

What is new in PWT 8.1?

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This document outlines the changes to PWT with the release of version 8.1 as compared to version 8.0. As a result, whatever is described in the documentation of version 8.0 can be assumed to have stayed the same, unless remarked upon here. Most importantly, this version does not yet incorporate the new purchasing power parities (PPPs) for the year 2011 that were released in 2014.¹ Furthermore, the period covered (1950-2011) and the vintage of National Accounts data are unchanged.² PWT 9.0 will incorporate the results from ICP 2011 and an updated and extended set of National Accounts data; it is scheduled to be released (no earlier than) the fourth quarter of 2015.

PWT 8.1 incorporates two main changes, namely a modification to the PPPs for the year 2005 to correct for biases in the original PPPs, and the introduction of new variables to provide additional perspectives on the comparative level of living standards and welfare. In addition, we use this version to fix a number of (mostly smaller) problems. Some of these have been brought to our attention by attentive users, for which we are very grateful. We close with two clarifications to the 8.0 documentation.

Modified PPPs for 2005

Ever since the PPPs of the International Comparison Program (ICP) 2005 were published in World Bank (2008), questions have been raised about their reliability. The ICP 2005 PPPs implied that major developing countries, such as India and China, had much smaller real GDP levels than had been estimated based on earlier

¹ See <http://icp.worldbank.org>.

² This means that National Accounts revisions that have occurred since the release of PWT 8.0, such as the upward adjustment of Nigeria's GDP by 90 percent or the revisions to EU GDP levels following the implementation of the ESA 2010 accounting rules, are not incorporated in PWT 8.1.

PPP estimates. More generally, the largely upward revisions to PPPs (and thus downward revision to GDP levels) for many lower-income countries led to substantial debate on whether the ICP 2005 results could be trusted, see e.g. Deaton (2010), Deaton and Heston (2010), Feenstra, Ma, Neary and Rao (2013) and Ravallion (2013). Indeed, when PPPs from ICP 2005 were first incorporated in PWT – in version 7.0 – adjustments were made to correct for cross-country productivity differences in public services and an urban bias in consumption prices collected in China.

New fuel was added to the debate by the release of ICP 2011 because it led to large *downward* changes to PPPs in developing countries compared with estimates based on ICP 2005, see Deaton and Aten (2014). In terms of methodology and price sampling practices, ICP 2011 was an important improvement over ICP 2005. Given this, Inklaar and Rao (2014) construct a counterfactual set of PPPs based on the data collected for ICP 2005, but harmonizing the methodology with that of ICP 2011 and correcting for price sampling biases in ICP 2005. As a result, the PPPs of this counterfactual are likely a more accurate reflection of relative prices across countries for the year 2005. The closer methodological alignment with ICP 2011 methods will make for a more straightforward comparison in PWT 9, when both sets of PPPs are included. Moreover, Inklaar and Rao (2014) find that the counterfactual 2005 PPPs lead to a very similar cross-country pattern of prices and income levels as ICP 2011.³

For PWT 8.1, we therefore incorporate the main results of Inklaar and Rao (2014). Note that PWT does not (and never has) directly used the PPPs as generated in ICP, see ‘PWT 8.0 – a user guide’. Most importantly, ICP first compares prices within regions and then across regions in a two-step aggregation procedure (leaving the within-region PPPs unaffected) – mostly for administrative reasons. PWT compares prices across all countries in a single step which is better motivated from an index-number perspective. This means that we incorporate adjustments that affect the detailed product-level PPPs as pointed out by Inklaar-Rao and then apply the aggregation methods that were also used in 8.0. Most

³ Though for individual countries, differences are often still substantial.

adjustments are made to prices of household consumption products and mostly in the regions of the world with many developing countries: Africa, Asia-Pacific and Western Asia.

Inklaar and Rao (2014) motivate and detail each of their adjustments in relation to the original ICP 2005 results. Here we provide an overview of the relevant adjustments to the ICP data on relative prices in 2005 and the direction of their impact; the interested reader is referred to Inklaar and Rao (2014) for a more detailed discussion of each adjustment:

1. ***Bias: Product and country selection.***⁴ The between-region comparison of prices in ICP 2005 was based on a limited set of countries and a list of products that was not representative of typical products consumed in lower-income countries.⁵ We correct for country-selection bias through an upward adjustment to household consumption prices in Asia-Pacific of about 7 percent. We correct for product-selection bias through a downward adjustment to household consumption prices in Africa by 25 percent, in Asia-Pacific by 21 percent and in Western Asia by 12 percent. This has a significant impact on overall GDP PPPs as household consumption accounts for 59 percent of GDP, on average.⁶
2. ***Bias: Chinese prices.***⁷ Chinese consumption prices were adjusted downwards by 20 percent in PWT7.0 to correct for the fact that for ICP 2005, China mostly surveyed prices in urban or suburban areas, while there is plausible evidence that rural prices were considerably lower. This same adjustment is made in both 8.0 and 8.1, so this is not a source of differences between 8.0 and 8.1.
3. ***Methodology: Between-region comparison of rents.***⁸ Comparing rents for dwellings across regions in ICP 2005 used comparatively extensive

⁴ See also Deaton (2010).

