J Econ Inequal
DOI 10.1007/s10888-010-9155-y

Global inequality recalculated and updated: the effect of new PPP estimates on global inequality and 2005 estimates

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Received: 13 March 2010 / Accepted: 14 October 2010

Abstract The results of new direct price level comparisons across 146 countries in 2005 have led to large revisions of PPP (purchasing power parity) exchanges rates, particularly for China and India. The recalculations of international and global inequalities, using the new PPPs, show that inequalities are substantially higher than previously thought. Inequality between global citizens is estimated at 70 Gini points rather than 65 as before. This high level of inequality is confirmed by the results obtained from the new set of 122 national household surveys from around year 2005.

Keywords Global inequality · International inequality · Purchasing power parity

JEL Classification D31 · I3 · 057

1 Introduction

Globalization and much greater number and easier accessibility of nationally-representative household surveys have stimulated interest in the issues of global poverty and inequality. While 20 years ago, there were, with the exception of a few

I am grateful for comments to Yuri Dikhonov, Peter Lanjouw, Thomas Pogge, editor of this *Journal* Jean-Yves Duclos and two anonymous referees. The views expressed are those of the author and should not be attributed to the World Bank or its affiliated organizations.

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Published online: 16 November 2010

papers [2, 6, 14, 34], no studies on either topic, the number of scholarly articles and books has by now grown literally into thousands. In fact, a simple Google scholar search (conducted in August 2010) produces more than 15,000 hits for the joint terms "global poverty" and about 9,000 hits for "global inequality". Halving global poverty between 2000 and 2015 is one of key the Millennium Development Goals, and estimates of global poverty have thus acquired somewhat of an international political "imprimatur." Global inequality does not enjoy the same political clout in the international arena, but a large number of papers, conferences, popular discussion forums, etc. dedicated to the topic show that, perhaps more among the general public and academics than among the politicians, it commands wide interest.

Studies of both global poverty and global inequality crucially depend on two "ingredients": representative national household surveys[1] and information about the "typical" level of prices in various countries. The latter plays a crucial role because it enables researchers to compare welfare between individuals living in different countries, by "deflating" domestic incomes not by market exchange rates but by PPP (purchasing power parity) exchange rates such that one international dollar provides, in principle, the same command over goods and services in any country of the world. PPP exchange rates here play a role similar to that played by national price indexes in the case of individual countries over time. In order to compare average or individual welfare in the same country in two periods of time, one needs to adjust for changing national price level. Similarly, to compare welfare between individuals living in different countries (or welfare between "representative" or "average" individuals living in different countries) at the same point in time, one needs an estimate of price levels they face. Global inequality and poverty calculations are thus extremely sensitive to the estimates of PPP exchange rates. These estimates are obtained through a large International Comparison Program (ICP). The project consists, put in simplified terms, in collecting individual price data for hundreds (or thousands) of goods and services consumed in most countries of the world, and thus constructing country-wide price indexes for total GDP and various components of GDP such as household consumption, investment or government spending and even narrower components of expenditures like clothing and footwear, transport, etc.[2]

The latest round of ICP was conducted in 2005. In December 2007, the preliminary results of the 2005 International Comparison Program (ICP) were published. In the Spring of 2008, the final results were presented to the public, fully confirming the preliminary data [37]. The new estimates of price levels in 146 countries—accounting for 95% of the world population and 98% of the world US dollar GDP—led to the new estimates of PPP (purchasing power parity) exchange rates, and accordingly new $PPP estimates of national aggregates such as gross or national domestic product,

[1] At least until a point when we would be able to conduct a world-wide representative household survey.

[2] It is worth mentioning that these estimates of PPPs are obtained by using a particular approach to the index number problem aggregation called EKS (Eltöte, Köves and Szulc) and that this aggregation produces, in principle, different PPPs from the alternative aggregations such as Geary-Khamis (used by Penn World Tables) or Afriat, recently studied by Dowrick and Akmal [13] and Ackland et al. [1].

household consumption expenditures, gross fixed capital formation, etc. for all the participating countries.[3]

The 2005 ICP results imply a dramatic downward revisions in GDPs, expressed in PPPs, of the two most populous countries in the world, China and India, as well as of a number of other large countries such as Indonesia, the Philippines and South Africa.[4] The new results, especially when used to retrospectively estimate PPPs and thus GDP per capita levels (in PPP terms), have led to serious adjustments of historical income levels. The revisions have directly affected estimates of global poverty and global inequality over time. Chen and Ravallion [8], and Ravallion et al. [32] have published new estimates of global poverty. They differ from the old not only for 2005 and subsequent years but for previous years as well. Poverty levels in these years are retroactively calculated using the new 2005 PPPs. In other words, the PPP data affect not only our view of the present but of the past as well. The objective of this paper is to do a similar empirical reassessment of international and global inequality.

It should be noted that the effects of new PPPs are not limited to global poverty or inequality estimates. The effects of new PPPs on numerous empirical studies produced in the last 15 years, which have used GDP data derived from the previous ICP round conducted in 1993, are yet to be assessed. That reassessment might produce some dramatic revisions in what are presently considered robust empirical findings. For example, many of the conclusions where GDP, GDP per capita, or some other formulation where GDP is included (e.g. its growth rate, trade/GDP ratio, or government expenditure/GDP) may be affected. The range of such topics is huge since one or another formulation of GDP plays a role in many areas of economics: growth, inequality (Kuznets curve or its variants), governance, climate change, gravity trade models, etc. GDP, in various formulations, is probably the most popular control variable in empirical economics, whether this is necessitated by structural models or not (i.e., GDP is often used in reduced-form regressions without much theoretical justification). The effect of revisions will be particularly strong for cross-country regressions. In panel data, run with country fixed effects, the current revisions may be regarded as affecting the intercept (coefficient on country dummies) only, and thus the "damage" to these results should be less.[5]

The objective of the paper is to update estimates of international and global inequality using the new PPPs, and present new estimates of global inequality for 2005 based on 122 national household surveys conducted around that year. In the next section, I will briefly explain some key characteristics and results of the 2005

[3]And based on the regressions run across participating countries, even the PPP estimates for countries that did not participate. The most important among the latter are Algeria, Burma and Uzbekistan.

