J Econ Inequal
DOI 10.1007/s10888-015-9312-4

PovcalNet, WDI and 'All the Ginis': a critical review

Timothy Smeeding[1] · **Jonathan P. Latner**[2]

Received: 16 January 2015 / Accepted: 23 June 2015

Abstract In this paper, we review three data sets which summarize world-wide inequality across countries and years: World Development Indicators ('WDI')/'PovcalNet' and 'All the Ginis' (ATG), each of which has some origins at the World Bank. We hope to inform both experienced and novice users of the existence of these important data sets, provide a review of their benefits and drawbacks, suggest how to use them, and provide suggestions for future improvements. The review is grounded in the history of the development of such data sets, which also necessarily informs users of critical information and the types of choices one must make in order to understand how to measure and compare poverty and inequality over space and time.

Keywords Trends in inequality · Purchasing power parity · Expenditure · Consumption · Income · Survey · Top incomes

1 Introductory and Framing Issues

The micro-data world has come a long way in a short period, with multiple sources of comparable (harmonized) household income data (both overall and top incomes), wealth data, and poverty data. Even heeding the warnings to take caution with harmonization and especially the non–harmonization of secondary data sets (Atkinson and Brandolini 2001), the

✉ Timothy Smeeding
smeeding@lafollette.wisc.edu

Jonathan P. Latner
jlatner@ssc.wisc.edu

[1] La Follette School of Public Affairs, University of Wisconsin–Madison, Madison, WI 53706, USA

[2] Department of Sociology, University of Wisconsin–Madison, Madison, WI 53706, USA

Published online: 22 July 2015

world now has a substantial number of new and more-comparable data series, both across nations and over time. Still, there are limits to what can be accomplished in terms of comparisons. The limits are greatest in developing countries and some middle-income countries where income distribution surveys are often suspect and guilty of severe sampling and non-sampling errors and where data sets have not been harmonized with each other, creating issues of non-comparability in both the level and trend of inequality. Taking a data set that is well designed for poverty measurement and extending it to measure overall inequality (and other uses) may prove troublesome. All these factors need to be kept in mind in the analysis of the levels and trends of national income inequality or in cross-national comparisons of emerging economies with richer nations. Of course, levels of development are continuous variables and nations move up and down in terms of rankings.[1] In geographically large and populous nations that are experiencing rapid growth, including the BRICS (Brazil, Russia, India, China, and South Africa), differences in inequality within nations are often larger than the inequality one finds between nations.[2] While the data used for such comparisons include a great deal of "noise" (unknown errors), the important assumption is that the signal derived from the data analysis exceeds the noise for most careful analyses, which also include sensitivity tests of assumptions (Atkinson et al. 1995; Gottschalk and Smeeding 2000).[3] But sometimes testing the sensitivity is difficult when one is faced with summary "meta-data" and is not able to examine the micro-data which underlie it.

Comparability is vastly increased when the researcher can access the individual observations on household incomes available in a national archive, or in international databases where the original databases are harmonized such as the Luxembourg Income Study (LIS), the European Union Statistics on Income and Living Conditions (EU-SILC), and the Socio-Economic Database for Latin America Countries (SEDLAC). Here, both levels and trends are more comparable across nations and across time than for other methods. But, at this time, harmonization is only beginning to take hold in the non-rich world. As a result, calculating global poverty rates or trends in inequality across a wide range of nations with any reasonable degree of accuracy is difficult at best. Tradeoffs between breadth and accuracy will therefore have to be made by users of the data sets profiled here.

In this paper, we review three data sets which summarize inequality across countries and years: the World Development Indicators ('WDI'), 'PovcalNet' and 'All the Ginis' (ATG). PovcalNet and the WDI share many similarities, but also many differences. The WDI

[1]For instance the World Bank (2014) lists of low-, middle-, and lower-middle-income nations change fairly regularly, see http://data.worldbank.org/about/country-and-lending-groups. For the 2014 fiscal year, low-income economies are defined as those with a GNI (not GNP) per capita, calculated using the World Bank Atlas method, of $1,035 or less in 2012; middle-income economies are those with a GNI per capita of more than $1,035 but less than $12,616; high-income economies are those with a GNI per capita of $12,616 or more. The Atlas method, with three-year average exchange rates adjusted for inflation, lessens the effect of exchange rate fluctuations, but it measures total currency flows, not purchasing power. https://datahelpdesk.worldbank.org/knowledgebase/articles/378834-how-does-the-world-bank-classify-countries.

[2]Of course, measuring inequality between nations does not always have the same meaning as measuring inequality within nations. Inequality between nations is often based on the national means, so as to facilitate simple comparison, whereas inequality within nations may be based on a variety of other measures, which should provide a better description of inequality within a nation.

[3]In examining trends, we are aided by the fact that errors may be more consistent across multiple rounds of the same survey and therefore trends may be more cross-nationally reliable and comparable than levels of inequality (Gottschalk and Smeeding 1997). But even then, almost all surveys undergo substantial changes over multiple decades, producing artificial changes in results due to changes in sampling, survey mode, or other changes in procedures. Because of these changes, full comparability is an impossible goal.

contains much more data than does the PovcalNet.[4] And, conversely, PovcalNet contains much data that the WDI does not report, including decile or (in some cases) percentile shares of the income or consumption distribution. While it is true that almost all the poverty and inequality statistics reported in the WDI originate from PovcalNet (with the main exception being national poverty lines/rates), the two data sets have many other differences.[5] Our assignment has several overlapping goals. We hope to inform both experienced and novice users of the existence of these important data sets, provide a review of their benefits and drawbacks, suggest how to use them, and provide suggestions for future improvements. The review is grounded in the history of the development of such data sets, which also necessarily informs users of critical information and the types of choices one must make in order to understand how to measure and compare inequality over space and time.

The logic of creating the WDI/PovcalNet and ATG data sets, which combines data on inequality from multiple sources under one expert reviewer, is that (i) they are all maintained by the World Bank and (ii), largely in consequence, they overlap to a considerable extent, and at least partially cross-feed one another. Given the reliance of ATG on PovcalNet for almost a quarter of its observations, we really have something less than three data sets here to review (Table 1). The very degree and nature of those overlaps ought to be of interest to readers. All three data sets are easily accessible, at least from an aggregate computational perspective, as they are all relatively simple databases, essentially large spreadsheets of "metadata" derived mainly from household unit record microdata of various sorts.[6] We are not the first to review data sets measuring inequality in almost all of the world's nations and we hope that such reviews will be an ever present constructive component of the continued development of these data banks in the future.

Before we address the intimacies of simple-to-access metadata – most, but not all of which is derived from microdata – we need to discuss the challenges of "worldwide" or even "multi-country" data measurement using inequality and poverty measures. For instance, one can find poverty measures in over 100 countries and some harmonized measures from the World Bank that use both secondary (published) data and microdata on based measures of consumption and income to determine those living below some particular amount of income per person day, from $1.25 to $2.50 (Ravallion and Chen 2011; Chen and Ravallion 2012).[7] There is surely the need for country specific poverty and inequality measures to assess the effect of policy, as the World Bank has done for years. But now there is also pressure to make these comparisons generalizable across countries as part of the new World Bank effort to assess poverty and shared prosperity on a global basis (Jolliffe et al. 2014).

The new millennium has been mostly marked by rising inequality and, relatedly, growing interest in measuring inequality and poverty across time and countries.[8] One consequence

[4]Even in the case of poverty, the WDI reports national poverty rates based on national poverty lines, which PovcalNet does not have or report, as we see below.

[5]The exact relationship between PovcalNet and WDI is described in greater detail below.

[6]Indeed, PovcalNet not only provides summary statistics – pre-calculated poverty and inequality estimates at regional or country level – but it also lets the user create new poverty measures at different poverty lines or using alternative purchasing power parity from the metadata.

[7]Several authors have also taken on the idea of measuring global inequality with some limited degree of success, for instance, these include Milanovic (2002, 2005, 2011, 2012), Lakner and Milanovic (2013), Sala-i-Martin (2006), and Ferreira and Ravallion (2009).

[8]Inequality is rising in most nations, but not everywhere, as 15 Latin American nations have had falling inequality in the past two decades, most notably Brazil and Mexico. See Lopez-Calva et al. (2010) and Lustig et al. (2013).

