Poverty estimates RM(1) to RM(3) are 'least refined' in the sense that they derive from applying the national accounts-based consumption to income ratio for each year (θ_{NA}) to all income groups to obtain a consumption profile of the population in that year, and by employing the official CPI to express the consumption means in constant 1993 Yuan (π_{off}). Poverty headcount ratios RM(4) and RM(5) are 'most refined' in the sense that

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considered are: 1.0267 Yuan/\$ and 2.1285 Yuan/\$. (Note that the consumption PPP for 1993 of 1.4185 Yuan/\$ employed by the World Bank in its poverty estimates is an intermediate value.) The local currency unit poverty lines (at 1993 prices) corresponding to the \$1/day international poverty line are therefore 404.7 Yuan/year (low poverty line) and 839.1 Yuan/year (high poverty line).

[8] Using data from the Chinese Statistical Yearbook (2003) and the World Development Indicators online database (2003), we find that the median ratio between the national accounts average per capita income and that reported from surveys between 1990 and 2001 was 2.07 while the average ratio was 2.02. We therefore judged it convenient and reasonable to assume that national accounts-based income estimates and survey-based estimates have been in the proportion of 2.07:1 between 1990 and 2001.

they use survey-based, decile-specific consumption to income ratios (θ_S) to obtain the consumption profile from the income data, and a decile-specific adjusted CPI to express these in constant prices (π_{adj}).[9]

For the $2/day poverty line, the first set of poverty estimates that we consider for China are drawn from Chen and Ravallion (2004), according to which Chinese $2/day poverty has fallen during the 1990s from 72.6 percent to 46.7 percent. We supplement these with 1990 and 2001 headcount ratios computed using the consumption profiles for 1990 and 2001 shown in Table 2. As noted above, the consumption profiles are constructed so as to reflect the possibility of using either China's national accounts and or surveys to arrive at a consumption profile from data on the income distribution and means, and the possibility of using either official or adjusted inflation rates to express that profile in constant prices. The $2/day headcount ratios for China that correspond to different combinations of underlying assumptions are reported in Table 3.[10]

Poverty in India

Indian poverty estimates during the 1990s have been the subject of an extended debate primarily due to changes in survey methodology in the 1999/2000 "thick" round of India's National Sample Survey relative to previous rounds, which led to difficulties in comparing estimates across rounds (Deaton, 2005).

Views on the extent of poverty reduction in the 1990s vary widely: for example, Bhalla (2000) takes the view that the national poverty headcount ratio in India fell by 50 percent between 1990 and 1998 (namely, from 26 percent to 13 percent; pp. 31). In contrast, the analysis of Sen and Himanshu (2004, p. 4259) leads them to the conclusion that between 1993/94 (50th round) and 1999/00 (55th round) the poverty headcount ratio fell by no more than 3 percentage points (from 35.97 percent to 32.97 percent) and the aggregate headcount may have well increased over the period. Patnaik (2004, 2005, 2006) suggests that poverty has actually risen substantially over the period. We may call these views pessimistic by contrast to that of Bhalla, without any suggestion that any one of these views is correct. Official poverty estimates indicate that the national poverty headcount ratio was 35.11 percent in 1990/91 (based on a "thin" round survey employing a smaller sample) and 35.97 percent in 1993/94 (based on a "thick" round survey employing a larger sample). The estimates are based on the national poverty line, which is found to be approximately 80 percent of the $1/day international standard when employing the 1993

[9] Note that RM do not report headcount ratios for 1990 due to a failure of the World Bank's POVCAL software to estimate poverty based on the 1990 consumption profile for China corresponding to (θ_S, π_{adj}).

This malfunction has been recognized by the authors of the POVCAL software in personal correspondence but the source of the problem has not been identified and the problem has not been corrected. Since the 1990 poverty estimates are needed in this paper, we estimate them by replacing the 1990 income shares with those of 1992. We compute the 1990 income profile by applying the 1990 per capita GDP to the (1992) income shares. The 1990 consumption profile thus obtained is reported in Table 2.

[10] The Yuan equivalents of the $2/day poverty line considered here are: 809 Yuan/year (low poverty line) and 1678 Yuan/year (high poverty line).

consumption PPP used by the World Bank for the purpose. Deaton and Drèze (2002) posit a rate of poverty reduction that is in an intermediate range. They conclude that between 1987 and 1988 and 1990 and 2000 the poverty headcount ratio fell from 39.4 to 26.3 percent in rural areas and from 22.5 to 12 percent in urban areas. We do not take a view here on what has actually happened in India. Rather, we examine the impact of alternative assumptions concerning what has happened in India on broader conclusions concerning the trend of global consumption poverty in the 1990s.

To determine Indian poverty headcounts for 1990 for purposes of this analysis, we consider three alternative baseline (1990) poverty levels: 42.10 percent, 40 percent and 35.11 percent (the official estimate based on the 1990/91 "thin" round, using the official national poverty line). The first is the $1/day poverty estimate for 1990 as constructed by CR. We also consider the second and the third to allow for the possibility that the $1/day poverty line overestimated the cost of meeting basic human requirements, since the official poverty line was at the time widely accepted in India for that purpose.