[4]In the rest of the paper, GDP should be always understood to mean (unless stated otherwise) GDP in international dollars (of equal purchasing power parity).

[5]This is true only in cases where growth rates remain unaffected, as in the World Bank and IMF approaches to recalculating GDPs. But in Penn World Tables, which calculates its own real growth rate for each country/year, based on real growth in GDP components, the new PPPs will lead to the change in the relative importance of the components (consumption, gross investment, etc), and thus to the change in past rates of growth as well.

round of ICP. In Section 3 I present the definitions and new estimates of international and global inequality.[6] Section 4 concludes the paper.

It is important to underline at the outset that the objective of the paper is quite limited. Section 3 presents the recalculations of international and global inequality in the past and gives new estimates for 2005, but does not discuss implications of these findings. It does not go into any deeper discussion regarding the fundamental meaning and usefulness of various concepts of international and global inequality. Similarly, it does not, except occasionally, deal with the methodological problems that accompany such research (choice of the proper welfare indicator, income or consumption; use of equivalence scales or per capita measures; reliability of household surveys; issues of under-reporting or non-participation in household surveys, etc.) These are huge topics of their own right and the reader is referred, among others, to the book dedicated to global inequality [24], to the detailed methodological discussion of the problems that bedevil calculations of global inequality and poverty [10, 11, 26, 30], or to an excellent critical review of the empirical findings [5]. Similarly, the paper takes the 2005 ICP results basically as given, and does not address some problems which have recently been highlighted, among others, by Deaton [11] in his American Economic Association presidential address. All of these are much broader and complex topics, while the purpose of this paper is simply to update inequality calculations so that researchers, when they move to these other more complex issues, have at least a clear and up-to-date empirical baseline from which to start.

2 International Comparison Program, 2005 round

International Comparison Program is a joint UN-OECD-World Bank-regional development Bank project that, at approximately decennial intervals, covers the entire world with the objective of determining, from direct price comparisons of about 1000 goods and services, price levels within nations.[7] The latest ICP was the largest such project in the history of ICP, and probably the largest worldwide single empirical economic project ever undertaken.

The 2005 estimates of purchasing power parity (PPP) exchange rates for 146 countries are not only the most recent and best estimates that we have, and the survey, "the most extensive and thorough effort ever to measure PPPs across economies" ([37], p. 9), but for a number of countries they are the first such estimates obtained from direct price comparisons. The number of participating countries has increased from 118 in the previous round (1993) to 146 now. China has for the first time participated in the ICP. Previous estimates of Chinese PPP exchange rates were based on 1983 and 1995 research papers [3, 33]. Similarly, India has participated for the first time since 1985. Up to now, the PPP estimates for India were based on the extrapolations of the 1985 results. The price comparisons now include 48 African countries, more than ever before and many of them for the first time.

[6] An initial estimate of global inequality with new PPPs for the year 2002 only was published by Milanovic [27].

[7] One can consider the first global ICP to have been the one conducted in 1980. The earlier, much smaller rounds, limited to developed economies, were done in 1970, 1973 and 1975.

The current round of ICP does not differ from the past rounds only in terms of better country coverage but also in the methodology, and scope of direct price comparisons. In the words of Australian Bureau of Statistics ([4], pp. 13), "[The 2005 round] is the most comprehensive and firmly-based ICP round to date." Prices of more than 1000 goods and services were compared across countries, using the assistance of national statistical offices and regional organizations (Asian Development Bank, Eurostat, Statistics Canada, Economic Commission for Latin America, etc.). The project was organized around six regions (Africa, Asia/Pacific, Commonwealth of Independent States, South America, OECD/Eurostat, and Western Asia). The methodological innovation was the concept of "ring" countries. These are countries (ranging between 2 and 6 from each region, 18 in total) with developed market economies and wide range of goods and services such that direct price comparisons (using the same basket of goods and services) can be made between them. Prices of about 1200 goods and services were directly compared for the ring countries (see [37], pp. 160–1). Using the results from the ring countries' price comparisons, the price levels for other countries belonging to a given region (for which ring countries are representatives) were linked to the rest of the world. The "ring approach" is considered better than the earlier-used "bridge-approach" (where only one "bridge" country's prices were directly compared with those of the "neighboring" region) because it requires a direct price comparison of the same bundle of goods and services in all eighteen "ring" countries.

The most important results concern the new estimates of price levels in China and India. As they are now estimated much higher than previously, the GDPs per capita of these two countries have been correspondingly revised downward by about 38% (Table 1). But while these downward revisions are among the largest, they are not the only ones. Indonesia's GDP per capita was revised downward by 17%, Philippines's by 41%, Ghana's by 50%, Argentina's by 24%, South Africa's by 32%. The upward revisions were much less frequent and more modest: Russia's GDP per capita turned out to be 7% higher than previously thought, Mexico's about 10%, and Nigeria's GDP per capita (the largest upward revision among the populous countries) is now estimated to be almost 27% higher. For the advanced economies, the differences between the direct price comparison from this round of ICP, and the previously-used extrapolations from the 1993 benchmark, are relatively small, ranging around 3 and 4%. For the US, UK and Japan, the revisions are 1.5 to 3% down, for Germany 4% up.[8] By region, the largest population-weighted revisions were for Asia/Pacific, where GDP per capita was revised 33% downward, followed by Africa (about 4% down). For other regions, the revisions were, on average, small (around 1%).

[8]The US discrepancy of 1.5% which in principle should be zero (since US price level is, by assumption, unity) arises, it seems, for the following reason: the update of the "old" 1993 GDPs expressed in 1993 international prices (call it x) to the subsequent years and subsequent years' PPPs is done by applying to x country's real growth rate and change in its real exchange rate, measured by its nominal exchange rate against the US dollar and Consumer Price Index (CPI). In the case of the United States, the exchange rate is always = 1. But the correction of x by real growth rate and CPI produces a slightly different 2005 value compared to the actually observed nominal dollar GDP in 2005 because the latter is implicitly obtained by applying to x subsequent years' real growth rates and GDP deflators. In short, it seems that a difference in the movement of US CPI and US GDP deflator explains this slight discrepancy.

