PPP Estimates: Applications by the International Monetary Fund

Mick Silver[1]

The International Monetary Fund (IMF) is an international organization of 187 countries that works to foster global monetary cooperation, secure financial stability, facilitate international trade, promote high employment and sustainable economic growth, and reduce poverty. Through its economic surveillance, the IMF tracks the economic health of its member countries, alerting them to risks on the horizon and providing policy advice. It also lends to countries in difficulty and provides technical assistance and training to help countries improve economic management. This work is backed by IMF research and statistics available in publications that include the *World Economic Outlook* (WEO).[2] The WEO focuses on major economic policy issues, as well as on analysis of economic developments and prospects. It presents IMF staff analysis and projections of economic developments at the global level and for major country groups and many individual countries.

The IMF's resources are drawn mainly from member countries' quota subscriptions. Quotas broadly reflect the relative size of each member's economy—for example, the larger a country's economy in terms of output, the larger its quota tends to be. The largest member of the IMF is the United States, with a quota of SDR 37.1 billion (about US$56.7 billion), and the smallest member is Tuvalu, with a quota of SDR 1.8 million (about US$2.8 million).[3] A member country's voting power in IMF decisions is largely determined by its quota subscription, which is the maximum amount of financial resources the member is obliged to provide to the IMF. Quotas also have a bearing on the amount of financing a member can obtain from the IMF (its access limit). When a country joins the IMF, it is assigned an initial quota in the same range as the quotas of existing members that are broadly comparable in economic size and characteristics. The IMF uses a quota formula to guide the assessment of a member's relative position. The IMF has used purchasing power parity (PPP)–adjusted gross domestic product (GDP) measures in its *World Economic*

Outlook since 1993 and, more recently, as an element of the formula used to help guide decisions on the distribution of its members' quotas.[4]

This chapter begins by briefly outlining the IMF's use of the International Comparison Program's (ICP) PPP estimates.[5] The focus then moves to PPP measurement issues that are particularly salient to the IMF's usage. The measurement issues considered include country coverage and the imputation of PPP estimates for member countries not participating in the ICP, PPP estimates for nonbenchmark years, the timeliness and periodicity of PPP estimates and updating mechanisms, country groupings, and transparency. This focus is not to detract from the importance of minimizing measurement errors and biases in weights and price surveys, including issues relating to sampling, data collection, validation, and aggregation methods for the estimates. These matters are adequately covered in preceding chapters. This chapter ends with a brief summary.

Use of PPPs by the IMF

An important use of GDP volume at purchasing power parity (PPP GDP) is as an element of the formula used to help guide decisions on the distribution of the quotas of IMF members. IMF use of PPPs is also naturally pervasive in the research and analytical work of the IMF staff given their concern with monitoring and analyzing levels and changes of macroeconomic indicators across economies and over time for country groups. Their research output can be found in the *IMF G-20 Surveillance Notes, Global Financial Stability Report, Regional Economic Outlook Reports, Staff Position Notes, Working Paper Series,* and *World Economic Outlook,*[6] as well as in external (to the IMF) publications. The account here is limited to the IMF's use of PPP adjustments for the WEO, although the issues raised are indicative of the general use of PPP adjustments, not least because many IMF researchers use the WEO database.[7]

Determining Quotas

The quota subscription of a member country of the IMF not only determines the amount of financial resources the member is obliged to provide to the IMF, the amount of financing it can obtain from the IMF (its access limit), and its share in a general allocation of special drawing rights (SDRs),[8] but also largely determines its voting power in IMF decisions. On April 28, 2008, a large-scale quota and voice reform was adopted by the Board of Governors of the IMF. Its aim was to make quotas more responsive to economic realities by increasing the representation of members, many of which are emerging market economies whose weight and role in the global economy have increased, and, at the same time, giving low-income countries more say in the IMF's decision making. This reform marked the first time GDP calculated with PPP "exchange rates" has appeared as an argument in the debate over the IMF quota formula.[9]

The current quota formula is the weighted average of GDP (weight of 50 percent), openness (30 percent), variability (15 percent), and international reserves (5 percent). For the formula, GDP is measured as a blend of GDP based on a market exchange rate (weight of 60 percent) and on PPPs (40 percent). Both the market exchange and PPP GDP weights are an average of the data of the last three years. The 2008 data set therefore requires GDP data for 2006–08. A compression factor of 0.95 is applied to the linear combination of the four variables to reduce the dispersion of calculated quotas. The previous formula included GDP but measured only at market prices. The new formula is outlined in box 23.1 and the previous one in box 23.2.[10]

The process leading to the adoption of the new quota formula and the rationale for the IMF's inclusion of PPP-based GDP estimates is well documented.[11] The amalgam of market exchange

BOX 23.1 The New Quota Formula

The new quota formula includes four quota variables—GDP, openness, variability, and reserves—expressed in shares of global totals, with the variables assigned weights totaling 1.0. The formula also includes a compression factor that reduces dispersion in calculated quota shares.

