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Use of Country Purchasing Power Parities for International  
Comparisons of Poverty Levels: Potential and Limitations

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# Use of Country Purchasing Power Parities for International Comparisons of Poverty Levels: Potential and Limitations

Bettina Aten and Alan Heston<sup>1</sup>

## Introduction

Individual scholars and expert groups have considered both physical and monetary measures to define a poverty line. Physical measures might be based upon caloric intake, or as considered in India, the number of square meals (thoughtfully defined) in a sample period and the purchase of clothing, with some experts also arguing for an inventory of physical household assets. The attraction of choosing physical measures is that they appear to avoid the necessity of converting currencies across countries to a common measure. However, the survey problems of identifying those below such thresholds, or of choosing equivalent food baskets across space to obtain the same caloric intake, involve problems as knotty as those using monetary measures. In any event the focus of this paper is on monetary measures of poverty and takes up three interrelated issues of comparing poverty levels within and between countries.

Section A outlines the usual methods of counting those in poverty across countries including the role of prices and expenditure weights used to generate the aggregate purchasing power parities (PPP). Some limitations of past practice are discussed in using data from the benchmark comparisons of the International Comparison Programme (ICP) and those of Penn World Table (PWT). An Appendix to the paper describes the approach to estimating PPPs in the Penn World Table (PWT) as well as the benchmark estimates, reconciliation methods, short-cut estimates and comparisons with other data sets. In Section B the nature of the item prices that enter into any calculation of PPPs, including PPPs for sections of the population (e.g., the poor, rural residents) is discussed including the recent work of Deaton, Friedman and Alata (2004) on comparing unit values of basic commodities consumed by various income deciles. It is concluded the present state of our knowledge on whether the poor pay different prices for the same products, use different outlets, or consume unique products is weak. However, it is clearly true that the expenditure patterns of the poor are different from the rich so it is possible, assuming common prices for the same items, to compute "poverty parities" both within and between countries. This issue is taken up in Section C where the sensitivity of "poverty PPPs" to different weighting patterns is explored.

## A. Generating Poverty Counts Across Space

There is a voluminous literature on this subject at the national level where this exercise began in the 1960s. Typically country poverty lines in monetary terms have been based on a particular consumption bundle, or as some percent of the median consumption. In either case, the poverty count, including variations involving intensity of

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poverty, provides a snapshot of the number or percent of persons below the line. The poverty count is usually from an income or expenditure survey, and has the great policy advantage that it can go up or hopefully down over time.

Even within countries like India, which first introduced reduction of measured poverty as a Plan goal, there may be lower poverty lines for rural than urban areas, because it is thought that prices for some of the consumption bundle will be lower in rural areas. Clearly if one wants to have an international poverty line, the problem of conversion of monetary measures is crucial. The factor used to make currencies comparable across countries, whether it be an exchange rate or purchasing power parity, does not change the underlying economic inequalities around the world. However, it does significantly affect the perception of economic size and of poverty. At PPPs the economies of China and India are ranked among the world's top seven, but not so at exchange rates. Similarly if one took a simple poverty line like one quarter the world per capita average, then at exchange rates in 1980, the proportion in poverty was near 80% in Asia and other poorer continents, while at PPPs closer to 50%.<sup>2</sup> So use of a particular conversion factor can significantly change our perception of the extent of the problem.

Use of the PPP for consumption is clearly more appropriate than say the PPP for gross domestic product (GDP) for converting any common international poverty line into local currencies. Both are available from benchmark ICP surveys, and for a larger number of countries for recent years in the World Bank, and for a longer time series in PWT. Are there other PPP concepts that should be considered? PWT and the benchmark International Comparison Program (ICP) estimates are based on plutocratic weights. An obvious alternative would be to use consumption weights of the poor. This is a fairly natural extension of what is done in temporal price indexes where one might estimate a consumer price index (CPI) for subgroups of the population like the elderly, or use democratic versus the more common plutocratic weights. Heston (1986) experimented with this approach using expenditure weights of the poor (approximately the lowest quintile) to estimate what could roughly be called a PPP of the poor. It is reported below.

## A1. Consumption PPPs with Weights of the Poor

As will be clear from the discussion in Part B, this experiment is only possible for ICP benchmark countries where parities for detailed headings of consumption are available. The exercise reported below was based upon 55 of the 60 countries in the 1980 ICP benchmark (Eastern Europe was excluded). Two limitations of this exercise should be mentioned. First, the exercise was not on input parities at the basic heading level of 100 or so categories of consumption, but on parities at the level of major expenditure components, about 10-20 summary categories. These summary category parities for 1980 had been estimated by the Geary-Khamis (G-K) aggregation method. It is possible that the over-all quantitative effect of alternative weights would differ from those using detailed parities, but it is not likely that the use of G-K parities would change the qualitative findings.

The second limitation of this exercise is that it used representative expenditure weights of a very diverse character. For Africa, the expenditure distribution was of

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<sup>2</sup> These comments and parts of this section are based on Heston (1986).

estate workers in Malawi. In Asia, the 3<sup>rd</sup> decile of rural workers in India; for South America, the lowest quintile in Brazil; and in high income countries, the 1960 expenditure distribution for those in poverty in the United States was used. The overall results are given in Table 1.

**Table 1: Ratio of PPPs of the Poor to those of the Average PPPs, 1980**

Region	Number of 1980 Countries	Ratio (Poor/Average PPP)
Africa	14	.876
Asia	5	1.205
South America	17	1.310
Developed Countries	19	1.064

The major surprises were that the weights made as much difference as indicated in Table 1, and that the results were so different in Africa. What drives the results in the developing countries is the relative price of food, which is typically high compared to other headings of consumption. This means that for Asia and South America, using a consumption PPP based upon an expenditure distribution closer to the poverty level would increase the number in poverty.

If we believed the African figures they would suggest the number in poverty in 1980 was substantially overstated, especially compared to Asia and Latin America. Prices of many food items were controlled in Africa in 1980, and while efforts were made to obtain prices of food as a weighted average of ration and free market prices, it is doubtful that this was actually done in many countries. The average ratios in Table 1 cover up a fair amount of country variance, but there were only 2 of the 14 countries in Africa where the parity of the poor was higher than of the national average. However, it seems probable that the African PPP for the poor is low because ration prices entered into the estimation with more weight than justified by their quantitative importance. A study carried out by Yonas Biru and Sultan Ahmad at the World Bank, based on prices collected in a number of African countries for 1985, produced a result similar to that reported above for Asia and South America.

There is little basis for strongly defending the numerical results of this earlier exercise. However, it seems to be an area worth more exploration, and this is the exercise that is reported in Part C of the paper.

## A2. Which Consumption Concept Should be Used?

The benchmark framework adopted in 1968 used an ICP concept of consumption, namely private consumption expenditure plus those parts of government expenditure on health and education that accrued directly to households. At the time this was not the practice in the 1964 SNA, but was recommended by the Eastern European countries participating in the 1970 benchmark comparison. The reason was that the ICP approach would allow more meaningful comparisons of consumption and its components across countries that financed their education primarily from public funds, versus countries that mainly used private expenditures. In the early benchmark comparisons both the ICP and SNA consumption concepts were presented.

Unfortunately, PWT versions 3 to 5.6 had to be based on the SNA concept of consumption, namely final household consumption; this was because the detail necessary to provide both concepts was not available for years and countries other than benchmark ones. Since the PWT treatment corresponds to the basis for most poverty estimates, it means that the consumption PPP from PWT is generally the best conversion factor for international poverty accounts available from that data set.

In 1993 the SNA adopted the original ICP convention and distinguished between Household Final Consumption Expenditure, the old SNA concept, and Household Actual Final Consumption, which differs primarily in including the expenditures of government and non-profit institutions on health and education that directly accrue to households. The OECD countries have all adopted the 1993 SNA, and PWT6.1 (2002) but most developing countries do not yet provide Household Actual Final Consumption. There is a significant political/economic debate in some countries as to whether publicly provided goods and services should be included in the poverty line, and this has also been an important research question.