Table 1 New GDP per capita compared to the "old" WDI (World Development Indicators) data: Thirteen most populous countries in the world, year 2005, PPPs year 2005

	GDP per capita based on "old" PPPs	GDP per capita based on "new" PPPs	Revision (in percent)
Vietnam	3,106	2,143	−31.0
Philippines	4,991	2,956	−40.8
Mexico	10,356	11,387	+10.0
Japan	31,262	30,290	−3.1
Nigeria	1,200	1,520	+26.7
Bangladesh	2,025	1,068	−47.3
Russia	11,053	11,858	+7.3
Pakistan	2,437	2,184	−10.4
Brazil	8,854	8,474	−4.3
Indonesia	3,898	3,209	−17.7
United States	42,454	41,813	−1.5
India	3,536	2,222	−37.2
China	6,666	4,088	−38.7

Both GDPs per capita are expressed in 2005 international dollars. Countries ranked by population size. Countries ranked in increasing order by their population

As mentioned, the importance of these revisions does not lie solely in the fact that for the year in which the ICP is conducted, the national accounts of the countries are affected. The revisions, at times dramatic, ensue for the past years, because national account aggregates in PPP terms (in particular GDP, with which we are concerned here) are recalculated for all previous years. The recalculation is done is a such a way that the previous years' GDP *levels* are obtained by applying to the "new" 2005 level the national real growth rates from the earlier years.[9] An obvious implication is that India and China will now be shown to have been poorer than previously thought for all the years since the late 1940s or early 1950s when their modern national accounts start. As this is a level effect (which of course varies from country to country), it will not impact countries' growth rates, but it will impact a number of other calculations. For example, the new calculations of world poverty for the period 1981–2005, based on the 2005 ICP results, were presented by the World Bank in August 2008 [8]. Predictably, these results led to an upward revision in the number and proportion of the world poor, but to little change in the time evolution of world poverty (percentage change in the number of the world poor, or trend rate of decline of the global poverty headcount).[10] However, notice that in this case, as in the case of global inequality (as we shall show below), even if the overall trend may not be much affected, there are non-trivial annual revisions in the indicators because the weights of various countries in global output have changed due to the new ICP numbers. A nice example of this effect is presented by the December 2007 revision of IMF global output projections for the next year (2008), merely a week after the

[9]This procedure has always been used although it is not strictly speaking entirely accurate: the PPP basket of goods is different from the basket of goods used by each individual country in calculating its own real growth rate. But this is the only way that both spatial and temporal comparisons between countries' national account aggregates can be made.

[10]It has also led to the replacement of the well-known global poverty line of approximately one PPP dollar per capita per day by a new one of $1.25 per capita per day (in 2005 international prices).

preliminary ICP results were unveiled. As the weight of the Chinese economy in the world was reduced (from almost 15 to about 10%), and as China's growth was expected to be higher than the world average, the global growth rate was revised downward on account of the change in weights only (that is, without any change in the underlying national real growth rate projections).

Up till now (Spring 2010), only the World Bank and the IMF have revised the GDP accounts for all the previous years. Penn World Tables, according to its website accessed on 15 August 2010, is in the process of doing so and the 2005 PPPs (deemed by Heston, "a better set of PPP conversions"[11]) will be incorporated in its PWT 7.0 expected to be out later in 2010. The third source of long-term GDP data (Angus Maddison series) has not proceeded to any revision.

The new ICP results have attracted a fair amount of criticism, highlighted particularly by what they imply for China. A broad discussion and criticism of ICP methodology has been made by Angus Deaton [11] who points out to ICP's overemphasis on the same composition of the basket of goods across all countries rather than basket's representativeness of countries' consumption patterns. This has, according to Deaton, led to some anomalous results because the goods included in the basket (Deaton gives the example of a specific Bordeaux red wine included in an African consumption basket) tend to be, for some countries, unrepresentative and thus relatively too expensive. Deaton points to the trade-off between the "sameness" of the basket (which is in principle desirable) and "representativeness" of the basket (which is also desirable). In his view, the latest round has moved too much toward the "sameness". While this may, or may not, be a fair criticism, it remains for the new rounds to take it on board and perhaps come with a more satisfactory approach—although as long as patterns of consumption remain different across the globe, this problem cannot even in principle be entirely solved.

In the calculations that follow we use PPP exchange rates as given by International Comparison Program [37]. This would be an obvious and rather odd comment to make were it not for the fact that higher price level and thus lower real income for China has attracted particular attention and been subject of dispute [11, 12, 22, 32]. It is fair to say that were these results obtained for a less important country than China, few people would have noticed and discussed them. Moreover, it is remarkable that similar PPP and real income changes implied by new ICP results for India, Bangladesh and the Philippines (see Table 1) have attracted much less attention and were generally accepted without demur. Why are Chinese numbers subject of such a debate? Probably for three reasons. First, China (as we have seen) has never participated in an ICP exercise before and there was obviously a huge interest in finding out how close the "guess-estimates" of PPP used earlier came to "reality". Second, many Chinese statistics, from national accounts to price statistics to household surveys, have constantly been subject of debate and their reliability has often been questioned (see, for example, [15–17, 20, 21]). PPPs are thus not an exception. Third, Chinese results drive to a large extent any global calculation, be it that of global GDP or global poverty and inequality. As such, they are subject of greater scrutiny.

[11] See Alan Heston's "What is new in PWT 6.3?" available at http://pwt.econ.upenn.edu/php_site/pwt_index.php.

Chen and Ravallion [7, 8] have recently decided in their updated calculations of global poverty to treat the 2005 PPP results for China as representative for urban areas only and to reduce the price level for rural areas by some 20% which is their estimate of the cost of living differential, assessed on a basket consumed by the poor, between urban and rural areas. This is not a new approach and it has been already used for China by Ravallion and Chen [31] in their global poverty work as well as by Milanovic in global inequality calculations ([23], p. 61; [24], Chapter 9).[12] We stick to this practice here—reducing rural price level in China by 20% (compared to the PPP numbers as reported by ICP, which are used for urban areas only). In order to test the sensitivity of our results to different important countries' PPPs, we also show calculations where similar distinction between rural and urban PPPs (lower for rural) is applied to India and Indonesia.