The new formula is

$$CQS = (0.5 \times Y + 0.3 \times O + 0.15 \times V + 0.05 \times R)^k$$

where

CQS = calculated quota share;

Y = blend of GDP converted at market rates and PPPs averaged over a three-year period (the weights of market-based and PPP GDP are 0.60 and 0.4, respectively);

O = annual average of the sum of current payments and current receipts (goods, services, income, and transfers) over a five-year period;

V = variability of current receipts and net capital flows (measured as a standard deviation from the centered 3-year trend over a 13-year period);

R = 12-month average over a year of official reserves (foreign exchange, SDR holdings, reserve position in the IMF, and monetary gold); and

k = compression factor of 0.95. The compression factor is applied to the uncompressed calculated quota shares, which are then rescaled to sum to 100.

and PPP GDP weights was justified as capturing the central role of quotas in the IMF's financial operations, for which nominal GDP at market exchange rates is the most relevant, as well as the IMF's nonfinancial activities, for which PPP GDP can be viewed as a relevant way to capture the relative volume of goods and services produced by economies. Yet the inclusion of the PPP GDP and the compression factor was recognized as one of the most difficult aspects of the deliberations (IMF 2008, para. 7). As a result, the Executive Board of the IMF decided to include them in the formula for a period of 20 years, after which their inclusion will be reviewed.

At the IMF's annual meetings in Singapore in September 2006, the membership endorsed a program to modernize and reform quotas and voice. Members agreed to a package of reforms that included a new quota formula, an initial ad hoc increase in quotas for the most underrepresented members, and a second round of ad hoc quota increases based on the new formula. The new formula was the basis for guiding a comprehensive "second round" of quota reform that was agreed on in April 2008.[12]

BOX 23.2 The Previous Five Quota Formulas

Bretton Woods: $Q1 = (0.01Y + 0.025R + 0.05P + 0.2276VC)\,(1 + C/Y)$
Scheme III: $Q2 = (0.0065Y + 0.0205125R + 0.078P + 0.4052VC)\,(1 + C/Y)$
Scheme IV: $Q3 = (0.0045Y + 0.03896768R + 0.07P + 0.76976VC)\,(1 + C/Y)$
Scheme M4: $Q4 = 0.005Y + 0.042280464R + 0.044\,(P + C) + 0.8352VC$
Scheme M7: $Q5 = 0.0045Y + 0.05281008R + 0.039\,(P + C) + 1.0432VC$

where

$Q1, Q2, Q3, Q4$, and $Q5$ = calculated quotas for each formula;

Y = GDP at current market prices for a recent year;

R = 12-month average of gold, foreign exchange reserves, SDR holdings, and reserve positions in the IMF for a recent year;

P = annual average of current payments (goods, services, income, and private transfers) for a recent five-year period;

C = annual average of current receipts (goods, services, income, and private transfers) for a recent five-year period; and

VC = variability of current receipts, defined as one standard deviation from the centered 5-year moving average, for a recent 13-year period.

For each of the four non-Bretton Woods formulas, quota calculations are multiplied by an adjustment factor so that the sum of the calculations across members equals that derived from the Bretton Woods formula. The calculated quota of a member is the higher of the Bretton Woods calculation and the average of the lowest two of the remaining four calculations (after adjustment).

Of note is that including PPP GDP in the formula was facilitated by the updated PPP GDP data, which incorporated the new parity rates published by the International Comparison Program in December 2007. These data reflect substantial improvements in the methodology and consistency of the PPP estimates. Earlier, data quality issues and the coverage of the world's economies had impeded consideration of using the PPP GDP (IMF 2007, 5). The use of the PPP GDP variable in the formula had a significant impact on the distribution of calculated quota shares by increasing those of emerging and developing countries. Table 23.1 presents the *calculated* quota shares under the old and new formulas for the major economies, responsible in total for about 80 percent of the world's PPP GDP. Not all of the differences in shares were the result of the adoption of the PPP GDP. Boxes 23.1 and 23.2 reveal that other factors also influenced the outcomes for calculated

TABLE 23.1 IMF Quota Shares under Different Formulas

	Quota shares		
	Previous five formulas	**New formula**	**Percentage difference: new to previous**
United States	16.284	18.991	16.62
Japan	7.011	8.032	14.56
Germany	6.850	6.227	−9.09
China	6.137	6.390	4.12
United Kingdom	5.240	4.429	−15.48
France	4.129	4.016	−2.74
Italy	3.317	3.336	0.57
Canada	3.065	2.569	−16.18
Netherlands	2.897	1.930	−33.38
Korea, Rep.	2.512	2.245	−10.63
Belgium	2.270	1.504	−33.74
Spain	2.237	2.304	3.00
Singapore	1.929	1.031	−46.55
Mexico	1.841	1.970	7.01
Russian Federation	1.702	2.053	20.62
Ireland	1.660	1.173	−29.34
Switzerland	1.485	1.211	−18.45
Malaysia	1.374	0.859	−37.48
Luxembourg	1.369	0.624	−54.42
India	1.287	1.997	55.17
Australia	1.205	1.321	9.63
Sweden	1.172	0.993	−15.27
Austria	1.129	0.913	−19.13
Brazil	1.069	1.725	61.37
Denmark	1.040	0.853	−17.98
Saudi Arabia	1.030	0.835	−18.93

Source: IMF 2008, table 1.
Note: The quota shares here are derived from the calculated formulas only.

quota shares such as raising the effective weight for the GDP and reducing that for openness. However, the substantive nature of the changes is noteworthy: increases of over 50 percent for India and Brazil and decreases of a similar magnitude for Luxembourg and Singapore. Major economies saw their calculated quota shares change considerably—for example, the United States, 16.6 percent; Japan, 14.6 percent; Germany, –9.1 percent; and the United Kingdom, –15.5 percent.

