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Global Absolute Poverty: Behind the Veil of Dollars

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Abstract:
The widely applied "dollar-a-day" methodology identifies global absolute poverty as declining precipitously since the early 80's throughout the developing world. The methodological underpinnings of the "dollar-a-day" approach have been questioned in terms of adequately representing equivalent welfare conditions in different countries and years. These key issues of measuring global poverty are addressed here using the concept of the bare bones consumption basket (BBB). This methodology pinpoints equivalent levels of welfare, both internationally and intertemporally. The results validate the critique against the "dollar-a-day" methodology, showing large variations in costs of BBB between countries and years, even when one explicitly allows for additional expenses such as education and health. This volatility represents the differential among the typically used average CPI and a price index which is more relevant to those living in absolute poverty. On a point estimate level, success in terms of the first Millennium Development Goal (MDG) appears marginal. Once uncertainty in the estimates is accounted for, the BBB poverty lines provide the ground to dispute MDG 1 early celebrations. While BBB absolute poverty remains at very low levels during the entire 1983–2014 period, it also demonstrates strong persistence throughout. On the contrary, the higher welfare level BBB derivative shows overall much less flattering poverty levels.

Keywords: absolute poverty, bare bones basket, global poverty, poverty lines, subsistence basket

JEL classification: I32, E31, O15, C43

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1 Introduction

The state of the art in the global absolute poverty literature is encapsulated in the World Bank's PovcalNet estimates. The "dollar-a-day" methodology endorsed therein has prevailed as the field's standard for several decades now. Those estimates show that absolute poverty throughout the developing world was in the vicinity of 50% during the early eighties, then dropped to about 35% by the second half of the 90's, and by 2012 it was about 15%.[1] This constitutes a more than three-fold reduction in about 30 years. Taken at face value this translates to an enormous success on poverty reduction on a global scale. However, reliable estimates and conclusions can only be the result of a well founded methodology. The lack of convincing methodological underpinnings has been the principal concern in the long list of critics throughout the literature Reddy and Pogge (2010), Deaton (2010a), Srinivasan (2010), Aten and Heston (2010), Subramanian (2015), and Moatsos (2015). Those voiced concerns boil down to the issue of intertemporal and international consistency in measuring absolute poverty. The fundamental issue resides with the extent to which any monetarily fixed iPL is capable of measuring absolute poverty with the same standard all over the world and over time.[2] If empirically substantiated, such criticism directly questions the validity of the "dollar-a-day" methodology since in international poverty measurement "the first-order issue is to demand welfare consistency" (Ravallion 2015, 4). Without a consistent methodology of measuring global absolute poverty, investigating the effect of growth or inequality on poverty, or the result of policy on global poverty will remain perennially at bay.

The principal sources of the "dollar-a-day" inconsistency reside with the use of purchasing power parity (PPP) exchange rates, that relate with total household consumption, and consumer price index (CPI) rates tracking average consumption. On the one hand, the PPP rates are used to express the national poverty lines and the consumption distribution to international dollars adjusted for purchasing power differentials. Thus PPP rates bear the responsibility to achieve the between countries equivalence of the welfare level encapsulated in the iPL. However, this can only be performed for the benchmark year that the PPP rates are available.[3] On the other hand, the CPI rates are used in order to apply the iPL on years other than the PPP benchmark. Thus the CPI rates are responsible to deliver intertemporal welfare equivalence within each country. As a result, the global

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absolute poverty literature accepts the implicit proposition that a fixed value in PPP dollar terms represents the exact same standard of living (in conditions of absolute poverty) for all people around the world.

Nevertheless, the PPP exchange rates do not necessarily achieve this equivalence for the least affluent groups (Deaton 2010b; Deaton and Heston 2010, among others). In addition, the CPI rates applied are plutocratic and thus not constructed to follow the consumption of those living in poverty (Reddy and Pogge 2010). Consequently, the central argument that is substantiated in this paper is that only by coincidence the iPL would be consistently representative of a welfare specific type of absolute poverty in any specific country, or the world as a whole.

The alternative – to the "dollar-a-day" – methodological approach is to estimate absolute poverty on a global level using appropriately defined consumption baskets for each country and year separately. Measuring poverty using a consumption basket is an approach far from novel. One of the early references points to Rowntree (1901) as cited in Kakwani (2003). In addition, the concept of a well defined consumption basket is found in most of the national poverty lines that the World Bank uses to derive the iPL (Chen and Ravallion 2010, 1584). However, the consumption basket approach has been dismissed by World Bank researchers on the basis that people living in poverty adapt their consumption habits in response to relevant price changes (Ravallion 2010), and more recently as paternalistic (World Bank 2016).[4] As already noted by Allen (2013), there is no reason why this type of behavior could not be accommodated in the subsistence basket. Given the long standing foundations of the consumption basket method as such, and that the core of the necessary data is readily available from various sources, it seems rather bizarre that no one before has pursued the goal of applying such a method on a global scale.

Therefore, the contribution of this paper to global poverty measurement is the use of well defined purpose oriented consumption baskets to provide estimates of poverty levels and trends throughout the developing world. This is done for the 32-year period 1983–2014. The BBBs account for the substitution effects by the poor – that occur as a result of price fluctuations – by selecting the cheapest available nutritional sources that meet the minimum dietary energy requirements (MDER) and suffice for a reasonable amount of proteins. In light of the identified issues with the iPL methodology, the main innovation embedded in the BBB approach is that it completely avoids the use of both the PPP rates, since the calculation takes place in the local currency for each country, and marginalizes the average CPI rates, since the re-estimation of its value is done from the nominal price dataset for every year separately.

Conceptually the basic version of the BBB closely observes the definition of absolute poverty by Unesco, according to which: "[a]bsolute poverty measures poverty in relation to the amount of money necessary to meet basic needs such as food, clothing, and shelter."[5] For the purpose of depth in measuring global poverty, an additional BBB derivative is constructed[6] that follows closer the definition used in the Copenhagen Declaration by the United Nations: "[a]bsolute poverty is a condition characterized by severe deprivation of basic human needs, including food, safe drinking water, sanitation facilities, health, shelter, education and information. It depends not only on income but also on access to social services."[7] In addition, the BBB derivative closely follows article 25 of the Universal Declaration of Human Rights. Pogge utilizes this article in defining an individual as living in poverty when he lacks: "a standard of living adequate for the health and well-being of himself and of his family, including food, clothing, housing and medical care."[8]

The rest of the paper is organized as follows: 2 provides a thorough exposition of the methodology applied. 3 exhibits the data and sources used, and 4 positions the constructed poverty lines in comparison to the dollar-a-day line. 5 presents the new global absolute poverty estimates on regional and global levels, as well as for a small set of key countries, and in comparison to the World Bank's figures as reported in PovcalNet. 6 concludes.

2 Bare Bone Baskets

2.1 Articulating Consistent Poverty Lines

The concept of measuring absolute poverty internationally using a common achievement has been explicitly proposed by Reddy and Pogge (2010) and implicitly by Allen (2013). To this end, Reddy and Pogge argue that any two currency amounts are equivalent in time and space only if they both just suffice to meet a common achievement. In the case of BBBs, the common achievement is bare bones survival, calculated based on choices mainly given by nature in terms of most basic nutrients absolutely necessary for survival, and largely beyond normative judgments. Furthermore, BBBs by construction observe the principle of consistency as defined in Ravallion and Bidani (1994). According to that definition, consistent poverty lines must be comparable between different regions and subgroups, thus "representing the same level of welfare".[9]

Basic nutritional needs provide a widely defensible and objective starting point for consistently defining a common achievement and a common welfare level. In accordance to Sen (1980), the level of income or con-

sumption that suffices for basic nutritional needs to avoid malnutrition "has a claim to be considered as an appropriate poverty line even when [...] nutritional requirements vary interpersonally around that average". The satisfaction of those basic nutritional needs, along with the basic needs required by the Unesco definition, such as housing and clothing, assemble the foundations that the BBB methodology builds upon. In practice, consumption baskets are embedded in the iPL as well, albeit in an inconsistent manner. According to Chen and Ravallion (2010), 80% of the national poverty lines (NPLs) used in Ravallion, Chen, and Sangraula (2009) to derive the iPL of 1.25$-a-day in 2005 prices, are constructed also using some variation of a cost of basic needs approach. In all its versions, the dollar-a-day iPL is estimated by averaging a set of NPLs from a group countries (Chen and Ravallion 2001; Ferreira et al. 2015; Ravallion, Chen, and Sangraula 2009; Ravallion, Datt, and van de Walle 1991), without any explicit analysis of what the underlying NPLs actually represent in terms of welfare.[10] The methodological variation among the NPLs underlying the iPL, especially with respect to the encapsulated normative choices,[11] does not allow for any use of the NPLs, as they stand, to consistently measure global poverty. These methodological choices in the construction of the iPL are insufficient, since, in order to avoid the application of inadequate PPPs, it is necessary to have local poverty lines that have been derived using the same method on every country individually. NPLs fail to provide such a basis. Moreover, local poverty lines must be separately calculated for every year, based on domestic prices, to avoid using average consumer price indices as much as empirically possible.

Allen (2001) defines the BBBs for use in the historical real wages literature, and de Zwart, van Leeuwen, and van Leeuwen-Li (2014) apply them on a global scale. Table 1 contains the overview, and compares with the BBB definition followed here. The main component of the basket is the consumption of staple food, and in a secondary role the consumption of beans/peas. Some minimum consumption variety is included in the basket by allowing the consumption of 3 kg of meat on a yearly basis, or 6 kg of fish if cheaper. The food component also includes 2 kg of sugar and 3 kg of butter, oil, or ghee per year. In total the food component should allow for 40 g of protein per day and a specific number of kcal per day. The non-food component includes allowance for clothing in the form of 3 meter of linen, some candles and lamp oil, and 3 mbtu of the cheapest fuel per year. Finally, a mark-up of 5% provides the means for extremely basic housing facility. As shown in the last column of the table, the BBBs from the real wages literature are updated here in a number of ways.

Table 1: Classic bare bones baskets compositions for a male adult.*

Commodity	Unit/Year	N.Europe	China	India	Africa	L. America	BBB
Main staple	kg	155-178	171-179	164-209	185-413	132-165	MDER**
Beans or peas	kg	20	20	20	–	45	MDER**
Meat or fish	kg	3 or 6	3 or 6	3 or 6	3 or 6	3 or 6	3 or 6
Butter/oil/ghee	kg	3	3	3	3	3	3
Sugar	kg	–	–	2	2	2	2
Soap	kg	1.3	1.3	–	1.3	1.3	1.3
Linen (defined)	m	3	3	3	3	3	3
Linen (applied)	share	8%	8%	8%	8%	8%	8% ± 2%
Candles	kg	1.3	1.3	–	1.3	1.3	1.3
Lamp oil	liter	1.3	1.3	–	1.3	1.3	1.3
Fuel	mbtu	3	3	–	3	3	Temperature**
Cooking	mbtu	–	–	–	–	–	MDER**
Housing	mark-up	5%	5%	5%	5%	5%	5% ± 2%

Note: Variation in the weight of the main staple represents the different staple used for different sub-regions, see de Zwart, van Leeuwen, and van Leeuwen-Li (2014) and Allen et al. (2011) for more details.
*: As defined and applied for different parts of the world; adapted from de Zwart, van Leeuwen, and van Leeuwen-Li (2014). Last column contains the composition of the basic BBBs adapted for measuring contemporary global absolute poverty
**: Calculated as a function of Minimum Dietary Energy Requirements (MDER) or temperature as noted respectively; see text for details concerning the estimation of each component in the BBBs.

First, in both Allen and de Zwart et al., the nutritional content in kcal is fixed to 1455 kcal per person, and Allen (2013) revised it to 2100 kcal per person, as the original value was found too low. In any case, in Allen's methodology the same caloric target is set for all countries and for all years. In the context of absolute poverty, this extrapolation ignores the important variation and the changes in the anthropometric characteristics, as well as the evolution of the population's age/gender composition. For example, an increase in height, while

maintaining the same relation of weight and height, would imply an increase in the number of kcal needed at minimum. In other words, if one chooses not to update the nutritional content of the basket for what the FAO calls the minimum dietary energy requirement (MDER) for each country-year, the result would be measuring poverty for a population different to what it actually is. If the MDER for a country is lower (higher) than the MDER incorporated in the calculation of the BBB value, then we will be overestimating (underestimating) actual absolute poverty. Kakwani (2003) argues that using an average calorie allowance for all "gives biased estimates of poverty incidence because all individuals do not have the same caloric needs". This argument refers to measuring poverty within a country, but it also holds on the international level. Despite the empirical challenge to account for individual differences within countries, it is relatively easy to account for the differences in minimum nutritional energy requirements between populations.

An additional consideration should be set forth in support of using MDER for determining the nutritional content of the consumption basket. The poverty lines alone cannot provide an answer for the incidence of poverty, as a distribution of a welfare measure is required as well; typically that of consumption, or income as a second best choice. These distributions are corrected for the size of the household in the sample, and the resulting distributional information is on a per-average-individual basis. In absence of such a correction there would be cases where a family of 2 with say $20,000 income would be worse off than a family of 3 with $20,500. Such a ranking is reasonably disputable, and a statistical correction is applied. At the same time, due to the large differences in energy requirements within the population, by different age cohorts for example, implies that "the incidence of poverty will likely be overestimated among families with children and underestimated for couples without children" (Kakwani 2003). Which is essentially the same problem the welfare distributions face before household size correction. Given this observation, the corresponding representation of energy requirement should also be in terms of average individual basis. By construction this is what MDER represents on the population level.[12]

More specifically, the calculation of the BBB caloric content follows FAO (2008) methodology consisting of a set of equations that estimate the energy requirement per age/gender group based on a small set of anthropometric variables. These variables consist of the height for each age cohort, the distribution of the population by age and gender, the body mass index (BMI) that describes the relation of height and weight, and finally the physical activity level (PAL) which describes the intensity of the lifestyle in terms of energy consumption. The height and BMI data are combined to get the weight for each gender/age group. Subsequently, the weight and the PAL level for each group, along with the share of each group in the total population, allow us to estimate the population wide MDER.[13]

The second deviation from the Allen (2001) methodology is that the food component of BBBs is restructured to move closer to the absolute minimum cost combination of resources that achieves the goal of meeting the MDER caloric intake and the 40 g of protein per day. Thus, the main staple and the beans/peas are grouped together, and the budget minimization problem is solved via linear programming. The incorporated food variety within the BBBs is very limited even if compared, for example, to the allowance of the quite frugal 1993 NPL in India. According to Chen and Ravallion (2010), "[t]he daily food bundle comprised 400 g of coarse rice and wheat and 200 g of vegetables, pulses, and fruit, plus modest amounts of milk, eggs, edible oil, spices, and tea". For an overall comparison regarding the food component, Ravallion, Chen, and Sangraula (2009) report that in NPLs the average food component share is 65% of the total costs. This share in the case of the BBBs here increases to 71% signifying the BBBs' frugality.

