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WP/95/18

INTERNATIONAL MONETARY FUND

Treasurer's Department

A Review of PPP-Adjusted GDP Estimation and  
its Potential Use for the Fund's Operational Purposes

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February 1995

Abstract

International comparison of economic aggregates, expressed in domestic currencies, requires their conversion into a common numeraire currency such as the U.S. dollar or the SDR. Since market (or official) exchange rates are subject to fluctuations which may result in comparisons that do not reflect cross-country differences in real economic activity, it is often recommended that purchasing power parity (PPP) rates be used for conversion instead of exchange rates. It is generally agreed that PPP rates are conceptually appropriate conversion factors. However, their practical implementation raises questions regarding the quality of the PPP indices which are currently available. This paper reviews the data and methodology underlying the construction of PPP indices, with particular emphasis on the PPP-based estimates of GDP used in the Fund's *World Economic Outlook* and the World Bank's *World Development Report*, and examines some of the issues associated with the use of such PPP-based estimates of GDP for the Fund's operational purposes (such as quota calculations or determination of SAF or ESAF eligibility).

JEL Classification Numbers

C43, E31, F31

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\*I wish to thank Sultan Ahmad, James Blalock, Jitendra Borpujari, David Coe, Yuri Dikhanov, Orlando Roncesvalles, and George Tavlas for their helpful comments and suggestions. I would also like to thank Costas Christou for providing some of the calculations used in this paper. Of course, all opinions and any remaining errors are solely my responsibility.

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### Summary

International comparison of economic aggregates requires the conversion of such aggregates, expressed in domestic currencies, into a common numeraire currency, such as the U.S. dollar or the SDR. As market exchange rates are often subject to fluctuations that do not fully reflect fundamentals and can result in inconsistent cross-country comparisons of real economic activity, it is often recommended to use purchasing power parity (PPP) rates instead. In this context, PPP refers to the purchasing power of a country's currency. This paper reviews the data and methodology underlying the construction of PPP indices (based on extensive price surveys conducted by the International Comparison Programme in selected countries) and examines some of the issues associated with the potential use of PPP-based estimates of GDP for the Fund's operational purposes. The paper concludes that, in general, because of unresolved data and methodological issues, the use of PPP-adjusted estimates would seem inappropriate for the Fund's operational purposes at this time.

Although it is generally agreed that PPP rates are appropriate conversion factors from a conceptual viewpoint, their practical implementation has been hampered by the uneven quality of the PPP indices currently available. Perhaps the most critical problem with the ICP database is its incomplete coverage of countries and even entire regions. Other data-related problems include extrapolations of current price data from constant price growth rates and difficulties in comparing baskets of goods and services across widely diverse countries (a particularly acute problem with nontradables).

Apart from data deficiencies, a number of methodological issues remain unresolved. The method most commonly used by the ICP has been criticized for imparting an upward bias in GDP estimation for those countries whose price structures differ significantly from price structures in the high-income industrial countries. However, alternative methodologies have also been subject to criticism on other grounds. The various methodological choices produce substantially different results, and no consensus has emerged as to the appropriate estimation procedure.



## I. Introduction

In order to make international comparisons of economic aggregates such as GDP, it is necessary to convert such aggregates, measured in national currencies, into a common unit of account. The most frequently used method of conversion has been to apply market (or official) exchange rates to convert individual country data into U.S. dollars or SDRs. However, such a methodology leaves the comparison of relative economic sizes subject to exchange rate fluctuations and international differences in price levels that may have little bearing on cross-country differences in real economic activity. For this reason, suggestions have been made to use conversion factors based on purchasing power parities (PPPs). In this context, PPP refers to the purchasing power of a country's currency defined as the number of units of the currency required to purchase in that country the same (or similar) representative basket of goods and services that a unit of reference currency (such as the U.S. dollar) buys in the reference country.

This paper reviews the data and methodology underlying the development of PPP-indices, with particular emphasis on the PPP-based estimates of GDP used in the Fund's *World Economic Outlook* and the World Bank's *World Development Report*. The paper then examines some of the issues that arise if PPP-adjusted estimates of GDP were used for the Fund's operational purposes, such as quota calculations or the determination of members' eligibility to use resources under the Enhanced Structural Adjustment Facility (ESAF). 1/

## II. Background

The Purchasing Power Parity hypothesis proposes an equilibrium relationship between the exchange rate and the relative price levels in different countries. The concept of PPP first became widely known following World War I, when governments sought guidance in attempting to return to the prewar gold standard parities after the profound disturbances to the international economy. 2/ For this purpose, PPP has been used as a short-cut method for predicting what the equilibrium exchange rate should be when a country has a balance of payments disequilibrium. 3/

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1/ In addition to its regular facilities, the Fund has also generated resources to provide assistance to low-income developing countries on concessional terms. Such assistance has been provided through the Trust Fund, the Structural Adjustment Facility, and, more recently, the ESAF.

2/ Cassel (1923).

3/ One weakness in the formulation of the PPP doctrine is the lack of any description of the dynamics of transition toward this "equilibrium" exchange rate. In addition, Stein (1993) notes that the PPP theory is inadequate for the purpose of even defining an equilibrium exchange rate because of an implicit assumption of stationarity underlying PPP. The assumption that equilibrium real exchange rates are stationary has been empirically refuted for reasonable time spans. In effect, stationarity would imply that any fundamental determinants of the real exchange rate, such as disturbances to productivity or changes in the rate of capital formation, would also have to be stationary. Instead, Stein develops an economic generalization of PPP which is a moving equilibrium rate determined via endogenous changes in capital and debt.

PPP has appeared in two versions: the absolute version and the relative version. The absolute version is essentially a generalization of the Law of One Price, which assumes that the prices of identical tradable goods are equalized through spatial arbitrage. According to absolute PPP, the equilibrium exchange rate is determined by the ratio of the price levels in the two countries; that is,

$$e = \frac{p}{p^*}$$

where

$e$  = the PPP exchange rate (in units of domestic currency per unit of foreign currency);

$p$  = the price level in the domestic country; and

$p^*$  = the price level in the foreign country.

The relative version is a weaker proposition that states that the changes in exchange rates should be proportional to changes in the relative price levels; that is,

$$\frac{\dot{e}}{e} = \frac{\dot{p}}{p} - \frac{\dot{p}^*}{p^*}$$

where

$$\dot{x} = \frac{dx}{dt} \quad \text{for } x = e, p, p^*.$$

Considerable empirical evidence indicates that market exchange rates exhibit frequent and persistent deviations from PPPs, in both the short-run and the long-run. <sup>1/</sup> Various explanations have been given for this phenomenon, including short-run causes such as divergent rates of price adjustment in goods and asset markets, speculative bubbles, and exchange market intervention. More fundamental reasons for this discrepancy include the fact that PPP is based on a goods-flow model of exchange rate equilibrium, while in practice, exchange rate changes are dominated by

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<sup>1/</sup> However, there is also a body of empirical evidence suggesting that market exchange rates, in the long run, tend toward PPP levels. See, for example, MacDonald (1993).

capital flows (indeed, even within the goods-flow framework, spatial arbitrage could, at best, ensure the law of one price only for traded goods); market imperfections; 1/ the "productivity difference model" which postulates greater international productivity differentials in the tradables sectors than in nontradables; 2/ and differences in factor endowments coupled with imperfect international labor mobility. 3/ The latter two explanations provide a theoretical justification for a downward bias in the exchange rate-based GDPs of labor-abundant developing countries as compared to their PPP-based GDPs.

