HOW *NOT* TO COUNT THE POOR

Sanjay G. Reddy[1] and Thomas W. Pogge[2]

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Abstract:

The estimates of the extent, distribution and trend of global income poverty provided in the World Bank's World Development Reports for 1990 and 2000/01 are neither meaningful nor reliable. The Bank uses an arbitrary international poverty line unrelated to any clear conception of what poverty is. It employs a misleading and inaccurate measure of purchasing power "equivalence" that creates serious and irreparable difficulties for international and inter-temporal comparisons of income poverty. It extrapolates incorrectly from limited data and thereby creates an appearance of precision that masks the high probable error of its estimates. The systematic distortion introduced by these three flaws likely leads to a large understatement of the extent of global income poverty and to a false appearance of its decline. A new methodology of global poverty assessment is feasible and necessary.

[1] Dept. of Economics, Barnard College, Columbia University: sr793@columbia.edu

[2] Dept. of Philosophy, Columbia University: tp6@columbia.edu.

[3] The latest version of the paper, along with a précis in non-technical form, and our responses to attempted defenses of the World Bank's approach to measuring global income poverty, will be made available on www.socialanalysis.org.

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1.0 *Introduction:*

How many poor people are there in the world?[4] This simple question is surprisingly difficult to answer.

In the 1990 World Development Report, and subsequently in the 2000/01 World Development Report (henceforth WDR), the World Bank (henceforth Bank) has presented groundbreaking comprehensive estimates of the number of poor people in the world as a whole, and in its regions, in different years. These estimates have been widely accepted and employed, for a range of policy analyses and assessments.[5]

Among the questions that the figures for global income poverty produced by the Bank have been used to answer is whether the world is "on the right track" in terms of poverty reduction strategy. A primary conclusion of WDR 2000/01 is that the world is indeed on the right track. Others have drawn similar conclusions from the reported data. Consider for example, the following statement by James D. Wolfensohn, the Bank's President:

"Over the past few years, [these] better policies have contributed to more rapid growth in developing countries' per capita incomes than at any point since the mid-1970s. And faster growth has meant poverty reduction: the proportion of people worldwide living in absolute poverty has dropped steadily in recent decades, from 29% in 1990 to a record low of 23% in 1998." [Remarks to the G-20 Finance Ministers and Central Governors, Ottawa, November 17, 2001, available on www.worldbank.org/html/extdr/extme/jdwsp111701.htm].

The estimates of the number of poor people in the world also influence assessments of the seriousness of the problem of world poverty, the scale of resources that should be devoted to reducing it, and the regions to which these resources should be directed. WDR 2000/01 argues, for example, that the largest number of the world's poor are now in Africa rather than in South Asia. The questions of how many poor people there are in the world, how poor they are, where they live, and how these facts are changing over time are clearly very important ones. The Bank's estimates of global income poverty are influential not only because of their importance and usefulness, but because the Bank is currently the sole producer of such estimates.[6]

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[5] The authors of these studies must be credited with laboring valiantly against the odds of limited data and resources to produce the first estimates of global income poverty. It is only because of the existence of this extensive effort that we are able to argue today that it is necessary to move beyond it.

[6] In two recent unpublished papers, "The Disturbing 'Rise' of Global Income Inequality" and "The

This paper argues that the Bank's estimates of the level, distribution and trend of global poverty should not be accepted. These estimates are flawed due to three related but distinct types of significant conceptual errors, which make it impossible to use them to identify with any reasonable accuracy the level, distribution or trend of global poverty. The first type of error involves the failure to define a global poverty line that corresponds to a clear underlying conception of poverty, so as to allow identification of the commodities that must be commanded in order to avoid being poor. The second type of error involves the failure to employ purchasing power parity factors that permit meaningful and accurate identification of the national currency equivalents of the global poverty line, and of changes in their value through time. The third type of error involves the building into the methods used of false precision and mistaken inferences, in the face of data limitations. These three types of error together lead to the likelihood of substantial distortions in estimates of global poverty. It is impossible to identify precisely the extent and direction of the gap between the Bank's estimates and those that would have been yielded by a sounder methodology. Simple estimation procedures *suggest* however that the biases may be very substantial, and may have led to a substantial underestimation of the extent of world poverty. Moreover, these errors may also have led to false claims about downward trends in global income poverty. In particular, for various reasons outlined below, growth in incomes of the non-poor throughout the world may have led to mistaken inferences that global income poverty has fallen.

It is not difficult to describe a methodology for assessing global poverty that would inspire substantially greater confidence. A sound methodology may not require significantly greater effort or resources than that actually expended in producing current estimates. The current estimates should no longer be employed, and new ones corresponding to a defensible methodology, covering past as well as current years, should be generated. Income poverty is only one aspect of poverty, and other poverty estimates, based on under-nutrition, infant mortality, access to health services, and other indicators can continue to inform us even in the absence of usable figures concerning global income poverty. International development targets should appropriately continue to focus on these measures of deprivation in the world, while a new procedure for the global assessment of income poverty is developed and implemented.

2.0 *An Ill-Defined Poverty Line*:

The procedure normally used in national exercises of poverty assessment is to define a poverty line in terms of the cost of meeting a set of minimal criteria. These minimal criteria are most often defined in terms of access to some set of basic (for example, nutritional) capabilities or of

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World Distribution of Income (estimated from Individual Country Distributions)" Xavier Sala-i-Martin (see www.columbia.edu/~xs23/papers/GlobalIncomeInequality.htm and www.columbia.edu/~xs23/papers/WorldDistribution.htm) has produced a set of estimates of global income poverty. His methodology, however, involves applying the World Bank's $1 (and $2) a day poverty lines at 1985 PPPs to a world income distribution profile generated using country GDP data converted at PPPs, and is therefore subject to almost all of objections we make to the World Bank's estimates of global poverty.

commodities that generate such capabilities. The commodity requirements specified in this way can in principle be allowed to vary across groups of persons (defined for instance by age, gender, and other factors). Procedures of this general kind have the advantage that, once fixed, they offer a consistent basis for determining the level of the poverty line across time and space. Of course, they also face difficulties. When specified too rigidly, a commodity-specification approach may fail to take note of the substitution possibilities available to the poor when prices change, which may enable them to escape poverty at *lower* incomes than suggested by updating the cost of a fixed bundle.[7] Such approaches may also fail to account for the fact that escaping poverty may require *additional* commodity resources when a society becomes more prosperous.[8] A capability approach seeks to take account not only of people's command over commodities, but also of their diverse needs, handicaps, and endowments. It must therefore find a plausible way of gathering and integrating such information. Despite these difficulties, the approach of defining a poverty line in terms of the resources necessary to gain access to a fixed set of commodities or capabilities offers a feasible methodology for consistent poverty assessment across time and space, and for this reason has been widely employed.

The methodology pursued by the Bank in its landmark 1990 and 2000/01 global poverty assessment exercises does not correspond to such a procedure. In 1990, the Bank constructed a global poverty line from a set of official domestic poverty lines for thirty three countries surveyed during the mid 1980s as follows: These official domestic poverty lines were scaled upward or downward by changes in the national consumer price index to their "equivalent" in 1985 national currency units. These 1985 national currency units were then converted into a common unit of "real purchasing power" equivalence using the 1985 purchasing power parity conversion factors for consumption (expressed in US dollars) calculated by Summers and Heston (1988a). A global poverty line of $31 per month was chosen on the basis that the official domestic poverty lines of eight of the poorer countries in the sample, converted in to dollars in this way, were very close to it.[9] This "most typical" poverty line became the "$1 (PPP 1985) a day" (actually $1.02 PPP 1985) global poverty line applied in WDR 1990 (and subsequently revised downward, without justification, to $1 in Chen et al. (1994) and later poverty measurement work). This uniform poverty line was then converted to the national currency units of different countries using the Penn World Tables (Summers and Heston) PPP conversion factors for 1985. The resulting poverty line was then inflated or deflated as appropriate by changes in the national consumer price index (as reported in the IMF International Financial Statistics) and applied to household survey data to create a measure of the number of poor persons in a country in a particular year.

For the 2000 poverty estimation exercise, the Bank established a new poverty line. For the same list of 33 countries used earlier, the Bank identified the ten countries with the now lowest

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[7] See for example Jorgenson and Slesnick (1999).

[8] For the idea that poverty is best conceived as relative in the space of commodities but absolute in the space of capabilities see e.g. Sen (1984).

[9] "A...representative, absolute poverty line for low income countries is $31, which (to the nearest dollar) is shared by six of the countries in our sample, namely Indonesia, Bangladesh, Nepal, Kenya, Tanzania, and Morocco, and two other countries are close to this figure (Philippines and Pakistan)" [Ravallion, Datt and van de Walle (1991)].

poverty lines when converted to $ PPP 1993 using PPP conversion factors for consumption, and chose the median of these poverty lines — $1.08 1993 per day — as its new poverty line. No justification has been offered for this change.[10] The 33 countries and their official poverty lines expressed in both 1985 and 1993 PPP dollars, as identified by the World Bank, are listed in Table 1.

Is the new poverty line "higher" or "lower" than the old one? This is a difficult question to answer, as PPP dollars corresponding to different years are not in any way comparable (as will be discussed below). WDR (2000/01) claims that "This [new $1.08 1993] line has a similar purchasing power to the $1 a day line in 1985 PPP prices, in terms of the command over domestic goods" (p.17). This claim is repeated in Chen and Ravallion (2001).[11] However, as PPP units in different years are non-comparable, this claim has no discernible meaning. Chen and Ravallion (2001) offer as justification for their claim the observation that aggregate world poverty is approximately the same for the most recent common year (1993) in which both methodologies were applied.[12] In offering this fact as a justification for the ostensible "equivalence" of the new poverty line with the old they make a serious conceptual error. It is easily recognized on reflection that it is possible, when employing *any* reasonable[13] method of poverty assessment, to define an international poverty line that is just high enough to yield whatever rate of poverty incidence one wishes to match (because it had resulted from a method previously used). There will *necessarily* be some level of the international poverty line as calculated by the new method at which the aggregate number of poor people will be equal to the number previously estimated by the old method. Such coinciding results, easily achievable

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[10] It is also not made clear whether the new domestic poverty lines were derived from a fresh survey of official poverty lines, or were simply based on updating the earlier domestic poverty lines by changes in the national consumer price index or other means.

[11] In describing the relationship between the two poverty lines, the Bank's note entitled "Details on the methodology for global income poverty estimates" [posted on its PovertyNet website] declares "This year, the same lines [as used in 1990] were converted in [sic] 1993 PPP prices, and the new line was obtained as the average [the median was actually used] of the ten lowest poverty lines. …The line obtained is $1.08 per day in 1993 PPP terms...This methodology maintains the purchasing power of the line constant [sic] while changing the reference prices." As argued below, this statement has no basis whatever, as there is no well-defined procedure for "converting" between PPP dollars in the two years.

[12] The authors' preferred way "to compare the two poverty lines is to compare the implied aggregate poverty rates for the same year" (Chen and Ravallion 2001, 288). They do admit a small change due to the shift in methodology: "When we compare the most recent common year (1993) we get approximately the same poverty rate as we found in Ravallion and Chen (1997) using $1/day at 1985 PPP; the old poverty rate for 1993 was 29.4% versus 28.2% using the new poverty line for 1993" (ibid. 290; these percentages refer to the total number of persons in the developing countries, which in 1993 was 4,633 million). It is worth noting that the implied 4 percent purely methodological reduction in the poverty headcount reduces the number of persons the Bank considers poor by 55.6 million. This is rather a substantial achievement compared to the reported actual reduction in the number of very poor people: Over the entire 1987-98 period, the number of persons living on less than $1.08 a day (PPP 1993) reportedly declined by 8.05 million — from 1183.19 to 1175.14 million (ibid.)!

[13] That is, in which the poverty incidence increases monotonically with the poverty line.

between *any* pair of methods whatever, do not therefore show two methods to have any particular consistency with each other, nor do they provide *any* reason to believe that either of the methods are at all appropriate for assessing the purchasing power of the poor.

Chen and Ravallion (2001, 291) admit that the change in methodology results in a drastic shift in the regional composition of the poor, so that even where the same data are employed (as in their estimates for 1993) the number of poor in South Asia falls significantly and that in Sub-Saharan Africa rises significantly. The extent of change in poverty that can be associated purely with methodological change is demonstrated in Tables 2 and 3, which compare cases in which estimates employing both old and new methodologies are available. In Table 2 this comparison is exact as both methodologies are applied to estimate poverty from an identical household survey. Changes in poverty that result here may therefore be referred to as *purely methodological poverty revisions*. We cite here all the instances (17 in total) for which we have been able to find publicly available estimates employing both methodologies. In contrast, Table 3 compares estimates derived from household surveys for the same country at two points in time. In these cases, the old methodology was applied to an earlier survey and the new methodology to a later survey. Here large differences in poverty are only *suggestive* (though often strongly so) of the scale and significance of methodological poverty revision, as the possibility of significant real changes in the economic circumstances of the poor between the two survey dates, or significant sampling error, cannot be ruled out. However, these possibilities seem unlikely, especially in the numerous cases where poverty varies greatly over brief time spans between survey dates. Finally, Table 4 outlines the dramatic changes in the head count indices of poverty for different regions of the world brought about by the shift in the Bank's methodology, as revealed by comparison of its own published estimates. The purely methodological changes for entire regions are quite large. Large changes in poverty headcounts due solely to the methodological shift suggest the great sensitivity of poverty assessments (for countries, regions, and the world as a whole) to details of the Bank's global poverty measurement methodology.

An alternative approach to judging the claim that the new poverty line maintains "a similar purchasing power...in terms of the command over domestic goods" is to compare the level of the original poverty line as updated by national consumer price changes with that of the new poverty line expressed in terms of national currencies. We carried out this exercise and show the result in Table 5. As is evident from the table, the results of updating the original poverty line (as expressed in national currencies) to the year in which the new poverty line is defined can lead to rather different results from that of translating the new poverty line into national currencies. The updated old poverty line is as much as 30 percent lower than the new poverty line (Nigeria) and as much as 157 percent higher than is the new poverty line (Mauritania). The implications of these discrepancies are variously to raise the estimate of poverty (Nigeria) or to lower it (Mauritania). The wild discrepancies involved seem difficult to reconcile with the suggestion of Chen and Ravallion (2001) that the new methodology maintains the same real level of purchasing power implicit in poverty lines as does the old.

A final issue is the failure to define a clear underlying conception of poverty (specified for instance in terms of elementary capabilities) that would allow identification of the commodities that must be commanded in order to avoid being poor. Without such a conception, it is difficult to determine whether even changes in the general consumer price index within countries

adequately capture the increases in income that are necessary to avoid poverty. For instance, in the United States the consumer price index has increased by 34.3 percent in the period between 1985 and 1993 (www.bls.gov/cpi/home.htm). If for the moment we admit the purchasing power interpretation of PPPs then in some given (base) year $1 PPP is deemed equivalent in "purchasing power" to $1 US. Since the poverty line has only been adjusted upward by 8 percent in this period, the hypothesis that this poverty line maintains a constant level of purchasing power for the poor entails that there has been a 20 percent decline in the price of commodities consumed at the poverty line relative to prices in general. However, it is conceptually (and therefore practically) *impossible* to determine whether such a relative decline has occurred, and to what extent, if there is no specification of the goods that must be commanded in order to avoid being poor (as there is not in the framework used by the Bank). As a result, the claim that the new poverty line "maintains" the purchasing power of the old is *entirely* unverifiable and without justification.

3.0 *A Misleading and Inaccurate Measure of Purchasing Power "Equivalence"*

What does determining equivalent purchasing power require?[14] The most obvious way of establishing a concept of equivalent purchasing power is to fix a *reference bundle* of commodities (or, more generally, the characteristics of commodities).[15] The costs of purchasing this reference bundle in different countries in national currency units at the prevailing local prices then establish a set of ratios that may be called *purchasing power parities* (PPPs). The PPP for a country is usually defined in terms of a number of units of a country's currency per unit of the currency of a base country. It is usually interpreted (misleadingly, as we shall argue below) as a conversion factor identifying the number of units of a nation's currency necessary to purchase the same amount of commodities as can be purchased in the base country at the base country's prices. This fundamental concept of purchasing power parity is that which underlies applications.[16]

It is important to note here that there cannot be one set of PPPs that is appropriate for all purposes. As Rogoff (1996) notes: "Ultimately, there is no 'right' PPP measure; the appropriate variation of PPP depends on the application." The reference basket that corresponds to the consumption of corporate executives will for instance be different from that which corresponds

[14] When nearing completion for this research, we came across two short, thoughtful research notes by Michael Lipton and Shahin Yaqub that contain a few of the insights we have developed further here regarding the importance of PPPs in global poverty assessment. The issue is also noted although not fully explored by Deaton (2000).

[15] An alternative (that is more sophisticated in at least one respect) that is sometimes employed is to identify the maintenance of real purchasing power with a constant level of utility (although in principle any other concept of well-being, such as capabilities, could also be used).

[16] An example is the Economist's 'Big Mac' PPP index, which treats the components of a 'Big Mac' as the relevant reference basket.

to individuals on the threshold of poverty and in turn will be different from that which represents the composition of a typical unit of military expenditures. Each of these reference baskets, appropriate to hold in mind when asking distinct questions, will give rise to a distinct set of PPPs.

Despite the clarity of the concept that PPPs are intended to capture, the widely used PPP estimates do not directly correspond to it. They do not in fact estimate the relative costs across countries of *any* fixed reference consumption bundle. The reasons for this derive from the complexity of international comparisons and from the dominant motivational basis for undertaking such comparisons. Differences in expenditure patterns across countries substantially complicate the identification of a common reference basket [Vachris and Thomas, 1999]. Moreover, the primary motivation for constructing PPPs has been to produce comparisons of aggregate real national income rather than to compare living standards or to permit comparative assessment of poverty and income distribution. Considerations of whether PPP estimation methods permit consistent inter-country orderings (obeying such properties as transitivity, base-country invariance, and 'fixity' of rank orderings[17]) have therefore been of greater interest than considerations of whether they permit an accurate and robust basis for comparison of individuals' living standards, especially at the most basic level of well-being.[18] Despite their limited appropriateness to the task of poverty assessment, PPPs resulting from these methods have widely been employed for this purpose.

A measure of "real" or purchasing power equivalence is an inescapable requirement of an exercise of absolute poverty assessment, as such an exercise must identify the level of resources required to establish command over some set of necessary goods. This is not to deny that exchange rate incomes may also be relevant to assessing how poor people are in certain contexts. Differences in exchange rate incomes are an important determinant of how much more power wealthy people have compared to poor people in the world economy (we can think of exploitative forms of tourism and other such examples). However, we abstract from this issue here and focus (as does the Bank) on the adequacy of domestic incomes to establish command over the domestically available commodities necessary to avoid absolute poverty.

3.1 *Inappropriate Informational Bases and Methods of Aggregation:*

All of the available methods for calculating PPPs suffer from a set of *common* problems when applied to absolute poverty assessment. These common problems arise from a *single* source, which is the *lack of an appropriate focus* in their informational base. The fundamental problem of an inappropriately focused informational base is compounded by a second common problem, which is that even the available information is *aggregated* in a manner that is inappropriate to the task of absolute poverty assessment. In short, currently available PPPs are inappropriate for measuring absolute poverty because they draw *too much* on information that is irrelevant and *too little* on information that is relevant to this particular *task*.

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[17] This refers to the property that rank orderings of countries are maintained when the procedure for PPP estimation is applied only to a proper subset of the countries.

[18] On the former set of concerns see for instance Diewert (1990).

Problems that arise as a result:

The problems that arise from using PPPs derived from current methods in a poverty assessment exercise may be classified as follows:

(1) Vague Referent: Available PPPs do not refer clearly to any commodity basket or even a composite of commodity baskets with respect to which they identify purchasing power. In Appendix 1, we state and prove a theorem regarding PPP calculation methods. The theorem states that it is generally *impossible* to interpret purchasing power parities derived from current methods as identifying the costs in the different countries of the world of purchasing *any* single basket of commodities (including one that is a composite of demand in different countries). This means that statements to the effect that purchasing power parities reflect the relative costs of purchasing goods and services in different countries are without a conceptual foundation.[19]

It follows that existing PPPs are generally inappropriate for identifying the real incomes of poor households, and hence the incidence of absolute poverty.[20] The theorem further suggests that the *only* way to avoid this problem is to *start* from a particular reference basket of commodities and to construct PPPs that accurately reflect the relative costs of purchasing *this* basket in different countries.[21] This procedure is exactly what we recommend be undertaken in the future in order to produce meaningful poverty estimates.

(2) Inappropriate Referent: To the extent that available PPPs refer to a set of commodities (which they do at *most* vaguely), they refer to the *wrong* one from the standpoint of poverty assessment. This is because existing methods for calculating PPPs involve aggregating information on the quantities of a wide variety of commodities demanded in different countries and the (explicit or implicit) prices at which these commodities are exchanged there. As such, PPPs from existing methods reflect quantities and prices that have no relevance to absolute poverty assessment. PPPs from existing methods are influenced by *irrelevant* information in the following ways, among others:

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[19] The following statement is illustrative: "PPPs measure the relative purchasing power of different currencies over equivalent goods and services. They are international price indexes that allow comparisons of the real value of consumption expenditures between countries in the same way that consumer price indexes allow comparisons of real values over time within countries…The resulting PPP indexes measure the purchasing power of national currencies in 'international dollars' that have the same purchasing power over GDP as the US dollar has in the United States" [Notes to Table 4.10, World Bank World Development Indicators 1998].

[20] Arguably, PPPs produced in this way are a *less* inappropriate way to produce comparisons of the aggregate level of real national income, as such an exercise relies more heavily on the creation of a common metric for measuring the national aggregates than it does on the interpretation that PPPs convey relative purchasing power over the same, or similar, commodities, although it also cannot fully escape the latter concern.

[21] This is the notion of Purchasing Power Parity associated originally with Gustav Cassel. Irving Kravis also reserved the term Purchasing Power Parity (as distinguished from Purchasing Power of Currency) for this use (see e.g. World Bank 1993).

(i) PPPs generated through existing methods are influenced by information about the prices and quantities of commodities consumed disproportionately (both in relation to their incomes and in relation to the total demand for commodities) by the *non*-poor, both within the same country and in other countries. In principle, the price of *some* such commodities *could* be relevant to determining whether an individual who does not consume it is absolutely poor. In particular, this will be true of commodities that are essential to maintaining an adequate level of well-being and unaffordable for many poor people. However, most commodities consumed disproportionately by the non-poor do not have this feature.