The PPP GDP was also used as a criterion to identify dynamism by bringing forward expected future growth for those countries most out of line in their PPP GDP. Specifically, emerging market and developing economies whose shares in the global PPP GDP were substantially larger (by more than 75 percent) than their actual pre-Singapore quota shares received a minimum nominal quota increase ("boost") of 40 percent. Among the countries that benefited from the boost were Brazil, India, and Vietnam.

The PPP-based GDP data used for the quota calculations based on the new formula are taken from the WEO database. The WEO PPP-based GDP is derived by dividing a country's nominal GDP in its own currency by its PPP relative to the United States.[13] The WEO PPP-based data are converted into SDR units using the SDR-US$ period average exchange rate. The WEO PPPs are based on ICP data for 2003–05 that were published in December 2007. These data were then extended in the WEO database by using the growth in relative GDP deflators (the deflator of a country divided by the deflator of the United States).

Uses of PPPs in the *World Economic Outlook*

The WEO reports for composite groups of economies a wide range of world, regional, and analytic aggregates of economic indicators. These aggregates are either sums or weighted averages of the individual country indicators. Composites for data relating to the domestic economy, whether growth rates or ratios, are generally weighted by GDP country shares valued at PPP—that is, the nominal GDP divided by the PPP exchange rate.[14] The PPP GDP weights used in the WEO are expressed in international dollars. Exceptions are the results for groups of economies for exchange rates, interest rates, growth rates of monetary aggregates, the external economy, unemployment rates and employment, and the domestic economy for the Euro Area (IMF 2009, 181).[15]

Estimates of regional and world output and their growth, and forecasts thereof, are key macroeconomic indicators reported in the WEO. Because the appropriate weighting scheme may depend on the issue being considered, the WEO reports (in table A.1 of its statistical appendix) alternative measures of world output using both PPP and market exchange rates. The value of world output in 2009 increased from an estimated US$54,864 billion to $68,651 billion when valued at PPP as opposed to market exchange rates. The projected growth in world GDP volume between 2009 and 2014 also differed: 28.7 percent compared with 30.2 percent for GDP at market exchange rates as opposed to PPPs (IMF 2009, 189). Naturally, GDP growth for each country is the same whether exchange rates or PPPs are used. However, the country shares in world GDP used as weights to derive world output growth differ, depending on whether the GDP shares are valued at PPP or market exchange rates.

The weights used in the WEO between rounds are updated by the growth in the relative GDP (the country's GDP deflator divided by the U.S. GDP deflator).[16] However, this approach is not equivalent to the data-rich country price comparisons that constitute an ICP round (see the next section of this chapter).

The weighting system for economies used in the WEO can change over time. For example, table A16 of the April 2009 WEO provides a summary of sources and uses of world savings as a percentage of GDP (IMF 2009). Composites for groups of economies are calculated as the sum

of the U.S. dollar values for the relevant individual economy. This differs from the calculations in the April 2005 and earlier issues of the WEO, where the composites were weighted by estimates of GDP valued at PPP as a share of total world GDP (see the next section).

The IMF's *International Financial Statistics* (IFS) also uses PPP-based weights for some of its regional and global aggregates: global consumer price indexes (CPIs), producer and wholesale price indexes (PPIs/WPIs), GDP volume, GDP deflator, gross capital formation as a percentage of GDP, and final consumption expenditure as a percentage of GDP. The IFS PPP weights are updated and revised from the WEO about every five years for the base years 1953, 1958, 1963, 1970, 1975, 1980, 1984–86, 1990, 1995, 2000, and 2005. The values of the PPP weights of the base years are used for the subsequent intervening subperiod. The updates do not take effect immediately, not least because of the time lag between collecting the survey data for the PPP and their compilation and publication. The most recent update referring to the 2005 PPP weights was updated in the October 2008 WEO, taking effect in the IFS from May 2009 onward. Countries whose weights are not available from the WEO are excluded from the IFS aggregation process.

PPP Measurement Issues of Concern to the IMF

Earlier chapters of this volume have covered a range of technical issues, all of which affect the reliability of the ICP results and all of which are of concern to the IMF. These issues include the reliability of the data used for price comparisons and the GDP expenditure components for the weights, an area in which the IMF actively helps countries.[17] Some more specific issues relevant to the IMF's use of PPPs are described in this section.

Country Coverage

The IMF's use of PPPs relies on estimates provided by the ICP.[18] The last round of survey-based estimates was conducted in 2005, and the next is planned for 2011.[19] Over the history of ICP rounds, the number of participating countries has noticeably increased—from 10 countries in 1970, to 16 in 1973, 34 in 1975, 60 in 1980, and 64 in 1985. After a partial program in 1990, the 1993 participation level reached a new high—118 countries covering all regions of the world for the first time. Although 118 countries participated in the 1993 comparisons, many countries used reduced information surveys that proved to be relatively unreliable, notably China (Deaton and Heston 2008). The 2005 ICP round, on which the IMF bases its PPP GDP variable, covered 146 economies.[20] Indeed, it marked a turning point for many countries because of the significant changes shown in the size of many economies.[21] And yet the IMF, an organization of 187 countries, had to rely in part on an estimation routine for the PPP variable for 36 countries.[22] Particularly serious was the exclusion from the 2005 ICP of all the countries of Central America and the Caribbean and the participation of only 10 countries in South America, mainly because of a lack of resources.[23]

In country coverage, two key issues emerge. The first is to ensure that in subsequent rounds the number of participating countries increases. At this stage, it is too early to comment on the number of countries participating in the 2011 round, although the World Bank expects over 170 countries (World Bank 2010, 23–26, para. 16).

