International Comparison Program

Measuring the Size of the World Economy

Framework, Methodology, and Results of the International Comparison Program

Executive Summary

ICP 2011

Measuring the Size of the World Economy
ICP Book

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In its 2005 round, the International Comparison Program (ICP) became the largest and most complex international statistical program in the world. One hundred and forty-six countries provided the thousands of prices and related measures used to estimate purchasing power parities (PPPs) in order to deflate national gross domestic product (GDP) expenditures into a common global currency. The resulting PPPs and volume indexes make possible sound comparisons between countries that are based on economic and statistical theory. Each successive round of the ICP since its launch in the 1960s has involved more countries and more innovations in methodology. The results of each round provided the building blocks for the new theory and methods introduced in the next rounds.

This book describes the challenges faced by the 2005 round of the ICP, the new theories and methods developed to address those problems, and the lessons learned that can be applied to future rounds of the ICP. This book has been prepared to ensure complete transparency in the theory and methods used and the problems encountered. Much of the analysis presented by the authors of the chapters was made possible by giving them access to a data file containing the basic heading PPPs and expenditures for the 146 participating countries.

1. What Is a Purchasing Power Parity?

In its simplest form, a PPP is a price ratio. PPPs for the total consumption aggregate of the GDP, for example, are built up from comparisons of the prices of products purchased by households. To ensure that comparable products are being priced, the characteristics of each product must be carefully defined. This summary relies on the data example in table 1 to explain the concepts and methods used in the ICP. The data are taken from the Ring data collection in the 2005 ICP.[1] The table shows the national average prices for three products and four countries for the rice basic heading. The PPP between the Arab Republic of Egypt and the United Kingdom for prepacked long grain rice is the average price in Egypt in its national currency (Egyptian pound or LE) divided by the average price in U.K. pounds sterling (£). The price ratio 7.54 means that LE 7.54 is the cost of an amount of long grain rice in Egypt that would cost £1.0 in the United Kingdom. Likewise, LE 3.30 is the cost of the same quantity of long grain rice sold loose that would cost £1.0 in the United Kingdom.

As table 1 illustrates, the relative prices (product PPPs) differ by product. Therefore, the product PPPs are averaged to arrive at a PPP for the rice basic heading. The simple geo mean is the bilateral PPP. In practice, multilateral PPPs are computed, which takes into account the relative prices between all of the countries as a group. More will be said about this in the sections that follow.

Because there are no weights reflecting the quantities of each product purchased, the basic heading PPPs are computed with products and countries treated equally. However, expenditures are available for each basic heading; therefore, they are used as weights when averaging basic

heading PPPs to major aggregates such as food. The PPPs for the major aggregates are then averaged to the GDP, again using weights. Table 2 shows PPPs for selected basic headings in the food aggregate and the average PPP for food. The food PPP means that LE 4.22 is the cost of an amount of food in Egypt that would cost £1.0 in the United Kingdom. More important, the expenditures in Egyptian pounds for the food aggregate of the GDP in Egypt can be converted to the U.K. currency by dividing it by the PPP, or 4.22. The food PPPs in the other countries can also be converted to the U.K. pound by dividing their food expenditures by their respective PPPs.

Another important measure is the price level index (PLI), which is simply the PPP divided by the exchange rate. PLIs that are less than 1.0 mean the products or aggregates are relatively cheap. The PLI is also a measure of the ratio of nominal expenditures (based on the exchange rate) to real expenditures based on PPPs. The price level indexes for food shown in table 2 indicate that food is relatively cheap in those countries and also that the nominal expenditures for food would be 0.42, 0.64, and 0.52 of the real expenditures, respectively, in Egypt, Estonia, and the Philippines.

The PPP for the GDP is based on the prices collected for about 1,000 products plus measurements for other aggregates such as housing, government, and construction that are used to first estimate basic heading PPPs and then average them to the GDP. The PPPs at each level of aggregation and for the GDP are simply a form of exchange rate to calibrate expenditures in national currencies to a common currency. While simple to say, the resulting PPPs are based on the very complex statistical and economic theories presented in detail in chapters 1, 4, 5, and 6 and summarized here in a later section.

Table 1 Prices of Products in Rice Basic Heading and Their Ratios to U.K. Prices for Selected Countries

	Egypt, Arab Rep./United Kingdom		Estonia/United Kingdom		Philippines/United Kingdom		United Kingdom	
Rice basic heading	National price	PPP to U.K.	National price	PPP to U.K.	National price	PPP to U.K.	National price	PPP
Long grain, prepacked	5.51	7.54	11.59	15.87	32.73	44.83	.73	1.00
Long grain, loose	3.47	3.30			23.35	22.23	1.05	1.00
Basmati	5.69	5.69	45.68	20.48			2.23	1.00
Geo mean— bilateral PPP		5.22		18.02		31.56		1.00
Multilateral PPP		4.80		19.98		33.36		1.00
Exchange rate	10.12		22.78		90.87			

Source: Ring survey, ICP 2005.

Table 2 PPPs for Selected Basic Headings and Countries (U.K. =1.00)

Basic heading	Basic heading PPPs (U.K. = 1.00)			
	Egypt, Arab Rep./United Kingdom	Estonia/United Kingdom	Philippines/United Kingdom	United Kingdom
Rice	4.80	19.98	33.36	1.00
Other cereals	7.12	18.46	95.28	1.00
Bread	6.80	15.98	60.73	1.00
Beef and veal	4.60	10.60	31.22	1.00
…29 basic headings				
Food aggregate PPP	4.22	14.67	47.32	1.00
Exchange rate	10.12	22.78	90.87	1.00
Price level index	0.42	0.64	0.52	

Source: Ring survey, ICP 2005.