Table 1 Number of ATG Gini observations by data set

"Quality Ranking"	Data Source	Percent of Gini ATG Gini Observations Based on Microdata	(1) Number of ATG Observations in the original data set	(2) Number of ATG Observations used in Giniall*	Percentage of observations used: (2)/(1)
1	INDIE	100	224	224	100
2	LIS	100	199	164	82
3	SEDLAC	100	308	268	87
4	SILC	100	103	90	87
5	ECA (WB)	100	247	217	88
6	WYD (WB)	80	616	336	55
7	PovcalNet/WDI	most	818	189	23
8	WIDER (WIID)	some	886	555	63
	Total		3,401	2,043	60

Source: "All the Ginis Data sets Description," Table 1 (p. 5)

*Giniall is the preferred ATG gini coefficient for analytic purposes

is an increased number of meta or summary data sets that compile inequality measures from many sources, such as those based on already collected microdata and those based on "meso" data sets that abbreviate or summarize microdata sets (e.g. published quintile share data) according to a common template, as well as studies that are based on harmonized microdata itself.[9]

The potential value of these and other metadata sets for inequality researchers is the ability to move beyond one measure at one time for one country to multiple measures at multiple times for a wide range of countries, facilitating the creation of a more diverse, representative, and complete picture of inequality. At the same time, the potential value may only be realized if the data sets meet certain conditions of quality, replicability, and robustness. We begin with some ideas on the measurement of data quality before reviewing the state of cross-national inequality measurement, fundamental questions of comparability, and then turn to the measurement challenges that are particularly important to our three databases. The fundamental challenges include the type of inequality being measured (income or consumption); items included in the measure of these concepts; measurement techniques embedded in the data set outputs (such as the use of specific equivalence scales to adjust for household size); data harmonization and data set merging; and methods to transform all nations estimates into a common comparable currency, either by using exchange rates or Purchasing Power Parities (PPPs), whereby a market basket is constructed and the costs of the basket are collected by each nation and then transformed into one

[9]Some studies like the Luxembourg Income Study (LIS) and EU-SILC uniquely provide both metadata and microdata harmonized using the microdata. Others like OECD (2011) and the Gini project (see Toth 2014, which is not the same as the ATG database) base their results on microdata prepared to a common prescription, but without direct access to the microdata, while still other 'secondary' data sets, e.g. the World Income Inequality Database (WIID) provide only or mainly summary measures of inequality. The WDI/PovcalNet and the ATG uses all types of estimates mentioned above, but provide access to the metadata in spreadsheet form.

currency. Then, we review the data sets in question, WDI/PovcalNet and All the Ginis (ATG), which is actually *almost* all of the Ginis, as more appear every year from various sources. We focus on both content and access in our reviews, including elements of the WDI which are over and above basic poverty and income inequality data and conclude with an assessment of the current status of inequality measurement using these three data sets.

2 Fundamental challenges to inequality measurement in rich, developing and middle income countries

We begin the discussion by briefly considering how one measures data set quality scientifically (1 and 2 below) and operationally (3 and 4 below). Arguably, there are four main measures of quality in a data set:

1. Accuracy and reliability of reported indicators
2. Transparency and replicability
3. Accessibility and user-friendliness
4. Quality of documentation

Among the challenges is significant overlap in these four main measures and the lack of an overall objective definition of accuracy. For example, the definition of "accurate" in the context of an inequality database is not clear. One definition of accuracy and reliability is that the estimates are likely to be correct. To that extent, accuracy could be better assessed by hands-on access to the actual microdata that underlies the poverty and inequality metadata on the PovcalNet and the WDI. In the case of ATG, there is no microdata to access and other methods are used to determine accuracy, including selected efforts to measure inequality trends in some developing nations based on published articles.

The more accurate the figures in the data set are, the higher the reliability of the data set. However, accuracy is itself a consequence of the ability to replicate the data and test its robustness. In other words, reliability is a function of the degree to which transparent documentation exists allowing a user to find the original data point, replicate it, and accurately compare it to the one in the data set. One problem with this definition of reliability is that assembling multiple cross-national, cross-year measures of inequality is such a herculean task that formally measuring the reliability and accuracy of the data set defeats the purpose of creating the data in the first place. Given the difficulty of compiling the data and lack of access to the microdata, it is not possible to formally assess accuracy, but it may be possible to evaluate the possibility. In other words, *could* a user replicate the data using the documentation provided had they access to the microdata? As before, the answer to that question is partly a result of other quality measures, namely the degree to which the documentation is easy to understand and provides information on how the data was compiled in the first place, i.e., if the method is transparent.

2.1 Some brief history

Cross-national levels and trends in income inequality for rich OECD countries have been studied for decades with some growing degree of accuracy. In the early seventies, the first attempts for international comparisons were achieved when Adelman and Morris (1973), Paukert (1973), and Ahluwalia (1976) tested the Kuznets curve hypothesis using whatever

data they could find, mainly in published form. Malcom Sawyer (1976) produced the first OECD report on income inequality also using various types of data.[10]

Subsequently the LIS pioneered harmonized, but already collected, microdata sets in the 1980s with a second major report to the OECD on 10 nations in 1995 (Atkinson et al. 1995) which was much improved over the earlier Sawyer attempt, eventually making LIS the 'gold standard' for cross-nationally comparative micro-data at a point in time.[11] The European Union has also collected both harmonized household panel data where families were followed for some number of years (European Community Household Panel Study) and, more recently, a cross-sectional collection of microdata sets called the European Union Statistics on Income and Living Conditions, or EU-SILC.

In 1995, the OECD began to collect its own secondary data by sending instructions to national sources to provide secondary mesodata and metadata summary statistics collected from the microdata sets in each nation. By spreading the work amongst nations and not actually harmonizing the micro-data in one place, the OECD can collect summary measures of inequality and poverty in a more rapid fashion, with data now extending up until 2012 or 2013, depending on the country.[12] Others have collected single summary measures like the Gini coefficient from multiple sources, e.g. the World Income Inequality Database (WIID) and the ATG project reviewed below. Trend data from various rich nations are often built on the OECD method and on the Canberra Report (2001) that provides guidelines on how to comparatively measure income inequality for major nations. But, while not completely harmonized and therefore not strictly comparable, these data are heavily used now for comparing poverty and inequality trends across nations.[13]

Just as the rich countries were getting their data into clearer and more comparable focus, the emergence and growth of middle-income nations like Russia and Brazil, and rapidly growing large developing nations, like China, India and Indonesia, have created more demand for better national data and more comparable data on a much larger scale. One approach has been to go back to the collection of secondary data merged with somewhat more comparable micro-data. The income and consumption inequality portion of this work was pioneered in part by the World Bank, where Deininger and Squire (1996, 1997, and 1998) created an inequality database that later became part of the WDI, combining the World Bank LSMS surveys with various secondary data from other surveys around the world.[14] These first attempts at harmonizing inequality data were quite crude and led

[10] Mixing data from surveys, tax records, and other sources, Sawyer (1976) came to the conclusion that France was the most unequal nation of the 10 he studied. In the land of liberté, égalité, fraternité the report became a major social and political issue, and a strong response from the French government in a report by Bégué (1976) that was very critical of the quality of both data and analysis. These attempts provided a beginning, but also major setbacks for cross-national analyses of inequality for at least a decade.

[11] LIS now holds income inequality data on 47 nations, and almost 250 separate estimates, with many nations observed for several years since 1979. LIS holds mainly rich country data, but also now middle-income country data.

[12] www.oecd.org/social/inequality-and-poverty.htm

[13] Some summaries have multiple checks on estimations techniques and others compare various data series within one nation to arrive at a summary trend. Toth (2014), Brandolini and Smeeding (2009), and Atkinson and Morelli (2014) do so, and as illustrated for the United States in Fig. 1 below.

[14] The WDI provided a much wider set of data indicators as part of each nation's entry to the World Development Report. These compilations preceded the Deininger-Squire database.

to another round of critiques, culminating in the seminal Atkinson and Brandolini (2001) review article that criticized the Deininger and Squire database.[15] From these humble beginnings the PovcalNet, WDI, ATG, and other data sets reviewed in this volume have emerged as the leading sources of national measures for middle and lower income countries, as well as inputs into poverty measures. While these are clearly better than the first attempts, they are still short of full comparability

2.2 Basic issues in comparability and inequality estimation

The desire to expand inequality and poverty data to more nations has created several measurement challenges in terms of concepts (income or consumption), measurement techniques (such as the use of equivalence scales to adjust for household size), data harmonization, and data set merging. In order to correctly measure multi-country regional or even world poverty or income distributions, common denominators that transform two or more nations' estimates into a common comparable currency, either by using exchange rates (which are often manipulated by major nations, e.g. China) or better, Purchasing Power Parities (PPPs) are also needed. We address each of these issues below.

2.2.1 Consumption or income or does it matter?

Income is the most common indicator of economic resources in rich countries. While consumption expenditure is often used in developing countries, the Haig (1921) - Simons (1938) identity for income (or potential consumption) being equal to actual consumption plus the change in net worth over a given period ties income and consumption neatly together. But no one data set contains fully comparable measures of all three ingredients in any nation, mainly because change in net worth is difficult to measure (see Fisher et al. 2014).

The nearest alternative to disposable income is consumption or consumption expenditure, a variable which is often preferred in developing countries since it is more easily measured in such localities. Consumption can be smoothed over time and therefore is less volatile and less reliant on seasonal variation than is income, especially in agricultural societies (Deaton and Grosh 2000). Apart from this practical reason, many economists view consumption as a better proxy of well-being than income (Fisher et al. 2014). One argument is that well-being (utility) is a function of the goods and services actually consumed. However, focusing on the means available to purchase commodities (income) rather than the commodities actually purchased (expenditure) makes the assessment of well-being independent of the purchase or consumption choice.[16]

A second argument in favor of consumption is that it is more closely related to permanent income or lifetime resources than current income. As described by Friedman (1957, p. 209), the distribution of current income "...reflects the influence of differences among individ-

[15] Until recently, the literature on global and regional inequality used (i) distributional information (e.g. Gini indices) from secondary data sets, such as Deininger and Squire (1996), (ii) assumed that incomes or consumption were everywhere distributed according to a lognormal distribution, and (iii) used average incomes from national accounts where microdata were not available. Using such procedures Sala-i-Martin (2006) published what he called the first "truly" global income inequality estimates, which have been heavily criticized by Milanovic (2005) and others.

[16] Sen offers the example "...of the person with means who fasts out of choice, as opposed to another who has to starve because of lack of means" (1992: p. 111–112). Hagenaars et al. (1994, p. 8), also argue that using income helps us avoid the trap of confusing voluntarily low levels of consumption with material deprivation.

ual units both in ... the permanent component of income and ... the transitory component. Yet these two types of differences do not have the same significance; the one is an indication of deep-seated long-run inequality, the other of dynamic variation and mobility." If one is interested in "deep-seated long-run inequality," permanent income and, hence, consumption, is what matters, according to Friedman. However, the simple proportionality between consumption and permanent income in the baseline inter-temporal consumer's optimization problem does not hold if some of its basic hypotheses are relaxed and simple forms of personal heterogeneity are introduced (effects of savings or inherited wealth, the degree of inter-generational altruism, the variability of uncertain labor incomes, and capacity to borrow, to name just a few). Therefore, current consumption may not be a very good, and not even the best available, proxy of permanent income for measuring overall inequality.

