Chapter 1

The Framework of the International Comparison Program

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Measuring the Size of the World Economy
ICP Book

Table of Contents

The International Comparison Program (ICP)[1] is a global statistical initiative to collect comparative price data to estimate purchasing power parities (PPPs) of currencies of the world's economies which is conducted under the auspices of the United Nations Statistical Commission (UNSC). The program is designed to meet the data needs of the international community of government policy makers, international organizations, multinational enterprises, and researchers.[2] Worldwide, there is considerable demand for data on internationally comparable national income aggregates, including gross domestic product (GDP), per capita income, and government expenditures on health, education, defense, and investment. In a world that is increasingly integrated economically, interest is high in the relative size, structure, and performance of nations based on a comparative analysis of real incomes and growth performance. Meanwhile, serious debates are under way on the effects of globalization on the welfare of the global society as reflected in real incomes and global inequality. The evidence on global inequality is patchy at best. The current research in the area relies heavily on the availability of reliable real income measures together with information on the distribution of income at the national level.

Country-specific data are regularly produced and disseminated by the national statistical offices. However, the direct comparability of national data is limited because such data are usually expressed in the respective national currency units. The incomparability of published data on national aggregates also stems from differences in price levels, which imply the differential purchasing powers of currencies. For example, all countries in the Euro Area produce their national accounts aggregates in euros, but such figures are not directly comparable because there are marked differences in price levels. For several decades, it was standard practice to use market exchange rates in converting national aggregates, and this practice was adopted by major international organizations as well. However, since the seminal work of Gilbert and Kravis (1954) the reliance on market exchange rates for converting national aggregates has lessened, and exchange rates are gradually being replaced by the purchasing power parities (PPPs) of currencies.

The International Comparison Program,[3] which is designed to provide measures of the purchasing power parities of currencies, began as a small research project conducted by Prof. Irving Kravis at the University of Pennsylvania under the auspices of the UNSC. The project, which covered 10 countries in its first phase, grew to its most recent exercise, the 2005 ICP, which covered146 countries accounting for

[1] The ICP included the geographic regions of Africa, Asia-Pacific, Commonwealth of Independent States (CIS), South America, and Western Asia. It was conducted in parallel with the Eurostat-OECD comparison for their member countries. Chapter 2 provides more details about the coordination between the two programs. For the purposes of this chapter, the methodology applies to the ICP regions and the OECD-Eurostat as another region.

[2] The revised version of this chapter has benefited at various stages in its preparation from the comments of Frederic Vogel, Derek Blades, Michel Mouyelo-Katoula, and Erwin Diewert.

[3] The ICP was initially known as the International Comparisons Project, but over time it evolved into the International Comparison Program, reflecting its transformation from a small research project to a global statistical exercise.

95 percent of the world's population and 98 percent of the world's gross domestic product in nominal terms. The general framework for undertaking these cross-country comparisons has been evolving over the last 40 years, and the methods for compilation of PPPs are being continually refined.

The 2005 round of the ICP was the latest in the series of international comparisons, and a brief review of the principal findings confirms the significance of the project.[4] In PPP terms, the size of the world economy in 2005, as measured by the world GDP, was US$55 trillion, which was 24 percent larger than GDP converted to U.S. dollars using market exchange rates. According to the ICP estimates of PPPs for 2005, the United States is the largest economy in the world with a world share of 22.5 percent. It is followed by China with 9.7 percent and Japan with 7.0 percent. When these shares are computed using exchange rates, they are 27.9 percent for the United States, followed by 10.3 percent for Japan, 6.3 percent for Germany, and 5.1 percent for both China and the United Kingdom. It is obvious that the sizes of the economies do not necessarily correspond with the living standards enjoyed in different countries.

In 2005 the economies with the highest per capita incomes (per capita GDP) were Luxembourg at 780 percent of the world average, followed by Qatar at 765 percent, Norway at 530 percent, Brunei Darussalam at 529 percent, and Kuwait at 501 percent. The per capita income of the United States was only 465 percent of the world average. By contrast, the poorest country was the Democratic Republic of Congo with a per capita GDP of US$264 (in PPP terms), which was 6.6 percent of the world average. However, the *per capita actual individual consumption*[5] used in the ICP provides a more accurate measure of the current welfare enjoyed by people in different countries. Indeed, the ICP revealed some interesting results. Luxembourg was still ranked first in terms of actual individual consumption (553 percent of the world average). However, on the basis of this measure the United States was a close second with 525 percent of the world average. Even more interesting was Qatar, where the level of actual consumption was only 207 percent compared with 765 percent in per capita GDP terms. Similar sizes of actual consumption were revealed for Kuwait and Brunei Darussalam. A more complete overview of the results is presented in chapter 19 of this volume.

On the flip side of income comparisons data was the information on the relative price levels in different countries. Inferences on price levels were drawn through a comparison of the PPPs from the ICP and the corresponding exchange rates of currencies. Price level indexes[6] (PLIs) were generally low for the poorer countries, and they were around and above unity for high-income countries. For example, at the GDP level the PLI for India was 41 percent of the world level compared with Luxembourg, which had a

[4] See the full report on the 2005 ICP, *Global Purchasing Power Parities and Real Expenditures: 2005 International Comparison Program,* which was published by the World Bank (2008).

[5] Actual individual consumption includes individual consumption by the household as well as consumption by the government on behalf of the household. Government consumption in the areas of education and health are important contributors to this. This concept is further elaborated in chapter 3 on national accounts.

[6] A formal definition of price level indexes and further explanations are provided in section 1.2 of this chapter.

PLI of 142 percent. These PLIs varied across countries belonging to different income groups and also across different aggregates. For example, for the machinery and equipment aggregate the PLI for India was 75 percent of the world level, whereas it was about 102 percent for Luxembourg.

Measures of real income are a useful source of data for the study of inequality in the distribution of income worldwide. Recent work by Milanovic (2009) has shown that world inequality as measured by the Gini coefficient was 0.71[7] in 2005 compared with 0.66 in 2002. This level of inequality is far greater than that observed in countries with the most inequality. Results reported by Chen and Ravallion (2010) based on the 2005 ICP results indicate that the world is poorer than what was previously thought. The number of poor under an international poverty line approximately equal to US$1 per day in 1993 terms is now considered to be about 1.5 billion compared with the 1 billion estimated by relying on previous data on real incomes based in turn on extrapolations from the 1996 round of the ICP.[8]

The results from the 2005 ICP just discussed reinforce the significant role of the ICP in providing internationally comparable economic aggregates. There is little doubt about the significance of and the importance attached to the findings of the 2005 ICP. But to use these results effectively, one must understand the process and methods employed in the compilation of the ICP results. The main objective of this chapter is to provide an overview of the framework of the ICP and briefly describe the concepts and methods employed. The chapters that follow are designed to provide the reader with details of the actual procedures used in implementation of the ICP at the regional and global levels.

This chapter is organized as follows. Section 1.1 describes the national accounts concepts that underpin the ICP, and it highlights the decomposition of value aggregates into price and volume/quantity components. The pivotal concept of purchasing power parities and related measures such as price level indexes and real expenditures are discussed in section 1.2. Because the ICP strives to provide measures of PPPs of currencies, section 1.3 presents the framework used for price comparisons across countries. Various aspects of price surveys, data validation, and the methods used in the process of aggregating the price data are the main elements of this section. Section 1.4 then focuses on the regionalization of the ICP and the approach used in deriving global comparisons by linking regional comparisons. The chapter ends with concluding comments.

[7] The Gini coefficient is a commonly used measure of inequality. It takes values of between 0 and 1: a value of 0 means perfect equality in the distribution of income, and a value of 1 represents perfect inequality in which one individual receives all the income and the rest of the population receives zero income. For most countries, the Gini coefficient is in the range of 0.3–0.4.

[8] See Deaton's introductory chapter in this volume entitled "Reshaping the World: The 2005 Round of the International Comparison Program."

1.1 National Accounts as a Basis for the ICP

The principal objective of the ICP is to provide internationally comparable data on suitable measures of economic activity and incomes in different countries. The United Nations and other international organizations such as the Organisation for Economic Co-operation and Development (OECD) and Eurostat, the statistical office of the European Union, have been actively engaged in setting up a framework to measure economic activity. The current best practice in economic measurement is the *System of National Accounts 1993* (SNA93)[9] published by the Commission of the European Communities et al. (1993). It forms the basis for the ICP.

The gross domestic product is the most commonly used measure of economic activity.[10] Within the framework of national accounts, GDP can be measured using three different methods: the production measure, the income measure, and the expenditure measure. For the purpose of international comparisons, the focus has always been on the production and expenditure measures. The reason for this focus is mainly operational: it is difficult to gather the data needed to compare income measures across countries.

On the expenditure side, GDP is expressed as the sum of (1) final consumption by households; (2) government expenditure; (3) gross fixed capital formation; and (4) exports net of imports. Because the basic building blocks are expenditures within different categories, it is feasible to collect data on the prices paid by the purchasers associated with different transactions, which can then be used in making price comparisons across countries. Since its inception, the ICP has based all of its comparisons on data from the expenditure side.