The second issue is to ensure the reliability and integrity of the methods for estimating PPPs for the nonparticipating countries.[24] The World Bank's methodology for estimating PPPs for non-benchmark countries is documented in Changqing and Swanson (2009).[25] Using data for all benchmark countries, researchers estimated regression equation price level indexes (PLIs), defined as the

ratio of PPP GDP (also for PPP private consumption) to a corresponding market exchange rate, normalized with the United States equal to 100. The explanatory variables include GDP per capita in U.S. dollars; imports and exports as shares of GDP (for GDP but not private consumption); ratio of dependents to working-age population; dummy variables for countries in Sub-Saharan Africa, member states of the Organisation for Economic Co-operation and Development (OECD), island economies, and landlocked developing economies; and interaction terms for GDP per capita with the previously mentioned dummy variables.

The value added of these country PPP estimates to the IMF lies not only in their ready availability, but also in their independent derivation as part of the ICP. As with most econometric work, alternative estimates could be generated with different specifications and estimators. However, the availability of these "official" and independently derived estimates allows the IMF to sidestep such issues. What is important to IMF usage is that the estimates, along with an account of their methodology, are available on a timely basis and that some indication is available as to which countries may have very wide prediction intervals.[26] Indeed, for IMF usage one consideration in devising the specification for the model might be ensuring that it is robust to extreme prediction intervals, especially for the larger of the nonbenchmark countries.

PPP Estimates for Nonbenchmark Years

PPP GDP estimates based on ICP benchmark price surveys are available only periodically—the last benchmark rounds were in 1993 and 2005.[27]

PPP benchmark survey-based weights are normally updated at about five-year intervals. Index number theory and international guidelines would advise that the weights be updated more frequently, especially if consumption/GDP component shares are subject to change. If the weights are highly volatile for some groups, a case could perhaps be made for a rolling update. And yet despite these concerns, the infrequency of ICP updates results in a concomitant infrequency of PPP GDP weight updates, unless the PPP GDP figures are based on extrapolated annual figures using benchmark data from the ICP rounds. Extrapolations to provide annual PPPs for a country, as used in the IMF's work, are based on multiplying the country's last round's PPP GDP estimates, relative to the United States, by the country's volume growth in GDP between the last round and the year in question. The resulting volume-inflated measure is then multiplied by the U.S. inflation rate to provide an estimate in U.S. dollars.[28] Countries whose volume estimates are based on weights that change rapidly—say, annually—are less likely to have their PPP GDP estimates drift above the PPP GDP estimate from the next ICP round. Many advanced economies, which constitute much of the quota allocation, compile annually chain-weighted volume GDP estimates.[29] But many other countries fall short of this requirement.

New PPP estimates from new ICP rounds act as benchmarks for these extrapolated estimates. The PPP estimates for the 2005 benchmark year replaced benchmark PPP estimates that dated back to the benchmark figures for 1993 or earlier for most emerging market and developing countries.[30] The revisions to PPP rates as a result of the 2005 round led to a substantial reduction in the PPP-based GDP of some large, fast-growing economies and consequently reduced their estimated contribution to global growth. In the October 2007 issue of *World Economic Outlook*, the IMF's estimate for global growth in 2007 was revised down to 4.7 percent from 5.2 percent, based on the 2005 PPP results. Downward revisions of the PPP-based GDP of two of the world's fastest-growing economies, China and India, were mainly responsible for the overall reduction in global growth estimates. For 2007, China's share of global output was revised to an estimated 10.9 percent (down from 15.8 percent), and India's share declined to 4.6 percent, from 6.4 percent

(Elekdag and Lall 2008). The 2005 ICP round benefited from some significant methodological advances, as outlined in Deaton and Heston (2008), Diewert (2008) and World Bank (2008). The extent of these advances may not be repeated in future rounds.

PPP GDP estimates for nonbenchmark years are available, using different methodologies, in versions of the Penn World Table (PWT), *World Development Indicators* (WDI), and *World Economic Outlook.* Recent research on such estimates, mainly relating to the PWT but also applying to WDI and WEO estimates, have highlighted serious inconsistencies in the results across versions of the PWT[31] (Johnson et al. 2009) and country inconsistencies between growth rates and per capita PPP GDP estimates (Bhalla 2008). A major concern is that the growth rates used to derive estimates for the nonbenchmark years are based on domestic, not international, (PPP) prices and that the share weights of the growth rates are based on some hybrid of international and domestic prices (see also Deaton and Heston 2008). Johnson et al. (2009) demonstrate that economic studies using annual data are generally not "safe" in terms of their robustness to data revisions, except for countries with high-quality data (generally OECD countries). PPP GDP–level data also are not considered "safe" when looking at cross-country comparisons in nonbenchmark years. Johnson et al. find that estimates for smaller countries are more inconsistent and the variability increases as the distance of the data from the benchmark round increases. While there may be deficiencies in the extrapolated estimates, there remains a case for using such estimates on the basis that a weighting system that relies on estimates of annual figures is better than an assumption of no change. The implication for IMF use of these estimates is the need for more frequent rounds and updates of PPP estimates. One possibility in view of their high resource cost is better integration of the ICP methodology with CPI and PPI programs so that price data that could perhaps be used for PPP programs are collected regularly as part of the routine compilation of national statistics. A second possibility is that a "mini" ICP exercise be held between rounds, as is currently under way for the Asia region. But neither of these proposals negates the need to improve the estimation procedures for nonbenchmark years. Proposals for doing so can be found in Deaton and Heston (2008) and Johnson et al. (2009).