⁵ ICP not only follows a two-step aggregation procedure (which PWT does not), but also a two-step data collection process. Prices are first compared within a region, based on a regional product list, and then across regions, based on a global product list.

⁶ This excludes expenditure on (imputed) rents; see adjustment 2.

⁷ See also Feenstra, Ma, Neary and Rao (201).

⁸ See also Heston (2013a) .

information about characteristics of dwellings in different countries. Yet much of this information was not widely available, potentially biasing estimated (implicit) prices, especially if the information is not missing at random. We therefore restrict ourselves to the method used in ICP 2011, which only requires information on (imputed) expenditure on rents, the number of dwellings and some basic amenities; all this information is widely available. This reduces the relative price for dwellings downward by 9 percent in Africa, by 23 percent in Asia-Pacific, 37 percent in Latin America and upwards by 6 percent in Western Asia. Expenditure on (imputed) rents accounts for 6 percent of GDP, on average.

4. **Methodology: Productivity adjustment for public services.**⁹ The prices of government consumption expenditures are typically not observable, so rather than comparing the price of output of these services, ICP has compared prices of inputs and specifically relative wages of civil servants, teachers and healthcare professionals at various qualification levels. But possible cross-country differences in labor productivity of these workers, even with the same qualifications (e.g. due to difference in available capital), means that relative wages might overstate the output price differences this method aims to proxy. Hence, in ICP 2005 an adjustment was made for productivity differences to the wages comparisons within the regions of Africa, Asia-Pacific and Western Asia. Productivity differences within other regions were ignored however and the productivity differences were also not accounted for in comparing wages across regions. In PWT 7.0, a single global productivity adjustment was made based on a cross-country production function estimate of the output elasticity for capital for 2005 (see Heston, 2013b). Given the difficulty in arriving at reliable output elasticities from estimated production functions, the potential for cross-country variation in those elasticities, and the improved estimates of capital in PWT 8.0, we modify the approach used in PWT 7.0, 7.1 and 8.0. We apply the non-parametric approach that was also followed in ICP 2011, using PWT8.0 estimates of the capital stock per worker and country-specific estimates of the share of capital income in GDP (see Chapter 4 in World Bank,

⁹ See also Heston (2013b).

2014). This new productivity adjustment implies smaller adjustments to relative wages than applied in PWT 7 and PWT 8.0. As a result, prices for government consumption are, on average, lower in Western Asia (-40 percent), Africa (-24), Asia-Pacific (-14) and Latin America (-10) but higher in the CIS (+19); differences in the Eurostat/OECD region are typically smaller. Government consumption expenditure accounts for, on average, 14 percent of GDP.