Uses of PPPs

The PPP-based expenditures allow direct comparisons of indicators of well-being, such as expenditures per capita, because they are now in a common currency. Similar comparisons can be made for other aggregates such as health, education, housing, government, and GDP. The PPPs for household consumption are the main input for estimation of the international poverty line, which is a main driver of international development efforts. Countries with different rates of economic growth can compare their price levels and per capita expenditures to guide their development policies. PPP-based expenditures allow comparisons across countries for different sectors. For example, the 2005 ICP showed that China accounted for 29 percent of global real expenditures on construction.

A major use of PPPs is for poverty assessments (see chapters 20 and 21). National poverty assessments differ by country because purchasing power differs. Therefore, an international poverty line is established using PPPs to hold the real value constant across countries. The international poverty line of $1.25 in international dollars is translated to the national level using PPPs. Household survey data are then used to determine the number of people living with per capita consumption below the poverty line.

The International Monetary Fund (IMF) uses PPP-based GDP to determine the quota subscriptions of member countries (see chapter 23). The quota not only determines the financing each country must provide to the IMF, but also determines the amount of financing a country can obtain from the IMF and largely determines its voting power in IMF decisions. The IMF also

uses PPP-based GDP numbers in its *World Economic Outlook,* which provides estimates of regional and world output and growth.

Finally, the U.S. Federal Reserve Board uses PPP-based data on the GDP and aggregates to undertake an empirical analysis of international price levels (see chapter 23). Other organizations and researchers use PPPs for international comparisons of output and productivity at the sector level (agriculture, manufacturing, and services). These comparisons produce useful complements to comparisons of GDP or expenditure categories (see chapter 24).

Why Not Use Exchange Rates?

This question arises often. First, exchange rates do not reflect the different price levels across components of the GDP—for example, table 2 shows the variability of selected basic headings in the food aggregate. Table 3 shows the PLIs for the GDP and major aggregates for China and India. If exchange rates were used to deflate GDP expenditures by aggregate, the same value would be used regardless of the difference in price levels. The comparisons of per capita expenditures across countries would then not reflect the relative price differences. Second, the use of PPPs allows direct comparisons. Again using table 3, the PLI for health in both countries is several times smaller than the food price level. The PLI also reveals the difference in health expenditures if they are deflated using the exchange rate instead of PPPs. In other words, the nominal expenditures for health in China and India based on the exchange rate would be 16 and 13 percent, respectively, of the real expenditures based on PPPs.

Table 3 Price Level Indexes for Major Aggregates, China and India

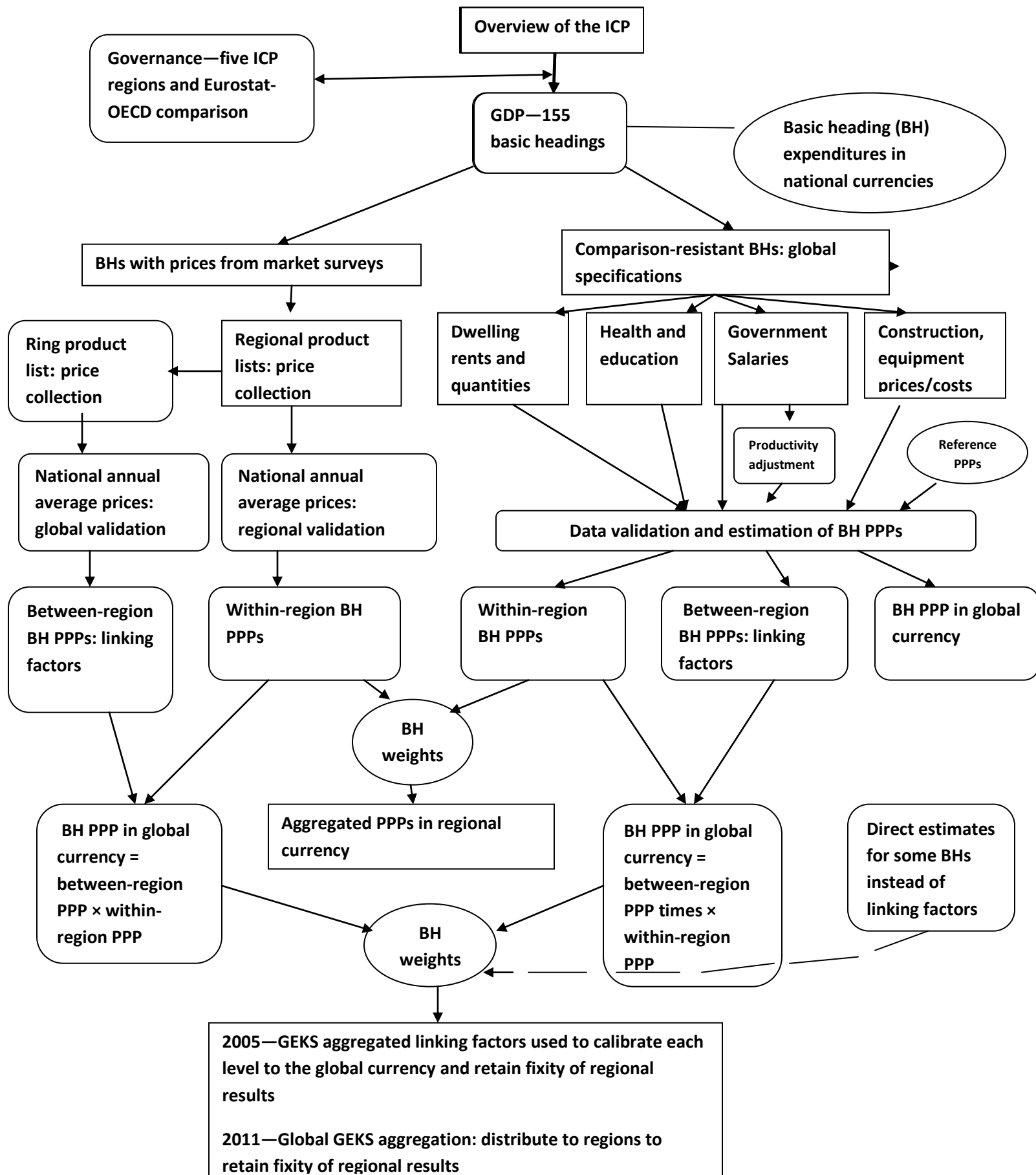|	Price level indexes (world = 100 for major aggregates)					
	GDP	Food	Health	Education	Collective government	Gross fixed capital formation
China	52	75	16	31	31	79
India	41	53	13	16	35	48

Source: ICP 2005.