To obtain Indian poverty headcounts for 2001, we assume two alternative poverty reduction rates and apply them to the initial headcount ratio. These are an optimistic poverty reduction scenario of 50 percent (corresponding to Bhalla, 2000) and a more pessimistic poverty reduction scenario of 10 percent. The latter figure is nevertheless more optimistic than that proposed by Sen and Himanshu (2004), who claim that the highest decrease in the national headcount ratio that is suggested by the survey data is 8.34 percent (or 3 percentage points) between 1993/94 and 1999/00, and far more optimistic than the scenario of increasing poverty suggested by a few observers The six resulting scenarios for the extent and trend of poverty in the 1990s in India, reflecting prevailing perspectives, are presented in Table 4 (and are labeled I(1) to I(6)).

For the $2/day international poverty line, we use only one set of headcount ratio estimates drawn from CR: 86.1 percent in 1990 and 79.9 percent in 2001, as there are no alternative estimates for a poverty line in a corresponding range that are available in the literature on Indian poverty.[11]

Poverty in the developing world outside China and India

The baseline $1/day and $2/day non-China-India headcount ratios that we employ for 1990 are those of CR (20.14 percent and 46.16 percent, respectively). However, in order to reflect uncertainties about these estimates, we allow for the possibility that the level of the headcount ratio in 1990 judged according to alternative means or better data may have been higher or lower, by multiplying CR's headcount ratio by a range of factors (0.75, 1, and 1.5).[12] In this way, we allow the $1/day aggregate headcount in the

[11] CR's $1/day and $2/day equivalents in Indian rupees are 2,560.9 Rp and 5,537.4 Rp/day, corresponding to a 1993 PPP of 7.0162Rp/$.

[12] The results based on other multiplicative factors for the non-China-India poverty headcount (e.g., 0.5 and 2) do not change the qualitative conclusions of the paper, and are available from the authors upon request.

developing world outside India and China to vary between 361.7 million and 729.5 million so as to explore the impact of alternative assumptions.[13]

3. Findings

The method by which we obtain the lowest non-China-India 2001 poverty headcount ratios that are consistent with increasing world poverty (henceforth, 'threshold' non-China-India headcount ratios) when the extent of poverty is measured by both the world poverty headcount ratio, and the world aggregate poverty headcount, is described in the appendix.

It is evident from the expressions derived there that a higher initial headcount ratio or a lower final headcount ratio in India or China implies a higher threshold non-China-India headcount ratio. The reasons that this is so are straightforward. A higher initial headcount ratio in India or China means that poverty reduction in these countries contributes a greater relative weight in the calculation of the global poverty headcount (or headcount ratio). Since for all of the assumptions that we consider poverty decreased in both of these countries over the period, the higher are these weights the larger is the increase in poverty required outside China and India to counteract the poverty reduction in these countries. Similarly, a lower final headcount ratio (i.e., a higher rate of reduction of poverty over the period) in India or China entails that the rate of poverty increase outside China and India must be higher in order to counteract the decrease in global poverty arising from these two countries. The initial extent of non-China-India poverty that is assumed is also crucial, as it too influences the relative weight that is attached to the poverty reduction experiences in the rest of the developing world in the assessment of global poverty reduction.

If the pace of poverty reduction was relatively high in the countries with high initial poverty rates, the estimated global poverty reduction will be consequently high. The

[13] This is a (necessarily imprecise) way of laying down 'confidence bounds' reflecting the uncertainties associated with CR's global consumption poverty estimates. For example, the total population that is not covered by household surveys is around 400 million people. Poverty headcount ratios for this population are imputed by CR from regional averages for countries for which they do have surveys. Based on population statistics for 2001, the following percentages of the population of different regions were not directly represented by household surveys or grouped data in CR's poverty estimates: 25.95 percent (Middle East and North Africa), 22.14 percent (Sub-Saharan Africa), 4.69 (Latin America and Caribbean), and smaller percentages for East Asia, Eastern Europe and Central Asia, and South Asia. For the countries for which there is no data, it is assumed by CR that the country's poverty headcount ratio is the same as the regional average. The regional average is computed by dividing the aggregate headcounts for the countries for which data was available by the population of these countries. The regional average headcount ratio is then imputed to countries for which data is not available. We presume that a new regional average was afterwards computed (and is reported in the paper), though this is not explicitly stated in CR. Other reasons for concern regarding the validity and precision of poverty estimates for the developing world are outlined in Reddy and Pogge (2006). They include the lack of price surveys on the basis of which to construct PPPs for many countries, the inappropriateness for poverty assessment of the price data collected and the PPPs that are constructed from them, the lack of alignment of survey years and estimation years, the poor correspondence between the prevailing 'money-metric' international poverty lines and the local cost of achieving basic human requirements, and the lack of use of equivalence scales to take note of the sizable differences in average household size across countries and years.

threshold non-China-India headcount ratio will be highest when the initial poverty headcount in China and in India is high relative to that in other countries, and poverty reduction in China and in India is high in absolute terms. The rate of increase in poverty outside China and India consistent with global poverty having increased over the period will be of a large magnitude in such a case. The results concerning the smallest non-China-India headcount ratios consistent with global poverty having increased during the 1990s are presented in Tables 5-7.