Finally, there is the problem of measuring of "true" consumption in rich societies. Consumption expenditure data are collected mainly to provide weights and prices for measuring the Consumer Price Index, not for measuring consumption. Very few surveys try to measure actual consumption, because purchases of durables, such as major appliances, automobiles, and especially housing must all be spread out over the useful life of a good which is bought in one period but consumed in another. Indeed, measures of consumption may differ greatly from expenditures for such persons as older individuals living in an owned but mortgage-free house (Meyer and Sullivan 2012, 2013; Johnson 2004).

In brief, there is *a priori* no cogent or practical reason to prefer consumption to income, or permanent income to current income. As mentioned earlier, Haig (1921) and Simons (1938) recognized that income represents the possibility to consume, and therefore established their famous identity. Most often, the choice between income and consumption is driven by the available information and there is a clear preference among rich nations to rely on income and not consumption. Middle income countries are also increasingly likely to have living standards better measured by incomes, especially in their rapidly growing urban areas. Indeed, if the value of informal labor (including production for own consumption) is captured as earnings in the income definition, income and consumption differ only by changes in net worth, which may be small in the poorer and less modern regions of middle income countries. Current income therefore appears to be the best measure of living standards in rich and middle-income nations.

But in developing nations, good survey income measures still do not exist. As a result, consumption data has been substituted for income data in inequality studies and in such instances treated the same despite consumption being liable to be more equally distributed (Lakner and Milanovic 2013) and likely to produce less poverty (and inequality) than income alone (Meyer and Sullivan 2012, 2013). Unfortunately, only a few major countries have actually compared income and consumption inequality using the same data set. In the Unites States, Fisher et al. (2014), find that consumption inequality is about 80 percent as large as disposable income inequality and that the rise in consumption inequality was two-thirds that of income inequality in the United States from 1989 to 2011.

2.2.2 Which definition of income and does it matter?

After settling on income (or consumption) as the focal variable, a number of important conceptual issues and data concerns remain. In addition to the issues of data availability and consistency over time and comparability across countries, the analysis of distributional measures requires decisions and assumptions regarding the income concept and income

sharing unit. While there are preferred measures, i.e. disposable household income from the Canberra report (2001), with an adjustment for household size, the accounting period (normally a calendar year), the choice of statistics for measuring poverty (absolute or relative), and the distribution of income (Gini or other index of inequality) are also important (Smeeding and Weinberg 2001; Johnson and Smeeding 2014). Below, we focus on two of these key decisions – the adjustment for household size (equivalence scales) and the inequality index.[17]

2.2.3 Equivalence scales

It is widely accepted that there are greater costs associated with larger households and economies of scale in consumption that are generated by cohabitation. A family with two children faces greater costs than a family with one child, with greater expenses for food, clothing, education, transportation, and housing. As a result, the same level of after-tax income implies a lower material standard of living for the larger family.[18] Income is typically shared within family or household units. Analysis of the distribution of income across countries and over time requires both adjustments for the economies of scale associated with income sharing and the use of comparable income units. The typical and preferred income receiving unit is the household.[19]

The choice of the equivalence scale affects inequality and poverty comparisons, especially between those who typically live in small units (i.e. elders in rich countries) or larger units (i.e. families with children or multigenerational units) (Buhmann et al. 1988; Coulter et al. 1992). Most analysts use a simple scale like the one recommended in Buhmann et al. (1988), where they define equivalent income as household income divided by the number of persons n in the unit raised to the power 0.5, where 0.5 is a value that captures economies of scale, in essence the square root of household size.[20] One may also rely on per capita calculations for poverty or inequality measurement. This is just one extreme form of an equivalence scale. Using income per capita argues for no economies of scale as the poverty line for six is just six times the poverty line for one, or in terms of Buhmann et al. (1988), n raised to the first power. Such a scale, used by the World Bank's PovcalNet and WDI to calculate poverty and inequality, discriminates against larger families and yields disproportionate numbers of poor (or more inequality) in larger households, such as those with children or with multiple generations. The other extreme is using no equivalence scale, meaning income of a one person unit and a six

[17] A comparison of income concepts including levels and trends is presented later for the USA in Fig. 1 below to give but one example of how and why the income definition matters.

[18] With economies of scale in a household, providing for the second child will not be as costly as for the first. Similarly, a couple living together will spend more on housing, utilities, food, and transportation than a single person, but the couple does not need to spend twice as much to obtain the same standard of living, cet. par.

[19] Some data sources report income for individuals, families, or tax-paying units, which potentially include individuals, families, and sub-family units as well as households.

[20] It is worth noting that consumption-based equivalence scales often depend on relative prices within nations. Arguably, a 'correct' equivalence scale would need to be created for each country, which is an enormous task that would require access to micro data on consumption patterns and prices in all countries.

person unit is treated the same or, in terms of the Buhmann at al. (1988), income raised to the zero power. One way or another then, an equivalence scale is implicitly or explicitly selected.[21]

2.2.4 Conversion to a basic currency: exchange rates or Purchasing Power Parities (PPPs)?

Comparing incomes in different countries requires the use of exchange rates or PPPs to convert to a common currency. Because of currency trading and other issues such as goods and services, like health care that are not widely tradable across nations, and differences in goods-specific taxes within countries (like the VAT) and exchange rates, even three-year averages as employed by the World Bank's Atlas Method may not be good guides to living standards. They measure total currency flows, not purchasing power.

The computation of PPPs involves the collection of price data around the world, and the computation of a price index or a particular weighting scheme that combines the national price estimates with shares of a country-specific market basket.[22] The technique most often used is to start with one year of common PPPs (say 2005 or 2011) and then use domestic price indices to bring annual data to a common year. In so doing, the estimation of PPPs faces many challenges including urban-rural price differences within nations and the definition of common baskets across nations. Most analysts use a single PPP exchange rate per country, ignoring any market basket or price difference for various parts of the distribution.[23]

But PPPs, like wine, differ substantially by vintage. The latest round of price comparisons, 2011, yields quite different PPPs for large nations such as China, India, and Indonesia compared to the 2005 round. This makes one suspicious about starting with one set of PPPs and extrapolating, as argued by Ravallion (2012), but critiqued by Inklaar (2013). Extrapolating forward from the 2005 PPP using country price indices does not produce the same results as taking the 2011 PPPs and pricing back to a given year in the same country.[24] The main reason is that the 2011 PPPs increased the real incomes of China and India by substantial amounts, meaning that the two billion people in these nations now have higher

[21] The ATG includes quite a large number of Ginis based on both per-capita and per-household income in its inequality series.

[22] The pioneers in this exercise were Kravis et al. (1975), which led to the creation of the Penn World Tables, collected by Heston et al. (2002). A new, more thorough, and wide-reaching group, the International Comparison Program (ICP) has taken on the task by coordinating national statistical offices to produce more comparable PPPs.

[23] Deaton and Dupriez (2011) suggest that reweighting market baskets to reflect consumption patterns of the poor makes little difference in PPPs.

[24] Using the new PPPs for 2011, one finds a huge drop in poverty at $1.25 a day, falling by almost half, according to some analysts (Dykstra et al. 2014; Chandy and Kharas 2014). But the $1.25 per day weighted average poverty line will also change given the new PPPs. Hence, poverty will likely be lower using the new PPPs, but not as low as these estimates suggest. Joliffe and Prydz (2015) argue that if one can ignore the urban–rural price differences in the 2011 PPPs (which were adjusted for in 2005), the $1.25 per day poverty line would rise to $1.92 in 2011, and if so world poverty may even have increased with the new PPPs, despite the fact that they say on page 24 that "Indeed, income and consumption levels are about 24 percent greater on average when using the 2011 PPP data, suggesting that the world is much richer than extrapolations of the 2005 PPP data led us to expect."

living standards than was previously realized. Regional and world poverty and inequality estimates are sensitive to these changes.[25]

2.2.5 Basic Inequality measures

Finally, one has to realize that different measures of inequality may give different results. The most popular one-number inequality estimator is the Gini coefficient. But while it is used by almost every paper on inequality, it is only one index among many. The Gini does not track changes in the top or bottom of the income distribution as well as do the Theil or Atkinson indices, respectively.[26] For instance, the changes in Indian and Chinese incomes mentioned above would show much larger change in inequality if one used the Atkinson measure instead of the Gini measure. More importantly, changes in the Gini can come from either the top end of the distribution (say the 90th percentile growing faster than the median or 50th percentile) or from the bottom of the distribution (say the 50th percentile growing faster than the 10th percentile). For many important questions, such as the effects of inequality on growth, changes at the top can have an entirely different effect than changes at the bottom of the distribution (Voitchovsky 2005, 2009; OECD 2014).

2.2.6 Overall importance of adjustments and data harmonization

The three items that go into the calculation of levels and trends in multiple country, regional or even world inequality (or world poverty estimates either absolute or relative) are the absolute levels of income in each quintile in each country (and especially for the bottom quintile for poverty), the trends in inequality in each country, and the PPP. Changes in any or all of these components are important in making such calculations. For instance, take the 2011 ICP results, which significantly increased real incomes in China and India. If income distributions remained the same in both nations, and if the measures of incomes and consumption and their distribution were the same in both nations, the PPP adjustment would be all that is needed. But we know that income inequality in China has grown quite rapidly since 1980, and especially from 2007 to 2012 according to Xie and Zhou (2014), but less so in India, where national consumption surveys are used for inequality and poverty measurement. The ATG and WDI both have approximately the same estimates of Indian consumption inequality from 1990 to 2008 or 2010 and the Gini rises here by about 10 percent, from 30.9 to 33.9 in WDI (based on 3 observations) using national consumption data.[27] In the ATG, they combine a series for India from 1983 to 1997 with 11 observations by Ravallion (2001) with the WDI figures, but with more observations.