Lastly, the third difference with Allen's approach is that the energy and clothing allowances are linked to the year and country specific temperature conditions, thus explicitly accounting for the climatic differences between cold and warm countries. The energy allowance includes, on top of the heating costs, the energy required to cook the specific amount of calories of the BBB food component that require cooking to become edible. The energy needs related to the outside temperature conditions are calculated as the required energy to bring the temperature of a small room at 18°C, and maintain it at that level for 8 hours per day.[14] The temperature has been chosen from the literature as a temperature above which the risk "to the health of a sedentary person, wearing suitable clothing" (Wookey et al. 2014) is minimized [see also Healy and Clinch (2002) for a further discussion]. The World Health Organization also recommends 18°C as the minimum indoor temperature as noted in Collins (1986). The 8 hours duration rests on the idea that total daily hours are equally split among work, rest and leisure.[15] An important parameter in the calculations of the energy required for heating is that of how well insulated the room is. Since there are no readily available estimates of the exact insulation parameters, a variety of parameters representing low-cost and accessible materials is used instead. Ergo additional uncertainty in the energy requirements estimates that propagates in all the subsequent calculations. For the purpose of allocating the heating expenses per person, it is assumed that the heated room is shared by 3 to 5 persons and the heat energy produced by body heat is accordingly subtracted from the estimated required energy.[16] The National Oceanic and Atmospheric Organization in the USA provides monthly data for almost all developing countries.[17]

The clothing allowance – in lack of available prices – is estimated as a share of the basket that includes the food and energy components. This indirectly makes a link between clothing and temperature. The budget share used for imputation follows de Zwart, van Leeuwen, and van Leeuwen-Li (2014) and it is set on 8%. On this a standard deviation of 2% is assumed to account for part of the variation in relative prices among countries. The energy required for cooking is estimated independently from heating energy and it is based on the FAO finding that the amount of energy needed to cook food is typically on a 3-to-1 ratio.[18] The aforementioned imputation assumptions are relaxed for the BBB derivative introduced in 2.3.

2.2 Advancing the Bare Bones Baskets as Global Absolute Poverty Lines

Given that the BBBs are estimated based on domestic prices, and that the predominant component is staple food, then by construction BBBs follow closely the variation of prices that are most relevant to those living in dire conditions of absolute poverty. Regmi (2001), using income elasticities of demand for staple foods, finds support for this claim concluding that "the poor cannot substitute away from staple foods to anything else". In turn, this allows for a closer monitoring of the changes for people living in absolute poverty. Such a level of granularity in measurement cannot be achieved by the "dollar-a-day" methodology, because of its lack of specificity due to its averaging nature. The "dollar-a-day" averaging occurs on three counts. First, in the way the iPL is estimated as the average of some NPLs. Second, by applying PPPs that track the household consumption on average in each country. And third, by the use of CPIs that track average consumption patterns.

Indeed the BBB method avoids this triad of problems and closely follows the common ground in the recommendations of both sides of the "how not to count the poor" argument.[19] On the one hand, it follows the recommendations of Ravallion (2010), who argues that the consumption basket cannot be the same across countries due to price differences. According to this point the ideal price index should capture the price variation "of a reference level of welfare". In the basic BBB it is the welfare level of bare bone subsistence that is being used as the explicit reference level of welfare. On the other hand, by using a reference level of welfare, it automatically incorporates the suggestion of Reddy and Pogge (2010) who conclude that only an achievement based procedure is a consistent method for estimating poverty of comparable type across countries and time. And, as already mentioned, consistency is a necessary methodological property in obtaining reliable global poverty estimates.

Lanjouw (2001) argues that "the least cost criteria rarely reflect actual consumption patterns". And indeed, the BBBs have less to do with actual consumption patterns, and more with identifying a specific–bare bones–consumption capacity threshold. The BBB identifies the absolute poor in the world by constraining the space of consumption alternatives of any person down to the bare bone essentials. Those with consumption capacity at BBB levels, in order to make different consumption choices are bound to pay for that choice by sacrificing part of the absolute essentials, and this sacrifice has to happen in nutritional terms at large. Adopting consumption patterns that deviate the BBB does not imply that people doing so do not live in absolute poverty; they simply choose another way of surviving in absolute poverty conditions. The cost of this bare bones consumption is what the BBB tracks, thus qualifying as an absolute poverty yardstick.

In relation to the methodological inertia against applying a "cost of basic needs" (CBN) approach, such as the BBBs, Srinivasan (2010), rightfully points that any poverty consumption bundle unavoidably contains some arbitrariness. A related important objection from Srinivasan (2010) is that a common interregional consumption bundle is hardly representative in the presence of all sorts of geographically and cultural differences. The BBBs can partially address both of the above concerns, at least on the international level, since BBBs do not take the form of a fixed bundle, but the form of a bundle that enables a specific achievement within a cost minimizing setup. In addition, BBBs are not constructed with a particular representative household in mind, but rather the bare essentials for survival. These essentials provide enough caloric intake and prevent protein deprivation. They also – in a very frugal manner – keep a person dressed, housed, as well as not cold, and with enough fuel to cook food. This is a well-defined common achievement standard for measuring absolute poverty, that defensibly represents equivalent levels of welfare in intertemporal and international comparisons. It is also mostly linked to objective natural necessities for bare bones subsistence life conservation, thus in a lesser degree prone to arbitrariness compared to consumption baskets constructed to capture non-absolute poverty.

Another point of concern in using consumption baskets for measuring poverty can be found in Ravallion (2008). According to this source "it is quite possible to find that the 'richer' sector (by the agreed metric of utility) tends to spend so much more on each calorie that it is deemed to be the 'poorer' sector". This concern, does not apply to the BBBs, since by construction the cheapest – and not the minimum observed – calories are assigned to the absolute poor. Also, Ravallion (2008) referring to the work of Wodon (1997) argues that a general increase in prices may also imply a drop in a "food energy intake"-based poverty line. In the case of BBBs this is embedded in the cost calculation process of the food component, which in nutritional terms follows the evolution of local anthropometric characteristics and is independent of actual consumption behavior.

Finally, two additional benefits are brought about with the use of BBBs in absolute poverty identification. First, as a result of the BBB method, any errors in the required data, relate only to the particular country-year a data point represents. In contrast, the chained errors in PPPs and CPIs influence the entire time-series of global absolute poverty estimation. In other words, any errors in poverty estimates are in principle not contagious to other country-year estimates. The second point relates to the underreporting of consumption – or income – in household surveys that is noted in the literature (Anand and Segal 2008; Bhalla 2002; Ravallion, Chen, and Sangraula 2007). As it has been found also by Bhalla (2002), the foodgrains, are the least understated consumption group in the 1993/4 national household survey for India. This understatement is about 10%, compared to more highly valued food products, such as dairy products, fruits, and vegetables, which show an underestimation of 53%. This observation translates in BBBs being a safer choice in hedging the poverty estimates against the household survey underreporting, since in their greater part they rely on food items that appear less prone to this problem.

2.3 Targeting a Higher Welfare Level

The BBBs are constructed such as to represent bare minimum absolute poverty levels in consumption terms. However, the absolute poverty yardstick can be expanded to account for other essential elements of life and wellbeing, such as education and health, as both the Copenhagen Declaration and the Universal Declaration of Human Rights stipulate. Table 2 offers one such BBB derivative that allows for considerably higher welfare levels compared to the basic BBB.

Table 2: The composition of bare bones baskets in real wages and the BCS derivative applied here.

Item	Unit/Year	Real Wages Basket	BBB	BCS
Energy Target	kcal	1455/2100	MDER	MDER
Minimization	–	Cheapest bundle		Mean of three cheapest bundles
Main staple	kg	155–413*	Based on kcal/protein target**	
Beans or peas	kg	–/20/45	LP	40 at minimum
Meat or fish	kg	3 or 6	3 or 6	12 or 24
Butter or oil or ghee	kg	3	3	12
Sugar	kg	–/2	2	8
Linen (applied)	share	8%	8% ± 2%	WBGC
Lamp oil	liter	1.3	1.3	WBGC
Soap	kg	1.3	1.3	WBGC
Candles	kg	1.3	1.3	WBGC
Fuel	mbtu	3	f(T in °C)	WBGC
Cooking	mbtu	–	MDER	WBGC
Housing	mark-up	5%	5% ± 2%	WBGC
Health, Education, Water	%	–	–	WBGC
Additional shares***	%	–	–	WBGC

Note: The Bare bones basket with Consumption Shares (dubbed BCS) uses the average of three cheapest bundles, and four times more meat/fish, butter and sugar allowance. In addition, an allowance covering health, education, and water is included using the consumption budget shares from the World Bank Global Consumption dataset (noted as WBGC on the table). Consumption budget shares are also used for energy, housing, and clothing, and allowances for personal care, ICT, financial services, and "others" are included in the additional shares.
*Depending on the country and main staple.
**To avoid inflating the price of the consumption bundle, priority in linear programming is given to the kcal target, and protein target is allowed to overshoot by 200% at maximum if necessary. Only for Dominican Republic this cap increases the bundle price by more than 20%, and for Belarus by more than 10%, compared to allowing for unlimited protein overshooting. For all other countries there increase if any is restricted to only a few percentage points increase.
***Additional budget shares available from the World Bank Global Consumption data include: Personal Care, ICT, Financial Services, and Others.

The BBB derivative introduced here is the Bare bones basket with Consumption Shares (BCS). In terms of the food component, it explicitly allows for 40 kg of beans or peas annually (767 g per week), and quadruples the BBB allowance of meat or fish, of sugar and of butter, oil or ghee. The increases in meat or fish despite their size they only allow for 230 g of meat or 460 g of fish per week, depending which one is cheaper. Another important differentiation is that the implicit assumption according to which people living in absolute poverty have the comfort and resources to solve the minimization problem via linear programming is two-steps relaxed. Instead of the strictly cheapest staple food bundle the average of the three cheapest is used, thus expanding the variety included in the consumption bundles. In addition, explicit allowances are introduced for expenses on health, water facilities and education. Those budget shares are available by the World Bank Global Con-

sumption dataset for about 80 countries in 2010, and on within country breakdown into four "consumption segments".[20] BCS further utilizes all additional information available on budget shares from the World Bank Global Consumption dataset. Hence, all the imputation methods used in BBB are substituted by budget shares from the World Bank. Those include explicit allowances for Personal Care, ICT, Financial Services, and Other expenses.

These World Bank budget shares allow us to account for expenses about items that no global price dataset exist for. In the presence of the Engel's law, however, they also give rise to concerns regarding the validity, consistency and comparability of the estimates across time and countries. According to the Engel's law the higher the welfare level the lower the share a household or person will spend on food. The Engel's law broadly holds also for international comparisons, assuming, as in the case for households, that the countries face the same relative prices. In response, the budget shares are introduced in a manner that would partially address these concerns by accounting for the implied uncertainty.

The workaround to the Engel's law implications is to use the ratio of the estimated food-component in the BBBs over the 'food and beverages' budget share (FnB) of the first consumption segment. The procedure is best described in terms of an example. Suppose for instance that the BBB/FnB ratio is 0.5 for the poorest consumption group, and that the housing budget share of that group is 20%. The question is then, which is the appropriate budget share percentage to estimate the housing costs of a household consuming the BBB food component. If the housing expenses are inelastic with respect to the food expenses then the housing share should become 40% (i.e. the costs remain the same even if they increase as a share). The alternative for housing expenses would be to perfectly follow the drop of the BBB relative to the FnB, then the housing share should remain at 20%. The usual response to two alternatives is to take their average, and in this example the housing budget share would be 30% $\pm$ 7%, that includes half the uncertainty in the estimate as a standard deviation in order to account for our ignorance regarding the actual position of the share between the two alternatives.[21] For years other than 2010 the non-Food value of the BCS is updated using the average of BBB, expressed as a price index, and the CPI. This is done so in lack of an appropriate price index for the commodities and services imputed using the WBGC budget shares.[22]

3 Data

3.1 Food Energy

To estimate the value of the BBBs, the first step is to identify the MDER per person in a country-year following the FAO (2008) methodology. For this purpose data on the age and gender composition of the population, and the average height for adults are required, along with two basic assumptions. The first assumption concerns the height of newborns, which is set to 60% of the height of one year olds. The second concerns the Physical Activity Level (PAL) of adults, which is discussed below. The age and gender demographic data can be found at the United Nations World Population Prospects (United Nations 2015). This dataset covers 192 countries and territories, annually from 1950 until 2015. However, the population is classified in five-year age groups (0–4, 5–9, 10–14,..., 95–99, 100+), while the FAO model requires annual information until the 20th year, and every five years thereafter. To overcome this mismatch, a non-parametric kernel density estimator is applied to obtain the yearly approximate information on the age/gender distributions.

Regarding the PAL value, FAO (2001) offers three versions of PAL representing light, moderate and vigorous lifestyles. For working age population (here assumed to be 18 to 70), the average of moderate and vigorous lifestyles is taken as a middle-ground approach between two competing arguments: The first is in favor of a vigorous lifestyle, and assumes intense manual labor to be typical among people living in poverty. And the second argument favors a moderate lifestyle, and calls for a certain constraint in very intense physical activity due to limited nutritional sources. Thus the numeric value of PAL is set to about 2, as the average among 2.25 and 1.76 respectively. For the population above 70, following FAO, the PAL is set to 1.55, corresponding to the light lifestyle. Finally, a small correction of the initial MDER result is needed to account for the extra kcal required by women during pregnancy and breastfeeding following FAO (2008).

The male adult height data are from the ClioInfra (2015) height dataset, that expands the work of Baten and Blum (2012). This dataset covers 165 countries, with data starting from the mid-19th century for most. When no height information is available for any year for a given country then the average height of the corresponding region is used. The height for female is calculated using the conversion formula provided in Baten (2008).[23] Typically these height data are given per decade of birth and do not cover all the years we are interested in. In turn, data imputation is necessary to yearly cover the full 100-year span in each required population distribution. This was done by linear interpolation for years between the observations, and when extrapolation was needed, the regional growth rate was applied on the last observation. Sub-Saharan Africa has no data in the

post-1980 period. To partially entertain concerns about this lack of data, it is instructive to observe that for the 1860–1980 period it is the region with the least volatility in height levels, and the regional average is ranging within 2.4 cm.