Since there exist divergences between market (or official) exchange rates and PPPs, the issue arises as to which conversion factor should be used for international comparisons of GDP or for such related purposes as conversion of GDP data for use in the Fund's quota formulas. Since market exchange rates may not adequately reflect differences in international price levels, their use as conversion factors may not always provide an appropriate indication of real economic performance differentials. For example, among the members of the Fund, the pace of growth in real GDP between 1985 and 1990 for the industrial countries and the major oil-exporting countries was slower than that for the non-oil developing countries. This pattern of real growth rates is not reflected in the data on nominal growth rates of GDP in SDR terms. In nominal terms, the industrial countries experienced a higher-than-average growth rate, significantly above that of the developing countries. 4/

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1/ For example, Kleiman (1993) empirically examines the role of taxes in explaining deviations from PPP and concludes that domestic indirect taxes significantly influence cross-country price levels.

2/ Balassa (1964) provides some empirical evidence of international differences in productivity between the tradables and nontradables sectors. Relatively high productivity in the tradables sector for high-income countries implies, under factor price equalization, that the production of nontradables will be relatively inefficient, while the reverse is true for lower-income countries.

3/ Bhagwati (1984) notes that the production of nontradables is relatively labor-intensive, so that the prices of nontradables tend to be relatively low in labor-abundant (usually low-income) countries. The reverse is true for relatively capital-abundant (usually higher-income) countries.

4/ In real terms, the growth rates between 1985-90 for the industrial countries and for the major oil-exporting countries were 3.2 percent and 2.5 percent, respectively, compared with a growth rate of 4.1 percent for the non-oil developing countries. However, in nominal terms, the respective growth rates were 6.9 percent, 3.1 percent, and 2.1 percent for the industrial countries, the major oil-exporting countries, and the non-oil developing countries. Thus, over the 1985-90 period, the nominal exchange rate movements have not reflected differentials in domestic and external inflation rates and have, therefore, resulted in significant changes in real exchange rates.

However, PPPs, as defined above, are also inadequate for the purpose of international comparisons; the absolute version, based on the Law of One Price, could at best describe the relationship for a small subset of homogeneous tradable goods, while the relative version is essentially deprived of useful computational content for conversion factors since it merely postulates a relationship between changes, rather than levels, of prices and exchange rates. For this reason, an alternative concept of PPP, a computable version, has been employed. This computable PPP refers to the purchasing power of currencies 1/ and, like the theoretical version of PPP, controls for international price level differences in order to measure differences in real incomes. Throughout the remainder of this paper, the term, PPP, will be used to refer to the purchasing power of currencies rather than to the theoretical constructs of absolute or relative purchasing power parities.

### III. The UN International Comparison Programme

The attempt to define a standard for making cross-country comparisons of national incomes led to the creation of the International Comparison Programme (ICP) in 1968, a joint venture between the United Nations and the University of Pennsylvania with support from the World Bank. More recently, regional organizations, such as the EC 2/ and the OECD, have assumed a fundamental role in conducting the associated statistical work.

Since its inception, the ICP has focused on estimating PPPs based on extensive price surveys in selected countries for given years. The ICP forms the primary database underlying the PPP weights used by the staffs of both the Fund and the Bank. ICP price surveys have generally been conducted in phases that occur every three to five years. 3/ Countries which participate in an ICP phase are referred to as "benchmark" countries. Six phases have now been conducted, beginning in 1970 with Phase I which surveyed 10 countries. Phases II (1973), III (1975), and IV (1980) extended the coverage to 16, 34, and 60 countries, respectively. Phase V (1985) surveyed 64 countries, but the entire Latin American continent was omitted, while Phase VI (1990) was conducted for a total of only 30 mostly industrial countries, primarily European countries or those belonging to the OECD. For the first six phases, a total of 90 countries have participated at some point in the ICP survey. However, it is important to note that about two-thirds of non-OECD countries 4/ have either not participated in the ICP surveys or their participation has been no more recent than in 1980.

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1/ Some authors have used the abbreviation, PPC, for Purchasing Power of Currencies to explicitly distinguish this approach from the PPP theory.

2/ The European Community is now called the European Union, or EU.

3/ In 1993, the UN Statistical Commission formally endorsed a move to include the ICP price surveys as part of regular national price data collection.

4/ These countries account for more than one-half of non-OECD GDP.

Progress is now underway for a 1993 survey which will cover more than 80 countries, including China 1/ and several former Soviet Union (FSU) economies. 2/

In the first three phases, the emphasis was on developing an effective methodology that could be applied for global comparisons. A major change in methodology was introduced (at the request of the EC) in 1980 (Phase IV) and retained for subsequent phases. The EC did not want shifts to occur in relative rankings between EC countries when moving from a regional comparison to a global comparison. Therefore, a two-stage procedure is now employed to make cross-country comparisons. In the first stage, the focus is on developing multilateral intraregional 3/ comparisons (for EC, OECD, Central Europe, Asia, Africa, etc.). To this effect, weighted average prices for the region, rather than for the world as a whole, are developed for determining PPPs. The regional figures are then linked to each other via bilateral comparisons using "core countries" (for example, Japan would be the link for OECD and Asia) such that the regional relationships are retained even in global comparisons. That is, in a global comparison, the ranking of countries by PPP-adjusted GDP within a given region should remain unchanged with respect to the other countries in the region. This property of the ICP figures is referred to as "regional fixity." 4/

During the ICP phases, price data 5/ are collected for more than 400 types of goods and services in each of the chosen benchmark countries. An attempt is made to control for quality, regional (within a country), and seasonal price differences. (See Section V.1., Data Issues, for a fuller discussion on the data.) These price data are then aggregated into approximately 150 basic headings (categories) 6/ of goods and services.

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1/ However, China's participation in the 1993 survey was on a very limited basis.

2/ Much of the survey work for this survey will be conducted throughout 1994, but 1993 will serve as the base year.

3/ The term, "region," is used here to denote a grouping of countries which is not necessarily geographic, but may be organizational in nature (for example, the OECD).

4/ However, when one country belongs to more than one region, its ranking relative to other countries may differ within the regions, so that for global comparisons, a dominant region is chosen for the fixity property.

5/ Final product prices, which include taxes and subsidies, are used.

6/ The 150 basic headings are comprised of approximately 110 consumption, 35 investment, and five government categories.

The ICP has used two different approaches for obtaining PPPs, both of which are based on "statistical" approaches to index number construction as opposed to "functional" approaches. <sup>1/</sup> In the first approach, known as the Geary-Khamis (GK) method, both a vector of international prices and a vector of PPPs are derived. Each country's relative share of GDP (within the given basic headings) determines its weight in the procedure of deriving the international prices and PPPs. Each PPP index is calculated as the ratio of total expenditure on a basket of goods and services valued at the country's own prices to total expenditure on the same basket valued at international prices. International prices are calculated as the quantity-weighted average of domestic prices of the countries being compared, where the domestic prices are converted into a common currency (usually the U.S. dollar or, as explained below, the international dollar) using the country's PPP index. Thus, the international prices and the PPPs are determined as the solution to the following system of simultaneous equations:

$$I_i = \sum_{j=1}^n \frac{P_{ij}}{PPP_j} \cdot \frac{Q_{ij}}{\sum_{k=1}^n Q_{ik}} \quad i = 1, \dots, m$$

$$PPP_j = \frac{\sum_{i=1}^m P_{ij} \cdot Q_{ij}}{\sum_{i=1}^m I_i \cdot Q_{ij}} \quad j = 1, \dots, n$$

where

$I_i$  = average international price of commodity  $i$ ;  
 $P_{ij}$  = price of commodity  $i$  in country  $j$ ;  
 $Q_{ij}$  = quantity of commodity  $i$  in country  $j$ ;  
 $PPP_j$  = purchasing power of currency of country  $j$ ;  
 $m$  = number of basic headings; and  
 $n$  = number of countries.