We assess the global poverty headcount ratio as a percentage of the developing world population, following CR. We do this in order to maintain comparability with their results, although it is not obvious that this is an appropriate choice. There may be sound normative reasons to hold that the share of the entire world population that is poor is of greater interest. Specifying the headcount ratio in this way will lead to a lower estimated headcount ratio and also to a lower estimated rate of reduction of the headcount ratio (since the developing world population has grown at a faster rate than the world population as a whole).[14] Correspondingly, the threshold non-China-India headcount ratios will be lower when the world population (rather than the developing world population) is taken to be the denominator of the global poverty headcount ratio. The threshold non-China-India headcount ratios for this case, which we calculate but do not report, are fairly close to those that result when the developing world population is taken to be the denominator and lie between the thresholds (associated with an increasing headcount and an increasing headcount ratio) that we report.[15]

Did $1/day poverty really fall?

We initially consider the possibility that the CR non-China-India headcount ratio for 1990 is correct. As shown in Tables 5-6 (upper panels), under this assumption, regardless of the poverty reduction scenario for India, the scenario in which the extent of poverty in China in 1990 is lowest (RM(1)) is that in which the country's contribution to global poverty reduction has the smallest weight, and in which it is easiest to conclude that global poverty has increased. We understand the ease with which this conclusion may be drawn in a formal sense: the rate of increase of poverty that must be assumed to have happened elsewhere is lower in this case. Similarly, under this assumption, it is most difficult to conclude that world poverty has increased in those scenarios in which high poverty reduction takes place from a high initial level in India and in China. Naturally, when countries that possess large numbers of poor persons experience a high rate of poverty reduction, the increase in poverty elsewhere that is needed to conclude that world poverty has increased must also be high.

[14] For further discussion of this point in relation to the first Millennium Development Goal, see Pogge (2004).

[15] The threshold associated with an increasing headcount may also be understood as the threshold associated with an increasing headcount ratio when developing world population growth is nil. The two reported thresholds therefore provide bounds within which must lie the threshold associated with the world headcount ratio when the entire world population is the denominator.

Further, the higher the assumed initial non-China-India poverty headcount (Tables 5-6, lower panels), the easier it becomes to conclude that world poverty has fallen between 1990 and 2001. If the number of poor outside China and India in 2001 were 729.5 million instead of CR's estimate of 486.3 million, then an increase in the non-China-India poverty headcount ratio of only 15 percent (or 4.5 percentage points) between 1990 and 2001 would be consistent with world poverty having increased, despite reductions in poverty in both India and China.

It is much easier to conclude that the number of poor persons in the world has increased than it is to conclude that the global share of poor people has increased due to increases in the population of the developing world in the period considered. As shown in Table 7, under some poverty scenarios for the regions considered, the total number of '$1/day poor' must be concluded to have increased during the 1990s even though there may have been reductions in the proportion of poor in China, India, and indeed, possibly outside China and India. This is because the increase in the population of the developing world gives rise to a cleavage between the two measures of the extent of poverty. For instance, we find that if the initial headcount ratio outside China and India was 30.62 percent rather than 20.41 percent (an assumption that is not implausible in light of evidence discussed further below), then reductions in poverty in both China and India as high as 10 percent are still consistent with the conclusion that the world poverty headcount has *increased*, so long as China's initial level of poverty was low (and therefore the country obtains a lower weight in the calculations) and India had the 'pessimistic' rate of poverty reduction (Table 7, lower panel).

What do current estimates tell us about the evolution of world poverty? How large is the departure from CR's estimate that is needed to arrive at the conclusion that world poverty actually increased during the 1990s? As noted, CR report a reduction between 1990 and 2001 in the $1/day poverty headcount ratio outside China and India from 20.14 percent to 18.29 percent , i.e., a decrease of 1.85 percentage points. If we assess poverty with the headcount ratio and assume that the non-China-India poverty rate is 20.14 percent (as estimated by CR), then the extent of world poverty could *not* have increased (since there are no ratios lower than one in Table 6). However, Table 7 shows that a low reduction in the non-China-India headcount ratio from 20.41 percent to an end-of-decade level higher than 18.91 percent is consistent with the number of '$1/day poor' having increased under some assumptions. Thus, a reduction in the non-China-India headcount ratio of less than 1.5 percentage points would be consistent with the number of '$1/day poor' having increased, even if we assume that CR's estimates for the beginning of the period are correct. Even a moderate error in CR's estimated rate of reduction could ensure this result.

