Indian Growth and Development Review

Sensitivity of global and regional poverty rates to alternative purchasing power parities

Amita Majumder, Ranjan Ray, Sattwik Santra,

Received 25 September 2017
Revised 21 January 2018
Accepted 9 February 2018

Sensitivity of global and regional poverty rates to alternative purchasing power parities

Amita Majumder
Economic Research Unit, Indian Statistical Institute, Kolkata, India
Ranjan Ray
Department of Economics, Monash University, Melbourne, Australia, and
Sattwik Santra
Centre for Studies in Social Sciences Calcutta, Kolkata, India

Abstract

Purpose – The purpose of this study is to examine the sensitivity of regional and world poverty rates to the purchasing power parities (PPP) used in the calculations. The PPPs are required to convert the "international poverty line" typically denominated in US dollar to its local currency equivalent in the various countries. While recent studies on world poverty differ with respect to the specification of the international poverty line (IPL), they universally use the PPP available from the international comparison program (ICP). This study provides a departure and calculates PPPs using the Gini–Elteto–Koves–Szulc (GEKS) price index and country product dummy (CPD) model as alternatives to the ICP PPPs. The GEKS and CPD PPPs are compared with the ICP PPPs. The paper then compares the global and regional poverty rates based on the three sets of PPPs and presents evidence of significant revision to the poverty rates if we depart from the use of the ICP PPPs. The study tests for the presence of serial correlation between price movements in different countries and investigates its impact on the PPPs. The methodological contribution of this paper is to establish the close nexus between price indices and poverty rates via the PPPs used in obtaining the local currency unit (LCU) denominated IPL.

Design/methodology/approach – The PPP calculations in this paper relate to the ICP round, 2011. Along with the ICP PPPs from published reports (with India as the numeraire country), we report the following indices, namely, the GEKS, weighted CPD and its two spatially correlated generalisations. The ICP PPPs are used as benchmark. The ICP group in the World Bank made the price and expenditure information for 2011 available. Corresponding poverty rates are calculated at the country, regional and global levels.

Findings – The empirical evidence points to the fact that while at the country level the alternative calculations have high impact on the implied poverty rates, at the regional and global level the rates are reasonably quite robust.

Research limitations/implications – Three points are worth noting, namely, as opposed to the PPP for "Individual consumption expenditure by households" (ICEH), which is the PPP used for international poverty monitoring by the World Bank and others, we have used the ICP PPPs for "Actual individual consumption" (AIC); although ICP uses the GEKS procedure above the BH level, we independently calculated these PPPs using the price information provided, and the base country has been moved from the USA to India.

Practical implications – One can come up with independently estimated PPPs that do not require the elaborate and expensive procedure set up by the ICP and can arrive at robust poverty rates at the regional and global level.

Social implications – The change in base has been made as India shares many of the features of a developing country including high poverty rates, but at the same time provides a market and an economy size that places it in the top tier of nations. In addition, poverty comparisons amongst developing countries can be made using these PPPs directly, without reference to the USA. The poverty calculations are based on the PovcalNet program.

Indian Growth and Development Review
Vol. 11 No. 1, 2018
pp. 34-56

1753-8254
DOI 10.1108/IGDR-09-2017-0076

Originality/value – There is no clear answer to the question "how robust are the global poverty numbers to departures from the ICP PPPs?" in the literature nor is there any evidence on the robustness of the ICP PPPs themselves to changes in the ICP methodology. Given that the ICP uses the Gini–Elteto–Koves–Szulc (GEKS) multilateral price index in aggregation of ICP PPP basic heading data, in an attempt to partially answer this question this study examines the sensitivity of measures of relative prices (and poverty) to using CPD (and various spatial versions) and GEKS methods, using price data provided by the World Bank. It also verifies how these PPPs track the published 2011 ICP PPPs, which are used as benchmark.

Keywords Regional development, Poverty

Paper type Research paper

1. Introduction

With 2015 marking the end of the era for the millennium development goals (MDG) and the start of that for sustainable development goals (SDG), with reduction of global poverty featuring prominently in both sets of goals, there has recently been a surge of studies that seek to quantify the magnitude of global poverty. Examples include Cruz *et al.* (2015), Ferreira *et al.* (2016), Jolliffe and Prydz (2015), Kakwani and Son (2016). The literature on estimating global poverty[1] can be traced back to Ahluwalia *et al.* (1979) with the next major contribution by Ravallion *et al.* (1991). In the nearly 4 decades that have elapsed since the Ahluwalia *et al.* (1979) study, the complexity of the exercise has grown many fold with an increase in the number of countries included in the poverty enumeration. The complexity has been reflected in changes in the manner the "international poverty line" (IPL) has been defined and implemented in successive poverty counts.

While the Ahluwalia *et al.* (1979) study was based on the Indian poverty line used as the IPL, Ravallion *et al.* (1991) provided the first dollar-a-day poverty line at 1985 PPPs. This study, which was designed to answer a set of poverty related questions on world poverty and give aggregate results for 86 countries in the mid-1990s, was conducted as a background paper for the World Development Report, 1990. Since this was the first time the concept of an "international poverty line" was proposed and implemented, let us explain how the $1 a day figure was arrived at. Ravallion *et al.* (1991) proposed measuring global poverty by the standards of the poorest countries, based on a survey of national poverty lines. Drawing on 33 national poverty lines for the 1970s and 1980s (for both developed and developing economies), Ravallion *et al.* (1991) proposed a line of $23 a month ($0.76 a day) at 1985 consumption PPP. That value was the predicted poverty line for the poorest country in the sample of 88 countries (Somalia), based on a regression model that ran a semi-log regression of the national poverty line on per capita mean consumption and per capita mean consumption square (all at 1985 PPP). This value was quite close to the poverty line of India. As Ravallion *et al.* (1991, pp. 348/349) note:

> Thus, India's poverty line is very close to the poverty line we would predict for the poorest country, and as such, can be considered a reasonable lower bound to the range of admissible poverty lines for the developing world [. . .]. A more generous, and more 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). We shall use both these poverty lines, interpreting the lower line as defining "extreme absolute poverty".

The higher line of $31 a month ($1.02 a day) was therefore considered to be more representative of the poverty lines in low-income countries. Subsequently, the higher line became more accepted in the World Bank and internationally, and it became known the "$1 a day" (at 1985 PPP).

It was re-estimated to $1.08 at 1993 PPPs by Chen and Ravallion (2001). This was not a major revision since it simply involved reevaluating the $1 a day poverty line at 1993 PPPs. Subsequently, in the first major update of the $1 a day poverty line, proposed in World Development Report, 1990, Ravallion *et al.* (2009) revised the $1 a day poverty line at 1985 PPP to $1.25 a day at 2005 PPP based on an updated and expanded set of countries compared to what was used in Ravallionet al (1991). As explained by Ravallion *et al.* (2009, p. 166/167), "The new data set on national poverty lines differs from the old (Ravallion *et al.*, 1991) data set in four main respects. First, while the data were drawn from sources for the 1980s (with a mean year of 1984) the new data are all post-1990 (mean of 1999), such that in no case do the proximate sources overlap. Second, the new data set covers 88 developing economies (74 with complete data for the subsequent analysis), while the old data set included only 22 developing economies (plus 11 developed countries). Third, the old data set used rural poverty lines when there was a choice, whereas the new one estimates national average lines. Fourth, the old data set was unrepresentative of Sub-Saharan Africa, with only five countries from that region (Burundi, Kenya, South Africa, Tanzania and Zambia), whereas the new data set has a good spread across regions, including 25 countries in Sub-Saharan Africa. The proportion of African countries in the old sample was about half what it should have been to be considered representative of poor countries. The sample bias in the Ravallion, Datt and van de Walle data set were unavoidable at the time (Ravallion *et al.*, 1991), but it can now be corrected."

In the latest round of the ICP, namely, the 2011 ICP round led to another revision of the IPL. The IPL, now defined as the mean of the poverty lines of the 15 poorest countries, mostly from Africa, yields IPL at around $1.90 a day at 2011 PPP. While Ferreira *et al.* (2016, Table AI) arrive at the IPL figure of $1.88 a day, Jolliffe and Prydz (2015, Table II) arrive at a lower value of $1.82. Using a different methodology based on the concept of "equivalent poverty lines", Kakwani and Son (2016) obtain the IPL as a weighted average of the equivalent poverty lines of 66 countries and arrive at the IPL figure of $1.78 a day. Since many of the households in the poverty count are bunched around the IPL, any movement in the IPL specification, however small, is likely to lead to large changes in the global poverty numbers.