The second approach utilizes the Elteto-Koves-Szulc (EKS) method, in which each country is implicitly assigned an equal weight. Unlike the GK method, this approach does not yield a set of international prices.

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<sup>1/</sup> A functional approach for making comparisons would be based on a theoretical structure with economic underpinnings, whereas a statistical approach emphasizes the index construction and its associated statistical properties.

This method is essentially a multilateralized bilateral procedure. Sets of binary comparisons are done; a Laspeyres-type and a Paasche-type PPP index is computed for pairs of countries using the following equations:

$$\text{Laspeyres Index: } L_{jk} = \frac{\sum_{i=1}^m \frac{P_{ij} w_{ik}}{P_{ik}}}{\sum_{i=1}^m w_{ik}}$$

$$\text{Paasche Index: } P_{jk} = \frac{\sum_{i=1}^m w_{ij}}{\sum_{i=1}^m \frac{P_{ik} w_{ij}}{P_{ij}}}$$

where, for all  $i = 1, 2, \dots, m$ ,

$P_{ik}$  = price of commodity  $i$  in base country  $k$ ;  
 $P_{ij}$  = price of commodity  $i$  in numerator country  $j$ ;  
 $w_{ik}$  = expenditure weight of commodity  $i$  in base country  $k$ ;  
 $w_{ij}$  = expenditure weight of commodity  $i$  in numerator country  $j$ ; and  
 $m$  = number of basic headings.

These two estimates are then combined into a Fisher index by calculating their geometric mean. That is, the Fisher index is computed as follows:

$$F_{jk} = \sqrt{L_{jk} P_{jk}}$$

The EKS PPP index is then determined as the geometric mean of all relevant direct and indirect Fisher indices as shown below:

$$EKS_{jk} = \sqrt[n]{F_{jk}^2 \prod_{l=1}^n \frac{F_{jl}}{F_{kl}}} \quad l \neq j, k$$

In Phases III and IV, the GK method was used. In Phase V, the GK method was used for global comparisons and some regional comparisons, but the EKS method was used for several regional comparisons. The EKS method was also used for Phase VI. The ICP results which use the GK method are

expressed in terms of the international dollar 1/ while those results determined via the EKS approach use the U.S. dollar. The primary difference between the two types of currencies is that the international dollar estimates were derived using the average international price structure, while U.S. dollar estimates are dependent upon the U.S. price structure.

#### IV. World Bank Methodology

The PPP-based estimates of GDP used in the Bank's *World Development Report 1992* and *1993* rely heavily on the data from the ICP. 2/ For the 1992 publication, estimates of 1990 per capita GDP were obtained as follows:

1. Estimates were first obtained for 1985 by using:
  - a. ICP Phase V results for the 64 countries which participated in 1985;
  - b. the most recent results from either ICP Phase IV (1980) or Phase III (1975) extrapolated to 1985 for those countries which did not participate in 1985 but had participated in earlier phases;
  - c. regression estimates (using "bridging equations") for those countries that had not participated in any ICP phase.
2. The 1985 figures were then extrapolated to 1990 via Bank estimates of real per capita GDP growth.
3. All results were then converted to 1990 international dollars using the U.S. inflation rate between 1985 and 1990.

To obtain estimates of PPP-based GDP per capita for those countries which never participated in the ICP studies, a regression (or bridging) equation was obtained using 1985 data. The explanatory variables used in the bridging equation are (1) exchange rate-based per capita GNP estimated by the *World Bank Atlas* method 3/ and (2) secondary school enrollment (used as a crude proxy for skilled human capital), with both variables expressed in logs. The dependent variable is the latest available ICP estimate (or extrapolation) of PPP-based per capita GDP (expressed in log

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1/ The international dollar is defined to have the same purchasing power as the U.S. dollar over total U.S. GDP, but its purchasing power is determined by average international prices rather than U.S. prices.

2/ See Table 30 and its associated technical notes in the *World Development Report 1992* and *1993* for a fuller discussion of the methodology.

3/ The *Atlas* method attempts to smooth fluctuations in exchange rates and per capita GNP estimates by using a three-year average for the official or market exchange rates which are used to convert the GNP figures to U.S. dollars.

form) for those countries that participated in Phases III, IV, or V. The resultant bridging equation was then used to predict the PPP-based per capita GDP for nonparticipating countries in the ICP.

In the 1993 publication, a similar methodology was used. However, a 1987 database was employed; since none of the ICP phases took place in 1987, this database was developed by using backward extrapolation for those countries which participated in the 1990 ICP Phase VI and forward extrapolation using the latest ICP data for the remaining benchmark countries which participated in at least one of the earlier phases. In addition, staff estimates for China and the FSU economies were used. For the remaining non-benchmark countries, the bridging equation described above was first fitted using 1987 data and then used to predict the PPP-based per capita GDPs. All 1987 data were then extrapolated forward using real growth rates and U.S. inflation rates to produce 1991 PPP-based per capita GDPs.

#### V. Fund Methodology

The PPP-based weights used by the Fund in the May 1993 issue of the *World Economic Outlook* differ from those used by the Bank, although they are also based on the ICP database (with 1985 figures, comparable to that used in the 1992 *World Development Report*). For the benchmark countries, rather than using the figures directly from the ICP, the Fund used the PPP estimates from the Penn World Table Mark 5 (PWT5), <sup>1/</sup> an extensive time series database derived from the ICP studies by Robert Summers and Alan Heston of the University of Pennsylvania. The PPP-based GDP estimates from the PWT5 differ somewhat from the ICP estimates for the benchmark countries for three reasons: (i) the GK method is used without requiring regional fixity; (ii) the PWT5 uses current national accounts data; and (iii) an errors-in-measurement model is used to provide maximum likelihood estimates of adjustment factors for reconciling ICP benchmark comparisons and national accounts growth rates. <sup>2/</sup>

For the non-benchmark countries, the Fund staff employed a combination of methods. For some countries, the estimates were obtained from the bridging equations developed by Summers and Heston for the PWT5. For the PWT5, PPPs were estimated from post-allowance adjustment price surveys conducted by the United Nations International Civil Service Commission. Although such price indices are appropriate only for a special population--expatriates usually living in capital cities--and, therefore, would not accurately reflect the country's true price structure, Summers and Heston found a structural relationship between the benchmark countries' PPP indices

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<sup>1/</sup> See Summers and Heston (1991) for a detailed description of the Penn World Table Mark 5. For practical reasons, the Fund adopted the PPP estimates of the Penn World Table, rather than those used by the Bank, because the Penn World Table provides time series while the Bank does not.