For modeling the growth in height up to the full adult height we use the implied growth rates from Table 3 in FAO (2008). There is, however, a mismatch on this point with the height source used. In Baten and Blum (2012) it is assumed that the full height is reached effectively during the 22nd year of age for a male person, while in FAO this happens in the 18th year.[24] In both cases however the same height is finally attained, the only difference is that the height growth takes more years in case of the Baten and Blum (2012) assumption. In turn, on the aggregate MDER this mismatch would play some role only if a relatively very large birth cohort is ascending from the 18th up to the 22nd year. In order to understand the implied error of this mismatch consider the case of Cambodia in 2000 which contains the relatively biggest birth cohort in the post 1983 UN WPP dataset,[25] the contribution of that cohort in the aggregate MDER is about 2.78% of total kcal, and we slightly underestimate a part of that.

From the height data and the body mass index (BMI) in the FAO MDER model, the weight for each age/gender group is obtained, and from the weight and the FAO formulas the kcal per age/gender group is estimated. In the final step, those values are weighted by population shares of each age/gender group based on the UN WPP information. This weighted average is the MDER kcal target for a specific country-year combination. It is important to note that the obtaining kcal value corresponds to a minimum requirement because of the body mass indices used for each age/gender group. Those BMI values are selected by the FAO from the WHO reference distributions of 1995, 2006, and 2007 within the entire population. They correspond to the 50th percentile until 10 years of age, and to the 5th percentile of the distribution thereafter.[26]

Figure 1 shows the evolution of the 5040 total MDER estimates for 140 developing countries, in all the years from 1983 until 2014. The median of the MDER distribution in 1983 is at 2029 kcal, with a minimum of 1839 kcal and a maximum of 2389 kcal. In 2014, the median has shifted to 2183 kcal, the minimum is at 1871 kcal and the maximum is at 2469 kcal. For China the growth in MDER from 1983 till 2014 is 9.1%, for India 7.1% and for Indonesia 9.2%. These countries are also traced on the figure in the entire period. The general trends shown in Figure 1, demonstrate the importance of accounting in the BBBs for the changes in MDER. It turns out that keeping the caloric intake fixed to 1983 levels will introduce a median error in the caloric content of the consumption basket of 5.6%, and more than double this error for 20 countries. For 12 countries the change is on the negative side, with Niger having the larger decrease in MDER at about 2%.[27]

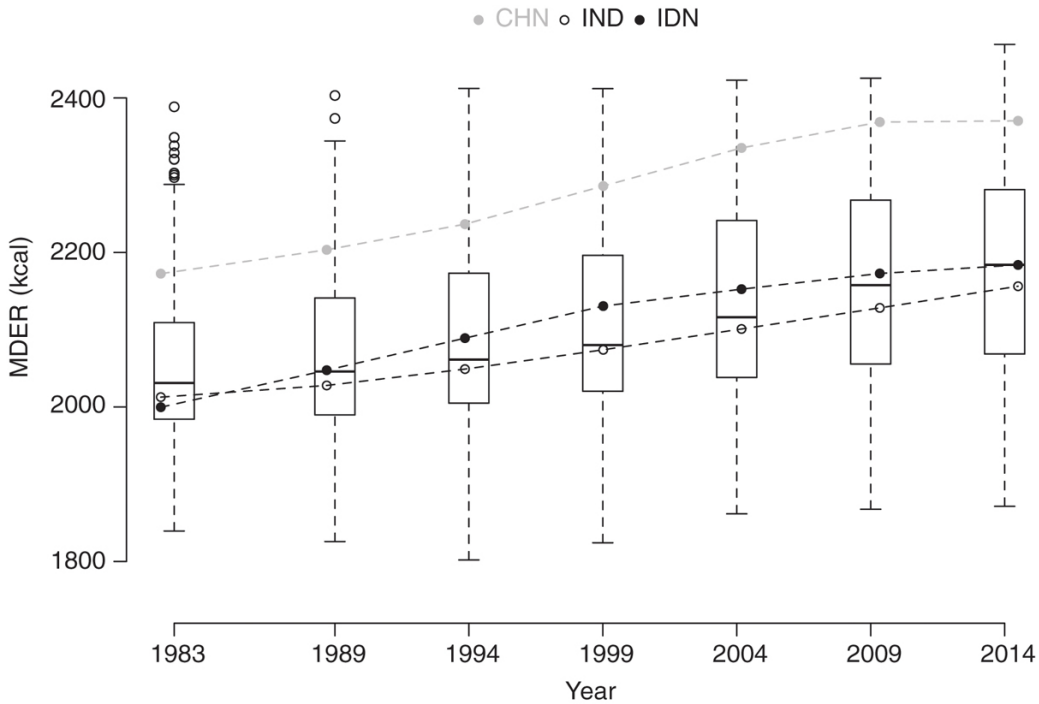

Figure 1: Evolution of MDER, developing countries 1983–2014.

An important issue with the MDER updating is the differential among heights of the average and the least affluent groups. It is hard to be conclusive about the extent of such a differential. An indication about the prevalence of such a problem can be drawn from the evolution of heights inequality among the population. The most relevant dataset is provided by Baten and Blum (2011) through the Clio Infra website. This dataset provides Gini coefficients for a large number of countries covering most of the recent 200 years. The rationale

of the investigation is that if this differential is considerable, it will be driving height inequality upwards. If one combines the evolution of heights with the evolution of inequality in heights in the post-1940 period, there is no positive trend among inequality in heights and the level of heights for developing countries. In a total of 97 pairs of height and the Gini of heights observations, 33 combine an increase in height with an increase in the Gini, while 31 with a decrease in the height Gini.[28]

Information regarding the nutritional content of the food items in raw form is drawn from USDA.[29] In addition, the loss in caloric content due to cooking has to be factored-in, as it can rise up to 40–50% for some food items. Therefore, the relevant retention rate that describes this loss is multiplied with the amount of kcal contained in the purchased form of a food item. The retention rates are provided by Appleton et al. (1999) as mentioned in Lindgren (2015).

3.2 Food Prices

With regard to the prices, the main source used is the online dataset from "The ILO October Inquiry",[30] covering 222 countries and territories with prices for the period 1985–2008. The October Inquiry covers 93 items of food and drink. The data contain price information in local currency units and at the currency denomination available at each sampling year. The ILO dataset covers items that allow the pricing for most of the BBB food items, including the main staple, beans/peas, meat/fish, butter/ghee/oil, and sugar. To determine the unit costs for fuel, I used the share of each in the BBBs estimated by de Zwart, van Leeuwen, and van Leeuwen-Li (2014) using pre-1983 ILO data. For fuel, when constraining to the non-extreme cases,[31] the cost of 1 mbtu of fuel is 4% with a standard deviation of 2%, expressed as a markup on the pre-fuel BBB cost. Additional information on prices has been gathered from FAO that covers the years 1990–2015, and WFP that covers the period 1992–2015.[32] All three price sources contain price information on a per market, per city or on a national level. In the first two cases I take the arithmetic average of the available prices per product. The FAO price data are in nominal terms using the most recent denomination. Thus, in order to have a homogeneous nominal dataset, I redenominated all prices back to the original denomination for each specific country-year. This was done using the dataset on history of currencies curated in the Global Financial Dataset.[33] For some of the most recent changes this dataset is not up-to-date, so additional sources had to be used involving information available on national central banks, along with the invaluable contribution of relevant Wikipedia entries regarding the history of some national currencies.

An important concern over prices is the differential among rural and urban prices. For India, Deaton (2003) has estimated the urban value of his poverty line to be 11.5% higher than the rural in 1987–1988, 15.6% in 1993–1994 and 15.1% in 1999–2000. This information is of practical importance as it pin-points a value for this differential over a very important country for which PovcalNet provides separate distributions for the rural and urban sub-domains. This is also the case for China and Indonesia. For China, we operationalize the estimates provided by Brandt and Holz (2006) and The World Bank (2009). Those estimates concern years 1990, 2000 and 2003, with urban/rural differential being 19.3%, 23.7% and 26.5% respectively. Finally, for Indonesia Asra (1999) estimates the differential at 13% for 1987 and at 16% at 1993 and 1996. For these three countries, and for the years between price differential data-points, the linearly interpolated value is used, and the last available value is applied for years outside of those periods. For any other country, a price differential would be of rather limited practical use, since not both rural and urban distributions are available.

3.3 Estimated Bare Bones Baskets

In total, 1982 BBBs have been priced directly from data in the period 1985–2014, with the aforementioned limitations, distributed as shown in Figure 2. In the years 1985 until 2008, an average of about 70 developing countries have a priced BBB per year directly from original prices. Also on average the linear programming can identify the cheapest product combinations, that would yield the needed MDER caloric target and the specific protein amount, among about 12 relevant products with available prices.[34] There are, however, two important issues that dictate the use of imputation techniques for missing prices. First, the need to have both priced BBBs and distributions from PovcalNet for the same years for a given country. Second, the bias introduced when missing prices of the otherwise cheapest products occur only in some years. For example, take the case that in a country we have the price for maize for three consecutive years, and the price for rice for the first and the last of those years. Assuming further that rice is the cheapest nutritional source, the missing price for rice would artificially inflate the value of BBBs for that year. This happens, not because there was actually no rice in that country for that particular year, but because the dataset did not contain it.

To overcome these shortcomings food CPIs have been in principle applied to impute the missing prices. Occasionally food CPIs have been complemented by other more generic CPI types, such as average consump-

tion CPIs. All CPI data are drawn from ILO, FAOSTAT, IMF, the World Bank and the Clio Infra dataset. After exhausting available CPI options, the average price change in the available prices of the dataset is used to estimate the price change for other products of the same category. If no other products were available from the same category the price change in staple foods is utilized instead. In the process, the error introduced by the imputation is ball-parked. For that purpose, a standard deviation of 20% is used for original prices from ILO, FAO, and WFP, on the basis of the deviation present in the original price data when more than three sampling locations are available per product, country and year combination. When the imputation is done for a year that follows one with available price data the assumed uncertainty increases by 1 percentage point by convention. For every additional year of distance between a missing price and the closest year with available price in the original data, an extra percentage point is added to the uncertainty level up to an overall maximum of 30%. This uncertainty is later propagated in the estimation of the poverty rates. In the case of a price imputation between given prices, there are two ways of estimating a value for that year. Either by starting from the later year going back using a CPI rate, or by starting from the earlier year and then going forward. Here the average of the two approaches is applied, weighted by the distance of the imputation year and the upper and lower years with available data. The data point of the year closest to the imputation year gets the higher weight proportionally.

Using this technique a total of 3679 BBBs have been priced for the period 1983–2014. Here the linear programming can choose from about 25 priced staple food or beans/peas products on average. The available estimates translate to about 120 per year, out of the 125 developing countries in the price datasets. This is shown on Figure 2, alongside the BBBs priced only using the original data. To add some perspective the price availability of the staple food component in the original data is also shown. In the final poverty estimates the overall population coverage achieved throughout the developing world using these baskets is higher than 85.2% on average. Lowest coverage is 76% in 1983 and highest is 1995 at 88.3%.

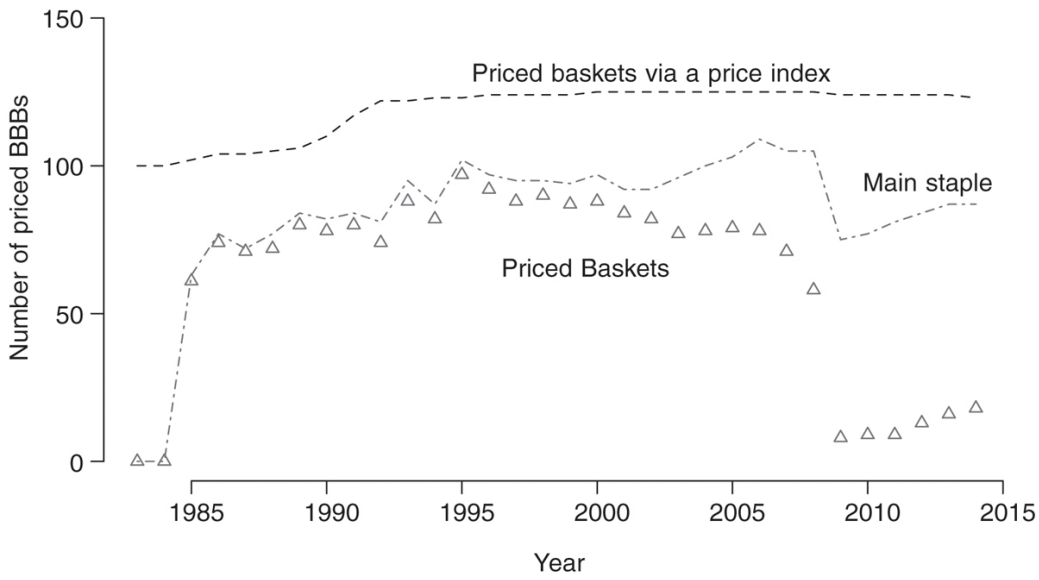

Figure 2: Priced BBB per year, globally 1983–2014.

3.4 Household Survey Consumption and Income Distributions

With respect to the distributional data, PovcalNet contains data on consumption or income distribution for 165 countries or territories, since 1981.[35] The distributional data are available in terms of both 2005 and 2011 PPP international dollar for most countries.[36] To make the conversion back to nominal terms, the actual CPIs applied by the World Bank were used, along with the appropriate PPP exchange rates and the aforementioned data for currency denomination.[37] Since our target is to maintain the welfare level of those at the poverty line constant, it is important that in most relevant occasions the PovcalNet distributions concern consumption, since in those distributions own production is accounted for.[38]

As in the case of the regional and global aggregates presented in PovcalNet and Chen and Ravallion (2004, 2010) , one needs to devise a way to align countries' consumption or income distributions to get the yearly estimates with acceptable coverage. For having a better comparability of the results, I follow their methodology. The basic idea of the method consists of using the evolution of a national accounts statistic, typically GDP per capita or household final consumption per capita, to increase or decrease the average of the distributions for the years without distributional data. The selection of GDP per capita or household final consumption is based on

the per country data availability. When the year of interest lies anywhere between two available distributions, then both distributions are used and two different consumption or income averages are computed and two poverty rates are thus produced. Consequently, I take the weighted average of the two rates, with the one resulting from the distribution of the year closest to the year of interest taking the higher proportional weight. If only one distribution for a previous or a later year exists, then only that single value is extrapolated using the national account statistic.