3 Recalculated international and global inequality, 1952–2006

3.1 Discussion of the three concepts of inequality

Following Milanovic [23, 24], World Bank [36], and Anand and Segal [5], we distinguish between international and global inequality. Unweighted international inequality (called also Concept 1 inequality) is inequality calculated across unweighted GDPs per capita of all countries in the world. It is similar to the so-called sigma convergence/divergence except that we use a more common measure of inequality, Gini coefficient, rather than the standard deviation of logs. Changes in Concept 1 inequality basically reflect whether there has been or not unconditional income convergence among countries. Weighted international inequality (Concept 2 inequality) also uses national GDPs per capita but weights them by populations of the countries.[13] It thus begins to approach global inequality (inequality calculated across world *individuals*) because the number of people who live in various countries is taken into account even if they are all assumed to have the average income (GDP per capita) of their country. This assumption is abandoned in global inequality (or Concept 3) which calculates inequality across world citizens, taking in principle everybody's actual income into account.[14]

When going from Concept 2 to Concept 3 inequality another important methodological change occurs, namely while Concepts 1 and 2 are calculated from national accounts. Concept 3 inequality can be calculated only from household surveys (since this is the only source for within-country distributions which are needed to get

[12] "For China… I use the rate reported in the International comparison project (ICP) for urban areas only…and reduce the price level in rural areas by an estimated 20% (see [38], p. 138)" ([23], p. 61).

[13] Note that the use of the term "international" here is not accidental. Concept 1 and 2 inequalities are truly those between national mean incomes, and not between individuals.

[14] Obviously Concept 3 in its relevance and meaningfulness dominates Concept 2. The only reason why one may use Concept 2 as a rough, but possibly misleading, estimate of global inequality is that household survey data for a sufficient number of countries are not available for the period prior to 1980s.

Table 2 Data sources from which global inequality (Concept 3) is calculated

Benchmark year	1988	1993	1998	2002	2005
(1) Number of household (HH) surveys	103	122	124	122	122
(2) Number of HH surveys with unit (micro) data	45	80	86	117	117
(3) Number of consumption-based surveys	22	52	63	66	71
(4) Total number of data points (mostly ventiles)	1,111	1,422	1,871	2,393	2,391
(5) Assumption re. inequality within each data point	0	0	0	0	0
(6) Percentage of surveys from benchmark year and ±1 year	71	67	70	66	85
(7) Population coverage of the world (in %)	87	92	92	94	93
(8) GDP coverage of the world (in %)	96	95	96	98	97

to Concept 3 inequality).[15] This creates two problems: first, national accounts and household survey means do not always coincide and have moreover recently been in many countries moving apart [5, 10, 30], and second, household surveys for a sufficiently large number of countries (such that they would cover more than 90% of world population and 95% of world income) are, unlike national accounts data, available only from the late 1980s onward. They are also not available at annual intervals for most countries, thus necessitating the use of benchmark years, spaced approximately at 5-year intervals so that all countries that have had surveys within that interval are included.

Table 2 gives detailed information regarding the coverage and the way the calculations are done for each of the five benchmark years: 1988, 1993, 1998, 2002 and most recently 2005. The number of available household surveys (with micro data) is steadily increasing. By 2002 and 2005, almost all results are based on directly observed household incomes or consumption as reported in surveys. It is from these micro data that we calculate countries' income ventiles (5% of population ranked by their household per capita income) and it is from these ventiles that our estimate of global inequality is in turn derived.[16] The use of ventiles is done for the sake of simplicity and entails a very small loss of information and a very small underestimate

[15]We obviously cannot calculate Concept 3 from national accounts; but we can calculate Concepts 1 and 2 from household surveys. The reason why the alternative approach is preferred is that it enables us to have a much longer time series, since national accounts (unlike household surveys) are available for most countries in the world for the last 50 years. The GDP per capita data, which incorporate the new PPPs, used for the calculations here are from World Bank WDI (World Development Indicators). The data are available at http://web.worldbank.org/WBSITE/EXTERNAL/DATASTATISTICS/0,,menuPK:232599~pagePK:64133170~piPK:64133498~theSitePK:239419,00.html (accessed March 8, 2010).

[16]The increase in the number of directly accessible surveys is also reflected in the increase in the number of data points (see line 4) from which global inequality is calculated. This is so because grouped data (published by statistical offices) and which we use when micro data are *not* available are generally given for less than 20 income groups, most often only for the deciles.

Table 3 Comparison of Ginis calculated from micro data and ventiles

Country (survey year)	Number of micro observations	Gini calculated from micro data	Gini calculated from ventiles	Underestimation (in Gini points)	Underestimation (in %)
Belarus (2006)	5,227	28.67	28.50	0.2	0.6
Germany (2005)	11,197	31.49	31.23	0.3	0.8
Poland (2005)	34,767	34.49	34.23	0.3	0.8
Indonesia (2005)	64,595	39.41	39.01	0.4	1.0
Bangladesh (2005)	10,080	41.23	40.86	0.4	0.9
Iran (2005)	26,850	41.92	41.80	0.1	0.3
Uganda (2005)	7,421	42.94	42.54	0.4	0.9
Mexico (2004)	22,554	45.72	45.56	0.2	0.3
Kenya (2004–05)	13,158	47.62	47.10	0.5	1.1
Chile (2003)	65,809	54.56	53.96	0.6	1.1

Countries ranked by Gini. Source: World Income Distribution (WYD) database

of global inequality as we assume that inequality within each ventile is nil.[17] As Davies and Shorrocks ([9], pp. 102) write, "a partition into twenty or more [optimally selected] groups ensures that the error does not exceed 0.001 [that is, 0.1 Gini point]."[18] Since we have both survey micro data and ventiles calculated from them, we can show, for illustrative purposes, the extent of underestimation in ten cases that were chosen to include both low and high inequality countries, and countries from all regions. As Table 3 shows, the number of micro observations ranges from 5,000 to more than 65,000 and the Gini underestimation that occurs as we "squeeze" micro data into twenty ventiles varies between 0.1 and 0.6 Gini points (mean = 0.3), or

[17]The ventile data for years 1988–2002, together with information about individual surveys from which they are derived, are available at http://econ.worldbank.org/projects/inequality. The underlying surveys are in most cases the same as used by Chen and Ravallion in their calculations of world poverty except that we include also household surveys from rich (mostly OECD) countries which they do not. The source of data for OECD countries is principally Luxembourg Income Study. In a number of cases, however, we have received micro data directly from countries' statistical offices or national institutions working with such data. More information on surveys (although not necessarily micro data since many of them cannot be distributed except by the agencies that provided them to us in the first place) can be obtained from the author on request.