<sup>2/</sup> See Ahmad (1992) for a detailed comparison of the actual PWT5 and World Bank estimates.

and their post-allowance PPP, which was then employed for estimating non-benchmark countries' PPPs from their post-allowance data. For Bulgaria, the former Czechoslovakia, and the FSU, the PWT5 estimates were derived from a 1980 study by the United Nations Economic Commission for Europe which uses the Physical Indicators Global method. 1/

For other countries, the Fund used either the Bank bridging equations or its own bridging equations 2/ - in the Fund equations, PPP-based per capita GDP (in log form) was regressed on exchange rate-converted per capita GDP (in logs) and a dummy variable for African countries. 3/ Finally, the PPP index for China was based on an estimate by Jeffrey Taylor. 4/ Taylor's PPP estimate differs from those based on the ICP in two substantial respects: first, it is based on published data, rather than ICP-style price survey data; and second, his methodology approaches estimation from the production side rather than using final expenditure flows. Such differences in methodology may produce figures which are not strictly comparable. For example, for 1991, Taylor's method resulted in a PPP-adjusted estimate of China's GDP of \$1.4 trillion compared with an estimate of \$3.4 trillion using ICP-type data. 5/

As with the Bank estimates, the 1985 data were then extrapolated to 1990 using real GDP growth rates from the *World Economic Outlook* database. In general, although both the Fund and the Bank employed the same underlying database for estimating PPPs for the benchmark countries, the Fund used the PWT5 estimates, while the Bank used the ICP estimates. In addition, the Fund and the Bank often used somewhat different approaches to estimating bridging equations for the non-benchmark countries. In the future, it is expected that there could be a convergence between the PPP indices used by the staffs of the Fund and the Bank.

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1/ See United Nations, Economic Commission for Europe (1980) for a description of the Physical Indicators Global method.

2/ See Gulde and Schulze-Ghattas (1992) for more information regarding the Fund's bridging equations.

3/ Empirical studies have indicated that price levels (adjusted to a common numeraire) in Africa are higher, on average, than in other developing countries. This leads to a smaller divergence between the PPP-based and exchange rate-based estimates for Africa as compared to other developing countries. It is also possible that the dummy variable is capturing the effect of relatively overvalued exchange rates in Africa (particularly for the CFA countries prior to the January 1994 devaluation) compared with other regions.

4/ Taylor (1991).

5/ For comparison, the estimate for China's GDP, converted at the official exchange rate, is only \$379 billion. See Gulde and Schulze-Ghattas (1993), Box 1. GDP Estimates for China.

## VI. Issues for Operational Use

Although most analysts agree conceptually that the use of PPP-based GDP estimates for inter-country comparisons is likely to produce less bias than using exchange rate-based GDP, the question arises as to whether the same conclusion can be reached regarding the application of the currently available PPP conversion factors for operational purposes. Any existing reservations about the precision of the PPP estimates must be carefully considered in light of the significant effect that their usage has on the measurement of relative sizes of economies. In particular, since the purchasing power of the currencies of developing countries tends to be understated by exchange rates, PPP-based estimates of GDP for such countries are often substantially higher than their corresponding exchange rate-based figures. Table 1 provides a comparison of the relative shares of several groupings of countries using both PPP and exchange rate conversions for GDP. 1/ As can be seen in Table 1, the share in total world GDP declines significantly for the industrial countries, with a corresponding increase for the developing countries, when PPP weights are used rather than market exchange rates.

Furthermore, rankings based on PPP-converted GDP dramatically alter the rankings of the world's largest economies. For example, using market exchange rates in 1992, the five largest economies, ranked by GDP, are the United States, Japan, Germany, France, and Italy. However, using the Bank's 1990 PPP rates to convert GDP yields the following ranking: the United States, China, Japan, Germany, and India. 2/ Table 2 provides the rankings and shares in GDP of the 104 countries in the Bank 1991 database on PPPs; the rankings and shares are given for two market exchange rate conversions--those for 1990 and those used in the *WEO* (computed as a three-year moving average for 1987-89)--and the PPP conversion used in the Bank's *World Development Report*. As can be seen from Table 1, the *WEO* PPP-based shares and rankings generally exhibit a pattern similar to that given by the Bank estimates with respect to the large shift in shares toward the developing countries. Nevertheless, there are significant differences between the two PPP-based data sets. 3/ For example, while

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1/ The weights are the shares of total world GDP for each of the listed categories, where "world" GDP is the total GDP for the 104 countries in the Bank database for PPP-adjusted GDPs.

2/ The Fund's PPP weights place China in third place. This ranking does not include the FSU since the 1990 Bank database for PPPs does not have data on the FSU. The difference in the rankings between Table 2 and those given here reflect the differences in the underlying databases for GDP.

3/ With respect to the *WEO* aggregations, the Fund staff has not published the underlying PPP-based GDP data for individual countries, with the exception of the G-7, and a full comparison of the *WEO* PPP-based shares and rankings with the Bank's PPP data is not provided in Table 2. It is understood, however, that many of the estimates used in the *WEO* PPP data are largely derived from published original source data.

Table 1. Comparison of Exchange Rate-Based  
GDP Shares and PPP-Based GDP Shares

	Exchange Rate Shares <u>1/</u>	WEO-PPP Shares <u>2/</u>	WB-PPP Shares <u>3/</u>
<i>World (104) countries</i>	100.00	100.00	100.00
<i>Industrial countries</i>	78.56	56.96	57.12
United States	26.67	23.54	21.35
Japan	14.20	7.99	9.25
Germany	7.26	4.46	4.83
France	5.76	3.67	4.04
Italy	5.29	3.55	3.79
United Kingdom	4.74	3.62	3.62
Canada	2.76	2.27	1.98
Other EC countries	6.13	4.09	4.71
<i>Developing countries</i>	16.31	31.91	34.36
Africa	1.11	2.83	2.77
Asia	6.27	16.93	18.71
Middle East/Europe	4.22	3.61	4.00
Western Hemisphere	4.71	8.54	8.88
<i>Countries in transition</i>	5.14	11.14	8.53
Former U.S.S.R.	4.24	8.71	6.45
Central Europe	0.90	2.43	2.08

1/ These market (or official) exchange rate shares are computed from 1990 GDP data.

2/ These PPP-based GDP shares are from the Fund database that was used for the *World Economic Outlook*, May 1993, and reflect estimates for 1990.

3/ These PPP-based GDP shares are from the Bank's *World Development Report 1993* and reflect estimates for 1991. Although 1990 estimates are available, they do not include estimates for the former Soviet Union.

Table 2. Percent Share in Total World GDP 1/

Country	Market		WEO		WB	
	Rate GDP 1990	Rank	Rate GDP 1987-1989 2/	Rank	PPP-Based GDP 1991 3/	Rank
United States	26.669	1	26.932	1	21.350	1
Japan	14.200	2	15.098	2	9.247	2
Germany	7.257	3	6.436	4	4.825	5
France	5.758	4	5.154	5	4.036	6
Italy	5.287	5	4.525	6	3.793	7
United Kingdom	4.744	6	4.333	7	3.621	9
FSU	4.241	7	7.774	3	6.450	4
Canada	2.764	8	2.670	8	1.982	12
Iran	2.601	9	1.892	11	0.984	19
Spain	2.375	10	1.866	12	1.905	13
Brazil	1.926	11	1.953	10	3.042	10
China	1.787	12	2.019	9	7.387	3
Australia	1.418	13	1.341	14	1.100	17
India	1.412	14	1.492	13	3.671	8
Netherlands	1.348	15	1.218	15	0.971	20
Korea	1.179	16	0.953	19	1.666	15
Mexico	1.161	17	0.960	18	2.384	11
Sweden	1.099	18	0.976	16	0.578	31
Switzerland	1.092	19	0.975	17	0.564	33
Belgium	0.950	20	0.834	20	0.665	24
Austria	0.762	21	0.680	21	0.532	35
Finland	0.664	22	0.569	23	0.311	43
Denmark	0.638	23	0.583	22	0.355	41
Turkey	0.524	24	0.400	29	1.048	18
Indonesia	0.513	25	0.461	25	1.890	14
Norway	0.510	26	0.484	24	0.281	45
Argentina	0.502	27	0.427	27	0.639	26
Saudi Arabia	0.499	28	0.418	28	0.623	27
Thailand	0.394	29	0.325	31	1.141	16
Greece	0.322	30	0.281	35	0.300	44
Poland	0.301	31	0.366	30	0.662	25
Portugal	0.290	32	0.227	37	0.360	39
Algeria	0.289	33	0.304	33	0.545	34
Israel	0.251	34	0.226	38	0.242	49
Venezuela	0.235	35	0.280	36	0.606	29
Czechoslovakia	0.218	36	0.282	34	0.380	38
Philippines	0.214	37	0.209	41	0.579	30
Pakistan	0.209	38	0.213	39	0.852	21
Ireland	0.208	39	0.177	44	0.154	55
New Zealand	0.208	40	0.202	42	0.181	51
Malaysia	0.205	41	0.190	43	0.507	37
Columbia	0.195	42	0.210	40	0.695	23
Romania	0.182	43	0.315	32	0.618	28
Peru	0.176	44	0.173	45	0.259	46