Figure 1, CGDP^o per capita in PWT 8.1 versus PWT 8.0 in 2005

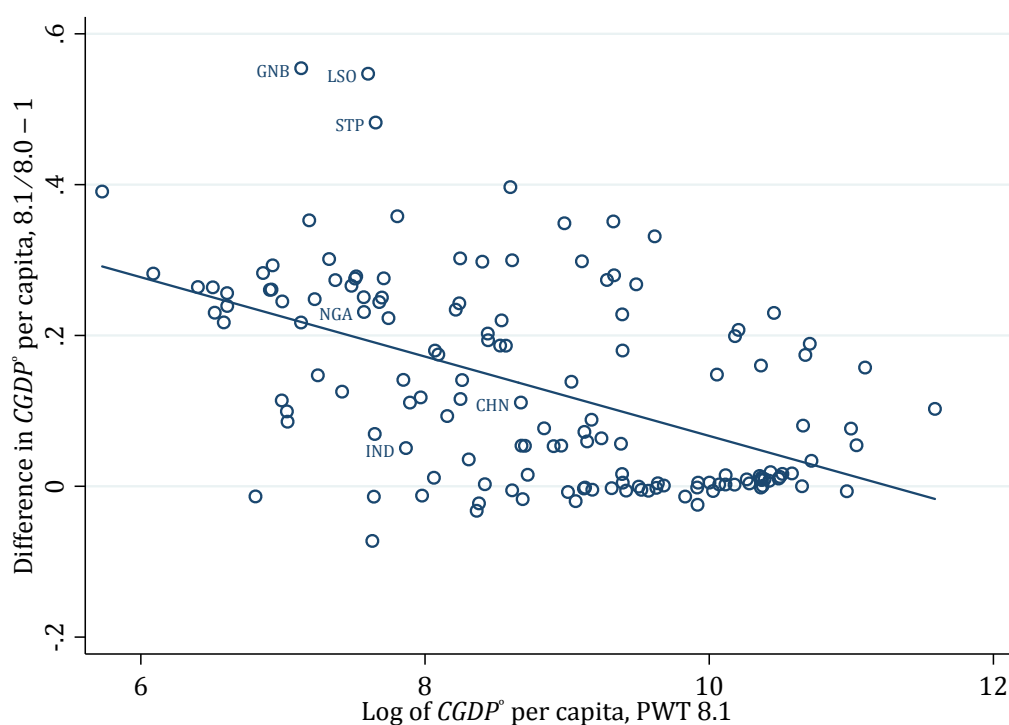


Figure 1 shows the net impact of modifying the 2005 PPP data for the level of CGDP^o per capita in 2005. For most countries, income levels relative to the US increase and the differences between the PWT 8.1 and 8.0 are larger, and especially so in lower-income countries. These differences are similar in magnitude to the difference between the original and counterfactual ICP 2005 results, as reported in Inklaar and Rao (2014). Also note the group of countries for which the differences are very small, which are the countries in the Eurostat/OECD region; the only source of differences for that group of countries is the productivity adjustment for public services.

Comparing living standards

In PWT 8.0, we introduced a measure of real GDP from the output side, GDP^o , that provides a more accurate measure of the productive capacity of an economy than previous real GDP measures in PWT by accounting for differences in the terms of trade. The traditional real GDP measure from earlier PWT versions was relabeled ‘real GDP from the expenditure side’, GDP^e , and suggested as a measure of comparative living standards. The underlying argumentation, based on Feenstra et al. (2009) and Kohli (2004), was that beneficial terms of trade have no effect on productive capacity, but do imply higher spending power and hence living standards. The decision to keep the nominal value of GDP in the numerator of GDP^e was made for purposes of continuity with previous PWT versions and to be in line with typical convention of comparing GDP and GDP per capita levels.

Yet recent literature has suggested new approaches for comparing welfare across countries, based in part on the type of information provided in PWT. In PWT 8.1, we therefore provide additional variables that can be useful ingredients in comparing living standards and broader measures of welfare. Our first point of reference is the work of Jones and Klenow (2011), who follow in the tradition of Nordhaus and Tobin (1972) by moving ‘beyond GDP’, i.e. by considering a broader range of measures impacting well-being than average consumption or GDP levels. Their thought experiment is to ask by how much consumption of a random person in the United States would have to be adjusted to make this person indifferent between living in the US or in another country. This involves taking into account differences between the two countries in the level of consumption, as well as in life expectancy, leisure and income inequality. PWT lacks the information to provide a comprehensive Jones/Klenow ‘consumption-equivalent’ measure, but in PWT 8.1 we do provide a total real consumption measure, which is an important element. It is computed as:

$$(1) \quad CCON = \pi_C q_C + \pi_G q_G = (CSH_C + CSH_G) \times CGDP^o,$$

where π_i is the reference price and q_i the quantity of good i (ignoring country subscripts). The variables after the second equality sign are defined as in PWT 8.0, namely the share of household consumption in $CGDP^o$ (CSH_C), and the share of

government consumption in $CGDP^o$ (CSH_G). Like in Jones and Klenow (2011), the new $CCON$ measure is the sum of real private and public consumption, valued at current PPPs. From a conceptual point of view, the choice to include public spending views this spending as not fully or partially wasteful. A large benefit of this choice is that it improves international comparability. The mix of individual and collective expenditure on health and education differs greatly across countries for institutional reasons, such that it is very unlikely that private expenditures reflect the choice for overall consumption of health and education services.

The Jones and Klenow (2011) flow-utility approach to comparing welfare is fairly comprehensive but it is a point-in-time measure, which does not take into account the link between today's consumption choices and future consumption possibilities. In contrast, Basu, Pascali, Schiantarelli and Servén (2014) provide a dynamic perspective on welfare measurement, in the tradition of Weitzman (1976). This dynamic perspective does require assuming a representative consumer (so ignoring inequality) and not accounting for differences in life expectancy. The thought experiment of Basu et al. (2014) is to ask how well off the representative consumer from the US would be if she were moved – with her particular set of preferences – to another country with different endowments and a different future path of consumption, investment, labor and capital. So while Jones and Klenow (2011) leave aside information on investment as irrelevant for current consumption, Basu et al. (2014) also consider how current investment (and other factors) have an effect on future consumption.