Timeliness

PPP estimates are based on intercountry price comparisons for the basic headings of economic activities that comprise GDP—155 for the 2005 ICP round—and their counterpart expenditure weights. Arising from this process are some key aspects of timeliness that are important to the IMF.

First and foremost, it is important to minimize the time lag between the completion of the price surveys and validation of the source data and the compilation of the (regional and global) PPPs. There is a natural time lag between the survey results and publication of the final global results and a trade-off between the reliability and the timeliness of the results. For the 2005 ICP round, the final global results were published in December 2007. The expectation for the 2011 round is that the results will be published during February–June 2014 (World Bank 2010, 23–26, para. 27). For logistical reasons, not all countries, and expenditure components within countries, collect prices over the same period. For the 2011 round, the plan is that the price surveys for household expenditures on goods and services will be conducted in 2011. However, in some small countries in the Caribbean, price surveys for these goods and services will take place in 2012. Price surveys for nonhousehold goods and services (education, health, compensation of government employees, equipment, and construction) will be carried out concomitantly with the compilation of the relevant expenditures data, from early 2011 to the end of 2012 (World Bank 2010, 23–26, para. 26). A "mini" ICP round for Asian countries will be undertaken to update their PPP estimates to a reference year of 2009.

A second aspect of timeliness is the time lag between the period(s) to which the component GDP expenditure data for the basic headings relate and the period(s) to which the price surveys relate. For example, the 2005 ICP round was based on price surveys principally conducted in 2005, although at the time the PPP estimates were compiled, not all countries had 2005 expenditure estimates available for all components of the GDP. Related to this problem is the procedure used to "update" the GDP estimates to 2005 if timely ones are not available.[32]

Finally, another aspect of timeliness is the need to issue estimates for nonparticipating countries and detailed information on their estimation procedures shortly after those of participating countries.

Groupings of Economies

The ICP is organized and executed on a regional basis. In the 2005 round, the regions were Africa, Asia-Pacific, Commonwealth of Independent States (CIS), South America, Western Asia, and the Eurostat-OECD countries, with regional aggregates published for countries in these groups. Membership of the ICP regional groups is related to the ICP sample design, which does not necessarily correspond to the standard regional aggregates maintained by the United Nations,[33] the member state groupings for the UN Regional Commissions,[34] or those used by the various international organizations, including the IMF. For example, countries such as Georgia and the Islamic Republic of Iran do not belong to any of the regional coordinating agencies. Countries such as Chile, the Arab Republic of Egypt, Mexico, and Sudan belong to more than one regional group. However, because PPP estimates for basic headings and GDP are provided for individual economies, it is not essential that the IMF and ICP groupings be the same; using the core data, the IMF can aggregate country PPP GDP in whatever manner it deems appropriate.

Large Economies

For large economies such as China and India, country-specific methodological issues may draw attention. For example, Deaton and Heston (2008) point out that price collection for China is limited to 11 cities and their mainly urban surrounding areas. Although the figures were adjusted to make them more geographically representative, it has been argued that the failure to include lower rural prices led to an overstatement of the PPP GDP deflator, suggested by Deaton and Heston to be by a little less than 10 percent. India, by contrast, has a long tradition of collecting urban and rural prices, and other large developed economies have smaller rural populations that to a large extent shop at urban outlets or chains.

Transparency

Because PPP estimates are used to help guide decisions on the distribution of members' quotas, which in turn help determine members' financial obligations, the allocation of a general increase in SDRs, and voting power in IMF decisions, there has to be transparency as to how the results are derived and disseminated. For the 2005 ICP round, a detailed operational manual and methodology handbook were usefully published on the ICP website (World Bank 2005, 2007), and similar publications are planned for the 2011 round. These publications do not incorporate and benefit from the many methodological innovations and twists and turns in the detail of the work as it proceeds. However, methodological papers are published as the round proceeds, mainly driven by members of the Technical Advisory Group and authors commissioned by the World Bank to examine particular issues. For the 2005 round, a quarterly ICP e-newsletter was published

to inform users about new developments and regional issues. Meanwhile, each region produced a separate publication that contained not only its results, but also details about region-specific methodological issues. The final results of the ICP round were then published, along with technical details (World Bank 2008). In a very real sense, the IMF relies on the professionalism of the ICP program for the GDP PPP estimates. The integrity of such figures lies in the care and attention given to collection of source data and compilation methods, and openness about the methods employed ensures that the integrity of the results can be defended.