It is well-established that global poverty measures are sensitive to estimates of relative prices across countries, as reflected in the large changes in global poverty estimates with new rounds of PPPs becoming available over past decades. Deaton (2001, 2010) has provided good summaries of these large changes and likened the new rounds of PPP data to "earthquakes", based on the 1985 PPPs to the 1993 PPPs and the 1993 PPPs to the 2005 PPPs. Chen and Ravallion (2001) comment on the large changes due to the PPPs. With the release of the 2011 PPPs, once again the global picture of global poverty changed, albeit less significantly than previous revisions (Ferreira *et al.*, 2016; Jolliffe and Prydz, 2015). While there is no consensus between Jolliffe and Prydz (2015), Ferreira *et al.* (2016) and Kakwani and Son (2016) on the exact figure to be used for the IPL, these three studies, as indeed all the global poverty enumerations so far, have all been based on the ICP PPPs. This raises the question: how robust are the global poverty numbers to departures from the ICP PPPs? This study addresses this question and provides empirical evidence. There is no clear answer to this question in the literature nor is there any evidence on the robustness of the ICP PPPs themselves to changes in the ICP methodology. Given that the ICP uses the Gini–Elteto–Koves–Szulc (GEKS) multilateral price index in aggregation of ICP PPP basic heading data, in an attempt to partially answer this question this study examines the sensitivity of measures of relative prices (and poverty) to using CPD (and various spatial versions) and GEKS methods, using

price data provided by the World Bank. It also verifies how these PPPs track the published 2011 ICP PPPs, which are used as benchmark. The poverty issue has recently taken on an added importance with the Global Poverty Commission (World Bank, 2016) recommending that from now till 2030 the PPPs to be used in the poverty count should be frozen at the 2011 ICP values with the inflation adjustment made every year at the country level in line with the CPIs of each country. This makes it imperative to examine the sensitivity of poverty measures to the PPPs used. Taking advantage of the fact that the CPD method allows stochastic formulation, this study provides further results on the sensitivity of the CPD PPPs and the corresponding poverty counts to allowing spatially correlated movements in prices between countries by admitting a more general error specification.

The plan of the rest of the paper is as follows. Section 2 describes briefly the ICP, GEKS and CPD procedures. Section 3 gives the data sources and empirical results. Section 4 concludes the paper.

2. Description of the alternative purchasing power parities estimation procedures

2.1 The international comparison program methodology

The ICP distinguishes between "below basic headings" and "above basic headings" in the procedures it uses to calculate the PPP. A full description of the ICP methodology is contained in World Bank (2013) – see, in particular, the contributions by Rao (Chapters 1, 4) and Diewert (2005) (Chapters 5, 6) in that volume. The ICP follows a hierarchical approach for estimating the PPPs. Basic Headings (BH) is the lowest level at which the PPPs are estimated. The BH PPPs are then aggregated to calculate PPPs for different uses in cross country comparisons. In this study we restrict ourselves to the PPP estimation procedure above the BH levels, building on the prices constructed from below the BH levels. While the unweighted CPD method (described below) is used by the ICP below the BH level to deal with the problem of missing price information, the commonly used methods of aggregation for computing PPPs for GDP and other major aggregates above the BH level are the Gini–Elteto–Koves–Szulc (GEKS), Iklé, Geary–Khamis and the Rao or weighted CPD methods. The ICP procedure, which is therefore quite complex, does not rely on only one set of price indices or PPP method at all stages, unlike the GEKS and CPD PPPs as described in Sections 2.2, 2.3 and used in this study to benchmark the ICP PPPs against alternative sets of PPPs.

An important principle that multilateral PPP estimation ought to satisfy and is satisfied by the ICP procedure is the "transitivity principle" which is as follows:

$$PPP_{jk} = PPP_{jm} \ldots PPP_{mk} \tag{1}$$

In words, the PPP between countries j and k can be obtained as the product of the PPP between j and m and that between m and k. This property guarantees the level of internal consistency required in international comparisons. When PPPs are based on a single product, this property is guaranteed for simple price indices such as relative price. However, this is not so if we have multiproduct in the multilateral comparisons. Instead, the GEKS method is used by the ICP above the BH level. The ICP procedure also satisfies the additional principles of "Additivity" "Base Invariance" and "Fixity" which have been explained in World Bank (2013).

2.2 Gini–Elteto–Koves–Szulc index

The GEKS method is a generic method, proposed independently by Eltetö and Köves (1964) and Szulc (1964), which generates transitive indexes from a matrix of binary indexes which satisfy the country reversal test but not transitivity. Let I_{jk} represent a price index (or PPP) for country k with country j as base such that $I_{jk}I_{kj} = 1$. Then the GEKS index is given by:

$$GEKS_{jk} = \prod_{l=1}^{M} \left(I_{jl} \ldots I_{lk}\right)^{\frac{1}{M}} \tag{2}$$

The GEKS index can be implemented once the binary index number formula to compute I_{jk} is chosen. The Fisher binary index is the most commonly used index[2]. As explained below in Section 3 (see footnote 6), though the ICP uses the GEKS indices at "above basic headings", there is no a priori reason for the ICP PPPs to coincide with the GEKS PPPs obtained in this study.

2.3 The country-product dummy purchasing power parities

The CPD model was originally proposed by Summers (1973) to calculate relative price levels between countries in the context of missing price information. The CPD PPPs are estimated from the following equation:

$$y_{ij} \equiv \ln p_{ij} = \alpha_1 D_1 + \alpha_2 D_2 + \ldots + \alpha_M D_M + \eta_1 D_1^* + \eta_2 D_2^* + \ldots + \eta_N D_N^* + v_{ij} \tag{3}$$

where D_j *(j = 1, 2,. . ., M)* and D_i* *(i = 1, 2,. . .., N)* are, respectively, country and commodity dummy variables and v_{ij}'s are random disturbance terms which are independently and identically (normally) distributed with zero mean and variance σ^2.

Under complete price information comparisons of price levels between two countries j and k, represented by PPP_{jk} can be derived as:

$$PPP_{jk} = \frac{\alpha_k}{\alpha_j} = \prod_{i=1}^{N} \left[\frac{p_{ik}}{p_{ij}}\right]^{1/N} \tag{4}$$

However, Rao (1995), in the spirit of the standard index number approach, proposed that a more appropriate procedure would be to find estimates of the parameters that are likely to track the more important commodities more closely. This is achieved by estimating the following equation:

$$\sqrt{w_{ij}} \ln p_{ij} = \sqrt{w_{ij}} \sum_{j=1}^{M} \alpha_j D_j + \sqrt{w_{ij}} \sum_{i=1}^{M} \eta_i D_i^* + u_{ij} \tag{5}$$

Where w_{ij} is the budget share of item i in country j.

Rao (2005) has shown that *PPP*s resulting from the least squares estimation of the above weighted CPD equation are equivalent to a system of expenditure-share weighted log-change system. The Rao system is given by:

$$PPP_j = \prod_{j=1}^{N} \left(\frac{p_{ij}}{P_i}\right)^{w_{ij}}, \text{ setting one country as the numeraire,}$$
$$\text{and } P_i = \prod_{j=1}^{M} \left(\frac{p_{ij}}{PPP_j}\right)^{\frac{w_{ij}}{\sum_{j=1}^{M} w_{ij}}}. \quad (6)$$

Here P_i, $i = 1, 2, \ldots, N$ are the international average prices (at the numeraire country's currency) of commodities. PPP_j is the PPP of country j with respect to the numeraire country. Note that $\sum_{i=1}^{N} w_{ij} = 1$, the sum of budget shares in country j.

The equivalence of purchasing power parities and international prices derived from the application of the weighted-CPD method with those arising out of the Rao-system for multilateral comparisons implies that the weighted-CPD method is a natural method of aggregation at all levels of aggregation within the context of international comparisons.

The basic CPD model, given by equation (3) above, has the advantage that, as it is based on stochastic formulation, it allows the use of a range of econometric tools and techniques that are not normally used in the computation of PPPs. The formulation can be extended to allow regionally correlated price movements via admitting spatially correlated errors. The empirical literature on sub national and cross-country PPPs is generally based on the assumption that there is no interdependence between the price movements in the various regions of a country or between that in the various countries. There is some evidence to the contrary in early work reported by Aten (1979) on sub national PPPs and by Rao (2001) on cross-country PPPs.