Table 2 (continued). Percent Share in Total World GDP 1/

Country	Market		WEO		WB	
	Rate GDP 1990	Rank	Market Rate GDP 1987-1989 2/	Rank	PPP-Based GDP 1991 3/	Rank
Singapore	0.170	45	0.134	49	0.183	50
Egypt	0.163	46	0.444	26	0.732	22
Hungary	0.159	47	0.153	47	0.243	48
Nigeria	0.157	48	0.166	46	0.570	32
Chile	0.134	49	0.122	51	0.359	40
Morocco	0.125	50	0.116	52	0.323	42
Syria	0.115	51	0.123	50	0.244	47
Bangladesh	0.110	52	0.108	53	0.518	36
Tunisia	0.060	53	0.055	57	0.146	56
Cameroon	0.055	54	0.063	54	0.110	60
Ecuador	0.051	55	0.057	55	0.172	54
Cote d'Ivoire	0.048	56	0.055	56	0.070	68
Oman	0.045	57	0.044	60	0.052	73
Kenya	0.042	58	0.046	58	0.125	57
Uruguay	0.040	59	0.044	59	0.080	64
Sri Lanka	0.039	60	0.038	62	0.174	52
Bulgaria	0.038	61	0.136	48	0.173	53
Guatemala	0.036	62	0.042	61	0.113	59
Dominican Rep.	0.035	63	0.029	67	0.085	61
Ethiopia	0.030	64	0.032	63	0.074	67
Honduras	0.030	65	0.024	74	0.036	81
Zimbabwe	0.030	66	0.031	64	0.078	65
Senegal	0.028	67	0.026	72	0.048	74
Ghana	0.028	68	0.028	68	0.116	58
Panama	0.026	69	0.026	71	0.046	76
El Salvador	0.026	70	0.031	65	0.043	77
Costa Rica	0.026	71	0.027	70	0.059	70
Paraguay	0.026	72	0.027	69	0.057	71
Trinidad & Tob.	0.025	73	0.025	73	0.040	78
Bolivia	0.024	74	0.024	75	0.062	69
Zambia	0.021	75	0.020	77	0.031	83
Jamaica	0.019	76	0.018	79	0.034	82
Jordan	0.019	77	0.030	66	0.075	66
Nepal	0.017	78	0.016	81	0.083	62
Botswana	0.017	79	0.012	85	0.024	93
Papua New Guinea	0.016	80	0.018	78	0.026	88
Madagascar	0.015	81	0.011	88	0.031	85
Congo	0.014	82	0.012	83	0.025	91
Burkina Faso	0.012	83	0.014	82	0.026	89
Mauritius	0.012	84	0.010	90	0.046	75
Tanzania	0.012	85	0.018	80	0.056	72
Niger	0.012	86	0.012	86	0.024	92
Mali	0.012	87	0.011	89	0.015	98
Rwanda	0.011	88	0.012	84	0.019	94

Table 2 (concluded). Percent Share in Total World GDP 1/

Country	Market		WEO		WB	
	Rate GDP 1990	Rank	Rate GDP 1987-1989 2/	Rank	PPP-Based GDP 1991 3/	Rank
Uganda	0.011	89	0.023	76	0.081	63
Haiti	0.010	90	0.011	87	0.031	86
Malawi	0.009	91	0.008	93	0.026	90
Benin	0.009	92	0.009	92	0.027	87
Togo	0.008	93	0.007	95	0.018	95
Mozambique	0.007	94	0.007	94	0.036	80
C. African Rep.	0.006	95	0.006	97	0.013	101
Chad	0.006	96	0.005	99	0.016	96
Burundi	0.005	97	0.006	96	0.015	97
Mauritania	0.005	98	0.005	98	0.011	102
Nicaragua	0.005	99	0.009	91	0.038	79
Lao P.D.R.	0.004	100	0.001	103	0.031	84
Sierra Leone	0.004	101	0.005	100	0.013	100
Lesotho	0.003	102	0.002	101	0.013	99
Bhutan	0.001	103	0.002	102	0.004	103
Guinea-Bissau	0.001	104	0.001	104	0.003	104

1/ Complete data is available for only 104 countries, so all shares are computed with respect to the total GDP of the 104 countries. See Table 2 attachment for the IMF members not included in this list.

2/ These are the weights used in the WEO statistical presentation. They are computed as a three-year moving average for 1987-1989.

3/ Although World Bank data exist for 1990, the 1990 data base excludes the FSU. For comparative purposes, the 1991 World Bank data base, which includes the FSU, is used in this table.

the FSU is ranked fourth for the Bank, the Fund's *WEO* 1990 ranking for the FSU would be second, with Japan third. In fact, of the 104 countries given in Table 2, 25 have shifts in rankings of at least five positions (with Switzerland, Columbia, Romania, Egypt, Bulgaria, Mauritius, Uganda, and Lao P.D.R. shifting by at least ten positions) when the *WEO* PPP data set is used instead of the Bank's.

The substantial changes in rankings and shares between exchange rate-based GDPs and PPP-based GDPs (as illustrated in Table 2) would be acceptable (and perhaps even desirable) if they more accurately reflected the true relative economic structures. However, as discussed further below, a number of issues, regarding the data and methodology underpinning the PPP conversion factors, appear to have a direct bearing on the robustness and reliability of either set of estimates.

#### 1. Data issues

With respect to country-specific operational use, perhaps the most serious problem with the ICP database is its incomplete coverage of countries and even of entire regions. For example, the Latin American countries have not been included in the phases since 1980, most Middle Eastern countries have never been covered, and China will only be participating for the first time in 1993 (and then only in a limited way since only two of the most affluent regions will be surveyed). Thus, bridging equations (sometimes referred to as "short-cut" estimation methods) must be used for the fairly large number of nonparticipatory countries. Since the interpolations from the bridging equations are subject to substantial error, the uncertainty regarding the estimated PPP-based GDPs for the non-benchmark countries will necessarily be much greater than that for the benchmark countries.

The fact that the ICP surveys are conducted infrequently constitutes another problem with respect to their operational usefulness. Since the surveys are performed only once every three to five years, extrapolations to the year of interest are usually necessary. These extrapolations involve the use of real GDP growth rates computed from constant price national accounts data or staff estimates, and are then adjusted upward by the U.S. inflation rate to express the estimate in current U.S. dollars. The results of these extrapolations often differ significantly from the estimates obtained via the actual ICP surveys, since the ICP figures reflect current year price data. Since the use of constant price growth rates imposes the fixed price structure of the base year onto the extrapolations, <sup>1/</sup> discrepancies with the current price ICP data will be most marked when significant changes in relative price structures have occurred. However, work is currently being undertaken to reduce this problem of inconsistency

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<sup>1/</sup> For example, extrapolations do not take account of changes in the terms of trade.

between ICP current price estimates and the extrapolations achieved through the use of constant price growth rates. 1/ Attempts are being made to harmonize the ICP data with those from national accounting and CPI data.

