



# IMF Working Paper

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## IMF Applications of Purchasing Power Parity Estimates

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**IMF Working Paper**

Statistics Department

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**Abstract**

**This Working Paper should not be reported as representing the views of the IMF.**

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The IMF's main uses of the International Comparison Program's (ICP) estimates of purchasing power parity (PPP)-adjusted Gross Domestic Product (GDP) are as an element of the formula used to help guide decisions on its members' quotas and in the *World Economic Outlook (WEO)*. The paper outlines these uses and considers measurement issues particularly salient to IMF usage including: PPP imputations for member countries not participating in the ICP; PPP estimates for non-benchmark years; timeliness and periodicity of PPP estimates; economy groupings; and transparency. The paper was written as a chapter on "IMF uses of PPPs" for the 2011 ICP Handbook.

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## I. INTRODUCTION

1. The IMF has used purchasing power parity (PPP)-adjusted Gross Domestic Product (GDP) measures in their *World Economic Outlook (WEO)*<sup>1</sup> since 1993 and, more recently, as an element of the formula that is used to help guide decisions on the distribution of its members' quotas.<sup>2</sup> This paper briefly outlines the IMF's use of the International Comparison Program's (ICP) PPP estimates.<sup>3</sup> The focus then moves to PPP measurement issues that are particularly salient to IMF usage. The measurement issues considered include issues of country coverage and the imputation of PPP estimates for member countries not participating in the ICP; PPP estimates for non-benchmark years; the timeliness and periodicity of PPP estimates and updating mechanisms; country groupings; and transparency. Other measurement issues, such as minimizing measurement errors and biases in weights and price surveys including issues relating to sampling, data collection, validation, and aggregation methods for the estimates are not covered in this paper, but this is not to minimize their importance. These matters are covered in the ICP documentation, World Bank (2008). Section II outlines the IMF's use of PPP-adjustments and Section III some PPP measurement issues of particular concern to IMF usage.

## II. INTERNATIONAL MONETARY FUND USE OF PPPs

2. The IMF uses PPPs both as an element in the formula used to help guide decisions on the distribution of its members' quotas (Section A, below) and in research and analysis work (Section B, below). Indeed, the use of PPPs is naturally pervasive in the 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. Such 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 the *WEO*,<sup>4</sup> as well

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<sup>1</sup> Information on IMF research, statistics and the *WEO* is available on the IMF's website at: <http://www.imf.org/external/index.htm> under the separate tabs for "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>.

<sup>2</sup> The IMF's resources come mainly from member countries' quota subscriptions. Quotas broadly reflect the relative size of each member's economy, e.g., the larger a country's economy is 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 \$56.7 billion), and the smallest member is Tuvalu, with a quota of SDR 1.8 million (about \$2.8 million). Members' calculated quota shares using the quota formula are distinct from their actual quota shares.

<sup>3</sup> Earlier accounts of the IMF usage of PPP estimates include Gulde and Schulze-Ghattas (1993) and Wagner (1995).

<sup>4</sup> These are all available at: <http://www.imf.org/external/research/index.aspx>.

as external (to the IMF) publications. The account given below in Section B is limited to the IMF's use of PPP adjustments for the *WEO*, though the issues raised are indicative of the general use of PPP adjustments, not least because much IMF research uses the *WEO* database.<sup>5</sup>

### A. Quota Determination

3. 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 that it can obtain from the IMF (its access limit), and a members' share in a general allocation of special drawing rights (SDRs),<sup>6</sup> 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 IMF quota formula.<sup>7</sup>

4. The current quota formula is a 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 rates (weight of 60 percent) and on PPPs (40 percent). Both market exchange and PPP GDP weights are an average of the last 3 years data: the 2008 data set therefore requires GDP data for 2006–2008. 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 1 and previous one in Box 2.<sup>8</sup>

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<sup>5</sup> Available for the October 2009 *WEO* at: <http://www.imf.org/external/pubs/ft/weo/2009/02/weodata/index.aspx>.

<sup>6</sup> 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) and SDRs can be exchanged for freely usable currencies.

<sup>7</sup> 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,” 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 indices 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.

<sup>8</sup> 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 multi-formula approach was introduced in the 1960s, when the Bretton Woods formula was supplemented with four other formulas, with national income replaced by gross domestic product and trade variables 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

(continued...)