2. Data Collection for the Estimation of PPPs

The ICP is made up of three major components. The first component is the conceptual framework, which is determined by the set of national accounts making up the GDP. The second component is the national annual average prices or quantity or value data for a basket of goods and services that are comparable across countries and are representative of purchasing patterns within each country. The third component is the methodology used to compute the PPPs at the following levels: product, basic heading, aggregates of GDP, and GDP.

These three components are carried out under a governance structure whereby countries are grouped into regions with a regional coordinator. The ICP Global Office in the World Bank provides the overall coordination of the program across the regions and also the coordination with the Eurostat–Organisation for Economic Co-operation and Development (OECD) comparison (see chapter 2).

Figure 1 is an overview of the different steps required to produce estimates of PPPs. The starting point is the GDP. The best practice in the measurement of economic activities is the *System of National Accounts 1993*, which forms the basis of the ICP (see chapter 3). The breakdown of the GDP expenditures into 155 basic headings forms the building blocks to estimate PPPs. The basic heading represents the categories into which individual products are grouped for pricing purposes; it is the lowest level for which expenditure estimates (breakdown of the GDP) are required. Use of the GDP as the main element of the conceptual framework of the ICP means that the prices to be collected must be consistent with the underlying values in the national accounts. The prices must be national annual averages and basically represent purchaser prices that include taxes and other costs.

Figure 1 Main Components of the International Comparison Program

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                              │  Overview of the ICP │
                              └──────────────────────┘
┌──────────────────────┐                  │
│ Governance—five ICP  │◄─────────────────┤
│ regions and Eurostat-│                  ▼
│ OECD comparison      │         ┌──────────────────┐        ┌──────────────────────┐
└──────────────────────┘         │   GDP—155        │────────│ Basic heading (BH)   │
                                 │  basic headings  │        │ expenditures in      │
                                 └──────────────────┘        │ national currencies  │
                                                             └──────────────────────┘
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Overview of the ICP

Governance—five ICP regions and Eurostat-OECD comparison

GDP—155 basic headings

Basic heading (BH) expenditures in national currencies

BHs with prices from market surveys

Comparison-resistant BHs: global specifications

Ring product list: price collection

Regional product lists: price collection

Dwelling rents and quantities

Health and education

Government Salaries

Construction, equipment prices/costs

National annual average prices: global validation

National annual average prices: regional validation

Productivity adjustment

Reference PPPs

Data validation and estimation of BH PPPs

Between-region BH PPPs: linking factors

Within-region BH PPPs

Within-region BH PPPs

Between-region BH PPPs: linking factors

BH PPP in global currency

BH weights

BH PPP in global currency = between-region PPP × within-region PPP

Aggregated PPPs in regional currency

BH PPP in global currency = between-region PPP times × within-region PPP

Direct estimates for some BHs instead of linking factors

BH weights

2005—GEKS aggregated linking factors used to calibrate each level to the global currency and retain fixity of regional results

2011—Global GEKS aggregation: distribute to regions to retain fixity of regional results

Basic headings fall into three main categories. The first category is those basic headings containing products consumers purchase in various markets. Prices for these basic headings are obtained by means of market surveys. The second category is made up of the basic headings that are "comparison-resistant" because of the difficulties encountered in collecting data to estimate PPPs. These include the basic headings grouped into dwelling rents, health, education, government, construction, and equipment. The third category is those basic headings in which the prices either are not available or are too expensive to obtain. Therefore, their PPPs are imputed using PPPs from other basic headings (reference PPPs.)

Basic Headings with Prices Collected from Market Surveys

These basic headings account for about 100 out of the total of 155 basic headings and for about 60 percent of the world GDP (see chapters 7 and 8). Each region determines the products to be priced in these basic headings and prepares their specifications using structured product specifications—a new method introduced for the 2005 ICP that provides a systematic and consistent way to describe products. Under the regional concept, the goods and services to be priced can be chosen as those the most representative of a region's countries. Although this approach provides the best comparison between countries in the same region, say India and Indonesia, it is not possible to compare either with Brazil or the United States. For that reason, a method coined the "Ring" was adopted for the 2005 ICP.

The Ring concept involved creating a list of products that represented a composite of what was priced in each region. Eighteen countries representing the geographic ICP regions and the Eurostat-OECD program priced the set of Ring products in addition to the products in their regional list. National annual average prices were provided by all countries for their regional products, and the Ring countries also provided prices for the Ring products. The prices from the regional lists were used by each region to compute *within-region* basic heading PPPs for its countries. These within-region basic heading PPPs were used to deflate the Ring prices into five sets of *regional prices* that were then used to estimate between-region PPPs. These between-region PPPs were in effect scalars that calibrated each country's within-region basic heading PPPs to a common global currency.

Comparison-Resistant Basic Headings

A common feature of the comparison-resistant basic headings is that *global* specifications for pricing or data collection are defined, whereas each region prepares its own lists of products for which prices are collected in market surveys.