[25] For instance, see Milanovic (2012) who recalculates world inequality with the 2005 estimates; and soon, one imagines, with the 2011 estimates. Most recently, Deaton and Aten (2014) have argued that the 2011 series are much closer to reality than the 2005 series which appear to be an outlier and for reasons they clearly explain. Ravallion (2014b) offers a different explanation. Joliffe and Prydz (2015) focus on World Bank world poverty estimates, and do not directly address world inequality estimates. Of course, nationally estimated Ginis do not depend on PPPs, but if real incomes in China, India and Indonesia rose appreciably relative to other nations using the 2011 PPP's, any attempts to combine these nations with others in a regional or larger poverty or inequality measures will have different results using 2011 PPPs compared to pricing up 2005 PPPs

[26] Of course, the Atkinson index relies on income that may be weighted in different ways according to the level of inequality aversion, meaning there is no single Atkinson index.

[27] The poverty estimate from national Indian consumption and expenditure data sets have been severely criticized by Deaton and others (see Deaton and Kozel 2005; Deaton and Drèze 2009; Deaton 2011).

The ATG and WDI use different estimates of Chinese income inequality, with the Gini rising from 32.4 to 42.1 between 1990 to 2010 in the WDI, compared to a rise from 32.7 to 41.5 from 1990 to 2001 in the ATG, which is based on one study by Wu and Perloff (2005) These results can be compared to the various estimates in Xie and Zhou (2014, Figure 1), who find inequality in China rising from about 30.0 in 1985 to 53.0 in 2007 and 61.1 in 2011.[28]

In summary, and to be fair to the World Bank and its serious and committed analysts, there was until recently little effort or interest in harmonization of welfare aggregates such as various measures of income and consumption. Each nation was treated on its own measurement basis and suggestions for improving economic performance, inequality, or poverty were mainly country specific. In contrast, PovcalNet was explicitly designed to use the definitions and welfare aggregates "used in the countries" and then to apply a PPP-adjusted "global" poverty line. It is only recently that ex-post harmonization of data has become a feature of middle income country analysis as in Latin America by the Socio-Economic Database for Latin America and the Caribbean (SEDLAC) and LIS in its Middle Income country data project. More such work needs to be done in East Asia, Africa, and Southern Asia, in particular.[29] And a new report (Jolliffe et al. 2014) suggests that the Bank will need these data to measure changes in global poverty and gauge improvements in the prosperity of the bottom 40 percent of people in each country over the next 20 years, suggesting large scale efforts to improve the comparability of household surveys worldwide. Hence, new pressure for better and more comparable data will be self-imposed by the World Bank.

If one is to use PovcalNet/WDI as a harmonized and comparable data sets and for the new World Bank aims, these critiques must be brought to bear. Estimates of the number of people living below an absolute poverty line and real income inequality in the two largest nations on Earth are inextricably linked to the levels and distributions of income (or consumption) in each nation and how they have changed, as well as the PPPs used to combine them into one comparable data set.

3 Income and poverty estimates from PovcalNet and the World Development Indicators (WDI)

3.1 Basic description and overview

The current versions of the WDI and PovcalNet data sets are dated April 14, 2015 (http://data.worldbank.org/data-catalog/world-development-indicators) and were compiled by Shaohua Chen of the World Bank Research Department. The primary WDI are in fact compiled from officially-recognized international sources. In all its manifestations, the WDI

[28] One can also look at the LIS which has used harmonized household income surveys in both China and India but, so far, for one period only. Their India income Gini is 49.1 (for 2004) and the Chinese Gini is 50.5 (for 2002). While LIS does not yet have trend data for these two important nations, their results argue that Chinese and Indian inequality are much closer here than they are in the WDI and ATG, and that Indian consumption inequality is far below its harmonized level of income inequality, consistent with other critiques of Indian data mentioned in the footnote above.

[29] The Europe Central Asia division in the World Bank does have a standardized database for most of Europe and Central Asian countries (former Communist countries, plus Turkey), but it is not available publicly. The Middle East and North Africa have a number of standardized surveys made by the Economic Research Forum Cairo, available on the internet (http://www.erf.org.eg/cms.php?id=erfdataportal).

presents the most current and accurate global development data available, and includes not only national, but also regional and global estimates. The data cover the time period between 1960 to 2014, nearly 250 nations, and over 1,300 indicators, including various measures of inequality (Ginis, quintile shares) and poverty (fraction living below $1.25 per day and $2.50 per day) as well as a number of other useful indicators

The list of topics addressed by the WDI is long and deep including agriculture and rural development, economic growth and aid effectiveness as one might imagine, but also climate change and environmental quality estimates, as well as educational achievement, health estimates and other variables broken down by age and gender. Additional variables include public finance and external debt, trade, urban development and infrastructure investments, as well as labor, social protection and social development.

Perhaps most germane to inequality and poverty researchers, the WDI's social development data cover child labor hours for paid work and gender disparities, measured using data on key topics such as education, health, labor force participation, and political participation. Data on immigrant stocks flows and remittances, as well as refugees and asylum seekers are also available.

A bevy of over 30 measures of educational progress for girls and boys, including enrollment, completion rates and other data (for primary, secondary and tertiary schooling), schooling persistence (fraction in and out of school by age), grade attainment, grade repetition, literacy rates by ages, and teacher training are listed. One could combine these with a similarly large number of health estimates (including birth and death rates by age and gender, maternal deaths, fraction with prenatal care, malnutrition, teenage birth rates, chronic diseases such as HIV and tuberculosis, and the need for and availability of contraceptive devices) to add additional shape and substance to the United Nations famous Human Development Index (United Nations 2015), were the entire matrix filled in for all nations.

Indeed the Millennium Development goals and progress toward them in health, nutrition and population are easily charted using the WDI, where data is available. In many cases like the under-5 mortality rate, and adolescent fertility rates, almost all nations have estimates from 1995–2014; but in others such as prenatal health care coverage and the contraceptive prevalence rate are much spottier and less frequent.

Still one must be impressed with the growing numbers of measures of human progress to which poverty and inequality may be compared. These measures are much harder to collect and keep frequent in developing nations, compare for instance to the OECD's Better Life Index (OECD 2015), but the longer term goals and intent are very similar.

Both the PovcalNet and WDI poverty and inequality estimates are based on household microdata of various sorts, but these microdata are not available to researchers. Rather, one can access only the harmonized metadata. In fact, the WDI covers a wide variety of indicators, health, hardship, nutrition, social protection and many others as mentioned above. But in keeping with the spirit of these reviews and their focus on traditional measures of poverty and inequality, we limit our analyses here to these.

The relationship between PovcalNet and the WDI is a first point of basic understanding.[30] PovcalNet is a tool for analyzing world poverty based on the WDI, but the WDI also

[30] PovcalNet is designed and managed by the staff of the Development Research Group (DECRG), in a small team managed by Shaohua Chen in the poverty and inequality unit of DECRG, while the WDI team sits in the Data Group managing by Neil Fantom. Assembly of the underlying household survey data of PovcalNet is undertaken under the auspices of the Bank's Global Poverty Working Group which brings together the PovcalNet team and country- and regional-level counterparts in the World Bank's Poverty Global Practice, and which compiles country-level data and assesses these for international comparability.

has its own set of poverty measures and contains data that PovcalNet does not. Poverty and income inequality measures in the WDI include income shares held by various percentiles of the distribution and poverty headcounts and poverty gaps at national poverty lines with corresponding estimates of rural and urban poverty at national poverty lines, in addition to the $1.25 and $2.00 per day measures in PovcalNet.

PovcalNet is an online tool to analyze poverty-related aspects of WDI data in a cross-nationally comparable framework. "PovcalNet therefore is the source of the Bank's official global, regional and internationally comparable country level poverty estimates published in the WDI."[31] Alternatively, one may bypass PovcalNet and download the underlying WDI data. Here, WDI will refer to the Excel file and PovcalNet will refer to the online tool. WDI is one large (72 MB) Excel file with 10 individual spreadsheets. One of the sheets is the Data sheet. Other sheets contain supporting materials, such as variable codes, but also information on changes to the series made in 2011, 2012, and 2013 as well as other types of information. The entire data set and all supporting materials are contained in a single Excel document.

3.2 User friendliness

The primary benefit of the WDI data set is that it is so comprehensive. But that is also its primary drawback and what makes using the data difficult. WDI contains a wide variety of indicators of inequality or, more broadly, development across space and time. Specifically, 1,356 indicators, 247 countries, and 52 possible years yield a data set with over 17 million cells that could be filled.[32] Each indicator must also be described according to various criteria, including, but not exclusive to its source, statistical interpretation, and topic area (environmental, economic, health, etc.). The size of the data is emblematic of the effort used to create it and because of its metadata nature users must take it as fact, meaning it is almost impossible to see how a user could systematically check for accuracy and reliability without direct access to the underlying microdata. Analyzing the data set is made more difficult by the very thing that makes the data set so useful, its comprehensiveness.