### Box 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 to 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 = the calculated quota share;

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

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

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

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

5. 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.<sup>9</sup> The amalgam of market exchange 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 non-financial 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 PPP GDP, as well as the compression

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reducing the weight of the variability variable and reintroducing reserves as a variable, while retaining the basic structure of the formulas.

<sup>9</sup> 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>

factor, were recognized (IMF, 2008, paragraph 7) as having been one of the most difficult aspects of the deliberations and, 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.

**Box 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;

$R$  = twelve-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 five-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).

6. At the time of the IMF 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 in April 2008.<sup>10</sup>

	Quota shares		Percentage difference: new to previous
	Previous five formulas	New formula	
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	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
Russia	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
<sup>1</sup> The quota shares here are derived from the calculated formulas only.			
Source: IMF (2008, Table 1).			

7. 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

<sup>10</sup> For detail on the second round of quota reform see IMF (2008, paragraph 9).

Program in December 2007. These data reflect substantial improvement in the methodology and consistency of PPP estimates. Previously, data quality issues had been viewed as impeding consideration of using PPP GDP.<sup>11</sup> The use of the PPP GDP variable in the formula had a significant impact on the distribution of calculated quota shares by increasing the calculated quota shares of emerging and developing countries. Table 1 provides the *calculated* quota shares under the old and new formula for major economies, responsible in total for about 80 percent of world PPP GDP. Not all of the differences in shares were the result of the adoption PPP GDP. As apparent from Boxes 1 and 2, there were other factors that influenced the outcomes for calculated quota shares besides PPP GDP including raising the effective weight for GDP and reducing that for openness. However, it remains worth drawing attention to the substantive nature of the changes: increases of over 50 percent for India and Brazil and falls of a similar magnitude for Luxembourg and Singapore. Major economies including the United States, Japan, Germany, United Kingdom had considerable changes in their calculated quota shares of 16.6, 14.6, -9.1, and -15.5 percent respectively.<sup>12</sup>

## **B. Uses in the World Economic Outlook (WEO)**

8. The *WEO* reports on 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, nominal GDP divided by the PPP exchange rate.<sup>13</sup> The PPP-based GDP data used for the quota calculations using 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.<sup>14</sup> The *WEO* PPP-based data are converted into SDR units using the SDR-U.S. dollar period average exchange rate. The *WEO* PPPs are based on the data from the International Comparisons Program (ICP) for 2003-05 that were published in December 2007. These data were then extended in the *WEO* data base by using the growth in relative GDP deflators (the GDP deflator of a country divided by the GDP deflator of the United States).<sup>15</sup> Exceptions to

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<sup>11</sup> See page 5 of *A New Quota Formula—Additional Considerations, Statistical Appendix* (March 14, 2007) at <http://www.imf.org/external/np/fin/quotas/pubs/>

<sup>12</sup> Further, emerging market and developing economies whose shares in 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. Countries that benefited from the boost included Brazil, India, and Vietnam.

<sup>13</sup> For a discussion of the use of PPP weights against market exchange rates see IMF (2003, Chapter 1, Box 1.2) and Zieschang (2009).

<sup>14</sup> Choice of numeraire country is arbitrary and does not affect the calculations, since PPPs are adjusted to be transitive across countries.

<sup>15</sup> The gross domestic product (GDP) deflator is a price index that measures the price component of changes in the nominal value of GDP—domestically produced final goods and services in an economy. It is an implicit index

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PPP weighting 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—*WEO* (April 2009, page 181).<sup>16</sup>

9. Estimates of regional and world *output* and their growth, and forecasts thereof, are key macroeconomic indicators and are reported in the *WEO*. Since the appropriate weighting scheme for output can depend on the issue being considered, the *WEO* reports (in Table A1 of the Statistical Appendix) alternative measures of world output using both PPP and market exchange rates. The estimated value of world output in 2009 increased from an estimated 54,864 to 68,651 billion U.S. dollars 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 for GDP at market exchange rates compared with 30.2 percent at PPPs (*WEO*, April 2009, page 189). 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, and some countries with higher weights under the PPP measure are forecast to have faster growth in 2009 to 2014 relative to countries with higher weights under the market exchange rate measure.

10. ICP benchmark rounds take place every 5 or so years, the last of which was in 2005. The weights used in the *WEO* between ICP rounds are updated by the growth in the relative GDP (the country's GDP deflator divided by the United States' GDP deflator).<sup>17</sup> However, this is not equivalent to the data-rich country price comparisons that constitute an ICP round—see Section III part B below.