[18]In a recent paper, van Ourti and Clarke [35], propose a correction term when Gini is calculated from grouped data. It is derived from a measurement error framework and depends only on the number of groups. Their formula $k^2/(k^2–1)$ where k=number of equally-sized groups, gives for $k = 20$, a correction factor of 1.0025, that is an underestimation of the Gini by 1/4 of a percent.

between 0.3 and 1.1% of "true" Gini value (mean = 0.8).[19] Thus our ventile-based Gini estimates come to within 99% or more of the "true" Gini.

Calculating global inequality from individual countries' percentiles rather than ventiles raises Gini by less than 0.1 point (results obtained for the benchmark year 2005). Despite the smallness of the underestimate, it is strictly correct to say that the reported inequality statistics represent a lower bound to global inequality. In order to reduce further this downward bias, household survey data for very populous countries (China, India and Indonesia) are presented separately for rural and urban areas. This is made all the easier because the actual household surveys conducted for China's rural and urban areas are indeed two separate surveys and putting them together entails significant problems (see [32]).

Another feature of the data is a steadily increasing proportion of consumption-based, as opposed to income-based, surveys (see line 3 in Table 2). This is mostly the product of greater inclusion of African countries that, under the influence of the World Bank, tend to conduct consumption-based surveys, and a shift of many East European countries from income to consumption surveys. In both cases, the main rationale is that consumption surveys are more reliable because the underestimate of consumption by the rich is less than the underestimate of income by the rich. We do not adjust for income vs. consumption in our global inequality calculations, and in that respect follow the same approach as Chen and Ravallion [7] do in the calculations of global poverty. The main reason is that any such adjustment would be entirely ad hoc. There is moreover nothing to guide us in that area. Even if there are some, although highly tentative, regression-based estimates of how much inequality is, on average, greater when we use income instead of consumption (see [18]), we just cannot estimate at all how much, for example, the share of the third, tenth, etc. ventile is greater (or lower) if we use consumption instead of income. Not only would it vary from country to country and from year to year, but it is worth mentioning that people who are in a given ventile according to income per capita will generally be entirely different from the people belonging to that same ventile according to consumption per capita.

Most of the surveys (between 2/3 and 85%) are conducted in the benchmark year or 1 year before or after it (see line 6 in Table 2). No surveys which are more than 2 years before or after the benchmark year are accepted. A high share of surveys done in the same year as benchmark year reduces the potential error that is introduced when local-currency incomes as reported in household surveys are inflated or deflated by the Consumer Price Index to express them in the prices of the benchmark year.

Finally, it is worth pointing out another reason why global inequality estimates shown here are lower-bound estimates. Although our surveys include between 87% and 94% of the world population, and between 95% and 98% of the world GDP, the excluded population is not random: it entirely comes from the poor and war-affected countries (e.g., Afghanistan, Sudan, Congo, Liberia, Somalia) and consequently their inclusion would almost certainly raise our global Gini.

Taking all these problems and shortcomings faced in the calculations of global inequality, we can briefly define the desirable changes which would make some

[19]The Ginis, whether from micro data or from ventiles are calculated using Stata's ineqerr or ineqdeco routines. For more information on the way Ginis and their standard errors are calculated see Joliffe and Krushelnytskyy [19].

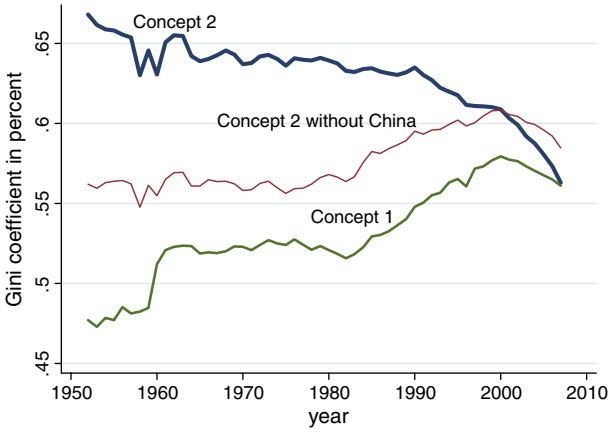

Fig. 1 Concept 1 and Concept 2 (international) inequalities, 1952–2006. Before 1960, there are between 80 and 90 countries included. After 1960, the number varies between 130 and 150

future calculations more accurate: (1) introduction of household surveys in the countries which currently do not field them; (2) annual frequency of surveys; (3) complete access to micro data; (4) movement toward both consumption- and income-based annual surveys with international standardization of both aggregates, and, unrelated to the survey technology, (5) improvement in the estimate of countries' price levels (PPPs) with possible differentiation between rural and urban PPPs, particularly in the case of large and not fully market-integrated countries.

3.2 Calculation of the three concepts of inequality

We now proceed to the calculations of the three concepts of inequality. Figure 1 shows the calculations of Concept 1 and Concept 2 international inequality for the period 1952–2006.

The data start in 1952, mostly because it is the first year for which GDP for China is available, and the calculation of Concept 2 international inequality without China would be meaningless.[20] The sample composition is practically fixed (the number of countries does not vary much) since 1960, when after decolonization the data for most African countries became available.[21] Let us focus first on Concept 1 inequality. Its *level* is between 4 and 5 Gini points higher than with the earlier PPP data (in order to save space, "old" Concept 1 inequality is not shown here; it can be found in Milanovic [24], p. 39). Between 1960 and early 1980s, Concept 1 inequality was stable at the Gini value of about 53. After the early 1980s, and not just coincidentally with the increase in oil prices, real interest rates, and Third World debt crisis, there is a process of rapid divergence in incomes between the countries. The "lost decade" (or rather two decades) in Latin America, stagnation and then substantial declines

[20]For more details on the data see Milanovic ([24], Chapter 4) although the calculations there were done with the "old" PPPs.