The speculation that CR's non-China-India $1/day poverty estimate for 1990 is low may not be unreasonable, especially if we adopt the requirement that the international poverty line should be aligned with a norm of adequacy such as command over commodities needed to achieve basic human requirements (which is an interpretation often claimed on behalf of the $1/day international poverty line). In this connection it is informative to compare the (loosely) nutritionally based poverty estimates produced by the Economic Commission on Latin America (ECLAC, 2003) following the methodology of Altimir

(1979) with those produced by CR. As can be seen from this comparison (Table 8), Latin American poverty headcounts based on the ECLAC approach are substantially higher than those of CR in a number of countries. Moreover, the regional average reported by ECLAC is notably higher.

In 1990, the Latin America's poverty headcount was estimated by ECLAC to be 200 million (upper poverty line) and 93.5 million (lower poverty line) representing 46 percent of the population and 22 percent of the population respectively. In 2002, the region's poverty headcount was estimated to be 221 million (upper poverty line) and 95 million (lower poverty line) or 44 and 19 percent of the population, respectively (ECLAC, 2006). The discrepancies between estimates produced by the methodologies employed by ECLAC and by the World Bank draw attention to the uncertainties of interpretation and measurement attached to prevailing regional and global poverty estimates (Reddy and Pogge, 2006).[16]

Another conclusion which emerges from Tables 5-7 is that the threshold non-China-India headcount ratio is more sensitive to the assumptions made about China's poverty reduction experience than it is to the assumptions made about India's. This fact suggests the potential value of further research producing poverty estimates for China that are reliable and internationally comparable.[17]

Did $2/day poverty really fall?

For the $2/day international poverty threshold, the conclusions we draw are similar (Table 9). It is easiest to conclude that the $2/day world poverty headcount ratio has fallen if the initial non-China-India poverty headcount index is assumed to have been underestimated by CR, and if China is assumed to have made relatively little progress in reducing poverty. According to CR, the proportion of the $2/day poor outside China and India has remained virtually unchanged at approximately 46 percent. However, the global ratio has fallen in the 1990s from 60.8 percent to 52.9 percent. This poverty reduction must have been driven, therefore, by China and India. Table 9 (upper panel) demonstrates that to conclude that the $2/day poverty headcount ratio has increased globally it is necessary to hold that there has been an increase in the corresponding non-China-India poverty headcount ratio of at least 18 percent.

That global poverty has increased is again easiest to conclude when world poverty is assessed by employing the aggregate headcount. CR themselves report an *increase* between 1990 and 2001 in the number of '$2/day poor' from 2.65 billion to 2.74 billion. Table 9 (lower panel) shows that assuming an initial non-China-India poverty headcount ratio of 69.24 percent (instead of 46.16 percent), *reductions* in the non-China-India poverty ratio as large as 8-10 percent are consistent with increases in the number of poor worldwide.

[16] On which, see also footnote 10 above.
[17] See, in this regard, recent studies such as Chen and Ravallion (2007); Meng, Gregory and Wan (2007), and Zhang and Wan (2006).

4. Conclusions

In this paper we have scrutinized the claim that the proportion of poor (headcount ratio) and number of poor (aggregate headcount) in the world have fallen during the 1990s. We have drawn on the prevailing $1/day and $2/day international consumption poverty standards as starting points for our analysis but assumed that estimates of poverty we considered should be both meaningful and internationally comparable. Recognizing that there are uncertainties about what estimates of poverty in each country and region are most in accord with these criteria, we have examined the robustness of the conclusion that poverty has fallen to alternative plausible assumptions concerning the initial extent of poverty and subsequent poverty reduction experience in China, India and the rest of the developing world.

We found that under various assumptions, the proportion and the number of poor in the developing world have decreased in the 1990s. However, under other assumptions, the proportion and the number of poor in the developing world may have increased in the period. The magnitude of the increase or decrease in the extent of world poverty is crucially dependent on the assumptions made. The probability that there has been a relatively slow rate of reduction of poverty outside China and India, and especially in Latin America and sub-Saharan Africa, gives reason for concern that goals of reducing poverty will not be met in these regions, even if they are met globally.

Our results call for caution in coming to the conclusion that world poverty has fallen in the 1990s, and that global poverty reduction goals are on their way to being achieved, and point to the need for international investment in sound approaches to global poverty monitoring.

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APPENDIX

Table 1 China's $1/day Poverty headcount ratios

Scenario	Sets of underlying parameters		1990	2001
CR	$\left(PL_{INTERMEDIATE}, \pi_{off}\right)$[18]		33.0	16.6
RM (1)	θ_{NA}, π_{off}	$\left(PL_{LOW}, \hat{Y}_{NA}\right)$	13.2	4.9
RM (2)		$\left(PL_{HIGH}, \hat{Y}_{NA}\right)=\left(PL_{LOW}, \hat{Y}_{S}\right)$	50.8	23.0
RM (3)		$\left(PL_{HIGH}, \hat{Y}_{S}\right)$	88.0	54.0
RM (4)	θ_{S}, π_{adj}	$\left(PL_{HIGH}, \hat{Y}_{NA}\right)=\left(PL_{LOW}, \hat{Y}_{S}\right)$	32.3	6.1
RM (5)		$\left(PL_{HIGH}, \hat{Y}_{S}\right)$	75.1	31.9

Source: Chen and Ravallion (2004), Reddy and Minoiu (2006), and authors' estimations using POVCAL, Generalized Quadratic interpolation method.