11. The IMF's *International Financial Statistics (IFS)* also uses PPP-based weights for some its regional and global aggregates, namely global consumer price indices (CPIs), producer/wholesale price indices (PPIs/WPIs), GDP volume, GDP deflator, gross capital

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derived by dividing the measured changes in the nominal value of GDP by the measured changes in the volume of GDP.

<sup>16</sup> 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 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.

<sup>17</sup> The PPP-based GDP *share weights* used in the *WEO* for composite groups of economies are based on a different vintage of data to 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 the nominal GDP and 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.

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 or so, for the base years of 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 sub-period. 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 2005 PPP weights, was from the October 2008 *WEO* taking effect in *IFS* from May 2009 onwards. Countries whose weights are not available from the *WEO* are excluded from the *IFS* aggregation process.

### III. SOME SALIENT PPP MEASUREMENT ISSUES FOR IMF USE

12. Issues relating to the reliability of data used for PPP price comparisons and GDP expenditure components for the weights are areas of concern to the IMF and in which the IMF actively helps countries.<sup>18</sup> Notwithstanding the importance of these issues, the concern of this paper is with some specific issues relevant to the IMF's use of PPPs as outlined below.

#### A. Country Coverage

The IMF usage of PPPs relies on estimates provided by the ICP.<sup>19</sup> These take place periodically and are referred to as "rounds" and the years in which they take place as "benchmark years." Countries participating in a particular round are referred to as "benchmark countries" for that round. The last round of survey-based estimates was conducted in 2005 and the next is planned for 2011.<sup>20</sup> There has over the history of ICP rounds been a pronounced increase in the number

<sup>18</sup> The IMF's Statistics Department (STA) has an active and extensive program of technical assistance (TA) that takes the form of missions to individual countries and regional and international training courses. The Real Sector Division of STA was responsible for 9 training courses/seminars and 223 TA missions on price statistics and national accounts in the financial year 2010. Such missions promulgate international standards including those given in the *Consumer Price Index Manual* (ILO *et al.*, 2004), *Producer Price Index Manual* (ILO *et al.*, 2004), *Export and Import Price Index Manual* (ILO *et al.*, 2009), and 2008 *System of National Accounts* (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 improved CPI methodology and ICP price surveys, especially with regard to sampling issues, variety specification, price collection and validation, issues considered in detail in Part III of this Handbook.

<sup>19</sup> Details of which are available at:

<http://web.worldbank.org/WBSITE/EXTERNAL/DATASTATISTICS/ICPEXT/0,,menuPK:1973757~pagePK:62002243~piPK:62002387~theSitePK:270065,00.html>.

<sup>20</sup> The United Nations Statistical Commission (UNSC) in its 39<sup>th</sup> session requested the World Bank to host the Global Office and take on the global program coordination of the 2011 Round, which the World Bank accepted. Following the Friends of Chair evaluation of the ICP, the UNSC at its 40<sup>th</sup> session in February 2009 gave the final go ahead for the ICP 2011 Round. Significant progress has been made in preparing for the 2011 Round since the 40<sup>th</sup> session of the UNSC. During this period, the ICP governance structure was put in place: the hiring of the Global Manager completed in April 2009 and the new Global Office was established. 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.

of participating countries—increasing from 10 countries in 1970, to 16, 34, 60, and 64 in 1973, 1975, 1980, and 1985 respectively. Following a partial program in 1990, the 1993 participation level was a landmark with an increase to 118 countries covering all regions of the world for the first time. While 118 countries participated in the 1993 comparisons, many countries used reduced information surveys that proved to be relatively unreliable, notably so for mainland China (Heston and Deaton, 2008). The last ICP round in 2005,<sup>21</sup> upon which the IMF bases its PPP GDP variable, covered 146 economies. The World Bank (2008, page 164) Report on the 2005 round noted that at least another 65 economies or territories did not participate for a variety of reasons, including lack of resources or no national interest.<sup>22</sup> The IMF, as an organization of 187 countries, had to rely in part on an estimation routine for the PPP variable for 41 countries.<sup>23</sup> Particularly serious was the lack of PPP data from all the countries of Central America and the Caribbean and participation of only 10 countries in South America, mainly due to a lack of resources.<sup>24</sup>