The Spatial CPD model is given by:

$$y_{ij} = \alpha_1 D_1 + \alpha_2 D_2 + \ldots . \alpha_M D_M + \beta_1 D_1^* + \beta_2 D_2^* + \ldots \ \ldots + \beta_N D_N^* + \varepsilon_{ij} \quad (7)$$

where D_j and D_i^* are, respectively, the country and commodity (product) dummy variables.

Here ε, the vector of ε_{ij}'s is specified as follows:

$$\varepsilon = \rho S \varepsilon + \eta \quad (7a)$$

where ρ is the overall spatial correlation and η_{ij}'s are i.i.d. with mean 0 and variance σ^2.

S is a spatial weight matrix of order $NC \times NC$. The spatial weight matrix can be of various types depending on the neighbourhood criteria, based on distance, in general. One possible neighbourhood criterion, in the cross-country context, can be defined as follows:

$S_{jk} = 1$ if j and k refer to the same region and same item and $j \neq k$,

$S_{jk} = 0$ otherwise.

ρ = can be estimated using maximum likelihood methods in the joint estimation of the two equations.

Another possible neighbourhood criterion is to define neighbours in terms of inverse of distance between Centroids of two countries. We have provided PPP estimates employing both types of spatial CPD models, referred to below in Table III as CPD-S1 (Region Cluster) and CPD-S2 (Inverse Distance between Centroids), respectively.

3. Data sources and the empirical results

The PPP calculations in this paper relate to the ICP round, 2011. Along with the ICP PPPs from published reports (with India as the numeraire country), we report the following

indices, namely, the GEKS, weighted CPD and its two spatially correlated generalisations. The ICP PPPs are used as benchmark. Three points are worth noting here:

(1) as opposed to the PPP for "Individual consumption expenditure by households" (ICEH), which is the PPP used for international poverty monitoring by the World Bank and others, we have used the ICP PPPs for "Actual individual consumption" (AIC);

(2) although ICP uses the GEKS procedure above the BH level, we independently calculated these PPPs using the price information described below in Section 3.1[3]; and

(3) the base country has been moved from USA to India.

The change in base has been made as India shares many of the features of a developing country including high poverty rates, but at the same time provides a market and an economy size that places it in the top tier of nations. In addition, poverty comparisons amongst developing countries can be made using these PPPs directly, without reference to USA. The poverty calculations are based on the PovcalNet program.

3.1 Price data

The ICP group in the World Bank made the price and expenditure information for 2011 available. We constructed the prices for item groups at the basic heading (BH) level by considering the item prices (in LCU) within the BH taking into account the importance matrix provided by the World Bank. For our analysis, we considered the average (geometric mean) prices of similar items (having the same units of measurement) with the highest importance. It needs to be mentioned here that:

- the World Bank makes available prices at the BH level, but these are PPPs (US$=1) not in LCUs; and
- ICP does not use averages of item prices, instead price data are aggregated using CPD method to derive basic heading PPPs.

Here, we reiterate that our objective is to look at sensitivity of PPPs to alternative procedures and that the price aggregates used in our computation of the GEKS and CPD models are the same[4]. ICP PPPs are used only as benchmark.

3.2 The alternative sets of purchasing power parities

Table I presents, for all the countries participating in the 2011 ICP, the 5 sets of PPPs corresponding to the ICP (published), the GEKS [equation (2)], the weighted CPD [equation (6)] and its two spatially correlated generalisations given by equations (7)-(7a). Note that unlike the conventional format, Table I presents the PPPs with the Indian Rupee as the numeraire. The following points are worth noting. First, within the CPD framework, the introduction of spatial correlation between price movements[5] in countries in the same region has little effect on the PPPs. Second, while the orders of magnitudes are comparable among the 5 sets of indices, the calculated GEKS and CPD PPPs differ in many cases from that of the ICP PPPs. Although generalised statements cannot be made on the sign of the difference between the ICP and the other PPPs that hold in all cases, in several countries the ICP PPPs exceed the other PPPs, often by quite a large margin. This is particularly true of several of the poorer countries in Africa and Asia with consequent implications for the poverty rates.

Region	Country	ICP	GEKS	CPD	CPD-S1 (Region cluster)	CPD-S2 (Inverse distance between centroids)
Africa	Algeria	2.062	1.932	1.981	1.99	1.98
	Angola	4.996	2.973	3.447	3.49	3.48
	Benin	14.801	11.202	11.231	11.22	11.22
	Botswana	0.290	0.262	0.254	0.25	0.25
	Burkina Faso	14.552	13.841	12.527	12.58	12.42
	Burundi	31.130	30.494	30.518	30.90	31.10
	Cameroon	15.253	11.706	13.641	13.82	13.71
	Cape Verde	3.164	2.180	2.420	2.44	2.41
	Central African Republic	17.419	18.330	17.953	18.28	18.05
	Chad	16.499	15.216	14.829	14.57	14.71
	Comoros	14.360	10.748	12.249	12.03	11.94
	Congo, Rep	35.145	39.599	35.070	35.23	34.93
	Congo, Dem	19.711	18.889	19.256	19.52	19.29
	Côte d'Ivoire	15.691	12.713	15.514	15.69	15.59
	Djibouti	6.727	6.733	6.566	6.49	6.52
	Egypt, Arab Republic	0.115	0.109	0.101	0.10	0.10
	Equatorial Guinea	21.712	14.536	14.824	14.63	14.68
	Ethiopia	0.352	0.361	0.340	0.33	0.34
	Gabon	23.877	21.778	22.521	22.78	22.46
	Gambia, The	0.697	0.691	0.680	0.67	0.65
	Ghana	0.051	0.046	0.044	0.04	0.04
	Guinea	165.403	199.346	182.576	180.93	176.37
	Guinea-Bissau	15.827	16.995	17.382	17.52	17.62
	Kenya	2.365	1.952	1.959	1.99	1.98
	Lesotho	0.261	0.231	0.222	0.22	0.23
	Liberia	0.037	0.031	0.031	0.03	0.03
	Madagascar	46.309	34.873	34.217	34.66	34.40
	Malawi	5.195	5.376	4.867	4.95	4.89
	Mali	14.437	14.193	13.735	13.92	13.78
	Mauritania	7.395	6.409	6.163	6.27	6.21
	Mauritius	1.181	1.037	0.969	0.98	0.97
	Morocco	0.276	0.322	0.277	0.28	0.28
	Mozambique	1.051	1.011	0.993	1.01	1.00
	Namibia	0.342	0.136	0.270	0.27	0.27
	Niger	14.995	18.045	15.431	15.45	15.36
	Nigeria	5.184	4.912	4.464	4.53	4.49
	Rwanda	16.717	12.803	14.652	14.85	14.82
	Senegal	16.285	17.197	16.643	16.86	16.54
	Seychelles	0.499	0.517	0.490	0.49	0.49
	Sierra Leone	114.179	107.708	106.962	108.75	107.00
	South Africa	0.340	0.334	0.299	0.30	0.30
	Sudan	0.096	0.098	0.083	0.08	0.08
	Swaziland	0.273	0.205	0.189	0.19	0.19

(*continued*)

Table I.
Alternative PPPs for 2011 (numeraire: Indian rupee)