Table 2 China's 1990 and 2001 consumption profiles

	1990	1992	1990 consumption profiles			2001 consumption profiles	
[1]	[2]	[3]	[4]	[4']	[5']	[6]	[7]
Income decile	income shares[19]	income shares	based on 1990 income shares 'least refined'	based on 1990 income shares 'most refined'	based on 1992 income shares 'most refined'	based on 2001 income shares 'least refined'	based on 2001 income shares 'most refined'
Poorest 10%	3.08	2.57	308.3	627.7	523.7	407.1	478.3
10%	4.25	3.6	425.4	666.9	564.9	646.8	585.1
10%	5.36	4.64	536.4	808.3	699.7	886.6	770.7
10%	6.49	5.73	649.5	925.8	817.4	1148.9	944.8
10%	7.65	6.95	765.6	1060.1	963.1	1438.4	1149.1
10%	8.97	8.34	897.7	1389.3	1291.7	1777.6	1587.2
10%	10.55	10.1	1055.9	1548.0	1482.0	2202.8	1863.3
10%	12.66	12.51	1267.0	1831.8	1810.1	2802.1	2337.3
10%	16.01	16.55	1602.3	2186.0	2259.7	3828.9	3013.8
Richest 10%	24.98	29.01	2500.1	2799.9	3251.6	7476.9	4831.2

Notes: Column [4] reports the 1990 consumption profiles corresponding to a 'least refined' and a 'most refined' set of underlying parameters. The least refined set of parameters include the national accounts consumption to income ratios (i.e., the share of total household expenditure in GDP) which is constant across the income deciles, as well as decile-constant official CPI). The most refined set of parameters are the survey-based shares of consumption in income, which vary across the income spectrum, and decile-specific adjusted CPIs. However, the set of consumption means presented in column [4'] cannot be used to estimate poverty with POVCAL due to a software failure (see footnote 6). Column [5'] reports the 'most refined' 1990 consumption profile constructed using the 1992 income shares and the 1990 per capita GDP. Columns [4] and [4'] are from Reddy and Minoiu (2006). Columns [5'], [6] and [7] contain authors' estimations using POVCAL, Generalized Quadratic method.

[18] $PPP_{INTERMEDIATE}$ refers to the World Bank default 1993 consumption PPP of 1.4185 Yuan/$ for China.

[19] Income shares are expressed as percentage of total income (estimated from that year's household survey).

Table 3 China's $2/day poverty headcount ratios

Scenario	Sets of underlying parameters		1990	2001
CR		$\left(PL_{INTERMEDIATE}, \pi_{off}\right)$	72.6	46.7
RM (1)*	θ_{NA}, π_{off}	$\left(PL_{INTERMEDIATE}, \pi_{off}\right)$	48.5	21.8
RM (2)*		$\left(PL_{HIGH}, \hat{Y}_{NA}\right) = \left(PL_{LOW}, \hat{Y}_{S}\right)$	86.9	52.4
RM (4)*	θ_{S}, π_{adj}	$\left(PL_{HIGH}, \hat{Y}_{S}\right)$	30.3	5.1
RM (5)*		$\left(PL_{HIGH}, \hat{Y}_{NA}\right) = \left(PL_{LOW}, \hat{Y}_{S}\right)$	73.3	30.4
RM (6)*		$\left(PL_{HIGH}, \hat{Y}_{S}\right)$	96.3	65.2

Source: Chen and Ravallion (2004), Reddy and Minoiu (2006), and authors' estimations using POVCAL, Generalized Quadratic interpolation method.

Table 4 India's $1/day Poverty headcount ratios

Scenario	1990 poverty headcount	Rate of poverty reduction	1990	2001
I (1)	CR	Optimistic: 50 percent	42.1	21.05
I (2)		Pessimistic: 10 percent	42.1	37.89
I (3)	Based on 1993/94 official headcount ratio (thick round) adjusted to accord with international poverty line	Optimistic: 50 percent	40.0	20.0
I (4)		Pessimistic: 10 percent	40.0	36.0
I (5)	Based on 1990/91 official headcount ratio (thin round) and national poverty line	Optimistic: 50 percent	35.11	17.56
I (6)		Pessimistic: 10 percent	35.11	31.06

Source: Chen and Ravallion (2004) and authors' assumptions drawn from the literature.

Determining the maximum 2001 poverty rate outside China and India which is consistent with the hypothesis that world poverty has not increased between 1990 and 2001

Denote the headcount ratios by θ and the size of the population (indexed by *t* for the world, *i* for India and *C* for China) by *P*.