13. There are two key issues going forward: the first is to increase in subsequent rounds the number of participating countries. It is too early, at this stage of writing, to be certain on the number of countries participating in the 2011 round, though the World Bank expects 170 countries.<sup>25</sup>

14. Second, is to ensure the reliability and integrity of the methods for estimating PPPs for the non-participating countries.<sup>26</sup> The World Bank methodology for estimating PPPs for economies not participating in the ICP, non-benchmark economies, is documented in

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<sup>21</sup> The Eurostat-OECD PPP program continued to include a number of non-OECD and non-EU member economies for each of their 1996, 1999, and 2002 rounds. The number of economies participating in each of those rounds was 32, 43, and 42, respectively. The OECD, in collaboration with the European Commission, spearheads the program in member countries while the World Bank coordinates activities for the rest of the world. The OECD/Eurostat PPP program was responsible for 46 of the 146 countries for the 2005 round.

<sup>22</sup> For a history of the ICP see: <http://web.worldbank.org/WBSITE/EXTERNAL/DATASTATISTICS/ICPEXT/0,,contentMDK:20118245~menuPK:62002075~pagePK:60002244~piPK:62002388~theSitePK:270065~isCURL:Y,00.html> and the World Bank (2008, Appendix A).

<sup>23</sup> The World Bank/ICP provided the Fund with the PPP exchange rate estimates for these countries based on regression analysis.

<sup>24</sup> As outlined by Barcena (2009). Included South American countries were Argentina, Bolivia, Brazil, Chile, Columbia, Ecuador, Paraguay, Peru, Uruguay, and Venezuela, R.B. Copuntries not included in the 2005 round were relatively small, the largest, by percentage contribution to global (estimated) PPP GDP, being Algeria and United Arab Emirates at 0.34 and 0.27 percent respectively—IMF *World Economic Outlook* Database.

<sup>25</sup> *Report of the World Bank on the International Comparison Programme to the United Nations Statistical Commission*, Forty-first session, pages 23–26, February 2010, paragraph 16.

<sup>26</sup> Wagner (1995) discusses the possibility of countries choosing to not participate if they believe the formula will provide a more beneficial outcome.

Changqing and Swanson (2009).<sup>27</sup> Data for all benchmark countries are used to estimate regression equations for price level indices (PLIs), defined as the ratio of PPP GDP (also for PPP private consumption) to a corresponding market exchange rate, normalized with the United States = 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), the ratio of dependents to working age population, dummy variables for Sub-Saharan African, OECD, island, and landlocked developing economies, as well as interaction terms for GDP per capita with the aforementioned dummy variables.

15. The value added to the IMF of PPP estimates for non-benchmark IMF member countries lies not only with their ready availability but, particularly for quota purposes, also with their independent derivation as part of the ICP program. 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 countries that may have very wide prediction intervals.<sup>28</sup> Indeed, for IMF usage, one consideration in devising the specification for the model might be that it is robust to extreme prediction intervals, especially for the larger of the non-benchmarked countries.

### **B. PPP Estimates for Non-Benchmark Years**

16. PPP GDP estimates based on ICP benchmark price surveys are only available periodically—the last benchmark rounds were in 2005 and 1993.<sup>29</sup> PPP benchmark survey-based weights are normally updated at about five-year intervals. Index number theory and international guidelines would advise that weights be updated more frequently, especially if consumption/GDP component shares are subject to change. However, 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 ICP rounds. Extrapolations to provide annual PPPs for a country, as used in the IMF work, are based on multiplying the country's last round's PPP GDP estimates, relative to the U.S., 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 (GDP deflator) to provide an

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<sup>27</sup> An account of an estimation procedure that differs from that given in Changqing and Swanson (2009) is given in World Bank (2008, pages 164–165), but this is not used in practice. The World Bank's *World Development Indicators*' database, from which the IMF estimates are drawn, uses the methodology in Changqing and Swanson (2009).

<sup>28</sup> 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.

<sup>29</sup> Sometimes an ICP 1993/96 round is referred to. The results of the 1993 round were presented in "1996 terms", that is, the 1993 BH PPPs are re-referenced to 1996 with [usually] one deflator.

estimate in U.S. dollars.<sup>30</sup> Countries, whose volume estimates are based on weights that are revised annually, are less likely to have their PPP GDP estimates drift above the PPP GDP estimate from the next ICP round. Many advanced economies, that constitute much of the quota allocation, compile annually chain-weighted volume GDP estimates.<sup>31</sup> But there are many countries that fall short of this requirement.