In practice the question of publicly provided services is beyond the scope of this paper. If it were possible to add these services to survey data to obtain actual household final consumption by income or expenditure decile, it would clearly be valuable to calculate both. Hopefully this will become feasible in after the next round of the ICP. Since comparative poverty studies have conversion factors for currencies estimated in different ways, we have included in an appendix, a treatment of PWT methods with some comparisons with the World Bank and other sources.

## B. What Prices Should be Used to Estimate Poverty Parities?

Estimation of basic heading or aggregate PPPs is not easy, even if there were agreement on all the methods to be employed. Comparisons of prices of comparable goods and services below the detailed heading level are the basis for estimating benchmark PPPs. However, the devil is in the details. And this is important for the benchmark ICP comparisons, and consequently for our ability to compare poverty levels in common currency units across countries. One of the key issues involves the common practice of using national average item prices from each country. This sounds sensible enough. But when we are focused on a particular population group, namely those in poverty, do national average prices make sense? Probably national average prices do make sense in small countries, because most of the evidence suggests that the poor are affected by lack of capital that constrains them to buy in small quantities, not that they pay higher prices for the same items. However, in larger countries, there may be regional price differences that require more than one poverty line in order to not over count the poor in some areas and undercount in others.

### B1. Items Consumed by the Poor

Consider an item about which millions of us are experts, haircuts. On a summer day in Beijing one can get a haircut at shops with varying amounts of amenities. Excluding hotels the charges might range from 10 to 15 yuan in shops down to 1 or 2 yuan for no-overhead service on the street. Most PPP estimates will choose a shop that might be found in a range of other countries. As long as the prices in such shops

represent the relative costs of these services in different countries, the comparisons may still be reasonable, even if they do not explicitly price street barbers.

However, the existence of phenomena like street barbers raises some disturbing issues. If we consider provision of a minimum bundle of necessary goods and services as the basis for determining the cost of a poverty bundle, then what do we do about items like street haircuts that may only be consumed by the poor? Other examples include rice with broken grains that is indifferently sorted and cleaned, inferior grains like *ragi*, in India, second hand clothing or cloth remnants, and a wide variety of inferior or makeshift housing. The present state of PPP estimation, at best, only represents consumption of these items by goods and services in the relevant expenditure heading that are available in a wide range of countries.

## B2. The Prices to the Poor Question

Outlets and items used in the ICP are those thought important in the expenditures of each country, and often the items representing a heading in one country will be different from those in another country. But do the poor pay different prices for the same items than the middle and upper classes? Those in the PPP estimation business are silent on this issue, and if asked, will say we would be glad to have such data if only countries collected them.

In an early study, Kunreuther (1973) set forth a simple model to examine this question that took into account size of packaging, type of outlet, and inventory costs of large package sizes or bulk purchases. He found that in New Haven the same package size was more expensive in small stores than chain stores and of course that price per physical unit declined with increasing package size.<sup>3</sup> The link to poverty occurs in where stores are located, where the poor make purchases and the size of package they purchase. His result was quite clear. The poor purchased in smaller size packages in smaller stores. Why? Chain stores were not in poor neighborhoods and the poor had less access to their own transport to travel to larger stores. The poor interviewed in the Kunreuther study traveled smaller distances than the more affluent, and had less ability to store goods. In addition to the storage constraint, the poor had weekly per capita purchases that were about 2/3 those of the middle class sample interviewed. The poor also made more frequent purchases suggesting that storage and liquidity constraints may have both operated to produce purchases of smaller size packages.

That was New Haven in 1973. A study in northeast Brazil by Musgrove and Galindo (1988) reported a somewhat different result when they looked at small and large stores in large, medium and small cities. Their study was in 1985 and in an attempt to overcome the effects of the overall rapid inflation in Brazil in those years they concentrated the survey into two weeks in a month with only (!) a 5.41% price increase. Whereas Kunreuther found that neighborhood stores sold the same size package at a price typically 10 to 15% higher than the chains, Musgrove and Galindo did not find such

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<sup>3</sup> In Kunreuther's sample the price per unit over the range of package sizes was from 50% to 75% going from largest to smallest size. The sample of poor and middle class respondents were well aware of the range of sizes available and the differences in price per physical unit even though this was before mandatory displays of this information in chain stores. In the sample of neighborhood stores, about 20 to 40% stocked the largest package size for each of the 8 items sampled by Kunreuther.

a consistent pattern, with some items like manioc flour, being sold at lower prices by small retailers. Further, they report that for items sold in bulk, like beans or rice, the price per unit was the same whether the size was a cup or a much larger quantity. A limitation of their study was that it relied solely on the response of storeowners. They did not have direct information on where the poor made their purchases or at what prices, a point that Deaton makes even more strongly. However, it does appear that in urban areas of Brazil the poor do not face different prices for the same goods as the rich, in part because many neighborhoods have a wide range of socio-economic groups living in close proximity, which is not to say that lack of capital does not constrain the size of unit that the poor purchase.

Another question is whether we can learn anything from the prices of goods that are thought to be purchased solely by the poor. Examples of such items day-old bread, inferior grains, used clothing, or street corner haircuts. In the current round of the ICP several such items will be priced and compared across African countries. If the PPPs are similar to other consumption items between countries, then it would suggest that comparisons across countries can be carried out on the basis of typical items of consumption. However, those purchasing day old bread or used clothing need no proof that they are in poverty to buy these items, so there is only a presumption that they are mainly purchased by the very poor.

V. Rao (2000) dealt with this question in a study of villages in South India and found that, because the poor buy in very small quantities, the price paid per kilogram of basic food items is higher than for the middle classes. For example, a kilo of yellow split peas would cost Rs. 28, and a 100 gram purchase, Rs. 3.50. While poor families in a week may buy grains in sufficient bulk, important commodities like *pulses* may, as in the above example, have a 20% higher unit cost. Similarly cooking oil is often purchased by the poor in 100 gram lots, raising the unit price. In rural areas, there may be little effect of outlets, but Rao found a significant effect of size of purchases on the cost of a given quantity of consumption goods between the very poor and better off villagers.

What of urban areas of India? Anecdotal evidence abounds. Sales of individual cigarettes at small street stalls reveal the same higher costs per unit as a correlate of low income and/or little liquidity.<sup>4</sup> Even when prices per kilogram are similar for larger and smaller size purchases, there is typically in India a valuable gift with the large package.<sup>5</sup> Is there an outlet effect for the same size of purchase such as in New Haven, but which was not systematically evident in northeast Brazil? Certainly the ICP framework has in the past provided no basis for examining this issue.

Even if there is no outlet effect, if the poor pay as much as 10-20% higher prices because they buy in smaller quantities, this would be useful to know. Would it make any difference in measuring the number in poverty? It would clearly affect the total count and it would also affect a comparison of countries if these effects are not similar in

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<sup>4</sup> In fact the pricing of an individual cigarette at Rs. 2 can be fairly close to a package of 10, that may cost something over Rs. 15. And *panwallas* may use a low price of a single cigarette as a loss leader. But informants in Brazil and Egypt suggest that the mark-up or the single cigarette is typically 10-20% above buying a package.

<sup>5</sup> For example a 1 kilogram package of cooking oil may sell for Rs. 55 and a 5 kilogram package at Rs. 225, but the latter will include a plastic bucket valued at Rs. 90 by the seller, but at cost perhaps Rs.50. A significant percentage of larger size consumer items in India are discounted in this tied manner.



magnitude across countries. The studies cited above suggest the size of purchase and outlet effects may be different across countries, in which case it would be even more desirable to have country research on these issues.