The main result of Basu et al. (2014) – similar in spirit to that of Basu and Fernald (2002) – is that total factor productivity (TFP) is a useful measure of welfare, in combination with the initial capital stock. The main contribution of Basu et al. (2014) is to show that one only needs to assume an optimizing representative consumer who is a price taker in factor and product markets to arrive at this result. In other words, this result requires no assumptions on the form of technology or product markets. The intuition is straightforward: if more can be spent without having to sacrifice more leisure (i.e. provide more labor input) or more future consumption (i.e. investment to build up the capital stock), then a consumer will

be better off.¹⁰ More specifically, Basu et al. (2014) show that welfare in their model equals the present value of current and future TFP plus the (per capita) capital stock. They also show that in an open economy, an appropriate, welfare-relevant TFP measure requires either accounting for terms of trade (as we do in our CGDP^o measure), and the net stock of foreign assets and future path of returns on foreign assets (both much harder to do) or the use of a measure of domestic absorption as output, so the sum of total consumption and investment. A first measure we include based on the work of Basu et al. (2014) is real domestic absorption:

$$(2) \quad CDA = \pi_c q_c + \pi_g q_g + \pi_i q_i = (CSH_C + CSH_G + CSH_I) \times CGDP^o,$$

where I equals investment (gross capital formation).

We follow further in their line of reasoning and also include a new welfare-relevant measure of TFP alongside the TFP measure that was introduced in PWT 8.0. The PWT 8.0 measure, $CTFP$, was in many ways a standard measure, following in the tradition of Solow (1957), Diewert and Morrison (1986), Hall and Jones (1999), Caselli (2005) and Hsieh and Klenow (2010) in assuming an aggregate revenue function or an aggregate production function. To interpret the resulting TFP measure as a measure of technology requires assuming perfect competition and a common production function.

As discussed above, the approach of Basu et al. (2014) does not require either of those assumptions but it does require a TFP measure that is computed differently from the $CTFP$ measure. We therefore include a new welfare-relevant TFP measure based on relative real domestic absorption, CDA , computed as:

$$(3) \quad CWTFP_{jk} = \frac{CDA_j}{CDA_k} / Q_T,$$

where the function Q_T is the relative level of factor inputs, computed in the same way as for the $CTFP$ variable. In other words, the difference between $CTFP$ and

¹⁰ This would also accommodate those who argue that measures of aggregate activity should not be gross measures, but net of the consumption of fixed capital.

CWTFP is that *CTFP* is based on relative real GDP from the output side, while *CWTFP* is based on relative real domestic absorption.

Table 1, Comparison of relative per-capita income and spending and productivity for selected countries in 2005 (US=1)

	<i>CGDP^o</i>	<i>CGDP^e</i>	<i>CCON</i>	<i>CDA</i>	<i>CTFP</i>	<i>CWTFP</i>
US	1.000	1.000	1.000	1.000	1.000	1.000
UK	0.758	0.751	0.764	0.730	1.109	1.068
Germany	0.755	0.702	0.643	0.629	0.877	0.731
Japan	0.748	0.712	0.629	0.664	0.768	0.682
France	0.690	0.672	0.635	0.640	0.948	0.878
Russia	0.282	0.284	0.246	0.234	0.458	0.379
Brazil	0.184	0.181	0.172	0.165	0.438	0.393
China	0.138	0.137	0.100	0.123	0.378	0.335
Indonesia	0.082	0.084	0.076	0.077	0.398	0.373
India	0.062	0.058	0.052	0.057	0.420	0.390

Notes: *CGDP^o* is output-side real GDP, *CGDP^e* is expenditure-side real GDP, *CCON* is real (public and private) consumption and *CDA* is real domestic absorption; these are all compared in per capita terms to the US. *CTFP* is relative productivity, which under perfect competition can reflect relative technology; *CWTFP* can be part of a cross-country comparison of (household) welfare.