3.5 Uncertainty

Data used in global poverty estimates are not without important limitations (Deaton 2010a). Simply acknowledging this feature and carry on to provide plain point estimates is, however, far from satisfactory. Antithetically, an important role should be attributed to uncertainty in terms of interpretation of the results, at the very least because in many countries the poverty line is positioned at a point where the gradient of the distribution is a relatively steep one. This implies that a small error in the estimation of the actual level of the poverty line implies a larger one on the level of the poverty rate. In principle all data treatments and problems discussed above are sources of uncertainty and errors in the estimates. In the present treatment not all sources of uncertainty are accounted for. Those considered include price uncertainty by following a simple convention; uncertainty in energy required for heating and cooking; uncertainty in the number of persons per household; and uncertainty in the various budget shares applied. All the poverty estimates in the results that follow are reported with one standard deviation, as this obtains from error propagation.[39]

4 Bare Bone Baskets in Perspective

4.1 Bare Bone Baskets as a Price Index

In order to empirically establish the discrepancy between the average consumption price index for the entire population, and the evolution of the prices that are most relevant to those living in absolute poverty, the relation between the two indexes is investigated. Figure 3 shows the evolution of the ratio of the CPI and BBB expressed as a price index with their 1990 values normalized to 100.

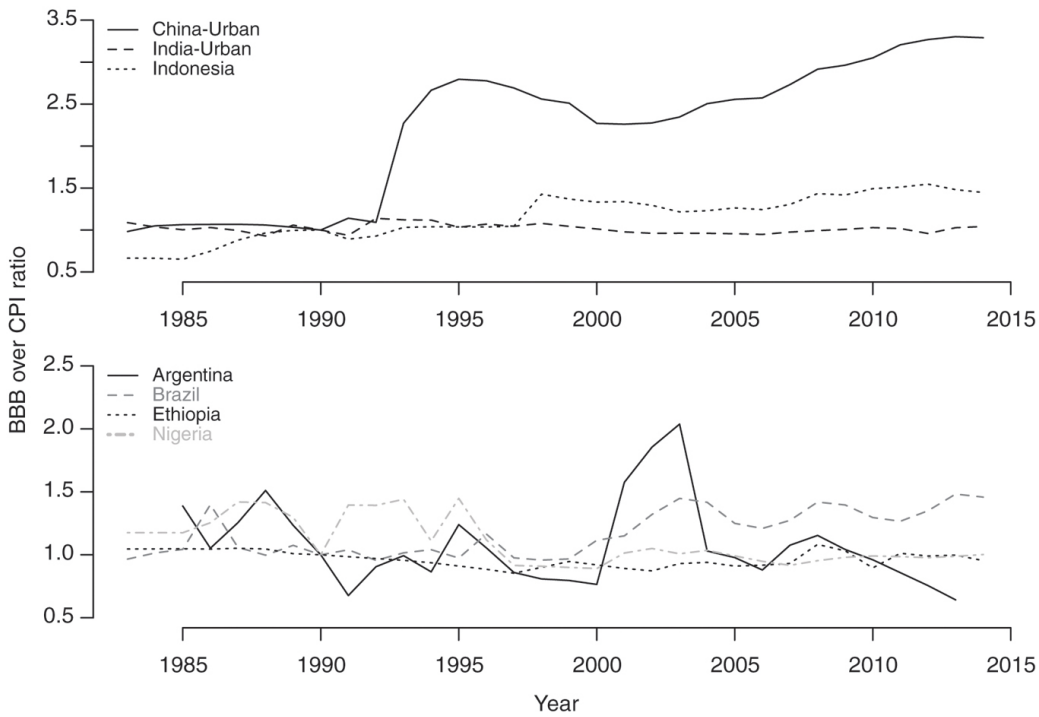

Figure 3: Evolution of the BBB over CPI ratio for selected countries, 1983–2014. For both the base year is 1990. Note the scale difference on the y axis between the two panels.

Overall, Figure 3 supports the point that using a CPI which focuses on the average consumption habits tends to substantially skew the picture of the evolution of prices that are most relevant to those living in abso-

lute poverty. The intensity of this differential varies considerably from country to country. China represents a distinctive case in this comparison. Until 1992 the implied underestimation of price changes is minimal. In the 1993–1995 period, the BBB price index moves with a much larger pace than either the urban or the – not shown here – rural CPIs. This is followed by a relative slow down of the BBB price index from 1995 until 2000. Then BBB clearly accelerates again in the post-2000 period. India, in contrast, demonstrates a very modest difference in the evolution of the two indexes for the entire period. For Indonesia the BBB price index almost continuously accelerates from 1983 up to the sharp peak in 1998. This peak comes after the 1997/1998 food crisis episode, caused by a combination of drought, forest fires and massive capital outflows as reported by the World Bank,[40] and related food shortages (Soekirman 2001). In the post-1998 period the ratio of the two indexes continues to vary, with some milder discrepancies.

On the lower panel, Argentina demonstrates the most extreme variation between CPI and the BBB index. The most sharp acceleration of the BBB occurs during the onset of the Argentinian financial crisis in 2001/2003. Similarly, in Brazil accelerating spikes are present for the most part. Only during 1987–1995 the discrepancies are substantially mitigated. Antithetically, in the case of Ethiopia the two indexes evolve largely in agreement for most of the period, with CPI gaining speed against BBB for the greater part until 1997. Only during the 2007/2011 period the two indexes evolve in relatively larger disagreement. Finally, in Nigeria sharp discrepancies are identified in the first part of the period until 1997. For the remaining of the period, Nigeria shows milder differences among the two indexes, that only become apparent during the 2000/2002 period.

4.2 Bare Bone Baskets in Dollar Terms

Figure 4 makes the direct comparison between the dollar-a-day and BBB based poverty lines. For this purpose the BBB poverty lines are expressed in 2011 PPP dollars. It is clear from the figure that the assumption that the "dollar-a-day" line provides an internationally constant standard in terms of welfare does not hold in practice, although it is methodologically required to. Note in addition that methodologically only for 2011 a direct comparison with the 1.90$/day iPL makes sense. For that benchmark year the figure clearly points out that iPL is overestimating global absolute poverty compared to the consistent common achievement approach, for all but two developing countries (El Salvador and Venezuela). In that year the lowest BBB poverty line stands at $0.27 for Namibia, the median at $1.07 and the maximum at $2.74 for El Salvador.

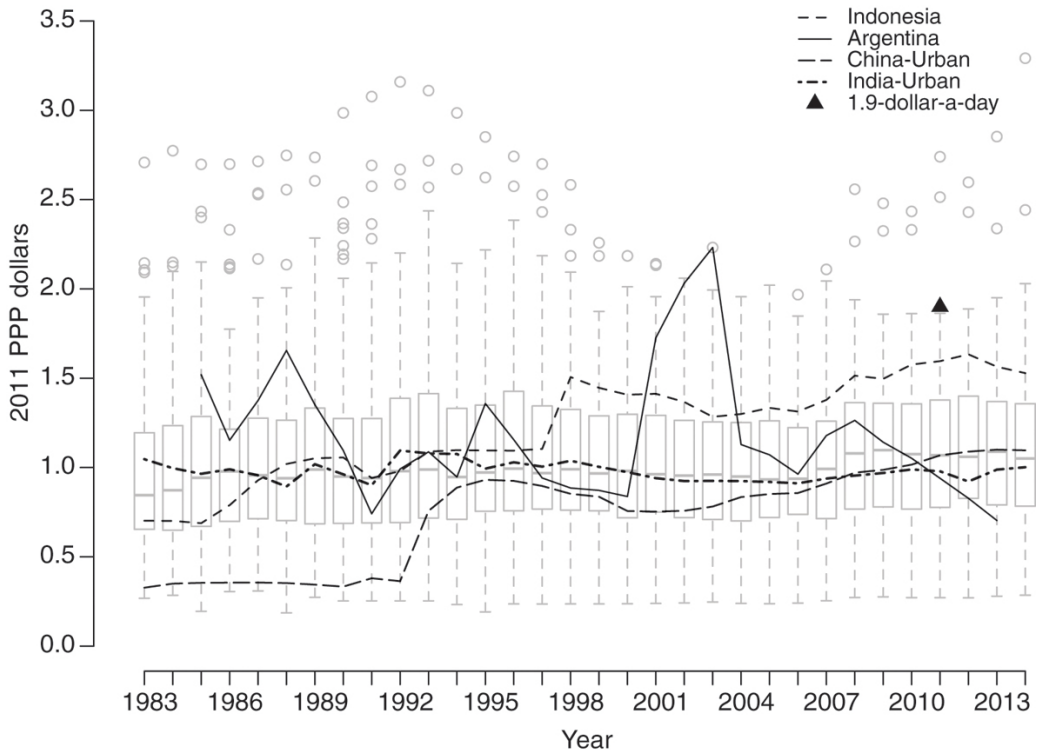

Figure 4: Evolution of BBB poverty lines expressed in 2011 PPP dollars, 1983–2014.

Note that for any other than the benchmark year there is no equivalent iPL to compare to. That is the result of having one benchmark year for the ICP. It is not possible to estimate an iPL for, lets say, 2010 by simply correcting the 2011 iPL for the CPI in the reference country of the ICP (which is the USA) (Ravallion 2010). Nevertheless,

for all the non-benchmark years the BBB values expressed in PPP dollars provide an understanding of the fluctuation of the BBB poverty lines, either in relation to the same country's BBB value in 2011, or in comparison to the other country's BBB poverty line for the same year. Thus even if there was a 2010 ICP round, it would be extremely unlikely that the BBB poverty lines would largely coincide with a 2010-based iPL.

The central point remains evident from the figure. The iPL applied by the World Bank does not consistently correspond to the same type of poverty, in terms of a reasonably defined welfare, in different years and locations. If that were the case then the variation among the BBB poverty lines for the benchmark year should have been quite modest, only representing some uncertainty in pinpointing the exact iPL level in dollar terms. This cannot be concluded from the figure. The common achievement method, delivers estimates of the same type of absolute poverty that range, in 2011 PPP dollar terms, from a remarkably low $0.19 for Uganda in 1988, up to $3.29 for Venezuela in 2014, and a median value of $0.99 for the entire 1983–2014 period.

In the same figure a number of important countries are traced by lines that mark the evolution of their BBB values. In the evolution of the BBB values expressed in PPP dollars, there are some pronounced episodes that introduce volatility. The 2001–2003 pronounced spike in Argentina for example, relates to the crisis that struck the country in the same period. The hump shown on the graph regarding Indonesia during 1998 relates to the 1997/1998 food crisis episode mentioned above. India is the only country shown here that has a rather smooth upward trending evolution without such large episodes.

For China, a big hump in the BBB values takes place within a few years, from 1993 to 1995. It is important to note that this is not a result of imputation, but it is driven by available original price data.

Figure 5 shows the BCS poverty lines expressed in 2011 PPP dollars. BCS results confirm the main conclusion that the basic BBB poverty lines have supported. Volatility of the BCS values in 2011 PPP dollar terms maintains throughout. At the benchmark year the minimum value is found in Uzbekistan at $1.26, the maximum value is found in Angola at $12.30, and the median stands at $3.09. For the entire period the minimum value is found in Tajikistan in 1995 at $0.96, the maximum in Angola in 1991 at $20.12 and the median stands at $3.71. The variations in the evolutions of the four traced countries are less pronounced due to the scale; still present nonetheless. The overall similarities with Figure 4 imply that the identified inconsistency of the iPL and the "dollar-a-day" method is not explained by the explicit methodological choices or the low welfare level targeted in the BBBs, as it survives the different computational treatments applied to obtain the BCS.

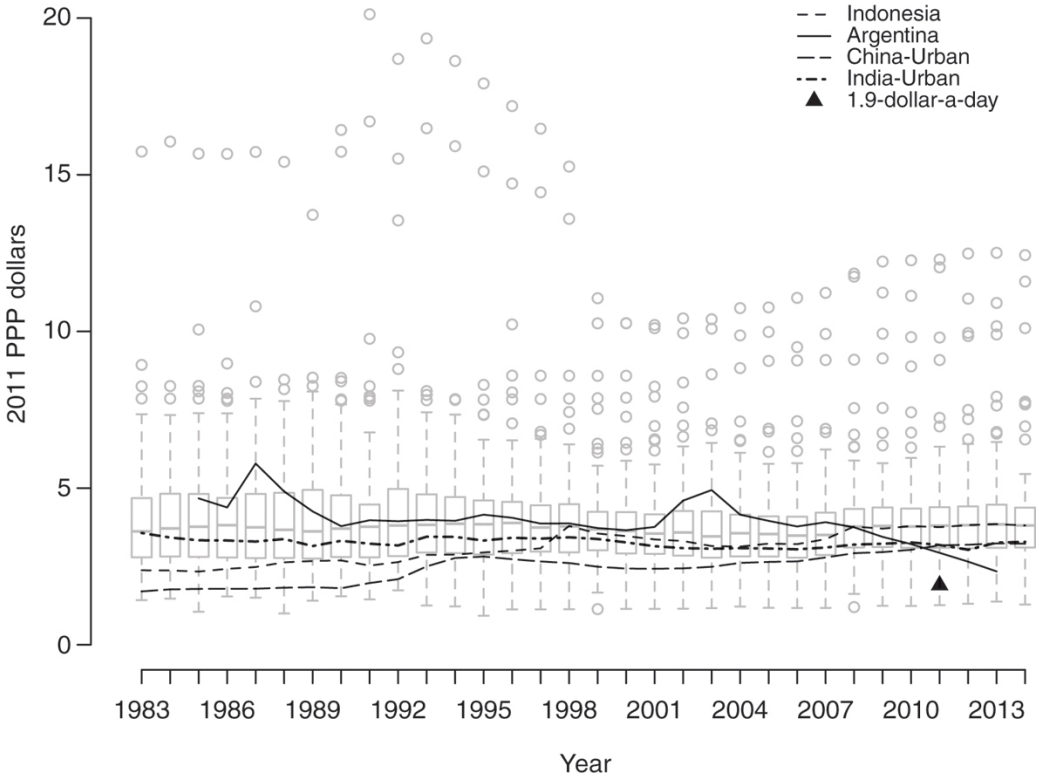

Figure 5: Evolution of BCS poverty lines expressed in 2011 PPP dollars, 1983–2014.

5 Global Absolute Poverty Estimates

5.1 Developing World

The absolute poverty rates of the Developing World are shown in Figure 6. The figure shows both types of BBB based poverty lines, along with the available estimates of the World Bank. As anticipated the picture shaped by each type of poverty lines differs substantially. For the BBB poverty lines, a weak upward trend characterizes its aggregate point estimate evolution from 1983 – were the poverty rate is estimated at 5.6% (3.8, 7.5)[41] – until 1994, with poverty rates at 8.9% (6.1, 12.4). In 1990, which is the reference year for the Millennium Development Goals, BBB poverty stands at 5.5% (4.1, 7.2). A gradual decrease starting in 1995 lasts until 2007, were it reads 3.4% (2.4, 5.2). The first two years after the onset of the 2007/2008 Global Food Crisis shortly interrupt this mild trend, and in the post 2009 period the BBB poverty rate remains practically constant. In 2014 BBB poverty stands at 3% (2.2, 4). These results show that, in terms of levels, on the one hand the target of alleviating absolute poverty is not as far off as was thought of, but on the other hand, absolute BBB poverty has shown remarkable persistence throughout the period. The difference with the PovcalNet estimates is enormous throughout. Comparing the 1990 and 2014 estimates leaves little room for celebrations over the achievement of halving absolute global poverty between 1990 and 2015.[42] The same insight is supported using the BCS poverty lines as well, thus it does not result from the very low welfare level of the BBB poverty lines.