Continuing this theme we report some results from an exercise carried out by Michael Perling, an undergraduate having low budget travel time in Asia and need for course credit for an independent study. With limited resources but an enthusiastic traveling companion, he collected some 2787 price observations on 13 commodities and services in rural and urban areas of China, Hong Kong, Thailand, Malaysia and Singapore in the Spring of 2002. While necessarily anecdotal, these results are suggestive of the type of survey that would address some of the issues raised above. Before highlighting a few of his findings, a slight digression is in order on the role that hedonics can play in estimation of parities for ICP purposes as well as for prices for particular population groups.

### B3. The Bureau of Labor Statistics (BLS) Approach to Spatial Price Comparisons

ICP type price research looked for models in terms of known frameworks for price collection for country consumer price indexes (CPI). CPI methodology typically either averages prices across outlets in a city and then takes the time to time price relative for the item, or takes a price relative at each outlet and averages the relatives across outlets in a city. In either case, information that might have been available on outlet type and average quantity purchased is discarded in the aggregation process. However, in general, price collectors know the location of their outlets, and could easily learn about typical sizes of purchase for items where it is relevant.

The BLS in the United States changed its framework for CPI price collection in a way that at first glance made the problem of using their data to compare prices across space very difficult. There is a sampling frame at which the price collector checks off for each entry level item (ELI) the outlet, the size, the type of package and other information about the volume seller within the ELI as indicated by an outlet employee. When this framework was adopted by BLS in the 1970s it seemed not to lend itself to place to place comparisons because collectors were not asked to price the same item in different outlets. There is no way of knowing in this framework whether, for example, the type of soft drink priced in supermarkets in Denver is the same as those priced in Chicago.

Kokoski, Moulton and Zieschang (1999) demonstrated that the framework of the CPI lends itself clearly to a hedonic approach. The BLS group began experimenting with the hedonic approach that was also part of early ICP work, namely the Country Product Dummy method (CPD) developed by Robert Summers (1973). The version that Summers used was a very straightforward hedonic regression model akin to those used for temporal studies (Griliches, 1990, Triplett, 1990, Berndt, 1995).

The prices are regressed against the two sets of dummy-variables as given in equation (1) below: one set contains a dummy variable,  $D_j$  for each country other than the numeraire country (country 1), and the second set with a dummy for each item specification,  $z_i$ .

$$(1) \ln p_{ij} = \sum_{i=1}^n \mathbf{b}_i z_i + \sum_{j=2}^m \mathbf{a}_j D_j + \mathbf{e}_{ij}$$

The transitive price parities,  $\mathbf{a}_j$ s, are the logarithms of the estimated country parity for the heading relative to the numeraire country. The item coefficients, the  $\mathbf{b}_i$ s, are the logarithms of the estimates of the average item price in the currency of the numeraire country (which could also be a regional currency).<sup>6</sup>

The innovation of the BLS group was to apply this data to estimating internal price parities by BLS city using the entry level item (ELI) characteristics of the prices being collected. The basic idea was similar to the CPD procedure. We may not be able to match the specific apples priced in Philadelphia with those priced in Los Angeles. But across all the BLS cities, so long as there is an overlap of specific apples priced in some cities, then a parity can be obtained for all apples between any pair of cities. If Apples is the basic heading, and price per kilo is the unit, then for each price observation in the ELI (Apples), there would be a code for outlet type, city, and item specification (Fuji, Rome, Granny Smith, Delicious, McIntosh, etc.)

The application of this hedonic framework that is proposed for a poverty PPP is set out in (2) below. The subscript  $j$  may refer to countries as in the CPD method or as in the BLS formulation,  $j$  may refer to regions within a country.

$$(2) \ln p_{ikj} = \sum_{i=1}^I \mathbf{b}_i z_i + \sum_{k=1}^K \mathbf{b}_k z_k + \sum_{j=2}^m \mathbf{a}_j D_j + \mathbf{e}_{kj}$$

The subscript  $i$  refers to the outlet type e.g., low, average or high income outlet), while the  $k$  are item specifications. With this information a simple hedonic regression could tell us whether coefficients for dummy variables in outlets in poor neighborhoods were significantly higher than in middle class neighborhoods for different types of items. However, neighborhoods are often not so easily defined, and the poor frequently make purchases in outlets where higher income persons make most of their purchases.

#### B4. Illustrations of Subnational PPPs by Population Group and Geography

Perling (2003) estimated a version of equation (2) for each of the thirteen items for which price information was collected in his Asian sample. A few of his findings illustrate the way in which check-list type price information may improve our understanding of how prices may differ across socio-economic groups and regions<sup>7</sup>.

<sup>6</sup> Chapter 10 of the draft ICP handbook deals extensively with the estimation of heading parties using both a weighted (roughly) and unweighted CPD and EKS. In this chapter simulations are developed indicating that the weighted CPD approximates more closely what would be obtained if all prices were available for all products in all countries than other methods.

<sup>7</sup> In the next set of benchmark comparisons for 2004 the term "structured product description" (SPD) will be used in place of item specification. Item specifications in the ICP have often been highly specific, and SPDs will introduce more flexibility into price collection by listing variations

Table 2 provides summary results for three items in Perling's study, a durable item, batteries, a perishable, onions, and a service item, haircuts for men. In Table 2 the price level of each item is presented. The base for the comparison prices collected in outlets in a middle class area of Chengdu city in China. For Bangkok, the PPP of the Thai Bhat to the Chinese Yuan is divided by the exchange rate and expressed as a percent. For example, the entry of 227 for a kilo of onions in Bangkok means that it costs the Bangkok middle class 2.27 as much as the price for a kilo of onions in Chengdu at exchange rates.

**Table 2. Price Levels in Selected Asian Markets, Spring 2002  
(Base Chengdu, Middle Class = 100)**

	Batteries	Onions	Haircuts
Bangkok – Middle	79	227	208
Bangkok – Poor	79	306	102
Singapore – Middle	135	500	582
Singapore – Poor	101	312	406
Shanghai - Middle	110	151	160
Shanghai – Poor	84	135	107
Fuli – Rural	59	85	22
Shenzen – Middle	109	164	126
Hong Kong – Middle	118	477	835
Chengdu – Middle	100	100	100

In Table 2, differences within a country can be interpreted as involving mainly a price difference for batteries (brand and outlet type is held constant) and onions (type of outlet held constant), and both price and quality for haircuts. The only rural setting is Fuli in China, which represents the lowest price level for all items. In the case of batteries, this may represent quality differences that are not observed (shelf life date, for example). The difference between poor and middle class in the sample represents judgments about the neighborhoods where the outlets were sampled. For a perishable item like onions, or a durable, like batteries there is only a suggestion that prices are the same or less in poorer than higher income neighborhoods in the same city. For a service item like haircuts, where quality of outlet is quite variable, poorer areas are always less expensive, probably reflecting lower quality. The results in Table 2 are not implausible and are not supportive of the notion that urban poor pay less than urban middle and upper classes.

Taken at face value, what would the information in Table 2 on China suggest about the geographical distribution of poverty within a country? As is well known, the poverty count is inversely related to the level of income in states, provinces or any other sub-national unit. This fact is often used to justify policies that promote overall economic growth in a country as the most useful way to reduce poverty. However, it is not

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that are acceptable. In this way an SPD is somewhere between the ELI and the traditional item specification. It may be noted that the Fundação Instituto de Pesquisas Economicas (FIPE) regularly estimates a consumer price index for São Paulo, using SPDs that permit the type of analysis described here. Professor Heron Carmo, Director of the CPI for FIPE kindly provided some sample data for the 55 districts of the city covering a range of outlets, brands and varieties of goods and services. Experiments have been carried out for a number items, including chicken, milk, dental services and shampoo and were quite promising and are continuing.

inconsistent with that position to also try to measure the poverty in different regions better than we do. In some cases better measures of the geographic dispersion of poverty may facilitate targeted policies that can supplement income growth in raising the economic, educational, or health status of specific groups. (See for example, Bigman and Fofack, 2000) The numbers for China in Table 2 suggest that taking account of price differences within China would reduce the poverty count in rural areas and poorer cities and raise them in better off cities.