An issue related to the infrequency of the ICP surveys is the timeliness of dissemination of the data. For example, although some regional results were available within a reasonable period of time, the global report for Phase V (1985) was not published until 1993. Such delays result in data that are less relevant for work on contemporary issues.

There are also a number of problems involved in evaluating baskets of goods and services produced in different countries. In conducting price comparisons across very diverse countries, it is extremely important that the prices correspond to items of the same quality and quantity. This often poses a conflict with the goal of having items be representative of a country's expenditure pattern. In order to achieve representativeness, a fixed basket of goods cannot, however, be used for all countries. Thus, since countries do not price the exact same set of items, the basic headings may contain a somewhat different composition of goods and services across countries.

Some countries may focus more on representativeness in their price collection, while others may emphasize comparability. An emphasis on representativeness, since such items tend to be less expensive in developing countries, may lead to overestimating GDP compared to those countries which may have stressed the collection of price data on comparable-quality items. For this reason, comparisons between countries with similar expenditure patterns (and levels of development) are likely to be more reliable than comparisons between countries with diverse consumption patterns.

Certain categories of items are particularly difficult to compare accurately. For example, for housing and cars, where quality differences are quite pronounced and particularly important, hedonic regressions are often used for price estimation. 2/ Perhaps the greatest difficulty in comparing like items occurs with the "comparison-resistant" services sectors. 3/ Frequently, government, education, or health services have no market price. In addition, the quantity and quality of output is difficult to measure. Therefore, the levels and prices of inputs are often used as a crude measure of output, but this method is likely to ignore quality or

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1/ See Ahmad (1993). However, another source of intertemporal inconsistency arises from inconsistencies over time in the ICP basic categories.

2/ Such regressions postulate a relationship between prices of varieties of heterogeneous goods and the quantities of characteristics contained in them. In this manner, the quantities of characteristics are used as a measure of the quality of the good, so that differences in prices are associated with variations in quality.

3/ This is the terminology used by the ICP to indicate the difficulty in determining the proper international pricing of services.

productivity differences. For these reasons, the prices for the service categories are probably among the least reliable prices in the ICP. 1/ However, a number of the data problems described above are not unique to interspatial (ICP) income comparisons but are also likely to plague intertemporal (national accounts) income comparisons to some degree.

PPPs do not account for the price of capital. 2/ By ignoring capital flows and concentrating on consumption goods and services, PPPs overlook a major determinant of a currency's value in the international marketplace. Indeed, capital transactions are not relevant for PPP calculations since PPPs are designed to measure purchasing power of currencies in domestic markets and not in international markets. This issue would seem to be critical with respect to the usage of PPPs for such operational procedures as the quota calculations. For example, Lancieri (1990) argues that the failure to account for the capital market is likely to produce higher estimates for developing countries (in particular, for those countries with the least developed financial markets) if PPP-adjusted GDP is employed. 3/

Market exchange rates are more indicative of the relative valuation of both the tradables sectors and capital flows of members' economies, since market exchange rates are the actual prices at which external transactions take place. For the computation of PPPs, the nontradables sectors play a critical role, and, as noted earlier, international comparisons of the transactions in nontradables are difficult to make. However, it is important to note that market exchange rates suffer from many deficiencies as well. Most seriously, exchange rate-converted GDPs often produce results that are inconsistent with developments in real GDP growth rates. For example, the use of exchange rates for computing China's GDP produces the anomalous result that nominal GDP in U.S. dollar terms is lower than three years ago, despite real growth rates substantially higher than those of most other countries. Nevertheless, for Fund operational purposes (such as quota calculations) for which measures of the relative international influence of an economy are required, the use of market exchange rates for the conversion of GDP may, on balance, be preferable.

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1/ The increasing share of services in global GDP as countries mature will pose further difficulties for PPP-based comparisons.

2/ Lancieri (1990) discusses in more detail the potential for bias and distortion as a result of the non-inclusion of the price of capital in the construction of PPP indices.

3/ It has been argued that market exchange rate-based GDP captures much of a country's relative financial importance since market exchange rates can be strongly influenced by capital flows. In addition, capital account variables are indirectly reflected in the quota formulas via changes in reserves.

## 2. Methodological issues

Apart from data deficiencies, a number of methodological issues also need to be considered with respect to the use of PPP conversion factors. A PPP index should have several desirable properties: (1) base country invariance; (2) transitivity; 1/ (3) additivity; 2/ and (4) characteristicity. 3/ However, there are trade-offs between the properties. For example, complete characteristicity for each pair of countries would make transitivity impossible. If the property of characteristicity is fully satisfied, then the quantity weights used for a pairwise comparison would be based solely on the characteristic consumption patterns of the two countries involved. Hence, each bilateral comparison would utilize a set of weights unique to that specific pair of countries so that the resulting indices would not be transitive.

The GK method of aggregation satisfies the properties of base country invariance, transitivity, and additivity. However, this procedure is subject to the Gerschenkron effect. The Gerschenkron effect refers to the upward bias for countries whose local price structures differ considerably from the "average" international price structure. 4/ In particular, the international "prices" are a weighted average of prices observed across many different countries, where the weights reflect country shares in total global expenditure for the given commodity. Thus, since the affluent industrial countries account for a disproportionate share of total global expenditure, the synthetically constructed international prices tend to be

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1/ Transitivity refers to the property that direct bilateral comparisons between two countries should yield the same result as indirect comparisons between the same two countries, using a third country as an intermediate between the first two.

2/ Also referred to as matrix consistency, this property implies that estimates of subaggregates of GDP (within a country) should add up to total GDP, and consistent comparisons can also be made across countries (within a subaggregate).

3/ This property, similar to the property of representativeness discussed in the previous section, implies that the quantity weights used in the PPP index should accurately reflect the consumption patterns for the countries under consideration.

4/ The GK version of PPP estimation developed by Kravis, Heston, and Summers (1982) employs "super-country weights" to deal with the problem of incomplete coverage (for example, if country A participated in the ICP exercise, but country B did not, country A's price and quantity structures could be treated as representative of those in country B, if both countries come from the same income group). While this approach softens the Gerschenkron effect (since it shifts the "average" country more toward the developing countries, which are underrepresented among the ICP participants), it depends on a rather strong assumption of structural similarity within respective income groups and introduces a degree of arbitrariness and inaccuracy that is difficult to measure.

dominated by the price structures of these high-income countries. For this reason, the outputs of the lower-income countries are evaluated using higher prices than might be consistent with their level of development or with quality differentials, with the consequence that the purchasing power of developing countries may be inflated and the PPP-based GDPs overestimated. However, the regionalization of the ICP estimates is expected to moderate this effect to some extent.

The EKS procedure minimizes the Gerschenkron effect, but this aggregation method does not satisfy additivity (that is, estimates of subaggregates of GDP may not sum up to total GDP). For this reason, the GK method is often preferred, although the EC and the OECD have been using the EKS procedure 1/ for their "official" estimation of PPP indices.

The ICP's use of regional fixity in their estimation procedure implies that the gains in reliability within regions come at a cost of a loss in reliability in global comparisons. 2/ However, it could be argued that even with a global method of aggregation, comparisons between countries in different regions with markedly disparate consumption structures may not be very accurate. Nevertheless, improvements could be made in the current methodology of linking regions by switching from the link via binary comparisons of "core countries" to a link using "core commodities." With this method, each country prices a subset of common items in order to provide the linkage. Among the advantages of this approach are the multiplicity of linkages and the independence of the linkage from the choice of core countries. The core commodities technique will be tried in the 1993 Phase VI.