GDP can equivalently be derived from the production side of the national accounts—that is, as the value of gross output less intermediate consumption plus taxes less subsidies. The production approach provides the most direct measure of GDP, and it is the main approach used by many countries because output measures are available through enterprise surveys and so forth. International comparisons on the production side are often referred to as the industry-of-origin approach to international comparisons.[11]

In obtaining measures of economic activity and well-being, it is more appropriate to focus on the expenditure approach to the measurement of GDP. Using this approach, one could examine the role of government expenditures, and in particular the level of government expenditures in the areas of health and education. By contrast, the production side of GDP and the industry-of-origin approaches are useful in comparing economic performance in different countries and by different industries. Using sectoral

[9] The 2005 ICP was based entirely on the SNA93, and the 2011 round of the ICP also makes use of the SNA93, even though it was recently revised.
[10] These concepts are covered in detail in chapter 3, which focuses on the national accounts framework of the ICP.
[11] More details about this approach and the interrelationships between the expenditure and production side approaches to international comparisons appear in chapter 24 of this volume.

data, one would find it possible to measure and compare productivity by different industries and sectors of the economy. Operationally, though, it is more difficult to collect the data necessary for undertaking international comparisons on the production side.[12]

Structure and Components of GDP from the Expenditure Side

GDP consists of the following main components. In particular, GDP is equal to

individual consumption expenditure by households +
individual consumption expenditure by nonprofit institutions serving households (NPISH) +
government expenditure (consisting of individual consumption expenditure by government) +
collective consumption expenditure by government +
gross fixed capital formation +
changes in inventories and net acquisitions of valuables +
balance of exports and imports.

For the purpose of the ICP, GDP is then divided into 13 major *categories*, which are further subdivided into 43 *groups*. An example of a category is "food and nonalcoholic beverages," which is divided further into two groups: "food" and "nonalcoholic beverages." The category "clothing and footwear" is similarly split into two groups. Groups are then broken into classes; for example the food group contains 9 classes that include Bread and Cereals, meat, fish, etc. Each of these classes is then divided into basic headings—rice is a basic heading in the bread and cereals class.

Basic Headings

The basic heading (BH) is a pivotal concept used in the ICP. It is the lowest level of aggregation within the national accounts at which the expenditure and expenditure share data are available. For example, if *rice* is a basic heading, then national accounts data would show the total expenditure on the rice BH. However, if different kinds of rice (such as long grain rice and short grain rice with a percentage of broken rice) belong to the rice BH, then no expenditure or quantity data are available at the item level, although price data can be collected for each of the rice items in countries in which they are sold. Therefore, basic headings are important from the perspective of the aggregation of price data (this aspect of aggregation is discussed further in section 1.3).

In the 2005 ICP, a total of 155 basic headings were placed in categories. Of the total, 110 basic headings fell into the aggregate "individual consumption expenditure by households." By contrast, only

[12] The literature on international comparisons on the production side is large. Interested readers could refer to van Ark and Maddison (1994), Maddison and van Ark (2002), Feenstra et al. (2009), van Ark and Timmer (2009), and chapter 24 of this volume for more details.

12 basic headings fell into the "gross fixed capital formation" aggregate. The ICP essentially uses a pyramid approach, as illustrated in figure 1.1. Price data for different items are aggregated to yield price comparisons at the BH level, which are then aggregated upward to yield price comparisons for different commodity groups, for broad categories, for the main components of the GDP, and, at the end, for the GDP as a whole. Aggregation above the BH level makes use of the weights data available from the national accounts.

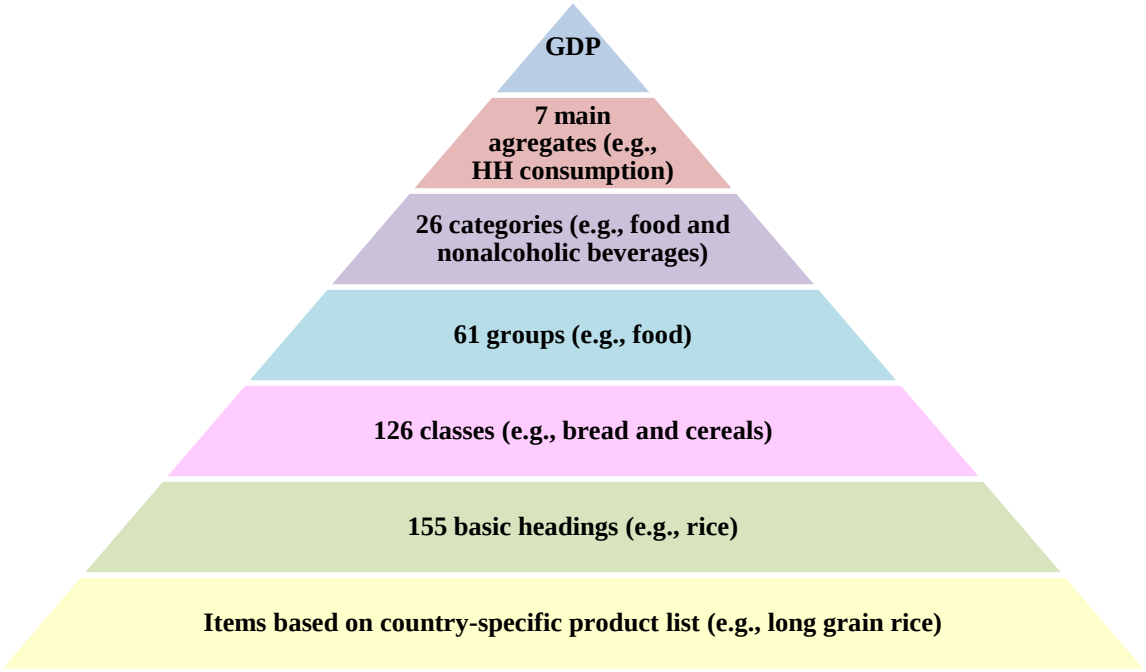

Figure 1.1 Hierarchical Approach to ICP 2005

Source: ICP 2005.

The Basic Index Number Problem: Decomposition of Value Aggregates

The main objective of the ICP is to compile national income aggregates from the expenditure side in an internationally comparable form expressed in the same currency unit and also adjusted for price level differences. For example, consider the aggregate "food consumption." Let the aggregate be based on the consumption of a range of food items. Let *N* be the number of commodities within the food category,

and let p_{ij} and q_{ij}, respectively, denote the price and quantity of the *i*-th commodity in *j*-th country.[13] Then the food consumption expenditure aggregate for country *j*, E_j, is given by

(1.1) $$E_j = \sum_{i=1}^{N} p_{ij} q_{ij}.$$

Typically, the price data are expressed in the currency unit of country *j*, and price levels vary across counties. The main problem is to decompose the value or expenditure aggregate in (1.1) into a price level component, P_j, and a quantity or volume component, Q_j, so that

(1.2) $$E_j = P_j \cdot Q_j.$$

The price level component, P_j, may be interpreted as a PPP[14] of currency *j* expressed in terms of the currency of a reference or numeraire country. Suppose country 1 is selected as numeraire, and so $P_1 = 1$. Then Q_j can be interpreted as the real expenditure or the volume of food consumption in country *j*. From equation (1.2) it can be seen that

$$\frac{E_j}{P_j} = \text{expenditure expressed in reference currency units} = Q_j.$$

Once the volumes or real expenditures are obtained, then the relative expenditure comparisons may be made either through the ratio Q_j / Q_k comparing the real expenditure on food in countries *j* and *k* or through country shares, computed as

(1.3) $$Q_j \Big/ \sum_{k=1}^{C} Q_k$$

where *C* is the total number of countries in the comparison.

The steps involved in the compilation of P_j and Q_j are the subject of this chapter and chapters 4, 5, and 6. The survey methodology used in the collection of price data and the aggregation methods for obtaining price level and volume measures vary a great deal, depending on the type of aggregate used. If certain products within an aggregate are not sold in the market—for example, hospital services in a

[13] It is quite possible that not all the items listed under this category are consumed in all countries. In such cases, the corresponding quantities are equal to zero and prices are unobserved. These possibilities are taken into consideration when the price data are aggregated (see chapter 4 on aggregation at the basic heading level).
[14] This concept is the most important one within the ICP. It is further elaborated later in this chapter.

country may be provided by the government—it is difficult to observe the price and quantities of the various types of hospital services provided. This situation calls for a different approach, which is discussed in chapter 16.

Sources of Price and Expenditure Data

Although the conceptual framework of the ICP is provided by the SNA and national accounts aggregates from the expenditure side, the sources of data for the decomposition discussed in the previous section and shown in equations (1.2) and (1.3) are quite different. The national accounts, which are published on an annual and quarterly basis in almost all countries, provide data only on the expenditure values, E_j, for different aggregates. These are typically expressed in current prices or prices in the year of the publication or in constant prices where the aggregates are expressed using prices in a fixed base year. Expenditure aggregates at current prices are available from the national accounts publications. By contrast, national accounts do not contain any price data. Therefore, the data needed for price comparisons within the ICP must be compiled from a completely different source, and usually these are through carefully planned and executed price surveys in different countries.