Summary

The PPP GDP estimates produced by the ICP are important to the IMF; they are an element of the formula that helps to guide decisions on the distribution of members' quotas, as described in this chapter. Furthermore, much of the analysis and monitoring of output and other key macroeconomic indicators across countries, and for regional, global, and analytic groups over time, require PPP estimates. The account in this chapter of the use of PPP-adjusted estimates in the WEO is indicative of such work. Because the IMF naturally seeks minimization of errors and bias in the source data for the PPP estimates and aggregation techniques,[35] the rigor of the discussion of such issues in the preceding chapters is welcome. The issues of particular concern to the IMF's usage are raised in this chapter and include country coverage and PPP estimates for member countries not participating in the ICP; PPP estimates for nonbenchmark years; the timeliness and periodicity of PPP estimates; groupings of economies; and transparency.

NOTES

1. The views expressed herein are those of the author and should not be attributed to the IMF, its Executive Board, or its management. Acknowledgments are extended to Yuri Dikhanov (World Bank), Yutong Li (IMF), D.S. Prasada Rao (University of Queensland), Frederic A. Vogel (World Bank), Kim Zieschang (IMF), and members of the IMF Finance and Research Departments (notably Sheila Bassett and Toh Kuan, respectively) who reviewed the paper.

2. Information on IMF research, statistics, and the WEO is available on the IMF's website, http://www.imf.org/external/index.htm, under the tabs "Research," "Data and Statistics," and "Publications." Copies of the WEO can be downloaded from the IMF website under "Publications." See also http://www.imf.org/external/ns/cs.aspx?id=29.

3. SDRs are special drawing rights.

4. Members' calculated quota shares using the quota formula are distinct from their actual quota shares.

5. Earlier accounts of the IMF's use of PPP estimates include Gulde and Schulze-Ghattas (1993) and Wagner (1995).

6. These are all available at http://www.imf.org/external/research/index.aspx.

7. Available for the October 2009 *World Economic Outlook* at http://www.imf.org/external/pubs/ft/weo/2009/02/weodata/index.aspx.

8. The SDR is an international reserve asset created by the IMF in 1969 to supplement its member countries' official reserves. Its value is based on a basket of four key international currencies: the euro, Japanese yen, pound sterling, and U.S. dollar. SDRs can be exchanged for freely usable currencies.

9.   PPP GDP for a given economy is the volume of goods and services produced for final uses by that economy relative to other economies. It is calculated by deflating GDP at market prices by the PPP price level index, allowing comparisons across countries for a given period. Although the term *PPP exchange rate* is used in IMF publications and this chapter in describing such use, PPPs are not exchange rates (the prices of currencies in terms of one another). They are spatial price indexes for GDP by expenditure, and the deflated GDPs using PPPs are volumes expressed in a numeraire currency, not nominal amounts converted into another currency. It is more precise to refer to them without the "exchange rate" modifier.

10. The oldest, the Bretton Woods formula, originally contained five variables: national income, official reserves, imports, export variability, and the ratio of exports to national income. A multiformula approach was introduced in the 1960s, when the Bretton Woods formula was supplemented with four other formulas. National income was replaced by gross domestic product, and the trade variables were expanded to include services and transfers. Current account transactions and variability were given larger weights. The quota formulas were last modified in 1982–83 by reducing the weight of the variability variable and reintroducing reserves as a variable while retaining the basic structure of the formulas.

11. IMF documents, data, and simulations over the period June 2006–April 2008 are available at http://www.imf.org/external/np/fin/quotas/pubs/index.htm.

12. For details on the second round of quota reform, see IMF (2008, para. 9).

13. The choice of numeraire country is arbitrary and does not affect the calculations, because PPPs are adjusted to be transitive across countries.

14. For a discussion of the use of PPP weights against market exchange rates, see IMF (2003, box 1.2) and Zieschang (2008).

15. Composites for exchange rates, interest rates, and the growth rates of monetary aggregates are weighted by GDP converted to U.S. dollars at market exchange rates. Composites for the Euro Area use GDP weights. For unemployment rates and employment growth, the weights are country labor force as a share of the group labor force. Composites relating to the external economy are sums of individual country data after conversion to U.S. dollars at market exchange rates. Composites of changes in foreign trade volumes and prices are weighted by the U.S. dollar value of exports or imports as a share of total world or group trade in exports or imports.

16. The PPP-based GDP *share weights* used in the WEO for composite groups of economies are based on a vintage of data that differs from that of the PPP-based GDP estimates used in the WEO for international comparisons. The share weights are calculated using the previous version of the WEO database, and PPP-based GDP estimates are calculated using the most recent estimates of nominal GDP and the PPP exchange rate. For example, each country's share weight in October 2007 is based on nominal GDP and the PPP exchange rate as of the April 2007 WEO. The PPP-based GDP estimates in the October 2007 WEO were calculated from the October 2007 estimates of nominal GDP and the PPP exchange rate.

17. The IMF's Statistics Department (STA) has an extensive program of technical assistance (TA) in the form of missions to individual countries and regional and international training courses. In the financial year 2010, the Real Sector Division of STA was responsible for nine training courses or seminars and 223 TA missions on price statistics and national accounts. Such missions promulgate international standards, including those given in the *Consumer Price Index Manual* (ILO et al. 2004a), *Producer Price Index Manual* (ILO et al. 2004b), *Export and Import Price Index Manual* (ILO et al. 2009), and *System of National Accounts 2008* (Commission of the European Communities et al. 2008). Improved national accounts expenditure estimates

naturally lead to improved PPP weights. There is also a synergy between the improved consumer price index methodology and the ICP price surveys, especially for sampling issues, variety specification, and price collection and validation—issues considered in this volume.