The choice of "short-cut" estimates for the non-benchmark countries is an issue for further examination. Substantial errors are likely to arise from the derivation of regression coefficients based on the set of ICP benchmark countries that are not necessarily representative of the non-benchmark countries. In addition, the equations include insufficient explanatory variables to capture diverse economic structures. The bridging equations developed by the Fund and the Bank both rely heavily on using exchange rate-converted GDP per capita as the major explanatory variable for predicting PPP-based GDP per capita. Such predictions are likely to be dominated by the underlying magnitude of local currency GDP, 3/ common to both the PPP and exchange rate conversions. This might be the driving force behind the high adjusted R-squared values obtained for the bridging

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1/ Since the EKS method does not suffer from the Gerschenkron effect, it was felt that this method would provide more accurate bilateral comparisons.

2/ Regional fixity also implies that additivity is not necessarily satisfied in the global comparisons, although additivity continues to exist within regions.

3/ This issue is somewhat related to the time series concept of spurious regressions, in which a common trend, rather than a true economic relationship, can produce very high R-squared values without any real explanatory power.

equations; thus, exchange rate-converted GDP per capita may have less explanatory power than it appears for predicting the deviation between PPPs and market exchange rates. 1/ A better choice of dependent variable might be the price level; that is, the ratio of the PPP rate to the market exchange rate. Indeed, when the price level is chosen as the dependent variable, the R-squared value drops considerably although out-of-sample prediction properties are similar. 2/

The bridging equations used in the PWT5 employ UN post-adjustment price survey data. This data is collected for goods and services consumed by relatively affluent foreigners living primarily in capital cities. Thus, the use of the post-adjustment data might impart a bias toward atypical consumption patterns in developing countries. Nevertheless, out-of-sample prediction properties seem reasonable.

As discussed above, the primary method for obtaining PPPs for the ICP benchmark countries currently involves the use of weights which are largely dominated by the industrial countries. Since this may produce biased estimates for those countries whose expenditure and price structures differ substantially from the industrial countries, various other weighting techniques have been suggested. Suggestions have included the assigning of equal weights to industrial and developing countries, 3/ or the use of weights based on population, so that average international prices do not reflect primarily the rich countries' price structures.

One alternative suggestion that has been given particular emphasis is the Iklé index 4/ for international comparisons. The Iklé approach can be interpreted as a "democratic" version of the GK system, in that this method removes the influence of real GDP on the international price structure and more nearly approximates an equal weighting scheme. Dikhanov (1994) shows that the Iklé system of simultaneous equations for international prices and PPPs can be expressed as

$$I_i = \sum_{j=1}^n \frac{P_{ij}}{PPP_j} \cdot \frac{S_{ij}}{\sum_{k=1}^n S_{ik}} \quad i = 1, \dots, m$$

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1/ Of course, a high R-squared is not indicative of a regression's ability to forecast out-of-sample.

2/ See Ahmad (1992) and Gulde and Schulze-Ghattas (1992) for more detailed descriptions of the bridging equations, associated R-squared values, and out-of-sample prediction properties.

3/ Note that assigning equal weights to all countries implies that a country which rarely consumes a given commodity will have as great an impact on the international price as a country for which the commodity comprises a significant portion of consumption.

4/ Iklé (1972).

$$PPP_j = \frac{\sum_{i=1}^m P_{ij} \cdot q_{ij}}{\sum_{i=1}^m I_i \cdot q_{ij}} \quad j = 1, \dots, n.$$

where

$$s_{ij} = \frac{I_i \cdot q_{ij}}{\sum_{i=1}^m I_i \cdot q_{ij}},$$

or the real share of commodity  $i$  in the total expenditures of country  $j$ , measured in international prices;

and

$I_i$  = average international price of commodity  $i$ ;  
 $P_{ij}$  = price of commodity  $i$  in country  $j$ ;  
 $q_{ij}$  = quantity of commodity  $i$  in country  $j$ ;  
 $PPP_j$  = purchasing power of currency of country  $j$ ;  
 $m$  = number of basic headings; and  
 $n$  = number of countries.

Thus, a comparison with the GK system of simultaneous equations shows that the primary difference between the GK method and the Iklé method lies in the difference in the weights used to produce an average international price. Whereas the GK method uses quantity weights, the Iklé approach employs expenditure shares, measured in international prices, as weights. Although the Iklé method eliminates the Gerschenkron effect bias toward high-income countries' price structures, the Iklé weights introduce another type of selection bias, in that a small economy with a marked preference for a given commodity could have a much greater impact on the international price than a large economy which actually consumes much more of the commodity.

Dikhanov examines the impact of various weighting schemes on estimates for GDP per capita. He demonstrates that the Iklé index produces results that are close to results obtained using either equal weights (i.e., unweighted) or expenditure share weights (using domestic prices to compute expenditures for a given country, rather than the international prices used in the Iklé index). In addition, the Iklé estimates are reasonably close to the EKS estimates, but there is a significant discrepancy between the Ikle and GK results. Furthermore, the Iklé approach, as compared with the GK method, yields estimates that are closer to those obtained using the market exchange rate.

With respect to the construction of the international price, the GK method has at least a reasonable statistical foundation. Since the quantity weights of the GK approach indicate the frequency with which a given price is used to value a given commodity, the GK international price is based on the commonly used frequency approach to point estimation. The Iklé index, with weights based on expenditure shares, is somewhat more difficult to interpret statistically. Nevertheless, a general criticism associated with computing international "prices" is the difficulty of interpreting such synthetic constructions from an economic point of view. Questions have been raised as to whether there is any choice-theoretic rationale behind the concept and as to the meaning of one price for a given commodity across all countries. It has been argued that the notion of a single cross-country price, particularly for nontradables (many of which could not become tradable whatever their price), assumes away the differential degrees of economic development, market imperfections, and differing production and consumption structures. However, the focus of global comparisons is not on an international price with an explicit economic interpretation as a market signal or resource allocation device, but rather on comparing real quantities across countries as a measure of economic well-being. To this effect, the international price is merely a mechanism, and not really a price in the economic sense, for aggregating and valuing otherwise noncomparable quantities. Thus, in assessing the alternative methodologies, it is important to avoid the misperception that the international "price" should function as a true market price.

While the ICP estimates are obtained from the expenditure side of national accounts, another method for obtaining PPPs would be to develop production-side estimates. Paige and Bombach (1959) note that, while an expenditure-based approach may be suitable for comparisons between industrial countries since "consumption patterns are usually more similar than production patterns" in such countries, the production-based approach may be preferable for developing economies where production data are frequently of better quality than consumption data. Several studies 1/ have examined both theoretical and empirical production-side approaches to inter-country comparisons, despite the considerable statistical difficulties. 2/ For example, Velupillai and Zambelli (1993) note that the production-side approach to global comparisons emphasizes the effectiveness of production structures across different economies. They develop a method for constructing production prices and productivity indices from input-output-type matrices. They then apply highest productivity

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1/ Kurabayashi and Sakuma (1990), Seton (1992), Steenge and Bramer (1993), and Velupillai and Zambelli (1993).

2/ For example, the problem of double deflation often plagues traditional production-side estimation. To estimate value added at constant prices requires that both output and intermediate inputs be valued at constant prices, so that value added is affected by errors of measurement in two series.

techniques to construct international standard commodities. However, such a procedure may be subject to a Gerschenkron-type effect of a bias toward the production structures of the high-income countries.