Region	Country	ICP	GEKS	CPD	CPD-S1 (Region cluster)	CPD-S2 (Inverse distance between centroids)
	São Tomé and Principe	649.078	614.993	617.702	606.56	600.27
	Tanzania	38.494	38.535	35.042	35.21	34.90
	Togo	14.966	15.461	15.011	15.19	15.06
	Tunisia	0.045	0.045	0.044	0.04	0.04
	Uganda	61.989	59.763	65.103	65.65	65.14
	Zambia	166.554	161.138	156.330	156.36	155.50
	Zimbabwe	0.035	0.035	0.033	0.03	0.03
Asia and the pasicfic	Bangladesh	1.628	1.519	1.519	1.54	1.54
	Bhutan	1.119	0.936	0.965	0.95	0.94
	Brunei Darussalam	0.058	0.044	0.051	0.05	0.05
	Cambodia	96.712	91.308	89.079	90.19	90.01
	China	0.249	0.257	0.232	0.23	0.23
	Fiji	0.080	0.059	0.062	0.06	0.06
	Hong Kong SAR, China	0.398	0.388	0.317	0.32	0.32
	India	1.000	1.000	1.000	1.000	1.000
	Indonesia	266.380	230.556	246.329	247.45	247.01
	Lao PDR	181.329	164.455	167.919	169.13	168.57
	Macao SAR, China	0.374	0.316	0.291	0.30	0.30
	Malaysia	0.106	0.057	0.090	0.09	0.09
	Maldives	0.677	0.524	0.529	0.54	0.53
	Mongolia	36.881	31.458	35.527	36.23	35.75
	Myanmar	16.380	6.164	14.278	14.16	14.20
	Nepal	1.698	0.991	1.065	1.06	1.06
	Pakistan	1.673	1.212	1.456	1.47	1.45
	Philippines	1.261	0.729	0.950	0.96	0.95
	Singapore	0.080	0.076	0.060	0.06	0.06
	Sri Lanka	2.689	2.339	2.645	2.66	2.64
	Taiwan, China	1.081	0.951	0.994	0.99	0.99
	Thailand	0.858	0.683	0.644	0.65	0.65
	Vietnam	479.060	363.134	394.883	398.14	394.89
Common wealth and independent states	Armenia	10.880	11.836	12.298	12.34	12.36
	Azerbaijan	0.020	0.022	0.023	0.02	0.02
	Belarus	109.735	114.905	123.162	124.24	123.87
	Kazakhstan	5.037	4.122	4.201	4.25	4.21
	Kyrgyzstan	1.037	0.901	0.944	0.94	0.94
	Moldova	0.328	0.343	0.325	0.33	0.33
	Russian Federation	1.059	0.995	1.048	1.06	1.04
	Tajikistan	0.106	0.105	0.109	0.11	0.11
	Ukraine	0.204	0.213	0.209	0.21	0.21
Eurostat-oecd	Albania	3.400	3.132	3.180	3.21	3.20
	Australia	0.107	0.079	0.079	0.08	0.08
	Austria	0.061	0.046	0.046	0.05	0.05

Table I.

(*continued*)

Region	Country	ICP	GEKS	CPD	CPD-S1 (Region cluster)	CPD-S2 (Inverse distance between centroids)
	Belgium	0.063	0.041	0.045	0.05	0.05
	Bosnia and Herzegovina	0.055	0.056	0.057	0.06	0.06
	Bulgaria	0.047	0.049	0.048	0.05	0.05
	Canada	0.091	0.068	0.070	0.07	0.07
	Chile	25.222	23.183	23.718	23.44	23.78
	Croatia	0.284	0.280	0.265	0.27	0.26
	Cyprus	0.050	0.046	0.043	0.04	0.04
	Czech Republic	0.960	0.820	0.826	0.84	0.82
	Denmark	0.603	0.443	0.450	0.46	0.45
	Estonia	0.038	0.032	0.035	0.03	0.03
	Finland	0.068	0.059	0.055	0.06	0.05
EUROSTAT-OECD	France	0.061	0.049	0.047	0.05	0.05
	Germany	0.056	0.043	0.043	0.04	0.04
	Greece	0.051	0.045	0.044	0.04	0.04
	Hungary	8.651	7.863	7.910	7.94	7.88
	Iceland	9.677	9.293	8.722	8.82	8.71
	Ireland	0.067	0.045	0.047	0.05	0.05
	Israel	0.288	0.213	0.214	0.22	0.22
	Italy	0.057	0.047	0.048	0.05	0.05
	Japan	7.789	6.515	6.588	6.65	6.59
	Korea, Rep.	60.669	42.568	52.186	52.48	52.03
	Latvia	0.025	0.024	0.023	0.02	0.02
	Lithuania	0.112	0.118	0.114	0.11	0.11
	Luxembourg	0.075	0.047	0.047	0.05	0.05
	Macedonia, FYR	1.392	1.455	1.366	1.37	1.37
	Malta	0.041	0.040	0.039	0.04	0.04
	Mexico	0.549	0.503	0.494	0.50	0.50
	Montenegro	0.028	0.027	0.026	0.03	0.03
	Netherlands	0.062	0.043	0.044	0.04	0.04
	New Zealand	0.105	0.084	0.084	0.09	0.08
	Norway	0.706	0.582	0.614	0.61	0.60
	Poland	0.124	0.112	0.106	0.11	0.11
	Portugal	0.048	0.040	0.040	0.04	0.04
	Romania	0.120	0.111	0.115	0.12	0.11
	Russian Federation	1.059	0.995	1.048	1.06	1.04
	Serbia	2.802	2.827	2.899	2.93	2.91
Eurostat-oecd	Slovakia	0.036	0.035	0.035	0.03	0.03
	Slovenia	0.047	0.040	0.041	0.04	0.04
	Spain	0.053	0.040	0.040	0.04	0.04
	Sweden	0.659	0.459	0.473	0.48	0.47
	Switzerland	0.114	0.069	0.074	0.08	0.07
	Turkey	0.072	0.071	0.071	0.07	0.07
	United Kingdom	0.052	0.041	0.039	0.04	0.04

(*continued*)

Table I.

Region	Country	ICP	GEKS	CPD	CPD-S1 (Region cluster)	CPD-S2 (Inverse distance between centroids)
	United States	0.071	0.056	0.055	0.06	0.05
Latin america	Bolivia	0.200	0.179	0.178	0.18	0.18
	Brazil	0.106	0.134	0.104	0.11	0.10
	Colombia	81.836	83.559	71.604	73.49	72.41
	Costa Rica	24.404	18.934	20.983	21.29	20.86
	Dominican Republic	1.379	1.248	1.245	1.27	1.27
	Ecuador	0.037	0.031	0.033	0.03	0.03
	El Salvador	0.036	0.032	0.034	0.03	0.03
	Guatemala	0.261	0.166	0.202	0.20	0.20
	Haiti	1.426	1.251	0.972	0.97	0.97
	Honduras	0.706	0.611	0.616	0.62	0.61
	Nicaragua	0.613	0.468	0.540	0.54	0.53
	Panama	0.037	0.038	0.035	0.03	0.03
	Paraguay	155.704	158.318	152.030	151.69	151.98
	Peru	0.104	0.097	0.093	0.09	0.09
	Uruguay	1.108	0.836	0.955	0.96	0.95
	Venezuela, RB	0.194	0.201	0.227	0.23	0.23
The Caribbean	Anguilla	0.168	0.124	0.141	0.14	0.14
	Antigua and Barbuda	0.138	0.114	0.116	0.12	0.12
	Aruba	0.106	0.106	0.094	0.09	0.09
	Bahamas, The	0.076	0.060	0.051	0.05	0.05
	Barbados	0.160	0.128	0.111	0.11	0.11
	Belize	0.079	0.054	0.071	0.07	0.07
	Bermuda	0.126	0.092	0.080	0.08	0.08
	Cayman Islands	0.075	0.075	0.067	0.07	0.07
	Curaçao	0.095	0.103	0.091	0.09	0.09
	Dominica	0.137	0.117	0.125	0.13	0.12
	Grenada	0.136	0.120	0.124	0.12	0.12
	Jamaica	4.136	4.055	4.377	4.41	4.36
	Montserrat	0.153	0.139	0.139	0.14	0.14
	St. Kitts and Nevis	0.108	0.098	0.097	0.10	0.10
	St. Lucia	0.137	0.131	0.143	0.14	0.14
	St. Vincent and the Grenadines	0.139	0.116	0.119	0.12	0.11
	Suriname	0.132	0.122	0.125	0.13	0.12
	Trinidad and Tobago	0.122	0.120	0.122	0.12	0.12
	Turks and Caicos Islands	0.299	0.300	0.298	0.30	0.30

Table I.

(*continued*)

Region	Country	ICP	GEKS	CPD	CPD-S1 (Region cluster)	CPD-S2 (Inverse distance between centroids)
	Virgin Islands, British	0.085	0.055	0.052	0.05	0.05
Western asia	Bahrain	0.015	0.011	0.013	0.01	0.01
	Egypt, Arab Republic	0.115	0.109	0.101	–	–
	Iraq	35.882	36.856	36.465	36.55	36.50
	Jordan	0.021	0.022	0.021	0.02	0.02
	Kuwait	0.013	0.011	0.011	0.01	0.01
	Oman	0.014	0.015	0.014	0.01	0.01
	Palestinian Territory	0.159	0.132	0.130	0.13	0.13
	Qatar	0.204	0.171	0.150	0.15	0.16
	Saudi Arabia	0.130	0.126	0.120	0.12	0.12
	Sudan	0.096	0.098	0.083	–	–
	United Arab Emirates	0.198	0.172	0.147	0.15	0.15
	Yemen	5.319	5.372	5.153	5.24	5.18

Table I.