With respect to the BCS poverty lines the estimates are located at a much higher level, and in all cases higher than the PovcalNet estimates on average. In 1983, BCS poverty level begins at 70.4% (65.9, 74.2), and its average follows a sallow u-shaped trajectory until it reaches a local maximum in 1994 at 64.6% (61.4, 67.6). From that point onward it follows a downward trend until 2014, with only an interruption following the aforementioned great food crisis. At the end of the period the BCS poverty stands at 33.2% (30.1, 36.1).

The vast differences among BBB welfare level and the iPL can be attributed on two elements. First, the much lower costs of bare bones subsistence compared to the $1.9 value for the vast majority of the countries and years. And second, on the differential between CPI and the BBB price index. The also very large differences of iPL with BCS, especially on the later years of the period, is attributable to the inability of the iPL to encapsulate expenses that are necessary in escaping absolute poverty as described in international treaties and conventions.

Figure 6 might give the impression that the BBB methodology does poorly in specifying welfare levels with some accuracy. The variance of the one standard deviation implies that there is considerable room for uncertainty. However, it needs to be noted here that the "dollar-a-day" methodology is far less successful in that respect. The standard deviation for the "$1.90" iPL is $0.68, and the null hypothesis for normality of the underlying NPLs cannot be rejected.[43] Therefore the equivalent – to the treatment of the BBB poverty rates – reading of the "dollar-a-day" global poverty for 1990 is 44.12% (19.49, 58.48) and for 2012 is 14.88% (4.63, 26.63). The variance in those estimates is by far greater than the one achieved by the BBB methodology. Using the 95% confidence interval for the iPL on the level of national poverty lines, then the reading of the "dollar-a-day" global poverty for 1990 is 43.56% (instead of 44.12%) with a corresponding 95% confidence interval of (32.37,51.91) and for 2012 it is 14.54% (instead of 14.88%)[44] with a corresponding 95% confidence interval of (8.88, 20.6). Thus the relative uncertainty of the iPL global absolute poverty estimates is on average above 20% for 1990, and around 40% for 2012; both quite far from satisfactory.

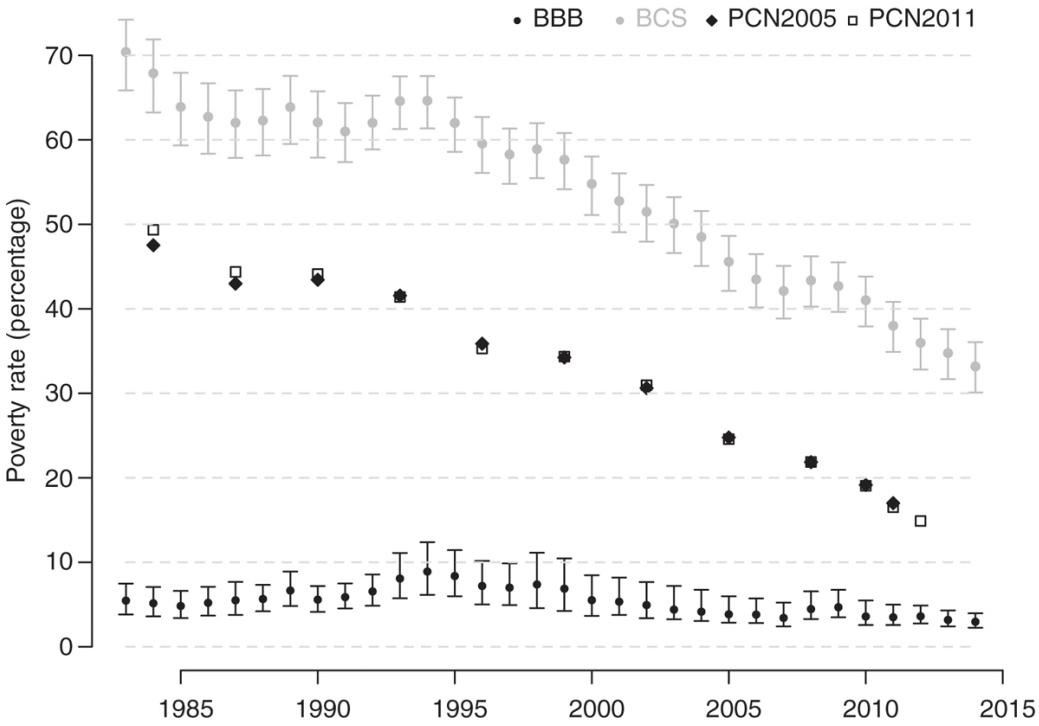

Figure 6: Evolution of poverty in the developing world, 1983–2014.

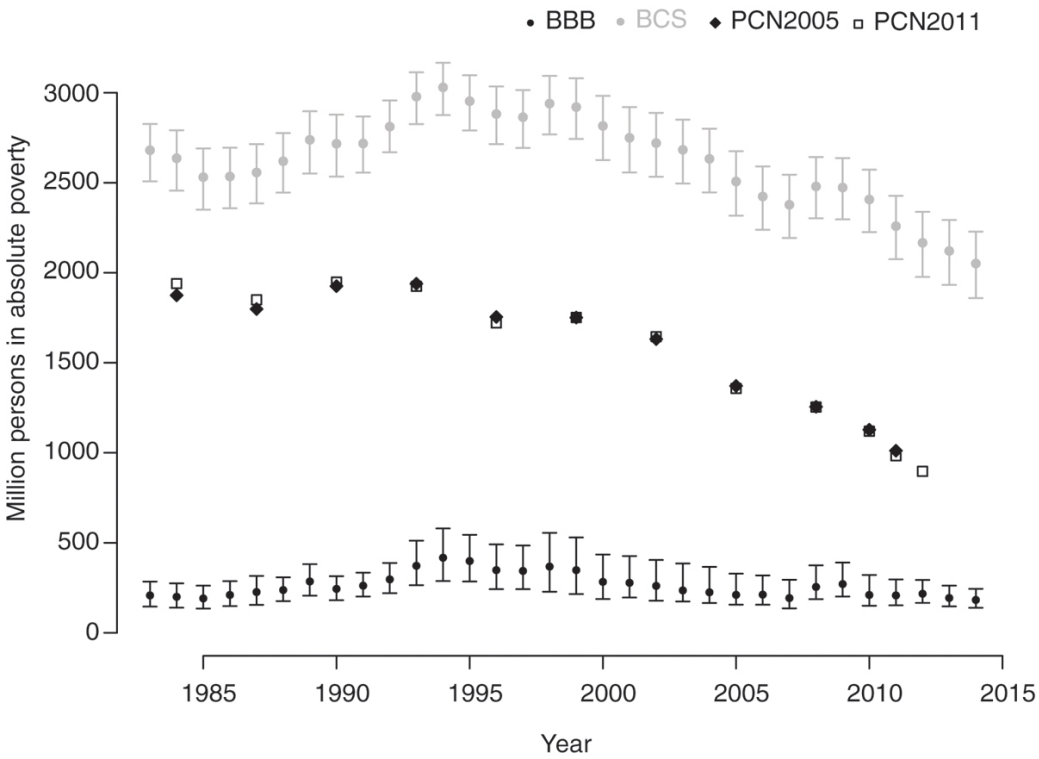

Figure 7: Evolution in the number of people living in absolute poverty developing world, 1983–2014.

In terms of the number of people living in absolute poverty, shown in Figure 7, each set of poverty lines shapes a different picture, while the underlying scattering translates up to several hundreds of million of people.[45] With respect to the most extreme form of poverty, captured by the BBB absolute poverty lines, the picture is quite unpleasant on the aggregate trend. In 1983, the population living in BBB level absolute poverty was 207.73 million (145.44, 284.59), and by 1994 this had increased to 416.98 million (287.48, 579.8), which is about double the 1983 average estimate. By 2014 the estimate drops at 182.55 million (138.79, 244.34), which is the only year for which its point estimate is lower than 1985's 191.04 million (134.76, 261.66).

The number of people living in conditions of the more demanding BCS absolute poverty lines are much higher than those of PovcalNet. More often than not this difference exceeds one billion people. In 1983, the BCS

estimate stands at 2680.91 million (2507.8, 2826.6), and in 1984 at 2636.23 million (2456.44, 2791.85). For 1984, which is the first year with both BBB based and PovcalNet estimates, the difference in point estimates with PovcalNet is at about 700 million people. By 1994, the BCS point estimate has reached its maximum at 3030.02 million (2875.85, 3166.61). By 2012, which is the last year that PovcalNet has an estimate for, this difference has increased at roughly 1.3 billion people. In 2014, the number of people living in BCS absolute poverty stands at its lower point at 2051.21 million (1859.4, 2228.44). At this welfare level BCS poverty was lower as point estimate than the 1985 local minimum, only after 2005.

Figure 8 demonstrates the geographical distribution of the people living in BBB absolute poverty in terms of the point estimates. As it is evident from the graph, Sub-Saharan Africa is constantly the largest contributor on global scale for this type of poverty. The second largest contributing region depends on the specific year. In the 80s it is South Asia that occupies the second place, while during the 90s it is the East Asia and Pacific region. In the 00s Latin America and Caribbean has the second place. The rankings shown in Figure 8 constitute an almost complete reshuffling compared to the PovcalNet rankings (see more details about the PovcalNet rankings below).

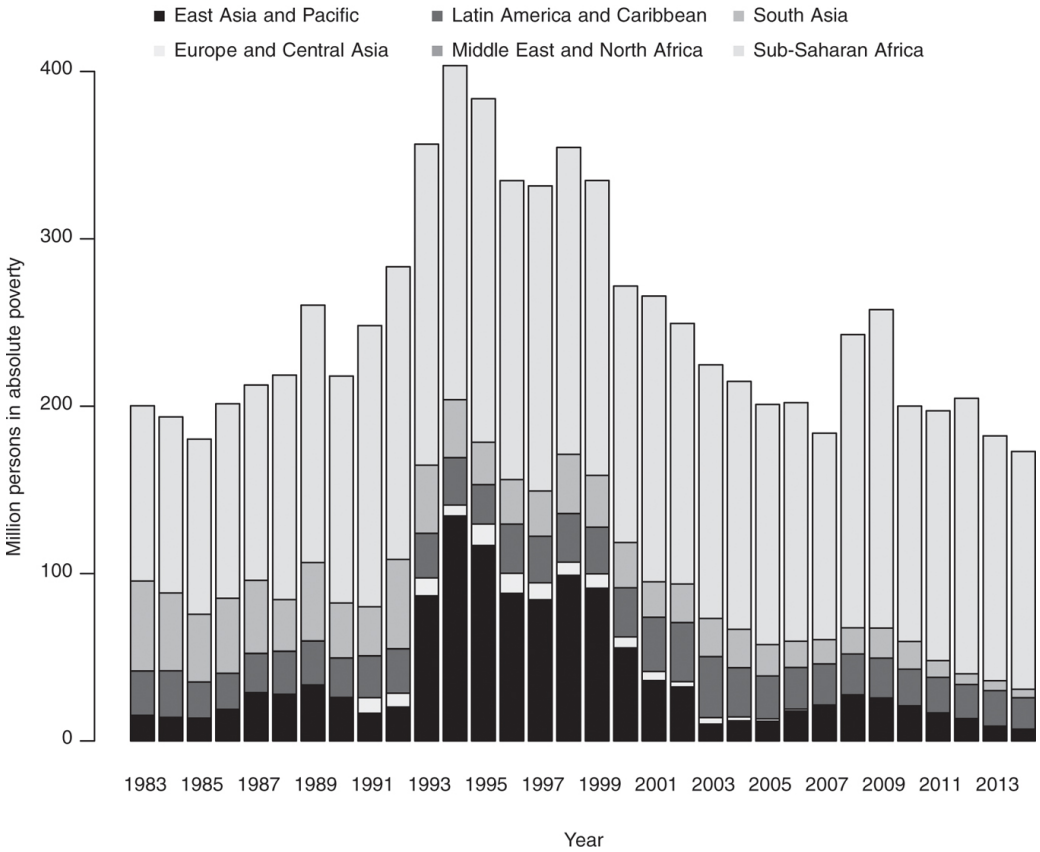

Figure 8: The geography of BBB based global absolute poverty on regional level, 1983–2014. *Note* that the region Middle East & North Africa is not visible due to the very low number of people living in absolute poverty in that region.

Figure 9 paints a largely different picture than the lower absolute poverty BBB lines do. As in the case of PovcalNet rankings, it is East Asia and Pacific that tops the rankings for the most part of the period, with South Asia in second place. In PovcalNet, East Asia and Pacific drops to second place in 1999 from South Asia, while in BCS rankings this happens in 2005. South Asia then is surpassed by Sub-Saharan Africa in 2011 in PovcalNet, but according to the BCS estimates it remains the highest BCS poverty contributor until the end of the period. In BCS terms, the region of Latin America and Caribbean ranks consistently in fourth place.