17. New PPP estimates from new ICP rounds act as benchmarks for these extrapolated estimates. The PPP estimates for the 2005 benchmark year replaced previous benchmark PPP estimates, which dated back to being based on benchmark figures for 1993, or earlier for most emerging market and developing countries.<sup>32</sup> The revisions to PPP estimates as a result of the 2005 round resulted in a substantial reduction in contribution of some large fast-growing economies to global growth. The IMF's estimate for global growth in 2007 was revised down to 4.7 percent from 5.2 percent in the October 2007 *World Economic Outlook*, based on 2005 PPP results. Downward revisions for PPP-based GDP of two of the world's fastest-growing economies, China and India, were mainly responsible for the overall reduction of global growth estimates. For 2007, China's share of global output was revised to an estimated 10.9 percent (down from 15.8 percent) while India's share declined to 4.6 percent, from 6.4 percent (Elekdag and Lall, 2008). It is worth noting that the 2005 round benefited from some significant methodological advances, as outlined in Deaton and Heston (2008), Diewert (2008) and the World Bank (2008), the extent of which may not be repeated in future rounds.

18. PPP GDP estimates for non-benchmark years are available in the *Penn World Tables (PWT)*, *World Development Indicators (WDI)*, and *WEO*. Each use different methodologies. Recent research on such estimates, mainly relating to *PWT* but also applying to *WDI* and *WEO* estimates, have highlighted serious inconsistencies in the results across versions of *PWT*<sup>33</sup>—

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<sup>30</sup> This is equivalent to taking the country's PPP, relative to the U.S., in the benchmark year and extrapolating it by the growth rate in the country's GDP deflator relative to the growth rate in the U.S.'s 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, page S68) and is invariant to the choice of the numeraire country, the U.S. in this instance.

<sup>31</sup> This follows the recommendations of the 2008 *System of National Accounts*, Chapter 15, adopted by the thirty-ninth session of the United Nations Statistical Commission, 26–29 February, 2008 available at: <http://unstats.un.org/unsd/sna1993/draftingphase/ChapterList.asp>.

<sup>32</sup> Rao *et al.* (2010) advocates a new approach that makes use of a state–space formulation which is 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 makes use of 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 non- benchmark years by Rao (2010) differed considerably from the extrapolated *Penn World Tables (PWT)* 6.2 estimates.

<sup>33</sup> However the current (at the time of writing) *Penn World Table Version* 6.3 do not yet use the 2005 survey results. Version 7.0 incorporating these results should be available by the end of 2009. The period to which the weights pertain, the weight reference period, say 2000, is used to weight series for the surrounding 5 years, i.e.

(continued...)

Johnson, Larson, Papageorgiou, and Subramanian (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 the non-benchmark year’s estimates are at domestic and not international (PPP) prices and the share weights of the growth rates at 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” Neither are PPP GDP level data considered “safe” when looking at cross-country comparisons in non-benchmark years. They find estimates for smaller countries to have greater inconsistency between growth rates and per capita PPP GDP estimates and for the variability to increase as the distance of the data from the benchmark round increases.

19. While there may be deficiencies in the extrapolated estimates, there remains a case for using such estimates on the basis that a weighting system based on estimates of annual figures is better than an assumption of no change. The implication for IMF usage is a need for more frequent rounds and updates of PPP estimates. One possibility, given their high resource cost, is a better integration of ICP methodology with CPI and PPI programs so that price data that may be used for PPP programs are regularly collected as part of routine national statistics compilation. A second possibility is that a “mini” ICP exercise take place between rounds, as is currently underway for the Asia region. Neither of these proposals is to negate the need to improve the estimation procedures for non-benchmark years, proposals for which may be found in Deaton and Heston (2008) and Johnson *et al.* (2009).

### C. Timeliness

20. PPP estimates are based on inter-country price comparisons for the basic headings of activities that comprise GDP, 155 for the 2005 round, and their counterpart expenditure weights. Arising from this there are some key aspects of timeliness of importance to the IMF.