3.3 Comparing the poverty lines and the poverty rates between purchasing power parities

Table II compares the IPLs (specified in Indian Rupees) between the values implied by the five sets of PPPs. The reader will recall that the IPL is defined as the mean of the national poverty lines of the 15 poorest countries converted to the Indian Rupee at PPP. This table also presents evidence for these 15 countries on the discrepancy between their national poverty lines and the IPL converted back to the Local Currency Units (LCU) of these countries. In many cases the discrepancy is considerable suggesting wide divergence between the national poverty rates and the globally relevant poverty rates for these 15 countries. The table also shows that the IPL based on ICP PPPs is lower in relation to the other PPPs. Though in absolute magnitude the difference is not considerable, since many of the globally poor households are very close to the IPL, this is likely to have some impact on the country specific poverty rates and on the distribution of the poor population between the ICP regions.

Table III compares the 5 sets of poverty rates for each country. There are several instances of large variation in the poverty rates at the individual country level between alternative sets of PPPs, especially for several African and South Asian countries. In contrast, the poverty rates are quite robust to PPPs in case of the affluent countries in the EUROSTAT-OECD region. This is also true of countries in the Caribbean region. Consistent with the comparison of PPPs within the CPD framework in Table I and the picture of robustness of PPPs from the last three columns of numbers, Table III confirms that the introduction of spatially correlated price movements has very little effect on the CPD poverty rates at the country level. Table IV compares the regional poverty rates, which are obtained as the population weighted averages of the poverty rates of the countries in the region. It may be noted from Table IV that the computed GEKS and CPD poverty rates track the ICP poverty rates quite well at the regional level, although the CPD values for the CIS region is somewhat out of line from the others. While generalised statements are again not

Table II.
Poverty lines of the 15 poorest countries using alternative methods: 2011

Region	Country	National Poverty Line (Local Currency Unit) NPL(LCU)	Poverty Line in PPP (Numeraire: Indian Rupee)					Converted Poverty Line in Local Currency Unit using Mean Poverty Line in PPP (Numeraire: Indian Rupee) CNPL (PPP-LCU)					Ratio of NPL(LCU) to CNPL(PPP-LCU)				
			ICP	GEKS	CPD	CPD-S1	CPD-S2	ICP	GEKS	CPD	CPD-S1	CPD-S2	ICP	GEKS	CPD	CPD-S1	CPD-S2
AFRICA	Chad	295.8	17.9	19.4	20.0	20.3	20.1	433.4	425.6	416.4	407.2	413.7	0.68	0.70	0.71	0.73	0.72
	Ethiopia	10.0	28.4	27.8	29.5	30.1	29.7	9.3	10.1	9.5	9.3	9.5	1.08	0.99	1.05	1.08	1.05
	Gambia, The	17.8	25.5	25.7	26.1	26.5	27.3	18.3	19.2	19.1	18.7	18.3	0.97	0.92	0.93	0.95	0.97
	Ghana	2.2	43.0	47.7	49.5	48.9	49.3	1.3	1.3	1.3	1.3	1.3	1.64	1.71	1.76	1.75	1.75
	Guinea-Bissau	478.8	30.3	28.2	27.6	27.3	27.2	415.7	475.4	488.1	489.7	495.6	1.15	1.01	0.98	0.98	0.97
	Malawi	97.5	18.8	18.1	20.0	19.7	19.9	136.5	150.4	136.7	138.3	137.5	0.72	0.65	0.71	0.70	0.71
	Mali	434.8	30.1	30.6	31.7	31.2	31.6	379.2	397.0	385.7	389.0	387.6	1.15	1.10	1.13	1.12	1.12
	Mozambique	18.5	17.7	18.4	18.7	18.4	18.5	27.6	28.3	27.9	28.2	28.3	0.67	0.66	0.67	0.66	0.66
	Niger	313.0	20.9	17.3	20.3	20.3	20.4	393.9	504.8	433.3	431.8	432.2	0.80	0.62	0.72	0.72	0.72
	Rwanda	351.2	21.0	27.4	24.0	23.7	23.7	439.1	358.1	411.5	415.0	416.8	0.80	0.98	0.85	0.85	0.84
	Sierra Leone	4,365.9	38.2	40.5	40.8	40.2	40.8	2,999.1	3,012.9	3,003.7	3,038.9	3,009.5	1.46	1.45	1.45	1.44	1.45
	Tanzania	474.5	12.3	12.3	13.5	13.5	13.6	1,011.1	1,077.9	984.1	984.0	981.5	0.47	0.44	0.48	0.48	0.48
	Uganda	1,536.8	24.8	25.7	23.6	23.4	23.6	1,628.2	1,671.7	1,828.2	1,834.5	1,832.2	0.94	0.92	0.84	0.84	0.84
SOUTH ASIA	Nepal	34.96	20.59	35.27	32.81	32.87	32.33	44.60	27.73	29.92	29.72	29.81	0.78	1.26	1.17	1.18	1.17
CIS	Tajikistan	4.72	44.54	45.01	43.23	42.99	43.32	2.78	2.93	3.07	3.07	3.06	1.70	1.61	1.54	1.54	1.54
MEAN			26.27	27.97	28.08	27.94	28.13										

Notes: CPD-S1 and CPD-S2 are CPD methods with spatially autocorrelated errors. S1 is based on neighbours defined as countries belonging to the same ICP region and S2 is based on neighbourhood as a function of inverse of distance between Centroids of two countries

Region	Country	ICP	GEKS	CPD	CPD-S1 (Region Cluster)	CPD-S2 (Inverse Distance between Centroids)
Africa	Angola	26.69	10.16	14.65	14.82	14.91
	Benin	47.71	34.16	34.58	34.20	34.60
	Botswana	15.25	14.09	13.41	12.91	13.11
	Burkina Faso	49.55	50.45	43.88	43.83	43.42
	Burundi	71.79	74.11	74.29	74.55	75.04
	Cameroon	25.22	16.01	18.82	19.08	19.03
	Central Afr. Rep	61.68	66.54	65.80	66.38	66.18
	Chad	34.01	33.46	32.44	31.63	32.18
	Comoros	10.72	5.39	8.73	8.42	8.38
	Congo, Rep	25.53	26.20	35.68	35.90	35.76
	Côte d'Ivoire	25.36	19.72	27.63	27.88	27.88
	Djibouti	16.19	18.03	17.51	16.93	17.19
	Ethiopia	25.53	31.78	27.57	25.99	27.18
	Gabon	6.31	5.54	6.60	6.65	6.56
	Gambia, The	39.96	42.52	41.74	40.60	39.96
	Ghana	21.01	19.06	18.23	18.41	18.37
	Guinea	27.53	44.76	38.78	37.82	36.37
	Guinea-Bissau	60.53	67.40	68.17	68.23	68.92
	Kenya	29.73	23.80	24.12	24.55	24.55
	Lesotho	57.26	55.04	53.60	53.90	54.65
	Liberia	61.98	53.58	54.71	54.71	54.31
	Madagascar	77.72	67.48	65.15	65.59	65.51
	Malawi	67.55	71.47	67.64	68.23	67.96
	Mali	41.51	44.59	42.60	43.25	42.92
	Mauritania	8.42	6.71	4.52	4.66	4.61
	Mauritius	0.40	0.27	0.21	0.21	0.21
	Morocco	2.08	4.97	2.95	2.97	2.97
	Mozambique	65.56	66.83	66.20	66.74	66.81
	Namibia	18.86	1.55	13.12	13.35	13.23
	Niger	42.19	61.12	50.16	49.87	49.90
	Nigeria	47.77	48.34	43.39	43.87	43.81
	Rwanda	56.73	44.54	52.92	53.37	53.64
	São Tomé and Principe	25.96	26.39	25.62	24.82	24.63
	Senegal	33.62	39.31	37.98	38.28	37.89
	Sierra Leone	44.67	44.84	44.70	45.49	44.80
	South Africa	14.45	15.57	12.68	12.49	12.88
	Sudan	10.93	13.77	8.87	8.94	8.93
	Swaziland	39.16	29.18	26.03	25.23	25.81
	Tanzania	39.75	44.68	38.08	38.13	37.91
	Togo	48.44	53.25	51.92	52.22	52.12
	Tunisia	1.30	1.84	1.59	1.71	1.62
	Uganda	27.94	29.15	35.58	35.82	35.76
	Zambia	61.27	62.35	61.45	61.22	61.26
	Zimbabwe	21.40		17.27	17.60	17.59
East asia and the pacific	China	9.44	11.84	6.35	6.27	6.42
	Fiji	2.73	0.82	1.50	1.41	1.50
	Indonesia	10.71	7.34	8.36	8.34	8.53
	Malaysia	0.16	0.00	0.10	0.10	0.11
	Mongolia	0.17	0.12	0.24	0.25	0.24