(ii) PPPs that are meant to reflect how much currency in one country is required to purchase the same amount of goods and services as can be bought with one unit of the currency of a base country are influenced by information about prices and quantities of commodities consumed in *third* countries. There are reasons why this sensitivity to third country information may be appropriate in the multilateral comparison of aggregate levels of real national income (in particular because in this case it may be deemed appropriate that the basket of commodities to which the comparison of purchasing power refers should be a *composite* of items on which expenditures are made throughout the world). However, this sensitivity is quite inappropriate in the case of absolute poverty assessment. One way to see why is that this sensitivity will imply that a poverty line in a country (calculated by converting an international poverty line expressed in a base country's currency using a PPP conversion factor) will fluctuate simply because of changes in prices in a third country, even though *nothing* has changed either in the country in which poverty is being measured or in the base country. Whether a household in India lives in absolute poverty by the $1 PPP per day standard cannot reasonably depend on information about Japanese real estate prices, but under the current methodology of poverty assessment it does.

The application of available PPPs in poverty assessment leads to the violation of a principle of independence of irrelevant alternatives: *poverty estimates for a country should not change simply because other countries' demand or price levels have changed, nor because the demand for or price level of goods that are not needed by the poor have changed*. A method of measurement that fails to satisfy this requirement is deeply flawed. The problem of dependence on irrelevant alternatives can be avoided straightforwardly by starting from an *appropriate* fixed reference basket of commodities and constructing PPPs which accurately reflect the relative costs of purchasing *this* basket in different countries.

(3) Changing Referent: Available PPPs do not admit of a consistent interpretation over time. The changing structure of the global and national economies also changes the *interpretation* of PPPs, to the extent that they admit of an interpretation. This problem makes it effectively impossible to "track" the depth and incidence of poverty over time. Assertions of the existence of poverty "trends" derived from methods that rely on these PPPs are therefore highly questionable. This is true even when the PPPs used are held constant, because the actually prevailing global pattern of prices and quantities is not constant. More generally, there arises a 'devil's alternative' when attempting to use existing PPPs to estimate the value of any aggregate

(including absolute poverty) over time. If the PPPs used in the calculation are *not* adjusted, then the world nevertheless changes around them, making their interpretation, to the extent that it is coherent, increasingly out of date, and thereby prejudicing the quality of poverty estimates for years distant from the year in which the PPPs were calculated. If the PPPs used in the calculation *are* adjusted, then the poverty lines defined in terms of international dollars and the poverty estimates derived from them do not refer to a consistent underlying concept, and do not permit of comparison.[22] In either case, it will be difficult if not impossible to judge the trend of global poverty. There is no solution to this problem as long as the method of generating PPPs relies (as current methods do) on aggregating information about prices and quantities of broad classes of commodities throughout the world. If such PPPs are relied upon, then institutions concerned with global poverty monitoring will find themselves in the embarrassing position of having continually (decennially, for instance) to revise the PPP factors they use, in effect adopting an entirely new poverty line with an entirely different (and unmeasurable) meaning in relation to the command over goods. Once again, there is a simple alternative. The problem can be avoided by starting from a *particular* reference basket of commodities and constructing PPPs that accurately reflect the relative costs of purchasing *this* basket in different countries. This procedure provides a consistent and robust basis for inter-temporal as well as inter-spatial comparisons.

As noted, each of the above problems besets in some measure all of the currently favored methods of constructing PPPs. In the two sections below we explain more fully how they affect two particular methods that are in common use and underlie all of the global poverty estimates offered to date by the World Bank. Subsequently, we address the empirical evidence that the use of these methods does indeed result in substantial distortions to estimates of the true pattern and extent of absolute poverty in the world.

3.2 *The Example of the EKS System of Calculating PPPs:*

The EKS (Eltetö-Köves and Szulc) method of calculating purchasing power parities has been one of the two most widely used methods for calculating PPPs. It is employed by the World Bank to calculate (from International Comparison Programme data) the PPPs for consumption used in the World Bank's most recent global poverty assessments. Although the properties of the EKS method are arguably suitable for certain purposes, it is our view that they are quite inappropriate for absolute poverty assessment.

The EKS method, like all other methods for PPP calculation in use, offers a way of calculating for each country a single PPP conversion factor that defines relative prices between it and a base country. As with other methods, the basic information upon which it relies consists of the observed or inferred prices $\{p\}$ and quantities $\{q\}$ of commodities, belonging to a list common to all countries, sold in each country.

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[22] This fact has not prevented the Bank from claiming to have "updated" poverty lines as a result of the availability of newer PPPs: "The 1990 calculations of the international poverty line had to be updated using 1993 price data and the 1993 price estimates" (WDR 2000/01, p.17). The uninitiated reader is left a trifle bewildered as to exactly *what* was being "updated."

In particular, the EKS method[23] defines the PPP prevailing between country *i* and country *j* [which is generally interpreted as the number of units of country *j* currency "corresponding" in purchasing power to that of country *i*] as:

$$PPP_{ij} = [(f_{ij})^2 \ (\Pi_{(k \neq i,\, j)} f_{ik} f_{kj})]^{1/n} \qquad (1)$$

where f_{ij} is the Fisher 'ideal' price index of country *i* relative to country *j*, defined in turn as:

$$f_{ij} = ([(p_i \, o \, q_j)/(p_j \, o \, q_j)] \ [(p_i \, o \, q_i)/(p_j \, o \, q_i)])^{1/2} \qquad (2)$$

where p_i and q_j represent the local prices prevailing and physical quantities demanded in a country, where *k* represents a third country, where *n* is the total number of countries, and where o represents the 'dot product' (i.e. $p_i \, o \, q_j$ represents the value of the basket of commodities q_j evaluated at the prices p_i). Let us suppose for simplicity that country *j* is the 'base country,' so that PPP_{ij} is meant to be interpreted as the number of units of country *i*'s currency needed to purchase the same amount of commodities that can be purchased with one unit of country *j*'s currency.

The core idea of the EKS method is simple. A PPP estimate generated by the EKS method is nothing more than the geometric mean of a set of price indices between country *i* and country *j*. However, these price indices take the form of both direct and 'indirect' comparisons of prices between the two countries. The 'indirect' comparisons result from comparing the price level of country *i* and that of *every* third country, *k* , and multiplying the resulting price index in turn by that which results from comparing the price level of country *k* and country *j*. Finally, the type of price index used for every comparison of price levels between countries is the Fisher 'ideal' price index, which takes the geometric mean of the relative price levels of the countries calculated when using in turn as base quantities the quantities demanded in each of the countries being compared.

The EKS method of calculating PPPs has a number of advantages over other methods. Among these are that the resulting PPPs are invariant to the base country chosen, that they lead to a consistent (or transitive) relation among the price levels of countries, and that by taking into account the commodities consumed in each country in a fashion that does not directly take into account the scale of national consumption as such, they can be interpreted as referring to a bundle that is equally "characteristic" (or, as we shall argue below, uncharacteristic!) of consumption in all countries. However, the invariance of the EKS procedure to the scale of demand in a particular country masks a number of more subtle but pernicious biases through which the EKS method gives undue and excessive weight to the consumption of rich countries.

To see this, note that the invariance of EKS PPPs to the scale of consumption in individual countries takes the form of their being unaffected by an increase of the same proportion in all quantities in a given country (because a scalar multiple of q_i multiplies both numerator and denominator and therefore has no net effect wherever it appears in (2)). However, when growth

[23] See for instance Kurabayashi and Sakuma (1990) and Ward (1985).

in consumption takes the form of some quantities increasing proportionately more than other quantities, this invariance result no longer holds.

This point is unfortunately of more than academic interest. Rich countries do vary from poor countries in the *pattern* of the commodities consumed, as well as in the sheer *quantity*. Although the EKS system does not directly pay attention to the quantity of commodities it does pay heed to the pattern. This has implications of two kinds. First, as argued below, the way in which the EKS system reflects the pattern of demand for commodities systematically distorts PPPs away from reflecting the relative cost of the commodities actually consumed in poor countries. This distortion may be greatest for the commodities that matter most for absolute poverty assessment. Second, over time the changing structure of the global and national economies can be expected to shift calculated PPPs in a particular *direction*, a phenomenon that can make them *increasingly* inappropriate as a measure of the relative costs of specific commodities. There is reason to think that this shift is also especially pronounced for the commodities that are most relevant to absolute poverty assessment.

We now consider in more detail the exact manner in which the EKS method leads to error when applied to absolute poverty assessment:

Vague Referent:

PPPs derived by the EKS method do not refer to the relative prices across countries of any *particular* basket of commodities. In fact, as shown in Appendix 1, it may be theoretically impossible to find a basket of commodities with respect to which the PPPs define a set of relative prices. In this sense, it is not correct to say (as is often done) that the EKS method refers to the relative price level of goods and services in different countries, unless one is not referring to the same goods and services in each country! However, since the EKS PPPs are a mean of directly and indirectly calculated relative price levels determined with respect to different quantity bases, they *do* certainly convey some real information about 'average' relative prices between countries, measured across all goods and services consumed in those countries. The averaging process weights individual *commodities* unequally according to the pattern prevailing in each country, although it weights each of the *patterns* of consumption found in different countries equally. The 'relative price level' between any two countries reflects the pattern of consumption in both countries. However, it ceases to have a ready interpretation in terms of the prices and patterns of consumption in those two countries alone, because the patterns of consumption in *all* countries enter into *each* bilateral calculation of relative price level.

Inappropriate Referent:

The EKS method leads to error when PPPs derived from it are used to estimate the costs in poor countries of commodities consumed by poor people. To see why, suppose that in the expression (1) that defines PPP_{ij} country i is a poor country, and country j (consider it to be the base country with respect to which all relative prices are measured) is a rich country. Now, examine the direct Fisher 'ideal' relative price index for the two countries whose price levels are being compared:

$f_{ij} = ([(p_i \circ q_j)/(p_j \circ q_j)]\ [(p_i \circ q_i)/(p_j \circ q_i)])^{1/2}$

$$= \left(\frac{\sum_{k=1}^{l} p_i^k q_j^k}{\sum_{k=1}^{l} p_j^k q_j^k} \right) \left(\frac{\sum_{k=1}^{l} p_i^k q_i^k}{\sum_{k=1}^{l} p_j^k q_i^k} \right) \qquad (3)$$

, where each superscript k represents a particular commodity. Consider now the impact of a change in the consumption of a single commodity (without loss of generality, call it commodity 1) in either country. It is straightforward to show by simple differentiation that

$$\frac{df_{ij}}{dq_j^1} < 0 \quad iff \quad \left(\frac{p_i^1}{\sum_{k=2}^{l} p_i^k q_j^k} \right) < \left(\frac{p_j^1}{\sum_{k=2}^{l} p_j^k q_j^k} \right) \qquad (4)$$

and, analogously,

$$\frac{df_{ij}}{dq_i^1} < 0 \quad iff \quad \left(\frac{p_i^1}{\sum_{k=2}^{l} p_i^k q_i^k} \right) < \left(\frac{p_j^1}{\sum_{k=2}^{l} p_j^k q_i^k} \right)$$

In other words, an increase in the consumption of a commodity in either country decreases the price index if and only if the price of the good relative to the average price of all other commodities is lower in country *i* (henceforth the 'poor country') than in country *j* (henceforth the 'rich country'), with the weight for each good used in calculating both the average prices being that corresponding to the level of demand for that good in the country where the change was experienced.

This result has significant implications for understanding why PPPs derived from this method may be inappropriate for poverty assessment:

(1) The direct price comparison between two countries will register a lower cost of purchasing commodities in the poor country (a lower calculated PPP) if there is higher demand in either country for commodities that are more expensive in the rich country than in the poor country relative to other commodities. For example, if services are relatively more expensive in rich countries (as is generally believed) then an increase in the consumption of services (such as manicures) in the rich country will lead to a lower apparent (though not actual) cost of purchasing all commodities in the poor country (as measured by the price index). The same will be true if there is a service sector expansion in the poor country (for which there is some evidence in many poor countries in recent years). Effects of this type will cause calculated PPPs (and therefore national currency

equivalents of global poverty lines) for poor countries to fall (actually or counter-factually) as incomes increase in rich or poor countries.

(2) By the same logic, higher demand in either country for commodities that are relatively less expensive compared to other commodities in the rich country will result in higher calculated PPPs, higher apparent (although not necessarily actual) cost of purchasing all commodities in the poor country, and hence higher poverty lines. This phenomenon may arise when rising incomes raise the consumption of food, a category of commodities that accounts for a large proportion of consumption in poor countries, and one for which relative prices are higher in poor countries [strong evidence that this is so is provided in section 5 below as well as by Heston and Summers (1995)]. However, the magnitude of this effect is likely to vary significantly between countries of different levels of income. This is because rising incomes tend to raise both the level and the *proportion* of expenditure on non-food commodities (Engel's Law).[24] Some of these commodities are bound to be ones for which the relative price compared to other commodities is lower in poor countries than it is in rich countries, causing lower calculated PPPs (as described in (1) above). As a result, the richer is the country in which demand is increasing, the more likely it is that the effect of rising demand will be to lower rather than to raise calculated PPPs, since the richer countries (surprisingly) consume more of the commodities that are less expensive (relative to other commodities) in poor countries than they are in rich countries (in general items other than food, and in particular services).[25] Growth in consumption in middle and high income countries, which ought to be irrelevant to poverty assessments in poor countries, is likely to lead to a net decrease in the calculated PPPs (and therefore the national currency equivalents of global poverty lines) of poor countries because it is more likely to involve growth in consumption of the items that are more expensive relative to other goods in rich countries than they are in poor countries.

(3) Lower demand in either country for a good that is more expensive relative to other commodities in the rich country than in the poor country (such as services) will cause calculated PPPs, (and therefore national currency equivalents of global poverty lines) to rise.

(4) Similarly, lower demand in either country for a good that is less expensive relative to other commodities in the rich country than in the poor country (such as food) will cause calculated PPPs, (and therefore national currency equivalents of global poverty lines) to fall. It is an empirical question which of effects (3) and (4) is more significant as a result of the income declines occasionally actually experienced in most countries.

All of the analysis above has been about the direct component of the EKS price comparison

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[24] Regmi et al. (2001) provide evidence from International Comparison Programme data that Engel's Law is true in the cross-country context: "Low-income countries spend a greater portion of their budget on food."

[25] Further evidence is that elasticities of demand for food in general (though not for staples) appear to be higher in poor countries (Regmi et al. 2001). For some evidence on the quantity of services consumed in rich countries, see for example Bhagwati (1983).

between a poor country and the (rich) base country. The logic described here carries over to the indirect price comparisons and therefore to the EKS method as a whole.[26]

To summarize, PPPs *may* be inappropriately (in relation to the poverty measurement exercise) inflated either by high consumption of commodities that, relative to the others, are more expensive in the poor countries (case 2) *or* by low consumption of commodities that, relative to the others, are less expensive in the poor countries (case 4). However, the phenomena that are likely to be more significant in the real world, because of the empirical consumption pattern of middle and high income countries, are the opposite ones: PPPs may be inappropriately *deflated* either by high consumption of commodities (such as services) that, relative to the others, are less expensive in the poor countries (case 1) *or* by low consumption of commodities (such as food) that, relative to the others, are more expensive in the poor countries (case 3). This deflation is inappropriate insofar as the poor require food, and not services, to meet their basic needs.

We can consider also the impact of a change in the price of a commodity. It is straightforward to show that an increase in the price of any commodity consumed in country *j* will decrease PPP_{ij} and an increase in the price of any commodity consumed in country *i* will increase it. Although this is only reasonable for an index intended to create an average measure of relative prices in two countries, it is not so appropriate for a measure of the cost of commodities needed by the poor. The reason is that a change in the price of commodities that are not needed by the poor at all will also influence PPPs calculated by this method. An increase in the price of luxury automobiles in a rich country will lower the PPP (and therefore the poverty line deemed equivalent to a global standard) of a poor country, and a decrease in the price of commodities consumed only by the wealthy in a poor country (such as the same luxury automobile) will have the same effect.

The key lesson to emerge from the analysis above is that PPPs derived from the EKS method are based on the aggregation of a great deal of information that is irrelevant to the exercise of poverty assessment. This sensitivity to irrelevant information can often lead to error. For instance, national currency poverty lines held to be "equivalent" to a global poverty line can fall simply because there has been growth in the service sector (or any other sector in which prices are relatively high) in rich countries. "Equivalent" poverty lines can fall as the demand for such commodities increases in poor countries as well. In either case, however, the prices of the commodities that the poor need in order to escape poverty may not have changed at all: the poverty line deemed equivalent to a fixed global standard will change over time (and very likely fall) independently of whether or not the prices of commodities needed by poor people have fallen! More generally, the poverty line estimated at the base country's prices to be sufficient to meet the needs of poor people will be misstated (and very possibly understated) because of the reliance of the EKS method of calculating PPPs upon information that is irrelevant to estimating the costs of avoiding poverty.

Changing Referent:

[26] The exercise of showing that this is true is not undertaken here, but is straightforward in view of the arguments we have made.

PPPs derived by the EKS method depend on the prices and quantities of commodities consumed in all countries in the world at a moment in time. As a result, when these prices and quantities shift, the PPPs derived from them also shift. Although EKS PPPs do not refer to any fixed basket of commodities, to the extent that they refer to anything they refer to an aggregate of the commodities consumed throughout the world, and the pattern of this consumption is shifting. Moreover, there is a systematic dimension to these shifts. As development occurs, the rising proportion of consumption (in both poor and rich countries) accounted for by items (such as services) that are relatively less expensive (compared to other commodities) in poor than in rich countries will lead to lower PPPs for poor countries calculated by the EKS method, and therefore to lower "equivalent" poverty lines. If PPPs calculated on the basis of later data were applied to a poverty line defined in constant terms in a rich country's currency, as a way of "updating" a poverty assessment, the net effect would be to *lower* poverty lines and therefore poverty estimates in developing countries. This would be true even if structural change along these lines had taken place only in rich countries, without *any* change having taken place in poor countries: the appearance that poverty is falling may arise as a consequence of development in rich countries, even if *no* development in poor countries actually takes place! In these circumstances, the exercise of "updating" poverty lines through the adoption of PPPs based on newer data is meaningless at best and likely to be misleading as well.

3.3 *The Example of the Geary-Khamis System of Calculating PPPs:*

A second method used widely in the construction of PPPs (most prominently, by the Penn World Tables) and adopted in poverty assessment (as for example in the methodology for measuring global poverty adopted in WDR 1990) is the so-called Geary-Khamis (henceforth G-K) method [see e.g. Kurabayashi and Sakuma (1990)]. It consists in the imposition of three requirements (simultaneous equations) concerning the relation between the derived PPPs, and observed data (commodity demand and prices) in the countries of the world, that together allow the calculation of a determinate (though not necessarily meaningful) set of PPPs:

$$\Pi_k = \sum_{i=1}^{n} \frac{p_i^k}{PPP_i} \left[\frac{q_i^k}{\sum_{i=1}^{n} q_i^k} \right] \qquad (k = 1,...m) \qquad (1)$$

$$PPP_i = \frac{\sum_{k=1}^{m} p_i^k q_i^k}{\sum_{k=1}^{m} \Pi_k q_i^k} \qquad (i = 1,..n) \qquad (2)$$

$$PPP_1 = 1 \qquad (3)$$

The first expression defines a set of purely notional *international prices* for each good (k=1,..m) in terms of an equally notional *international currency*, by imposing a requirement that the *international price*, $\prod_k$ for any good should be the weighted average of the prices that actually prevail for that good in different countries (i=1,..n) in national currency units deflated by a measure of the 'relative inflatedness' of a country's price level, identified here with the country's PPP (taken to represent the number of units of its national currency that "correspond" in real terms to one unit of international currency). Thus, the PPP serves the function of an exchange rate between national currency and international currency. The application of this "exchange rate" to national prices from different countries enables them to be converted to a common unit of measurement (namely international currency) and then averaged. The weights correspond to each country's share of world consumption of the good, as measured in physical units.

The second expression imposes the requirement that each country's PPP be equal to the ratio of the value of its national income as evaluated in national currency units at actually prevailing national prices, and the value of its national income as evaluated at the notional international prices. In this sense, each country's PPP represents its relative price level, interpreted in terms of the 'cost' at international prices of its own GDP. However, the international prices at which this relative price level is determined are notional composites rather than being actually observable.

The third expression requires simply that there exist a base country for which the PPP is one (i.e. the national income of the base country evaluated in notional international currency at international prices and in its own currency at its own prices have the same magnitude). In global comparisons of real prices and product, the base country has invariably been chosen as the United States.

We now consider in more detail the exact reasons that the Geary-Khamis method leads to error when applied to absolute poverty assessment:

Vague Referent:

PPPs calculated by the G-K method do not generally correspond to the classical idea (associated with Gustav Cassel) of identifying the cost in different countries of purchasing some basket of commodities. In fact, it can readily be shown that it is only in rare cases that the method permits of the interpretation that the PPPs derived from it correspond to the relative costs of purchasing some basket of goods in different countries (for the proof see Appendix 1). For arbitrary price and demand vectors in different countries, such an interpretation will therefore generally be impossible. What meaning if any do G-K PPPs have? It is difficult to tell. In particular, it is difficult to tell whether they are likely to understate or overstate the number of units of currency required to purchase a fully specified commodity bundle corresponding to the consumption of the poor, without defining such a bundle and pricing it. One unit of international currency (with respect to which the PPP of a country functions in the G-K system as an "exchange rate") has widely been interpreted as containing the "same purchasing power" as one US dollar (and the

notional international unit is accordingly usually dispensed with altogether). This statement of equivalence (that is made, among others, by the major agencies that construct PPPs) involves a conceptual error, however. The only sense in which this statement is true is that by construction (equation three of the G-K system) it would be possible to purchase the components of the United States GDP at notional international prices using the same number of international currency units as it would take to purchase the components of the United States GDP at actual US prices. There is in fact no guarantee that this equivalence holds for *any* other basket of goods.

Inappropriate Referent:

PPPs resulting from the G-K method are likely to lead to distorted estimates of the 'true' cost of consumption for the poor, since by construction the G-K method gives greater weight in the determination of notional international prices to countries that account for a large share of world demand and have high price levels, with resulting implications for PPPs.

There is a conceptual and an empirical point to be made here. The conceptual point is that as a result of equations (1) and (2) of the G-K system, countries' PPPs (and therefore the national currency equivalents of the global poverty line) will vary simply as a consequence of *other* countries' price level and share of world output. This violates the basic 'independence of irrelevant alternatives' requirement mentioned above, that poverty estimates for a country should not change simply because other countries' quantities demanded or price levels have changed.

The allied empirical point is that richer countries are likely to have higher average price levels measured in relation to a common standard (this is the so-called Balassa-Samuelson effect).[27] The effect of this correlation under the G-K system of equations is to raise the calculated PPPs of rich countries and lower those of poor countries. Poor countries' calculated PPPs are low because the commodities that are expensive and extensively consumed in rich countries are inexpensive in poor countries, rather than because costs for the commodities actually consumed in poor countries are low. Poverty lines derived by this method will therefore underestimate poverty because they will understate the price level in poor countries. This differential role of the pattern of prices and demand in rich countries in determining the world PPPs would not occur if PPPs were derived from a fixed consumption basket appropriate to persons at low income levels.