[21]For the countries that emerged after the break-up of the Soviet Union, Yugoslavia and Czechoslovakia we use, when available (and they generally are), their republican GDPs per capita for all years prior to independence. We do this in order to keep the composition and the number of the countries in the sample as fixed as possible. The same approach is applied to Pakistan and Bangladesh, and Ethiopia and Eritrea.

in income in Eastern Europe and the former Soviet Union, and the disastrous performance of many African countries, have been the main factors behind this divergence (combined of course with a respectable performance of rich economies). This fact is not new: it has been amply documented and is simply reflected here in the increase in inter-country inequality.[22] The new GDP numbers do not change our interpretation of the recent past, in that regard. Divergence lasted for some 20 years.

However, since 2001, we notice a change. For the first time since 1982 divergence between countries' GDPs per capita has stopped and even become reversed. In effect, the period 2001–06 has been good not only for the global economy (which is driven by the largest and richest countries), but also for the African countries that have grown at the rate of more than 4% per annum, post-Communist countries (growth at more than 6% per annum), and Latin America (3% p.a.). These factors were behind the reversal of divergence which we observe after 2001. It is, of course, not obvious that the global financial crisis and its aftermath will allow these hopeful developments to continue. Note that even with the favorable developments around the turn of the century, the level of Concept 1 inequality is still significantly greater than it was in the 1960s and 1970s.

The level of Concept 2 inequality is about 7–8 Gini points higher than with the "old" PPP data (again, the "old" Concept 2 inequality is not shown here; see [24], pp 85–88). The increase, is, of course, mostly due to Chinese and Indian data revisions. Concept 2 inequality "enters" the 1960s with an extremely high level of 65 Gini points. There is then a mild slide until the mid-1980s, and after that, thanks to high growth rates first of China, and more recently of India, the slide becomes much steeper. By year 2006, when our series ends, Concept 2 inequality amounted to only 55 Gini points. This is a substantial decrease of 10 Gini points, or about 1/6th of its value in 1960s. The line which shows Concept 2 inequality without China (Fig. 1) allows us to notice an important change that occurred around the turn of the century. While until 2000, Concept 2 inequality was sliding downward thanks to China only (since Concept 2 inequality without China was still increasing), after 2000, the decline takes place even *without* China. As mentioned, this is due to the high growth rate of India. But it also shows that the world now has two "engines" of downward pressures on international (and ultimately global) inequality: high growth rates of China and India which because of their size dwarf all other countries.

We now move to Concept 3 inequality. Table 4 shows the recalculated global Ginis and Theil indexes with their (rough) standard errors.[23] The new retrospective PPP exchange rates are simply applied to the existing survey data expressed in local currencies from the benchmark years 1988, 1993, 1998 and 2002, and all inequality indicators recalculated. (In other words, for a given benchmark year and given

[22] See Milanovic [25], Minoiu and Reddy [28], Pritchett [29].

[23] The standard errors shown here are simply a *pis-aller* in the sense that they are calculated as if the data came from a single random survey of worldwide household income and the only error is attributable to sampling. This, of course, is not the case. First, country surveys are independent and their sampling errors related to sample design (e.g., stratified sampling or not) are different. Second, the conversion from incomes expressed in local currency into PPPs presents another source of uncertainty for which we would ideally like to give confidence intervals. An attempt to address the second problem may be worth making in a more methodologically-oriented paper. We do it here only partly by distinguishing between rural and urban PPPs for China, India and Indonesia. The first type of problem is impossible to correct satisfactorily without more information on each individual survey.

Table 4 Global inequality, with the "new" 2005-based PPPs and "old" 1993-based PPPs (household survey data from WYD dataset)

	1988	1993	1998	2002	2005
(1) Gini ("new" PPP)	68.4 (1.8)	69.9 (1.6)	69.4 (1.6)	70.6 (1.5)	70.7 (1.5)
(2) Gini ("old" PPP)	62.3 (2.0)	65.5 (1.7)	64.4 (1.9)	65.7 (1.3)	–
Change (in Gini points)	*+6.1*	*+4.4*	*+5.0*	*+4.9*	–
(3) Theil ("new" PPP)	87.5 (6.5)	93.7 (6.4)	94.2 (6.7)	99.8 (6.4)	98.2 (6.2)
(4) Theil ("old" PPP)	71.5 (5.9)	81.2 (5.6)	79.1 (6.7)	83.4 (5.4)	–
Change (in Theil points)	*+16.0*	*+12.5*	*+15.1*	*+16.4*	–
(5) Gini ("new" PPP) with differentiation between rural and urban price levels for India and Indonesia	67.8 (1.5)	69.3 (1.7)	68.8 (1.7)	70.1 (1.4)	70.2 (1.2)
(6) Top decile share, in percent ("new" PPP)	51.4	53.4	57.0	57.5	55.5

Standard errors of Gini and Theil estimates given between brackets. These standard errors are calculated based on an implicit assumption that we are dealing with a single worldwide household survey which, of course, is not the case. For explanation see footnote 23 above. Ginis in lines (1) and (2) and Theils in lines (3) and (4) already include different price levels for urban and rural China. For 1988–1998, see Milanovic **[**24**]**. Estimates for 1988–2002 calculated by author from WYD (World Income Distribution) dataset available at http://econ.worldbank.org/projects/inequality (under DATA)

country, we have average local currency per capita income or consumption by ventile. These local currency amounts are simply divided by the new PPPs for that particular year and country to yield amounts in PPP dollars). Obviously, an increase in China's price level will reduce the level of incomes in China, measured in PPPs, the same way that it reduces the GDP numbers for China. Table 4 displays a significant increase in the level of global inequality, compared to that calculated with the "old" PPPs. The increase ranges between 4.4 and 6.1 Gini points. The pattern of change however remains the same. After an increase in global inequality between 1988 and 1993, there was a modest decline, and then another increase, with global inequality staying at the level slightly above 70 Gini points in 2005 (see line 1 in Table 4). Note however that the increase between 1988 and 1993 is smaller with the new PPP data (1.5 Gini points) than with the "old" data (+3.2 Gini points). This can be also seen from Fig. 2.