An experienced user might find the data set in its current form ideal for analysis, but lay users will not. In its current form, the WDI is best employed by experienced users. This should be stated on the website. We also recommend that the data documentation be separated from the data set and placed in a text document, not a spreadsheet as it is now. To improve transparency, it should be made clear on the WDI website that PovcalNet is an online tool to analyze WDI data and separately, on the PovcalNet website, that the underlying metadata may be downloaded from the WDI website. Further, the website where one can download the WDI data should have a link to the PovcalNet website.

According to its website, "PovcalNet is an interactive computational tool that allows you to replicate the calculations made by the World Bank's researchers in estimating the extent of absolute poverty in the world." Users may analyze the entire spectrum of development

[31] http://iresearch.worldbank.org/PovcalNet/index.htm

[32] One can also begin with the type of welfare indicator, say poverty or inequality, and the information about underlying household survey data for each country can be found in PovcalNet by double clicking the name of country. For example, if you select Albania within PovcalNet, you will get a pop up window that displays the detailed information about the household surveys, CPI, and so on, which are used to estimate poverty and inequality measures for Albania in PovcalNet. See http://data.worldbank.org/data-catalog/world-development-indicators.

indicators in a way that is simple to understand. While it may not be the preferred method of analysis for experienced users, we believe it excels as a method of analysis for most users.

PovcalNet is, like the WDI data, missing a single document that would explain to users what the data is and how it may be used. While there is a section on the website on methodology and the introduction section directs users to read the background paper, neither of these easily or simply walks users through frequently asked questions. The inclusion of such a document would improve the usability of the data. A more useful example would be the type of manual that is provided by ATG, as described below.

Even better would be to follow the practice of including both the methods by which well-being is measured (income or consumption definition and adjustments) and then the exact programs used to generate their summary inequality estimates as is done by LIS in its Key Figures spreadsheets (http://www.lisdatacenter.org/data-access/key-figures/). From here, the user could reconstruct or deconstruct any definition of income or poverty and other adjustments for the question they are asking. Something akin to such a system will be necessary for the new aims of comprehensive global poverty and inequality measurement (Jolliffe et al. 2014).

3.3 Analytic issues, evaluation transparency, and related issues

The WDI is a huge data set, but here we are most interested in their mix of consumption and income inequality data sets. While that brings to mind the evaluation of cross country comparability and multi-country poverty and inequality mentioned above, it raises other issues as well. First and foremost, one must realize that the WDI income inequality measures are largely based on a set of PovcalNet data explicitly focused on calculating poverty, or better, focused on the lower tail of the income distribution. Indeed, in the lower tail, where there is little capital accumulation, consumption, and income data sets are very comparable and consumption may indeed be preferable (Ravallion 2014a). But the closer one comes to the top of the distribution, the more unlikely it is that income and consumption provide the same measures of inequality. The first issues to consider are with consumption itself. For example, the Gini coefficient for a "basic needs" definition of current consumption (excluding imputed rents and the flow of services from durables) can be far below a consumption Gini using a more comprehensive definition of welfare (including for instance, imputed rents on housing and durables). And, as mentioned above, given a broadly based definition of consumption including flows from housing and durables, one finds average propensities to consume of only about 65 percent of disposable income at the top of the U.S. income distribution, suggesting considerable savings for such households and making income a far better measure of capacity to consume than consumption itself the higher the percentile point in the distribution (Fisher et al. 2014).[33]

Further, if one were interested, for instance, in which countries consumption inequality was measured as compared to, say, income inequality, one would have to go through a detailed review of each WDI national data point to determine the answer. In some cases there are multiple sources of inequality estimates within one nation and both data sets could be used to produce inequality estimates. For example, ATG lists several series for both China and India, and articles like the one cited above by Xie and Zhou (2014) ought to also be consulted.

[33] We comment below on top income data series and how they need to be incorporated in both WDI and the ATG data sets.

Take the important case of India within the WDI. All of the India estimates from ATG are from consumption data sets. Annoyingly, the WDI does not indicate whether it uses consumption or income unless one digs deep into each nation's documentation. In comparison, the ATG indicates that the World Bank Gini data for India comes from consumption. But then, which consumption data set? We suspect, the National Household Consumption/Consumer Expenditure data set, which is part of the wider set of national sample surveys (NSS).[34] The documentation from both the WDI and the ATG states, "This [ATG] data set consists only of the Gini coefficients that have been calculated from actual household surveys. It uses no Gini estimates produced by regressions or short-cut methods." But the ATG does not say whether the Ginis were calculated by the WDI or not, as compared to being calculated from the Indian data set by the Indian authorities and then reported to the WDI. And it does not say if bracketed (grouped) data or microdata were used to create the historical estimates.

4 All the Ginis (ATG)

4.1 Basic description and overview

Branko Milanovic, of the Graduate Center at the City University of New York (CUNY) has assembled (virtually) all the Ginis in the world that are of high quality and put them into one large spreadsheet, along with a very good, simple 20-page user's guide. ATG covers the years 1950 to 2012, with 164 countries included and over 3,000 separate Ginis. ATG is purely a secondary source compiled from eight separate sources, which are used to create a single standardized Gini variable. The eight sources are subdivided into four data sets with Ginis calculated from the direct access to the microdata: LIS, SEDLAC (Latin America), SILC (European Union), and the World Bank's ECA (Eastern Europe and Central Asia) database. The ATG also includes a fifth series called "INDIE" which numbers eight data sets taken from eight separate research articles, systematically covering one nation each but using microdata to which the ATG does not always have access. These are all shown in Table 1.

The other three data sets provide pre-calculated Ginis, most often from access to microdata, but not always. One is the World Income Distribution (WYD)[35] database, and the other two are PovcalNet and the WDI above, and the United Nations University World Institute for Development Economics Research (UNU-WIDER) database, also known as WIID (reviewed in this issue by Jenkins 2015). In this context, the first five data sets listed in Table 1 may be thought of as "primary" meaning the estimates come entirely from microdata and the other three may be thought of as " primary and secondary" as not all of the estimates come directly from microdata in the WYD, PovcalNet/WDI, or the WIID data collections.

From this, ATG creates a set of "preferred" coefficients – "Giniall" – based on selections from the eight sources. There is a preference ordering for the Ginis, a sort of overall quality ranking used to make these choices, but ATG also provides the data from each Gini so that

[34] See http://www.indiastat.com/civilsuppliesandconsumeraffairs/4/householdconsumptionconsumerexpenditure/281123/stats.aspx and http://mospi.nic.in/Mospi_New/site/inner.aspx?status=3&menu\id=31.

[35] The database was constructed by Milanovic and Yitzhaki (2002), which offers decompositions, is available at http://go.worldbank.org/6F2DBUXBE0

Table 2 Composition of Variable Giniall by Welfare Aggregate and Recipient (number of observations)

	Income		Expenditures		
	Per Person	Per Household	Per Person	Per Household	Total
Net	590	95	350	19	1054
Gross	456	273	252	8	989
Total	1046	368	602	27	2043
	1414		629		2043

Note: All PovcalNet/WDI welfare aggregates treated as "net"

Source: "All the Gini Data sets Description," Table 1 (p. 5)

every researcher can decide to use only one source, to combine two or three or more, or to combine all of them in any order. This flexibility will be valuable to any user of the ATG. While a detailed narrative description is provided for how the coefficient is created in the first place, the code used to do so is not. This is a small oversight that could be easily corrected. Nonetheless, the underlying eight sources of Gini are provided, which would allow a user to create a single, standardized Gini coefficient according to their own specifications. Milanovic chooses all the INDIE results, and he frankly admits that he hopes to get more of them, then LIS, SEDLAC, SILC, etc., in the order given in Table 1 (derived from the ATG Table 1). The PovcalNet/WDI where "most" of the data sets are based on microdata are rated second from last in this quality rating (but contributing only 9.3 percent, or 189 of the 2,043 final observations in Giniall). More worrisome is the WIID/WIDER data set, the last- or worst-quality-rated data set, where only "some" of the estimates are based on microdata, but where 27.2 percent, 555 of the 2,043, of the observations in Giniall are found.

The data set indicates not only the Gini, but also the type of Gini, especially those used in Giniall. Dummy variables indicate whether the Gini was derived from household or per capita data, income or expenditure data, and gross consumption or disposable income. Table 2 below also suggests that 31 percent of Giniall figures come from 'expenditure data.'[36] Only half are from net after-tax income or expenditures, the other half from gross income (which means post-transfer but not post-tax) or gross expenditures. Further, 19 percent of the data points are based on a per household basis, while the rest are on a per capita basis.

The good news is that all of this summary information is reported in the database description by the ATG. Some examples are provided that show how inequality is increasing in the United States (more on that below) using Ginis derived from various sources within the ATG database, but also and more importantly perhaps, for Germany, where inequality is either increasing or decreasing, depending on the source. The somewhat limited ability to compare different types of Ginis within countries is also acknowledged. And finally, by definition, only the Gini is shown, meaning that other measures of inequality including decile ratios and other indices sensitive to the top or bottom of the distribution are not included.

[36]This raises the sticky point about how consumption of durables is or is not treated. If only expenditures are recorded, the results are very different than if durable consumption is also somehow included, be it from housing, autos, appliances, or livestock.

The strength of the Gini is its usefulness for a one number summary of inequality which is both easily explained and understood, but its weakness is the same one number and so trends in Ginis make it hard to understand which part of the distribution is changing – the top or the bottom or both?