Changing Referent:

G-K PPPs are not comparable over time. This problem is well understood by those who have implemented it (see for instance Summers and Heston 1988, 1991). The fundamental reason for the non-comparability over time of the G-K PPPs is that they derive from the entire global pattern of demand and prices that prevails at a moment in time, rather than from the relative price in different countries of a specified reference basket. As a result, G-K PPPs no longer refer to command over purchasing power in any consistent sense. In other words, to the extent that G-K

[27] There is substantial evidence for this relationship, associated with the higher cost of non-tradable goods in richer countries.

PPPs refer at all to purchasing power over something (which they do vaguely at best!), that something is changing over time. The devil's alternative also described above in relation to the EKS method is again the result: inter-temporal comparability can be achieved only by confining the PPPs used to those which derive from a particular year, but the cost of fixing PPPs is that they become increasingly out of date, referring (to the extent they refer to anything at all) to an ever more outdated pattern of demand and prices, and jeopardizing their claim to capture command over goods in a consistent sense. As a result, over long periods of time it becomes necessary to accept significant underlying distortions or alternatively to update PPPs at the risk of losing inter-temporal comparability of poverty assessments.

Structural changes in the global and national economies will affect the calculation of G-K PPPs in a systematic way. In particular, the degree of distortion inherent in using the G-K PPPs rather than ones based on a fully specified consumption basket may change over time. The G-K method of deriving PPPs implies that if over time some countries experience a relative increase in their price level or in their share of world demand (both likely to occur as a country becomes richer relative to others[28]), the G-K procedure will assign them higher PPPs (the number of local currency units understood as equivalent in purchasing power to a notional international currency unit) and will assign lower PPPs to poorer countries. Specifically, growth in the share of output of countries with higher price levels (and more generally, rising prices in any other country) will reduce the PPP of a poorer country. This implies that high levels of inflation in any country and economic growth in countries with higher price levels can both contribute to lowering poverty estimates, even *without* any change in conditions in the country for which the estimate is being produced. Although in recent years some developing countries with lower price levels have had higher growth than developed countries, they have also experienced higher inflation. The net effect of these two factors on the PPPs that would be calculated for these countries is ambiguous. Moreover, steady growth in developed countries will tend to lower the PPPs that would be calculated for poorer countries. There is therefore reason to think that structural change in the world economy has tended systematically to *lower* the poverty line (in domestic currency units judged "equivalent" to a fixed global standard) that is applied in the poorer countries, and thereby to lower the estimate of global poverty. The "updating" of national poverty lines through using revised PPPs, while maintaining a fixed global poverty line, far from maintaining a neutral standard, would systematically *reduce* the estimated extent of poverty.

4.0 *False Precision and Mistaken Inferences*

In addition to errors resulting from the conceptual problems described above, the Bank's estimates of global poverty carry large errors due to measurement problems associated with the data used under the Bank's preferred approach. These errors — not explicitly identified or quantified by the Bank — are large. Some of these errors can be eliminated by a different approach. Others cannot be, but can at least be more explicitly identified and limited. In addition, the Bank's approach to replacing missing data produces mistaken conclusions about the level and trend of poverty. We outline why below.

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[28] Once again this is the so-called Balassa-Samuelson effect.

4.1 *Lack of Statistical Significance*

The Bank's estimates of global poverty are point estimates. They are numbers that ostensibly represent the total number of the absolutely poor, in specific countries and in the world. These estimates are based on data that are bound to be infected with measurement errors. For this reason alone, final totals based on these data will also be error-infected. How high is this error? There is reason to think that it is extremely high. Nonetheless, poverty headcounts are reported with six-digit "precision".[29] There is no scientific justification for doing so. As Kakwani (1993) notes, "No significant tests [of the statistical significance of estimates] have been devised for poverty measures because of their complex nature." However, this is no reason to avoid providing at least a gross indication of the errors involved. Suggestions of false precision can be avoided even in the absence of well-developed statistical tests.

In section 2.0 above we showed that significant fluctuations in the level of headcount poverty in particular countries and regions were caused simply by the choice of one set of PPP conversion factors rather than another. These massive fluctuations reveal the sensitivity of aggregate poverty estimates to the PPP factors chosen.

It is important to note that the uncertainty emerges not only from changes in estimated PPPs over time (as discussed in section 3.0 above), but also from the fact that PPPs for a very large number of countries are based on interpolations rather than on observations of prices and quantities of goods consumed in that country. For example, 63 countries participated in the International Comparison Programme Phase V Benchmark Study in 1985.[30] Relative prices levels for the remaining countries were determined purely through regression estimations, involving predicting real per capita income (and thereby PPPs) by exchange rate income and secondary school enrolment ratio, supplemented by data on "post adjustments" for costs of living of expatriates living in capital cities collected by the UN and private sector consultants (Ahmad, 1992). Although this method serves as a statistically significant predictor of calculated consumption PPPs, it has errors and the errors associated with it carry over to the resulting poverty estimates. In certain large countries, the errors are of special significance. India participated in the 1985 but not in the 1993 ICP benchmark survey. China participated in neither. Thus, PPPs for these two vast and heterogeneous countries with significant shares of world poverty are based entirely on "educated" guesses. The consumption PPP reported by the World Bank for India in 1993 is based on the updating of its assumed international price level in 1985 by domestic inflation, with some adjustment made for changes in post adjustments and other data. The consumption PPP reported by the World Bank for China are based primarily on an estimate of China's PPP in 1986 produced by independent authors (Ruouen and Kai 1995) through a bilateral comparison of prices in China and the United States. The construction of China's PPP on this basis is inconsistent in method with the manner in which PPPs are assigned to other countries. More

[29] Chen and Ravallion (2001, 290). There is more modest five-digit precision in WDR 2000/01, 23.

[30] We have not been able to find any public enumeration of the countries that participated in the 1993 benchmark survey.

importantly, it is now substantially out of date. In addition, where the state statistical bureau did not report national average prices for items, the authors undertook price surveys in a limited number of cities (10) with no coverage of rural areas. Finally, the PPP estimates derived from it are quite different from those proposed by others for China, which vary dramatically. PPPs proposed for China vary by a factor of *more than two*, reflected in per capita GDP estimates for 1990 spanning the range from $1300 (IMF), $1600 (Ruoen), and $1950 (World Bank) to $2695 (Penn World Tables)! [These different estimates and their differences are discussed extensively in Heston, n.d.]. Ruoen and Kai (1995) report that even within their favored methodology, reasonable estimates for China's PPP per capita income in 1991 vary from $1227 to $1663. Obviously, the potential impact of adopting different PPPs on China's poverty line, and thereby on its poverty headcount, would be massive. The estimated level and trend of global poverty would be consequently strongly affected. This extraordinarily important issue is however never once mentioned in the Bank's presentation of its global poverty estimates.

A further issue is that purchasing power parity estimates derive not from a single global comparison of prices of goods and quantities demanded, but from regional comparisons that are then "linked" together using bridge countries that participate in more than one regional price comparison, so as to establish price parities between the relative prices of countries in the different regions. This procedure is however sensitive to the choice of bridge country. An alternative choice of bridge countries would produce a distinct set of global relative prices (and hence of poverty lines). Although the bridge country approach has been an understandable response to resource limitations, it is also a source of error in estimates of global poverty and must be recognized as such.

Finally, the Bank's global poverty assessments estimate the level of individual consumption from mean consumption reported in household surveys. It is well known however that there are very large discrepancies between consumption reported in household surveys and consumption reported in the national income accounts.[31] Which of these sources is more accurate? It is far from clear. As noted by Karshenas (2002), "the discrepancy in average consumption between the household survey and national accounts data, apart from definitional discrepancies between the two concepts, is due to possible errors in both sources of data."

4.2 *The Poor May Face Different Prices*

The benchmark surveys of the International Comparison Programme collect data on prices paid by consumers for standard items at standard points of sale in countries throughout the world. However, it does not consider the possibility that the poor face different prices than the non-poor for the goods they consume, for instance because of where they buy (in areas that are both more distant and have less-competitive market structures), because of the quantities in which they buy (smaller - because of cash-in-hand, credit, and storage limitations), or because of who they are (social marginalization may permit retail market discrimination). There is evidence that the poor pay more for the goods they purchase. In this respect, the use of PPPs based on prices observed to be paid by the non-poor may be rather misleading. This is a distinct and additional issue to the

[31] We are grateful to Michael Ward for emphasizing to us the importance of this issue.

focus of existing PPPs on commodities that may be consumed substantially by the non-poor. The issue here is that in purchasing even the *same* commodities, the poor may pay higher prices. For example, Biru (1999) finds that lower income groups pay more for the same commodities in Zambia, and that the differences in the prices paid by the different income groups are greatest in the poorest regions. Similar results are found by Rao (2000) in rural South India. To be appropriate for poverty assessment, purchasing power parities should take account not only of the specific commodities consumed by the poor, but also of the specific prices the poor must pay for these commodities. Improved knowledge concerning these prices will require the collection of primary data.

4.3 *Automatic Poverty "Reduction"*

The method adopted by the Bank to deal with the fact that household survey data are available only on an occasional basis builds in a tendency for poverty to *appear* to fall when it need not be doing so in fact. This tendency for an apparent (and very possibly non-existent) reduction in poverty to arise is an *inherent* feature of the Bank's methodology. Why? In the absence of up-to-date survey based data on the distribution of consumption, the procedure adopted is to "estimate measures for each reference year by applying the growth rate in real private consumption per person from the national accounts to the survey mean – assuming in other words that the Lorenz curve for that country does not change" (Chen and Ravallion 2001, 289). This procedure inadvertently *ensures* a reduction in poverty, as long as the relevant growth rate is positive — and an increase in poverty where this growth rate is negative. The reason is obvious: While a new household survey would offer a new 'snapshot' of household incomes (*both* their level and distribution), the procedure adopted by Chen and Ravallion updates only *half* the picture -- mean consumption -- without updating the other half, distribution. This procedure yields merely apparent poverty reductions in countries in which both real private consumption per capita and the inequality in its distribution have increased. This double-increase case seems to be quite common in the 1990s. How much of the vaunted reduction in global poverty is due to the assumption that national Lorenz curves have not changed since the last survey? Table 1 in Chen and Ravallion (2001, 286-7) reports the survey dates for each of the countries for which they estimated poverty and for which surveys were available. It is readily observed that for a number of the countries involved, the latest survey date was in the early 1990s, or even in the late 1980s. It is quite possible, then, that the small global poverty reduction the Bank has calculated on the basis of its flawed PPP methodology is entirely due to a plainly false empirical assumption *built into* its measurement approach.[32] The more important

[32] "Drawing on 297 national sample surveys spanning 88 countries we find that there was a net decrease in the overall incidence of consumption poverty over 1987-98" (Chen and Ravallion 2001, 283). The reported decrease can in any event be presented in various occasionally contradictory ways. Using the $1.08/day (PPP 1993) poverty line, the reported number of poor decreased from 1183.19 to 1175.14 million, or from 23.55% to 19.84% of world population, or from 28.31% to 23.45% of the population of the developing world. Using the $2.15/day (PPP 1993) poverty line, the reported number of poor *increased* from 2549.01 to 2811.73 million, or decreased from 50.74% to 47.46% of world population, or from 61.00% to 56.11% of the population of the developing world (cf. ibid, 290, and http://www.census.gov/ipc/www/worldpop.html).

point however is that the impact of this assumption adds further confusion to an already muddy picture, making it even more difficult to discern the truth about global poverty (as distinguished from the Bank's published statistics).

5.0 *Erroneous Estimates: Empirical Evidence*

In section 2.0 above and in Tables 2, 3 and 4, we offered empirical evidence that the methodological shift in global poverty assessment from WDR 1990 to WDR 2000/01 entailed significant changes in the extent of poverty deemed to exist in many countries and regions. The Bank notes that the total number of poor persons under the two methodologies is roughly the same for the year 1993. However, in view of the magnitude of the shift in the regional composition of poverty caused by the change in methodology, there is no reason to expect that the total would continue to be similar for subsequent years.

In this section, we offer a range of empirical evidence that the use of an inappropriate PPP concept has led to error (and specifically understatement) in estimates of the level of global poverty. First, we consider an international poverty line that is defined in US dollars and converted into national currency equivalents. Here we show that it makes an enormous difference which PPP concept is used for this conversion. In particular, the use of general consumption PPPs (rather than an appropriately narrower PPP concept) leads to a substantial underestimation of national poverty lines. Second, we will show that this conclusion also holds when the Bank's poverty line is understood as *endogenously* generated and thus compared to alternatives that are also generated endogenously through use of a more appropriate PPP concept. In constructing these alternatives, we follow the Bank's procedure of using data on official domestic poverty lines for constructing an international poverty line which is then converted into national currency equivalents — but we employ another specific PPP concept to execute both of these tasks. The exercise shows that, relative to such alternatives as well, the Bank's reliance on general consumption PPPs leads to substantial underestimates of national poverty lines in most countries. Third, we show how these underestimates in turn produce a substantial undercount of the global poor. Fourth, we show that the supposedly close fit between the international poverty line and official domestic poverty lines for the poorest countries — used by the Bank to motivate the choice of its international poverty line — breaks down when a more appropriate test is used. On the basis of all this evidence, we conclude that the use of general consumption PPPs grossly distorts global poverty assessments and should be replaced by a PPP concept that is related as closely and *explicitly* as possible to the consumption needs of the poor.

5.1 *Inappropriate PPPs and the Understatement of Local Equivalents (with a Fixed International Poverty Line)*

One way to judge the extent of distortion resulting from the use of inappropriate PPPs when estimating what it costs the poor to meet their basic needs is to compare the values of the PPPs for general consumption, used by the Bank to translate a given international poverty line (fixed

in US dollars) into national currency "equivalents," to the values of the PPPs linked to a narrower range of consumption data. For a limited but still substantial range of countries, PPPs for all-food and for bread-and-cereals sub-aggregates are available. These PPPs are calculated from price and quantity data for various items collected in specific 'benchmark' years by the International Comparison Programme under its 'basic headings' (comprising internationally comparable product categories). The PPPs for 'all foods' and for 'bread and cereals' — henceforth 'food-based' PPPs — derive from applying the EKS aggregation procedure to the price and quantity data (basic headings) corresponding solely to these sub-aggregate classifications. These data are of special relevance to poverty assessment insofar as food is a large component of the elementary consumption needs of the poor, whereas the general consumption pattern contains many goods that are not a part of these needs. It is likely that bread-and-cereals PPPs are those most closely related to the consumption needs of the poor in developing countries (the other sub-categories making up the 'foods' category as a whole in 1985 were 'meat,' 'fish,' 'milk, cheese and eggs,' 'oils and fats,' 'fruits, vegetables and potatoes,' and 'other food'). Some empirical evidence that this is so is the finding of Regmi et al. (2001), using ICP data, that the income elasticities of demand for staple foods (including cereals) are lower than those for non-staple foods in all countries and that this phenomenon is especially marked for the poorest countries. The poor cannot substitute away from staple foods (considered as a whole) to anything else.

Table 6A shows how food-based PPPs and those for general consumption differed for all the countries for which these data were available in the 1985 benchmark year. A figure greater than one in the last two columns for each country shows that prices of 'all foods' or 'bread and cereals' respectively are higher than suggested by the PPP conversion factor for general consumption. The summary statistics that follow the table show this to be true for most countries, including *all* countries in the low-income category. For these low-income countries, food prices are on average 67 percent higher (40 percent higher when weighted by population) than consumer prices in general, and bread-and-cereals prices are on average 111 percent higher (34 percent higher when weighted by population)[33]. Table 6B collates analogous figures for the 1993 benchmark year. In the vast majority of low income countries, food prices are again higher than consumer prices in general — 27 percent higher on average (31 percent higher when weighted by population). Bread-and-cereals prices are on average 51 percent higher (40 percent higher when weighted by population) than consumer prices in general. By any reasonable judgment, these magnitudes are very substantial, suggesting that choice of a more appropriate PPP concept would greatly increase the estimated extent of severe income poverty worldwide.

The distortion arising from the use of PPPs for general consumption rather than ones for food-based PPPs is greater for the poorer countries. This is shown dramatically by the summary statistics grouped by income class for Tables 6A and 6B and by the regressions in Tables 9.1A and 9.1B. The regressions show (for the 1985 and 1993 data respectively) that whatever measure of disadvantage is used (per capita GDP measured at exchange rates or at PPP, infant mortality rate or under-5 mortality rate) the gap between poverty lines based on food-based PPPs and poverty lines based on general consumption PPPs increases as national disadvantage

[33] We report geometric means here and elsewhere in the text where we interpret means of ratios, for which it is the appropriate concept. We also report arithmetic means in the tables, as these are more familiar to many readers, although they are not equally meaningful in this context.

increases. The results involving the PPP measure most closely related to the needs of the poor (bread and cereals) shows coefficients of the highest magnitude, and show a very high level of statistical significance. We conclude that general consumption PPPs underestimate the costs in national currency of purchasing a quantity of basic foodstuffs equivalent to that which can be purchased in the United States and that this underestimate is larger for the poorer countries.

5.2 *Inappropriate PPPs and the Understatement of Local Equivalents (with an Endogenous International Poverty Line)*

An obvious objection to our estimate of the distortions arising from the use of inappropriate PPPs is that the international poverty line cannot be taken as given. If the PPP concept in use is changed (for example, from one pertaining to general consumption to a food-based one) then the international poverty line must also change. One obvious reason for this is that the Bank's poverty line has itself been calculated by using general consumption PPPs to convert the official domestic poverty lines of a set of countries into US dollars. The median of the bottom 10 among the resulting US dollar amounts has been chosen as the international poverty line. It would be inconsistent to use one PPP concept to construct the international poverty line and another to translate it into national currency equivalents.

To meet this concern, we examined the effect of adopting food-based PPPs *both* in the construction of an international poverty line *and* in its subsequent translation into national currency equivalents. We followed the Bank's procedure of defining the international poverty line as the median of the 10 lowest available official domestic poverty lines, using all of the countries for which we have comprehensive data (i.e. all types of PPPs) from the same list of official domestic poverty lines (for 33 countries) used by the Bank (as ranked when the chosen PPP concept is used to convert from national currencies to U.S. dollars). This international poverty line is *endogenous* in the sense that it varies according to the PPP concept used. We then converted the resulting international poverty line into national currencies, using the same PPP concept as was used in its construction. Table 8A lists the international poverty line and its national currency equivalents constructed in this fashion (which we call method A) for each of three distinct PPP concepts ('all consumption,' 'all food' and 'bread and cereals') for which data is available for 1993. (We do not undertake this exercise for 1985 because the Bank used a less transparent procedure in calculating its international poverty line for that year.) In the final columns in each row we examine whether the resulting national poverty lines are higher when food-based PPPs are used than when general consumption PPPs are used for both construction and conversion of the international poverty line. As shown by the summary statistics following the table, this is overwhelmingly the case in low-income countries — and more so when bread-and-cereals PPPs, likely to be most closely related to the consumption needs of the poor, are used. For these poorest countries, the use of bread-and-cereals PPPs rather than general consumption PPPs for both the construction and conversion of the international poverty line raises equivalent national poverty lines by 36 percent on average (by 26 percent when weighted by population). Once again, by any reasonable judgment these magnitudes are quite substantial, suggesting that the choice of an alternative PPP concept more reflective of the consumption needs of the poor would greatly increase the estimated extent of severe income poverty worldwide.

A possible objection to this procedure is that by choosing the international poverty line as the median of the bottom 10 poverty lines of those countries for which all three PPPs were available, we have introduced a systematic selection bias. In particular, our endogenous poverty line for all consumption of $1.22 per day differs from the $1.08 of the Bank due to the loss of some countries in the sample for which data on food-based PPPs was not available. To deal with this concern to the extent possible, we construct a second set of endogenous international poverty lines interpreting the Bank's methodology as involving choosing the median of the bottom 30.3 percent of countries ranked according to their poverty lines converted according to the chosen PPP concept. [The 30.3 percent arises from the Bank's choice of the bottom 10 out of a list of 33 countries as the set from which the median poverty line would be drawn]. This second method (which we call method B) allows us closely to mimic the Bank's own poverty line for all consumption (our endogenous international poverty line from this method using all consumption PPPs for the countries for which all the data is available is $1.10 as compared to the Bank's $1.08). The international poverty lines constructed both through method A and method B along with the values of the official domestic poverty lines for which all three PPPs are available (converted into US dollars using the respective PPP concepts) are exhibited in Table 7. In Table 8B we report the national poverty lines equivalent to the endogenous international poverty lines associated with the various PPP concepts (but now calculated through method B). Once again, it is evident that the use of food-based PPP concepts leads to higher poverty lines than when general consumption PPPs are used both to calculate the international poverty line and its national currency equivalents. For the low income countries, the use of bread and cereals PPPs leads to national poverty lines that are on average 42 percent higher (31 percent when weighted by population)! Once again, by any reasonable judgment these magnitudes are quite substantial, suggesting that the choice of an alternative PPP concept more reflective of the consumption needs of the poor would greatly increase the estimated extent of severe income poverty worldwide.

The distortion arising from the use of general-consumption PPPs instead of all-food or bread-and-cereals PPPs is greater for the poorer countries, even when the international poverty line varies endogenously. This is shown dramatically by the summary statistics grouped by income class that follow Tables 8A and 8B and by the regressions in Tables 9.2A and 9.2B. The regressions show that whatever measure of disadvantage is used (per capita GDP measured at exchange rates or at PPP, infant mortality rate or under-5 mortality rate) the gap between poverty lines based on food-based PPPs and poverty lines based on general consumption PPPs increases as national disadvantage increases. The results involving the PPP measure most closely related to the needs of the poor (bread and cereals) show coefficients of the highest magnitude, and show a very high level of statistical significance. The result of section 5.1 thus turns out to be stable: By using general consumption PPPs, the Bank grossly underestimates the costs in national currency of purchasing a quantity of food equivalent to that which can be purchased in the United States at an international poverty line, even if we correct for the fact that this line itself is inflated by the use of general consumption PPPs in its construction.

5.3 *The Effect of PPP-Influenced Variation in National Poverty Lines on Poverty Headcounts*

What is the effect of lowered poverty lines on the incidence of poverty itself? We answer this question for the set of poor countries for which we have general-consumption and food-based PPPs as well as household survey based data on the size distribution of income. For these countries, we estimate the headcount poverty associated with different poverty lines using the POVCAL software program designed and distributed by the Bank. We report all cases for which the necessary data was available and for which the program generated theoretically consistent results.

A Fixed International Poverty Line

We find that the impact of using food-based PPPs rather than general PPPs to translate a fixed international poverty line of $1.08 PPP 1993 is to raise poverty headcounts substantially. For our set of poor countries, as shown in Table 10.1, on average a 1-percent increase in the national equivalent of the international poverty line due to the use of all-food PPPs rather than general-consumption PPPs is associated with a 1.03 percent increase in the poverty headcount. On average, a 1-percent increase in the poverty line due to the use of bread-and-cereals PPPs rather than general-consumption PPPs is also associated with a 1.03 percent increase in the poverty headcount. The effect of using all-food rather than general-consumption PPPs is to raise the average headcount from 32.84 to 44.66 percent. The effect of using bread-and-cereals rather than general-consumption PPPs is to raise the average headcount from 32.84 to 59.34 percent!