Table 1 shows some illustrative outcomes for a set of ten large economies in 2005. The first four columns show GDP, consumption and domestic absorption per capita, relative to the United States; the last two columns show the two relative total factor productivity measures. A first observation is that the relative rankings are almost identical, with only small movements for German, Japan and France. Still, there are notable differences between the different measures. For instance, in most countries, the relative real consumption per capita level is lower than the relative GDP per capita level, a point also noted by Jones and Klenow (2011). A similar pattern also holds for relative domestic absorption, which suggests the current account deficit of the US is the main reason for both this pattern and the

relatively high consumption levels. As a consequence, the ‘welfare-relevant’ *CWTFP* levels are generally lower than the *CTFP* levels.¹¹

Smaller fixes

1. Data on the depreciation rate of fixed capital was added as a separate data file after the release of PWT 8.0. For 8.1, it is integrated in the main PWT files.
2. Export and import PPPs at the level of 6 Broad Economic Categories (BEC) are available for most countries starting in 1984. Before that year, changes in export and import prices from the National Accounts are used for extrapolation. In 8.0, we estimate deflators at the BEC level for all countries using US BEC-level deflators, adjusted for the overall rate of export or import price inflation in each country relative to the US. This approach leads to the same *CGDP^o* series as an approach that would simply use the relative change in overall export and import deflators to extrapolate the PPPs. However, for *RGDP^o*, there is a difference because changes in reference prices affect this variable more substantially. The result is a wedge between *CGDP^o* and *RGDP^o* that is solely driven by the use of US BEC-level deflators. A more cautious approach, which we adopt in 8.1, would simply use total export and import deflators until BEC-level deflators are more widely available for other countries. This change affects *RGDP^o* for years in which extrapolated export and imports PPP are used (i.e. mostly the 1950-1983 period), but only has a notable impact in countries where oil exports are large.
3. For 8.0, the employment-to-population ratios published by the World Bank in the World Development Indicators (WDI) were wrongly interpreted as employment-to-*total*-population ratios, while the ratios are actually given relative to the working-age-population. In correcting for this error, current vintage data from WDI were incorporated, which led to improved employment estimates for Djibouti (ISO code DJI) and St. Vincent and the Grenadines (VCT): previously their employment figures referred to the labor force and now they are proper employment numbers. This leads to substantial downward

¹¹ The broader welfare comparison of Basu et al. (2014) is based on the net present value of current and future *CWTFP* levels, so a higher current level financed by a current account deficit would (in principle) be reflected in lower future levels.

adjustments for these two countries. For a range of other countries the WDI employment data provide better estimates for part of their time series, but this typically leads to adjustments of less than 5 percent.

4. For Germany, data on employment is available since 1950 from The Conference Board's (TCB) Total Economy Database but erroneously, the pre-1991 employment data were not used in 8.0. In 8.1, TCB employment data for the full period is used, thereby extending Germany's employment data back to 1950.
5. In Zimbabwe, rapidly declining export and import prices between 2008 and 2011 in the National Accounts led to a decline in the price level of GDP^o of 63 percent. As a result, real GDP on the output-side (CGDP^o) increased more than threefold, while National Accounts GDP only increased by 41 percent. Given the period of hyperinflation, which peaked in 2008, we have decided to label the period 2009-2011 as an outlier. See the document 'Outliers in PWT8.0' for general criteria in labeling observations as outliers and motivation in other cases.
6. The National Accounts data for a number of countries contained errors in 8.0, which have been fixed in 8.1. This affects the National Accounts data and the GDP series in PWT for, typically, a number of years:
 - GDP growth in Japan from 1969 to 1970 was shown in 8.0 as 36 percent, while the correct figure was 10 percent. The National Accounts data for Japan for the period 1950-1969 have been revised using data published by the Cabinet Office of Japan.
 - GDP growth in Israel from 1968 to 1969 was shown in 8.0 as 54 percent, while the correct figure was 15 percent. The National Accounts data for Israel for the period 1950-1969 have been revised using data published by the Central Bureau of Statistics of Israel.
 - The constant prices National Accounts data for Sudan in 8.0 covered the former territory of Sudan, i.e. before the secession of South Sudan, while the current price data covered the post-secession territory for the full period. In 8.1, the constant price data now also cover the post-secession territory.

- The constant price GDP series for Ethiopia was erroneously omitted from the 8.0 National Accounts data before 1990, while these data were available and used for the PWT GDP series. In the 8.1 National Accounts data, the series is now complete.

Documentation clarifications

1. The National Accounts data file includes two sets of series for China, namely the official national series and the series adjusted based on Harry Wu's research. The official series are shown under ISO code CHN, the adjusted series under ISO code CH2. In the standard PWT8 tables, the National Accounts data as shown for ISO code CH2 are used.
2. To construct PWT's human capital index, we use data on the average years of schooling from Barro and Lee (2013). However, these data are only available at 5-year intervals. In between those observations, we linearly interpolate the average years of schooling; for 2011 we assume that 2010 average years of schooling prevail.

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