A study of the poverty line in the United States by Aten (1996) illustrates another aspect of the regional problem. The notion of a national poverty line has been under review in the United States for a number of years but there remains a lack of consensus on exactly what to do. In the meantime, a number of poor in regions like the Dakotas are over-counted and those in large cities undercounted. In her work Aten [based on Kokoski, Cardiff and Moulton (1994)] study of inter-area price differences in the United States calculated the cost of the national poverty bundle in 1987 which was then \$5778 per person. This bundle cost \$4867 in the North-Central region versus just over \$6970 in San Francisco and the New York SMA, hence the likely over-count of those in the North-Central and South Regions compared to most large U.S. cities. While the government may have had political reasons to shy away from sub-national poverty lines, it has certainly not stopped a number of private firms from selling their estimates of how costly it is to live in different parts of the United States.

One conclusion is that it would be desirable, in countries with dispersion in prices and incomes across regions, to build up price levels by geographical region and population groups like the poor, perhaps by estimation of hedonic regressions for a number of goods and services. These hedonic equations would explain price *by item characteristics* like size of package, national or local brand and *market characteristics such as* type of outlet, region of the country, rural versus urban location, and within urban areas, poor and other neighborhoods. If the relative importance of different size purchases in rich and poor neighborhoods is known, it could be used to sharpen the PPP estimates for the poor. This would permit regional estimates of price levels, real income and numbers in poverty. National totals of poverty would then be summed up from the regional numbers. This would serve national statistical goals and provide at least as good a basis for policy decisions as obtained using a national poverty line and then estimating the numbers in poverty in each region.

### C. Estimation of Poverty Basket Parities

How is the World Bank poverty line of \$1 to \$2 a day estimated? Essentially national poverty baskets of low income countries are taken as a world standard. The national lines would have been converted to a world currency at purchasing power parities (PPPs). Any other country could provide a poverty count based on this line by converting the world line to their currency at PPPs, and use their income distribution to do the count. This would provide a number that might, or often might not, convey the level of the line to the world.<sup>8</sup>

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<sup>8</sup> Some users do not regard a dollar or so a day as helpful because they believe no one could live on \$1 or 2 in the United States. Of course, the dollar amount buys 3 or 4 times the amount of goods in a rural area of a poor country than it would in the United States. It might be of interest to note that about the time that the

The PPP used for this purpose refers to consumption, which is clearly more appropriate than the PPP for GDP. However, the PPPs from the ICP involve the budget shares of rich and poor countries as weights so the market basket is quite different from that of the poor. Further, in the case of several aggregation methods, the PPP for consumption is affected by the relative prices of investment goods and government services. For example, the PPPs for consumption in the Penn World Table are based upon an aggregation over all of GDP. The purpose of this section is to make a first pass at examining how sensitive are consumption PPPs and by extension conversions of world poverty lines to national currencies, to different methods, to different country groups, and different reference expenditure distributions used in estimation.

## C1. The Empirical Framework

The input parities that we use refer to 1996 and are derived from benchmark comparisons in different parts of the world between 1993 and 1996. As such, the underlying input parities are imperfect but adequate for the exercise at hand. The advantage of the data set is that it involves 115 countries, rich and poor. This permits us examination of several different weighting schemes to derive PPPs appropriate to converting world poverty lines. The variations considered are given in Table 3.

**Table 3: Sensitivity Tests of PPPs for Consumption to Countries Included, Level of Aggregation, and Method of Aggregation**

- A. *Use of Consumption PPPs based on all countries where the aggregation is over GDP. Variations on this include two different methods of aggregation.*
  - (1) *Geary-Khamis method with own country weights (as used in PWT)*
  - (2) *Geary-Khamis method with share weights (close to EKS)*
  
- B. *Use of Consumption PPPs based on all countries where the aggregation is only over Consumption. Variations include five different methods.*
  - (1) *Geary-Khamis method*
    - a. *country weights*
    - b. *share weights*
    - c. *representative share weights*
  - (2) *CPD method*
    - a. *share weights*
    - b. *representative share weights*
  
- C. *Use of Consumption PPPs based on only low-income countries where the aggregation is over Consumption. Further, in one exercise the group of poor countries did not include what may be termed the lower middle income countries. Variations on this include 2 different methods.*

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\$1 a day poverty line was being discussed, the homeless in Chicago on average had \$5 of spending money a day.

- (1) *Geary-Khamis method*
  - a. *Using share weights: Groups 1-4*
  - b. *Using representative share weights: Groups 1-4*
- (2) *CPD method*
  - a. *Using representative share weights: Groups 1-4*
  - b. *Using representative share weights: Groups 1-3*

The approach under A(1), and B (1) is to use the aggregation method underlying PWT. The weight of each country in the G-K method is its nominal total GDP<sup>9</sup>. This gives larger and higher per capita income countries more importance in determining world prices. For the purposes of determining a world poverty line, this approach has the advantage of providing a link between rich and poor countries for aggregates and sub-aggregates; however, the G-K method has a major disadvantage in giving rich countries too much influence on the results. Further, both variations under A are influenced by the relative prices of investment and government goods and services. They are presented here because they are frequently used in studies involving the world income distribution and poverty.<sup>10</sup>

Both B and C seem preferable to A because they only consider household consumption, and this is certainly the most relevant PPP for establishing international poverty lines. The major difference between B and C is that the latter only compares those countries that have a significant proportion of their populations in poverty at the international standard. Under either B or C it is possible to establish an international poverty line. Under C some rather ad hoc procedure would be required to express the line in US dollars or similar developed country currency, but this is more a question of presentation, not a major drawback.

We believe that the alternatives under C are in principle preferable to A or B, and there are arguments for both C (1) and (2). In both versions, each country is given equal weight. However, the weighted CPD method as developed by Prasada Rao (2002) is a superlative index (Diewert, 2003). The G-K method essentially values quantities in each country without allowing those quantities to adjust to the common prices, and so there is no substitution. Its major advantage is that it provides easy comparison of sub-aggregates, whereas the CPD method does not.<sup>11</sup>

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<sup>9</sup> In practice, PWT uses the nominal GDP modified by a ‘super-country-weight’ factor to adjust for the fact that the number of countries that participate in PWT changes every benchmark year. Details are in the Appendix.

<sup>10</sup> It should also be noted that variation A(2) is a version of G-K that gives each country the same weight. The EKS system which is commonly used in EU and OECD comparisons is usually run in an unweighted version so that Luxembourg is given the same weight as Germany. When the G-K system is run as in variation A(2) the results are very close to EKS, or if EKS is run with the weights in variation A(1) it is close to G-K. Also, the chain or spanning tree procedure that Robert Hill has employed tends to be close to that of EKS and hence variation A(2). For comparisons, see Heston, Summers and Aten (2001).

<sup>11</sup> The main reason that G-K is a useful aggregation procedure is that it is additive so that quantities are easily compared across countries for components and totals of GDP, and is analogous to national income accounting. Further, many decisions in the allocation of government and parts of investment are not obviously in response to price as is assumed in economic theory. However, in aggregations to obtain a PPP

## C2. Expenditure Distributions for the Poor

The benchmark data are based on an expenditure distribution of the average consumer in each country. These have been used in most work producing PPPs for poverty thus far, and are used again in A, B [except B (2b)], and in C (1a). In addition to the plutocratic weights involved in country expenditure distributions, we would like an expenditure distribution for those in poverty which departs from the average in obvious ways, like a higher proportion of expenditure on food. But there are two major problems in obtaining an expenditure distribution for those in poverty, one practical and the other conceptual. We begin with the practical data problem that, even though household surveys are widely available, expenditure distributions are not available by income groups in a standard format in an easily accessible manner.