An Endogenous Poverty Line

We repeated the same exercise using the endogenously generated international poverty lines (varying with the PPP concept used) calculated in section 5.2 above. We find that using food-based PPPs rather than general-consumption PPPs both to construct and to convert an international poverty line raises poverty headcounts substantially. For the set of countries for which we have a complete set of data, on average, as shown in Tables 10.2A and 10.2B, a 1-percent increase in the poverty line due to the use of all-food PPPs rather than general-consumption PPPs is associated with a 0.96 percent increase (method A) and a 0.95 percent increase (method B) in the poverty headcount. Similarly, on average, as shown in the tables, a 1-percent increase in the poverty line due to the use of bread and cereals PPPs rather than general consumption PPPs is associated with a 0.96 percent increase (method A) and a 1.02 percent increase (method B) in the poverty headcount. Roughly, then, a 1-percent increase in the poverty line is associated with a 1 percent increase in the poverty headcount. The effect of using all-food rather than general-consumption PPPs is to raise the average headcount from 39.85 to 44.66 percent (method A) and from 33.88 to 35.59 percent (method B). The effect of using bread-and-cereals rather than general-consumption PPPs is much more dramatic. It raises the average headcount from 39.85 to 60.31 percent (method A) and from 33.88 to 56.81 percent (method B)!

5.4 *How Close Together are Official Domestic Poverty Lines of the Poorest Countries?*

A justification offered by the authors of the Bank's poverty measurement methodology for the

international poverty line they choose is that the official domestic poverty lines of several poor countries are close to it when converted by general-consumption PPPs. Chen and Ravallion (2001) and Ravallion (1998) report regressions attempting to establish this and state, "The poverty rate on this basis must thus be deemed a conservative estimate, whereby aggregate poverty in the developing world is defined by perceptions of poverty found in the poorest countries" (Chen and Ravallion 2001, 288). We show in Figure 1, however that this statement is not robust. In that figure, we replicate their core result that there is a relatively 'flat' cluster of poor countries whose official domestic poverty lines are close if converted by general-consumption PPPs. [Our result is not numerically identical to the Chen and Ravallion (2001) result since we use data on consumption per capita from national income accounts rather than the household survey data they use, due to our lack of access to the latter]. However, when these same official domestic poverty lines are converted by food-based PPPs, the purported relationship breaks down and, in particular, becomes less flat. When bread-and-cereals PPPs rather than general-consumption PPPs are used, the elasticity of official poverty lines with respect to per capita income *doubles* for the poorest countries composing the cluster. It is not true, then, that the international poverty line chosen by the Bank is innocuous because it matches closely the official domestic poverty lines of a wide range of poor countries. This claim depends on the use of the very PPP concept we are challenging.

6.0 *Conclusion and an Alternative*

Income poverty is, as we have noted above, only one aspect of poverty, and other poverty estimates, based on under-nutrition, infant mortality, access to health services, and other indicators can continue to inform us even in the absence of usable figures concerning global income poverty. International development targets should appropriately continue to focus on these measures of deprivation in the world, which are not equally subject to the concerns we have outlined above, while a new procedure for the global assessment of income poverty is developed and implemented.

Such a new procedure is urgently needed. There are strong reasons to doubt the reliability and meaning of the estimates of the level, distribution and trend of global poverty provided both in WDR 1990 and in WDR 2000/01. These reasons for doubt revolve around the lack of a well-defined poverty line that permits of meaningful and reliable inter-temporal and inter-spatial comparisons, the use of a misleading and inaccurate measure of purchasing power equivalence, and the building into the methods used of false precision and mistaken inferences in the face of data limitations. All of these flaws are likely systematically to distort estimates of the level and trend of global income poverty. There is reason to think that much of the distortion is in the direction of understating the extent of poverty in the world. Moreover, statements that global poverty is decreasing have no evidential justification in light of these distortions. The problems are readily avoidable, although their avoidance would require a fundamental change in the methodology of global poverty assessment. The poverty statistics regularly calculated and published by the Bank are entirely useless for the purposes they are officially intended to serve.

Our rejection of the Bank's procedure does not support the sceptical conclusion that the attempt to provide a standard of income poverty comparable across time and space is doomed to fail.

There exists a much better procedure which, given its modest informational and institutional requirements, can be easily implemented. This alternative procedure would construct a reference basket of commodities containing relevant characteristics (for example, calorific content) that enable them to meet the elementary consumption needs (or capabilities) of individuals.[34] It then defines the international poverty line as the amount of national currency minimally necessary in each country or more specific locality to purchase this reference basket. This procedure focuses on whether the incomes of poor people are sufficient not in relation to all prices everywhere but rather in relation to the local prices of goods that are relevant to meeting their elementary requirements. The reference basket employed in the proposed alternative procedure should be composed of commodities that are defined in a suitably abstract way so as to take reasonable account of local variations in tastes, while also possessing the characteristics that enable elementary requirements to be met.

To be sure, income poverty statistics based on the procedure we suggest cannot be objective and precise in the way of measurements of physical distance. There are differences of opinion about the relative significance of various basic needs, about the relevance of interpersonal variations in such needs, about the quantity and quality of commodities needed to fulfill basic needs, and about the appropriate degree of deference to cultural norms and values.[35] Such disagreements can be narrowed through reasonable debate to a sufficient degree to permits a workable framework for action. In the context of assessing severe poverty (rather than living standards more generally), such differences will in any case be relatively narrow.

Although approximations will necessarily be involved in an alternative exercise of global poverty measurement (as in any empirical estimation exercise), it will at least be possible to interpret the resulting errors in estimation in a transparent, consistent and meaningful way. Until and unless we undertake the task of counting the global poor by such a less suspect method, we will simply not know how many poor people there are in the world and how this number is evolving.[36] Such ignorance handicaps inquiries into whether and to what extent the current world order is benefiting or harming the global poor.

The heart of an alternative (and credible) approach to measuring global poverty is to carry out on a world scale an equivalent of the poverty measurement exercises conducted regularly by national governments. In large federal countries, in which there are significant internal variations in tastes and in prices, workable structures for accommodating internal differences

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[34] We do not believe that it is necessary finally to resolve here the issue of whether these needs should be conceptualized in terms of elementary capabilities or in some other manner. An adequately operational approach to global poverty assessment need not require final agreement on this issue.

[35] To illustrate the last point, consider someone who has enough income to satisfy her basic needs through wheat but not through rice purchases. If she is a (perhaps religiously) committed rice eater, should she, or should she not, count as income poor?

[36] As we have stressed before, this statement applies in particular to measurements of income poverty. Non-income measures of global deprivation are unaffected by the criticisms offered in this paper, and in particular continue to offer a suitable informational basis for the pursuit of global development targets.

within a consistent aggregate assessment exercise have been implemented long ago. Today a similar approach is needed at the global level. It should begin with a transparent and consultative process of identifying a core conception of poverty defined in terms of elementary capabilities or, operationally, in terms of the characteristics of commodities (e.g. nutritional content). This core conception should be used to define minimal thresholds, appropriately adjusted to take account of relevant inter-regional and inter-group variations in requirements and tastes. These thresholds should then be applied to available income survey and price data so as to determine whether individuals have sufficient incomes to escape poverty. Such a procedure can produce consistent estimates of poverty that are comparable across space and time.

Data should be produced specifically with the aim of facilitating the poverty assessment exercise described here. In particular, price data relevant to poverty assessment will have to be collected. Much information on national prices of essential commodities is already collected by the International Comparison Programme under its 'basic headings,' and could easily be augmented with limited additional effort. Until now, the ICP has focused on producing data that would enable comparison of the total real income of countries, and has paid scarcely any attention to the data requirements of poverty assessment. Even in this task, it has often received inadequate financing and cooperation. This must change.[37]

We are surprised that the Bank has been publishing regular poverty statistics for twelve years now — "precise" to six digits and very widely used in academic publications and popular media all over the world — without significant attention having been paid to the massive flaws in its procedures. It is hard not to see this fact as indicative of the low priority that has hitherto been attached to the global problem of persistent severe poverty.

[37] One of the authors was present at a planning meeting of the ICP on March 12, 2002 at which the first session on poverty-assessment appropriate PPPs in the *entire* history of the programme took place.

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Table 1

List of the Official Domestic Poverty Lines in $ Per Month Per Person
(Converted at PPPs for All Consumption)
Used as Data by the World Bank in Construction of its International Poverty Line

Country	1985 Official Poverty Line ($/month/person; Converted at 1985 PPPs for All Consumption)	1993 Official Poverty Line ($/month/person; Converted at 1993 PPPs for All Consumption)
Australia	265.75	423.44
Bangladesh	31	36.23
Belgium	183.58	243.16
Burundi	24.85	52.98
Brazil	42.42	68.70
Canada	290.19	353.25
China	24.88	24.48
Costa Rica	50.75	78.90
Dominican Republic	48.38	85.41
Egypt	25.5	52.06
India	23	26.97
Indonesia	31.25	32.03
Jamaica	71.23	86.78
Japan	129.91	192.60
Kenya	30.63	47.09
Malaysia	58.04	57.21
Morocco	31.33	54.02
Nepal	30.7	33.60
Pakistan	34.25	45.61
Philippines	32.25	72.04
Poland	74.92	136.63
South Africa	88.46	112.83
Sri Lanka	51.78	50.26
Taiwan	57.45	.
Tanzania 91	30.96	26.07
Thailand	41.06	33.45
Tunisia	24.2	38.29
Turkey	46.22	63.80
U.K.	163.33	223.32
USA	246.67	328.21
W. Germany	251.03	349.88
Venezuela	53.48	84.61
Zambia	18.33	26.81

Notes to Table 1:

The World Bank has kindly provided us with these figures. It also reports that “The poverty lines chosen are the lowest available (most often for rural areas), and on a per capita basis for the average household size. Consumer price indices from the International Financial Statistics are used to inflate or deflate to 1985 levels unless otherwise noted. Consumption is private consumption per capita from the National Accounts (BESD) for 1985.”

Table 2

Pure Methodological Poverty Revision

Country	Survey Year	Poverty Headcount in 1st survey year (%)(Methodology 1)	Poverty Headcount in 2nd survey year (%)(Methodology 2)	Revision from Methodology (% Change from Methodology 1 Poverty Headcount)
Algeria	1995	<2	<2	0
Botswana	1985-6	33.0	33.3	+1
Czech Rep.	1993	3.1	<2	- 35.5
Guatemala	1989	53.3	39.8	- 25.3
Hungary	1993	<2	<2	0
Madagascar	1993	72.3	60.2	-16.7
Moldova	1992	6.8	7.3	+7.4
Morocco	1990-1	<2	<2	0
Nepal	1995	50.3	37.7	-25.0
Poland	1993	6.8	5.4	-20.6
Rwanda	1983-5	45.7	35.7	-22.0
Slovak Republic	1992	12.8	<2	-84.4
Slovenia	1993	<2	<2	0
South Africa	1993	23.7	11.5	-51.48
Tunisia	1990	3.9	<2	-48.7
Turkmenistan	1993	4.9	20.9	+326.5
Zimbabwe	1990-1	41.0	36.0	-12.2

Notes to Table 2:

All numbers in the third column are from Table 4, 'Poverty', in World Bank: *World Development Report 1999/2000*. Oxford University Press: New York, 2000, pp. 236-237 (www.worldbank.org/wdr/2000/fullreport.html). All numbers in the fourth column are from Table 4, 'Poverty', in World Bank. *World Development Report 2000/2001*. New York: Oxford University Press, 2001, pp. 280-281,(available at www.worldbank.org/poverty/wdrpoverty/report/index.htm).

Table 3

Poverty Changes: Possible Role of Methodological Revision

Country	Survey Year	Poverty Headcount in 1st Survey Year (%) as reported in WDR 1999/2000	Poverty Headcount in 2nd Survey Year (%) as reported in WDR 2000/2001	Possible Revision from Methodology (% Change from Methodology 1 Poverty Head Count)
Belarus	1993 v. 1998	<2	<2	n/a
Brazil	1995 v. 1997	23.6	5.1	-78
Bulgaria	1992 v. 1995	2.6	<2	-23
Chile	1992 v. 1994	15.0	4.2	-72
China	1995 v. 1998	22.2	18.5	-17
Colombia	1991 v. 1996	7.4	11.0	+49
Costa Rica	1989 v. 1996	18.9	9.6	-49
Côte d'Ivoire	1988 v. 1995	17.7	12.3	-31
Dominican	1989 v. 1996	19.9	3.2	-84
Ecuador	1994 v. 1995	30.4	20.2	-44
Egypt	1990-1 v. 1995	7.6	3.1	-59
Estonia	1993 v. 1995	6.0	4.9	-18
Ethiopia	1981/2 v. 1995	46.0	31.3	-32
Honduras	1992 v. 1996	46.9	40.5	-14
India	1994 v. 1997	47.0	44.2	-6
Indonesia	1996 v. 1999	7.7	15.2	+97
Jamaica	1993 v. 1996	4.3	3.2	-26
Jordan	1992 v. 1997	2.5	<2	-20
Kazakhstan	1993 v. 1996	<2	1.5	n/a
Kenya	1992 v. 1994	50.2	26.5	-47
Latvia	1993 v. 1998	<2	<2	n/a
Lesotho	1986/7 v. 1993	48.8	43.1	-12
Lithuania	1993 v. 1996	<2	<2	n/a
Mauritania	1988 v. 1995	31.4	3.8	-89
Mexico	1992 v. 1995	14.9	17.9	+20
Niger	1992 v. 1995	61.5	61.4	0
Nigeria	1992-3 v. 1997	31.1	70.2	+126
Pakistan	1991 v. 1996	11.6	31.0	+167
Panama	1989 v. 1997	25.6	10.3	-60
Romania	1992 v. 1994	17.7	2.8	-84
Russian	1993 v. 1998	<2	7.1	+255
Senegal	1991-2 v.1995	54.0	26.3	-51
Sri Lanka	1990 v. 1995	4.0	6.6	+65
Thailand	1992 v. 1998	<2	<2	n/a
Uganda	1989-90 v.	69.3	36.7	-47
Ukraine	1992 v. 1996	<2	<2	n/a
Venezuela	1991 v. 1996	11.8	14.7	+25
Zambia	1993 v. 1996	84.6	72.6	-14

Notes to Table 3:

All numbers in the third column are from Table 4, 'Poverty', in World Bank: *World Development Report 1999/2000*. Oxford University Press: New York, 2000, pp. 236-237 (www.worldbank.org/wdr/2000/fullreport.html). All numbers in the fourth column are from Table 4, 'Poverty', in World Bank. *World Development Report 2000/2001*. New York: Oxford University Press, 2001, pp. 280-281, (www.worldbank.org/poverty/wdrpoverty/report/index.htm

Table 4

Changes in Estimates of the Prevalence and Regional Distribution of Poverty Due to Methodological Revision

Region	Head count Index for 1985 PPP Poverty Line (% of population living below $1.00 a day at 1985 PPP)			Head count Index for 1993 PPP Poverty Line (% of population living below $1.08 a day at 1993 PPP)			% Change in head count from 1985 to 1993 PPP Poverty Lines		
	1987	1990	1993	1987	1990	1993	1987	1990	1993
East Asia	29.7	28.5	26	26.6	27.58	25.24	-10.44%	-3.23%	-2.92%
Eastern Europe & Central Asia	0.6	.	3.6	0.24	1.56	3.95	-60.00%	.	9.72%
Latin America & Caribbean	22	23	23.5	15.33	16.8	15.31	-30.32%	-26.96%	-34.85%
Middle East & North Africa	4.7	4.3	4.1	4.3	2.39	1.93	-8.51%	-44.42%	-52.93%
South Asia	45.4	43	43.1	44.94	44.01	42.39	-1.01%	2.35%	-1.65%
Sub-Saharan Africa	38.5	39.3	39.1	46.61	47.67	49.68	21.06%	21.30%	27.06%
Total	30.7	.	29.4	28.31	28.95	28.15	-7.79%	.	-4.25%

Notes to Table 4:

We draw the estimates of the prevalence and distribution of global poverty for the years 1987, 1990, and 1993 using the poverty line of $1 a day at 1985 PPP from Table 3 of Ravallion and Chen (1997). We draw the estimates of global poverty prevalence and distribution for these years using the poverty line of $1.08 a day at 1993 PPPs from Table 2 of Ravallion and Chen's "How did the world's poorest fare in the 1990s?." (Comparisons of these tables are also discussed in Chen and Ravallion (2001), pp. 9-10).

Table 5

1985 World Bank Poverty Line Updated by CPI vs. 1993 WB Poverty Line at PPP (National Currency Units)

Country	CPI Updated Old Poverty Line (1.00*PPP85*CPI)	New Poverty Line (1.08*PPP93)	Ratio, Updated Old PL / New PL	Country	CPI Updated Old Poverty Line (1.00*PPP85*CPI)	New Poverty Line (1.08*PPP93)	Ratio, Updated Old PL / New PL
Algeria	15.08	11.94	1.26	Luxembourg	48.13	39.71	1.21
Australia	2.13	1.43	1.49	Madagascar	665.13	567.64	1.17
Austria	18.22	14.84	1.23	Malawi	2.75	1.63	1.69
Bahrain	0.29	0.28	1.01	Malaysia	1.56	1.69	0.92
Bangladesh	10.90	13.59	0.80	Malta	0.25	0.26	0.98
Barbados	2.03	1.19	1.70	Mauritania	93.28	36.24	2.57
Belgium	48.76	39.40	1.24	Mauritius	12.98	7.41	1.75
Botswana	1.54	1.49	1.04	Morocco	5.31	3.30	1.61
Burkina Faso	160.95	110.66	1.45	Mozambique	631.85	864.85	0.73
Burundi	120.05	60.27	1.99	Nepal	10.10	9.89	1.02
Cameroon	341.47	152.42	2.24	Netherlands	2.77	2.20	1.26
Canada	1.56	1.37	1.14	New Zealand	2.45	1.61	1.52
Central Afr. Rep.	198.10	116.14	1.71	Niger	175.61	107.70	1.63
Chad	156.82	94.94	1.65	Nigeria	8.68	12.33	0.70
Chile	257.70	222.71	1.16	Norway	11.25	9.84	1.14
China	1.59	1.52	1.16	Pakistan	8.12	8.85	0.92
Colombia	317.76	214.39	1.48	Panama	0.74	0.48	1.55
Congo	376.58	219.11	1.72	Paraguay	1018.92	801.80	1.27
Costa Rica	84.02	57.85	1.45	Philippines	13.94	6.68	2.09
Denmark	11.66	9.88	1.18	Portugal	182.30	124.98	1.46
Dominican Rep.	7.37	4.47	1.65	Rwanda	106.04	58.69	1.81
Ecuador	1107.22	890.63	1.24	Saudi Arabia	4.80	2.52	1.90
Egypt, Arab Rep.	2.38	1.25	1.91	Senegal	210.63	136.64	1.54
El Salvador	9.52	4.78	1.99	Sierra Leone	281.97	250.47	1.13
Ethiopia	1.14	1.39	0.82	Singapore	1.53	1.71	0.90
Fiji	0.95	0.90	1.06	South Africa	2.13	1.79	1.19
Finland	8.52	6.93	1.23	Spain	151.55	125.72	1.21
France	8.36	7.05	1.18	Sri Lanka	12.47	13.75	0.91
Gabon	470.04	326.38	1.44	Sudan	77.28	50.89	1.52
Gambia, The	6.24	2.62	2.38	Swaziland	1.66	1.29	1.28
Germany	2.83	2.17	1.30	Sweden	14.35	10.80	1.33
Ghana	292.17	191.51	1.53	Switzerland	3.25	2.36	1.38
Greece	257.75	194.31	1.33	Syria	9.95	11.48	0.87
Guatemala	2.92	1.98	1.48	Tanzania	99.47	126.44	0.79
Haiti	5.60	2.60	2.15	Thailand	10.96	14.40	0.76
Honduras	3.63	2.08	1.74	Togo	189.00	95.93	1.97
India	8.23	7.51	1.10	Trinidad&Tobago	3.66	3.50	1.05
Indonesia	651.49	680.38	0.96	Tunisia	0.55	0.37	1.48
Iran, Islamic Rep.	257.73	275.01	0.94	Turkey	8190.38	6351.30	1.29
Ireland	0.91	0.71	1.27	United Kingdom	0.86	0.68	1.28
Italy	1983.72	1600.92	1.24	United States	1.34	1.08	1.24
Jamaica	14.39	12.64	1.14	Venezuela, RB	60.17	40.70	1.48
Japan	277.70	200.49	1.39	Zambia	326.81	239.14	1.37
Jordan	0.34	0.32	1.05	Zimbabwe	3.24	2.45	1.32
Kenya	23.70	12.60	1.88				
Korea, Rep.	736.56	743.48	0.99				
Kuwait	0.31	0.25	1.24				
Lesotho	1.67	1.20	1.39				

Table 5 Summary:

Number of Countries	92
Number of Countries With Ratio > 1	77
Number of Countries With Ratio < 1	15
Arithmetic Mean Ratio of Old PL to New PL (unweighted)	1.36
Geometric Mean Ratio of Old PL to New PL (unweighted)	1.31
Percentage of Sample Population for Whom Ratio > 1 (1985 Population)	81.62%
Arithmetic Mean Ratio of Old PL to New PL (weighted by 1985 population)	1.17
Geometric Mean Ratio of Old PL to New PL (weighted by 1985 population)	1.15

Notes to Table 5:

We calculate the "CPI Updated Old Poverty Line" by multiplying the $1.00 (1985 PPP) US poverty line by the 1985 PPP conversion factor (for all consumption) for each country and updating this figure to 1993 by multiplying by the ratio of the 1993 consumer price index to the 1985 consumer price index for the country in question. We calculate the "New Poverty Line" by multiplying the $1.08 US poverty line for 1993 PPPs by the 1993 PPP conversion factor (for all consumption) for each country. In accordance with the procedure followed by the World Bank, we draw the PPP conversion factors for 1985 from Table 3 of Summers and Heston's "A New Set of International Comparisons of Real Product and Price Levels Estimates for 130 Countries, 1950 – 1985" (1988) (by multiplying PC by XR to obtain the PPP for all consumption). China's PPP for 1985 is drawn from the on-line Penn World Tables 5.7 as it is not available in Summers and Heston (1988). Similarly in accordance with the World Bank's procedure, we draw the PPP conversion factors for 1993 from the table "World Bank 1993 Consumption PPP" from the "Global Poverty Monitoring" section of the World Bank's website at http://www.worldbank.org/research/povmonitor/PPP1993.htm). Because the PPP conversion factors reported for 1993 are not normalized to US = 1 (the conversion factor for the US is given as 1.009), we normalize by dividing the 1993 PPP conversion factor for each country by the PPP conversion factor for the US. We draw the country specific consumer price index data from the 1998 WDI ("Consumer price index (1987 = 100)", series code: FP.CPI.TOTL). Data for a small number of countries was dropped due to wildly improbable differences between the 1993 poverty lines calculated according to the two methods. We confirmed through examination of Economist Intelligence Unit country reports that in each of these cases a hyperinflation or change of currency was experienced. We provide arithmetic means because they are more familiar and not much different here from geometric means, which alone are meaningful for aggregating ratios.