Dwelling Rents for Owner-Occupied Households

Household dwelling expenditures consist of market-rented housing and imputations for nonmarket rents and owner-occupied housing (see chapter 12). The imputations complicate both the preparation of the national accounts and the estimation of PPPs for housing. Therefore, it is difficult to compare housing across countries because of the varying mix of rental versus owner-occupied dwellings. In the 2005 ICP, PPPs for dwellings were computed three different ways. Where there was a large rental market, rental surveys provided average rental rates by size and type of housing—these were also used to estimate PPPs for owner-occupied dwellings. However, in many countries the rental market is not sufficient to provide data to impute PPPs for owner-occupied housing. The preferred method in this case is to derive PPPs based on the relationship provided by expenditures = prices × quantities. Here prices = expenditures/quantities. Therefore, an indirect PPP is the ratio of the derived prices between countries. This is called the quantity approach because total housing quantities such as number of structures, rooms, and square footage from housing surveys and censuses are used as the quantity measure after they are adjusted for quality. This method was used in some of the Eurostat-OECD countries and in the Commonwealth of Independent States (CIS) and South America regions because the rental market was too small to provide rents to impute for owner-occupied housing. Because there was a similar lack of a rental market in Africa and Asia, the quantity method was also attempted in the Africa and Asia-Pacific regions, but it produced implausible results. Therefore, PPPs were imputed for countries in the Africa and Asia-Pacific regions using the PPP for individual consumption expenditures by households (excluding housing), which meant that the housing PPP probably does not reflect the true volume of housing services in those countries.

Data users, especially those undertaking poverty analysis, were very critical of the method used in the Africa and Asia-Pacific regions. Therefore, in the 2011 ICP round efforts are being redoubled to enable all countries to base dwelling PPPs on a combination of dwelling rents and quantities. Chapter 12 explains in detail how the within-region dwelling PPPs were linked in the 2005 ICP using a set of quantity data representing each region.

Health and Education

The difficulty with comparing health and education across countries is that countries have different arrangements for providing their citizens with health and education goods and services (see chapter 11). In the majority of countries, health and education are provided by a mix of government-run and private services. PPPs for the health aggregate therefore include seven basic headings in household consumption and 12 basic headings in individual consumption by government aggregate. For education, there is one basic heading in household consumption, but six basic headings in individual consumption expenditures by government. Prices are collected for pharmaceutical products, therapeutic appliances and equipment, outpatient and hospital

services, and other medical products for household consumption health basic headings. The same prices are used for the basic headings under government health benefits. For the government basic headings for the production of health and education services, it has been assumed that the comparative value of the government output is equal to input costs as measured by employee compensation. The problem with the traditional method of using government compensation to estimate PPPs is exacerbated by developments in the use of technologies; that method ignores the productivity gains from the use of technology.

For the 2005 ICP, prices were collected for products and services purchased by consumers for health and private education, and average salaries were obtained for a selection of occupations for certain health and education basic headings. For the first time, productivity adjustments were used in three ICP regions to adjust the compensation PPPs for differences in productivity across countries.

Government Services

As described earlier, in the 2005 ICP government services were compared by using government compensation as a measure of the value of output (see chapters 15 and 16). Detailed specifications were prepared describing 50 different government occupations in terms of the work done. For each, annual salaries were obtained that reflected gross salaries and wages that included payments for benefits, and employee contributions for insurance and pensions. These salaries for each occupation and country were treated as national annual average prices, and PPPs were computed accordingly. Also as described earlier, the average salaries were adjusted for productivity in the Africa, Asia-Pacific, and Western Asia regions. Because this was the first time productivity adjustments were made, chapter 16 is devoted to this issue. The adjustments were needed because the very low salaries in some countries would have resulted in implausible levels of real expenditures. The assumption underlying the productivity adjustments was that the output per worker was likely to increase with more capital per worker.

The issue for 2011 is whether to make adjustments for productivity or to find output measures such as numbers of health care workers or other health outputs and numbers of students and test scores for education that are comparable across countries for the estimation of PPPs. The situation becomes even more complex if different methods are used across regions, because the PPPs will have to be linked. One of the outcomes of the debate is that all countries will furnish compensation data for the same set of occupations. These will be used in a global aggregation to the basic heading and aggregates that in one run will provide regional and global PPPs and real expenditures. If a region prefers to use a different method to estimate within-region PPPs, it can do so, and the regional share of the world expenditures from the global aggregation will be distributed to its countries to maintain within-region fixity.

Construction

The comparison of construction across countries depends on the concept of comparability, just as for any other component of the ICP (see chapter 13). Construction poses special problems because most construction outputs are unique. No two office buildings in different countries are identical, nor are the bridges, highways, and dams. One method of making comparisons is based on comparing input prices. Inputs are materials, labor, and equipment hire, each of which can be described so that the resulting costs are comparable between countries. The main problem with using input costs is that productivity, profits, and overhead costs are assumed to be the same relative size in each country.

Output pricing involves creating a model building or civil engineering project with detailed specifications describing the final product. Construction professionals in each country are asked to quote a price for the construction output. This output price takes into account differences in productivity and other components such as profits and overhead. The disadvantage is that it is very costly to create the model projects and then to have them priced in each country. This method was used in the Eurostat-OECD comparison, but it was considered too costly to use in the ICP regions.

In the 2005 ICP, construction was compared using an approach called the basket of construction components. It involved collecting prices for a range of major construction components and basic inputs that were common across countries. Detailed specifications were prepared for components such as a column footing and the cost of labor, materials, and equipment. Basic input costs such as a fixed quantity of cement or an amount of reinforcing steel were also obtained. Because the component prices included labor, materials, and equipment, they met the requirement for output prices (still excluding profits and overhead). The problem was that a complex set of weights was required to combine the construction components, and most countries had difficulty providing them.

For the 2011 ICP, 38 different kinds of materials, 7 types of labor, and 5 types of equipment will be priced based on detailed specifications. PPPs will be computed for each of these three components within each of the three basic headings. Each country will furnish weights indicating the relative shares of materials, labor, and equipment for the residential buildings, nonresidential buildings, and civil engineering basic headings to aggregate the three component PPPs to the respective basic heading PPPs.