4.2 User friendliness

In terms of user friendliness, ATG transparency is good, but could be improved. Links are provided in the PDF documentation to the original source databases. While this is helpful, it is but one necessary component and more detail should be provided. For example, on p. 13 of the data set description, there are links to find the original data sources that are compiled in the ATG data set. We clicked on the link to the PovcalNet database found in the documentation and then clicked on data for Albania. The next screen that one is faced with asks us to select the survey years, monthly poverty line, and PPP rate. Default figures are preselected for us. If we use the preselected figures, then the resulting Gini coefficients are the exact same as in the ATG. This is good. However, what would happen if the preselected figures change and/or the user alters these figures according to their own specifications? While one real strength of the Gini is that it is invariant to these choices one still wants to know particular specifications from each of the original data sources, but additional information on exactly how the data in the ATG is derived, beyond links to the data, would be helpful.

The PDF description is a helpful document that is easy to read and understand. It is relatively short (16 pages) and is divided into sections organized around helpful and instructive questions, like "what is this database," "where to find the original (source) databases," and "variables in All the Ginis." The sections flow in order of priority to the user. The description supports the data in a way that is intuitive for even the most lay user. The actual data file is also easy to understand and use. The file is available from the website in one Stata file that is about 2 megabytes in size. We would recommend that an option be made available to download the file in CSV format for users without access to a statistical software package. This is a small suggestion that does not detract from the main value: it is easy to understand for even the most lay user. Specifically, the variable codes and labels are easy to understand even if one were to not read the PDF description and the file may be used with little effort or confusion the moment one opens it up.

4.3 Analytic and substantive issues

In terms of analytics, Tables 1 and 2 set off a host of red flags, most of which were previewed above in Section 2. There are no equivalence scales except for the polar cases of per capita income (no economies of scale) or per household "unadjusted" incomes (complete economies of scale). Expenditure data is mixed with income data in some fashion and also mixed with consumption data. The general tendency is that income inequality is understated when using expenditure/consumption inequality.

The addition of the INDIE estimates provides even more uncertainty – some are limited in years and many in concept as well. For instance, the U.S. ATG series are gross annual cash income per household taken from the standard CPS series and unadjusted for household size. Critically, the U.S. definition of gross annual cash income includes cash transfer income, but does not subtract taxes. These are different from other data sets (for instance, the LIS, EU-SILC, and Gini project series) in that the others also include taxes and near-cash

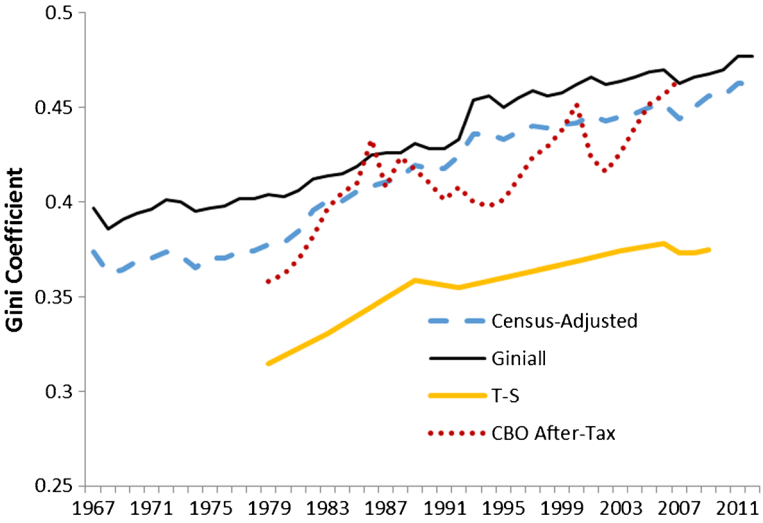

Fig. 1 Four Measures of Income Inequality in the United States. Sources: T-S: Thompson and Smeeding (2012), Net Equivalized Income (NEI), as in the LIS and Canberra Report. Census: DeNavas-Walt et al. (2012, Table A-3), gross money income adjusted for household size. CBO: Congressional Budget Office (2011, Figure 11). Giniall: Milanovic spreadsheet, taken from all ATG and therein from the INDIE data set based on DeNavas-Walt et al. (2012, Table A-2); gross money income unadjusted for household size

income like food stamps and housing allowances. What difference does it make when one is using one of these series or the series in the ATG?

To illustrate the issues that are concerning to us, we explore inequality in the United States using four measures, as shown in Fig. 1. The four measures are the ATG Giniall and three additional income concepts for the United States based on U.S. Census data, published by Kenworthy and Smeeding (2014). The sources are cited in the table and explained below. All three measures begin with the same Current Population Survey (CPS) data but then undergo some types of imputations or matching with other administrative data sets on earnings or taxable incomes.

The U.S. Census Bureau's money income measure includes cash incomes received on a regular basis (exclusive of certain money receipts such as capital gains) and before payments for personal income taxes, but gross of income transfers such as social security. This is the most commonly referenced income measure and the longest series, dating back to 1967 for households, with adjustments for household size.[37] This measure suggests the income inequality Gini for the United States increased from .37 in 1979 to .44 in 2007 and .46 in 2012. In contrast, the Giniall measure is based on the same series, but unadjusted for changes in household size. It rises from .40 in 1979 to .46 in 2007 and then to .48 in 2011.

[37] As specified in the original documentation in footnote 22 (DeNavas-Walt et al. 2012), the household adjustment used by the Census Bureau, and replicated here, uses an equivalence adjustment based on a three-parameter scale. For details on the three–parameter scale, see Short et al. (1999), as cited in Current Population Reports, P60-216, U.S. Census Bureau, October 2001, <www.census.gov/prod/2001pubs/p60-216.pdf>

Hence, equivalence adjustments produce different levels of income inequality, but virtually the same trend.[38]

Thompson and Smeeding (2012), T-S in the figure, calculate Net Equivalized Income (NEI). They start with gross money income as above. They then add near-cash transfer income not included in money income, such as food stamps and housing benefits, and refundable tax credits, including the Earned Income Tax Credit (EITC) and the child tax credit. Next, they subtract direct taxes, namely state and federal income taxes and the employee share of payroll (social insurance) taxes. They then adjust for differences in household size using an equivalence scale, dividing net income by the square root of household size. This income definition is closest to the Gini Project, EU-SILC, Luxembourg Income Study (LIS), and Canberra (2001) definitions employed by most rich nations. But this series excludes income with top codes, so it misses the rapid growth in incomes at the top of the U.S. distribution. It also excludes capital gains and employer benefits, such as health insurance and pensions, which are important income sources in the United States. According to this series, the Gini increased from .32 in 1979 to .37 in 2007. This is a much lower level of inequality than in either the Giniall or Census-adjusted series, and with a somewhat flatter trend since the early 1990s.

The third measure shown in Fig. 1 is from the U.S. Congressional Budget Office (CBO 2013). The CBO merges CPS household survey data with tax records, so it gives us a more accurate picture of incomes at the very top of the distribution.[39] According to this measure, the Gini for household income increased from .37 in 1979 to .49 in 2007. The level of inequality is above the T-S measure, and it increase more rapidly than does the Giniall or the Census-adjusted measures. And finally, because of the inclusion of capital gains and losses, the series in Fig. 1 is less smooth than the others.

Because of income top-coding and the presence of a few extremely high income households in the public use sample, it is difficult to use the Current Population Survey (adjusted or unadjusted Census money income or T-S's NEI) to accurately estimate inequality at the top of the income distribution. In recent years, a number of studies have demonstrated that much of the growth in U. S. inequality since the 1970s has been isolated to the top few per-

[38] It should be noted that the CPS data were redesigned in the early-1990s, which led to a jump in the Gini in money income inequality and which are smoothed over by most analysts, including those in Fig. 1, by equating the 1993 and 1994 Ginis at the 1993 inequality level.

[39] The CBO income measure includes wages, salaries, self-employment income, rents, taxable and non-taxable interest, dividends, realized capital gains, cash transfer payments, and retirement benefits plus taxes paid by businesses (corporate income taxes and the employer's share of Social Security, Medicare, and federal unemployment insurance payroll taxes) and employees' contributions to 401(k) retirement plans. Other sources of income include all in-kind benefits (food stamps, school lunches and breakfasts, housing assistance, and energy assistance in all years). Then it subtracts all federal taxes. Individual income taxes are attributed directly to households paying those taxes. Social insurance, or payroll, taxes are attributed to households paying those taxes directly or paying them indirectly through their employers. Corporate income taxes are attributed to households according to their share of capital income. Federal excise taxes are attributed to them according to their consumption of the taxed good or service. Finally, one should note that the most recent CBO series includes the value of health insurance benefits received from government or employers at cost. This inclusion is unlike any other data set reviewed here and reduces the rate of growth of the CBO income measure substantially. For more, see Johnson and Smeeding (2014).

centiles of the distribution.[40] To the extent that the top few percentiles are driving inequality, Gini coefficients (or other inequality measures) calculated with the CPS using NEI or Census money income understate the level of inequality at any point in time and possibly the trend toward greater inequality over time in the United States. The Congressional Budget Office's comprehensive income measure, while only shown here through 2007 (or with new definitions and methods to 2010 only, which we do not show), and suggests that inequality from 1993 to 2007 was driven almost exclusively by gains in the income of households at the 95th percentile and higher (CBO 2011: Figure 9).

So why go through all these comparisons? If the purpose is to argue that inequality in the United States is rising or not, all the data sets yield the same conclusion. If the question is by how much it is rising, that depends on the series used. Equivalence-adjusted or per household incomes produce lower measures of base inequality and a flatter pattern of increase in the U.S. data. On the other hand, the CBO series with the more comprehensive income and a more accurate top end income measure suggests a steeper rise in inequality than all the other series. And so, if one asked which data set series yields the lowest or the highest increase in inequality, different series would produce different answers. If the top incomes are driving inequality, then the CBO series (which already shows some rapid uptick through 2007) is the one shown above to use for comparisons since the early 1990s.[41] Suppose one were to use these data to calculate a world income distribution where all countries (indeed, all unit records where possible) were converted to PPP terms, one would face a more difficult choice, as the mean and median incomes for these series also differ substantially, and by quintile as well as overall (Kenworthy and Smeeding 2014).