The global poverty headcount ratio has not decreased between 1990 (θ_{world1}) and 2001 (θ_{world2}) if $\theta_{world1} \leq \theta_{world2}$. This is equivalent to writing:

$$\frac{\theta_{C1}P_{C1} + \theta_{i1}P_{i1} + \theta_{nci1}P_{nci1}}{P_{t1}} \leq \frac{\theta_{C2}P_{C2} + \theta_{i2}P_{i2} + \theta_{nci2}P_{nci2}}{P_{t2}}$$

$$\Rightarrow \frac{P_{t2}}{P_{t1}}(\theta_{C1}P_{C1} + \theta_{i1}P_{i1} + \theta_{nci1}P_{nci1}) \leq (\theta_{C2}P_{C2} + \theta_{i2}P_{i2} + \theta_{nci2}P_{nci2})$$

$$\Rightarrow \theta_{nci2}P_{nci2} \geq \frac{P_{t2}}{P_{t1}}(\theta_{C1}P_{C1} + \theta_{i1}P_{i1} + \theta_{nci1}P_{nci1}) - \theta_{i2}P_{i2} - \theta_{C2}P_{C2}$$

$$\Rightarrow \theta_{nci2}P_{nci2} \geq \theta_{nci1}P_{nci1}\frac{P_{t2}}{P_{t1}} + \left[\theta_{C1}P_{C1}\frac{P_{t2}}{P_{t1}} - \theta_{C2}P_{C2}\right] + \left[\theta_{i1}P_{i1}\frac{P_{t2}}{P_{t1}} - \theta_{i2}P_{i2}\right]$$

$$\Rightarrow \theta_{nci2} \geq \theta_{nci1}\frac{P_{nci1}}{P_{nci2}}\frac{P_{t2}}{P_{t1}} + \left[\theta_{C1}\frac{P_{C1}}{P_{nci2}}\frac{P_{t2}}{P_{t1}} - \theta_{C2}\frac{P_{C2}}{P_{nci2}}\right] + \left[\theta_{i1}\frac{P_{i1}}{P_{nci2}}\frac{P_{t2}}{P_{t1}} - \theta_{i2}\frac{P_{i2}}{P_{nci2}}\right] \quad (*)$$

The global poverty aggregate headcount has not decreased between 1990 (θ_{world1}) and 2001 (θ_{world2}) if $\theta_{world1}P_{t1} \leq \theta_{world2}P_{t2}$. This is equivalent to writing:

$$\theta_{C1}P_{C1} + \theta_{i1}P_{i1} + \theta_{nci1}P_{nci1} \leq \theta_{C2}P_{C2} + \theta_{i2}P_{i2} + \theta_{nci2}P_{nci2}$$

$$\Rightarrow \theta_{nci2}P_{nci2} \geq (\theta_{C1}P_{C1} + \theta_{i1}P_{i1} + \theta_{nci1}P_{nci1}) - \theta_{i2}P_{i2} - \theta_{C2}P_{C2}$$

$$\Rightarrow \theta_{nci2}P_{nci2} \geq \theta_{nci1}P_{nci1} + \left[\theta_{C1}P_{C1} - \theta_{C2}P_{C2}\right] + \left[\theta_{i1}P_{i1} - \theta_{i2}P_{i2}\right]$$

$$\Rightarrow \theta_{nci2} \geq \theta_{nci1}\frac{P_{nci1}}{P_{nci2}} + \left[\theta_{C1}\frac{P_{C1}}{P_{nci2}} - \theta_{C2}\frac{P_{C2}}{P_{nci2}}\right] + \left[\theta_{i1}\frac{P_{i1}}{P_{nci2}} - \theta_{i2}\frac{P_{i2}}{P_{nci2}}\right] \quad (**)$$

Inequality (**) can be obtained from (*) by setting $\frac{P_{t2}}{P_{t1}} = 1$.

Results (Poverty Line: $1/day; Indicator of world poverty: headcount ratio)

Table 5. Smallest non-China-India poverty headcount ratios in 2001 consistent with the conclusion that global poverty (expressed as % '$1/day poor') has increased

Assumption:		Minimum 2001 % poor outside China and India consistent with an increase in global % of poor					
	India →	I (1)	I (2)	I (3)	I (4)	I (5)	I (6)
the non-China-India 1990 poverty headcount ratio is correct: 20.41 percent	**China ↓**						
	RM (1)	31.32%	25.23%	30.96%	25.18%	30.13%	25.05%
	CR	35.41%	29.32%	35.05%	29.27%	34.22%	29.14%
	RM (4)	39.75%	33.67%	39.40%	33.61%	38.56%	33.49%
	RM (2)	40.92%	34.83%	40.56%	34.78%	39.72%	34.65%
	RM (3)	44.59%	38.50%	44.23%	38.44%	43.39%	38.32%
	RM (5)	48.37%	42.28%	48.01%	42.23%	47.17%	42.10%