Table 6A

1985 Relative Prices of Food vs. General Consumption

Country	PPP for Food	PPP for Bread and Cereals	PPP for All Consumption	Ratio PPP Food / PPP All Consumption	Ratio PPP B&C / PPP All Consumption
Australia	0.98	0.91	1.23	0.80	0.74
Austria	18.47	15.77	17.29	1.07	0.91
Bangladesh	8.49	6.91	5.93	1.43	1.16
Belgium	48.51	38.50	45.58	1.06	0.84
Benin	171.56	213.42	87.50	1.96	2.44
Botswana	1.02	1.04	0.48	2.13	2.17
Cameroon	259.50	396.60	129.10	2.01	3.07
Canada	1.27	1.24	1.23	1.03	1.01
Congo	313.60	477.50	160.80	1.95	2.97
Côte d'Ivoire	236.10	355.60	152.80	1.55	2.33
Denmark	10.74	8.85	10.22	1.05	0.87
Egypt	0.45	0.30	0.24	1.91	1.26
Ethiopia	1.30	3.08	0.74	1.77	4.17
Finland	7.74	7.39	6.38	1.21	1.16
France	7.42	7.08	7.39	1.003	0.96
Germany	2.42	2.10	2.54	0.95	0.83
Greece	89.32	72.18	78.16	1.14	0.92
Hong Kong	4.45	3.14	4.11	1.08	0.76
Hungary	20.51	11.45	17.02	1.21	0.67
India	5.42	4.81	4.07	1.33	1.18
Iran	83.24	63.21	61.55	1.35	1.03
Ireland	0.77	0.62	0.75	1.03	0.83
Italy	1450.00	1237.00	1304.00	1.11	0.95
Japan	296.90	260.10	212.90	1.39	1.22
Kenya	7.83	8.38	4.18	1.87	2.01
Korea	625.60	470.90	428.10	1.46	1.10
Luxembourg	46.85	37.89	43.54	1.08	0.87
Madagascar	429.20	572.50	234.00	1.83	2.45
Malawi	0.58	0.83	0.41	1.42	2.05
Mali	292.70	336.30	169.60	1.73	1.98
Mauritius	6.08	6.46	2.24	2.71	2.88
Morocco	3.49	3.55	2.10	1.66	1.69
Netherlands	2.55	1.99	2.50	1.02	0.79
New Zealand	1.20	1.19	1.30	0.92	0.91
Nigeria	1.47	1.98	0.86	1.71	2.30
Norway	11.18	9.39	9.19	1.22	1.02
Pakistan	4.69	3.89	3.73	1.26	1.04
Philippines	7.01	5.24	5.62	1.25	0.93
Poland	106.63	50.61	73.26	1.46	0.69
Portugal	104.60	93.53	70.38	1.49	1.33
Rwanda	53.34	120.49	34.93	1.53	3.45
Senegal	227.30	408.00	130.20	1.75	3.13
Sierra Leone	3.27	9.55	1.88	1.74	5.09
Spain	118.43	97.03	92.46	1.28	1.05
Sri Lanka	8.64	6.43	6.35	1.36	1.01
Swaziland	1.07	1.63	0.52	2.05	3.12
Sweden	10.89	10.06	8.18	1.33	1.23
Thailand	8.01	4.60	7.25	1.11	0.63
Tunisia	0.37	0.52	0.24	1.51	2.14
Turkey	181.80	101.40	176.80	1.03	0.57
Tanzania	26.38	20.05	13.52	1.95	1.48
U.K.	0.57	0.42	0.57	0.996	0.74
USA	1.00	1.00	1.00	1.00	1.00
Yugoslavia	129.30	76.80	103.20	1.25	0.74
Zambia	2.17	3.49	0.86	2.52	4.06
Zimbabwe	0.82	0.69	0.46	1.78	1.51

Table 6A Summary:	Full Sample (All Available Countries)	No High Income Countries	No High or High Middle Income Countries	Low Income Countries Only
Number of Countries	56	36	30	15
Number of Countries With Ratio > 1 for Food	51	36	30	15
Number of Countries With Ratio > 1 for B&C	35	29	26	15
Number of Countries With Ratio < 1 for Food	4	0	0	0
Number of Countries With Ratio < 1 for B&C	20	7	4	0
Arithmetic Mean Ratio, PPP Food / PPP All Consumption (unweighted)	1.44	1.64	1.71	1.69
Geometric Mean Ratio, PPP Food / PPP All Consumption (unweighted)	1.39	1.60	1.67	1.67
Arithmetic Mean Ratio, PPP Bread & Cereals / PPP All Consumption (unweighted)	1.60	1.97	2.17	2.39
Geometric Mean Ratio, PPP Bread & Cereals / PPP All Consumption (unweighted)	1.35	1.67	1.87	2.11
Percentage of Sample Population for Whom Ratio of PPP Food / PPP All Consumption > 1 (1985 population)	83.53%	100.00%	100.00%	100.00%
Percentage of Sample Population for Whom Ratio of PPP Bread & Cereals / PPP All Consumption > 1 (1985 population)	67.45%	86.21%	87.08%	100.00%
Arithmetic Mean Ratio, PPP Food / PPP All Consumption (weighted by 1985 population)	1.31	1.41	1.42	1.41
Geometric Mean Ratio, PPP Food / PPP All Consumption (weighted by 1985 population)	1.29	1.40	1.40	1.40
Arithmetic Mean Ratio, PPP Bread & Cereals / PPP All Consumption (weighted by 1985 population)	1.23	1.35	1.37	1.44
Geometric Mean Ratio, PPP Bread & Cereals / PPP All Consumption (weighted by 1985 population)	1.14	1.23	1.25	1.34

Notes to Table 6A:

We draw the PPP conversion factors for all consumption from Table 3 of Summers and Heston's "A New Set of International Comparisons of Real Product and Price Levels: Estimates for 130 Countries, 1950 – 1985" (1988) (by multiplying PC by XR to obtain the PPP for all consumption). We draw the PPP conversion factors for 'all food' and for 'bread and cereals' from table 5 of "World Comparison of Real Gross Domestic Product and Purchasing Power, 1985", Department for Economic and Social Information and Policy Analysis (United Nations, 1994). We provide arithmetic means because they are more familiar and not much different here from geometric means, which alone are meaningful for aggregating ratios.

Table 6B

1993 Relative Prices of Food vs. General Consumption

Country	PPP for Food	PPP for Bread and Cereals	PPP for All Consumption	Ratio PPP Food / PPP All Consumption	Ratio PPP B&C / PPP All Consumption
Antigua & Barbuda	2.75	3.04	2.32	1.18	1.31
Australia	1.16	1.58	1.33	0.87	1.19
Austria	15.84	16.32	13.74	1.15	1.19
Bahamas	1.17	1.30	1.14	1.02	1.14
Bangladesh	21.94	23.53	12.59	1.74	1.87
Belarus	24.15	26.36	14.29	1.69	1.84
Belgium	39.01	39.74	36.48	1.07	1.09
Belize	1.18	1.13	1.16	1.02	0.97
Botswana	1.61	1.89	1.38	1.17	1.38
Bulgaria	10.86	12.47	7.52	1.44	1.66
Cameroon	138.47	169.80	141.13	0.98	1.20
Canada	1.38	1.44	1.27	1.08	1.14
Congo, Rep.	263.36	261.00	202.88	1.30	1.29
Côte d'Ivoire	180.34	216.94	157.68	1.14	1.38
Croatia	2.63	2.60	2.00	1.31	1.30
Czech Rep.	10.96	7.03	9.16	1.20	0.77
Denmark	11.14	11.95	9.15	1.22	1.31
Dominica	2.44	2.95	1.93	1.27	1.53
Egypt	1.15	1.36	1.15	0.999	1.18
Fiji	0.94	1.14	0.83	1.13	1.37
Finland	8.78	10.82	6.41	1.37	1.69
France	7.51	7.57	6.53	1.15	1.16
Gabon	503.11	350.37	302.20	1.66	1.16
Germany	2.05	2.24	2.01	1.02	1.11
Greece	211.47	277.42	179.92	1.18	1.54
Grenada	2.23	2.23	1.65	1.35	1.35
Guinea	403.71	485.83	336.30	1.20	1.44
Hong Kong	6.12	6.86	7.17	0.85	0.96
Hungary	39.64	44.93	47.27	0.84	0.95
Iceland	114.68	112.81	84.59	1.36	1.33
Indonesia	662.75	628.40	629.99	1.05	0.997
Iran	302.57	359.26	254.64	1.19	1.41
Ireland	0.75	0.72	0.66	1.14	1.10
Italy	1757.08	1816.78	1482.34	1.19	1.23
Jamaica	15.71	14.34	11.70	1.34	1.23
Japan	273.33	306.55	185.64	1.47	1.65
Kenya	12.01	17.49	11.67	1.03	1.50
Korea, Rep.	1064.80	1454.73	688.40	1.55	2.11
Luxembourg	38.86	37.77	36.77	1.06	1.03
Malawi	1.67	2.01	1.51	1.11	1.33
Mali	129.14	198.39	123.77	1.04	1.60
Mauritius	6.29	5.49	6.86	0.92	0.80
Moldova	0.27	0.29	0.18	1.48	1.56
Morocco	2.86	2.88	3.05	0.94	0.94
Nepal	13.39	14.42	9.15	1.46	1.58
Netherlands	2.11	1.97	2.03	1.04	0.97
New Zealand	1.53	1.69	1.49	1.03	1.14
Nigeria	19.38	23.89	11.41	1.70	2.09
Norway	12.09	12.71	9.11	1.33	1.40
Pakistan	10.66	10.28	8.20	1.30	1.25
Philippines	7.36	9.40	6.19	1.19	1.52
Poland	8.42	8.48	8.26	1.02	1.03
Portugal	163.33	144.57	115.72	1.41	1.25
Romania	291.68	175.55	194.89	1.50	0.90
Russian Fed.	255.51	137.32	184.70	1.38	0.74
Senegal	124.29	184.12	126.52	0.98	1.46
Sierra Leone	369.05	543.75	231.92	1.59	2.34
Singapore	1.20	1.39	1.58	0.76	0.88
Slovak Republic	9.87	6.68	10.01	0.99	0.67
Slovenia	90.10	93.58	73.89	1.22	1.27
Spain	131.27	159.43	116.41	1.13	1.37
Sri Lanka	17.73	17.04	12.74	1.39	1.34
St. Kitts & Nevis	2.24	2.74	1.89	1.18	1.45
St. Lucia	2.31	3.15	1.83	1.26	1.72
St. Vincent & the Grenadines	2.23	2.29	1.50	1.49	1.53
Swaziland	1.13	1.46	1.20	0.95	1.22
Sweden	11.61	12.57	10.00	1.16	1.26
Switzerland	2.67	2.57	2.19	1.22	1.17
Thailand	15.97	12.85	13.33	1.20	0.96
Trinidad & Tobago	3.26	3.87	3.24	1.01	1.19
Tunisia	0.31	0.26	0.34	0.91	0.75
Turkey	8154.38	7211.75	5880.83	1.39	1.23
Ukraine	0.01	0.01	0.01	1.63	0.80
United Kingdom	0.61	0.56	0.63	0.98	0.89
United States	1.00	1.00	1.00	1.00	1.00
Vietnam	2235.14	2240.21	1582.26	1.41	1.42
Zambia	316.02	501.46	221.43	1.43	2.26
Zimbabwe	2.09	2.68	2.26	0.92	1.18

Table 6B Summary:	Full Sample (All Available Countries)	No High Income Countries	No High or High Middle Income Countries	Low Income Countries Only
Number of Countries	78	54	41	15
Number of Countries With Ratio > 1 for Food	63	44	33	13
Number of Countries With Ratio > 1 for B&C	61	42	31	14
Number of Countries With Ratio < 1 for Food	14	10	8	2
Number of Countries With Ratio < 1 for B&C	16	12	10	1
Arithmetic Mean Ratio, PPP Food / PPP All Consumption (unweighted)	1.21	1.25	1.25	1.29
Geometric Mean Ratio, PPP Food / PPP All Consumption (unweighted)	1.19	1.23	1.23	1.27
Arithmetic Mean Ratio, PPP Bread & Cereals / PPP All Consumption (unweighted)	1.29	1.34	1.32	1.56
Geometric Mean Ratio, PPP Bread & Cereals / PPP All Consumption (unweighted)	1.25	1.28	1.27	1.51
Percentage of Sample Population for Whom Ratio of PPP Food / PPP All Consumption > 1 (1993 population)	78.87%	90.60%	90.80%	91.37%
Percentage of Sample Population for Whom Ratio of PPP Bread & Cereals / PPP All Consumption > 1 (1993 population)	61.76%	64.01%	62.44%	75.62%
Arithmetic Mean Ratio, PPP Food / PPP All Consumption (weighted by 1993 population)	1.25	1.32	1.31	1.34
Geometric Mean Ratio, PPP Food / PPP All Consumption (weighted by 1993 population)	1.22	1.29	1.29	1.31
Arithmetic Mean Ratio, PPP Bread & Cereals / PPP All Consumption (weighted by 1993 population)	1.26	1.30	1.28	1.45
Geometric Mean Ratio, PPP Bread & Cereals / PPP All Consumption (weighted by 1993 population)	1.21	1.24	1.21	1.40

Notes to Table 6B:

We draw the PPP conversion factors for all consumption from the table "World Bank 1993 Consumption PPP" from the "Global Poverty Monitoring" section of the World Bank's website (http://www.worldbank.org/research/povmonitor/PPP1993.htm). We draw the PPP conversion factors for 'all food' and for 'bread and cereals' from Table 4.11, "Relative Prices in PPP terms" of the 1998 World Bank World Development Indicators. These data are not normalized to give the US a PPP of 1. To make these data comparable (i.e. for purposes of comparing their effects on a poverty line defined in the two years as US$1.00 and US$1.08), we normalize each series (all consumption, all food, and bread and cereals) to US = 1 by dividing the PPP conversion factor for each country by the PPP conversion factor for the US. We provide arithmetic means because they are more familiar and not much different here from geometric means, which alone are meaningful for aggregating ratios.

Table 7

Calculation of 'Endogenous' Food Based International Poverty Lines for 1993 Following the World Bank's Procedure

	Using PPPs for All Consumption		Using PPPs for All Food		Using PPPs for Breads & Cereals	
	Countries Ordered Lowest to Highest by Converted Poverty Line	Official Domestic Poverty Line Converted to $ / day Using 1993 PPPs for all Consumption	Countries Ordered lowest To Highest by Converted Poverty Line	Official Domestic Poverty Line Converted to $ / day Using 1993 PPPs for All Food	Countries Ordered Lowest to Highest by Converted Poverty Line	Official Domestic Poverty Line Converted to $ / Day Using 1993 PPPs for Breads & Cereals
1	Zambia	0.88	Zambia	0.62	Zambia	0.39
2	Indonesia	1.05	Bangladesh	0.68	Bangladesh	0.64
3	Thailand	1.10	Nepal	0.76	Nepal	0.70
4	Nepal	1.10	Thailand	0.92	Kenya	1.03
5	Bangladesh	1.19	Indonesia	1.00	Indonesia	1.06
6	Tunisia	1.26	Pakistan	1.15	Thailand	1.14
7	Pakistan	1.50	Sri Lanka	1.19	Pakistan	1.20
8	Kenya	1.55	Tunisia	1.38	Sri Lanka	1.24
9	Sri Lanka	1.65	Kenya	1.50	Egypt	1.45
10	Egypt	1.71	Turkey	1.51	Philippines	1.56
11	Morocco	1.78	Egypt	1.71	Tunisia	1.67
12	Turkey	2.10	Morocco	1.90	Turkey	1.71
13	Philippines	2.37	Philippines	1.99	Morocco	1.88
14	Jamaica	2.85	Jamaica	2.13	Jamaica	2.33
15	Poland	4.49	Japan	4.30	Japan	3.83
16	Japan	6.33	Poland	4.40	Poland	4.37
17	U.K.	7.34	Belgium	7.48	Belgium	7.34
18	Belgium	7.99	U.K.	7.52	U.K.	8.24
19	USA	10.79	Canada	10.72	Canada	10.23
20	W. Germany	11.50	USA	10.79	W. Germany	10.34
21	Canada	11.61	W. Germany	11.27	USA	10.79
22	Australia	13.92	Australia	15.92	Australia	11.68

Method A: Median of bottom 10

International Poverty Line Using PPPs for All Consumption:	1.22
International Poverty Line Using PPPs for All Food:	1.08
International Poverty Line Using PPPs for Bread & Cereals:	1.10

Method B: Median of bottom 30.3% of countries in sample

International Poverty Line Using PPPs for All Consumption:	1.10
International Poverty Line Using PPPs for All Food:	0.92
International Poverty Line Using PPPs for Bread & Cereals:	1.03

Notes to Table 7:

We compute international poverty lines for 'all food', 'bread and cereals', and 'all consumption' by following the Bank's methodology for computing the international poverty line for 1993 for all countries for which we had comprehensive data on 'all food' PPPs, 'bread and cereals' PPPs, and 'all consumption' PPPs for 1993 (see notes to table 6B for a discussion of our sources for these data). We use official domestic poverty lines in national currency units, which we constructed from the list (Table 1) in US dollars per month of the poverty lines used by the Bank in its own original effort to construct an international poverty line. We recovered the official domestic poverty lines' national currency amounts by converting the official domestic poverty lines expressed in dollars back into national currencies using PPPs for all consumption (as these were the conversion factors used by the Bank originally to construct the reported US dollar 'equivalents' of the official domestic poverty lines). More specifically, we first translate the Bank provided official domestic poverty lines into dollars per day (by multiplying by 12/365), and then translate them back into national currency by multiplying by the PPP conversion factor for all consumption. Once we have these poverty lines in the format of national currency units per day, we divide by the PPP conversion factors for 1993 for 'all food', 'bread and cereals', and 'all consumption' to obtain the 'equivalents' to the official domestic poverty lines in dollars per day as converted by using the PPPs for 'all food', 'bread and cereals', and 'all consumption', respectively. The Bank set the international poverty line at the median of the bottom 10 official domestic poverty lines converted at consumption PPP to obtain the 1993 dollar per day poverty line of $1.08 (see Ravallion and Chen (2000), "How did the World's Poorest Fare in the 1990s?"). We therefore compute the international dollar per day poverty lines using 'all food', 'bread and cereals', and 'all consumption' under two interpretations of the World Bank's methodology for setting the 1993 international poverty line. Under the first, methodology A, we simply order the official domestic poverty lines in dollars per day for all countries for which we have comprehensive data and set the international poverty line at the median of the bottom 10 poverty lines (when ranked according to the chosen PPP concept). (Here our poverty line for all consumption of $1.22 per day differs from the $1.08 of the Bank due to a loss of some countries in the sample for which data on all food PPPs and bread and cereals PPPs were not available). This corresponds to the interpretation of the Bank's methodology as being to set the international poverty line at the median of the bottom 10 official domestic poverty lines for which data is available. However, the Bank took the median of the bottom 10 poverty lines given a sample of 33 countries for which data was available. One could therefore alternatively interpret the Bank's methodology as taking the median of the subset corresponding to the bottom 30.3% of all countries for which data was available. We thus also employ method B, setting the international poverty line at the median of the bottom 30.3% of the official domestic poverty lines for all countries for which we had comprehensive data on 'all food' PPPs, 'bread and cereals' PPPs, and 'all consumption' PPPs for 1993 (22 countries), which corresponds approximately to the median of the bottom 7 countries in our sample. For poverty lines converted at all consumption PPPs, this second method happens also to corresponds to taking the median of the subset (7 countries) for which we have complete data from the 10 countries used by the Bank to construct the 1993 $1.08 poverty line. [The Bank used the median of the converted poverty lines of the following countries to construct its $1.08 1993 PPP poverty line: China, Tanzania, Zambia, India, Indonesia, Thailand, Nepal, Bangladesh, Tunisia, and Pakistan. We lack data on PPP conversions for food and bread and cereals for 1993 for China, Tanzania and India].