18. Details are available at http://siteresources.worldbank.org/ICPEXT/Resources/ICP_2011.html.

19. At its 39th session, the United Nations Statistical Commission (UNSC) asked the World Bank to host the Global Office and take on global program coordination of the 2011 ICP round, which the Bank accepted. After the Friends of Chair evaluation of the ICP, the UNSC at its 40th session in February 2009 gave the final go-ahead for the 2011 round. Since that session of the UNSC, significant progress has been made in preparing for the 2011 round. During this period, the ICP governance structure was put in place: the hiring of the global manager was completed in April 2009, and the new Global Office was established. Meanwhile, the Executive Board, the Technical Advisory Group, and the regional coordinating bodies were set up, and they held their first meetings in September–October 2009.

20. The Eurostat-OECD PPP Programme continued to include some economies that were not members of the Organisation for Economic Co-operation and Development (OECD) and the European Union in its 1996, 1999, and 2002 rounds. The number of economies participating in each of those rounds was 32, 43, and 42, respectively. The Eurostat-OECD PPP Programme is responsible for 46 of the 146 countries included in the 2005 ICP round. OECD, in collaboration with the European Commission, spearheads the program in member countries, and the World Bank coordinates activities for the rest of the world.

21. For a history of the ICP, see http://web.worldbank.org/WBSITE/EXTERNAL/DATA STATISTICS/ICPEXT/0,,contentMDK:20118245~menuPK:62002075~pagePK:60002244~ piPK:62002388~theSitePK:270065~isCURL:Y,00.html, and World Bank (2008, appendix A).

22. The World Bank/ICP provided the IMF with the PPP exchange rate estimates for these countries based on regression analysis.

23. As outlined by Barcena (2009). The excluded countries are relatively small. The largest, as measured by percentage contribution to global PPP GDP, including their estimates, were Algeria and the United Arab Emirates at 0.34 percent and 0.27 percent, respectively (source: IMF's WEO database).

24. Wagner (1995) discusses the possibility of countries choosing to not participate if they believe the formula used for nonparticipating countries will provide a more beneficial outcome.

25. An account of an estimation procedure that differs from that given in Changqing and Swanson (2009) appears in World Bank (2008, 164–5), but the database for the World Bank's *World Development Indicators*, from which the IMF estimates are drawn, uses the methodology in Changqing and Swanson (2009).

26. Country estimates may have relatively large prediction intervals in spite of the high $\bar{R}^2$ often found for the regressions. Prediction intervals depend on the sum of squared residuals, sample size, and (sum of squared) distances of the explanatory variables from the mean of the variables.

27. References to the ICP 1993/96 round are heard on occasion. The results of the 1993 round were presented in "1996 terms"—that is, the 1993 basic heading PPPs were re-referenced to 1996 with (usually) one deflator.

28. This is equivalent to taking the country's PPP, relative to that of the United States, in the benchmark year and extrapolating it by the growth rate in the country's GDP deflator relative to the growth rate in the United States' GDP deflator. Weights are calculated each year as nominal GDP in the national currency divided by the extrapolated PPP. The method is akin to that described by Rao et al. (2010, S68) and is invariant to the choice of the numeraire country—the United States in this instance.

29. These countries are following the recommendations of the 2008 *System of National Accounts* (see chapter 3), adopted by the 39th session of the United Nations Statistical Commission, February 26–29, 2008, http://unstats.un.org/unsd/nationalaccount/sna.asp.

30. Rao et al. (2010) advocate a new approach that uses a state-space formulation designed to generate predictions of PPPs, along with their standard errors, over time and across countries that are broadly consistent with benchmark data on PPPs and observed country-specific price movements. The method uses PPP data from all the benchmark rounds. It derives a weighted average of the extrapolations from different benchmarks, which is superior to the current practice of basing extrapolations on data from a single benchmark round. PPP estimates for nonbenchmark years by Rao et al. (2010) differed considerably from the extrapolated Penn World Table Version 6.2 (PWT 6.2) estimates.

31. However, the current PWT 6.3 does not yet use the 2005 survey results. The period to which the weights pertain, the weight reference period—say, 2000—is used to weight series for the surrounding five years: 1998, 1999, 2000, 2001, and 2002. There is also a two-year implementation period, so the 2000 weights are applied to the 1998–2002 five-year series in 2004, and similarly for other five-year intervals. This approach implies that a weight update for the 2005 weights will be applied to 2003–07 inclusive and will take place in 2009.

32. GDP figures are not revised just to update them to 2005. The data for nominal GDP at market prices underlying the 2005 PPP data for some of the 48 countries covered by the African Development Bank (AfDB) may be higher than similar data submitted to the IMF's *International Financial Statistics.* This difference reflects a massive effort by the AfDB to improve these data (e.g., to add informal sector estimates). However, it is not clear whether the authorities in some of these countries have adopted these data as official estimates.

33. http://unpan1.un.org/intradoc/groups/public/documents/un/unpan008092.pdf.