Assumption:		Minimum 2001 % poor outside China and India consistent with an increase in global % of poor					
	India →	I (1)	I (2)	I (3)	I (4)	I (5)	I (6)
the non-China-India 1990 poverty headcount ratio is 15.31 % instead of 20.41%	**China ↓**						
	RM (1)	26.29%	20.20%	25.93%	20.15%	25.10%	20.02%
	CR	30.38%	24.29%	30.02%	24.24%	29.19%	24.11%
	RM (4)	34.73%	28.64%	34.37%	28.58%	33.53%	28.46%
	RM (2)	35.89%	29.80%	35.53%	29.75%	34.70%	29.62%
	RM (3)	39.56%	33.47%	39.20%	33.42%	38.36%	33.29%
	RM (5)	43.34%	37.25%	42.98%	37.20%	42.14%	37.07%

Assumption:		Minimum 2001 % poor outside China and India consistent with an increase in global % of poor					
	India →	I (1)	I (2)	I (3)	I (4)	I (5)	I (6)
the non-China-India 1990 poverty headcount ratio is 30.62 % instead of 20.41%	**China ↓**						
	RM (1)	41.38%	35.29%	41.02%	35.24%	40.19%	35.11%
	CR	45.47%	39.38%	45.11%	39.33%	44.27%	39.20%
	RM (4)	49.81%	43.73%	49.45%	43.67%	48.62%	43.54%
	RM (2)	50.98%	44.89%	50.62%	44.84%	49.78%	44.71%
	RM (3)	54.64%	48.56%	54.29%	48.50%	53.45%	48.37%
	RM (5)	58.42%	52.34%	58.07%	52.28%	57.23%	52.16%

Table 6. Smallest factor increases in the non-China-India headcount ratio during the 1990s consistent with the conclusion that global poverty (expressed as the # of '$1/day poor') has increased

Assumption: the non-China-India 1990 poverty headcount ratio is correct: 20.41 percent		Minimum increase in % of poor outside China and India in the 1990s consistent with an increase in global % of poor					
	India →	I (1)	I (2)	I (3)	I (4)	I (5)	I (6)
	China ↓						
	RM (1)	1.53	1.24	1.52	1.23	1.48	1.23
	CR	1.73	1.44	1.72	1.43	1.68	1.43
	RM (4)	1.95	1.65	1.93	1.65	1.89	1.64
	RM (2)	2.00	1.71	1.99	1.70	1.95	1.70
	RM (3)	2.18	1.89	2.17	1.88	2.13	1.88
	RM (5)	2.37	2.07	2.35	2.07	2.31	2.06

Assumption: the non-China-India 1990 poverty headcount ratio is 15.31 % instead of 20.41%		Minimum increase in %of poor outside China and India in the 1990s consistent with an increase in global % of poor					
	India →	I (1)	I (2)	I (3)	I (4)	I (5)	I (6)
	China ↓						
	RM (1)	1.72	1.32	1.69	1.32	1.64	1.31
	CR	1.98	1.59	1.96	1.58	1.91	1.58
	RM (4)	2.27	1.87	2.25	1.87	2.19	1.86
	RM (2)	2.34	1.95	2.32	1.94	2.27	1.93
	RM (3)	2.58	2.19	2.56	2.18	2.51	2.17
	RM (5)	2.83	2.43	2.81	2.43	2.75	2.42

Assumption: the non-China-India 1990 poverty headcount ratio is 30.62 % instead of 20.41%		Minimum increase in % of poor outside China and India in the 1990s consistent with an increase in global % of poor					
	India →	(I1)	(I2)	(I3)	(I4)	(I5)	(I6)
	China ↓						
	RM (1)	1.35	1.15	1.34	1.15	1.31	1.15
	CR	1.49	1.29	1.47	1.28	1.45	1.28
	RM (4)	1.63	1.43	1.62	1.43	1.59	1.42
	RM (2)	1.67	1.47	1.65	1.46	1.63	1.46
	RM (3)	1.78	1.59	1.77	1.58	1.75	1.58
	RM (5)	1.91	1.71	1.90	1.71	1.87	1.70

Results (Poverty Line: $1/day; Indicator of world poverty: aggregate headcount)

Table 7. Smallest factor increases in the non-China-India headcount ratio during the 1990s consistent with the conclusion that global poverty (expressed as the # of '$2/day poor') has increased

Minimum increase in the % poor outside China and India in the 1990s consistent with an increase in global # of poor

Assumption: the non-China-India 1990 poverty headcount ratio is 20.41 percent

India → / **China ↓**	I (1)	I (2)	I (3)	I (4)	I (5)	I (6)
RM (1)	1.22	0.93	1.21	0.93	1.18	0.94
CR	1.36	1.06	1.34	1.06	1.32	1.07
RM (4)	1.56	1.26	1.55	1.27	1.52	1.27
RM (2)	1.57	1.27	1.56	1.28	1.53	1.28
RM (3)	1.61	1.31	1.60	1.31	1.57	1.32
RM (5)	1.84	1.54	1.83	1.55	1.80	1.55