(*continued*)

Table III.
Poverty rates (%) by country and region under alternative PPPs: 2011[6] (numeraire: Indian rupee)

Region	Country	ICP	GEKS	CPD	CPD-S1 (Region Cluster)	CPD-S2 (Inverse Distance between Centroids)
	Philippines	10.14	1.22	3.91	3.92	3.92
	Thailand	0.03	0.01	0.01	0.01	0.01
	Vietnam	2.26	0.89	1.28	1.31	1.29
South Asia	Bhutan	1.62	1.01	1.15	1.02	1.02
	India	16.41	20.12	20.38	20.07	20.47
	Maldives	2.93	1.57	2.55	2.55	2.55
	Nepal	10.84	1.68	2.16	2.16	2.16
	Pakistan	4.87	0.87	3.10	3.22	3.10
	Sri Lanka	1.09	0.72	1.51	1.51	1.52
CIS	Armenia	0.92	2.00	2.44	2.44	2.53
	Azerbaijan	0.00	0.00	0.53	0.53	0.57
	Kazakhstan	0.01	0.01	0.01	0.01	0.01
	Kyrgyzstan	0.42	0.27	0.35	0.34	0.35
	Moldova	0.06	0.22	0.11	0.11	0.15
Eurostat- Oecd	Albania	0.46	0.46	0.46	0.46	0.46
	Australia	0.67	0.67	0.67	0.67	0.67
	Austria	0.42	0.37	0.37	0.37	0.37
	Belgium	0.43	0.38	0.40	0.40	0.40
	Bosnia and Herzegovina	0.06	0.06	0.07	0.07	0.07
	Bulgaria	1.87	2.04	1.99	1.99	1.99
	Canada	0.34	0.34	0.34	0.34	0.34
	Chile	0.94	0.94	0.96	0.93	0.96
	Croatia	0.73	0.73	0.70	0.70	0.70
	Cyprus	0.03	0.03	0.03	0.03	0.03
	Czech Rep	0.04	0.04	0.04	0.04	0.04
Eurostat- Oecd	Denmark	1.22	1.22	1.22	1.22	1.22
	Estonia	1.08	0.95	1.03	0.98	0.98
	Finland	0.08	0.08	0.08	0.08	0.08
	France	0.08	0.07	0.07	0.07	0.07
	Germany	0.19	0.18	0.18	0.18	0.18
	Greece	2.17	2.16	2.16	2.13	2.14
	Hungary	0.05	0.05	0.05	0.05	0.05
	Iceland	0.32	0.32	0.32	0.32	0.32
	Ireland	0.50	0.39	0.41	0.41	0.41
	Israel	0.39	0.39	0.39	0.39	0.39
	Italy	1.22	1.17	1.17	1.17	1.17
	Japan	0.35	0.35	0.35	0.35	0.35
	Latvia	1.18	1.18	1.10	1.10	1.10
	Lithuania	0.84	0.87	0.86	0.86	0.86
	Luxembourg	0.32	0.30	0.30	0.30	0.30
	Macedonia, FYR	0.70	1.17	0.90	0.90	1.04
	Mexico	4.70	4.50	4.43	4.45	4.45
	Montenegro	0.21	0.21	0.21	0.21	0.21
	Netherlands	0.38	0.38	0.38	0.38	0.38
	Norway	0.21	0.18	0.21	0.18	0.18
	Poland	0.28	0.27	0.27	0.27	0.27
	Portugal	0.46	0.38	0.38	0.38	0.38
	Romania	4.18	4.13	4.39	4.36	4.36
	Russian Federation	0.04	0.04	0.05	0.06	0.05

Table III.

(*continued*)

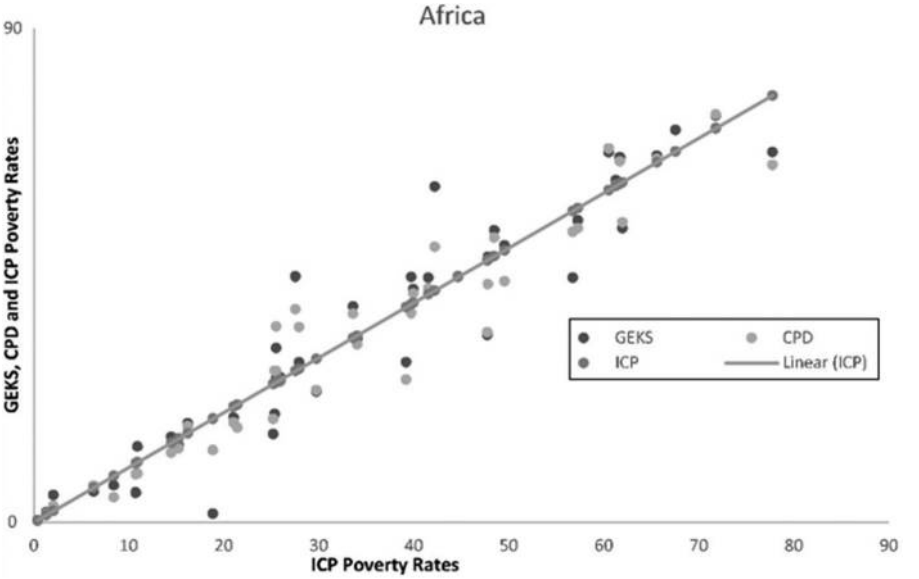
Region	Country	ICP	GEKS	CPD	CPD-S1 (Region Cluster)	CPD-S2 (Inverse Distance between Centroids)
	Serbia	0.05	0.05	0.10	0.10	0.10
	Slovakia	0.30	0.34	0.34	0.34	0.34
	Spain	1.53	1.45	1.45	1.45	1.45
	Sweden	0.64	0.62	0.62	0.62	0.62
	Switzerland	0.10	0.10	0.10	0.10	0.10
	Turkey	0.00	0.05	0.05	0.00	0.05
	United Kingdom	0.82	0.81	0.81	0.81	0.81
	United States	1.33	1.00	1.00	1.00	1.00
Latin America	Bolivia	7.61	7.20	7.11	7.07	7.07
	Brazil	4.84	6.88	5.05	5.14	5.06
	Colombia	5.86	6.83	5.17	5.34	5.29
	Costa Rica	1.66	1.13	1.37	1.37	1.37
	Dominican Rep.	2.21	1.81	1.81	1.90	1.95
	Ecuador	5.27	4.57	4.80	4.79	4.79
	El Salvador	3.69	3.22	3.99	3.97	3.79
	Guatemala	10.01	4.79	7.28	7.12	7.24
	Haiti	52.12	50.28	40.82	40.75	40.77
	Honduras	17.43	15.49	15.74	15.63	15.70
	Nicaragua	9.44	6.36	8.34	8.23	8.23
	Panama	3.48	4.02	3.33	3.27	3.29
	Paraguay	4.55	5.64	5.10	5.10	5.10
	Peru	3.53	3.46	3.15	3.06	3.07
	Uruguay	0.25	0.12	0.20	0.20	0.20
	Venezuela, RB	8.76	9.34	10.44	10.73	10.66
The Caribbean	Belize	12.59	8.18	12.30	12.30	12.37
	Jamaica	1.18	1.43	1.84	1.84	1.84
	St. Lucia	31.00	26.04	27.11	27.09	25.85
	Suriname	21.14	21.41	21.41	21.41	21.41
	Trinidad and Tobago	2.42	2.97	2.94	2.90	2.88

Table III.