Our procedure is to use reference distributions for the poor based on quintile distributions for two poor countries, Ethiopia and Guatemala. It would clearly be better to have distributions for each country by income or expenditure group. However, budget shares of the very poor are unlikely to be substantively different over the 26 headings of expenditure with which we will be working. Moving from average budget shares of a country to those of the poor in a country with a similar average income, is certainly going to be an improvement over using the average distribution.

There are 115 countries in our sample. We have put them into five groups based on their average income and on the percentage in poverty by international standards of \$1 or \$2 a day. The first group of countries has 40% or more of the per capita GDP of the United States (above \$14,000 GDP per capita in 2003 from PWT 6.0) and poverty counts of less than 2% at international standards. These are the countries that are excluded from the estimation in C above, a total of 36 countries. The initial distribution of countries is given in **Table 4**. Not every country met both criteria in the table, in which case countries were usually moved down a group.

The second difficulty in determining an expenditure distribution for the poor is the conceptual issue of simultaneity. We are seeking a conversion factor appropriate to those in poverty in each country, but we do not know the proportion in poverty and how their expenditure distribution departs from the average for the country. In order to cut through this simultaneity, we develop an iterative procedure as follows:

- a) Begin with an initial grouping of countries (**Table 4**) and a representative distribution of expenditure share weights as discussed above and shown in **Table 5**. Together with the input parities, estimate a set of PPPs (and international prices) for consumption for each country using the approaches outlined in **Table 3**,
- b) Find a new estimate of the PPP-adjusted per capita consumption of each country and a new grouping of countries,
- c) Also find a new representative distribution of expenditure shares for each country based on the newly estimated international prices,
- d) Repeat a)-c) until the country groupings are stable and/or the PPPs converge.

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for all of consumption, the G-K procedure appears much less satisfactory than the weighted CPD, EKS, or Tornquist.

**Table 4: Initial Country Groupings**

Country Group	Number of Countries	Per capita Income as Percent of US	Typical Poverty % based on \$2 per day
Very Low	15	5% or less	More than 50%
Low	13	5-10%	35-60%
Low Medium	24	10- 20%	10-65%
Medium	27	20-40%	10-35%
Medium to High	36	40% or more	Less than 2%

Details of the iterative procedure are given in the next section. There is rapid convergence (three iterations) in part because the representative distributions assigned to each group are fairly continuous, certainly more so than might be expected if we had actual decile expenditure distributions for each country. The initial representative distributions are provided in **Table 5** for the 26 headings of expenditure.

Neither Guatemala nor Ethiopia took part in the 1996 PPP exercise. If these countries were in this exercise, Guatemala would have been in Group 3 and Ethiopia in Group 1.<sup>12</sup> It was felt that the distribution for the first and second deciles for both countries was problematic, so only the higher deciles, grouped into quintiles, were used. For Group 1, Ethiopia's second quintile was used. For Group 2, the average of Ethiopia's and Guatemala's second quintiles was used. For Group 3-5, only Guatemala's distributions were used, from second to fourth quintile respectively.

This grouping has one obvious defect; it makes no use of the average expenditure distributions for individual countries in any of the representative country options in **Table 3**.<sup>13</sup> However, since the country distributions have been used for some of the estimating alternatives, some judgments can be made about whether the results for particular countries are sensitive to this treatment. The empirical results presented in the next section in effect allow us to narrow down the candidate methods in **Table 3**, and to apply the iterative approach to just one method.

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<sup>12</sup> The Ethiopian distribution is not available for all of the headings, but it has been possible to fill in the missing detail for present purposes. A distribution was also available for Uganda, but it contained a number of anomalies as one moved across deciles so it was decided not to use it.

<sup>13</sup> For example it might be possible to simply modify national distributions towards lower income households. This would take account of location (more substantial housing or more fuel needed in some countries by both rich and poor) or custom (calories from root rather grain crops), and clearly would improve on the present method.



**Table 5. Representative Distribution**

Representative Distribution for 5 Country Groups					
Expenditure Heading	Country Group				
	1	2	3	4	5
Cereals	0.485	0.340	0.196	0.187	0.150
Meat	0.025	0.052	0.080	0.078	0.071
Fish	0.003	0.004	0.005	0.005	0.004
Egg,Milk	0.055	0.066	0.077	0.100	0.103
Oils	0.056	0.033	0.010	0.008	0.008
Fruit,Vegetables	0.019	0.082	0.145	0.123	0.097
Other Foods	0.055	0.068	0.082	0.065	0.083
Non-Alcoholic Beverages	0.038	0.026	0.014	0.013	0.015
Alcoholic Beverages	0.004	0.004	0.004	0.003	0.004
Tobacco	0.002	0.002	0.001	0.001	0.002
Clothing	0.029	0.031	0.034	0.028	0.025
Footwear	0.016	0.017	0.017	0.015	0.014
Rent	0.063	0.087	0.111	0.108	0.106
Fuel	0.010	0.006	0.002	0.003	0.007
Furniture	0.005	0.003	0.001	0.002	0.003
Household Operation	0.014	0.025	0.037	0.038	0.037
Appliances	0.005	0.003	0.002	0.002	0.003
Health	0.018	0.034	0.049	0.057	0.064
Transport Equipment	0.002	0.002	0.002	0.002	0.003
Transport Operation	0.002	0.002	0.002	0.007	0.014
Transport Services	0.005	0.017	0.029	0.028	0.031
Communication	0.002	0.002	0.002	0.005	0.006
Recreation	0.007	0.008	0.008	0.011	0.016
Education	0.036	0.035	0.035	0.042	0.051
Restaurants	0.013	0.014	0.015	0.015	0.025
Other Expenditures	0.039	0.038	0.037	0.054	0.057
Total	1	1	1	1	1

### C3. The Empirical Results

**Tables 6a and 6b** in the Appendix require explanation. First, the countries are ordered by their per capita GDP expressed as a percentage of the United States in 1996 from PWT. This is the variable labeled **y** in column 1 of **Table 6a**. The ordering could also be done by consumption. Our preference for GDP is only that it indicates the potential of a country to provide goods to its population from domestic production. The countries are in five groups with the initially assigned group being given in column (2).

Columns (3) to (13) in **Table 6A** present the results in the form of price levels of consumption for each alternative given in **Table 3**. A consumption price level is the PPP

of consumption divided by the exchange rate, so a value greater than one means that the prices are greater than the reference country and currency. The reference currency is the US dollar but in **Table 6A** we have not used the United States as the reference country, as for example, is done in PWT. Rather, we have made the average of all the countries in Groups 1-4 as the reference price level because these countries are the focus of the paper; and for the technical reason that as a Group 5 country, the US does not enter some alternatives described in **Table 3**, namely columns (10) – (13). Thus, the average price level over the 79 countries in Groups 1-4 is taken as equal to one.

In those columns where the US appears, the price level of any country can be put on a US base simply by dividing by the US value, which is 2.55 in column 3 of **Table 6A**. The interpretation of the entry for Tanzania in column 3 (1.01), is that prices of consumption goods when converted at exchange rates are about the same as the other 79 countries in Groups 1-4. Prices in Tanzania are, of course, much lower compared to richer countries, about 40% of the US level (1.01/2.55). The advantage of using Group 1-4 countries as a reference price level is that it makes comparisons across the different alternatives in **Table 3** possible, and highlights the differences between rich and poorer countries' price levels.

In **Table 6B** the price levels in **6A** are expressed relative to column (9), which is a preferred method, namely a CPD version using representative weights for each income group. The entry for Tanzania in column (3) of **Table 6B** is 114 which is  $(1.01/.88*100)$ , the ratio of columns (3) to (9) in **Table 6A** for Tanzania, expressed as a percentage. The interpretation of 114 is that the use of a G-K estimate of consumption for Tanzania would produce an estimate of its consumption price level 14% higher than a CPD based estimate using representative consumption shares. The higher price level would imply Tanzania's real consumption estimate would be 14% higher using B (2b) alternative compared to A (1) in **Table 3**.