21. First and foremost, is minimizing the time lag between the completion of the price surveys and validation of source data and 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 trade off between the reliability and the timeliness of the results. For the 2005 round the final global results were published in December 2007. The expectation for the 2011 round is that the results are published during February–June 2014.<sup>34</sup> For logistical reasons not all countries, and expenditure components within countries, have their prices collected in the same period. For the

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1998, 1999, 2000, 2001, and 2002; there is also a two years implementation period so the 2000 weights are applied to the 1998–2002 five year series in 2004, and similarly for other 5-year intervals. This implies that weight update for 2005 weights will be applied to 2003–2007 inclusive and will take place in 2009.

<sup>34</sup> Report of the World Bank on the International Comparison Programme to the United Nations Statistical Commission, Forty-first session, pages 23–26, February 2010, paragraph 27.

2011 round the plan is for the price surveys for household expenditure on goods and services to be conducted in that year, however, price surveys for these goods and services for some small countries in the Caribbean is to take place in 2012. Price surveys for non-household goods and services (education, health, compensation of Government employees, equipment, and construction) are to be carried out concomitantly with the compilation of relevant expenditures data, from early 2011 to end of 2012.<sup>35</sup> A “mini” ICP for Asian region countries is being undertaken to update their PPP estimates to a reference year of 2009.

22. Second, there is the time lag between the period(s) to which the component GDP expenditure data for the basic headings relate and that of the price surveys. For example, the 2005 round was based on price surveys principally conducted in 2005, though at the time of compiling the PPP estimates, not all countries had 2005 expenditure estimates available for all components of GDP. Related to this problem is the procedure used to “update” the GDP estimates to 2005 if timely ones are unavailable.<sup>36</sup>

23. Third, there is the need for estimates for non-participating countries, outlined in Section B above, and detailed information on their estimation procedures, to quickly follow those of participating countries.

#### **D. Groupings of Economies**

24. The ICP is organized and executed on a regional basis for Africa, Asia and the Pacific, Commonwealth of Independent States, Latin America and the Caribbean, Western Asia, and OECD-EUROSTAT countries with regional aggregates published for countries in these groups. The membership of regional ICP groups relates to the ICP sample design, which does not necessarily correspond to the standard regional aggregates maintained by the United Nations (<http://unpan1.un.org/intradoc/groups/public/documents/un/unpan008092.pdf>), the member state groupings for the UN Regional Commissions (<http://www.un.org/Depts/otherprgs.htm>), or those used by the various international organizations, including the IMF. For example, there are countries such as Georgia and Iran that do not (at the time of writing) for the 2011 round belong to any of the regional coordinating agencies. There are countries including Chile, Egypt, Mexico, and Sudan that belong to more than one regional group. However, since PPP estimates for basic headings and GDP are provided for individual economies, it is not essential that the IMF and ICP groupings are the same since the core data exists for the IMF to aggregate country PPP GDP in whatever manner it deems appropriate.

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<sup>35</sup> *Ibid* paragraph 26.

<sup>36</sup> Revisions to GDP figures are not just taken to update them to 2005. 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 *IFS*. This 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.

### **E. Large Economies**

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

### **F. Transparency**

26. Since PPP estimates are used to help guide decisions on the distribution of members' quotas, that 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 round a detailed Handbook of Methodology and Operational Manual were usefully published on the ICP websites very early into the program and similar publications are planned for the 2011 round. These naturally 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 which served to inform users as to new developments and regional issues. Each region produced a separate publication that contained not only their results, but also details of region-specific methodological issues. The final results were published along with technical details—World Bank (2008). There is a very real sense in which 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 as to the methods employed ensures the integrity of the results can be defended.

## **IV. SUMMARY**

27. PPP GDP estimates from the ICP are important to the IMF as an element of the formula that helps to guide decisions on the distribution of members' quotas, as outlined in Section IIA above. Further, much of the analysis and monitoring of output and other key macroeconomic indicators across countries, and for regional, global, and analytic groups over time, requires PPP estimates and the account of the use of PPP-adjusted estimates in the *WEO*, outlined in Section IIB above, is indicative of such work. While the IMF has a natural concern that errors and bias

in source data for the PPP estimates and aggregation techniques are minimized,<sup>37</sup> there are issues of particular relevance to the IMF's usage and these were raised in Section III. They included issues of country coverage and PPP estimates for member countries not participating in the ICP; PPP estimates for non-benchmark years; the timeliness and periodicity of PPP estimates; groupings of economies; and transparency.

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<sup>37</sup> IMF staff serve on the ICP Executive Board and Technical Advisory Group. Research on PPP methodological issues is also conducted by IMF staff, for example, Silver (2009).

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