Table 8A

1993 Food Based Poverty Lines vs. General Consumption Based Poverty Line
Using 'Endogenous' Food Based International Poverty Lines Calculated by Method A

Country	All Food Poverty Line in National Currency ($1.08*PPP Food)	Bread and Cereals Poverty Line in National Currency ($1.10*PPP B&C)	All Consumption Poverty Line in National Currency ($1.22*PPP Consumption)	Ratio, All Food Line / All Consumption Line	Ratio, Bread and Cereals Line / All Consumption Line	Country	All Food Poverty Line in National Currency ($1.08*PPP Food)	Bread and Cereals Poverty Line in National Currency ($1.10*PPP B&C)	All Consumption Poverty Line in National Currency ($1.22*PPP Consumption)	Ratio, All Food Line / All Consumption Line	Ratio, Bread and Cereals Line / All Consumption Line
Antigua & Barbuda	2.97	3.34	2.83	1.05	1.18	Malawi	1.81	2.21	1.84	0.98	1.20
Australia	1.25	1.74	1.62	0.77	1.07	Mali	139.47	218.23	151.00	0.92	1.45
Austria	17.10	17.95	16.76	1.02	1.07	Mauritius	6.79	6.04	8.37	0.81	0.72
Bahamas	1.26	1.43	1.40	0.90	1.03	Moldova	0.29	0.32	0.22	1.31	1.40
Bangladesh	23.69	25.88	15.36	1.54	1.69	Morocco	3.09	3.17	3.73	0.83	0.85
Belarus	26.08	28.99	17.43	1.50	1.66	Nepal	14.46	15.86	11.17	1.29	1.42
Belgium	42.13	43.71	44.51	0.95	0.98	Netherlands	2.28	2.17	2.48	0.92	0.87
Belize	1.27	1.24	1.42	0.90	0.88	New Zealand	1.66	1.86	1.82	0.91	1.02
Botswana	1.74	2.08	1.68	1.04	1.24	Nigeria	20.93	26.28	13.92	1.50	1.89
Bulgaria	11.73	13.71	9.17	1.28	1.49	Norway	13.05	13.98	11.11	1.17	1.26
Cameroon	149.54	186.78	172.18	0.87	1.08	Pakistan	11.51	11.31	10.00	1.15	1.13
Canada	1.49	1.59	1.55	0.96	1.02	Philippines	7.94	10.34	7.55	1.05	1.37
Congo, Rep.	284.43	287.10	247.51	1.15	1.16	Poland	9.10	9.33	10.07	0.90	0.93
Côte d'Ivoire	194.76	238.64	192.37	1.01	1.24	Portugal	176.39	159.03	141.18	1.25	1.13
Croatia	2.84	2.86	2.44	1.16	1.17	Romania	315.01	193.10	237.76	1.32	0.81
Czech Rep.	11.84	7.74	11.17	1.06	0.69	Russian Fed.	275.95	151.05	225.33	1.22	0.67
Denmark	12.03	13.15	11.16	1.08	1.18	Senegal	134.23	202.53	154.35	0.87	1.31
Dominica	2.64	3.24	2.35	1.12	1.38	Sierra Leone	398.58	598.12	282.94	1.41	2.11
Egypt	1.25	1.50	1.41	0.88	1.06	Singapore	1.29	1.53	1.93	0.67	0.79
Fiji	1.01	1.26	1.02	1.00	1.24	Slovak Rep.	10.66	7.35	12.22	0.87	0.60
Finland	9.49	11.90	7.83	1.21	1.52	Slovenia	97.31	102.94	90.15	1.08	1.14
France	8.11	8.32	7.97	1.02	1.04	Spain	141.77	175.37	142.02	1.00	1.23
Gabon	543.36	385.40	368.69	1.47	1.05	Sri Lanka	19.15	18.74	15.54	1.23	1.21
Germany	2.22	2.46	2.46	0.90	1.00	St. Kitts & Nevis	2.42	3.01	2.31	1.05	1.30
Greece	228.39	305.17	219.50	1.04	1.39	St. Lucia	2.50	3.46	2.24	1.11	1.55
Grenada	2.41	2.45	2.01	1.20	1.22	St. Vincent & the Grenadines	2.41	2.52	1.83	1.32	1.38
Guinea	436.01	534.42	410.29	1.06	1.30	Swaziland	1.23	1.61	1.46	0.84	1.10
Hong Kong	6.61	7.55	8.74	0.76	0.86	Sweden	12.54	13.82	12.20	1.03	1.13
Hungary	42.81	49.42	57.67	0.74	0.86	Switzerland	2.89	2.82	2.67	1.08	1.06
Iceland	123.85	124.10	103.20	1.20	1.20	Thailand	17.25	14.13	16.27	1.06	0.87
Indonesia	715.77	691.24	768.58	0.93	0.90	Trinidad & Tobago	3.52	4.26	3.95	0.89	1.08
Iran	326.78	395.18	310.66	1.05	1.27	Tunisia	0.34	0.29	0.42	0.81	0.68
Ireland	0.81	0.79	0.80	1.01	0.99	Turkey	8806.73	7932.93	7174.62	1.23	1.11
Italy	1897.65	1998.46	1808.45	1.05	1.11	Ukraine	0.01	0.01	0.01	1.45	0.72
Jamaica	16.96	15.77	14.28	1.19	1.10	U.K.	0.66	0.61	0.76	0.86	0.80
Japan	295.19	337.21	226.48	1.30	1.49	USA	1.08	1.10	1.22	0.89	0.90
Kenya	12.97	19.24	14.23	0.91	1.35	Vietnam	2413.95	2464.23	1930.36	1.25	1.28
Korea, Rep.	1149.98	1600.21	839.85	1.37	1.91	Zambia	341.31	551.61	270.14	1.26	2.04
Luxembourg	41.97	41.54	44.86	0.94	0.93	Zimbabwe	2.25	2.95	2.76	0.82	1.07

Table 8A Summary And Analysis:	Full Sample (All Available Countries)	No High Income Countries	No High or High Middle Income Countries	Low Income Countries Only
Number of Countries	78	54	41	15
Number of Countries With Ratio > 1 for Food Poverty Line	47	36	26	9
Number of Countries With Ratio > 1 for B&C Poverty Line	57	41	30	14
Number of Countries With Ratio < 1 for Food Poverty Line	31	18	15	6
Number of Countries With Ratio < 1 for B&C Poverty Line	21	13	11	1
Arithmetic Mean Ratio, Food PL / All Consumption PL (unweighted)	1.07	1.10	1.10	1.14
Geometric Mean Ratio, Food PL / All Consumption PL (unweighted)	1.05	1.09	1.09	1.12
Arithmetic Mean Ratio, Bread & Cereals PL / All Consumption PL (unweighted)	1.16	1.20	1.19	1.41
Geometric Mean Ratio, Bread & Cereals PL / All Consumption PL (unweighted)	1.12	1.16	1.14	1.36
Percentage of Sample Population for Whom Ratio of Food PL / All Consumption PL > 1 (1993 population)	59.07%	72.14%	71.20%	61.30%
Percentage of Sample Population for Whom Ratio of Bread & Cereals PL / All Consumption PL > 1 (1993 population)	59.45%	61.41%	59.66%	75.62%
Arithmetic Mean Ratio, Food PL / All Consumption PL (weighted by 1993 population)	1.10	1.17	1.16	1.18
Geometric Mean Ratio, Food PL / All Consumption PL (weighted by 1993 population)	1.08	1.15	1.14	1.16
Arithmetic Mean Ratio, Bread & Cereals PL / All Consumption PL (weighted by 1993 population)	1.13	1.18	1.15	1.31
Geometric Mean Ratio, Bread & Cereals PL / All Consumption PL (weighted by 1993 population)	1.09	1.12	1.09	1.26

Notes to Table 8A:

We use international poverty lines computed for 'all food', 'bread and cereals', and 'all consumption' by following the Method A Interpretation of the Bank's methodology for computing the international poverty line for 1993, applying this to all countries for which we had comprehensive data on 'all food' PPPs, 'bread and cereals' PPPs, and 'all consumption' PPPs for 1993 (see notes to table 6B for a discussion of our sources for these data). The Bank set the international poverty line at the median of the bottom 10 poverty lines converted into US dollars per day using 1993 PPPs for all consumption (see Table 1) to obtain the 1993 dollar per day poverty line of $1.08 [see Chen and Ravallion (2001)]. Thus, under Method 1, we simply repeat this procedure of taking for each PPP concept the median of the bottom 10 poverty lines converted into US dollars per day using that PPP concept ['all food', 'bread and cereals', and 'all consumption' respectively] for all countries for which we have comprehensive data available. (See Table 7 and notes to Table 7 for further details). We used from the WDR 1994 for our classification of high-income, middle-income, and low-income countries. We provide arithmetic means because they are more familiar and not much different here from geometric means, which alone are meaningful for aggregating ratios.

Table 8B

1993 Food Based Poverty Lines vs. General Consumption Based Poverty Line
Using 'Endogenous' Food Based International Poverty Lines Calculated by Method B

Country	All Food Poverty Line in National Currency ($0.92*PPP Food)	Bread and Cereals Poverty Line in National Currency ($1.03*PPP B&C)	All Consumption Poverty Line in National Currency ($1.10*PPP Consumption)	Ratio, All Food Line / All Consumption Line	Ratio, Bread and Cereals Line / All Consumption Line	Country	All Food Poverty Line in National Currency ($0.92*PPP Food)	Bread and Cereals Poverty Line in National Currency ($1.03*PPP B&C)	All Consumption Poverty Line in National Currency ($1.10*PPP Consumption)	Ratio, All Food Line / All Consumption Line	Ratio, Bread and Cereals Line / All Consumption Line
Antigua & Barbuda	2.53	3.13	2.56	0.99	1.22	Malawi	1.54	2.07	1.66	0.93	1.25
Australia	1.07	1.63	1.46	0.73	1.12	Mali	118.81	204.34	136.15	0.87	1.50
Austria	14.57	16.81	15.12	0.96	1.11	Mauritius	5.78	5.66	7.55	0.77	0.75
Bahamas	1.08	1.34	1.26	0.85	1.07	Moldova	0.25	0.30	0.20	1.24	1.46
Bangladesh	20.18	24.24	13.85	1.46	1.75	Morocco	2.63	2.97	3.36	0.78	0.88
Belarus	22.22	27.15	15.72	1.41	1.73	Nepal	12.32	14.85	10.07	1.22	1.48
Belgium	35.89	40.93	40.13	0.89	1.02	Netherlands	1.94	2.03	2.24	0.87	0.91
Belize	1.08	1.16	1.28	0.85	0.91	New Zealand	1.41	1.74	1.64	0.86	1.06
Botswana	1.48	1.95	1.51	0.98	1.29	Nigeria	17.83	24.60	12.55	1.42	1.96
Bulgaria	9.99	12.84	8.27	1.21	1.55	Norway	11.12	13.09	10.02	1.11	1.31
Cameroon	127.39	174.90	155.24	0.82	1.13	Pakistan	9.81	10.59	9.02	1.09	1.17
Canada	1.27	1.48	1.40	0.91	1.06	Philippines	6.77	9.68	6.80	0.99	1.42
Congo, Rep.	242.29	268.83	223.16	1.09	1.20	Poland	7.75	8.73	9.08	0.85	0.96
Côte d'Ivoire	165.91	223.45	173.45	0.96	1.29	Portugal	150.26	148.91	127.29	1.18	1.17
Croatia	2.42	2.68	2.20	1.10	1.21	Romania	268.34	180.81	214.38	1.25	0.84
Czech Rep.	10.09	7.24	10.07	1.00	0.72	Russian Fed.	235.06	141.44	203.17	1.16	0.70
Denmark	10.25	12.31	10.07	1.02	1.22	Senegal	114.35	189.65	139.17	0.82	1.36
Dominica	2.25	3.04	2.12	1.06	1.43	Sierra Leone	339.53	560.06	255.11	1.33	2.20
Egypt	1.06	1.40	1.27	0.84	1.11	Singapore	1.10	1.43	1.74	0.63	0.82
Fiji	0.86	1.18	0.92	0.94	1.29	Slovak Rep.	9.08	6.88	11.02	0.82	0.62
Finland	8.08	11.14	7.06	1.15	1.58	Slovenia	82.89	96.39	81.28	1.02	1.19
France	6.91	7.79	7.18	0.96	1.08	Spain	120.77	164.21	128.05	0.94	1.28
Gabon	462.86	360.88	332.42	1.39	1.09	Sri Lanka	16.31	17.55	14.01	1.16	1.25
Germany	1.89	2.31	2.21	0.85	1.04	St. Kitts & Nevis	2.06	2.82	2.08	0.99	1.35
Greece	194.56	285.75	197.91	0.98	1.44	St. Lucia	2.13	3.24	2.02	1.05	1.61
Grenada	2.05	2.30	1.82	1.13	1.26	St. Vincent & the Grenadines	2.05	2.36	1.65	1.24	1.43
Guinea	371.42	500.41	369.93	1.00	1.35	Swaziland	1.04	1.51	1.32	0.79	1.14
Hong Kong	5.63	7.07	7.88	0.71	0.90	Sweden	10.68	12.94	11.00	0.97	1.18
Hungary	36.47	46.27	52.00	0.70	0.89	Switzerland	2.46	2.64	2.41	1.02	1.10
Iceland	105.50	116.20	93.05	1.13	1.25	Thailand	14.69	13.23	14.67	1.00	0.90
Indonesia	609.73	647.25	692.98	0.88	0.93	Trinidad & Tobago	3.00	3.99	3.56	0.84	1.12
Iran	278.36	370.04	280.10	0.99	1.32	Tunisia	0.29	0.27	0.38	0.76	0.70
Ireland	0.69	0.74	0.72	0.96	1.03	Turkey	7502.03	7428.11	6468.92	1.16	1.15
Italy	1616.51	1871.28	1630.57	0.99	1.15	Ukraine	0.01	0.01	0.01	1.37	0.75
Jamaica	14.45	14.77	12.87	1.12	1.15	U.K.	0.56	0.57	0.69	0.82	0.83
Japan	251.46	315.75	204.20	1.23	1.55	USA	0.92	1.03	1.10	0.84	0.94
Kenya	11.05	18.02	12.83	0.86	1.40	Vietnam	2056.33	2307.42	1740.49	1.18	1.33
Korea, Rep.	979.62	1498.38	757.24	1.29	1.98	Zambia	290.74	516.50	243.57	1.19	2.12
Luxembourg	35.76	38.90	40.45	0.88	0.96	Zimbabwe	1.92	2.76	2.49	0.77	1.11

Table 8B Summary And Analysis:	Full Sample (All Available Countries)	No High Income Countries	No High or High Middle Income Countries	Low Income Countries Only
Number of Countries	78	54	41	15
Number of Countries With Ratio > 1 for Food Poverty Line	35	29	23	9
Number of Countries With Ratio > 1 for B&C Poverty Line	59	41	30	14
Number of Countries With Ratio < 1 for Food Poverty Line	43	25	18	6
Number of Countries With Ratio < 1 for B&C Poverty Line	19	13	11	1
Arithmetic Mean Ratio, Food PL / All Consumption PL (unweighted)	1.01	1.04	1.04	1.08
Geometric Mean Ratio, Food PL / All Consumption PL (unweighted)	0.99	1.03	1.03	1.06
Arithmetic Mean Ratio, Bread & Cereals PL / All Consumption PL (unweighted)	1.21	1.25	1.24	1.46
Geometric Mean Ratio, Bread & Cereals PL / All Consumption PL (unweighted)	1.17	1.20	1.19	1.42
Percentage of Sample Population for Whom Ratio of Food PL / All Consumption PL > 1 (1993 population)	46.54%	61.96%	61.19%	61.30%
Percentage of Sample Population for Whom Ratio of Bread & Cereals PL / All Consumption PL > 1 (1993 population)	60.05%	61.41%	59.66%	75.62%
Arithmetic Mean Ratio, Food PL / All Consumption PL (weighted by 1993 population)	1.04	1.10	1.10	1.12
Geometric Mean Ratio, Food PL / All Consumption PL (weighted by 1993 population)	1.02	1.08	1.08	1.09
Arithmetic Mean Ratio, Bread & Cereals PL / All Consumption PL (weighted by 1993 population)	1.18	1.22	1.19	1.36
Geometric Mean Ratio, Bread & Cereals PL / All Consumption PL (weighted by 1993 population)	1.13	1.16	1.14	1.31

Notes to Table 8B:

We use international poverty lines computed for 'all food', 'bread and cereals', and 'all consumption' by following the Method B Interpretation of the Bank's methodology for computing the international poverty line for 1993 for all countries for which we had comprehensive data on 'all food' PPPs, 'bread and cereals' PPPs, and 'all consumption' PPPs for 1993 (see notes to table 6B for a discussion of our sources for this data). The Bank has provided us with a list of 33 official domestic poverty lines converted into US dollars per day using 1993 PPPs for all consumption (see Table 1), from which it set the international poverty line at the median of the bottom 10 poverty lines so converted to obtain the 1993 dollar per day poverty line of $1.08 [see Chen and Ravallion (2001)]. One can thus interpret the World Bank's methodology as taking the median of the subset corresponding to the bottom 30.3% of all countries for which data was available. In method B we therefore set the international poverty line at the median of the bottom 30.3% of all countries for which we had comprehensive data on 'all food' PPPs, 'bread and cereals' PPPs, and 'all consumption' PPPs for 1993 (22 countries), which corresponds approximately to the median of the bottom 7 countries in our sample. (See Table 7 and notes to Table 7 for further details). We drew from the WDR 1994 for our classification of high-income, middle-income, and low-income countries. We provide arithmetic means because they are more familiar and not much different here from geometric means, which alone are meaningful for aggregating ratios.

Table 9

Regressions: Ratios of Poverty Lines Corresponding to Distinct PPP Concepts in Relation to Measures of Living Standards

9.1 Ratios of Poverty Lines for 1985 and 1993, International Poverty Line Exogenously Fixed

9.1 A: 1985 Ratio of Food and 'Bread and Cereals' Poverty Lines to Consumption Poverty Lines ('Equivalent' to an Exogenously Fixed International Poverty Line)

	Dependent Variable: Ratio of 1985 Food PPPs to 1985 All Consumption PPPs				Dependent Variable: Ratio of 1985 Bread and Cereals PPPs to 1985 All Consumption PPPs			
Log Per Capita GDP in constant 1995 US Dollars at Exchange Rates	-0.142***				-0.363***			
	(0.026)				(0.063)			
	[-5.55]				[-5.73]			
Log GDP in US Dollars at PPP		-0.207***				-0.572***		
		(0.038)				(0.093)		
		[-5.42]				[-6.15]		
Log Infant Mortality Rate			0.225***				0.579***	
			(0.037)				(0.090)	
			[6.09]				[6.47]	
Log Under 5 Mortality Rate				0.203***				0.530***
				(0.033)				(0.079)
				[6.18]				[6.73]
Number of Observations	52	49	55	55	52	49	55	55
R-squared	0.37	0.38	0.41	0.42	0.40	0.45	0.44	0.46

9.1 B: 1993 Ratio of Food and 'Bread and Cereals' Poverty Lines to Consumption Poverty Lines (Equivalent to an Exogenously Fixed International Poverty Line)

	Dependent Variable: Ratio of 1993 Food PPPs to 1993 All Consumption PPPs				Dependent Variable: Ratio of 1993 Bread and Cereals PPPs to 1993 All Consumption PPPs			
Log Per Capita GDP in constant 1995 US Dollars at Exchange Rates	-0.037**				-0.071***			
	(0.016)				(0.023)			
	[-2.34]				[-3.09]			
Log GDP in US Dollars at PPP		-0.050**				-0.127***		
		(0.023)				(0.032)		
		[-2.16]				[-3.93]		
Log Infant Mortality Rate			.030				0.097***	
			(0.025)				(0.036)	
			[1.20]				[2.67]	
Log Under 5 Mortality Rate				0.028				0.094***
				(0.022)				(0.032)
				[1.24]				[2.90]
Number of Observations	78	78	73	73	78	78	73	73
R-squared	0.07	0.06	0.03	0.02	0.11	0.17	0.09	0.11

9.2 Ratios of Poverty Lines for 1993, International Poverty Line Determined 'Endogenously'

9.2 A: 1993 Ratio of Food and Bread and Cereals Poverty Lines to Consumption Poverty Lines Using 'Endogenous' Food Based International Poverty Lines Calculated by Method A

	Dependent Variable: Ratio of 1993 Food Poverty Line to 1993 All Consumption Poverty Line				Dependent Variable: Ratio of 1993 Bread and Cereals Poverty Line to 1993 All Consumption Poverty Line			
Log Per Capita GDP in constant 1995 US Dollars at Exchange Rates	-0.032**				-0.064***			
	(0.014)				(0.021)			
	[-2.33]				[-3.11]			
Log GDP in US Dollars at PPP		-0.044**				-0.116***		
		(0.020)				(0.029)		
		[-2.15]				[-3.95]		
Log Infant Mortality Rate			0.026				0.088***	
			(0.022)				(0.033)	
			[1.20]				[2.70]	
Log Under 5 Mortality Rate				0.025				0.085***
				(0.020)				(0.029)
				[1.24]				[2.93]
Number of Observations	78	78	73	73	78	78	73	73
R-squared	0.07	0.06	0.02	0.02	0.11	0.17	0.09	0.11

9.2 B: 1993 Ratio of Food and Bread and Cereals Poverty Lines to Consumption Poverty Lines Using 'Endogenous' Food Based International Poverty Lines Calculated by Method B

	Dependent Variable: Ratio of 1993 Food Poverty Line to 1993 All Consumption Poverty Line				Dependent Variable: Ratio of 1993 Bread and Cereals Poverty Line to 1993 All Consumption Poverty Line			
Log Per Capita GDP in constant 1995 US Dollars at Exchange Rates	-0.031**				-0.067***			
	(0.013)				(0.021)			
	[-2.36]				[-3.10]			
Log GDP in US Dollars at PPP		-0.042**				-0.120***		
		(0.019)				(0.030)		
		[-2.18]				[-3.93]		
Log Infant Mortality Rate			0.025				0.091***	
			(0.021)				(0.034)	
			[1.22]				[2.69]	
Log Under 5 Mortality Rate				0.024				0.088***
				(0.019)				(0.030)
				[1.26]				[2.91]
Number of Observations	78	78	73	73	78	78	73	73
R-squared	0.07	0.06	0.02	0.02	0.11	0.17	0.09	0.11

Notes to Table 9:

In Table 9.1 A we undertake regressions using as our dependent variable the ratios for 1985 of 'all food' and 'bread and cereals' poverty lines to 'all consumption' poverty lines obtained by using a $ 1 1985 international poverty line and converting this into national currency using PPPs for 'all food', 'bread and cereals', and 'all consumption' respectively. Because the poverty lines cancel out in the course of division, these ratios correspond to those for 'all food' and 'bread and cereals' PPPs to 'all consumption' PPPs reported in Table 6A. Standard errors are reported in parentheses below coefficients and t-statistics are reported in brackets below standard errors. We repeat this procedure in Table 9.1 B using as our dependent variable the ratios for 1993 of 'all food' and 'bread and cereals' poverty lines to 'all consumption' poverty lines (again, because the dollar poverty lines cancel out in the course of division, these ratios corresponds to those for 'all food' and 'bread and cereals' PPPs to 'all consumption' PPPs as reported in Table 6B). (See notes to Tables 6A and 6B for a discussion of our sources for these data). In Table 9.2 A, we regress the ratios (reported in Table 8A) of 1993 'all food' and 'bread and cereals' national poverty lines to 'all consumption' national poverty lines equivalent to an international poverty line, where the international poverty line was obtained by following the method A interpretation of the Bank's procedure of defining the international poverty line as the median dollar value of the bottom 10 official domestic poverty lines for which comprehensive data is available (when converted into dollars using PPPs for 'all food', 'bread and cereals', and 'all consumption' respectively -- see notes to Table 7 and Table 8A for details). In Table 9.2 B, we regress the ratios of 1993 'all food' and 'bread and cereals' poverty lines to 'all consumption' poverty lines reported in Table 8B, obtained by calculating the international poverty line by following the method B interpretation of the Bank's procedure, i.e. by setting the dollar per day poverty line at the median dollar value of the bottom 30.3% of official domestic poverty lines for which we have comprehensive data (converted into dollars using PPPs for 'all food', 'bread and cereals', and 'all consumption' respectively -- see notes to Table 7 and Table 8B for details), which here corresponds to the bottom 7 official domestic poverty lines for each concept. We obtain our data on per capita GDP at market exchange rates in constant 1995 US dollars and our data on per capita GDP converted at PPP from the Bank's 2000 World Development Indicators. Our data on infant mortality rates and under 5 mortality rates were provided by UNICEF.