The main conclusion to be drawn from this discussion is that the quality of international comparisons depends on the quality of price data as well as that of the published national accounts data. In assessing the plausibility of the international comparison results, it is important that one examines both of these sources carefully in order to identify the main source of any problem.

1.2 Conceptual Framework of the ICP

The ICP focuses mainly on providing estimates of the three core measures—PPPs, price level indexes and measures of real and nominal expenditures—needed to conduct international comparisons of real incomes and standards of living. The first and foremost is the PPPs of the currencies of different countries. These PPPs are used in turn to derive measures of price levels in different countries. As explained earlier, PPPs are used in converting expenditure data from national accounts expressed in respective country currency units into real expenditures or volumes of expenditures that are directly comparable across countries. These three measures are elaborated further in the sections that follow.

Purchasing Power Parities

The main step involved in international comparisons is the conversion of national income aggregates expressed in national currency units into a common currency unit. Such a conversion makes it possible to compare the aggregates across countries, and one should also be able to sum them across countries or regions and examine the country shares within the global economy. The simplest method and one that was followed for a long time was the use of market exchange rates to convert national aggregates. Conversion using exchange rates makes it possible to compare and aggregate across countries, but the resulting aggregates are not very meaningful because exchange rate conversion does not necessarily account for price level differences. It is now well recognized that exchange rates are volatile, reflecting sizable movements of capital across countries. The exchange rates are less likely to refer to the actual price levels in different countries and the purchasing power of the currencies.[15] Therefore, PPPs are used in the place of exchange rates.

A working definition of a PPP is that it represents *the number of currency units required to purchase the amounts of goods and services equivalent to what can be bought with one unit of the currency unit of the base or reference or numeraire country*.

This simple but effective definition of a PPP has several key elements. The first element is to determine the number of currency units of a given country that have the same purchasing power as one unit of the currency of another country. Index number methods in conjunction with data on prices paid by consumers in different countries are used in determining the purchasing power. For example, a PPP of 13.5 Indian rupees (Rs) per U.S. dollar for the basic heading rice means that the quantity of a basket of different varieties of rice that can be bought for one U.S. dollar costs 13.5 Indian rupees at the prices prevailing in India.[16] Thus Rs13.5 represents the PPP for the commodity rice. An implication is that the PPP can vary, depending on the commodity or commodity group being considered.

The second element is that PPPs are measured relative to a numeraire or reference currency unit. In the example just given, the U.S. dollar is used as the *numeraire currency*—that is, the currency in which PPPs and real expenditures in different countries are expressed. The numeraire is usually an actual currency such as the U.S. dollar, but it can also be a world average currency or regional average currency. A commonsense requirement would be that international comparisons and relative levels of income or GDP not be affected by the choice of the reference currency.

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[15] See Kravis, Heston, and Summers (1982) and chapter 1 of the *ICP 2005Methodological Handbook* (World Bank 2007) for more detailed discussions of the suitability (or lack of it) of the exchange rates for the conversion of national income aggregates.

[16] In this example, the PPP of the U.S. dollar using the Indian rupee as the numeraire currency would be the reciprocal of 13.5, which is equal to 7.4 U.S. cents to one Indian rupee. The relative expenditures in India and the United States would not be influenced by the choice of either currency for conversion.

A simple and celebrated example of a PPP is the Big Mac index (published in the *Economist* since 1986). It measures PPPs based on just a single item, the Big Mac, and its prices in different countries. According to the index,[17] the price of a Big Mac in the United States is US$3.73, in Australia $A 4.35, and in Japan ¥320. These prices imply PPPs of $A 1.17 and ¥85.79 per U.S. dollar. An interesting feature is that the PPP for Japanese yen per Australian dollar can either be directly computed as the ratio of ¥320 to $A4.35, which is equal to ¥73.56, or indirectly obtained as the ratio of the PPPs of the Japanese yen (JY) and the Australian dollar (AUD), both expressed with respect to the U.S. dollar as

$$PPP_{JY,AUD} = \frac{PPP_{JY,USD}}{PPP_{AUD,USD}} = \frac{85.79}{1.17} = ¥73.56 .$$

This *transitivity property* of PPPs is automatically satisfied when only one commodity is included in the basket of goods and services used for the PPP computation. However, more complex methods are required when more goods and services are included. Chapters 4, 5, and 6 of this volume describe the index number methods used in the computation of PPPs. The property of transitivity is more formally defined in section 1.3.

It is important to note that PPPs are similar to the price index numbers computed over space—that is, across countries or regions within a country—and very similar to the price index numbers over time. But there are two important differences. First, the magnitude of a PPP has the currency dimension, and therefore it cannot be readily interpreted as a price index. Reverting to the example of PPPs based on the Big Mac index, a PPP of ¥85.79 per U.S. dollar simply says that what a consumer can buy for one U.S. dollar requires 85.79 Japanese yen. Can one infer the price level from this? It would be possible only if the currency unit were the same in both countries (the problem of measuring price level is considered shortly). The second difference is that price comparisons over time are undertaken in a sequence determined by chronological order. However, such sequencing is not possible where cross-country comparisons are concerned. For this reason, it is necessary to ensure that the PPPs satisfy the transitivity property.

What are the uses of PPPs? Purchasing power parities are gradually replacing market exchange rates as the conversion factors used to make international comparisons of the real incomes, price levels, and economic performances of countries. The use of PPPs is in fact essential to make real GDP comparisons—that is, comparisons of the underlying volume of goods and services in different countries. There is an exact parallel here between the use of PPP exchange rates for GDP comparisons between countries at a given point in time and the use of constant prices in comparisons of GDP for a given

[17] See http://www.onada.com/currency/big-mac-index for details. The figures in the text were retrieved on February 20, 2011.

country over time. In both cases, comparisons are impossible to interpret unless differences in the underlying volumes are separated from differences in prices. The spectacular growth in the use of PPPs for international economic analysis largely stems from the increased availability of PPP data from the World Bank through its International Comparison Program and also from the extrapolated series made available through the Penn World Table (PWT). The 2005 ICP covered 146 countries, including most of Africa, China for the first time, and India for the first time since its last participation in 1985. The PWT, constructed and made popular by Summers and Heston (1991) and Heston, Summers, and Aten (2009), provides extrapolated PPPs for over 170 countries covering the period 1970–2005.[18]

The World Bank's flagship publication *World Development Indicators* makes use of extrapolated PPPs and presents cross-country real income data (World Bank 2011).[19] The Bank has also been using PPPs from the ICP to measure regional and global poverty; it provides estimates of the number of people whose income/expenditure is below **US$**1 a day or $2 a day. Chen and Ravallion (2010) provide estimates of global poverty based on the recent 2005 ICP PPP data. They find that it is much worse than what was thought before release of the latest PPP data. Chapter 20 of this volume describes how PPPs from the ICP are used in the measurement of regional and global inequality and poverty.[20]

The ICP's PPPs have gained prominence from their use in the Human Development Index (HDI) by the United Nations Development Programme (UNDP). The HDI uses PPPs in the measurement of real per capita GDP, which is one of the three components of the HDI. In recent years, large countries such as India have begun to measure the HDI at the state and district levels. Thus PPPs are also being used for interregional price comparisons within a country.

The most important use of PPPs is in measuring the real GDPs of countries, thereby making it possible to rank countries by their relative size as well as by their real per capita GDP. Total and per capita GDP converted to a common currency using PPP exchange rates also provide the basis for a range of key analytic statistics such as CO^2 emissions or energy consumption per unit of GDP. The ICP produces PPPs not only at the GDP level but also for lower-level aggregates such as private consumption, government consumption, and investment. For example, government expenditures on health and education expressed in a common currency unit using PPPs are often used by institutions such as the World Health Organization (WHO) and the United Nations Educational, Scientific and Cultural Organization (UNESCO). Per capita gross fixed investment, per capita government collective

[18] The most recent version, PWT 7.0, provides PPPs and real expenditures in current and constant 2005 prices.
[19] The World Bank makes its own extrapolations, which are published in *World Development Indicators* (WDI). These differ from those published in the Penn World Table. The WDI extrapolations are based on the relative GDP growth rate of each country to that of the United States.
[20] Chapter 21 also discusses the derivation of PPPs that are conceptually more suitable for poverty measurement than what is available from the ICP.

expenditures, and per capita actual individual consumption of households are widely used in analyzing economic growth, the role of government, and living standards, respectively.

Given the long list of uses of PPPs, one might wonder whether there is a role for exchange rates in international economic analysis. Market exchange rates are useful in determining whether a country's exports can meet the costs of imports, in calculating the value of the current account balance in the balance of payments, and in comparing share prices. In addition, the traditional analysis of growth in GDP at constant prices, productivity growth, domestic inflation, and the structure of GDP within a country are best based on domestic data in which the value aggregates are all expressed in domestic currency units. For these purposes, it is not necessary to convert the value aggregates using PPPs.