Finally, ATG is not yet *all* the Ginis. Two new sources of secondary data have come online recently, each of which offers some advantages for inequality analyses in rich and middle-income countries. The most similar to the ATG's Giniall is by Toth (2014) from the "Growing National Inequalities Impacts (Gini – of course!) Project." These Gini Project data cover 30 nations for the 1980 to 2010 period prepared to a common net income definition (the Canberra 2001 definition of income) adjusted for household size. The US series is the same as the T-S line in Fig. 1 above. Here one finds not only all of Europe including the Baltic and Eastern European nations like Romania, but also Canada, the United States, Korea, and Japan. The series will improve the ATG in the next round for these nations. They correspond closely to the similar series in Brandolini and Smeeding (2009), which also follows an ATG-Giniall-like process by combining several data sources for 12 rich nations.

Recognizing the importance of different economic inequality measures based on different units and types of measurement, Tony Atkinson and Salvatore Morelli (2014) recently made available a new set of long-run trend data on 5 different measures of economic inequality across 31 different countries, including earnings, overall income, and wealth inequality, as well as poverty and top income shares. This new database, *The Chartbook of*

[40] Readers should also see Burkhauser et al. (2011, 2012), where they compare top-coded estimates of inequality formerly produced by the Census Bureau with "corrected" estimates based on the full, not top-coded data set.

[41] The World Top Income Database is very good only for changes at the top of the distribution, as it omits all redistribution, is based on tax units and tax records and is not adjusted for household size. See Morelli et al. (2014) and Burkhauser et al. (2012) as well as the discussion below at the end of this section.

Economic Inequality, heralds the 21st century, where not just income but also wealth and earnings are increasingly important for understanding the nature and degree of economic inequality and its differences across nations.

4.4 The top incomes issue

Most germane to both the WTG and the ATG, and to all the survey data set series, is the need to find ways to include, integrate or at least or reference top income inequality data series in their data sets. We know that it is difficult because tax series usually do not include non-taxed incomes, use different units of account, and so on (Burkhauser et al. 2012). But we also know that sampling and non-sampling error reduces the usefulness of household income surveys for measuring shares of income growth at the top of the income distribution. Indeed, the income inequality series which shows the fastest rate of growth in U. S. inequality is not shown above in Fig. 1, but comes from the U.S.'s best wealth survey, the Survey of Consumer Finances, which explicitly oversamples the very top of the income and wealth distribution and in so doing captures more high income individuals than any other United States income or wealth survey (Fisher et al. 2015).

5 Conclusions

Assessing data set quality is a difficult task. While quality may be measured by the reliability of the indicators, quality of documentation, accessibility of the data, and transparency and replicability of measures, none of these are objective measures and measuring one component often overlaps with the measurement of another. Further, it is not always advisable or even possible to develop a data set that would enable a user to replicate the underlying data. While we have discussed ways that the three data sets reviewed here could improve their usability, the nature of the data itself will place a certain restriction on how usable and accurate the analyses can ever be. Take for example India, where we seem to have just one single year's income survey and a set of consumption surveys that show a lower level of well-being, and a trend which shows only a modest rise in inequality. The data sets reviewed here also provide different outcome variables. ATG simply and exclusively aggregates Gini coefficients. WDI aggregates over a thousand various development and inequality measures, of which the Gini is only one such measure. PovcalNet is the basis for world poverty estimates, even if the WDI also contains national poverty estimates based on each nation's own definitions and data.

In the end, we are struck by the limitations of comparability of inequality measures across these and other data sets at this point in history, but also encouraged by the progress that has been made in measurement of poverty and inequality in less rich nations, and the new World Bank call for more comparability going forward (Jolliffe et al. 2014). The ATG is to be complimented for being up front about the ways in which its series are constructed and the sources it is derived from, as well as whether the estimates come from income or consumption, even if the definitions of neither are given in most instances. Reliance on series of INDIE or independent estimates as a first source suggests that the other available sources leave much to be desired. In the WDI/PovcalNet case, one can less easily find out if the original series are based on consumption or income data and there is no microdata access. Clearly, the more homogeneous the methods and the nations compared, the better such comparisons will be. However, moving to multi-country estimates of either absolute poverty or income inequality is hazardous at best at this time. The emergence of a new

2011 set of PPPs may or may not reduce worldwide absolute poverty once adopted by the World Bank (Joliffe and Prydz 2015), but these same PPPs should almost certainly compress multi-country Asian and world income inequality if employed in, say, the ATG framework.

The good news is that comparisons are rapidly expanding and improving. The bad news is that in certain key counties like India, the data may not yet be up to the uses to which they are being put. Populous countries like China, India and Indonesia which also show rapid income growth, using either GDP growth figures or surveys, with the new PPPs must be more carefully assessed in terms of their real living standards and distribution. It is encouraging to see the World Bank turn its resources and efforts in this direction.

Acknowledgments The authors would like to acknowledge the support of the Institute for Research on Poverty and the Assistant Secretary for Planning and Evaluation of the US Department of Health and Human Services. They would also like to thank Shaohua Chen, Branko Milanovic, Francisco Ferriera, Stephen Jenkins, Nora Lustig, and Valerie Kozol for comments on earlier drafts. We also thank David Chancellor and Dawn Duren for assistance with graphs, figures, and editing. The opinions herein are our own and not those of any other organization or sponsor. Finally, we alone are responsible for all errors of omission and commission.

References

Adelman, I., Morris, C.T.: Economic growth and social equity in developing countries. Stanford University Press, Stanford (1973)

Ahluwalia, M.S.: Inequality, poverty and development. J. Dev. Econ. **3**(4), 307–342 (1976)

Atkinson, A.B., Brandolini, A.: Promises and pitfalls in the use of secondary data-sets: income inequality in oecd countries as a case study. J. Econ. Lit. **39**(3), 771–800 (2001)

Atkinson, A.B., Morelli, S.: Chartbook of Economic Inequality - Economic Inequality over the Long Run. accessed at www.chartbookofeconomicinequality.com (2014)

Atkinson, A.B., Rainwater, L., Smeeding, T.M.: Income distribution in the OECD countries. OECD Social Policy Studies. No. 18. OECD, Paris (1995)

Begue, J.: Remarques sure une etude de l'OCDE concernant la repartition des revenus dans divers pays. Econ. Stat. **84**, 97–104 (1976)

Brandolini, A., Smeeding, T.M.: Income inequality in richer OECD countries. In: Salverda, W., Nolan, B., Smeeding, T.M. (eds.) The Oxford Handbook of economic inequality. Oxford University Press, Oxford (2009)

Buhmann, B., Rainwater, L., Schmauss, G., Smeeding, T.M.: Equivalence scales, well-being, inequality, and poverty: sensitivity estimates across ten countries using the Luxembourg Income Study (LIS) database. Rev. Income Wealth **34**(2), 115–142 (1988)

Burkhauser, R., Feng, S., Jenkins, S.P., Larrimore, J.: Recent trends in top income shares in the United States: reconciling estimates from March CPS and IRS tax return data. Rev. Econ. Stat. **94**(2), 371–88 (2012)

Burkhauser, R., Feng, S., Jenkins, S.P., Larrimore, J.: Estimating trends in US income inequality using the current population survey: the importance of controlling for censoring. J. Econ. Inequal. **9**(3), 393–415 (2011)

Canberra Group: Final report and recommendations. The Canberra Group: Expert group on household income statistics. Ottawa (2001)

Chandy, L., Kharas, H.: What do new price data mean for the goal of ending extreme poverty? May 5th Brookings at http://www.brookings.edu/blogs/up-front/posts/2014/05/05-data-extreme-poverty-chandy-kharas (2014)

Chen, S., Ravallion, M.: Absolute poverty measures for the developing world. In: Measuring the real size of the world economy. Chapter 20. World Bank, Washington, DC (2012)

Coulter, F., Cowell, F., Jenkins, S.P.: Equivalence scale relativities and the extent of inequality and poverty. Econ. J. **102**(414), 1067–1082 (1992)

Deaton, A.: Measuring development: different data, different conclusions? In: Measure for measure: How well do we measure development? Proceedings of the 8th AFD-EUDN Conference, Paris (2011)

Deaton, A., Aten, B.: Trying to understand the PPPs in ICP2011: Why are the results so different? NBER Working Paper No (2014)