## **Some Detailed Results**

The next four subsections provide some evidence on methods, weights, and the use of shares of consumption expenditures of the poor. This material is summarized at the end for the less committed reader. The final section describes the results of the iterative approach when applied to the reference method (column 9 in **Table 6A and B**), the CPD approach with representative share weights.

### **1. Do Country Weights Make a Difference?**

The answer is clearly yes. When country production is used as a weight it makes a big difference, whether it is done over GDP as in column (3) or just over consumption as in column (5) methods. For example, the Philippines is in group (3) and its entry in column (5) of 0.78 means that its price level using Geary-Khamis (G-K) with country weights over consumption is much higher than the 0.57 entry when the G-K approach is used with representative weights, as in column (7). In fact using representative weights the Philippines would be in a lower income group. Also notable is the high variance across the columns of **Table 6A or 6B** for the former republics of the Soviet Union. This may reflect more on the quality of the benchmark data than the methods.

What is surprising is that when the same methods and weights are used for GDP and Consumption there are only small differences in the results. That is, most of the differences between columns (3): GK over GDP, own weights and (5):GK over Consumption, own weights, or (4) GK over GDP, share weights and (6): GK over Consumption, share weights, are under one percent. This may be because there are relatively few headings in the data set compared to full benchmarks that have about 100 consumption headings and 50 headings of investment and government. The variance across the countries in **Table 6A** is smaller using country weights, reflecting the fact that income distribution across countries is more compact in columns (3) and (5).

## **2. Do the Methods Make a Difference?**

Here, one major limitation on the exercise is evident in columns (12) and (13) of **Table 6B** where the entries are the same for each country group. This is because the CPD regression is applying the same weight to a given heading parity of each country within a group. It points to the value of having expenditure distributions reflecting the variations of individual countries, as described in the iterative procedure that follows.

However, having said this, the comparisons of columns (7): G-K all countries with (9): CPD all countries, and columns (11): G-K group 1-4 countries, with (13): CPD group 1-4 countries, suggest that there are noticeable differences between the G-K method and the CPD method when the weights are the same and the aggregation is over similar countries. However, the differences are much less pronounced than the difference between using country weights versus expenditure share weights and the same method, as can be seen between columns (5) and (6):G-K with own weights versus G-K with share weights. The effect of using different methods and the same weights would not be enough to change the group of any country. We will discuss this point further below.

## **3. What is the Effect of Using All Countries versus Just Poor Countries?**

Here we need to compare similar methods applied to different sets of countries: columns (6) and (10) using G-K and share weights; (7) and (11) using G-K and representative share weights, and columns (9) and (12): CPD with representative share weights. In general the results are not affected by whether the rich countries are included or excluded. When the estimation is confined to the lower 3 groups as illustrated in column (13), the same general pattern emerges.<sup>14</sup> Again if the number of headings were greater, there might be larger differences.

## **4. What is the Effect of Using the Expenditure Distribution of the Poor?**

Comparisons of columns (6) and (7): G-K using own share weights versus representative share weights, (8) and (9): CPD using own versus representative share weights and columns (10) and (11): G-K excluding rich countries, using own versus representative share weights, provide evidence on this effect. That is, on what difference it makes to use the percentage expenditure distribution for the whole country

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<sup>14</sup> The entries in column (13) are normalized so that each entry in Table 6A was divided by column (12) in 6A adjusted so the average value over groups 1-3 was 1.0. The corresponding column (13) entries in Table 6B have not been normalized.

versus a distribution for the poor. For the comparisons using the G-K method, the differences are not small, running 5-10%, even when the countries are in the same income group.

### **Summary of Table 6A and Table 6B Results**

A count based on **Table 6A**, suggests that 7 countries would move up a country group and 7 would move down when we compare their relative consumption in 1996 based upon representative shares in a CPD equation versus that in the present PWT, that is, columns (9) versus (3) in **Table 6A**. This represents 18% of the 79 countries in groups 1-4. If more detailed shares of the poor were available by country, there would be many more shifts in relative position of countries. And as a consequence the poverty counts by countries would also change, though nothing can be said about the total number in poverty based on the estimates in this paper. The differences are much smaller when we compare a CPD or G-K with own country shares and representative shares, under 10% of the countries. These preliminary results may not hold up when shares of the poor are available for more countries, and when we have more detailed expenditure distributions.<sup>15</sup>

In the future when individual expenditure distributions for the poor are available for a number of countries, how would the results be expressed in say US\$ if the US was not included in the estimation? One way to do this can be illustrated from **Table 6A**. Suppose it is agreed that a reasonable way to put together the world is represented by column (9), namely a CPD with country share weights. But for purposes of poverty PPPs it was thought best to not include the Group 5 countries, but rather to use the results of column (12). Then it is a relatively simple matter to read off the US entry of 1.76 in column (9) of **Table 6A**. It is the price level of the United States relative to all the countries in groups 1-4. To obtain the price level relative to the US for each of the countries in column (12), the value in each country would simply be divided by 1.76.

### **An Iterative Approach**

The share weights and corresponding results discussed so far do not take account of country differences in their expenditure distributions, but rather use representative distributions for the poor in five country groups. To introduce country effects, the following exercise was carried out. We begin with the results of the CPD over consumption using representative shares for the groups (column 9 in **Table 6A**)<sup>16</sup>.

Compute each country's real share of expenditures based on its nominal shares and the international prices from the CPD. This provides a new estimate of the real per capita consumption in each country, and a new ordering of the countries as was done in **Table 4**. As a result, some countries may move up or down a country group, for example, Ecuador from Group 3 to Group 2. The next step introduces country shares into the iterative procedure.

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<sup>15</sup> In the 2004-05 round of the ICP that is being coordinated by the World Bank, there should be roughly 150 countries including China and India, and there will be about 100 headings of consumption.

<sup>16</sup> In principle, the iteration could be carried out for any method that required a categorization of countries into income groups prior to estimating the poverty price level, that is, to any of the methods that used representative shares (columns 7,9,10-13 in **Table 6A**)

Using the new country groups, find the average distribution of real expenditure shares for each of the five groups, and for each heading. Then calculate the ratio of each country's real expenditure share to the average group share, and multiply this ratio by the initial representative share of the group. The resulting shares are normalized to sum to one across headings, for each country. These are the new individual country representative share weights. Re-estimate the CPD, using the same input parities but the new weights.

The procedure is repeated until the international prices converge, which is equivalent to countries remaining in the same order and group. This in fact took only four iterations as the representative shares play a stabilizing role in the procedure.

In comparison to a non-iterative approach, there was about twice as much country movement between groups as reported earlier for the 79 countries in Groups 1 to 4. First there were two countries that went down and then back up into their original group during the iterations. After convergence 16 countries had moved down a group and 8 had moved up. That is, 24 changes with the iterations and representative distributions modified by country information, as compared to 14 country group changes with no iterations and using only representative expenditure distributions.

When the CPD aggregation approach is used one also gets regression statistics that basically do not change from iteration to iteration. The RMSE is about .085 and the explained variance, .66 in all the equations. In other aggregation approaches, of course, an index number is computed for which it is assumed there is no error.

Some changes do occur in the weights that enter the iterations.. For example, the share of cereals for Group 1 was up by over ten percent after taking account of expenditure distributions within Group 1 countries as compared to its initial value of 0.485 based on the Ethiopian distribution. For other country groups, the share of cereals was less than the representative shares in Table 5 after taking into account national expenditure shares. For the Group 1 countries, oils and non-alcoholic beverages were slightly higher among foods, and rents, fuels, household operation and education were lower when modified by national distributions.