Finally, it is also useful to note the purchasing power parity theory put forth by Gustav Cassel (1918), which states that if all goods and services were traded freely without barriers, then the purchasing power of currencies would coincide with the market exchange rates. This theory assumes that exchange rates are determined only by the demand for currencies to finance trade in goods and services. But this is clearly not the case; foreign currencies are also purchased for tourism, for folio and direct investment, and in expectation of speculative gains from movements in exchange rates. Purchases of currencies in order to finance trade may often be a relatively small part of the total volume of currency transactions. Market exchange rates do not tend to converge toward PPPs nor PPPs toward exchange rates, and the purchasing power parity theory of equilibrium exchange rates has long been discarded. As a result, there is a definite need for reliable PPPs for converting aggregates into common currency units.

Measuring Price Level

An ICP concept that matches PPPs in importance is the price level in a country, which is commonly measured by the price level index or PLI. As noted earlier, a PPP indicates the number of currency units that have the same purchasing power as one unit of a reference currency. It is not possible to make any inferences about the price level in the country concerned, but people do like to know which countries have lower prices and for what commodity categories. The general perception is that developing countries are relatively cheaper than more developed countries.

A measure of price level in a given country for a basket of goods and services is the ratio of the PPP for a particular basket to the market exchange rate for the currency. Thus the price level index for country *j* with respect to a commodity group is given by

$$PLI_j = \frac{PPP_j}{XR_j} \cdot 100 \tag{1.4}$$

where XR_j is the exchange rate of the currency of country *j*. For example, the 2005 ICP found that the PPP for the British pound[21] was US$1.00 = £0.65, where the exchange rate, *XR*, was US$1.00 = £0.55. Thus if a tourist from the United States exchanges $10 for £5.5 at a bank, he or she would have to spend £6.5 to buy what could be bought using $10.[22] This means that the price level index using equation (1.4) is equal to 118, which indicates that prices in the United Kingdom are 18 percent higher than those in the United States. Table 1.1 shows the PPPs, exchange rates, and price levels at the GDP level, which means that all the goods and services in all categories form the basket.

Table 1.1 PPPs, Exchange Rates, and Price Level Indexes: Selected Countries, ICP 2005

Country	*PPPs* (US$ = 1.00)	XR_j (US$ = 1.00)	PLI_j (US = 100)	PLI_j (world = 100)
Australia	1.39	1.31	106	132
Germany	0.89	0.80	111	138
Switzerland	9.24	7.46	140	174
India	14.67	44.10	33	41
China	3.45	8.18	42	52
Vietnam	4,712.69	15,858.90	30	37
Egypt, Arab. Rep.	1.62	5.78	28	35
Kenya	29.52	75.55	39	48
Ethiopia	2.25	8.67	26	32
South Africa	3.87	6.36	61	76
United States	1.00	1.00	100	124

Source: World Bank (2008, summary table and table 2).

Several features of table 1.1 are worth noting. The first feature is that the PLI for the United States defined when the U.S. dollar is the numeraire currency is equal to 100. Relative to that, countries in Europe appear to have higher PLIs, with Switzerland 40 percent above the price level of the United States. By contrast, all the developing countries have PLIs of less than 50 percent, except for South Africa, which has a PLI of 61. From the table, a negative relationship between income level and the PLI may be postulated. There is a lot of research explaining why the national price levels exhibit this type of

[21] This figure is drawn from the summary table in the 2005 ICP final report (World Bank 2008, 23–27).
[22] Strictly speaking, this interpretation holds if the tourist spends money on the items that make up the whole GDP. In practice, tourist expenditure patterns differ significantly from the composition of the GDP. See Dwyer, Forsyth, and Rao (2009) for an example of PPPs relevant for tourists.

relationship. Of particular importance is the work of Kravis and Lipsey (1983), Clague (1988), and Bergstrand (1996). The main conclusion is that price level differences are induced by differences in the prices for tradable and nontradable goods as well as the productivity level differences between developed and developing countries.

The second feature of table 1.1 worth noting is that when the PLI for India is 33 with the United States set at 100, it is difficult to know whether prices in India are low or prices in the United States are high. Column 3 of table 1.1 provides no answer. And it is for this reason that the ICP often reports PLIs relative to a world average level of 100.[23] From the last column, it is clear that the U.S. prices are themselves above the world average by 24 percent and that the Indian price level is now 41 percent of the world average.

In conclusion, PLI is an important concept that has significant practical relevance. Obviously, PLIs for the same country vary across different commodity groups. It is usually true that consumption goods are cheaper in developing countries, which is what the average tourist experiences during visits to Africa or South Asia. However, investment goods such as machinery and equipment are usually a lot more expensive than consumption goods or the whole of the GDP. For example, Bhutan has a PLI of 114 for machinery and equipment compared with a PLI of 44 for the GDP. The respective figures for Vietnam are 86 and 37 and for the Democratic Republic of Congo 153 and 63. These PLIs illustrate the importance of PLI data for different commodity groups because policy makers need to ensure that investment goods are more cheaply available.

Real and Nominal Expenditures

The main focus of the ICP is on the expenditure side of the GDP. Therefore, all the aggregates of interest relate to expenditures associated with certain commodity groups. The data available from the national accounts of countries are in the form of expenditures expressed in national currency units. These are denoted by E_j as defined in equation (1.1). Obviously, these E_j's are not comparable across countries. In this case, it is necessary to convert them into common currency units. The nominal expenditure aggregates are obtained by converting the value aggregates in national currency units using exchange rates. Let NE_j represent nominal expenditures, and then

[23] In this case, it can be shown that the numeraire currency is no longer the U.S. dollar but a basket of all the world's currencies.

(1.5) $$NE_j = \frac{E_j}{XR_j} = \frac{\sum_{i=1}^{N} p_{ij} q_{ij}}{XR_j}.$$

The term *nominal* is used in describing this aggregate because NE_j does not account for price level differences.

The real expenditures, which are also referred to as *volumes* for any expenditure category, are simply the expenditures for the category in national currency units converted using the PPPs for the category. Therefore, the volumes denoted by Q_j are given by

(1.6) $$Q_j = \text{real expenditure} = \frac{E_j}{PPP_j} = \frac{\sum_{i=1}^{N} p_{ij} q_{ij}}{PPP_j}.$$

The real value aggregate in (1.6) converts the national currency value aggregate into a reference or numeraire currency after adjusting price level differences using the PPPs.

1.3 Methodological Framework for Price Comparisons

The ICP is designed to yield reliable global comparisons of prices and real expenditures. As it has evolved over the last four decades, the ICP has become increasingly regionalized for reasons that will become clearer in this section. The 2005 ICP covered 146 countries from different regions of the world and at different levels of development. The ICP has devised an approach in which PPP computations and real expenditure comparisons are first undertaken at the regional level, where the items used in consumption are likely to have significant overlaps and the price structures in these countries are likely to be similar. The regional comparisons are then linked through the additional data collected for a set of countries selected from different regions—the so-called Ring countries—and for a single list of items. The additional price data are then used to link regional comparisons to yield global comparisons.

The general architecture of global comparisons is discussed in section 1.4. This section provides a brief description of the ICP methodology for compiling PPPs and real expenditures at the regional level. As mentioned in section 1.1, price data and national incomes data are the two key inputs for this process. The national accounts framework and the nature of data from national agencies are discussed further in chapter 3. The methods and procedures employed in the collection of suitable price data and some basic principles that underpin the choice of the methods used in aggregating the price data are the main elements of this section. It begins by explaining the structure of the ICP at a regional level. It then turns to

identification of the product lists and important considerations such as the *comparability, representativeness,* and *importance* of the products and the need to maintain consistency between national accounts. Price surveys for *comparison-resistant services* and special product categories such as machinery and equipment are also briefly described. The section concludes with an overview of the methodological considerations for the compilation of PPPs, including the *transitivity, base invariance, characteristicity,* and *additivity* properties of multilateral comparisons.

Structure of ICP Comparisons

The ICP has adopted a pyramid approach (see figure 1.1) to building up PPPs at various levels. Following on from the definition of a PPP and given that a PPP based on a single item of consumption is simply the ratio of prices,[24] the ICP starts with the price data at the item level. These price data are combined to yield PPPs at the basic heading level, where a basic heading is identified as the lowest-level aggregate for which information on expenditure is available from the national accounts. The ICP has 155 basic headings. Some examples of basic headings are rice; lamb, mutton, and goat; eggs and egg-based products; coffee, tea, and cocoa; small electric household appliances; motor cars; passenger transport by railway; newspapers, books, and stationery; pharmaceutical products; compensation of employees in the health sector; general-purpose machinery; and residential buildings.[25] At the first stage, the ICP compiles PPPs for each of the 155 basic headings.[26] The index number methods used in deriving basic heading PPPs are discussed in chapter 4.

The 155 basic headings are combined to form 126 classes. The main aggregation is in the food and nonalcoholic beverages area where 29 basic headings are grouped to form 11 classes. For example, the basic headings fresh milk, preserved milk and other milk products, cheese, and eggs and egg-based products are combined to form the class milk, cheese, and eggs. These classes are designed to provide PPPs useful for researchers who may wish to reweight them to derive PPPs for specific applications.[27] For example, the BH-level PPPs are combined with expenditure patterns of the poor in deriving poverty PPPs. The methodology used for this purpose is elaborated in chapter 20.