Machinery and Equipment

The procedure used for pricing machinery and equipment in the 2005 ICP was similar to that used for household goods and services (see chapter 14). Structured product descriptions were developed for different kinds of equipment and then used as the basis for product specifications,

so that comparable products could be priced across countries. The major difference was that the product specifications were very technical and dealt with combinations of characteristics such as torque, power, and lifting capacity. As a result, outside experts had to be brought in to assist countries with price collection to ensure that the products purchased were comparable across countries.

In addition, a set of 108 products was defined at the global level because of the difficulty in describing the price-determining characteristics. These products were used in the price collection for the ICP regions. Some equipment goods are unique because they are designed for a specific location or purpose. Examples are sea vessels, oil platforms, and power plants. No attempt was made to price these items; pricing was confined to the standard, generally mass-produced items. The set of global specifications prepared for 2005 has been updated for use in the 2011 ICP.

Basic Headings for Which PPPs Were Imputed

PPPs were imputed for different reasons (see chapter 17). One was that no good measures were available for comparing government basic headings such as intermediate services, gross operating surplus, net taxes on production, and receipts from sales. Household consumption also contained basic headings for narcotics, prostitution, games of chance, and animal-drawn vehicles that would be difficult to price. Moreover, some regions had found it difficult to define price-determining characteristics for basic headings such as repair of furniture and appliances and maintenance of major durables and household services.

The basic heading PPPs used to impute for those that were missing were called "reference" PPPs. For example, the reference PPPs for intermediate consumption for government health services were PPPs for individual consumption expenditures by households (excluding health, education, and other basic headings imputed using reference PPPs). At the global level, the imputed PPPs accounted for 14 percent of the global real expenditures. Countries with low government expenditures had smaller amounts from imputation; those with high government expenditures had much larger amounts. The Africa and Asia regions had higher levels because they imputed PPPs for owner-occupied housing. One outcome of this review was to set stricter standards on when PPPs would be imputed and to increase efforts to directly estimate PPPs for dwellings.

Data Validation

Prices and other measurements are first validated at the national level (see chapters 9 and 10). This review ensures that the same products were priced across the different outlets over the country. The validation then moves to the regional and global levels where the main goal is to

ensure the same products were priced across countries. In the 2005 ICP, the validation at these levels was carried out by first putting the prices in each basic heading into a common currency using PPPs. Two methods were used: the Quaranta tables from the Eurostat-OECD comparison and the Dikhanov tables derived by the World Bank. The Quaranta tables incorporate both exchange rates and PPPs in the identification of outliers. The Dikhanov tables allow the validation to be across basic headings in addition to the within–basic heading review. Both methods involve an iterative process because the basic heading PPPs will change as prices that are outliers are checked by the respective countries and are either revised or removed. For the 2005 ICP, the data validation of the regional prices was conducted region by region, whereas the Global Office validated the prices from the Ring price survey.

Because the regions published their results first, the *within-region* basic headings had to be taken "as is" for the estimation of linking factors and the global aggregation. Analysis since then indicates that the regional basic heading PPPs should be subjected to additional review when the global linking factors are being validated and estimated (see chapters 9 and 10). A major outcome is that the regional results will remain open for review until the global results have been finalized.

3.   Some Basic Concepts Underlying the Estimation of PPPs

The previous section outlined the steps taken to collect and validate the data used for estimation of PPPs. This section reviews some basic concepts underlying the estimation of PPPs, which is the subject of the next section.

There are many ways in which the basic heading PPPs can be computed using the relative product prices or simply the product PPPs—each has strengths and weaknesses. Many methods can be used as well to average the basic heading PPPs to aggregates and then to the GDP.

The first step is estimation of the basic heading PPPs. The bilateral PPP between any country and the United Kingdom is simply the geo mean of the product PPPs, which, as shown in table 1, equals 18.02 for Estonia. Also, the PPP between any two countries can be computed directly. For example, the geo mean of the price ratios between Egypt and Estonia is 0.243. The PPP between Egypt and Estonia can also be measured indirectly by the ratio of their respective PPPs to the United Kingdom as the base, or $5.22/18.02 = 0.289$. One could also compute the PPP between Egypt and Estonia indirectly by dividing the PPP for Egypt and the Philippines by the PPP for Estonia and the Philippines. If n countries are in the comparison, a PPP can be obtained directly between any two countries, and $n - 1$ PPPs between the same two countries can be obtained indirectly through the base country.

In each case, one will get different answers. The section that follows reveals that the one way to estimate multilateral PPPs between any two countries is to take the geo mean of the direct and indirect PPPs. In table 1, the PPP for Egypt to the United Kingdom goes from 5.22 (bilateral) to 4. 80 when the multilateral estimate is computed. This means that the PPPs between any two countries are affected by their respective PPPs with each other country. This also means that the PPPs between any two countries can change if the mix of countries included in the computations changes. As shown by table 1, not all countries price every product. And as shown in the sections that follow, there are many ways to estimate basic heading PPPs. These methods would all provide about the same answer if every country priced every item. The choice of methods is based on several properties.

Multilateral PPPs are computed so that the results satisfy two basic properties—transitivity and base country invariance. *Transitivity* simply means that the PPP between any two countries should be the same whether it is computed directly or indirectly through a third country. The second requirement is that the PPPs be *base country–invariant,* which means that the PPPs between any two countries should be the same regardless of the choice of base country. A simple solution is to use the geo mean of the direct and indirect PPPs.

The basic heading PPPs shown in table 1 are essentially averages of the relative prices with no weights taken into account, which means that every product is treated equally. However, in reality expenditure shares for each would not be equal. For example, the prices for long grain rice sold loose are cheaper than the prices for Basmati. It is likely that in Egypt and the Philippines long grain rice sold loose is purchased in much greater quantities than long grain prepacked and Basmati, and that in Estonia and the United Kingdom prepacked long grain is the most popular of the two kinds. Because products with the greatest expenditures are likely to have the lowest prices, it would improve the quality of the estimates if some form of weighting could be introduced. This brings in the concept of representativity used by the Eurostat-OECD and CIS in the 2005 ICP and attempted in the other regions.