Although theoretically both production- and expenditure-side approaches should yield similar results, recent work with the production-side methodology has produced substantially different estimates than that obtained from the ICP studies. While future work could be undertaken to integrate both approaches and achieve a more reliable estimation method, the choice of methodology may well depend ultimately on pragmatic considerations and on the relative quality of available data for either approach. 1/

### 3. Impact on operational procedures

The impact of using PPP factors for Fund operational procedures, such as quota calculations or determination of ESAF eligibility, is potentially significant. 2/ Any use of PPP conversion factors for operational purposes would have financial implications, and for this reason, such applications could prove controversial. Before such usage would be warranted, it would seem essential to have uniformity and consistency in the quality and coverage of country data. 3/ In addition, it would require wide-spread agreement on methodological issues, given that the results are highly dependent on the choice of methodology.

With respect to the impact of using PPP-based GDP on quota calculations, 4/ substantial shifts occur in the distribution of the calculated quotas, with the developing countries' share of total calculated quotas increasing by 4.7 percentage points, while the industrial countries' share declines by a commensurate amount. For ESAF countries, using PPP-adjusted GDP produces a significant shift in the share of calculated quotas to 7.9 percent, up from 5.1 percent. These aggregate figures, however, do not capture the degree of shifting for the individual countries. Of greater

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1/ Indeed, no single aggregation procedure or methodology will satisfy all the criteria that have generally been proposed. A choice would need to be made among the alternatives to meet the requirements of specific users.

2/ For example, the contribution of the GDP variable in the calculated quotas for the Ninth Review was approximately 36 percent.

3/ Of course, it could be argued that market or official exchange rate conversion factors also suffer from lack of uniformity and consistency in their quality. However, in contrast to the situation with PPP conversion factors, "market" exchange rates "exist" for all countries and do not have to be artificially constructed based on simple, but often inaccurate, comparisons with other countries (as must be done to obtain PPP conversion factors for many of the developing countries which have not participated in the PPP exercises).

4/ The results for the quota calculations are based on data through 1990 and the PPP database used by the Fund for *WEO* weights.

significance is the fact that the average percentage deviation from the shares in the conventional quota calculations is 21.9 percent, with 85 Fund members' shares 1/ moving outside a 5 percent deviation band from the shares calculated according to the customary method.

Closely related to the shifts in shares are shifts in the members' rankings based on calculated quotas. For example, if PPP conversion factors are used for GDP, Germany replaces Japan for the second place ranking. While no industrial countries are among the large gainers in ranking (shifting upward by three or more places), several industrial countries (Australia, Finland, Greece, and Iceland) move significantly downward in ranking. Among the developing countries, several of the largest show substantial gains, including China (which moves into ninth place from 15th), India, Brazil, Mexico, and Indonesia. Furthermore, while 35 developing countries move upward by at least three places (with nine shifting by ten or more positions - the largest upward shift was 37 places), 49 developing countries move downward by three or more positions (the largest downward shift was ten places).

If PPPs were to be used for quota calculations, the decision made by a country as to whether or not to participate in the ICP surveys could hinge on the expected outcome for the estimated GDPs. Quotas serve several diverse functions in the Fund: (i) they determine members' contributions to Fund resources; (ii) they determine the potential level of members' access to Fund resources; (iii) they form the basis of members' voting power; and (iv) they serve as the basis for distributing SDR allocations. Based on these functions, countries may want higher quotas since a larger quota could provide greater voting power, increase the extent to which the country can borrow Fund resources, increase the share in any SDR allocation, and be interpreted as an indicator of greater economic importance. Alternatively, some countries could prefer somewhat lower quotas if they expect to be creditors to the Fund.

Another potential operational application would be in the determination of ESAF eligibility. Eligibility for concessional assistance under either ESAF is based broadly on the criteria of per capita income and IDA (International Development Association) eligibility. As indicated above by the upward shift in total calculated quotas for ESAF countries when PPPs are used, per capita incomes for many of the countries would likely rise significantly. 2/ If PPPs were to be considered for determining SAF or ESAF eligibility, refusal to participate in the ICP exercise could be a particularly critical problem for those countries currently eligible. In

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1/ These members currently comprise 64.5 percent of the present quota shares.

2/ Of course, if PPP-based estimates of per capita income were to be employed, the cut-off for eligibility would also be reconsidered. Nevertheless, substantial shifts in eligibility can be expected to occur with the switch to PPP conversion rates for those countries in the region of the cut-off per capita income figure.

such cases, eligible countries could only lose if it were determined that their per capita incomes were significantly greater than previously estimated using market exchange rates. Furthermore, any attempt to use such methods as bridging equations to estimate PPP-adjusted GDP, in lieu of survey participation, could meet with considerable opposition, given the margin of error of such methods. 1/

## VII. Concluding Remarks

To improve the reliability of PPP estimates and enhance their potential for operational use, one of the most important steps would be to increase the frequency and coverage of the ICP surveys, which could be accomplished by integrating the collection of ICP price data into national income accounting systems. This would reduce the use of "short-cut" estimation with bridging equations and significantly enhance the quality of the estimates.

Given that full expansion of the ICP surveys may be difficult to implement, 2/ the use of bridging equations is likely to continue. The statistical properties of these equations could potentially be improved through the inclusion of additional explanatory variables. Alternatively, reduced-information techniques (i.e., collecting data on a small subset of prices) could be applied for those countries which are unable to participate in the full-scale ICP surveys. An initiative is currently underway to attempt the implementation of reduced-information surveys on a more frequent basis for a broader array of countries by 1995 or 1996, with the Bank spearheading the effort to more fully involve other international organizations, including the Fund.

Apart from data considerations, the choice of methodology underlying the construction of PPP indices is still subject to considerable debate. The various approaches can produce substantially different estimates of PPP-adjusted GDP, and further work on the relative merits of the differing approaches might better quantify the resulting biases or distortions in the methodologies.

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1/ In the World Bank's *World Development Report 1993*, regression estimates as well as actual ICP survey-based estimates of PPP-adjusted GDPs per capita are provided for comparison purposes. For example, in Ethiopia, actual survey results imply a per capita income of 370 international dollars, while regression results indicate an income of 620 international dollars.

2/ Conducting the extensive ICP surveys needed for accurate estimates of PPPs could entail considerable technical and financial support for some of the developing countries. The required resources for full implementation may not be available.

The difficulties encountered with the use of PPPs for operational purposes arise in part because many of the countries which would be most affected by the shift to PPP conversion factors are precisely those without ICP coverage or that have substantially obsolete data. Problems associated with the usage of PPP conversion factors are less severe in other applications where the need for precision may be less critical, such as for calculating statistical averages or aggregation. Indeed, the use of PPP indices has become more widespread for such applications as obtaining weighted averages of regional growth rates (as in the *WEO*) or approximating bilateral comparisons of standards of living for different countries.

On balance, the quality and coverage of PPP data currently available raise difficult questions regarding their present usability for the operational purposes of international financial institutions, and these questions are likely to need revisiting in the future. The use of PPP data for statistical purposes has generally been accompanied by reservations regarding undue reliance on PPPs for such purposes as determining "equilibrium" exchange rates or exchange rate policies for particular countries. According to the Statistical Commission of the United Nations: "further methodological improvement [needs to be] attained before the ICP results can be accepted for policy purposes at the world level." <sup>1/</sup> Thus, the use of PPPs for converting GDPs for application in quota formulas or for other Fund operational purposes would not seem warranted at this time.

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<sup>1/</sup> UN and EUROSTAT (1986-1987).

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