The 126 classes are then combined to form 61 broad commodity groups such as food, clothing and footwear, health, transport, construction, and machinery and equipment. For example, the group food

[24] See the example of the PPP associated with the Big Mac and its prices in different countries.
[25] A complete list of basic headings and various aggregates used in the ICP are available in appendix C of *Global Purchasing Power Parities and Real Expenditures: 2005 International Comparison Program* (World Bank 2008).
[26] In practice, it is not always possible to compile PPPs for all the basic headings. In such cases, *reference PPPs* are used. The concept and the rationale for using reference PPPs are fully discussed in chapter 17.
[27] See Dwyer, Forsyth, and Rao (2009) for an application in which PPPs at the BH level are combined to derive PPPs for making comparisons of price competitiveness of various destinations for tourists from different origin countries.

is made up of nine classes, which include bread and cereals; meat; fish and seafood; milk, cheese, and eggs; oils and fats; fruit; vegetables; sugar, jam, honey, chocolate, and confectionery; and food products not elsewhere classified.

Finally, the 61 groups are aggregated into 26 categories, which are listed in table 1.2. This list is indeed important because it represents the level of aggregation at which the PPP results from the ICP are actually published.[28]

Table 1.2 Main Aggregates Used in the ICP

Main aggregates	No. of basic headings
Individual consumption expenditure by households	*110*
01 Food and nonalcoholic beverages	29
02 Alcoholic beverages, tobacco, and narcotics	5
03 Clothing and footwear	5
04 Housing, water, electricity, gas, and other fuels	7
05 Furnishings, household equipment, and maintenance	13
06 Health	7
07 Transport	13
08 Communication	3
09 Recreation and culture	13
10 Education	1
11 Restaurants and hotels	2
12 Miscellaneous goods and services	10
13 Net purchases abroad	2
Individual consumption expenditure by NPISH	*1*
Individual consumption expenditure by government	*21*
01 Housing	1
02 Health	12
03 Recreation and culture	1
04 Education	6
05 Social protection	1
Collective consumption expenditure by government	*5*
Gross fixed capital formation	*12*
01 Machinery and equipment	8
02 Construction	3
03 Other products	1

[28] The PPP results for groups, classes, and basic headings are available from the World Bank upon request. Dissemination of the PPP results is guided by the dissemination policy determined by the Executive Board set up to oversee the ICP.

Main aggregates	No. of basic headings
Change in inventories and acquisitions less disposals of valuables	*4*
01 Change in inventories	2
02 Acquisitions less disposals of valuables	2
Balance of exports and imports	*2*
GDP	*155*

Source: World Bank (2008, appendix C).
Note: NPISH = nonprofit institutions serving households.

The methods used to compute PPPs at the BH level and at higher levels of aggregation differ because of the nature of the data available at those levels. These are discussed further in section 1.3.

Collection of Price Data

Price data are the crucial input for PPP compilation within the ICP. The meaningfulness of the final PPPs from the ICP critically depends on the accuracy, reliability, and representativeness of the price data collected. A few of the important considerations involved in the collection of price data are discussed in this section.

Consistency with National Accounts Data

Because PPPs are price level measures that are in turn used in deriving estimates of real expenditures and volumes, it is important that the price data used in the ICP are consistent with the national accounts notion of the aggregates under consideration. Equations (1.1) and (1.2) applied to a commodity aggregate such as food would be

(1.7) $$E_j^{food} = \sum_{i \in food} p_{ij} q_{ij} = P_j^{food} \cdot Q_j^{food}.$$

Equation (1.7) implies that the food value aggregate in country *j* is determined by the prices and quantities of items that belong to the food group in country *j*. However, international comparisons are made using a common list of items priced in different countries within a region. If the product list in the ICP is significantly different from the product list of the country, then there is a serious mismatch between the ICP and the national accounts data that underpin the expenditure data. Therefore, a degree of consistency must be maintained between the product list of the ICP and the items used in arriving at the national income aggregates at the country level. The consistency requirement has implications for the process involved in identifying and preparing the product list used in the price surveys. In deciding on the

product list for a particular aggregate, one must examine the coverage of the particular aggregate in national accounts and then identify the products for inclusion in the list. For example, if the aggregate concerned is equipment, the products identified must relate to the types of equipment used in deriving the expenditure aggregates.

Unless a reasonable degree of consistency between the national accounts coverage and the ICP item lists is maintained, the PPPs and real expenditures from the ICP will be less meaningful for comparative purposes.

Product Lists for Price Surveys

A critical first step in the ICP that has far-reaching implications for deriving the PPPs is the preparation of the item or product list for use with the price surveys. Within the ICP, these lists are prepared separately for the individual consumption expenditure by households, individual consumption expenditure by government, and gross fixed capital formation components of the GDP. No price data are collected for imports and exports because exchange rates are used as PPPs for the balance of trade component of the GDP.[29]

The regionalized approach, which is discussed further in section 1.4, has reduced the need to prepare a global list of products to be priced by all participating countries.[30] Because the regions are more homogeneous and are more likely to have similar tastes and preferences, it is easier to identify consumption items that are *comparable* across countries and at the same time *representative*. The process is much simpler in some regions such as the OECD-Eurostat—countries in this group are at a similar level of development. Furthermore, most of the countries in this group are in Europe, making it possible to identify products for price surveys. However, the process is more complex when diverse regions such as the Asia-Pacific are considered. In the 2005 ICP, the process of determining the product lists for the Asia-Pacific region was conducted through a series of workshops in which representative experts from all the participating countries discussed and identified a product list for the price surveys. For example, 656 goods and services were in the list for the individual consumption aggregate. Despite the elaborate

[29] Recently, Feenstra et al. (2009) extended this approach by using export and import unit values as price data in the derivation of PPPs for exports and imports. This approach has not yet been adopted by the ICP because the procedure is data-intensive and further research is needed to develop implementable procedures.

[30] However, in the 2005 ICP a global product list was used in the process of linking regions by means of a set of Ring countries. These Ring countries priced a common list of products irrespective of their region. In the next ICP round in 2011, the linking of regional PPPs will be facilitated by the use of a list of *core products* that will be priced by all the countries in all the regions.

process followed, there was a feeling that the region has identifiable subregions such as South Asia and East Asia with fairly different consumption baskets.[31]

Because the prices collected will be used in the PPP computations, several considerations arise. First, from the national accounts perspective discussed earlier, the products included must be *representative* and also consistent with the national accounts. Another consideration is the *comparability* of products in the list for the price surveys. To derive meaningful PPPs based on comparisons of prices at the item level, one must ensure that the products priced in different countries are comparable. Indeed, it is important to compare like with like in the process of deriving PPPs. The PPP based on the price of a Big Mac is a good example. Because the Big Mac is comparable across countries, it meets the comparability requirement. However, the Big Mac is only one consumption item, and it may not be representative of consumption patterns in different countries. In some developing countries, the Big Mac is an item consumed by high-income individuals. Thus it may not be typical of consumption, and reliance only on the Big Mac would tend to distort the price levels in the countries being compared.

In general, there is a tension between the two criteria, *representativity* and *comparability*, and so the ICP strives to strike a balance between these two requirements, as discussed in the sections that follow. The *ICP 2005 Methodological Handbook* (World Bank 2007) is an excellent source of discussion of the concepts of representativity and comparability, and this discussion draws on this major source.

Representativity

An important requirement of the product list for the ICP is that the products selected be representative of the products purchased in each country in the region. In practice, it is inevitable that differences will arise in the types of products purchased in the same basic heading in different economies, particularly in view of the cultural and economic diversity in the Africa and Asia-Pacific regions. The *ICP 2005 Methodological Handbook*[32] defines *representativity* as follows: "Representative products [are those that] figure prominently in the expenditures within a basic heading within a country. They are therefore products that are frequently purchased by resident households and are likely to be widely available throughout the country" (World Bank 2007).

The representativity of an item within a basic heading is also related to the general price level of the basic heading. The price levels of nonrepresentative products are generally higher[33] than those of

[31] The possibility of subregionalization is currently being researched by the Asian Development Bank, the regional coordinator for the Asia-Pacific region. Such regionalization may be relevant to the Africa region as well.
[32] See chapter 4 of the handbook for a discussion of these concepts (World Bank 2007).
[33] This need not be universally true for all nonrepresentative products. For example, an item such as beef is not representative of meat consumption of the predominantly Hindu population in India. However, the relative price of

representative products. Therefore, if in the same basic heading one country prices representative products while another prices nonrepresentative products, the price comparisons can be distorted. Because of these issues, price collectors or statisticians must exercise a fair degree of judgment in identifying products considered representative for a given basic heading. In this process, items in the consumer price index (CPI) of a given country may be considered representative for that country.

At the stage at which the product list is being prepared, it is important to ensure that countries would find it feasible to identify representative products to price. Each country is not expected to price all the products in the list for a given basic heading. All the countries are expected to price both representative and unrepresentative products. In the 2005 ICP, countries were asked to identify the *representativeness status* of each item they priced, but the responses were mixed, and it was evident that the concept of representativeness was difficult to implement. Thus the information collected on representativity was simply ignored.[34]

The criterion of representativity was used in the 2005 ICP only for items in basic headings that belonged to individual consumption expenditure by households. The government expenditure comparisons were based on wages and salaries data and therefore did not require any product list. The ICP's Global Office (located at the World Bank) prepared a list of items in order to compute PPPs for gross fixed capital formation and endeavored to make the list as representative as possible for all ICP countries.