A *representative product* is one that is purchased frequently by households and has a price level consistent with all products in the basic heading. This classification can be used in applying a form of weighting in the estimation of basic heading PPPs, as shown in chapter 4. Most countries in the ICP regions had difficulty applying the concept, especially the meaning of price level. To simplify the classification of products for its 2011 round, the ICP adopted a simpler concept, *importance*. Each country is asked to use expert judgment to determine which product(s) would have the largest expenditure shares. This will allow the introduction of simple weights for the products deemed important and used to estimate basic heading PPPs.

Weights based on basic heading expenditures are used in the methodology to average a group of basic headings to an aggregate level. The food aggregate, for example, contains 29 basic headings. In table 2, for the column of basic heading PPPs, say, between Egypt and the United Kingdom, there are two sets of weights: the expenditure shares for Egypt and those for the

United Kingdom. Another basic concept that determines the choice of index method is that countries be treated equally. Therefore, the basic heading PPPs are first averaged using Egypt's weights (Laspeyres index), and are then averaged using the United Kingdom's weights (Paasche index). Each index provides a PPP between Egypt and the United Kingdom, and therefore the geo mean is taken. The result is a Fisher index. As discussed in chapter 5, this is a superlative multilateral index that is consistent with economic comparisons of utility across countries. For each pair of countries, the multilateral PPP is the geo mean of the direct and indirect Fisher indexes. This method was used for the 2005 ICP even though it does not satisfy the additivity requirement.

Additivity means that, for example, the expenditures for each food basic heading (in national currency) divided by the respective PPPs should add to the sum of food expenditures (in national currency) divided by the aggregated food PPP. The addition of major aggregate expenditures in PPP terms to the GDP should equal the real expenditures obtained by dividing GDP expenditures (in national currency) by the aggregated PPP for the GDP. However, the requirement that countries be treated symmetrically produces results that are not additive. Because the nonadditive method was used for the 2005 ICP, the real world GDP was about 2 percent smaller than the GDP obtained by the summation of the aggregate real expenditures. These differences were many times larger at the national level. However, at each level of aggregation the results were consistent with economic comparisons of utility and also minimized the differences between the bilateral and multilateral PPPs.

Additive methods can be used, but they have the disadvantage of providing more weight to the relative prices of the larger, more developed countries. As a result, the real expenditures for poor countries become larger and further away from the bilateral PPPs.

Fixity is another concept that determines the methodology used. This means that the relative volume (ratio of real expenditures) between any pair of countries in a region remains the same after the region has been combined with other countries or regions. This concept is critical when a region prepares its results, which are then later converted from a regional currency to the global currency.

4. Estimation of PPPs—Within Regions

As depicted in figure 1, the PPPs between countries within a region are estimated in two steps. The first step is estimating the basic heading PPPs. The next step is averaging or, using ICP jargon, aggregating the basic heading PPPs for each country to higher aggregates and the GDP using expenditure weights. The basic requirement for each stage of aggregation is that the resulting PPPs are transitive and base country–invariant, as defined earlier.

From Product PPPs to the Basic Heading

This section provides a brief overview of the material presented in chapter 4 and builds off table 1 in this executive summary. The bilateral PPPs for each country shown in table 1 are a form of a Jevons index. If the table is full—that is, if every country priced every item—then the bilateral PPPs would be transitive and base country–invariant.

In practice, not every country can price every item. Two basic methods are used in the ICP to calculate basic heading PPPs. The first approach is based on the Jevons index and the Gini, Éltetö, Köves, and Szulc (GEKS) method, which turns the bilateral PPPs into multilateral PPPs to make them transitive and base country–invariant. The GEKS method is based on averaging the direct PPPs between any two countries with the $n - 1$ PPPs that can be obtained indirectly. The other method uses a regression model known as the Country Product Dummy (CPD), which directly estimates PPPs that are transitive and base country–invariant in one step.

As noted earlier, both methods treat every product equally regardless of their relative expenditures. For that reason, the concepts of representativity and importance were introduced.

Table 4 repeats the data shown in table 1 for Egypt and the United Kingdom with representative products indicated. Long grain rice, prepacked, is representative of the basic heading in the United Kingdom, whereas long grain rice sold loose is representative in Egypt. There are two ways to compute basic heading PPPs using this information. The PPP between Egypt and the United Kingdom is computed first using only products representative of Egypt, and then again using only products representative of the United Kingdom. The bilateral PPP between Egypt and the United Kingdom is then the geo mean of these two PPPs. Basmati is not considered representative in either country, even though prices were provided. Thus those prices are not used in the price comparison for either country. These bilateral PPPs are made transitive and base country–invariant using the GEKS method. This method is used by the Eurostat-OECD comparison and the CIS region.

Table 4 Estimation of PPPs When Products Classified as Representative or Nonrepresentative

Rice basic heading	Egypt, Arab Rep., national price	United Kingdom national price	Egypt, Arab Rep.[a]/United Kingdom	Egypt, Arab Rep./United Kingdom[a]
Long grain, prepacked	5.51	0.73[a]		7.54
Long grain, loose	3.47[a]	1.05	3.30	
Basmati	5.69	2.23		
Geo mean			3.30	7.54
Bilateral PPP			4.98	

Source: Ring survey, ICP 2005.

a. Products are representative of the basic heading price structure and frequently purchased.

The other regions in the 2005 ICP attempted to use the Country Product Representative Dummy (CPRD) method, with representativity included as another variable in the regression. However, the countries were not able to consistently provide the representativity coding because the concept required judgment about both price levels and relative expenditures. Therefore, the concept was not used in the remaining four regions. The concept has been simplified for the 2011 ICP, and the importance classification is being used only to indicate those products with the greatest expected expenditures. Because the importance classification is based on assumptions about expenditures, the Country Product Dummy-Weighted (CPD-W) method is being used in the 2011 ICP, with important products receiving weights greater than 2.