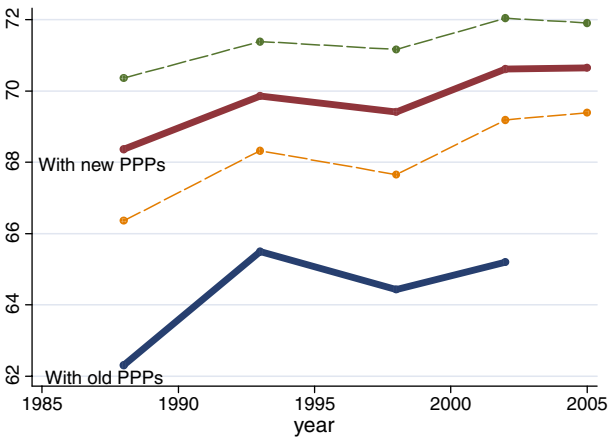

Fig. 2 Global Gini 1988–2005 calculated with new and old PPPs. The one-standard deviation confidence interval around the new Ginis displayed with *dashed line*. Note that these standard errors are calculated based on an implicit assumption that we are dealing with a single worldwide household survey which, of course, is not the case. For explanation see footnote 23 above

Table 5 Decile and top ventile shares of global income (year 2005; "new" PPPs; in %)

Decile	Percentage share
First	0.4
2	0.8
3	1.2
4	1.7
5	2.4
6	3.6
7	5.7
8	8.8
9	19.8
Tenth	55.5
Total	*100*
Top ventile	37.2

There, the two dashed lines show the confidence interval for the new-PPP based Ginis (see however note 24 below).

For 2005, we show global inequality calculations expressed only in "new" PPPs. This benchmark year is particularly useful, not only because it is most recent and its results unpublished, but because local currency incomes are converted into international dollar-equivalents actually "observed" (via the PPP exercise) in that particular year. The new Gini is just slightly over 70 points.

Theil coefficient with the new PPP values increases even more than the Gini, a reflection of Theil's greater sensitivity to the changes at the extremes of income distribution. Since China, India, Philippines and Indonesia all had their PPP-equivalent incomes reduced significantly, the decline has made many poor people from these countries seem even poorer.[24] Moreover, Theil now shows an uninterrupted increase over the period 1988–2002, thus illustrating how the new PPPs may affect not only levels but trends as well.

For the sake of completeness, we also show Ginis using new PPPs but with Indonesia's and India's rural areas assumed to have lower price levels (by some 25%) than urban areas (see line 5 in Table 4). Global Gini is now some 1/2 point lower than when both urban and rural areas were supposed to face the same price level (compare lines 1 and 5 in Table 4), but the movement of global inequality is otherwise little affected.

The table (line 6) also shows the recalculated top decile share of world income. It too increases steadily in every benchmark year but the last, going from 51.4% of global income in 1988 to 57.5% of global income in 2002 before decreasing slightly in 2005. Not surprisingly, with the "old" PPP data, the top decile of individuals was estimated to have controlled slightly less of global income, that is "only" about one-half (not shown in the table).

Finally, Table 5 shows the "new" global decile shares for the most recent benchmark year 2005. We no longer focus on how much the "new" PPPs have revealed global inequality to be greater than previously thought but simply show the current results. We have already seen that the top decile receives more than 55% of global income. The top 5% of the population gets more than one-third of global income. It is also noticeable that not even the eighth decile receives its population share, that

[24]This is not merely an "accounting" decline but a real one: if poor people really face much higher price levels than was previously thought then they are really poorer.

is the average income among the people belonging to the eighth decile is still below the world mean.

4 Conclusions

Calculations of international and global inequality (and poverty) crucially depend on the estimates of domestic price levels which are provided by the International Comparison Program in its more or less decennial exercises. The latest, and to date, the broadest, such exercise was conducted in 2005, and the final results were published in 2008. Despite the fact that it is often considered the best round ever of International Comparison Program, the latest round also proved the most contentious because it led to significant increases in the estimates of domestic price levels in India, China, Bangladesh and a number of other, mostly Asian, and relatively poor, countries. This, in turn, has led to the revisions of global poverty headcounts (including a revision of the global absolute poverty line). The objective of this paper was to document the corresponding changes in international and global inequality (Concepts 1 to 3) from 1952 to 2006. This is a very limited objective, and as stated in the Introduction, it is not the aim of this paper to discuss the methodological problems (which are numerous) attending such calculations, nor to pass judgment on the validity of the new PPP estimates.

With these clarifications in mind, we note that all international and global inequality concepts show higher *levels* of inequality with the new 2005 PPP data than with the extrapolations based on the previous 1993 round of ICP. This is very significant since the new ICP data include China (first time ever) and India (first time since 1985). As significantly higher price levels were estimated mostly for poorer countries, it is not surprising that the estimated *level* of global inequality has risen.

As for the evolution over time of international and global inequality, after 20 years of mean-income (GDP per capita) divergence, GDPs per capita of the countries of the world have begun a process of convergence since 2001 (Concept 1 inequality is on the decline). This is due to the pick-up-of growth in Africa, post-Communist countries, and Latin America. It is unclear how the global crisis will affect this process. Population-weighted (Concept 2) inequality, which has gone down during the last 20 years of the 20th century thanks to the high growth rates of China, shows, after year 2000, a decline even when China is excluded. This is principally due to the high growth rates of India. Uncertainty as to the effects of the crisis remains there too although to the extent that the "locomotives" of Concept 2 decline, China and India, continue to expand at higher per capita growth rates than the rest of the world, Concept 2 may go on with its downward trend.[25]

Finally, global inequality between individuals, which is with the new PPPs estimated to amount to some 70 Gini points rather than 65 Gini points as previously thought, does not show any clear trend over the period 1988–2005 for which we have detailed household survey data. The global Gini bounces between 68.4 and almost 71 Gini points, and this is a level some 10 Gini points higher than what we find in the most unequal countries in the world.