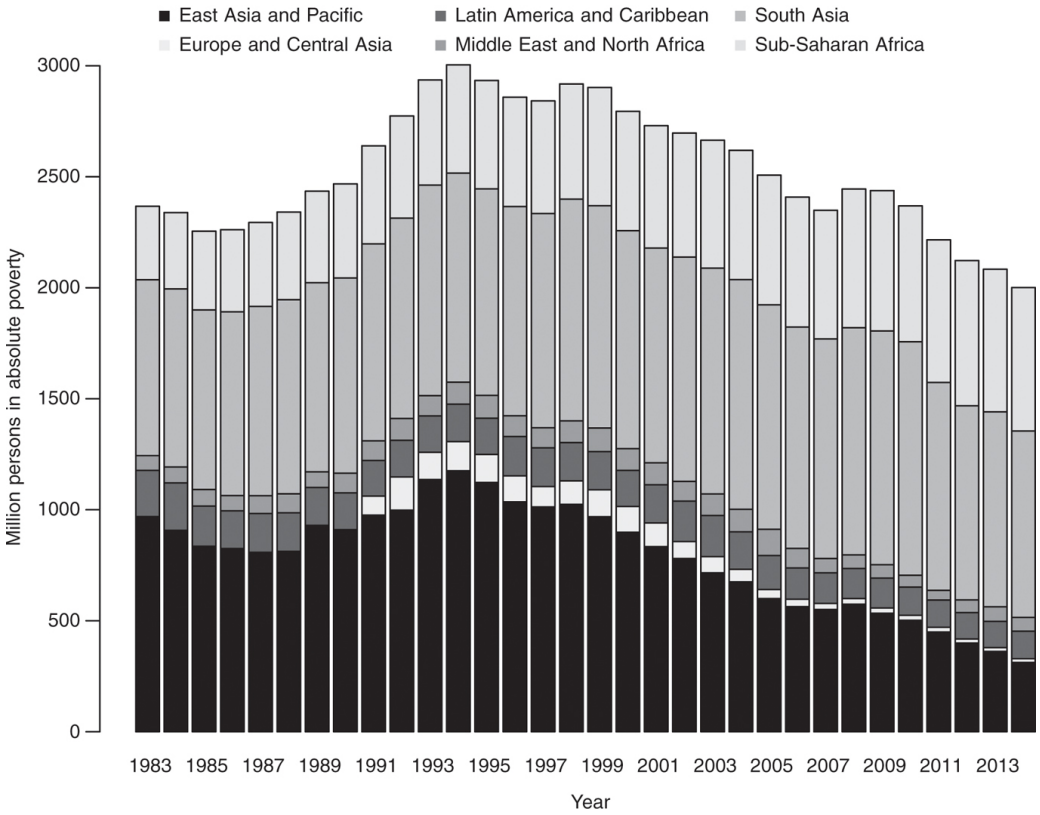

Figure 9: The geography of global absolute poverty on regional level, 1983–2014.

5.2 Regional Level

Figure 10 shows that while in South Asia the BBB poverty rates are typically below the 5% in point estimate, the BCS type of poverty have rates that are more than ten times higher. In 1983, BBB poverty rate is 5.6% (3.2, 8.9) and BCS poverty is 82% (79.2, 84.3). By 1995, these rates have dropped to 2% (0.8, 4.9) and 73.9% (70.3, 77) respectively. This slow, but persistent trend continues until 2010 when the rates have dropped at 1% (0.3, 3.8) and 64.5% (60.4, 68.1) respectively. Beyond that, and until the end of the period in 2014, both poverty rates are at their lowest point with BCS demonstrating accelerated reduction. By 2014 the poverty rates are at 0.3% (0.1, 1.2) and 48.8% (44.3, 53.1) respectively.

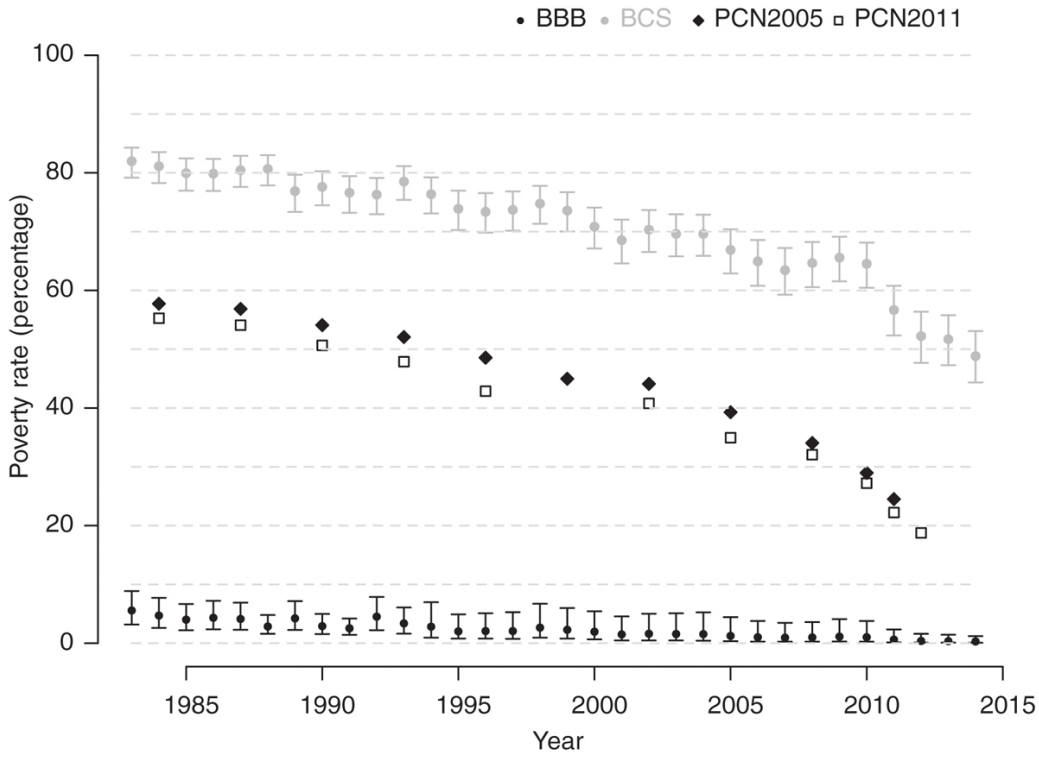

Figure 10: Evolution of absolute poverty rates in South Asia, 1983–2014.

For the region of East Asia and Pacific BBB poverty, as shown in Figure 11, demonstrates a more volatile picture than in South Asia. Despite the single digit BBB poverty levels throughout the period, a disturbance occurs in the greater part of the 90s. It tops in 1994 at 7.9% (4, 12.2). BCS lines also capture this disturbance. The right tip of the u-shaped trajectory followed by BCS lines in 1983–1994 period stands at 69.4% (66.1, 72.4), marginally higher than the 67.9% (62.1, 72.9) estimate for 1983. All of those peaks follow the sudden increase of the poverty lines in this period identified in the case of China. After 1994 and for the next 20 years, this region demonstrates strong decreasing trends for BCS lines. Within this period the BBB poverty has recovered from the 1993/1994 disturbance. Beyond 2002 it remains close to zero levels. By 2014, BCS poverty stands at 15.5% (13.9, 17.1). On a point estimate level this figure represent a more than four-fold decrease compared to 1983 or 1994.

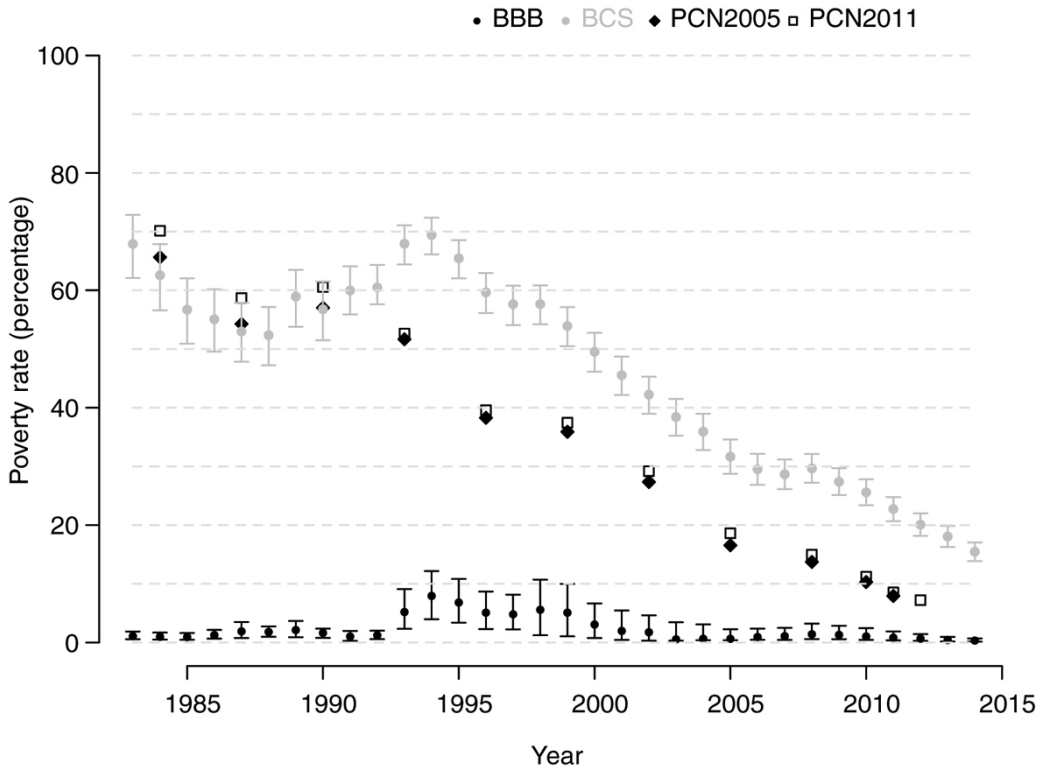

Figure 11: Evolution of absolute poverty rates in East Asia and Pacific, 1983–2014.

The patterns of single digits, or close to zero, BBB rates observed in the previous two regions are far from identifiable in the case of Sub-Saharan Africa shown in Figure 12. For 1983, BBB absolute poverty stands at 25.1% (20, 30) a clear indication of the unprecedented poverty hardships faced by people in Sub-Saharan Africa, compared to any other region (see below). By 1995 the BBB poverty rate reaches its maximum at 35.2% (30.5, 39.8). The gradual drop in BBB poverty is interrupted in 2008/9. A local maximum in those two years tips at 22.4% (18.3, 26.4). The relative intensity of this local maximum, compared to the similar maxima in other regions, is indicative of the relative intensity that the Great Food Crisis in 2007/8 hit the BBB absolute poor in the region. By 2014 the rate stands at 14.6% (11.4, 17.9) which is about as much as the BCS point estimate for East Asia and Pacific.

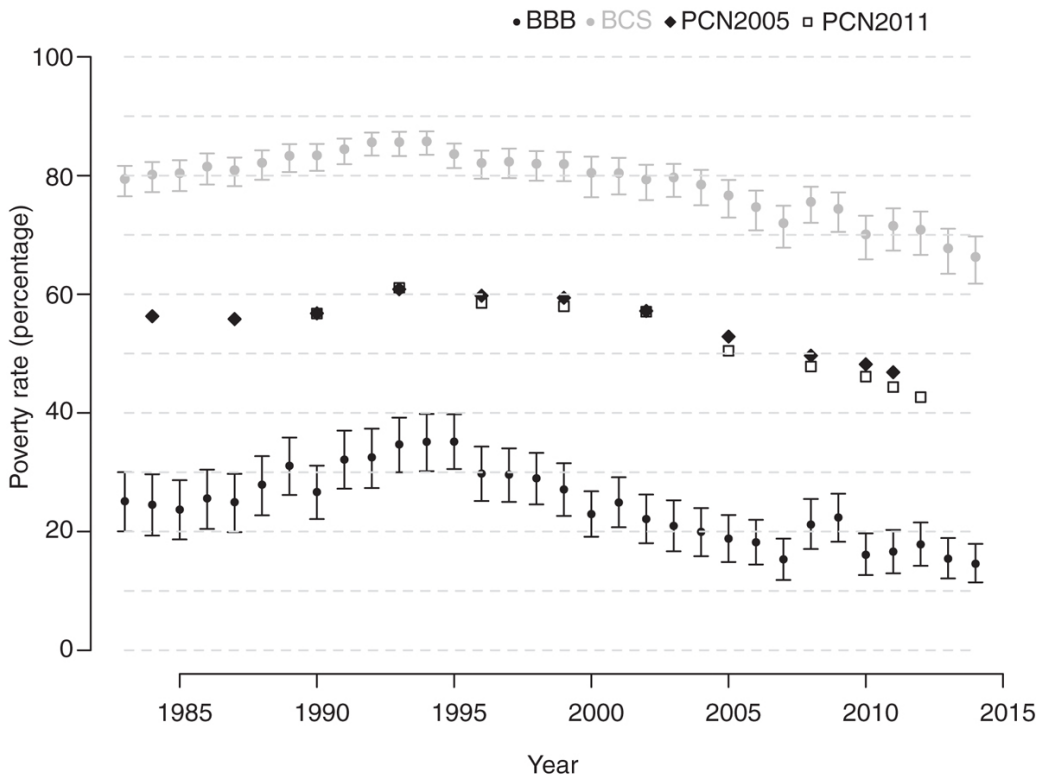

Figure 12: Evolution of absolute poverty rates in Sub-Saharan Africa, 1983–2014.

BCS poverty in the region stands at 79.4% (76.5, 81.6) for 1983 and moves generally upward until the peak of 1995 at the sky high 85.8% (83.5, 87.4). Its course then turns downward until its lowest estimate of 66.3% (61.8, 69.8) in 2014, while the 2008/9 interruption remains observable.

Figure 13 shows the poverty rates for Latin America and Caribbean. BBB absolute poverty rates are found on average above those in the two Asian regions presented. This is in sharp contrast with the PovcalNet perspective. In 1983, the BBB poverty rate is at 6.9% (5.3, 8.5). Thereafter the point estimates are dropping in 1985 in a 5–6% region from which they escape only after 2004. The clearly observable local maximum in 2008/9 found in the previous regions appears to be masked. By 2014 the BBB rate drops at its lowest point at 3% (2.5, 3.5). In terms of BCS poverty the region of Latin America and Caribbean is typically found lower than the two Asian regions above. When considered together with the observation that BBB poverty in this region is on average higher than its Asian counterparts, this implies that Latin America and Caribbean concentrates more extreme forms of absolute poverty relative to Asia, while, contrary to Sub-Saharan Africa, it manages to maintain poverty rates at higher welfare levels relatively low. By 2014, the BCS poverty rate settles at 19.9% (16.4, 23.3), and it is the only region showing a tendency to increase at the end of the observation period. Still that rate is less than half of the 1983 point estimate.