Table 5 shows the methods that can be used to estimate basic heading PPPs. The Jevons, Jevons-GEKS, and CPD methods provide the same results if every country prices every product and the representative or importance classifications are not used. However, the results produced by the GEKS* method and either the CPRD or CPD-W method will differ for one basic reason illustrated in table 4. In that table, Basmati rice was not representative for any country, and thus it would not enter into the estimation of PPPs for the group of countries using the Jevons-GEKS method. However, the CPRD and CPD-W regressions include all data, thereby becoming more robust when the price matrix is incomplete.

Table 5 Methods for Estimating Basic Heading PPPs

	Methods for estimating basic heading PPPs					
	Jevons	Jevons-GEKS	CPD	Jevons-GEKS*	CPRD	CPD-W
Properties	Transitive and base-invariant with full matrix	Multilateral procedure to ensure transitivity and base invariance with less than full price table	Multilateral procedure to ensure transitivity and base invariance with less than full price table	Implied weights used for representative products. Results are transitive and base-invariant.	Implied weights used for representative products. Results are transitive and base-invariant.	Specific weights used for "important" products. Results are transitive and base-invariant.

Source: ICP.

Note: GEKS = Gini, Éltetö, Köves, and Szulc; CPD = Country Product Dummy; CPRD = Country Product Representative Dummy; CPD-W = Country Product Dummy-Weighted.

The main outcome of the analysis of the 2005 ICP data is the realization that some classification process must be used to ensure that the products purchased most widely receive more weight than the other products being priced. The classification of "importance" discussed earlier is being used in the ICP regions for the 2011 ICP round, and basic heading PPPs are being estimated using the CPD-W method.

From Basic Headings to Major Aggregates to the GDP

Chapter 5 is an extensive review of the different methods used to aggregate basic heading PPPs to the GDP and their properties. Because expenditure weights are available for each country, the input to the estimation process is a matrix of 155 basic heading PPPs by country in the region and another matrix of basic heading expenditures in national currencies.

Chapter 5 examines three methods. The method used in five out of the six regions was the GEKS. The basic heading PPP between any two countries has two weights, one for each country. Therefore, two weighted averages of basic heading PPPs to estimate the GDP basic heading are computed, using the weights for each country in turn. The Fisher indexes, the geo mean of these weighted averages, are then made transitive and base country–invariant using the GEKS process described earlier. The GEKS method has the property that each country is treated in a symmetric way. One disadvantage is that the results are not additive.

The ICP has used two additive methods—Geary-Khamis and Iklé Dikhanov Balk (IDB)—but the results are not consistent with economic comparisons of utility across countries. In addition, large countries have a greater impact on the final results. If large countries have higher prices, then the impact is to raise the price levels of the poorer, smaller countries. The IDB method, however, has a smaller large-country effect. In the 2005 ICP, the GEKS method was used in every region except Africa. There, the IDB method was used because it was important that results be additive (see chapter 5 for an extensive review of its properties).

A problem with the GEKS method is that countries at very different stages of development with very different relative prices are given the same weight as countries with similar stages of development and relative prices. Therefore, chapter 5 examines the minimum spanning tree approach, which builds up the multilateral set of comparisons starting with bilateral comparisons with countries very similar in structure. This method offers considerable promise for the future, but still contains some arbitrary aspects, suggesting that further analysis and research are needed. Therefore, the 2011 round of the ICP is mainly using the GEKS method to aggregate basic heading PPPs to the GDP.

From Within-Region to Global Basic Heading PPPs

As indicated in figure 1, at this stage there is a set of PPPs and related indexes for each of the six regions, each in the currency of one of the countries in the region. The PPPs for each level of aggregation and the GDP in each region are transitive and base country–invariant. However, at this stage it is not possible to compute the PPPs between two countries in different regions. Therefore, the final step is to convert the within-region PPPs to a common global currency. The requirements remain the same, which means that the concepts of transitivity and base country invariance apply to the global results. In addition, there must be adherence to the principle of fixity. This simply means that the relative volumes between any two countries shown in the regional comparison remain the same after they are converted to a common global currency. This concept applies at every level of aggregation from the basic heading to the GDP.

A new method introduced for the 2005 ICP meets all of these requirements and is described in chapters 6 and 8. Two sets of PPPs are required for each basic heading to convert regional PPPs to a common global currency. The first set is the within-region PPPs by country for each region. The second set is six between-region PPPs or linking factors for each basic heading, with one region serving as the base and with the between-region PPP equal to 1.0.

In the 2005 ICP, the between-region PPPs for household consumption were based on separate prices (the Ring list) collected by 18 countries: six African countries, four countries in the Asia-Pacific region, four Eurostat-OECD countries, and two countries each from the Western Asia and South America regions. For each of these countries, there was a set of Ring product prices for each basic heading and its within-region PPP in a regional currency. These Ring prices for each country were converted to the currency of the regional base country by dividing each country's basic heading Ring prices by its within-region PPP from the regional comparison. For each basic heading, there was a set of five[2] prices, each in a regional base country. A CPD model that treated each set of regional prices as a country provided a set of PPPs for each region that reflected the relative prices (between-region PPPs or linking factors) for each basic heading. These linking factors were transitive and base country–invariant.

Chapters 11–16 describe the process undertaken to link the health, education, government, construction, and machinery and equipment basic headings. Because the same set of specifications was used for every region, the between-region PPPs were computed from the same data used for the regional comparisons for all basic headings except dwelling rents. The between-region PPPs for dwelling rents were computed using quantities of housing for a large number of countries within each region. Even though each region used different methods to estimate within-region housing PPPs, they were linked using the quantity method.