Comparability

Comparability is an important requirement that has implications for meaningful interpretation of the PPPs derived. The *ICP 2005 Methodological Handbook* defines *comparability* as follows: "Two or more products are said to be comparable either if their physical and economic characteristics are identical, or if they are sufficiently similar that consumers are indifferent between them. Alternatively, two similar products may be said to be comparable if consumers are indifferent to which of the two they consume. This implies that consumers are not prepared to pay more for one than the other" (World Bank 2007).

Identifying comparable products is difficult when undertaking comparisons in regions with diverse cultures and standards of living. In such cases, a useful starting point is to define detailed specifications for each product to be priced. When there are subregional variations such as in the Asia-

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beef tends to be lower than the price of other meats consumed in the country. The same is likely to hold for pork in countries such as Pakistan and Bangladesh.

[34] See chapter 4 of this volume for a discussion of aggregation methods that are designed to take into account additional information on the representativity of a given price quotation from a country in the computation of PPP for a given basic heading.

Pacific region, it may be necessary to have products that are comparable across countries in the subregion. This means that some products that can be priced in one subregion cannot be priced in another.

Usually, it is difficult to decide on the level of comparability to be achieved. A product selected for pricing is more likely to be comparable between economies if the specifications are tightly defined. This is the approach followed in the OECD-Eurostat region. But the more tightly defined the product, the more difficult it becomes to find products meeting the specifications. Similarly, two products that differ in some price-determining characteristics will generally not be comparable. In such cases, it may be necessary to define products more loosely to enable countries to find products that meet the specifications. A disadvantage of this approach is that in such cases it becomes difficult to determine whether countries priced the same item.

Within the ICP, comparability is closely related to the price-determining characteristics. For example, rice sold loosely in small quantities may be considered different from rice sold in packets of 5 kilograms. Here the size of the purchase is one of the price-determining characteristics because the price per kilogram could be higher when rice is purchased in small quantities. Similarly, an item, say potatoes, bought from an open market may be considered different from potatoes bought from a supermarket even if the quality characteristics are the same. Potatoes sold in a supermarket may have other service components, such as an air-conditioned store and help with packing the purchases made. It is recommended that these price-determining characteristics become part of the specifications and used in pricing the products.

In the preparation of product lists, it is important to strike a balance between *comparability* and *representativity*. On the one hand, comparability is clearly important because it is difficult to make sense of price comparisons unless the products have similar characteristics, including quality. On the other hand, representativity is also important because the prices of nonrepresentative products are usually higher than those of representative ones. If a good balance is not struck, the resulting comparisons are likely to be distorted.

The actual aggregation methodology used in computing PPPs from the price data is designed to make use of information on representativity as well as on the price-determining characteristics of the product. Chapter 4 of this volume looks at the aggregation of item-level prices and describes procedures that can incorporate representativity. In particular, the Country Product Representativity Dummy (CPRD) and GEKS (Gini, Éltetö, Köves, and Szulc) methods are used in handling the additional information on representativity.

Importance

The practical use of the concept of *representativity* proved difficult in the Asia-Pacific and Africa regions. Considerable confusion arose as to whether a particular product was representative. In many instances, products considered representative were not actually priced in the surveys. Meanwhile, a large proportion of nonrepresentative products were actually priced. Such imbalances in the surveys can lead to highly distorted estimates of PPPs. As a result, it was decided not to use the representativity information provided by the countries; it was used only for post-ICP research into this concept.

Consequently, for the 2011 round of the ICP it was recommended that the notion of the *importance* of a product be used in dealing with the price data provided by the countries. Because price surveys are usually based on a self-weighted design in which the weights represent the volume shares of the products in a particular basic heading, any notion based on either volume of the product sold or share of total sales could be used as an indicator of importance.

Basically, then, product lists should be prepared with the main focus on comparability. Once all the product characteristics are specified, then the price statisticians in each country provide an indication, in the first instance, as to whether the product is important or not. "Importance" refers to expenditure shares within the basic heading. Although statisticians will not usually know expenditure weights within basic headings, they are asked to use their expert judgment as to whether, if such weights were available, they would be relatively large. If so, the product concerned is to be regarded as "important." As a working rule, it has been agreed that any products also priced for a country's consumer price index would automatically be defined as "important."

Structured Product Descriptions

Once the product lists are finalized and their price-determining characteristics are identified, they are recorded in the form of *structured product descriptions* (SPDs). In the 2005 ICP, the product characteristics were identified using the checklist of the consumer price index of the U.S. Bureau of Labor Statistics as a starting point. The SPD of a product defines those characteristics that are price determining. Once the SPD is set for a product cluster, products within the cluster are identified by selecting the specific characteristic of each product included in the pricing list. The SPDs, which were developed at the Global Office, were used as a basis for preparing product lists at the regional level.

National Annual Average Prices

Once the product list is finalized and price surveys are conducted in the participating countries, these prices are reported back to the regional office for further processing. In the 2005 ICP, there was considerable discussion about the merits of using individual price quotations, but it was decided for

operational reasons to use *national annual average prices* as price data in the computation of PPPs. In concept, the national annual average price of a commodity would be obtained for each product as its average unit value for 2005 (defined as the value of the total quantity of the item sold during the year divided by the number of units of the item sold across the whole country). In practice, however, it was impossible to obtain the detailed data required to calculate unit values, and so the process adopted for the ICP was similar to that used within the CPI.

In the 2005 round, a sample of products was selected for pricing, and their characteristics were defined in detail using the SPDs. Prices were collected for these products in each quarter of 2005 from a range of outlets, including supermarkets, local stores, and markets, and from various regions (rural and urban and provinces) within each country. Basically, this was a self-weighting design in which collections were spread across outlets and regions broadly in proportion to their importance (sales or quantities) in the economy.[35] If sufficient information was available to enable the application of explicit weighting, especially to the urban and rural components to ensure they reflected the relative importance of each, such information was used in computing a weighted national average price.[36] Weighting the rural and urban prices was considered important. In cases in which no weights were available, simple arithmetic averages of the prices were used. If the product under consideration was not a seasonal product, the annual average was calculated as a simple arithmetic average of the quarterly prices. If the products were seasonal, the weighted averages of quarterly averages were used.

Participating countries reported to the regional coordinators the national annual average prices of selected items in the product list. Along with the averages, countries supplied detailed data on the number of quotations used in the computation of the averages as well as the standard deviations of the price quotations used in the averages. The standard deviations could serve as measures of reliability of the price data used as input for the PPP computations in future rounds of the ICP.

Price Surveys for Comparison-Resistant Areas

The preceding discussion focused mainly on the product lists used in comparisons of individual consumption by households. Individual consumption consists of 110 basic headings, and international comparisons of consumption are intrinsically important. However, the real problems encountered within the ICP are with the *comparison-resistant areas*. These are the components of GDP that are not easily amenable to international price comparisons. The difficulty stems in part from the fact that these components largely consist of nonmarketed services provided by the government either for individual consumption, such as health and education, or for collective consumption in the form of police and

[35] For more details, see chapter 7 of this volume on the survey framework for household consumption.
[36] See chapter 4 of the *ICP 2005 Methodological Handbook* (World Bank 2007) for more details on this process.

defense services and in the form of parks and the like for the enjoyment and benefit of the general population.

In the 2005 ICP, the government expenditure was classified by function, such as health and education, and then by type of expenditure, including compensation of employees, intermediate consumption, gross operating surplus, and net taxes on production and receipts from sales. Essentially, government expenditure PPPs were computed by means of the *input* approach and used prices for various inputs, including the wages and salaries of employees. Because the *input* approach does not explicitly account for productivity differences, a direct comparison of salaries could lead to misleading PPPs and inflated real expenditures or volumes for countries with low productivity. The Asia-Pacific, Africa, and Western Asia regions implemented a productivity adjustment, but it was not applied in other regions or when regions were linked to yield global comparisons.[37] Because of the difficulties associated with comparisons in the government sector, two chapters of this volume are devoted to this topic—chapter 15 to comparisons of government compensation and chapter 16 to the methodology for productivity adjustments.

Health goods and services were considered under several basic headings covering health products and health services. Because health services could be provided by both the government and private providers on a fee-for-service basis, the 2005 ICP relied on the basic principle that price should reflect the full price irrespective of who paid for the services. Similarly, detailed guidelines were established for pricing private education services to ensure that the prices collected for education were comparable. Education was divided into primary, secondary, and tertiary levels of education, and tutoring-type services were also included. Chapter 11 on health and education details the procedures used in the 2005 ICP, and refinements are being considered for the 2011 round of the ICP.