Region*	ICP	GEKS	CPD	2011 PPPs CPD-S1 (Region Cluster)	CPD-S2 (Inverse Distance between Centroids)
Africa	35.38	35.96	33.53	33.55	33.64
Commonwealth of Independent States	0.17	0.27	1.30	1.30	1.31
East Asia and the Pacific	8.70	9.46	5.89	5.84	5.97
South Asia	14.66	17.12	17.15	16.98	17.29
Eurostat-OECD	1.05	0.96	0.95	0.95	0.96
Latin America	6.76	7.54	6.41	6.48	6.43
The Caribbean	5.69	5.18	5.69	5.68	5.63
WORLD	11.62	12.64	11.34	11.29	11.42

Notes: *Based on Table III. The singleton countries have been omitted

Table IV.
Regional poverty rates (%) under alternative PPPs: 2011



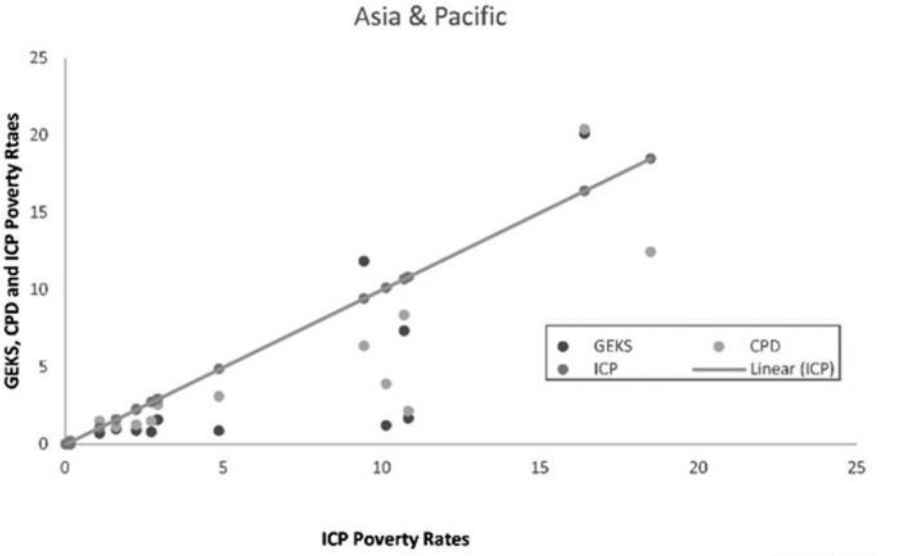


Figure 1.
Scatter plot of poverty rates (against ICP rates) for selected regions

(*continued*)

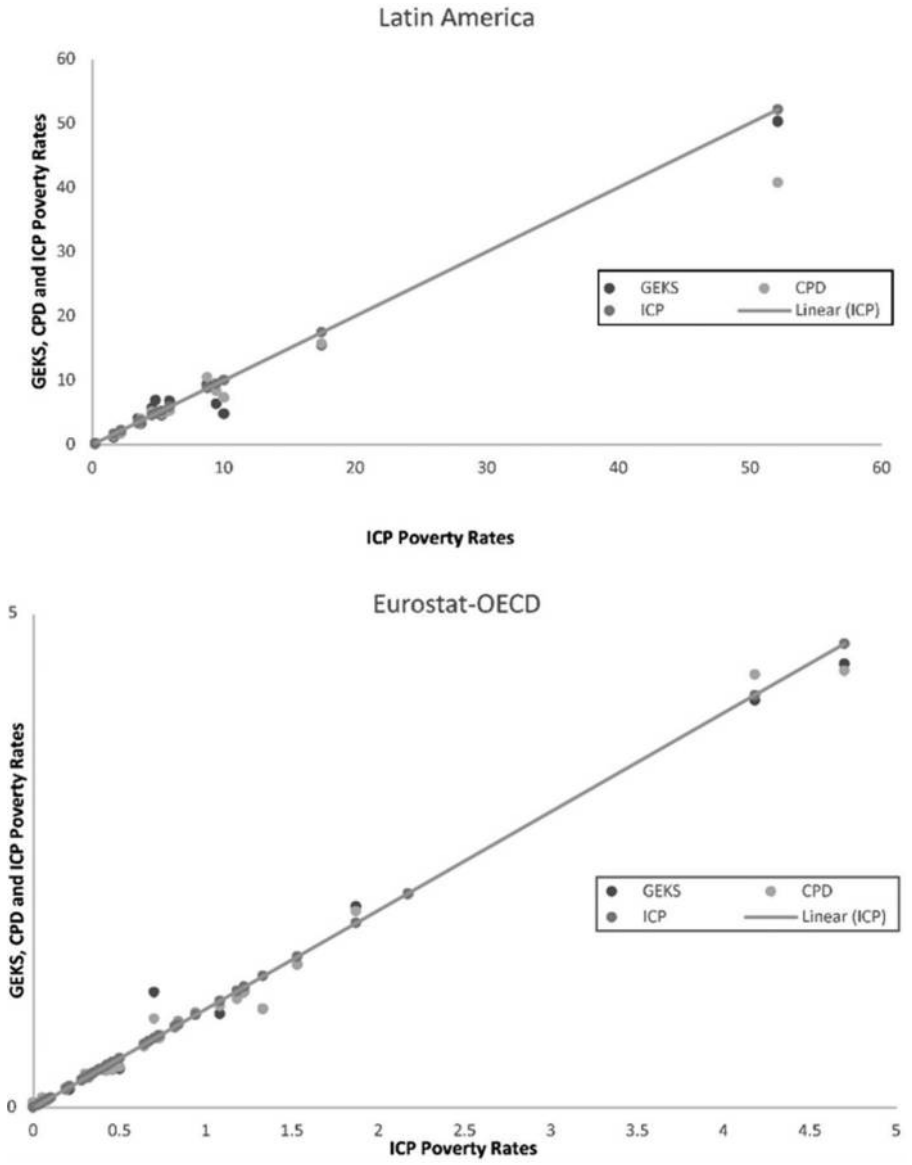


Figure 1.

possible, these tables show that the variation between the poverty rates are more between the ICP, GEKS and CPD PPPs than between the non-spatial and spatial CPD PPPs. There are large regional variations, but the rankings of the regions remain same across all PPPs. This table also shows that at the aggregate world level the introduction of spatial correlation in the CPD framework does not lead to any significant revision in the world poverty rate. The global poverty rate corresponding to ICP and GEKS are slightly higher than that

corresponding to the non-spatial CPD and the two variants of the spatial CPD, although the changes are all within 1 percentage point of each other. Therefore, relative to the many other data uncertainties about global poverty the methodological choice of GEKS versus CPD in aggregating PPPs above the country level seems to have relatively small impacts on the understanding of global poverty. In fact, the global poverty estimates appear largely "robust" to the choice of using GEKS versus CPD variants in aggregating PPPs[7]. However, at the country level there are large variations. Figure 1 presents some selected scatter plots of the GEKS and CPD (non-spatial) based poverty rates (y axis) against the ICP values (x axis). As can be clearly seen, the country level variations between poverty rates from the different PPPs in "Africa" and "Asia and the Pacific" regions are quite high compared to the variations in "Eurostat-OECD" and "Latin America" regions.

Table V compares the regional composition of the "extremely poor" global population, defined as those living on less than the IPL a day, under the 5 sets of PPPs. While for East Asia and the Pacific the ICP PPPs show a larger value for the share of the "extremely poor" global population, for South Asia the ICP PPPs show a smaller value in relation to the GEKS and CPD models. For other regions all the values are quite robust.

4. Conclusion

As the MDG gave way to the SDG, one set of targets that has received much attention is that relating to poverty reduction. While MDG and the SDG differ in the set of indicators, goals and targets, poverty reduction is common to both sets of goals. The idea is for the SDG to take off from where the world poverty was when the MDG era ended in 2015. This set off a spate of recent studies on poverty enumeration at the level of regions and the world as a whole. Such cross-national poverty comparisons require two crucial ingredients: an "international poverty line" (IPL) denominated in a common currency, typically the US dollar, and a set of country specific PPPs that allow the IPLs to be converted to the local currency units. While much of the sensitivity analyses of world and regional poverty rates has been with respect to variation in the national poverty lines and in the IPLs, what is lacking has been similar sensitivity exercise with respect to the PPPs used in the country level poverty calculations. Almost universally, the ICP PPPs have been used since they are the only ones that are publicly available.

This study attempts to overcome this gap in the literature by calculating and presenting alternative sets of PPPs to the ICP PPPs, comparing them and presenting results on the sensitivity of the poverty rates and the regional share of the world's poor population to the

Table V.
Regional composition of poor population (%) under alternative PPPs: 2011

Region*	ICP	GEKS	CPD	2011 PPPs CPD-S1 (Region Cluster)	CPD-S2 (Inverse Distance between Centroids)
Africa	40.92	38.60	39.71	39.93	39.58
Commonwealth of Independent States	0.02	0.03	0.19	0.19	0.19
East Asia and the Pacific	23.15	23.37	15.79	15.71	15.88
South Asia	29.79	32.30	38.77	38.56	38.83
Eurostat-OECD	2.06	1.74	1.89	1.90	1.88
Latin America	3.79	3.92	3.62	3.67	3.61
The Caribbean	0.04	0.03	0.04	0.04	0.04
WORLD	100.00	100.00	100.00	100.00	100.00

Notes: *Based on Table III. The singleton countries have been omitted

PPPs used in the calculations. While the comparison here is between the ICP, GEKS and CPD PPPs and the corresponding poverty rates, this paper also examines the presence of spatial correlation in the price movements between regions and the impact of allowing such serial correlation on the poverty rates within the CPD framework. It should, however, be emphasised that the main motivation of this study is to explore whether, on limited data and resources available to non-World Bank affiliated researchers and using a much less complex procedure than that of the ICP, one can come up with independently estimated and sensible PPPs required in poverty calculations and examine how they compare with the ICP PPPs and poverty rates. The empirical evidence points to the fact that while at the country level the alternative calculations have high impact on the implied poverty rates at the regional and global level the rates are reasonably quite robust.