The basic heading linking factors for each region were scalars used to convert the within-region basic heading PPPs to the global currency. Because the within-region basic heading PPP for each country was multiplied by the same between-region basic heading scalar, the fixity principle was

met. The outcome was a matrix of 146 countries and 155 basic heading PPPs that satisfied the transitivity and base country requirements, all relating to the same base country.

The 2011 ICP methodology is similar, but improvements are being made to the linking and aggregation. Instead of only selected countries pricing a large Ring list, all countries will price a smaller set of global core products. Analysis of the 2005 results revealed that the between-country variability was greater than the variability in product level prices. In other words, the optimum design calls for more countries to price fewer products for linking purposes. Therefore, a set of global core products was defined and will be part of the regional price comparisons as well. The prices for these core products from all countries are being used in the same two-step process described earlier: first estimate between-region PPPs and then use those as scalars to convert the within-region PPPs to the global currency.

In the 2005 ICP, the representativity concept was not used for the Ring prices. However, because of the diversity of economies across the world, it will be essential that the importance classification be applied to all of the prices in the set of global core products. Although countries will be able to price a large number of the core items, it is very unlikely that all countries will have the same price levels or the same relative expenditures. Products that are common in some countries may be found only in boutiques with higher prices in other countries; the importance classification is needed to prevent an upward bias in the price levels used to estimate the between-region PPPs. The importance classified will be used on both the regional and core prices. The between-region PPPs will be computed using the CPD-W method.

5. Aggregating (Averaging) Global PPPs to Higher Aggregates and the GDP

At this stage in the 2005 ICP, there was a matrix of five regional linking factors for each of the 155 basic headings and the summation of national expenditures to a total for each region in the currency of the regional base country. In the 2005 ICP, the between-region basic heading PPPs or linking factors were aggregated to the GDP and other aggregates using the GEKS method. As done at the basic heading level, the aggregated linking factors at each level times the within-region PPP for each country at the same aggregated level converted the regional PPP to the global currency. This step preserved fixity at all levels of aggregation. Later analysis, however, showed that the linking factors at the aggregated level were not base country–invariant—that is, they were dependent on the choice of regional base country.

For this reason, a global aggregation is being used for the 2011 ICP. The input will be the outcome of the linking at the basic heading level, which will provide a matrix of 155 basic heading PPPs for 180 countries and another for expenditures. A global GEKS aggregation of the entire matrix will directly estimate a set of PPPs to a global base country at every level of the GDP breakdown and the GDP. The resulting expenditures for each country in the global

currency will be summed to regional totals. These regional totals can be distributed to each country within a region to ensure that fixity is maintained with the within-region results.

6. Imputing PPPs for Missing Countries and Extrapolating PPPs between Benchmarks

The 2005 ICP covered 146 countries, and therefore PPPs were not available for about 65 other economies for a variety of reasons, ranging from resources to country interest (see chapter 18). Data users, however, requested a complete database, and so PPPs were imputed for the missing economies. For these economies, PPPs were imputed using a model based on benchmark data. The model imputed PLIs based on GDP per capita in U.S. dollars, imports and exports as shares of GDP, and an age dependency ratio as explanatory variables.

This process provided a database of PPPs to the U.S. dollar for 180-plus countries for 2005. However, many data users want PPPs for succeeding years. Therefore, PPPs are extrapolated forward and published each year in *World Development Indicators*. These extrapolations are based on GDP deflators. The problem is that the extrapolated PPPs will differ from the new benchmark PPPs. The challenge is explaining to data users why consumer price index price changes and GDP growth rates are not consistent with the changes in PPPs between benchmarks. Chapter 18 provides an in-depth look at the reasons the two data series will not always be consistent.

7. Conclusion

Although the 2005 round of the ICP was a vast improvement over previous rounds because of the significant effort to improve methodologies, much was also learned that has been taken forward to the 2011 round. A brief review of lessons learned and improvements being made follow:

- *National accounts.* More attention is being paid to the national accounts, starting with the national estimates of the GDP and then the breakdown to the 155 basic headings. The comparisons between countries are based on volume indexes and per capita measures—a perfectly good PPP is of no use if the GDP it converts is of weak quality. Therefore, a concerted effort is being made from the beginning to improve national accounts and make them more consistent between countries.
- *From Ring list to global core products.* The most significant change is moving from the use of a Ring list priced by a few countries for linking to the development of a set of global core products that will be priced by all countries. This change will greatly improve

estimation of the between-region linking factors used as scalars to convert within-region PPPs to the global currency. It also carries with it adoption of the principle of "importance" to classify products in order to give more weight to those most widely consumed in each country.

- *Difficult-to-compare basic headings.* Considerable effort is going into improving the estimates of PPPs for the difficult-to-compare basic headings.
- *Dwelling rent PPPs.* Because of the criticism from data users that dwelling rent PPPs were imputed in Africa and Asia, efforts are being redoubled to ensure direct PPPs are provided for both regional and global comparisons. The use of output measures for health and education are also being explored.
- *Productivity adjustments.* The issue of productivity adjustments for government services is being addressed. In the 2005 ICP, productivity adjustments were not used in every region, thereby making it difficult to compare results between countries in different regions. A significant improvement for the 2011 ICP is using a global aggregation of government compensation across all countries that is adjusted for productivity differences.
- *Construction.* The methodology for construction is being simplified so that countries can carry out data collection without having to engage expert consultants.
- *Data validation.* Greater attention is being given to data validation at the basic heading level and above for both the regional and core comparisons. A major change is that regional PPPs will be open for review while the core prices and PPPs are being validated because the within-region PPPs are an input into the estimation of linking factors.

Notes

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[1] The Ring was a composite of the regional products. It was priced by 18 countries representing all regions except countries in the Commonwealth of Independent States. These countries priced both the global list and the Ring list. The results were used to calibrate regional PPPs to the global level.

[2] The linking factors for the CIS region were based on the PPPs for the Russian Federation from the Eurostat-OECD comparison. Russia also priced the CIS products and was the base country for the region.