34. http://www.un.org/Depts/otherprgs.htm.

35. IMF staff serve on the ICP Executive Board and Technical Advisory Group. Research on PPP methodological issues is also conducted by IMF staff (e.g., see Silver 2009).

REFERENCES

Barcena, Alicia. 2009. "Interview with the Executive Secretary of ECLAC." *ICP Bulletin* 6 (March): 1, 4–15.

Bhalla, Surjit S. 2008. "World Bank—Most Asians Dead in 1950." *Business Standard,* August 23.

Changqing, Sun, and Eric Swanson. 2009. "Estimation of PPPs for Non-Benchmark Economies for the 2005 ICP Round." *ICP Bulletin* 6 (March): 1, 20–23.

Commission of the European Communities, International Monetary Fund, Organisation for Economic Co-operation and Development, United Nations, and World Bank. 2008. *System of National Accounts 2008.* UN: pre-edit version of Volume 1, approved by the Bureau of the UN Statistical Commission, August 2008. http://unstats.un.org/unsd/nationalaccount/sna.asp.

Deaton, Angus, and Alan Heston. 2008. "Understanding PPPs and PPP-Based National Accounts." Preliminary version presented at Conference on Research in Income and Wealth (CRIW)–National Bureau of Economic Research (NBER) Summer Workshop, July 14–15.

Diewert, W. Erwin. 2008. "New Methodology for Linking Regional PPPS." *ICP Bulletin* 5 (August): 1, 10–21.

Elekdag, Selim, and Subir Lall. 2008. "Global Growth Estimates Trimmed after PPP Revisions." *IMF Survey Magazine,* January 8. http://www.imf.org/external/pubs/ft/survey/so/2008/RES018A.htm.

Gulde, Anne Marie, and Marianne Schulze-Ghattas. 1993. "Purchasing Power Parity Based Weights for the *World Economic Outlook.*" *World Economic and Financial Surveys, Staff Studies for the World Economic Outlook 1993,* Part IV. http://www.imf.org/external/pubs/ft/wefs/1993/eng/studies/index.htm.

ILO (International Labour Office), International Monetary Fund, Organisation for Economic Co-operation and Development, Eurostat, United Nations Economic Commission for Europe, and World Bank. 2004a. *Consumer Price Index Manual: Theory and Practice.* Geneva: ILO. http://www.ilo.org/public/english/bureau/stat/guides/cpi/index.htm.

———. 2004b. *Producer Price Index Manual: Theory and Practice.* Geneva: ILO. http://www.ilo.org/public/english/bureau/stat/guides/cpi/index.htm.

———. 2009. *Export and Import Price Index Manual: Theory and Practice.* Geneva: ILO. http://www.ilo.org/public/english/bureau/stat/guides/cpi/index.htm.

IMF (International Monetary Fund). 2003. *World Economic Outlook.* Washington, DC: IMF, September. Various editions available at http://www.imf.org/external/ns/cs.aspx?id=29.

———. 2007. "A New Quota Formula—Additional Considerations, Statistical Appendix." March 14. http://www.imf.org/external/np/fin/quotas/pubs/.

———. 2008. "Reform of Quota and Voice in the International Monetary Fund—Report of the Executive Board to the Board of Governors." Washington DC, April 7. http://www.imf.org/external/pp/longres.aspx?id=4242.

Johnson, Simon, William Larson, Chris Papageorgiou, and Arvind Subramanian. 2009. "Is Newer Better? Penn World Table Revisions and Their Impact on Growth Estimates." NBER Working Paper Series, Number 15455, National Bureau of Economic Research, Cambridge, MA, October. http://www.nber.org/papers/w15455.

Rao, D.S. Prasada, Alicia Rambaldi, and Howard Doran. 2010. "Extrapolation of Purchasing Power Parities Using Multiple Benchmarks and Auxiliary Information: A New Approach." *Review of Income and Wealth* 56 (S1): S59–98.

Silver, Mick. 2009. "The Hedonic Country Product Dummy Method and Quality Adjustments for Purchasing Power Parity Calculations." Working Paper WP/09/271, International Monetary Fund, Washington, DC, December.

Wagner, Nancy. 1995. "A Review of PPP-Adjusted GDP Estimation and Its Potential Use for the Fund's Operational Purposes." Working Paper WP/95/18, International Monetary Fund, Washington, DC.

World Bank. 2005. "ICP Operational Manual." http://siteresources.worldbank.org/ICPINT/Resources/ICPOperationalManual2005.pdf.

———. 2007. *ICP 2005 Methodological Handbook.* http://web.worldbank.org/WBSITE/EXTERNAL/DATASTATISTICS/ICPEXT/0,,contentMDK:20126612~pagePK:60002244~piPK:62002388~theSitePK:270065,00.html.

———. 2008. *Global Purchasing Power Parities and Real Expenditures: 2005 International Comparison Program.* http://siteresources.worldbank.org/ICPINT/Resources/icp-final.pdf.

———. 2010. "Report of the World Bank on the International Comparison Programme to the United Nations Statistical Commission." 41st session, February.

Zieschang, Kim. 2008. "Integrating Regional GDP Aggregates Based on Exchange Rates and Inter-Country Comparisons Based on Purchasing Power Parity." *ICP Bulletin* (December).