Minimum increase in the % poor outside China and India in the 1990s consistent with an increase in global # of poor

Assumption: the non-China-India 1990 poverty headcount ratio is 15.31 % instead of 20.41%

India → / **China ↓**	I (1)	I (2)	I (3)	I (4)	I (5)	I (6)
RM (1)	1.35	0.96	1.34	0.96	1.30	0.97
CR	1.53	1.13	1.51	1.13	1.48	1.14
RM (4)	1.80	1.41	1.79	1.41	1.75	1.42
RM (2)	1.82	1.42	1.80	1.42	1.76	1.43
RM (3)	1.87	1.47	1.85	1.48	1.82	1.48
RM (5)	2.18	1.78	2.16	1.78	2.12	1.79

Minimum increase in the % poor outside China and India in the 1990s consistent with an increase in global # of poor

Assumption: the non-China-1990 poverty headcount ratio is 30.62 % instead of 20.41%

India → / **China ↓**	I (1)	I (2)	I (3)	I (4)	I (5)	I (6)
RM (1)	1.09	0.90	1.09	0.90	1.07	0.90
CR	1.18	0.98	1.17	0.98	1.15	0.99
RM (4)	1.32	1.12	1.31	1.12	1.29	1.13
RM (2)	1.32	1.13	1.32	1.13	1.30	1.13
RM (3)	1.35	1.15	1.34	1.15	1.32	1.16
RM (5)	1.51	1.31	1.50	1.31	1.48	1.31

Table 8. ECLAC and World Bank poverty headcount ratio estimates for Latin America

	World Bank POVCALNET		ECLAC		
Country	Year	$1/day poverty line	Year	Upper poverty line	Lower poverty line
Brazil	1990	14.04	1990	41	18
Chile	1989	4.92	1990	33	11
Colombia	1991	2.82	1991	50	23
Costa Rica	1990	5.24	1990	24	10
El Salvador	1995	25.05	1995	48	19
Guatemala	1987	47.04	1986	68	43
Honduras	1990	37.83	1990	75	54
Mexico	1992	15.77	1989	39	14
Panama	1991	11.81	1991	36	16
Peru	1985.5	1.14	1986	52	25
Venezuela	1989	2.97	1990	34	12
Latin America	**1990**	**11.89**	**1990**	**41**	**18**

Source: ECLAC (2003) and World Bank POVCALNET[20] (based on methodology of Chen and Ravallion, 2001).

Notes: The table includes estimates of the share of poor for two nutritionally-based poverty lines: an upper and a lower poverty line (obtained using the methodology developed by Altimir, 1979). Only those countries for which the poverty headcount ratios are reported by ECLAC for a year that is within five years of 1990 are included in the table.

[20] POVCALNET poverty estimates were retrieved on April 1, 2007.

Results (Poverty Line: $2/day; Indicator of world poverty: headcount ratio)

Table 10. Smallest 2001 headcount ratios and smallest factor increases in non-China-India poverty rates during the 1990s consistent with the conclusion that global poverty (expressed as the % and number of '$2/day poor') has increased

Global poverty indicator: % poor	Minimum 2001 % poor outside China and India consistent with an increase in global % of poor			Minimum increase in the % poor outside China and India in the 1990s consistent with an increase in the global % of poor		
Assumption: the non-China-India 1990 poverty headcount ratio is →	0.75*46.16%	46.16%	1.5*46.16%	0.75*46.16%	46.16%	1.5*46.16%
China ↓						
RM (4)*	47.46%	58.83%	81.58%	1.37	1.27	1.18
RM (1)*	48.57%	59.95%	82.69%	1.40	1.30	1.19
CR	48.80%	60.18%	82.92%	1.41	1.30	1.20
RM (6)*	51.70%	63.07%	85.82%	1.49	1.37	1.24
RM (2)*	52.98%	64.35%	87.10%	1.53	1.39	1.26
RM (5)*	56.39%	67.76%	90.51%	1.63	1.47	1.31

Global poverty indicator: # poor	Minimum 2001 % poor outside China and India consistent with an increase in global # of poor			Minimum increase in the % poor outside China and India in the 1990s consistent with an increase in the global # of poor		
Assumption: the non-China-India 1990 poverty headcount ratio is →	0.75*46.16%	46.16%	1.5*46.16%	0.75*46.16%	46.16%	1.5*46.16%
China ↓						
RM (4)*	33.66%	43.28%	62.53%	0.97	0.94	0.90
RM (1)*	34.84%	44.46%	63.71%	1.01	0.96	0.92
CR	35.17%	44.79%	64.04%	1.02	0.97	0.92
RM (6)*	35.37%	45.00%	64.24%	1.02	0.97	0.93
RM (2)*	36.80%	46.43%	65.68%	1.06	1.01	0.95
RM (5)*	41.19%	50.82%	70.07%	1.19	1.10	1.01