This study builds on the study by Majumder *et al.* (2017), which examined the sensitivity of regional rankings based on living standards to the PPPs used. We extend this study by moving from living standards to poverty rates, introducing spatial correlation in the CPD framework and providing evidence on the impact of regionally correlated price movements on the poverty rates. One of the positive features of both studies is the demonstration that one can come up with independently estimated PPPs that do not require the elaborate and expensive procedure set up by the ICP and can arrive at robust poverty rates at the regional and global level.

Notes

1. See Ravallion (2016) for a recent comprehensive review of poverty measures and the related literature.
2. Note that if the Fisher index is replaced by Tornqvist formula, the GEKS index can be derived from the stochastic CPD approach of Rao described below. However, Balk (2009) recently provided an overview of various multilateral methods and endorsed the GEKS-Fisher method as a centre stage method, particularly from the economic approach to international comparisons.
3. While GEKS forms the basis for PPP computations within ICP, there are many stages involved in PPP compilation. First, PPPs are compiled at the regional level and then linked through Global Core prices maintaining fixity. Therefore, applying GEKS to all the countries is not the same as applying GEKS within ICP. Hence one would expect differences between our computations of GEKS and ICP PPPs. Consequently, the poverty estimates for 2011 presented in the results section are expected to be different from the poverty estimates used in the World Bank's official poverty estimates. However, we only try to examine the comparability in terms of order of magnitude.
4. Evidence of alternative price calculations, which treat all countries symmetrically in a single calculation as opposed to multistage calculation, can be found in Deaton and Dupriez (2010) in the context of 2005 ICP round.
5. Appendix Table AI presents the overall Moran (1950) statistics for testing spatial correlation. Consistent with the results of Aten (1996) and Rao (2001), these establish the presence of spatially correlated prices though they are not having much of an impact on most of the PPPs. However, as we report later, the alternative formulations of the CPD framework do not have much of an impact on the individual country poverty rates or on the aggregate world poverty rate.
6. Table 3 gives the values for only those countries for which all the four poverty rates (ICP, GEKS, CPD, CPD-S1, CPD-S2) could be computed. At the time the exercise was done, the poverty rates (from POVCALNET) for Western Asia were not available.
7. The results relating to tests of spatial correlation are presented in Appendix Table AI. Although the results show significant spatial correlation, the impact on the PPP results is minimal.

References

Ahluwalia, M., Carter, N. and Chenery, H. (1979), "Growth and poverty in developing countries", *Journal of Development Economics*, Vol. 6 No. 3, pp. 299-341.

Aten, B. (1979), "Evidence of spatial autocorrelation in international prices", *Review of Income and Wealth*, Vol. 42 No. 2, pp. 149-163.

Balk, B. (2009), "Aggregation methods in international comparisons: an evaluation", in Prasada Rao, D.S. (Ed.), *Purchasing Power Parities of Currencies: Recent Advances in Methods and Applications*, Edward Elgar, Cheltenham, pp. 59-85.

Chen, S. and Ravallion, M. (2001), "How well did the world's poorest fare in the 1990s?", *Review of Income and Wealth*, Vol. 47 No. 3, pp. 283-300.

Cruz, M.J., Foster, B., Quillin, P. and Schellekens, (2015), "Ending extreme poverty and sharing prosperity: progress and policies", Policy Research Note, *Development Economics*, World Bank Group, Washington, DC.

Deaton, A. (2001), "Counting the world's poor: problems and possible solutions", *The World Bank Research Observer*, Vol. 16 No. 2, pp. 125-147.

Deaton, A. (2010), "Price indexes, inequality, and the measurement of world poverty", *American Economic Review*, Vol. 100 No. 1, pp. 5-34.

Deaton, A. and Dupriez, O. (2011), "Purchasing power parity exchange rates for the global poor", *American Economic Journal: Applied Economics*, Vol. 3 No. 2, pp. 137-166.

Diewert, W.E. (2005), "Weighted country product dummy variable regressions and index number formulae", *Review of Income and Wealth*, Vol. 51 No. 4, pp. 561-570.

Eltetö, Ő. and Köves, P. (1964), "On an index computation problem in international comparisons" (in Hungarian)", *Statiztikai Szemle*, Vol. 42, pp. 507-518.

Ferreira, F., Chen, S., Dabalen, A., Dikhanov, Y., Hamadeh, N., Jolliffe, D., Narayan, A., Prydz, E., Revenga, A., Sangraula, P., Serajuddin, U. and Yoshida, N. (2016), "A global count of the extreme poor in 2012: data issues, methodology and initial results", *The Journal of Economic Inequality*, Vol. 14 No. 2, pp. 141-172.

Jolliffe, D. and Prydz, E. (2015), "Global Poverty Goals and prices: how purchasing power parity matters", Policy Research Working Paper 7256, Development Research Group, World Bank.

Kakwani, N. and Son, H.H. (2016), "Global poverty estimates based on 2011 purchasing power parity: where should the new poverty line be drawn?", *The Journal of Economic Inequality*, Vol. 14 No. 2, pp. 173-184.

Majumder, A., Ray, R. and Santra, S. (2017), "Sensitivity of purchasing power parity estimates to estimation procedures and their effect on living standards comparisons", *Journal of Globalization and Development*.

Moran, P.A.P. (1950), "Notes on continuous stochastic phenomena", *Biometrika*, Vol. 37 Nos 1/2, pp. 17-23.

Rao, D.S.P. (1995), "On the equivalence of the generalized country-product-dummy (CPD) method and the rao-system for multilateral comparisons", Working Paper No. 5, Centre for International Comparisons, University of Pennsylvania, Philadelphia.

Rao, D.S.P. (2001), "Weighted EKS and generalised CPD methods for aggregation at basic heading level and above basic heading Level", mimeographed, Joint World Bank- OECD Seminar on Purchasing Power Parities: Recent Advances in Methods and Applications, Washington, DC, available at: www.oecd.org/std/prices-ppp/2424825.pdf

Rao, D.S.P. (2005), "On the equivalence of weighted country-product-dummy CPD method and the rao-system for multilateral comparisons", *Review of Income and Wealth*, Vol. 51, pp. 571-580.

Ravallion, M. (2016), "Toward better global poverty measures", *The Journal of Economic Inequality*, Vol. 14 No. 2, pp. 227-248.

Ravallion, M., Chen, S. and Sangraula, P. (2009), "Dollar a day revisited", *The World Bank Economic Review*, Vol. 23 No. 2, pp. 163-184.

Ravallion, M., Datt, G. and van de Walle, D. (1991), "Quantifying absolute poverty in the developing world", *Review of Income and Wealth*, Vol. 37 No. 4, pp. 345-361.

Summers, R. (1973), "International price comparisons based upon incomplete data", *Review of Income and Wealth*, Vol. 191, pp. 1-16.

Szulc, B. (1964), "Index numbers of multilateral regional comparisons, (in polish)", *Przeglad Statystyczny*, Vol. 11, pp. 239-254.

World Bank (2013), "Measuring the real size of the world economy: the framework, methodology, and results of the international comparison program", *International Comparison Program*, World Bank, Washington, DC.

World Bank (2016), "Monitoring global poverty", *Report of the Commission on Global Poverty*, World Bank, Washington, DC.

Appendix

Table AI.
Overall results on spatial autocorrelation

Spatial statistics	CPD-S1 (Region Cluster)	CPD-S2 (Inverse Distance between Centroids)
Moran's I	0.278*	0.229*
z-value	115.06	52.80
Estimated Value of ρ	0.674*	0.524*
z-value	74.29	60.16

Note: *Significant at 1% level

Corresponding author
Amita Majumder can be contacted at: amita@isical.ac.in