We also examined the coefficients on the various expenditure shares that are a part of the CPD regressions, which are analogous to what are termed international prices in the G-K aggregations. When these are compared across the various iterations the coefficients only vary in the third decimal place. This is not surprising since most variation will be for individual countries within each group.

## Concluding Remarks

This paper has reviewed some of the strengths and limitations of PWT for providing suitable PPPs for international poverty comparisons. It described some aspects of PPP estimation compared to alternatives and suggested several ways in which estimation of PPPs for the poor might be improved in benchmark ICP comparisons.

It seems clear that the weights used in PWT are not satisfactory for this purpose. It turns out that it is not so much that the aggregation in PWT is over GDP, but rather the weights suitable for national income accounting do not seem appropriate for poverty measures. Perhaps if China and India were in the exercise this conclusion might be modified. But it appears that use of country shares or poverty shares as the weight are a more appropriate way to go to answer the question about the PPP of the poor in each country.

Only two aggregation methods were used here and others should be examined. However, there was not much to choose between the methods, and previous work has shown that variations of both the G-K and CPD are known to be similar to EKS (Sergeev, 2003). An attempt was made here to represent the expenditure distributions of the poor based on household surveys in Guatemala and Ethiopia. Ideally one would like the distribution of expenditures for each country around the likely international poverty line, and then to carry out an iterative procedure such as Deaton (2004) has used for India and Indonesia. However, even the iterations computed here, using only a rough expenditure distribution for the five low-income groups, modified by their national expenditure shares, suggest a promising line of research.

Improvements to current methods of using average prices and expenditures to estimate country price levels for poverty comparisons can be summarized as

- a) Taking into account the prices paid by the poor into the initial parities when there are geographical concentrations of people.
- b) Using percentage share weights rather than actual weights for each country (democratic versus plutocratic weights)
- c) Adjusting these share weights to reflect expenditures distributions of the very poor, either by using low-income surveys for each country, or an iterative approach that combines representative shares and own country average-income shares.

If direct price surveys are not available, an indirect approach is to use existing surveys to identify the location, outlet and type of neighborhood where prices are collected, and the typical size of purchase. This would improve the underlying price data entering into PPP and subsequently PWT calculations of private consumption that are more appropriate for the poor, both within and between countries. Similarly, expenditure surveys for the poor that are comparable across countries would improve the iterative procedure in that the initial distributions represent individual countries, rather than representative groups of countries.

At present, PWT consumption PPPs provide a basis for conversion of international poverty lines into national currencies that are fairly stable over time. However, their underlying price base is no stronger than existing benchmark comparisons for which happily a major international effort is underway headed by a Global Office at the World Bank<sup>17</sup>. One feature of this new round of pricing centering on 2004-05 is that it provides an opportunity to compare prices within countries for urban and rural areas, the latter being the major concentration of the world's poor.

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<sup>17</sup> See ICP under Data & Statistics at <http://www.worldbank.org>.

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## Appendix on PWT and Other Conversion Factors for Poverty Studies

This section sets out the main differences between PWT and other data sets that might be used for studies of international poverty. We first distinguish between the treatment of benchmark and non-benchmark countries. The method of producing current and constant international price estimates is treated next along with the principal differences between the PPP estimates of the World Bank and PWT. A more detailed version of the materials described in this section is provided in the documentation of PWT 6.1<sup>18</sup> so this discussion will be brief.

### **Benchmark and Non-Benchmark Countries**

Benchmark ICP comparisons have been carried out for over 100 countries, some for just one year, and some for as many as eight years since 1970, originally at five-year intervals, and now every three years for the OECD countries.<sup>19</sup> Benchmark comparisons typically involve detailed price comparisons representing 150 or more basic headings of expenditure on consumption, capital formation and government. Beginning in 1980 these benchmark comparisons have been organized regionally with various procedures built into the process so that links could be established between countries in different world areas. Some links were provided by countries in both OECD and other groupings, as for example Austria with countries of Eastern Europe, and Japan with the Economic and Social Commission for Asia and the Pacific (ESCAP).

Unfortunately, the last ICP benchmark that represented most of the world regions for a particular date was 1985; it was incorporated in PWT 5.6, with later regional benchmark data. For PWT 6.1, a world comparison was cobbled by using 1996 OECD estimates for member countries plus an equal number of formerly planned economies. Several Latin American countries also made estimates for 1996, and it was possible to update 1993 estimates for the ESCAP countries, Africa, the Middle East and the Caribbean to 1996, for a total of 113 countries, albeit at the level of only 36 headings of expenditure<sup>20</sup>.

Figure 1 illustrates the inputs and procedures used in PWT to obtain the initial 1996 base year price levels (or PPPs) for the three components of GDP: consumption, investment and government.

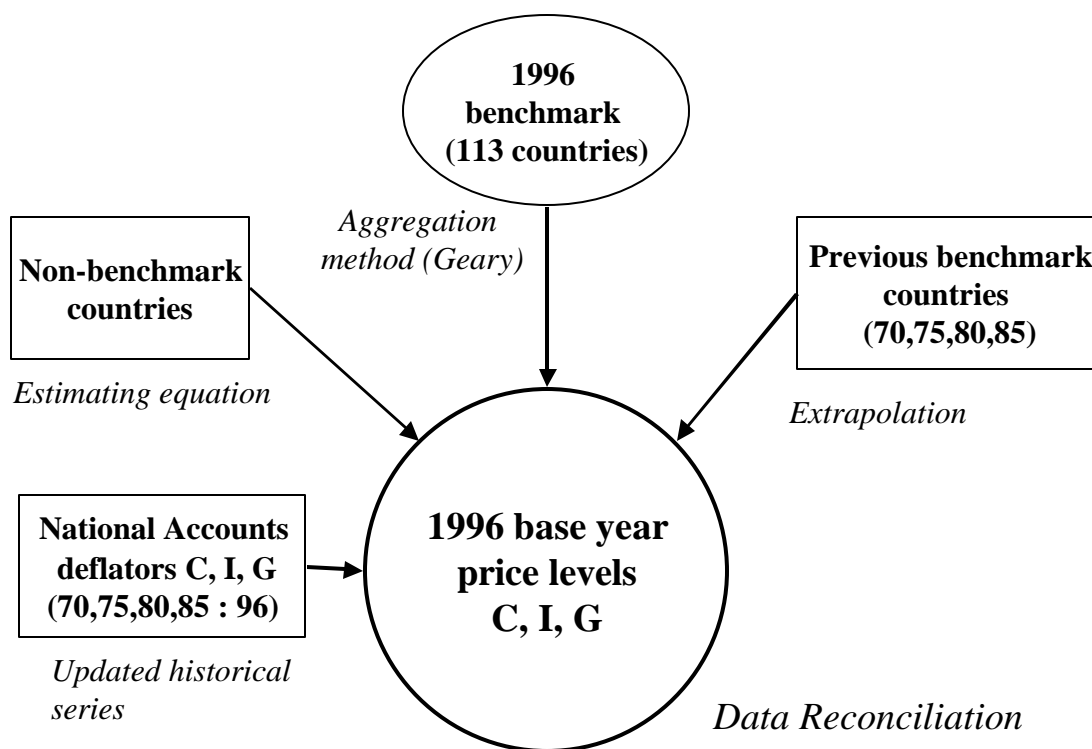
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<sup>18</sup> Technical Documentation, About PWT, in <http://pwt.econ.upenn.edu>.

<sup>19</sup> Actually the European Union countries have been carrying out annual estimates since 1993 where about one third of the underlying items are priced each year, and the remainder updated from the previous years by appropriate time-to-time indexes.

<sup>20</sup> In 1985 there were only 64 countries but a total of 139 basic expenditure headings.