Price comparisons for construction and equipment are difficult when the countries involved range from low to high income and the technology used in such a diverse range of countries could be quite different. In the 2005 ICP, a new approach known as the *basket of construction components* (BOCC) was employed. The PPPs for construction were based on the prices of the major installed components of major construction projects, which were then built up from the costs of the more basic building materials (e.g., sand, cement, steel) and labor. Chapter 13 of this volume on construction provides an overview of the issues and also explains the differences in the methodologies employed in different regions. Moreover, the chapter describes in detail a new approach under consideration for use in the 2011 ICP. PPPs for equipment were based on price surveys for equipment goods using specifications for equipment

[37] Details of the methodology for productivity adjustments used in the 2005 ICP can be found in appendix D of *Global Purchasing Power Parities and Real Expenditures: 2005 International Comparison Program* (World Bank 2008).

developed by the Global Office. Because comparison of the prices of equipment goods is a complex task, experts from different regions provided advice on product characteristics and their representativity in different countries. Chapter 14 on machinery and equipment provides further details on the procedures used in compiling PPPs for this aggregate.

Finally, one of the most difficult areas for international comparisons is dwelling services. Comparisons of rents even within a country present many difficulties, which are greatly compounded when it comes to international comparisons. Even using a regionalized approach, it is difficult to compile PPPs for dwelling services in regions such as the Asia-Pacific where the countries range from developed countries such as Hong Kong SAR, China, and Singapore to lower-income countries such as Cambodia and Vietnam. A simple approach known as the *quantity ratio method* was used by the OECD-Eurostat region for some countries and for all in the Commonwealth of Independent States (CIS) region. Basically, the national accounts data could be used in measuring value ratios in countries. If a quality-adjusted quantity ratio could be computed, then an indirect PPP could be derived. Although the approach is simple and well founded, actual implementation was not easy because it was difficult to compile reliable and meaningful quality-adjusted quantity ratios. Therefore, in the 2005 ICP the *reference volume method* was employed[38] in the Africa and Asia-Pacific regions. Other regions used price ratios or quantity ratios or both. Basically, then, the treatment of dwelling services was less than satisfactory in the last round of the ICP. This is an area in which major improvements are expected for the 2011 ICP. Details of the procedure used in compiling PPPs for dwelling services are presented in chapter 12.

Data Editing and Validation

Once the price data are collected from the price surveys conducted in different countries, an important next step is to ensure the quality of the price data. Data editing and validation were undertaken at various steps during implementation of the 2005 ICP. At the first step, the national ICP coordinators were expected to check the data for outliers. Then the price data were transmitted to the regional office where they were checked using data submitted by all the participating countries. The regional price data were validated through a series of workshops attended by the national statisticians in charge of price surveys for the ICP. Outliers in the price data were identified using the Qaranta tables developed and employed in the OECD-Eurostat regional comparisons. In the 2005 ICP, specially developed Dikhanov tables were employed to detect outliers in the price observations. More details on data validation, along with illustrations drawn from 2005 ICP, are provided in chapter 9.

[38] Because it was not possible to use reference PPPs, a reference volume relative was used in the place of a reference PPP. The volume relative selected was based on the individual consumption expenditure by households, excluding housing rentals. This approach ensured that the volume relatives for the household consumption expenditure aggregate remained unchanged.

Aggregation of Price Data and Computation of PPPs

The price data collected through price surveys in participating countries within a region are subsequently edited, validated, and prepared for use in the computation of PPPs. PPPs are computed using a hierarchical approach (see figure 1.1). The lowest level at which PPPs are computed is at the basic heading level.[39] PPPs at this level are computed without any quantity or expenditure share weights because such information is not available at the product level.[40] These PPPs then form the building blocks for the computation of PPPs at higher levels of aggregation, leading to PPPs for different classes, commodity groups, categories, and finally major aggregates of the GDP. Chapters 4, 5 and 6 are devoted to a detailed description of the various methods used for the computation of PPPs at various levels. The main purpose of this section is to provide an overview of the index number issues confronted in the context of international price and volume comparisons.

Bilateral versus Multilateral Comparisons

Bilateral comparisons are comparisons that involve two periods or two countries. By contrast, multilateral comparisons are comparisons made between all pairs of countries belonging to a set of countries. Typical examples of bilateral comparisons are temporal comparisons in which the prices in period *t* are compared with the prices in period *t – 1,* or in some cases the prices in period *t* (current) with the prices in period 0 (base period). Furthermore, time periods appear in a chronological sequence that facilitates easy chaining of comparisons over time. In the ICP, comparisons are sought between all pairs of countries within a region or between all the participating countries. The countries are not ordered in any systematic way.

When the notion of PPPs was introduced in section 1.2, the purchasing power parity of the currency of country *j* with respect to a numeraire country was denoted by PPP_j. Although this notation was adequate for expositional purposes, it is incomplete because it does not show the numeraire country used in computing the PPP. The more general notation introduced here will facilitate discussion of the various properties expected of PPPs in the context of the ICP. Let PPP_{jk} represent the purchasing power parity for the currency of country *k* with the currency of country *j* as the numeraire. Thus

$$PPP_{USA,India} = 14.67$$

which implies that 14.67 Indian rupees have the same purchasing power as one U.S. dollar with respect to a specific basket of goods and services.

[39] Strictly speaking, PPPs can be computed at the item level where the PPP is simply given by the price relative or the ratio of the price of the product in the two countries under comparison.
[40] However, it is possible to attach weights to products based on the importance classification.

If bilateral comparisons between two countries, denoted by 1 and 2, are the focus, then only the price and quantity data from these two countries are used in deriving a PPP or price comparison between these two countries. Let p_{i1}, p_{i2}, and q_{i1}, q_{i2} (I = 1, 2, …, N) represent, respectively, the price and quantity of the i-th commodity in countries 1 and 2. In this case, PPP_{12} is simply the price index computed using these price and quantity data. The recommended formulas for this purpose are the Fisher ideal index and the Tornqvist index. These index numbers possess impressive axiomatic and economic theoretic properties. Balk (1996) provides a detailed exposition of the axiomatic theory, and Diewert (1976, 1992) discusses the economic theoretic approach to the construction of consumer price index numbers. The Fisher and Tornqvist indexes are known to be *exact* and *superlative*, two concepts developed by Diewert (1976). The Fisher index is given by

$$PPP_{12}^{Fisher} = \left[\frac{\sum_{i=1}^{N} p_{i2} q_{i1}}{\sum_{i=1}^{N} p_{i1} q_{i1}} \cdot \frac{\sum_{i=1}^{N} p_{i2} q_{i2}}{\sum_{i=1}^{N} p_{i1} q_{i2}} \right]^{1/2}. \tag{1.8}$$

This index is the geometric average of the Laspeyres and Paasche indexes in the brackets of (1.8). The Tornqvist index is given by

$$PPP_{12}^{Tornqvist} = \prod_{i=1}^{N} \left[\frac{p_{i2}}{p_{i1}} \right]^{\frac{w_{i1}+w_{i2}}{2}} \quad \text{where} \quad w_{ij} = \frac{p_{ij} q_{ij}}{\sum_{i=1}^{N} p_{ij} q_{ij}}, \; j = 1, 2. \tag{1.9}$$

The Tornqvist index is the weighted geometric average of the price relatives computed for each of the commodities.

Equations (1.8) and (1.9) are typical examples of bilateral price index numbers in which only price data from countries 1 and 2 are used in computing the PPPs. By contrast, if multilateral comparisons between all pairs from a set of M countries are of interest, then comparisons between all possible pairs of countries are necessary. In the 2005 ICP, the total number of participating countries was M = 146. All these pair-wise comparisons can be represented in the form of a matrix as

$$\mathbf{PPP} = \begin{bmatrix} PPP_{11} & PPP_{12} & PPP_{13} & PPP_{1M} \\ PPP_{21} & PPP_{22} & PPP_{23} & PPP_{2M} \\ PPP_{31} & PPP_{32} & PPP_{33} & PPP_{3M} \\ PPP_{M1} & PPP_{M2} & PPP_{M3} & PPP_{MM} \end{bmatrix}. \tag{1.10}$$

For example, these PPPs could be between pairs of countries such as (United States, Japan), (United States, China), and (China, India). A simple approach to the computation of elements of the matrix **PPP** in (1.10) is to use the Fisher or Tornqvist index number formula in (1.8) and (1.9). However, such a simplistic approach is not adequate because the elements of **PPP** need to be internally consistent and also to satisfy a number of useful properties. These are discussed in the subsections that follow.

Transitivity

The first and the most important property in the context of international price comparisons is *transitivity*. Transitivity stipulates that the PPP computed between two countries, *j* and *k*, should be the same whether it is computed directly or computed indirectly through a third country, ℓ. Stated formally, the matrix **PPP** in (1.10) is said to be transitive if for any three countries, *j*, *k*, and ℓ, the PPPs satisfy

$$PPP_{jk} = PPP_{j\ell} \cdot PPP_{\ell k}. \tag{1.11}$$

For example, this requirement guarantees that for any set of three selected countries—say, India, Germany, and South Africa—the computed and published PPPs from the ICP should satisfy

$$PPP_{Germany,India} = PPP_{Germany,South\,Africa} \cdot PPP_{South\,Africa,India}.$$

These numbers from table 1 in the World Bank's 2008 report on the 2005 ICP are

$$PPP_{Germany,India} = 16.48;\ PPP_{Germany,South\,Africa} = 4.35;\ \text{and}\ PPP_{South\,Africa,India} = 3.79.$$

It is useful to note here that when transitivity is satisfied by a matrix of PPPs, then a binary comparison between two countries, *j* and *k*, is influenced by the price and quantity data for all other countries in the global comparisons. In the illustrative example just presented, it is clear that the comparison between Germany and India is influenced by the data for South Africa and all other countries. However, compensating for this factor is the internal consistency of all the PPPs for all the countries in the ICP.