Table 10

Comparisons of Poverty Lines and Estimates of Poverty Headcounts in Survey Year Selected Countries

10.1: Headcount Estimates from 1993 Food Based Poverty Lines vs. Estimates From 1993 Consumption Poverty Lines (NCU 'Equivalent' to an Exogenously Fixed International Poverty Line)

Country	Year	Estimate of Head Count Ratio for Consumption Poverty Line (Poverty Line = CPI*1.08*PPP Consumption)	Estimate of Head Count Ratio for All Food Poverty Line (Poverty Line = (CPI*1.08*PPP All Food)	Estimate of Head Count Ratio for Bread and Cereals Poverty Line (Poverty Line = CPI*1.08* PPPB&C)	Ratio of Head Count for All Food PL to Head Count for Consumption PL	Ratio of Head Count for Bread & Cereals PL to Head Count for Consumption PL	Ratio of (HC for Food PL / HC for Consumption PL) to (Food PL / Consumption PL)	Ratio of (HC for B&C PL / HC for Consumption PL) to (B&C PL / Consumption PL)
Bangladesh	1995-96	22.23	63.66	68.39	2.86	3.08	1.64	1.65
Cote d'Ivoire	1995	10.45	15.78	24.69	1.51	2.36	1.32	1.72
Kenya	1994	43.01	44.58	65.17	1.04	1.52	1.01	1.01
Mali	1994	57.92	59.85	77.03	1.03	1.33	0.99	0.83
Nepal	1995-96	25.33	51.29	56.44	2.03	2.23	1.38	1.41
Nigeria	1996-97	75.10	90.36	93.66	1.20	1.25	0.71	0.60
Senegal	1995	11.55	10.94	29.03	0.95	2.51	0.96	1.73
Sierra Leone	1989	57.32	68.53	78.75	1.20	1.37	0.75	0.59
Zambia	1996	60.86	75.99	89.10	1.25	1.46	0.87	0.65
Arithmetic Mean		40.42	53.44	64.70	1.45	1.90	1.07	1.13
Geometric Mean		32.84	44.66	59.34	1.36	1.81	1.03	1.03

10.2A: Headcount Estimates from 1993 Food Based Poverty Lines vs. Estimates From 1993 Consumption Poverty Lines (NCU 'Equivalent' to an Endogenous Food Based International Poverty Line Calculated by Method A)

Country	Year	Estimate of Head Count Ratio for Consumption Poverty Line (Poverty Line = CPI*1.22*PPP Consumption)	Estimate of Head Count Ratio for All Food Poverty Line (Poverty Line = (CPI*1.08*PPP All Food)	Estimate of Head Count Ratio for Bread and Cereals Poverty Line (Poverty Line = CPI*1.10* PPPB&C)	Ratio of Head Count for All Food PL to Head Count for Consumption PL	Ratio of Head Count for Bread & Cereals PL to Head Count for Consumption PL	Ratio of (HC for Food PL / HC for Consumption PL) to (Food PL / Consumption PL)	Ratio of (HC for B&C PL / HC for Consumption PL) to (B&C PL / Consumption PL)
Bangladesh	1995-96	30.68	63.66	69.56	2.08	2.27	1.35	1.35
Cote d'Ivoire	1995	15.24	15.78	25.66	1.04	1.68	1.02	1.36
Kenya	1994	49.71	44.58	66.12	0.90	1.33	0.98	0.98
Mali	1994	63.39	59.85	77.65	0.94	1.22	1.02	0.85
Nepal	1995-96	33.25	51.29	57.69	1.54	1.73	1.19	1.22
Nigeria	1996-97	79.51	90.36	93.89	1.14	1.18	0.76	0.63
Senegal	1995	16.33	10.94	30.00	0.67	1.84	0.77	1.40
Sierra Leone	1989	60.09	68.53	79.23	1.14	1.32	0.81	0.62
Zambia	1996	66.38	75.99	89.47	1.14	1.35	0.91	0.66
Arithmetic Mean		46.06	53.44	65.47	1.18	1.55	0.98	1.01
Geometric Mean		39.85	44.66	60.31	1.12	1.51	0.96	0.96

10.2B: Headcount Estimates from 1993 Food Based Poverty Lines vs. Estimates From 1993 Consumption Poverty Lines (NCU 'Equivalent' to an Endogenous Food Based International Poverty Line Calculated by Method B)

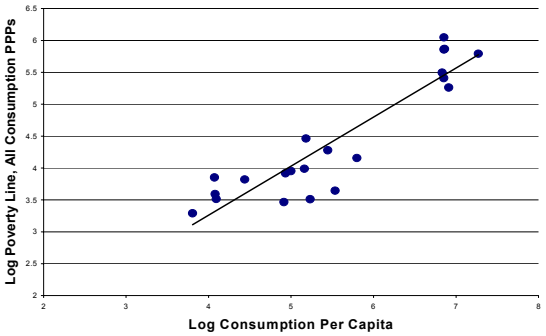
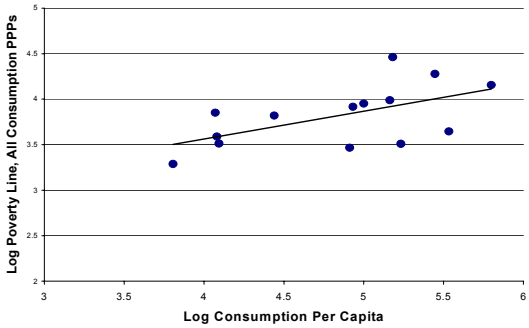
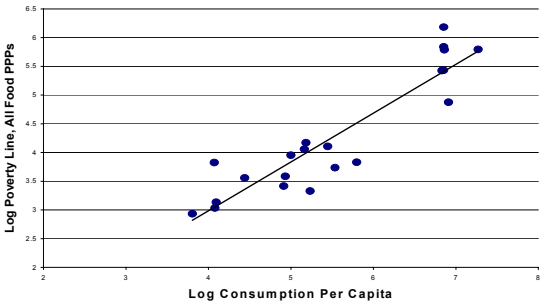
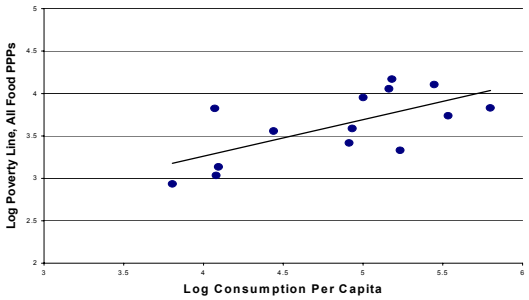
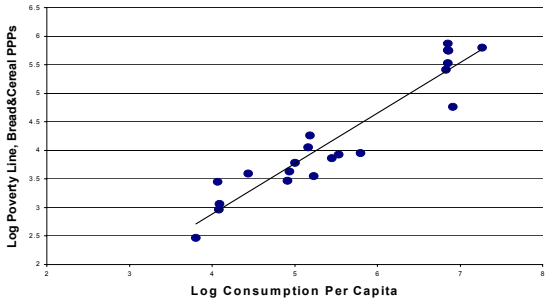
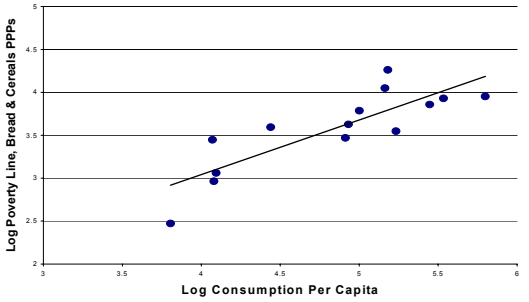
Country	Year	Estimate of Head Count Ratio for Consumption Poverty Line (Poverty Line = CPI*1.10*PPP Consumption)	Estimate of Head Count Ratio for All Food Poverty Line (Poverty Line = (CPI*0.92*PPP All Food)	Estimate of Head Count Ratio for Bread and Cereals Poverty Line (Poverty Line = CPI*1.03* PPP B&C)	Ratio of Head Count for All Food PL to Head Count for Consumption PL	Ratio of Head Count For Bread & Cereals PL to Head Count for Consumption PL	Ratio of (HC for Food PL / HC for Consumption PL) to (Food PL / Consumption PL)	Ratio of (HC for B&C PL / HC for Consumption PL) to (B&C PL / Consumption PL)
Bangladesh	1995-96	23.44	51.72	65.23	2.21	2.78	1.51	1.59
Cote d'Ivoire	1995	11.12	9.55	22.25	0.86	2.00	0.90	1.55
Kenya	1994	44.01	36.09	62.67	0.82	1.42	0.95	1.01
Mali	1994	58.76	52.42	75.4	0.89	1.28	1.02	0.85
Nepal	1995-96	26.47	39.96	53.18	1.51	2.01	1.23	1.36
Nigeria	1996-97	75.8	86.91	93.02	1.15	1.23	0.81	0.63
Senegal	1995	12.21	6.3	26.6	0.52	2.18	0.63	1.60
Sierra Leone	1989	57.73	64.47	77.5	1.12	1.34	0.84	0.61
Zambia	1996	61.71	69.56	88.11	1.13	1.43	0.94	0.67
Arithmetic Mean		41.25	46.33	62.66	1.13	1.74	0.98	1.10
Geometric Mean		33.88	35.59	56.81	1.05	1.68	0.95	1.02

Notes to Table 10:

We construct our headcount estimates using the World Bank's Povcal Program (see http://www.worldbank.org/LSMS/tools/povcal/ for details and to download the program). This program allows one to construct headcount, poverty gap, and other estimates by entering data on income distribution, average consumption or income, and poverty lines expressed in terms of annual income. We use the percentage shares of population quintiles for countries and survey years reported by the World Bank in the 2000-2001 World Development Report. We calculate average annual consumption per capita by dividing figures on total annual consumption by population in the survey year of the income distribution data. Shaohua Chen of the World Bank has kindly provided us with our data on total national final household consumption expenditure in national currency units (file name: gnp-pri-cons-cur-lcu.xls, received March 11, 2002). We use population data from the World Bank's 2000 World Development Indicators. In Table 10.1, we obtain poverty lines for 'all food', 'bread and cereals', and 'all consumption' by multiplying the $1.08 per day international poverty line by the PPP conversion factors for 1993 (from the World Development Indicators 1998 and from the PovertyNet website of the World Bank) for 'all food', 'bread and cereals', and 'all consumption' respectively, expressing this in annual terms by multiplying by 365, and updating the poverty lines to the survey year by multiplying by the ratio of the national CPI in the survey year to the national CPI in 1993 (this updating procedure is the same methodology used by the World Bank to estimate survey year poverty). We obtain our CPI data from the 2000 WDI (this is a CPI for all consumption, but similar results are obtained by using a national CPI for food, drawn from the U.N. Statistics Division database (http://unstats.un.org/), to update the 'all food' and 'bread and cereals' poverty lines). In Table 10.2 A, we use the poverty lines corresponding to 'all food', 'bread and cereals', and 'all consumption' PPP concepts corresponding to the Method A interpretation of the World Bank's procedure for constructing the international poverty line (i.e. that allows the international poverty lines corresponding to different PPP concepts to be determined endogenously by converting the official domestic currency poverty lines used by the World Bank in their own international poverty line construction exercise into dollars using the PPP conversion factors for 'all food', 'bread and cereals', and 'all consumption' respectively and then setting the international poverty line for each concept at the median of the bottom 10 of the resulting official domestic poverty lines expressed in US dollars, using all the countries for which comprehensive data is available -- See notes to Table 7 and Table 8A for details). In table 10.2 B, we use the poverty lines corresponding to 'all food', 'bread and cereals', and 'all consumption' PPP concepts corresponding to the Method B interpretation of the World Bank's procedure for constructing the international poverty line (analogous to the procedure employed in Method A, except setting the international poverty line at the median of the bottom 30.3% of the resulting official domestic poverty lines expressed in US dollars for which data is available, which in our case corresponds to setting the international poverty line at the median of the bottom 7 domestic poverty lines expressed in US dollars -- See notes to Table 7 and Table 8B for details). Again, in both Table 10.2 A and Table 10.2 B, we multiply our income per day figures by 365 to obtain annual poverty lines and update the poverty lines by multiplying by the ratio of the national CPI in the survey year to the national CPI in 1993. Arithmetic and geometric means for each column are reported at the bottom of each table. We provide arithmetic means because they are more familiar and not much different here from geometric means, which alone are meaningful for aggregating ratios.[38]

[38] These are un-weighted or simple arithmetic and geometric means, but results are qualitatively similar for arithmetic and geometric means weighted by country population in the survey year (although these are in general slightly higher for each column due to the population of countries (large relative to that of other countries in the sample) such as Bangladesh, Kenya, and Nepal which saw both relatively greater increases in poverty using food-based poverty lines as against general consumption poverty lines, and saw relatively greater increases in the head count index as a result of using food-based poverty lines relative to the increases in the poverty lines themselves).

Figure 1: Official Domestic Poverty Lines Converted into Dollars Using PPPs for Food vs. PPPs for General Consumption

All 21 Available Countries	Poorest 14 Countries
Official Domestic Poverty Lines Converted at PPP Using PPPs for All Consumption  Mean Log Poverty Line: 4.44 Standard Deviation Log Poverty Line: 0.95 $lnz_i = 0.181 + 0.770lny_i + residual_i$ (0.440) (0.078)	Official Domestic Poverty Lines Converted at PPP Using PPPs for All Consumption  Mean Log Poverty Line: 3.82 Standard Deviation Log Poverty Line: 0.34 $lnz_i = 2.347 + 0.304lny_i + residual_i$ (0.620) (0.127)
Official Domestic Poverty Lines Converted at PPP Using PPPs for All Food  Mean Log Poverty Line: 4.29 Standard Deviation Log Poverty Line: 1.04 $lnz_i = -0.411 + 0.849lny_i + residual_i$ (0.473) (0.084)	Official Domestic Poverty Lines Converted at PPP Using PPPs for All Food  Mean Log Poverty Line: 3.62 Standard Deviation Log Poverty Line: 0.40 $lnz_i = 1.538 + 0.430lny_i + residual_i$ (0. 670) (0.137)
Official Domestic Poverty Lines Converted at PPP Using PPPs for Bread and Cereals  Mean Log Poverty Line: 4.23 Standard Deviation Log Poverty Line: 1.05 $lnz_i = -0.651 + 0.883lny_i + residual_i$ (0.379) (0.067)	Official Domestic Poverty Lines Converted at PPP Using PPPs for Bread and Cereals  Mean Log Poverty Line: 3.57 Standard Deviation Log Poverty Line: 0.48 $lnz_i = 0.498 + 0.636lny_i + residual_i$ (0.588) (0.121)

Appendix 1

A Theorem Regarding the Use of Purchasing Power Parities for Living Standards Assessment

The theorem that we prove below shows that purchasing power parity factors that assign a single conversion factor for each country may not describe the comparative cost of purchasing a fixed basket of goods, for even a *single* such basket. For arbitrary prices, and *PPP*s associated with these prices, there is no guarantee that a basket of goods exists such that the *PPPs* can be understood as describing the relative cost of this basket around the world, even where these *PPPs* satisfy reasonable properties.

This result has significant implications for the validity of using such purchasing power parity factors in the assessment of living standards. In the text that follows the proof, the meaning and significance of the theorem are more fully explained.

Definitions:

Assume that there exist n countries and l commodities, and that $n, l > 1$.

The 'observed data', D, is the set of vectors of prices of goods $\{\mathbf{p}_i\}$, and vectors of quantities $\{\mathbf{q}_i\}$ demanded of those goods, that are observed in countries, where $\mathbf{p}_i, \mathbf{q}_i \in R^{l+}$, and $i \in \{1,..n\}$. The use of bold face here and below implies that the term in bold is a vector.

A 'PPP-system' is a function f such that $f: D \mapsto \{PPP_{jk}\}$, where $j,k \in \{1,..n\}$ and each $PPP_{jk} \in R+$. In other words, for a set of observed data, the PPP-system generates a set of positive real numbers (each one corresponding to an ordered pair of countries) called PPPs.

A PPP-system is 'transitive' if $PPP_{ik} = PPP_{ij}PPP_{jk}$ for all i,j,k.

A 'bilateral purchasing power constancy interpretation' for commodity bundle $\mathbf{q} \in R^l$ between countries j and k is the statement [call it $PPC(j,k,\mathbf{q})$] that $\mathbf{p}_j \bullet \mathbf{q} = (\mathbf{p}_k \bullet \mathbf{q})PPP_{jk}$.

The 'purchasing power constancy interpretation' for commodity bundle $\mathbf{q}$ is the statement that $PPC(j,k,\mathbf{q})$ for all j, k.

A set of PPPs generated by a PPP-system on the basis of observed data is 'within bounds' if for all j,k neither $\mathbf{p}_j > \mathbf{p}_k \bullet PPP_{jk}$, nor $\mathbf{p}_j < \mathbf{p}_k \bullet PPP_{jk}$, where the inequality refers to one that holds over every component of the price vectors.

Proposition:

Given any PPP-system and observed data, the set $\{\mathbf{q}\} \subseteq R^l$ for which the purchasing power constancy interpretation holds is a subspace of dimension of at most *(l-m+1)*, where *m* is the number of linearly independent price vectors in D. If the number of linearly independent price vectors is equal to the number of goods, then there will be at most one such $\mathbf{q} \neq 0$ (up to variations in the scale of this unique basket). Necessary conditions for there to exist a $\mathbf{q} > \mathbf{0}$ for which the purchasing power constancy interpretation holds are that the PPP-system is transitive and that the set of PPPs generated by it are within bounds. However, if the observed data does not take on specific values, no such **q** will exist.

Proof:

Rearranging *PPC(j,k,***q***)* gives the statement

$(\mathbf{p}_j - PPP_{jk}\,\mathbf{p}_k) \bullet \mathbf{q} = 0$, or $\mathbf{T}_{jk} \bullet \mathbf{q} = 0$ where $\mathbf{T}_{jk} = (\mathbf{p}_j - PPP_{jk}\,\mathbf{p}_k)$ (1)

We seek the set of **q** (call it *S*) that satisfies every such restriction given by prices and PPPs where one such restriction is generated by each pair of countries. It is evident that S is closed under addition and scalar multiplication and is therefore a subspace. As specifying a vector $\mathbf{T}_{jk}$ fully specifies the restriction corresponding to it, we may identify each restriction created by an ordered pair (j,k) of distinct countries as a $\mathbf{T}_{jk}$-restriction.

Note that setting $\mathbf{q} = \theta_{jk}\mathbf{T}_{jk}$ (with $\theta_{jk} \in R\text{-}0$) will cause **q** to fail the $\mathbf{T}_{jk}$-restriction, as long as $\mathbf{T}_{jk} \neq 0$. Let $T = \{\sum \theta_{jk}\mathbf{T}_{jk}$ such that $\theta_{jk} \in R\} = \{\theta_{j1k1}\mathbf{T}_{j1k1} + \ldots + \theta_{jzkz}\mathbf{T}_{jzkz}$ such that $\theta_{jiki} \in R$, $\mathbf{T}_{jiki} \in \{\mathbf{T}_{jk}\}\}$. Since *T* is closed under addition and scalar multiplication , it is a subspace. Let $d = dim\ (T)$. Then (see e.g. Hildebrand (1965), pp. 27-28) it is possible to find *(l-d)* linearly independent non-zero vectors (call them $\mathbf{u}_1, \mathbf{u}_2, \ldots \mathbf{u}_{l\text{-}d}$) that are orthogonal to all vectors in *T*, such that the basis vectors of *T* and $\mathbf{u}_1, \mathbf{u}_2, \ldots \mathbf{u}_{l\text{-}d}$ together span R^l. It is readily seen that any vector in the space (call it *U*) spanned by $\mathbf{u}_1, \mathbf{u}_2, \ldots \mathbf{u}_{l\text{-}d}$ is also orthogonal to all vectors in *T* and that any vector orthogonal to all vectors in *T* is in *U*. Therefore, $S = U$ and $dim\ S = (l\text{-}d)$. So to identify *dim S* it will suffice to identify $dim\ T = d$.

In order to do so, construct a set of linearly independent basis vectors in *T* by the following procedure. First order the $\{\mathbf{p}_j\}$ such that $\mathbf{p}_1$ through $\mathbf{p}_m$ are some set of linearly independent vectors. Now, consider $J = \{T_{(j)(j-1)}\} = \{\mathbf{p}_j - PPP_{j(j-1)}\,\mathbf{p}_{(j-1)}\}, j = 2..m$. It is clear that the vectors in this set are linearly independent, as if this were not true then the assumption that the $\{\mathbf{p}_j\}$ vectors are linearly independent would be violated [since if it were possible to write an element of *J* as a non-trivial linear combination of other elements of *J* then it would also be possible to write some element in $\{\mathbf{p}_j\}$ as a linear combination of other vectors in $\{\mathbf{p}_j\}$]. Note that there are only *(m-1)* elements in *J*. Since $J \subseteq T$, therefore *T* has dimension of at least *(m-1)* and *S* has dimension of

at most $l-(m-1) = l-m+1$. Is it possible to find an additional linearly independent $\mathbf{T}_{jk}$ vector in T ? Suppose that there exists an additional vector, $\mathbf{T}_{jk}$, that is linearly independent from those contained in J. This requires that it is not possible to write $\mathbf{T}_{jk}$ in the form $\mathbf{T}_{jk} = \alpha_1 \mathbf{T}_{12} + \alpha_2 \mathbf{T}_{23} + \ldots + \alpha_{(m-1)} \mathbf{T}_{(m-1)m}$ where the $\alpha_i \in R$ and are not all zero. We can re-write this requirement equivalently as follows:

$$\mathbf{p}_j\text{-}PPP_{jk}\,\mathbf{p}_k = \sum_{i=2}^{m} \alpha_{(i-1)}\,(\mathbf{p}_{i-1)}\text{-}PPP_{(i-1)(i)}\,\mathbf{p}_i) \qquad (2)$$

where not all of the α_{i-1} are zero, or (collecting terms on the right hand side)

$$\mathbf{p}_j\text{-}PPP_{jk}\,\mathbf{p}_k = \mathbf{p}_1\alpha_1 + \mathbf{p}_2(\alpha_2 - \alpha_1 PPP_{12}) + \mathbf{p}_3(\alpha_3 - \alpha_2 PPP_{23}) + \ldots \mathbf{p}_m(-\alpha_{m-1} PPP_{(m-1)m}) \qquad (3)$$

Now consider the case $(\mathbf{p}_j , \mathbf{p}_k) = (\mathbf{p}_1 , \mathbf{p}_m)$. i.e. suppose that $\mathbf{T}_{jk} = \mathbf{T}_{1m}$ [This choice is purely expository, for as we shall see, the reasoning from this point forward applies with appropriate modifications to any pair of price vectors chosen].