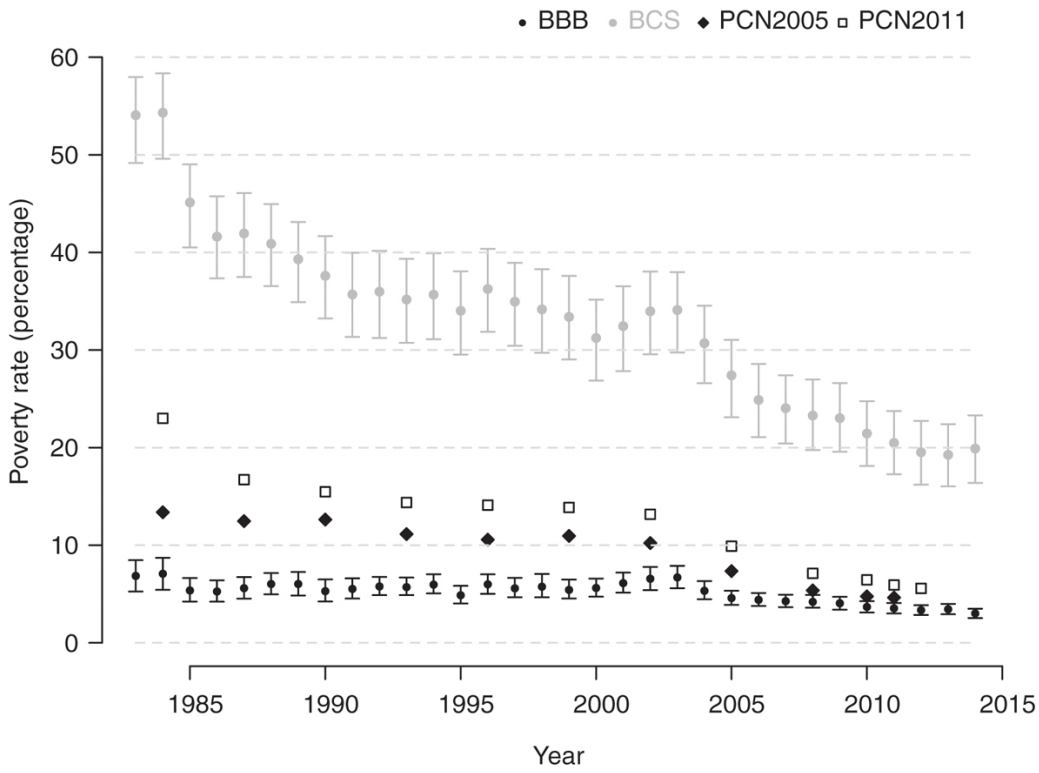

Figure 13: Evolution of absolute poverty rates in Latin America and Caribbean, 1983–2014.

Figure 14 shows the poverty rate estimates for Europe and Central Asia, but only for the 1991–2014 period due to low regional population coverage in the previous years. For the best part of the 90s this region is largely comparable in BBB terms to South Asia and East Asia and Pacific. The BBB poverty rate peaks in 1995 at 2.7% (1.7, 3.8), and fades to marginal levels by the late 00s. In 1992, BCS poverty rate stands at 32.1% (30, 34.2), which represents a surging point estimate increase from the 18.3% (16.3, 20.2) at the year before. It then follows an m-shaped trajectory until it gradually drops to 3.6% (2.9, 4.4) by 2014. This estimates is the lowest of its type among all regions.

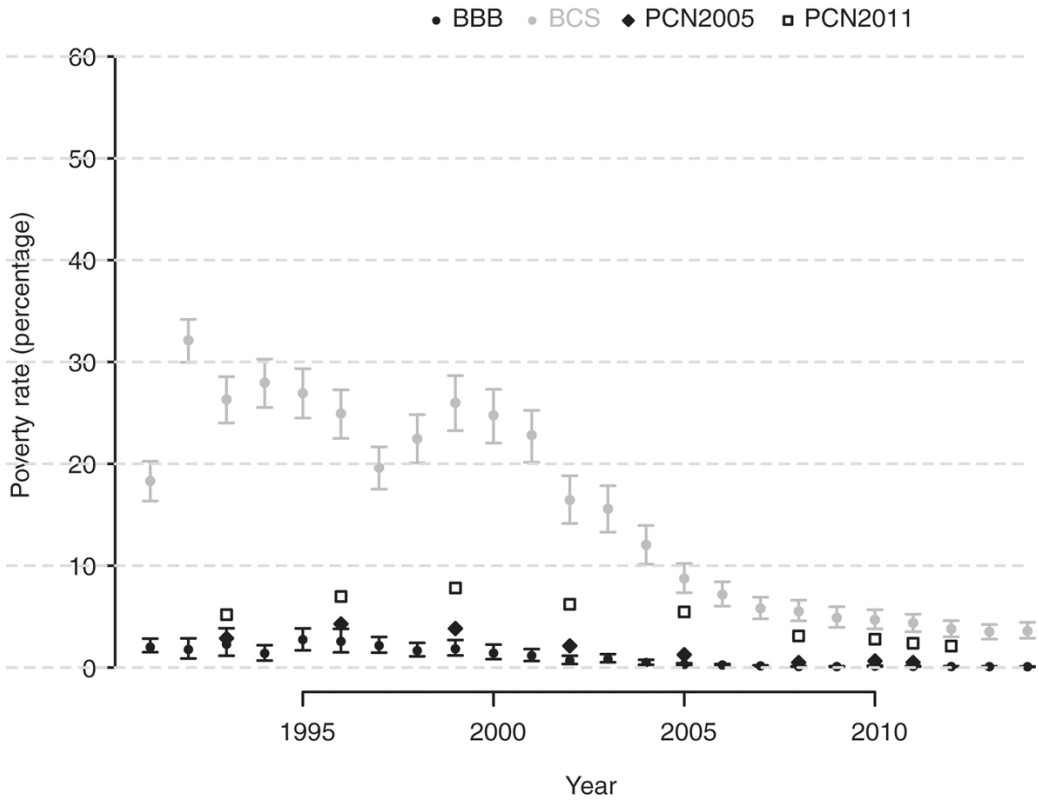

Figure 14: Evolution of absolute poverty rates in Europe and Central Asia, 1991–2014.

In Figure 15 the region of Middle East and North Africa is shown. Here BBB poverty is practically zero for the entire period. However, BCS type of poverty is quite present in the region. In 1983 it is estimated at 36.1% (29.6, 42.3). The maximum point estimate is found in 1995 at 40.2% (33.6, 46.4). After a peak at 38.7% (31.6, 45.3) in 2005, the BCS curve follows a strong downward trend until it reaches its minimum at 12.7% (9, 16.7) in 2011. Along with the region of Latin America and Caribbean, this is the only other region that shows an increase in BCS poverty during the last years of observation. By 2014 BCS poverty in the region reads 17% (12.2, 21.8). Finally, despite the similarities with Europe and Central Asia in terms of the 2011-based iPL, this region is considerably worse off in terms of the more demanding BCS welfare level.

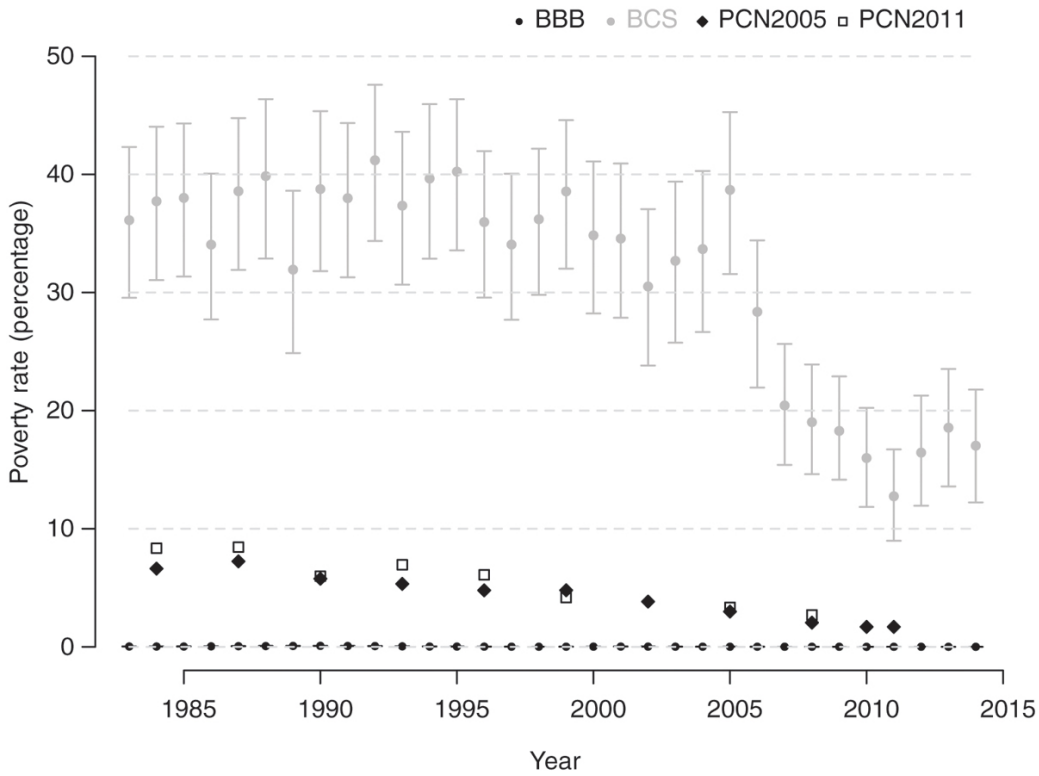

Figure 15: Evolution of absolute poverty rates in Middle East and North Africa, 1983–2014.

5.3 Country Level

Turning now on the country level the focus is first set on the two largest countries that also happen to have distributional data for both urban and rural areas. Figure 16 shows the estimates for urban and rural China.[46] From the perspective of BBB poverty lines, the two parts of the country demonstrate a characteristic difference. While urban BBB poverty remains at practically zero levels, the familiar hump already seen in Figure 11 appears to be almost entire attributable to the rural part of the country. The familiar peak of 1994 stands at 11.9% (6, 18) or 99.61 million (49.79, 149.76) people.

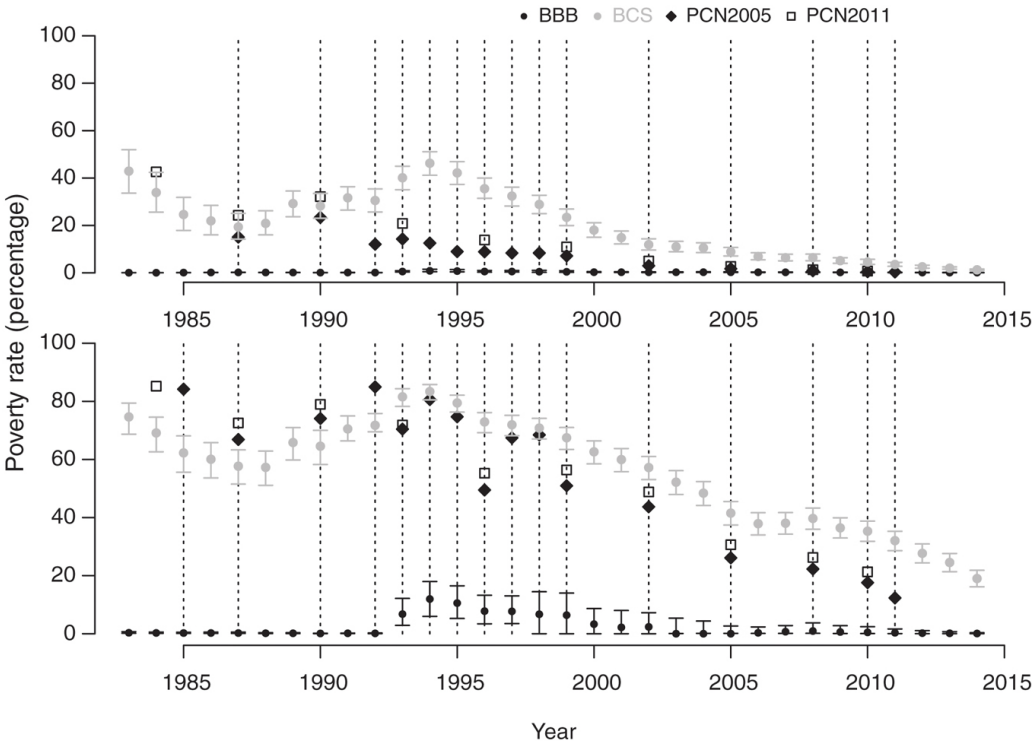

Figure 16: Evolution of poverty in urban and rural china, top panel and bottom panel respectively, 1983–2014.

In terms of BCS welfare levels the rural region in China is again the one with the highest poverty prevalence. At the peak of 1994 the estimate is as high as 83.4% (80.5, 85.8) or 695.3 million (671.45, 715.29) people. Nevertheless, in urban China BCS poverty reaches considerably high levels with a peak in 1994 at 46.2% (41.2, 51.1) or 165.49 million (147.31, 182.89) people.

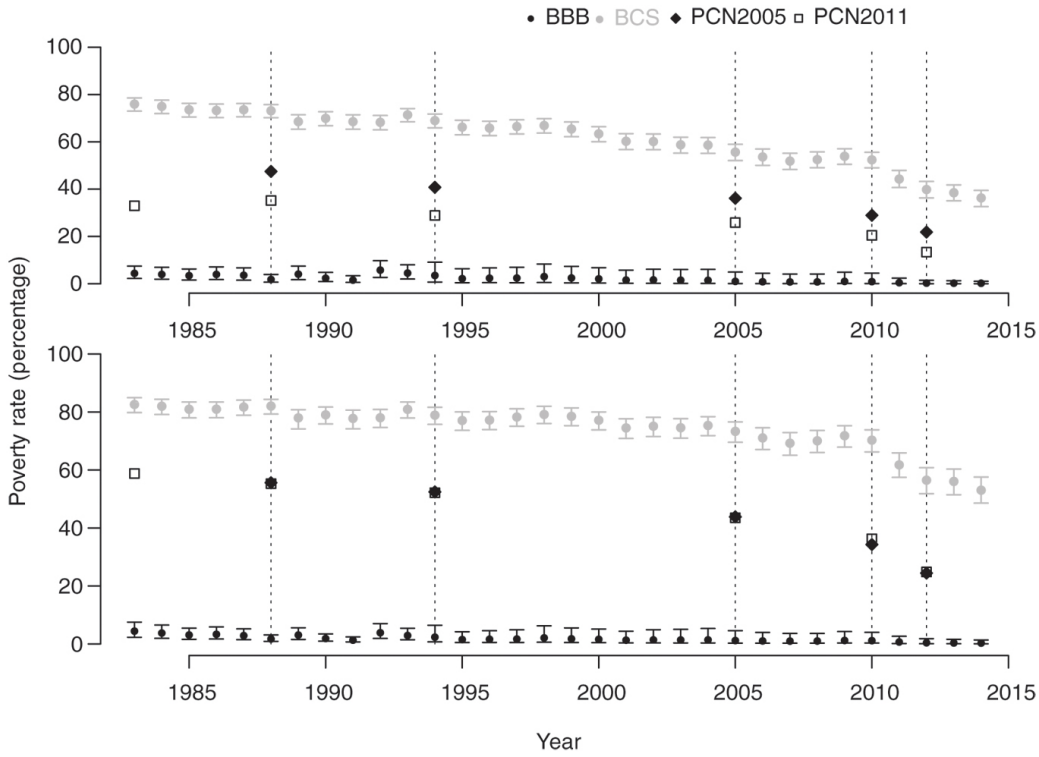

Figure 17: Evolution of poverty in urban and rural India, top panel and bottom panel respectively, 1983–2014.