**Figure 1. Base Year PPPs**



First, the ICP benchmark data for the 113 countries are aggregated to the level of C, I, and G using the Geary-Khamis (G-K) method and weights, termed super-country weights, that assign proportional representation of the benchmark countries relative to the world. The World Bank has used a different aggregation method and a different weighting scheme, one that assigns equal weight to each country over all of GDP, so that small countries such as Belize and Luxembourg will have the same importance over all headings as larger countries such as Mexico and Germany. The use of super-country weights in the G-K system provides continuity with previous versions of PWT.

The second step is to estimate the PPP of C, I and G for the non-benchmark countries.<sup>21</sup> In recent versions of PWT these estimates have been made in two stages. First, an estimate of the PPP for Domestic Absorption is made based upon the relationship between various cost of living measures and the PPP for GDP for benchmark countries. The values of these post adjustment indexes for the non-benchmark countries are then used in the estimating equation to obtain their Domestic Absorption. This may be contrasted with the method used by the World Bank, also a short-cut approach, but one that uses an equation involving education and nominal

<sup>21</sup> There are also countries for which benchmark results are not available but some studies have been made, notably China and Taiwan. For details see PWT6.1.

income but no direct information on prices in non-benchmark countries. In addition, the World Bank does not make estimates for C, I, and G, only for GDP, whereas in PWT the component PPPs are estimated again using a relationship derived from the benchmark countries.

The third and final step is to collate the 1996 benchmark PPPs, the non-benchmark PPPs and the PPPs from previous benchmark countries that may or may not be part of the 1996 ICP. When countries have multiple benchmarks, the relative PPPs of two countries in two benchmarks usually differs from what would be predicted from relative price movements in the two countries. For example, if the GDP deflator in country A rises by 20% between two benchmarks and that of B by 30%, then one would expect the  $PPP_{B/A}$  to rise between two benchmarks by about 8.3%  $[(1 - 1.3/1.2)*100]$ . In fact the two estimates will differ, often by 5 to 15% or more in either direction.

To deal with this empirical finding we use a reconciliation process<sup>22</sup>. The basic idea is to bring previous benchmark estimates of PPPs to a common year by use of the national accounts deflators. For countries with several benchmarks it is necessary to average the different PPP estimates and this is done by giving more recent estimates somewhat greater weight. The reconciled past and present benchmark PPPs, together with the non-benchmark short-cut PPP estimates, and the national accounts expenditure data, become the inputs to another multilateral aggregation procedure (G-K method, super-country weighting) that will generate the GDP PPPs and international dollar estimates for C, I, and G for the 168 countries in 1996.

It should be noted that these estimates will not necessarily correspond to the initial benchmark comparison for 1996 because both non-benchmark and previous benchmark countries are now included. The World Bank does not attempt this reconciliation process.

### **PWT Estimates in Other Years**

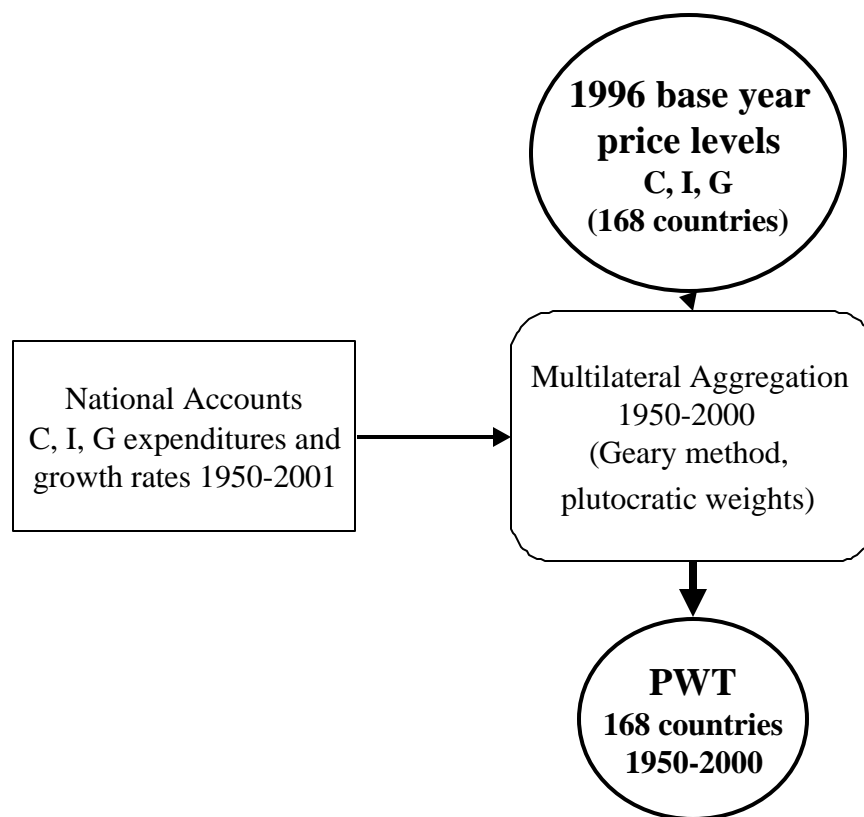
Frequently, international comparisons of poverty, and of wealth, are made at different points in time. One advantage of PWT as a data source for the PPP for such estimates is that it provides a continuous series from which erratic movements that may occur using benchmark estimates in two different years have in effect been removed<sup>23</sup>. Figure 2 illustrates the procedure to obtain the current and constant price series in PWT over time.

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<sup>22</sup> This reconciliation process was called 'consistentization' in previous versions of PWT, but Robert Summers has reluctantly given up the term.

<sup>23</sup> The reconciliation process does not remove erratic movements that originate in the national accounts series.

**Figure 2. PPP and GDP Estimates Other Years**



For 1996, we have the set of 168 benchmark, non-benchmark and previous benchmark countries and their component PPPs. For other years, we move the 1996 PPPs backwards and forwards by the changes in the national accounts deflators for each component of each country relative to changes in the United States. These become the input PPPs that, combined with the current price national accounts of each country, permit a new multilateral aggregation (G-K method, super-country weights) for each year. The result is a set of GDP PPPs and international price estimates of C, I and G for the 168 countries for 1950-2000.

Several different constant price measures are provided in PWT. It is not clear that researchers would want to use these in poverty comparisons, so the following discussion is highly condensed. A Laspeyres type measure is given that takes the real value of the components in each year and moves them backward and forward by the national accounts growth rates of the components. The resulting estimates are summed with the net foreign balance in 1996 prices to obtain the GDP in each year. Because the weights of C, I and G in international prices will not necessarily be the same as those in national prices, the growth rate of GDP in PWT will not be identical to that in national prices. In this PWT differs from most other series and this should be understood in research making use of the growth rates implicit in PWT. The same is true of the chain

index in PWT. The chain index applies the national accounts growth rates to the component shares in international prices, derived from the current year multilateral aggregation, obtaining a growth rate for Domestic Absorption (DA) for each pair of consecutive years.

The main differences between PWT and World Bank PPPs can be summarized as follows:

1. The initial *aggregation method* or price index number formula that is applied to the benchmark countries is not the same: PWT uses the G-K aggregation with plutocratic weights.
2. Estimates for *non-benchmark* countries are made using short-cut methods, but the equations and variables differ: the World Bank uses education and nominal incomes whereas PWT uses information on prices and no education variable.
3. Information on *previous benchmarks* is not used in the World Bank, but is collated and reconciled in PWT.
4. The *current price series*: PWT estimates PPPs and international prices for each component in each year, whereas the World Bank obtains the 1996 GDP PPPs and applies national accounts growth rates to obtain other years.
5. The *constant price series*: PWT's Laspeyres series is based on the growth rate of C, I and G from the national accounts plus the net foreign balance, the World Bank uses GDP growth rates.
6. *Chain series*: PWT provides a chained constant price series using component shares in international prices for each year.
7. *Consumption PPPs*: PWT provides the PPP and the constant and current international prices for consumption as well as for GDP for all countries and for as many years as there are national accounts series available.