We can then re-write the last expression as follows:

$$\mathbf{p}_1(\alpha_1 - 1) + \mathbf{p}_2(\alpha_2 - \alpha_1 PPP_{12}) + \mathbf{p}_3(\alpha_3 - \alpha_2 PPP_{23}) + \ldots \mathbf{p}_m(\alpha_{m-1} PPP_{(m-1)m} + PPP_{1m}) = 0 \qquad (4)$$

Now, because of the linear independence of $\mathbf{p}_{1,..}\ \mathbf{p}_m$ this statement can be true if and only if the coefficients of all of the $\mathbf{p}_i$ are zero. In other words, the linear independence of $\mathbf{T}_{1m}$ from the elements of J requires that at least one of the coefficients in requirement (4) should be non-zero. When is this true? We can answer this by identifying when it is not true. Solving the system of equations given by the requirement that all of the coefficients are zero (through sequential substitution) gives the expression $PPP_{1m} = PPP_{12}PPP_{23} \ldots PPP_{(m-1)m}$. This is a transitivity relation involving PPPs. To understand the origin and significance of this expression more fully it is useful to write down the 'augmented matrix' representing the equation system:

$$\begin{pmatrix}
1 & 0 & .. & .. & .. & .. & .. & .. & 0 & 1 \\
-PPP_{12} & 1 & 0 & .. & .. & .. & .. & .. & 0 & 0 \\
0 & -PPP_{23} & 1 & 0 & .. & .. & .. & .. & 0 & 0 \\
0 & 0 & -PPP_{34} & 1 & 0 & .. & .. & . & 0 & 0 \\
0 & 0 & 0 & -PPP_{45} & 1 & 0 & .. & .. & 0 & 0 \\
0 & .. & .. & .. & .. & .. & .. & .. & .. & .. \\
0 & .. & .. & .. & .. & .. & .. & .. & .. & .. \\
0 & .. & .. & .. & .. & .. & .. & .. & 0 & 0 \\
0 & .. & .. & .. & .. & .. & 0 & -PPP_{(m-2)(m-1)} & 1 & 0 \\
0 & 0 & .. & .. & .. & .. & .. & 0 & -PPP_{(m-1)m} & -PPP_{1m}
\end{pmatrix}$$

Now, since there are $(m-1)$ unknowns (namely $\alpha_1, \ldots \alpha_{m-1}$) but m linear equations, a solution can be found only if at least one of the equations is redundant, in the sense that it may be expressed as a linear combination of the other rows. It is evident that (PPP_{12})Row1 + Row2 will be a new row with zero in the first column, 1 in the second column, and PPP_{12} replacing 1 in the last column. Similarly, PPP_{23} [(PPP_{12})Row1 + Row2]+Row3 will be a new row with zero in the

first two columns and with 1 in the third, but with $PPP_{12}PPP_{23}$ in the last column. Iterating this process over the first *(m-1)* rows gives an expression with zeroes everywhere but in the final column, which contains the expression $PPP_{12}PPP_{23}\ldots PPP_{(m-2)(m-1)}$. The resulting composite row times $PPP_{(m-1)m}$ will equal the final row of the augmented matrix if and only if $PPP_{1m} = PPP_{12}PPP_{23}\ldots PPP_{(m-1)m}$. In this case the rank of the augmented matrix will equal the rank of the coefficient matrix, and a unique solution will exist. Thus, the transitivity relation $PPP_{1m} = PPP_{12}PPP_{23}\ldots PPP_{(m-1)m}$ is a sufficient condition for (4) to hold. Is it also a necessary condition? This is clearly true in view of the matrix structure, since each successive pair of rows establishes a unique factor of proportionality that must hold with regard to the column for which they uniquely share a non-zero element. There can thus be only one way of combining the rows in a linearly dependent relation.

Let us now return to the choice of $\mathbf{T}_{jk} = \mathbf{T}_{1m}$. If we had explored the requirement for some other $\mathbf{T}_{jk}$ with $j,k \in (1,..m)$ this would have led simply to a distinct augmented matrix, in which the non-zero elements in the final column would have been located at rows j and k, and (from expression (3)) taken the values of 1 and PPP_{jk} respectively. The subsequent logic would have been exactly analogous, using operations involving the rows *(j,...k)* to establish the relation $PPP_{jk} = PPP_{j(j+1)}PPP_{(j+1)(j+2)}\ldots PPP_{(k-1)k}$, as a requirement for the non-existence of an mth linearly independent constraint $\mathbf{T}_{jk}$, where we suppose that $k > j$ and $j,k \in (1,..m)$. Moreover, since the initial choice of $\mathbf{p}_{1,..}\ \mathbf{p}_m$ as linearly independent constraints was arbitrary, and since any $\mathbf{p}_i$ could have been chosen to be in this set, a similar set of transitivity requirements would hold over any ordered set of PPPs. It follows that the transitivity requirement must hold for all possible chains of PPPs, if there does not exist an mth linearly independent constraint $\mathbf{T}_{jk}$.

Are the necessary conditions thus far outlined sufficient for the existence of a $\mathbf{q} \neq 0$ in S? This is *not* the case. To see this, note that the sufficient condition is that *no* $\mathbf{T}_{jk}$ other than the *(m-1)* already in J should be linearly independent from those in J. In that case T will have dimension *(m-1)* and the subspace $U = S$ orthogonal to it will have dimension of at least 1, ensuring the existence of $\mathbf{q} \neq 0$ in S. As we have just shown, the existence of only *(m-1)* linearly independent price vectors among the $\mathbf{T}_{jk}$ such that $j,k \in (1,..m)$ requires that all possible transitivity relations of the form $PPP_{jk} = PPP_{j(j+1)}PPP_{(j+1)(j+2)}\ldots PPP_{(k-1)k}$ (where we suppose that $k > j$) hold. If this condition (which implies transitivity of the PPP-system) holds, then a necessary condition for the existence of a $\mathbf{q} \neq 0$ in S is satisfied. However, this leaves open the possibility that some $\mathbf{T}_{jk}$ such that j or k or both are drawn from *(m+1,...l)* is linearly independent from the *(m-1)* vectors in J. In the case that j or k or both are drawn from *(m+1,...l)* at least one of the price vectors that define the constraint are linearly dependent upon $\{\mathbf{p}_{1,..}\mathbf{p}_m\}$. Can such a constraint $\mathbf{T}_{jk}$ nevertheless be linearly independent from the constraints in J (which were constructed purely from the set of linearly independent price vectors $\{\mathbf{p}_{1,..}\mathbf{p}_m\}$)? As we now show, the answer is yes. Moreover, the conditions under which such an additional linearly independent constraint can be ruled out, when added to transitivity of the *PPPs*, fully determine the sufficient condition for the existence of a $\mathbf{q} \neq 0$ in S. This is because if there are only *(m-1)* linearly independent $\mathbf{T}_{jk}$ it follows, as shown above, that S is a subspace of dimension $l-m+1$. As $m \leq l$, it follows moreover that S has dimension of at least 1, and that there exists $\mathbf{q} \neq 0$ in S.

We therefore now examine under what conditions there does not exist an mth linearly independent $\mathbf{T}_{jk}$ constructed from at least one price vector linearly dependent upon $\{\mathbf{p}_{1,..}\mathbf{p}_m\}$.

In this case $\mathbf{p}_j$-PPP_{jk} $\mathbf{p}_k$ in (3) takes the form:

$\sum_{i=1}^{m} \beta_i \mathbf{p}_i$-$PPP_{jk} \sum_{i=1}^{m} \gamma_i \mathbf{p}_i$ where the β_i and γ_i are coefficients $\in R$ representing the (possibly trivial) linear decomposition of the vectors $\mathbf{p}_j$ and $\mathbf{p}_k$ in terms of linearly independent vectors. Therefore, (3) takes the form:

$$\sum_{i=1}^{m} \beta_i \mathbf{p}_i\text{-}PPP_{jk} \sum_{i=1}^{m} \gamma_i \mathbf{p}_i = \mathbf{p}_1 \alpha_1 + \mathbf{p}_2(\alpha_2 - \alpha_1 PPP_{12}) + \mathbf{p}_3(\alpha_3 - \alpha_2 PPP_{23}) + \ldots \mathbf{p}_m(-\alpha_{m-1} PPP_{(m-1)m})$$

(5)

As above, by collecting terms associated with each $\mathbf{p}_i$, we can establish:

$$\mathbf{p}_1(\alpha_1 - \beta_1 + PPP_{jk}\ \gamma_1) + \mathbf{p}_2(\alpha_2 - \alpha_1 PPP_{12} - \beta_2 + PPP_{jk}\ \gamma_2) + \mathbf{p}_3(\alpha_3 - \alpha_2 PPP_{23} - \beta_3 + PPP_{jk}\ \gamma_3) + \ldots$$
$$\mathbf{p}_m(-\alpha_{m-1} PPP_{(m-1)m} - \beta_m + PPP_{jk}\ \gamma_m)) = 0 \qquad (6)$$

Now, from the linear independence of the $\mathbf{p}_i$, all of the coefficients in the resulting expression must be zero in order for $\mathbf{T}_{jk}$ to be a linearly dependent constraint. The consequent simultaneous equation system can be expressed by the following augmented matrix, where $\delta_i \equiv \beta_i$-$PPP_{jk}\ \gamma_i$:

$$\begin{pmatrix}
1 & 0 & .. & .. & .. & .. & .. & .. & 0 & \delta_1 \\
-\text{PPP}_{12} & 1 & 0 & .. & .. & .. & .. & .. & 0 & \delta_2 \\
0 & -\text{PPP}_{23} & 1 & 0 & .. & .. & .. & .. & 0 & \delta_3 \\
0 & 0 & -\text{PPP}_{34} & 1 & 0 & .. & .. & . & 0 & \delta_4 \\
0 & 0 & 0 & -\text{PPP}_{45} & 1 & 0 & .. & .. & 0 & \delta_5 \\
0 & .. & .. & .. & .. & .. & .. & .. & .. & .. \\
0 & .. & .. & .. & .. & .. & .. & .. & .. & .. \\
0 & .. & .. & .. & .. & .. & .. & .. & 0 & \delta_{m-2} \\
0 & .. & .. & .. & .. & .. & 0 & -\text{PPP}_{(m-2)(m-1)} & 1 & \delta_{m-1} \\
0 & 0 & .. & .. & .. & .. & .. & 0 & -\text{PPP}_{(m-1)m} & \delta_m
\end{pmatrix}$$

In exact analogy to the previous argument, we note that a solution can be found if and only if one of the rows can be expressed as a linear combination of the other rows, which will be true if and only if the resulting sum of the elements in the final column that results from linearly combining the first *(m-1)* rows (in the sequential manner discussed in the previous argument) is equal to the value in the final column of the last row. In particular for the linear dependence of $\mathbf{T}_{jk}$, we require that:

$$PPP_{(m-1)m} \ldots PPP_{23} PPP_{12}\ \delta_1 + PPP_{(m-1)m} \ldots PPP_{34} PPP_{23}\ \delta_2 + \ldots + PPP_{(m-1)m}\ \delta_{(m-1)} = -\delta_m \qquad (7)$$

It may be checked that this expression reduces to the transitivity requirements established in (4) when the δ_i take on appropriate values. For example, when $\delta_m = -PPP_{1m}$, $\delta_1 = 1$, and all other $\delta_i = 0$ then (7) reduces to the previously identified transitivity requirement that $PPP_{1m} =$

$PPP_{12}PPP_{23}\ldots PPP_{(m-1)m}$.

One restriction of type (7) is established for each $\mathbf{T}_{jk}$, as all the $\mathbf{T}_{jk}$ must be either in J or linearly dependent on the $\mathbf{T}_{jk}$ in J if T is to have dimension of only *(m-1)*. Moreover, for T to have dimension *(m-1)* it is necessary that *all* of these restrictions are true. Is there any guarantee that, for arbitrary $\{\mathbf{p}_i\}$and $\{PPP_{jk}\}$, any *one* such equation will hold (let alone all of them)? The answer is no. This is clear from examination of (7). The equation is monotonic in each of the δ_i and therefore of the β_i and γ_i that together define $\mathbf{p}_j$ and $\mathbf{p}_k$. It follows that if it is true for specific $\mathbf{p}_j$ and $\mathbf{p}_k$ then it is always possible, through perturbations of β_i and γ_i, to make it untrue. It follows that for arbitrary observed data ($\{\mathbf{p}_i\}$and $\{PPP_{jk}\}$) , it is possible (indeed probable) that dim $T > m\text{-}1$. In the case in which $m=1$ this implies that it will be *impossible* to find $\mathbf{q} \neq 0$ in S. More generally, where it is possible to find $\mathbf{q} \neq 0$ in S, the dimension of S will depend on the number of the equations (7) (associated with distinct $\mathbf{T}_{jk}$) that fail to be satisfied by the observed price data and the *PPP*s generated by the PPP-system. The number of restrictions (7) that fail to hold will determine the dimension of T and, residually, the dimension of $S = U$. Whether it is possible to find $\mathbf{q} \neq 0$ in S will depend on the observed data and cannot be established independently of it.

We have so far established conditions for the existence of $\mathbf{q} \neq 0$ in S but we have not yet identified conditions under which $\mathbf{q} > 0$ in S exists. If $\mathbf{q} \neq 0$ in S exists, then a necessary and sufficient condition for $\mathbf{q} > 0$ is that all $\mathbf{T}_{jk}$ should have at least one positive and at least one negative component. It is easy to see that this is a necessary condition since if any $\mathbf{T}_{jk}$ had components of only one sign then $\mathbf{T}_{jk} \bullet \mathbf{q}$ would not be equal to zero unless $\mathbf{q}$ had some negative and some positive components. Since $\mathbf{T}_{jk} = (\mathbf{p}_j - PPP_{jk}\,\mathbf{p}_k)$ it follows that this can be true iff $\mathbf{p}_j$ is greater than $PPP_{jk}\,\mathbf{p}_k$ in some components and less than it in others. In other words, a necessary condition for $\mathbf{q} > 0$ is that for any pair of countries j and k, PPP_{jk} should not for all possible goods either consistently overestimate or consistently underestimate the relative price of the good between the countries. A sufficient condition for a $\mathbf{q} > 0$ that satisfies all the $\mathbf{T}_{jk}$ is also that the $\mathbf{T}_{jk}$ should all have at least one positive and at least one negative component. This is clear because the $\mathbf{T}_{jk}$ together define a subspace. If they all have at least one positive and at least one negative component, then none of the basis vectors defined by the $\mathbf{T}_{jk}$ are in the positive orthant. It follows that there must exist a vector in the positive orthant that is orthogonal to the entire subspace. Thus *if* $\mathbf{q} \neq 0$ in S exists, then a necessary and sufficient condition for the existence of a $\mathbf{q} > 0$ that satisfies the purchasing power constancy interpretation is that the set of PPPs generated by the PPP-system are within bounds.

QED.

Interpretation of the theorem:

A possible interpretation of Purchasing power parities (PPPs) is that they refer to the relative costs of purchasing some (actual or average) commodity basket in the different countries of the world. We call thisthe purchasing power constancy interpretation of purchasing power parities.

It is always possible to generate a set of PPPs that satisfies the purchasing power constancy interpretation by *beginning* with some commodity basket, calculating the cost in national currency of purchasing this basket in the different countries of the world, and assigning to the PPPs the ratio of these costs across pairs of countries. Is it possible however to go the other way? In other words, can one start with a set of PPPs and prices in countries, and find a commodity basket for which the PPPs satisfy the purchasing power constancy interpretation? The theorem shows that this will be possible only under special conditions.

It will obviously not be possible for any assignment of bilateral PPPs that fails to satisfy transitivity. Such an assignment must have some bilateral PPPs such that

$$PPP_{ij} * PPP_{jk} \neq PPP_{ik}$$

The purchasing power constancy interpretation, however, implies the opposite. It requires that there be some commodity bundle q, such that the bilateral PPP for any two countries matches the ratio of the prices of q in these two countries. Thus:

$$PPP_{ij} = p_i(q) / p_j(q)$$
$$PPP_{jk} = p_j(q) / p_k(q)$$
$$PPP_{ik} = p_i(q) / p_k(q)$$

The purchasing power constancy interpretation can therefore hold only for assignments of bilateral PPPs that satisfy transitivity.

The purchasing power constancy interpretation also fails to hold when even a single bilateral PPP is not "within bounds," that is, such that, for all commodities c:

$$p_i(c) > PPP_{ij} * p_j(c)$$

Existing methods for calculating PPPs *routinely* produce such "out of bounds" bilateral assignments. Here is a simple example of how the EKS method does so:

Country	Quantity of Commodity 1	Price of Commodity 1	Quantity of Commodity 2	Price of Commodity 2	Quantity of Commodity 3	Price of Commodity 3
A	1	1	1	1	1	1
B	1	2	1	2	5	2
C	1	1	1	1	1	5

Here, for any commodity or possible bundle of commodities, its price in country B (expressed in B's currency) is twice its price in A (expressed in A's currency). The EKS method makes the bilateral PPPs it assigns sensitive to quantity and price data from third countries (C, in this example) in order that the PPPs it generates satisfy transitivity. Nevertheless, it yields $PPP_{BA} \neq 2$(in particular, $PPP_{BA} = 1.839$). And so we have, for all three commodities, $2 = p_B(c) > PPP_{BA} * p_A(c) = 1.839$. The EKS method thus produces a PPP_{BA} assignment that fails to be within bounds (and by a large margin).

Even when an assignment of bilateral PPPs is transitive and all its bilateral PPPs are within bounds, the purchasing power constancy interpretation will generally still fail to hold, when the number of countries exceeds the number of categories of commodities for which price data are

collected. In that case, the purchasing power constancy interpretation will hold only in rare cases in which the prices that exist in different countries are related in a specified way. Even if it does hold, it will hold only for a vanishingly small share of all commodity bundles. In this case, the commodity bundles for which the purchasing power constancy interpretation holds cannot be known in advance without observation of the prices at which commodities trade in the countries of the world.

The logic of the proof is simple. Each bilateral requirement that the comparative cost of purchasing a basket of commodities in two countries be defined by the PPP factor between those two countries creates a constraint that can remove one degree of freedom from those available when selecting a basket of commodities that meets the requirements. As the number of these constraints increases, the set of commodity bundles that can fulfill all of the requirements diminishes. The initial number of degrees of freedom available to choose a basket that meets the requirements is given by the number of commodities. Each pair of countries introduces a constraint that can reduce these degrees of freedom, but this need not occur if the newly introduced constraint happens to be linearly dependent upon those previously introduced, as in this case it does nothing to expand the space already taken up by the constraints and to diminish the space available to choose a commodity bundle.

The result implies that statements that PPPs identify the costs in different countries of purchasing a basket of commodities (even a basket that is a composite of the commodities consumed in different countries) do not have a sound conceptual foundation. The basic insight underlying the result is that assigning a *single* purchasing power parity factor to each country does not generally offer a supple or rich enough informational basis to capture the comparative costs of a basket of *many* commodities, each of which faces its own price in each country. There may not be even a sole composite or 'average' basket for which the PPPs suffice to capture the comparative cost of the basket in the different countries of the world. In this case, such PPPs can refer at most in a *vague* sense to the level of resources needed across countries to establish a common level of command over commodities.

A very simple way to see the point of the theorem is as follows: when people invoke PPPs, they often suggest that these reflect the "cost of living" in different countries. But this is highly misleading, as people live differently (consume different baskets) and PPPs cannot simultaneously value the relative costs of all of these baskets. One might think that it would be true, at least, that PPPs reflect the cost of some 'life' – interpreted as some basket, for example of an average sort. The theorem establishes, however, that not even this will normally be true. In this sense, it is generally not correct to say that PPPs establish the relative price level of goods and services in different countries. Specifically, the purchasing power constancy interpretation holds only for assignments of bilateral PPPs that satisfy a very demanding combination of conditions: The assignment must be transitive. Each bilateral PPP assigned must be within bounds. And, barring coincidental linear dependence of prices in different countries, the number of countries must exceed the number of categories of commodities for which price data are collected.

The more 'gross' the level of aggregation at which data is collected and compared (for example, concerning passenger transportation services, as opposed to bus rides), and therefore the lower is

l in relation to a fixed number of countries, the more sure it will be that the PPPs cannot be given a purchasing power constancy interpretation. In actual practice, "In all phases of the ICP, the number of basic headings [or comparable product categories for which price and quantity data are collected] has been about 150" [UN Dept. of Statistics, *Handbook of the International Comparison Programme*, p. 9], whereas the number of countries for which PPPs have been generated has been higher. For example, the Global Poverty Monitoring website of the World Bank reports consumption PPPs for 1993 for 159 countries. It must be stressed here that the theorem refers to the interpretation of PPPs rather than to their generation. Even though the number of countries in which the ICP actually collects primary price data is smaller than the number of basic headings, the number of countries for which it reports PPPs is larger, and this is what matters for the theorem. As a result, the theorem establishes that the widespread interpretation of current ICP generated PPPs as reflecting the ability to establish command over some roughly common set of goods and services the world over is without an adequate foundation.[39]

Appendix 2

Measuring the Magnitude of the Error in Estimation of Expenditure Requirements Resulting from the Use of Inappropriate PPPs

A measure of the magnitude of the error in the estimation of expenditure requirements resulting from the use of inappropriate PPPs can be derived as follows.

Suppose that we wish to examine the cost in a particular country, j, of purchasing a specific basket of goods, **q**. Suppose prices $\mathbf{p}_0$ prevail in the base country. The cost of purchasing **q** in the base country is then given by $C_0 = \mathbf{p}_0 \bullet \mathbf{q}$. What is the cost of purchasing **q** in country j? One way to estimate this is to use a general purchasing power parity factor PPP_{j0} derived from a prior calculation to estimate the equivalent cost. Following this method, the estimated cost in country j's currency and at its prices of purchasing **q** is given by $EC_j = PPP_{j0}\, \mathbf{p}_0 \bullet \mathbf{q}$. However, if prices, $\mathbf{p}_j$ are those that prevail in country j, then the *actual* cost, C_j, of purchasing this basket in country j is given by $C_j = \mathbf{p}_j \bullet \mathbf{q}$. The difference between estimated and actual costs, Δ , is given by:

$$\Delta = C_j - EC_j = \mathbf{p}_j \bullet \mathbf{q} - PPP_{j0}\, \mathbf{p}_0 \bullet \mathbf{q} = (\mathbf{p}_j - PPP_{j0}\, \mathbf{p}_0) \bullet \mathbf{q}$$

A rise in Δ is equivalent to a greater magnitude of the underestimate of the true cost of purchasing **q** in country j. It is evident from the expression that if $\mathbf{p}_j = PPP_{j0}\, \mathbf{p}_0$ (i.e. if the structure of prices is identical in the two countries and the PPP estimate accurately captures the factor of proportionality between the two price systems) then the estimate will be correct. If either of these two requirements does not hold, then the estimate will generally be incorrect. In particular, Δ will be higher if PPP_{j0} is lower and it will be higher if the quantities of those commodities in **q** for which prices are relatively higher in

[39] A typical example is the following statement in the World Bank's *World Development Indicators* 1998: "PPPs measure the relative purchasing power of different currencies over equivalent goods and services".

country j are higher. The implications for poverty assessment are immediate. A poverty line needed to achieve some level of consumption defined in terms of a base country's currency and prices will be underestimated to the extent that calculated PPPs fail to reflect the true costs of purchasing goods in general in the poor countries, and to the extent that the consumption of the poor in those countries consists disproportionately in goods for which relative prices are higher there. As we have argued above, there are substantial theoretical and empirical arguments as to why both of these phenomena *are* in fact present: Use of an informational basis and aggregation methods that give disproportionate significance to richer countries result in PPPs that are likely to overstate the purchasing power of poor country currencies. Further, the relative prices of goods consumed by the poor tend in turn to be higher than the relative prices of all goods consumed in a country. Both of these phenomena will cause underestimation of the poverty line necessary to achieve a particular level of command over the commodities needed to avoid absolute poverty.