While rural BBB absolute poverty rates in China are much worse than in the urban part of the country, the situation in India, shown here in Figure 17, is relatively much more balanced overall. Indeed, the urban population here appears to be worse off but only marginally so. By the end of the period the differences in point estimates among the two regions become larger. In BCS terms rural India stands at 53% (48.6, 57.6) or 464.57 million (425.5, 504.35), and in the urban regions at 36.3% (32.6, 39.5) or 152.1 million (136.67, 165.47). In comparison to urban China, population in urban India is worse off at both welfare levels. Comparing the rural areas among the two countries India is found worse off as well, but with the important exception of the years around the 1994 peak in rural China.

6 Conclusions

Utilizing a more than 100 years old methodology, two absolute poverty lines of different welfare levels have been specified and measured throughout the developing world. The underlying inconsistency of the dollar-a-day methodology in measuring a specific standard of welfare level for each country has been substantiated at both welfare levels. Arguably the normative choices included in the methodology to track global absolute poverty should progressively incorporate the widest set of welfare elements found in the definitions of absolute poverty by independent international bodies and widely ratified international treaties. At the same time the most complete available data are used to directly or indirectly estimate their costs. BCS poverty lines follow this principle to a large extend. However, an improvement of poverty at this higher levels does not allow for celebrations when those who needed the most are not seeing much improvement in their numbers, as shown by the BBB poverty lines. The world had to wait for nearly 30 years to see the number of people living under the bare bone minimum conditions drop as a point estimate. This is very far from satisfactory, or a reason to celebrate.

Differentiating the poverty lines among various welfare levels, brings up the differences in the types of poverty that are mostly relevant in the various countries and regions. Regions that for some years appeared of having the same level of poverty under an iPL, such as Sub-Saharan Africa and the two Asian regions, have been found to be facing poverty issues of very different type and intensity.

In terms of levels, the identified differences are explained by the deviations among the BBB-based poverty lines and the iPL for the reference year of the PPP rates. Away from the reference year the additional discrepancies are controlled by the differentials between the local CPI and BBB price indexes. Overall, the low welfare level poverty line shows less encouraging trends to those demonstrated by the iPL, while the high welfare line shows a more worrisome picture in the levels of global poverty than the iPL does. The iPL tends to compromise

the two, by showing promising trends at relatively non-alarming levels for the more recent years. Regardless, this research indicates strongly that the World Bank should focus on specific well defended welfare levels such as to provide the proper framework in evaluating the success of its policies on a global scale. The lower the welfare level of poverty lines, the higher the importance of the level of the policy success since serious human rights violations may well be committed against those in the worst welfare positions (Pogge 2011). In terms of point estimates it appears that MDG 1 will probably be just barely fulfilled by 2015, despite the World Bank's conclusion that this was fulfilled already in 2010. Nevertheless, this prediction ignores the considerable uncertainties in the estimates. Uncertainty about halving the poverty rate in the developing world between 1990 and 2015 remains at both welfare levels that are measured.

The variance in the estimates presented here is considerable. However, it is smaller than the equivalent variance under the "dollar-a-day" approach. Further, it has been shown that the systematic uncertainty in the "dollar-a-day" estimates is–unacceptably–large.[47] It is a puzzle why this very important issue in the measurement of things has not been questioned–to the best of my knowledge – in the literature so far.[48] Those of us who live in conditions of extreme deprivation most certainly worth a better methodological conduct. An exact testing of the statistical significance in the poverty rate estimates, that would consider not only the variance arising from the distributional uncertainties, but also from the systematic uncertainties in the definition and measurement of the poverty line is crucial for future work. Naturally, not doing so implies that we know more than we actually do about poverty and its evolution.

In the above, one should also consider that in the BBB-based lines, only the caloric content and a fixed amount of proteins are the target requirements for the food components. However, as pointed out by Kakwani (2003)"[i]deally, the construction of food poverty lines must take account of all six nutrients."[49] This has been recently implemented for a group of countries by Allen (2016), and it presents itself as a natural extension of the poverty lines presented here. Such a step is likely to increase all the BBB based poverty lines. In addition, accounting for errors contained in the distributions; errors introduced by shifting distributions to years were they are unavailable; errors due to the quality of the price sources; and errors due to the estimation process of the PAL and MDER values is required as well.

Another important limitation that is shared among the BBB methodology and the "dollar-a-day" is the inability of both to account for any misallocation within households. This is of particular concern, and as shown by Klasen and Wink (2003) there are indications of strong misallocation, especially towards women. However, available data do not have the necessary level of detail that would allow us to address this particularly worrisome situation.

The presented uncertainties make a good case for better basic commodity price monitoring on nothing less than a global scale. While improvements have been made in this respect via the WFP and the FAO, and even if the frequency is much higher than the ILO's October Inquiry, still the number of items collected is a small fraction of the ILO's source. The same issue appears with respect to the number of countries covered as they only correspond to about 40% of what ILO's October Inquiry covered. The traditional openness of ILO to make available the price data it gathers is an important component in measuring global poverty research. Keeping this – now interrupted – policy in place is highly recommended. In addition, it is widely accepted that prices in rural areas are lower than urban ones. However, for the least affluent there is one additional element to consider. As noted by Ward (2009) and Reddy and Pogge (2010), low income groups tend to face higher prices for the same goods.[50] This negative effect for the poor is captured neither in our data, nor in the data of the World Bank. At the same time the need for frequent, consistent and comparable consumption and income distribution data is one of equal importance.

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Notes

[1]For reasons of comparability we keep the same definition of developing countries as the World Bank does. That is if the country was categorized by the World Bank as developing in 2005 then it remains categorized as such for the entire period (1983–2014).

[2]Recently the World Bank has commissioned in June 2015 a group of scholars to update the global absolute poverty methodology. The issue of holding the global poverty yardstick constant in real terms is one of the two commission's main tasks. The present paper closely follows recommendation 15 in their report (The World Bank 2017, xxi).

[3]Recently, the PPP rates are estimated by the ICP project every 6 to 8 years. The latest benchmark year is that of 2011, and it is the ICP round followed here. The results shown here hold for the 2005 ICP round as well (Moatsos 2015).

[4]The paternalistic argument ignores the fact that the "dollar-a-day" iPL is in practice also externally imposed to any given country, and at the same time it is lacking defensible methodological underpinnings.

[5]Obtained from Unesco on February 22nd, 2016.

[6]Introduced in section 2.3.

[7]Obtained from UN, Copenhagen Declaration on February 22nd, 2016.

[8]Universal Declaration of Human Rights, G.A. Res. 217 (III)A, art. 25, U.N. Doc. A/RES.217(III) (Dec. 10, 1948).

[9]The other principle that Ravallion and Bidani (1994) define is that of "specificity", which relates to poverty lines that are representative of "existing norms or values in a society"(Marivoet and De Herdt 2013, 2). BBBs do not necessarily observe that principle.

[10]The latest value of the iPL is set to $1.90 in 2011 PPP by Ferreira et al. (2015) following the "dollar-a-day" methodology.

[11]For example, Ravallion (2015) argues about the existence of "clearly political resistance" in updating NPLs, and Kakwani (2003) offers as an example the NPL of Pakistan for not allowing a "meaningful comparison of poverty incidence in different periods" due to explicit methodological choices.

[12]There might be a bias introduced by the use of MDER to the extend that the household size correction is consistently closer to the concept of adult male equivalence, than that on MDER. However, controlling for such a tentative bias requires knowledge of the underlying data which remain at bulk inaccessible for independent researchers.

[13]A distinction needs to be made in relation to the selection of BMI in different age groups. Up to the age of 10 the BMI of the median child in each age cohort is used following the FAO's model. Above that age the BMI of the 5th percentile is applied instead. This is done in order to capture the absolute minimum in terms of caloric intake for persons older than 10, without at the same time calculating such low calories for children age 10 and below that would most likely keep that cohort, and all its follow-up cohorts, shorter in the first place. Such a mistreatment would lower the population living in poverty by lowering the MDER due to the fact that the population would simply become shorter.

[14]The exact dimensions are $10 \times 10 \times 8$ ft.

[15]Non workdays are treated the same as workdays assuming that social or other needs a person needs to attend to roughly replace hours normally devoted to work and take place outside of the house. An implicit assumption is that leisure takes place indoors when outside temperatures suggest it, thus pin-pointing the 8 hours per day of heating needs.

[16]According to FAO calculations on average for a man without an intense lifestyle the food calories converted to body heat are equivalent to a heat source of 100W; http://www.fao.org/docrep/u2246e/u2246e02.htm accessed on 23rd of February 2016.

[17]For a few countries without data the average of adjacent countries was used.

[18]At section 13.5 Do we really need more energy under the pot than in the pot? from "Energy for sustainable rural development projects - Vol.1: A reader" located at http://www.fao.org/docrep/u2246e/u2246e02.htm. Here, more cautiously, I consider a multiplier of 2.5 ± 0.5.

[19]Referring to the article by Reddy and Pogge with the same title, and the publication exchanges thereof included in Anand, Segal, and Stiglitz (2010).

[20]The four consumption segments are constructed following three thresholds expressed in 2005 PPP dollar terms: $2.97, $8.44 and $23.03 per capita a day. For countries without WBGC data the simple average of their region was used instead.

[21]In the case that the BBB/FnB ratio is above 1, the weighted average of the shares from the first two consumption groups is used. In this average, the share that has a BBB/FnB ratio closer to 1 gets the relatively higher weight.

[22]This approach has the advantage of by-passing the relative element introduced in the poverty identification procedure when one is yearly updating the budget shares in the presence of a differential in costs stickiness between food and non-food components as pointed in Subramanian (2010), 34–35.

[23]Male height =28.969 + 0.8946 * female height - 3.4242 * NorthAfrica/SouthEastAsia, with an R-square of 0.94. The dummy for North Africa and South East Asia accounts for the fact that in those regions females are relative taller. The underlying data cover mostly late 20th century.

[24]More specifically, following Baten and Komlos (1998) they assume that "[t]hose who were 18 years of age were estimated to have 2.4 cm to go; those age 19 1.7 cm, those age 20 0.9 cm, those age 21 0.4, and finally those age 22 only 0.1 cm".

[25]The 15–19 cohort is 2.48 times the 20–24 cohort. The average such ratio in the entire post-1983 dataset is 1.095.

[26]As noted by Allen (2013) there are some typos in the formulas reported in FAO (2008). Beyond the correction he suggests, I also avoided the multiplier which doubled the energy needed for the gained weight during the first 2 years after birth. This was done in order to be in accordance with tables 3.1 and 3.2 in FAO (2001).

[27]The increase in MDER for India might appear as contrasting Deaton and Drèze (2009) who find a reduction of caloric consumption in India. However, this finding refers to the overall population, and they also identify an increase of caloric intake for the lower quartile in terms of consumption expenditure in the 1983–2005 period.

[28]Another 15 cases have a decrease in height with a decrease in the Gini, another 4 had no increase in height, and the remaining 14 cases have a decrease in height with an increase in the Gini. The overall correlation among the two is not significantly different from zero.

[29]Source for Nutrients Data: National Nutrient Database for Standard Reference, Release 27; accessed May 24, 2015. The three items not in USDA are: Fonio with data from here, Tortilla with data from here, and Foufou with data from here .

[30]Detailed description of the items and the dataset can be found at http://laborsta.ilo.org/applv8/data/to2ae.html

[31]Considering only cases where fuel was more than 2% or less than 20% of the total BBB.

[32]The FAO data were gathered during the 4th and 5th of May 2015 from the webservice available at http://www.fao.org/giews/price-tool/, and the WFP data from https://data.hdx.rwlabs.org/dataset/wfp-food-prices on the 3rd of February 2016.

[33]Global Financial Data, Global History of Currencies dataset downloaded from here, accessed on 16, July 2014.

[34]This number of relevant products does not include fish or meat items. It represents mostly staple food items, complemented with bean/peas.

[35]In case both consumption and income distributions are available, the consumption one is preferred, following (Ravallion 2013). Also note that due to the availability of prices the period investigated here begins in 1983.

[36]In principle the 2011 rates are applied, but for a few countries PovcalNet still uses the 2005 exchange rates. Those countries are Bangladesh, Cabo Verde, Cambodia, Laos and Jordan. Since there is no alternative I follow PovcalNet in this choice. The aggregated estimates here only refer to countries with 2011 PPP data at PovcalNet.

[37]For the few country/years that PovcalNet has no CPI, the available figure from the World Bank is used. For China in 2014 the official rural and urban CPI rates were taken from http://www.stats.gov.cn/tjsj/ndsj/2015/indexeh.htm, and for the 2013 and 2014 rural and urban CPIs for India were taken from https://data.gov.in/catalog/all-india-consumer-price-index-ruralurban.

[38]Using a slightly updated version of a script provided by Dykstra, Dykstra, and Sandefur (2014), and the BBBs as poverty lines, the poverty estimates for the BBB based poverty lines are obtained by querying PovcalNet directly. This treatment bypasses any discrepancies between the two datasets and allows direct comparisons of BBB absolute poverty estimates with those of the World Bank.

[39]Testing for statistical significance in the difference among the various estimations of poverty rates requires considerably more information about the scattering of the poverty rate estimates than gathered here. Such an investigation stretches beyond the scope of the present paper.

[40]General Food Price Subsidies in Indonesia: The 1997/1998 Crisis Episode

[41]This notation should not be read as a confidence interval. $\pm$ 1 SD of the BBB value gives in this case 3.8% and 7.5% respectively, or in the simpler notation (3.8, 7.5) as reported here.

[42]Millennium Development Goal 1: "Target 1.A: Halve, between 1990 and 2015, the proportion of people whose income is less than $1.25 a day", taken from http://www.un.org/millenniumgoals/poverty.shtml on June 6, 2016.

[43]The quotes around the 1.90 denote that the actual mean value is not $1.9, but rather $1.88. Several normality tests where applied (Shapiro-Wilk, Pearson chi-square, and Anderson-Darling among others) all which did not reject the null hypothesis for normality.

[44]The differences on the mean value are caused by the use of the actual average of the underlying NPLs, which is 1.88, instead of the adopted average of 1.9.

[45]For reasons of comparison with PovcalNet, we apply the same rule for getting the number of people living in poverty. That is the poverty rate of the region is applied to the entire population of the region regardless of coverage.

[46]Each figure in this subsection also marks with a vertical black dotted line the years with available distributional data from PovcalNet.

[47]A more appropriate investigation of systematic errors in the BBB estimates that would incorporate Monte Carlo simulations extends beyond the scope of this paper.

[48]More recently, recommendation 5 in The World Bank (2017) picks-up this point.

[49]The six nutrients are: calories, proteins, carbohydrates, fats, vitamins, and minerals

[50]On the matter, Rao (2000) finds relevant evidence for rural South India, and Biru (1999) for Zambia, as cited by Reddy and Pogge.

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