Deaton, A., Drèze, J.: Food and nutrition in India: facts and interpretations. Econ. Political Wkly **44**(7), 42–65 (2009)
Deaton, A., Dupriez, O.: Purchasing power parity exchange rates for the global poor. Am. Econ. J.: Appl. Econ. **3**(2), 137–66 (2011)
Deaton, A., Grosh, M.: Consumption in designing household survey questionnaires for developing countries. In: Grosh, M., Glewwe, P. (eds.) Designing Household Survey Questionnaires for Developing Countries: Lessons from 15 Years of the Living Standards Measurement Study, vol. 3. World Bank, Washington, DC (2000)
Deaton, A., Kozel, V.: Data and dogma: the great Indian poverty debate. World Bank Rese. Obs. **20**(2), 177–99 (2005)
Deininger, K., Squire, L.: A new data set measuring income inequality. World Bank Econ. Rev. **10**(3), 565–591 (1996)
Deininger, K., Squire, L.: Economic growth and income inequality: reexamining the links finance and development. Financ. Dev. **34**, 38–41 (1997)
Deininger, K., Squire, L.: New ways of looking at old issues. J. Dev. Econ. **57**(2), 259–287 (1998)
DeNavas-Walt, C., Proctor, B.D., Smith, J.C.: Income, poverty, and health insurance coverage in the United States: 2011. U.S. Census Bureau. Current Population Reports, pp. 60–243. U.S. Government Printing Office, Washington, DC (2012)
Dykstra, S., Kenny, C., Sandefur, J.: Global absolute poverty fell by almost half on Tuesday. Center for Growth and Development, Washington, DC. May 2, 2014. http://www.cgdev.org/blog/global-absolute-poverty-fell-almost-half-tuesday (2014)
Ferreira, F., Ravallion, M.: Poverty and inequality: the global context. In: Salverda, W., Nolan, B., Smeeding, T.M. (eds.) The Oxford Handbook of economic inequality. Oxford University Press, Oxford (2009)
Fisher, J., Johnson, D., Smeeding, T., Thompson, J.: The Demography of Inequality: Income, wealth and consumption, 1989-2010. University of Wisconsin-Madison (2015)
Fisher, J., Johnson, D., Smeeding, T.M.: Inequality of Income and Consumption: Measuring the Trends in Inequality from 1984-2011 for the Same Individuals. Rev. Income Wealth, in press (2014)
Friedman, M.: A theory of the consumption function. Princeton University Press, Princeton (1957)
Gottschalk, P., Smeeding, T.M.: Cross-national comparisons of earnings and income inequality. J. Econ. Lit. **35**(2), 633–687 (1997)
Gottschalk, P., Smeeding, T.M.: Empirical evidence on income inequality in industrialized countries. In: Atkinson, A.B., Bourguignon, F. (eds.) Handbook of Income Distribution, vol. 1. Elsevier-North Holland Publishers, New York (2000)
Hagenaars, A.J.M., De Vos, K., Zaidi, M.A.: Poverty statistics in the late 1980s. Research Based on Micro-Data, Luxembourg (1994)
Haig, R.M. In: Haig, R.M. (ed.): The concept of income: economic and legal aspects. Columbia University Press, New York (1921)
Heston, A., Summers, R., Aten, B.: Penn World Table Version 6.1. Center for International Comparisons at the University of Pennsylvania (CICUP) (2002)
Inklaar, R.: Price levels and economic growth: making sense of revisions to data on real incomes: a comment. Rev. Income Wealth **59**(4), 614–622 (2013)
Jenkins, S.P.: World Income Inequality Databases: an assessment. (this issue of Journal of Economic Inequality) (2015)
Johnson, D.: Measuring Consumption and Consumption Poverty: Possibilities and Issues, presented at workshop entitled, "Reconsidering the Federal Poverty Measure." American Enterprise Institute (2004)
Johnson, D., Smeeding, T.M.: Income distribution and inequality: measurement issues. In: Wright, J.D. (ed.) International Encyclopedia of the Social and Behavioral Sciences, 2nd ed. International Encyclopedia of the Social & Behavioral Sciences. 2nd, vol. 11, pp. 732–738. Elsevier, Oxford, UK (2014)
Jolliffe, D., Prydz, E.B.: Global poverty goals and prices: How purchasing power parity matters? Development Research Group, Poverty and Inequality Team. Policy Research Working Paper 7256. http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2015/05/05/090224b082e3fedf/3_0/Rendered/PDF/Global0poverty0power0parity0matters.pdf (2015)
Jolliffe, D., Lanjouw, P., Chen, S., Kraay, A., Meyer, C., Negre, M., Prydz, E., Vakis, R., Wethli, K.: A Measured Approach to Ending Poverty and Boosting Shared Prosperity: Concepts, Data, and the Twin Goals. https://openknowledge.worldbank.org/bitstream/handle/10986/20384/9781464803611.pdf (2014)
Kenworthy, L., Smeeding, T.M.: The United States: high and rapidly-rising inequality. In: Nolan, B., Salverda, W. (eds.) Inequality and Its Impacts, vol. 2. Oxford University Press (2014)
Kravis, I.B., Heston, A., Kenessy, Z., Summers, R.: A system of international comparison of gross product and purchasing power. World Bank, Washington, DC (1975)

Lakner, C., Milanovic, B.: Global income distribution: from the fall of the Berlin Wall to the Great Recession. The World Bank Development Research Group, Poverty and Inequality Team. World Bank Policy Research. Working Paper No 6719 (2013)
Lopez-Calva, L.F., Lustig, N.: Declining inequality in Latin America: a decade of progress? Brookings Institution Press (2010)
Lustig, N., Lopez-Calva, L.F., Ortiz-Juarez, E.: Declining inequality in Latin America in the 2000s: the cases of Argentina, Brazil, and Mexico. World Dev. **44**, 129–141 (2013)
Meyer, B., Sullivan, J.: Winning the war: poverty from the Great Society to the Great Recession. Brook. Pap. Econ. Act. **45**(2), 133–183 (2012)
Meyer, B., Sullivan, J.: Consumption and income inequality and the great recession. Am. Econ. Rev. **103**(3), 178–183 (2013)
Milanovic, B.: True world income distribution 1998 and 1993: first calculation based on household surveys alone. Econ. J. **112**(476), 51–92 (2005)
Milanovic, B.: Worlds apart: measuring income inequality. Princeton University Press (2011)
Milanovic, B.: Global inequality recalculated and updated: the effect of new PPP estimates on global inequality and 2005 estimates. J. Econ. Inequal. **10**(1), 1–18 (2012)
Milanovic, B., Yitzhaki, S.: Decomposing world income distribution: does the world have a middle class? Rev. Income Wealth **48**(2), 155–178 (2002)
Morelli, S., Thompson, J., Smeeding, T.M.: Post-1970 Trends in withincountry inequality and poverty: Rich and middle income countries. In: Atkinson, A., Bourguignon, F. (eds.) Handbook of income distribution, vol. 2. Elsevier Press, UK (2014)
OECD: Divided we stand: why inequality keeps rising. OECD, Paris (2011)
OECD: Jobs, wages and inequality. Quality review of the OECD database of household incomes and poverty and the OECD earnings database. OECD, Paris (2015)
OECD: Better Life Index. http://www.oecdbetterlifeindex.org/ (2014)
Paukert, F.: Income distribution at different levels of development. Int. Labour Rev. **108**(2), 97–125 (1973)
Ravallion, M.: Growth, inequality and poverty: looking beyond averages. World Dev. **29**(11), 1803–15 (2001)
Ravallion, M., Chen, S.: The developing world is poorer than we thought, but no less successful in the fight against poverty. Q. J. Econ. **125**(4), 1577–1625 (2011)
Ravallion, M.: Price levels and economic growth: making sense of revisions to data on real incomes. Rev. Income Wealth **59**(4), 593–613 (2012)
Ravallion, M.: The Luxembourg Income Study. (this issue of Journal of Economic Inequality) (2014a)
Ravallion, M.: An exploration of the ICP's new global economic landscape. National Bureau of Economic Research. Working paper No (2014b)
Sala-i-Martin, X.: The world distribution of income: falling poverty and...convergence, period. Q. J. Econ. **121**(2), 351–397 (2006)
Sawyer, M.: Income Distribution in OECD Countries. OECD Economic Outlook–Occasional Studies (1976)
Short, K., Garner, T., Johnson, D., Doyle, P. Experimental poverty measures: 1990 to 1997, U.S. Census Bureau, current population reports, consumer income, pp. 60–205. U.S. Government Printing Office, Washington, DC (1999)
Simons, H.C.: Personal income taxation. University of Chicago Press, Chicago (1938)
Smeeding, T.M., Weinberg, D.H.: Toward a uniform definition of household income. Rev. Income Wealth **47**(1), 1–24 (2001)
Thompson, J., Smeeding, T.M.: Country case study - USA. In: Jenkins, SP., Brandolini, A., Micklewright, J., Nolan, B. (eds.) The great recession and the distribution of household income. Oxford University Press, Oxford (2012)
Tóth, I.G., Tóth, I.G.: Revisiting grand narratives of growing income inequalities: Lessons from 30 country studies. In: Nolan, B., Salverda, W., Checchi, D., Marx, I., Mcknight, A., Van de Werfhorst, H.G. (eds.) Changing inequalities and societal impacts in rich countries: thirty countries experiences. Oxford University Press, Oxford (2014)
United Nations: Human Development Reports. United Nations Development Program, New York (2015). http://hdr.undp.org/en/content/human-development-index-hdi
U.S. Congressional Budget Office: Trends in the distribution of household income between 1979 and 2007. Washington, DC: U.S. Congress. http://www.cbo.gov/sites/default/files/cbofiles/attachments/10-25-HouseholdIncome.pdf (2011)
U.S. Congressional Budget Office: The distribution of income and federal taxes, 2011. Washington, DC: U.S. Congress. http://www.cbo.gov/sites/default/files/cbofiles/attachments/49440-Distribution-of-Income-and-Taxes.pdf (2013)

Voitchovsky, S.: Does the profile of income inequality matter for economic growth? Distinguishing between the effects of inequality in different parts of the income distribution. J. Econ. Growth **10**(3), 273–296 (2005)
Voitchovsky, S.: Inequality and economic growth. In: Salverda, W., Nolan, B., Smeeding, T.M. (eds.) The Oxford Handbook of economic inequality. Oxford University Press, Oxford (2009)
World Bank. http://data.worldbank.org/about/country-and-lending-groups (2014)
Wu, X., Perloff, J.: China's income distribution, 1985-2001. Rev. Econ. Stat. **87**(4), 763–775 (2005)
Xie, Y., Zhou, X.: Income inequality in today's China. Proc. Nat. Acad. Sci. **111**(19), 6928–6933 (2014)