[25] Up to a point, quite remote now (and made remoter after the 2005 ICP results) when China's growth—due to its having become a relatively rich country—turns to be globally disequalizing.

References

1. Ackland, R., Dowrick, S., Freyens, B.: Measuring Global Poverty: Why PPPs Matter. Australian National University Department of Economics, mimeograph. Available at http://voson.anu.edu.au/papers/GlobalPoverty_17Sep2008.pdf (2008)
2. Ahluwalia, M.S., Carter, N.G., Chenery, H.B.: Growth and poverty in developing countries. J. Dev. Econ. **6**, 299–341 (1979)
3. Ahmed, S.: International Comparison of Chinese Prices. Unpublished World Bank working paper, World Bank: Comparative Analysis and Data Division, Washington, D.C. (1983)
4. Australian Bureau of Statistics: The International Comparison Program and purchasing power parities. Available at http://siteresources.worldbank.org/ICPINT/Resources/internationalppp_AUS.pdf (2006)
5. Anand, S., Segal, P.: What do we know about global income inequality? J. Econ. Lit. **46**(1), 57–94 (2007)
6. Berry, A., Bourguignon, F., Morrisson, C.: Changes in the world distribution of income between 1950 and 1977. Econ. J. **93**, 331–50 (1983)
7. Chen, S., Ravallion, M.: China is Poorer than we Thought, but no Less Successful in the Fight Against Poverty. Policy Research Working Paper No. 4621, May (2008)
8. Chen, S., Ravallion, M.: The Developing World is Poorer than we Thought, but no Less Successful in the Fight Against Poverty. World Bank Policy Research Working Paper No. 4703, August. Forthcoming in Quarterly Journal of Economics, vol. 125(4), p. 2010 (2008)
9. Davies, J.M., Shorrocks, A.F.: Optimal grouping of income and wealth data. J. Econom. **42**, 97–108 (1989)
10. Deaton, A.: Measuring poverty in a growing world (or measuring growth in a poor world). Rev. Econ. Stat. **1**, 1–19 (2005)
11. Deaton, A.: Price indexes, inequality, and the measurement of world poverty. AEA Presidential Address. Am. Econ. Rev. **100**(1), 5–34 (2010)
12. Deaton, A., Heston, A.: Understanding PPPs and PPP-Based National Accounts. Research Program on Development Studies, Princeton University (2009)
13. Dowrick, S., Akmal, M.: Contradictory trends in global income inequality: a tale of two biases. Rev. Income Wealth **51**(2), 201–230 (2005)
14. Grosh, M.E., Nafziger, E.W.: The computation of world income distribution. Econ. Dev. Cult. Change **34**, 347–359 (1986)
15. Heston, A.: Treatment of China in PWT 6.1. Available http://pwt.econ.upenn.edu/ (2001)
16. Holtz, C.A.: China's reform period economic growth: how reliable are Angus Maddison's estimates. Rev. Income Wealth **52**(1), 85–119 (2006)
17. Holtz, C., Brand, L.: Spatial price estimates and price differences in China: estimates and implications. Econ. Dev. Cult. Change **55**(1), 43–86 (2006)
18. Li, Hongyi., Squire, L., Zou, Heng-fu.: Explaining international and intertemporal variations in income inequality. Econ. J. **108**, 26–43 (1998)
19. Joliffe, D., Krushelnytskyy, B.: Bootstrap standard errors for indices of inequality: INEQERR. Available at http://users.starpower.net/djolliffe/stb/ineqerr.pdf (n.d.)
20. Maddison, A.: Chinese Economic Performance in the Long Run. OECD Development Centre, Paris (1998)
21. Maddison, A.: The World Economy: Historical Statistics. OECD Development Centre Studies, Paris (2003)
22. Maddison, A.: Measuring the economic performance of transition economies: some lessons from Chinese experience. Rev. Income Wealth **55**, 423–441 (2009)
23. Milanovic, B.: True world income distribution, 1988 and 1993: first calculation based on household surveys alone. Econ. J. **112**(476), 51–92 (2002)
24. Milanovic, B.: Worlds Apart: Measuring International and Global Inequality. Princeton University Press, Princeton (2005)
25. Milanovic, B.: Why did the Poorest Countries Fail to Catch up? Carnegie Working Paper No. 62, September (2005)
26. Milanovic, B.: Global income inequality: what it is and why it matters. World Econ. **7**(1), 131–153 (2006)
27. Milanovic, B.: An even higher global inequality than previously thought: a note on global inequality calculations using the 2005 International Comparison Program results. Int. J. Health Serv. **38**(3), 421–429 (2008)

28. Minoiu, C., Reddy, S.: Real income stagnation of countries: 1960–2001. J. Dev. Stud. **45**(1), 1–23 (2009)
29. Pritchett, L.: Divergence, big time. J. Econ. Perspect. **11**(3), 3–17 (1997)
30. Ravallion, M.: Should poverty measures be anchored to the national accounts? Econ. Polit. Wkly. **34**, 3245–3252 (2000)
31. Ravallion, M., Chen, S.: China's (Uneven) Progress Against Poverty. Policy Research Working Paper No. 3408, September (2004)
32. Ravallion, M., Chen, S., Sangraula, P.: Dollar a Day Revisited. World Bank Policy Research Working Paper No. 4620, May (2008)
33. Ruoen, R., Chen, K.: China's GDP in U.S. Dollars Based on Purchasing Power Parity. Policy Research Working Paper No. 1415 (1995)
34. Theil, H.: World income inequality and its components. Econ. Lett. **2**(1), 99–102 (1989)
35. van Ourti, T., Clarke, P.: A simple correction to remove the bias of the Gini coefficient due to grouping. Rev. Econ. Stat. (2010, in press)
36. World Bank: World Development Report 2006: Equity and Development. Oxford University Press and the World Bank, Washington (2006)
37. World Bank: Global Purchasing Power: Parities and Real Expenditures, 2005 International Comparison Program. World Bank, Washington (2008)
38. Yao, S., Zhu, L.: Understanding income inequality in China: a multi-angle perspective. Econ. Plan. **31**(2–3), 133–150 (1998)