Which formula should one use in this context? It is easy to see that neither the Fisher index nor the Tornqvist index satisfies the transitivity property, but many index number methods could be used for this purpose. Balk (2009) reviews all these methods, and chapter 5 in this volume canvasses the core methods currently being used in international comparisons.

Base Invariance or Country Symmetry

Because the ICP is a global comparison exercise with participating countries from all regions of the world, it is important that all countries be treated equally in deriving the matrix of PPPs that satisfy

transitivity. It is possible to derive transitive multilateral comparisons by picking a country to serve as the star country through which all other countries are compared. For example, in the two sets of comparisons shown in figure 1.2 the United States and the United Kingdom serve as the star countries.

Figure 1.2a Comparisons Using the United States as the Star Country

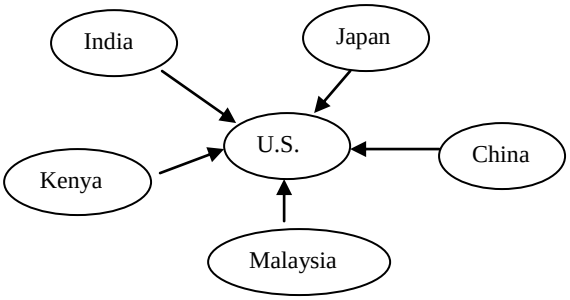
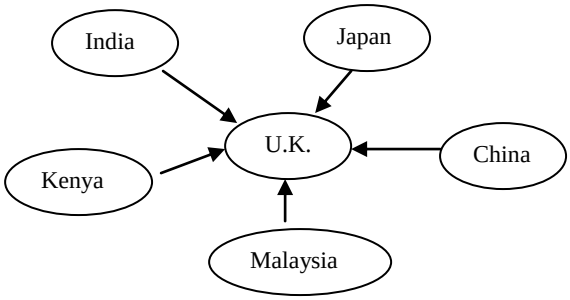


Figure 1.2b Comparisons Using the United Kingdom as the Star Country



In Figure 1.2a, all the comparisons are made through the United States, the star country. For example, India and China are compared in this case by comparing India first with the United States and then the United States with China. The star country approach does not allow for a direct comparison between India and China. Either the Fisher index in equation (1.8) or the Tornqvist index in equation (1.9) could be used in making comparisons between pairs of countries. It is easy to show that the comparisons made using this approach satisfy transitivity. Similarly, one could generate another set of transitive PPPs using the United Kingdom as the star country. Unfortunately, these two sets would not give the same numerical answers. This means that the choice of the star country is crucial, and that the star country is treated asymmetrically within the international comparisons. Thus figures 1.2a and 1.2b show that *transitivity* does not necessarily imply *country symmetry*, and so the PPPs between any two countries should be the same regardless of the choice of base country.

A simple solution to this problem is to generate star country comparisons using each and every country as a star country in turn in the comparisons. Therefore, when there are 146 participating countries, as for the 2005 ICP, 146 different sets of star country comparisons could be derived, and each of them would give a different answer. Because all countries should be treated symmetrically, a geometric average of the 146 star country comparisons could be obtained using a simple geometric mean. The results become base country–invariant. The resulting set of comparisons is exactly the same as that derived using the GEKS method, which is discussed in detail in chapters 4 and 5 of this volume.

Characteristicity

Drechsler (1973) was the first to note that *characteristicity* is an important requirement for international comparisons. When transitivity as defined in (1.11) is imposed, binary comparisons between pairs of countries are influenced by data on prices and quantities from other participating countries. The binary comparisons are then distorted as a result of the imposition of transitivity as an internal consistency requirement. The characteristicity property stipulates that distortions arising out of the use of transitive methods should be kept to a minimum. The GEKS method mentioned earlier is specially designed to maintain the characteristicity of binary comparisons. This is one of the main reasons why the GEKS method was selected as the main aggregation method for the 2005 ICP comparisons at the regional and global levels.

Additivity

Another desirable property for international comparisons is *additivity*. This property ensures that the additive nature of the national accounts within a country, expressed in national currency units, is also maintained when international comparisons are made. Basically, additivity means that the real expenditure aggregates derived by converting the aggregates in national currency units into a common currency unit using PPPs should add up to the real GDP, which is obtained by converting GDP using PPPs derived at the aggregate level. Additivity would enable researchers to examine the structure of the components of GDP in real terms after conversion using PPPs. However, additivity imposes certain theoretical restrictions and thus is not always preferred as a property to be maintained in international comparisons (see chapter 5 for more discussion of these theoretical restrictions). In temporal comparisons, additivity is not guaranteed when national accounts are constructed at constant prices.[41] Nevertheless, several aggregation procedures such as the Geary-Khamis (GK) and Iklé methods possess the additivity property. Until the 2005 ICP round, Geary-Khamis was the main aggregation procedure used in the ICP, even though the GEKS method had been used in the OECD-Eurostat region since 1985.

In addition to these four important properties expected of PPPs in the context of international comparisons, several other properties are discussed in the literature. For example, Balk (1996, 2009) and Diewert (1988) discuss a range of other properties used in evaluating the relative merits of various aggregation methods.

[41] See Balk and Reich (2008) for a discussion of the problems arising out of the additivity property in the context of national accounts at constant prices.

Aggregation of Price Data at the Basic Heading Level

Each of the 155 basic headings used in the ICP covers a list of products or items used in price surveys by the participating countries in each region. A distinguishing feature of the BH level is that only data on the prices of items in the basic heading are available. The quantities purchased at the observed prices are not known. Hence the aggregation at this level must be essentially unweighted. A complication to be handled at the BH level is that not all items in the basic heading are priced in all countries. Thus PPPs have to be compiled in the presence of large gaps in the price data. The aggregation methods used at the BH level are designed to make efficient use of all the available price data.

As discussed earlier, the prices collected by a given country within the basic heading are not all equally important. For example, a number of unrepresentative items may have been priced by countries within the region. Because unrepresentative items are likely to exhibit higher prices compared with representative items, the aggregation methods used at this level must take adequate account of the representativity of the products priced.[42]

The aggregation methods used in deriving PPPs at the BH level must satisfy transitivity and base invariance. A range of aggregation methods including the CPD, CPRD, Weighted Country Product Dummy (WCPD), GEKS, and GEKS* methods are commonly used for the computation of PPPs at the BH level. These methods are discussed in detail in chapter 4 of this volume.

PPPs above the BH Level

Once parities are computed for each of the 155 basic headings for all the participating countries, they are used as inputs for the higher levels of aggregation. Let PPP_{ij} represent the PPP for the *i*-th basic heading in the *j*-th country using one of the countries as a numeraire. Because the numeraire is the same for all countries, it is not explicitly mentioned in this notation. Typically, expenditure data are available for each of the basic headings. Let e_{ij} represent the expenditure on basic heading *i* in country *j* expressed in the currency unit of country *j*. Because expenditures are expressed in national currency units, it is not possible to sum these expenditures across different countries.

An implicit quantity associated with a given BH can be derived simply by converting the national currency into common currency units using the BH PPPs. For example, the implicit quantity of the *i*-th basic heading (which itself is made up of a number of items and hence can be considered a composite commodity) is measured by

[42] See chapter 4 for further details on how information on representativity could be used in aggregating item-level price data leading to PPPs at the BH level.

(1.12) $$Q_{ij} = \frac{e_{ij}}{PPP_{ij}}.$$

These Q_{ij}'s are in fact *real expenditures* obtained by converting nominal expenditures in national currency units by PPPs and thus adjusting for price level differences across countries at the BH level. These real expenditures are also referred to as *volumes*. Just as quantities of a single item can be added across countries, the real expenditures/volumes can be added and used in comparing the relative shares of countries for a given basic heading. These shares are given by

$$s_{ij} = \frac{Q_{ij}}{\sum_{j=1}^{C} Q_{ij}} = \frac{e_{ij} / PPP_{ij}}{\sum_{j=1}^{C} e_{ij} / PPP_{ij}}.$$

The shares are used in the ICP for comparing the relative sizes of countries, with respect to a specific basic heading *i*, with $i = 1, 2, \ldots, 155$ and countries $j = 1, 2, \ldots, C$.

The price and quantity data used in deriving PPPs at higher levels of aggregation are given by the PPPs at the BH level and the implicit quantities defined in (1.12). These can be represented by PPP_{ij}, Q_{ij} for $i = 1, 2, \ldots, 155$ and $j = 1, 2, \ldots, C$.

The aggregation methods used in computing PPPs at higher levels of aggregation are also expected to satisfy the basic properties of transitivity, base invariance, characteristicity, and, if desired, additivity. The main procedures currently used in international comparisons are the GEKS, Geary-Khamis, and Iklé methods for aggregation. These methods and their properties are discussed in detail in chapter 5 of this volume.[43]

In summary, this section has provided a detailed account of the methodological framework that underpins the collection of price data and the aggregation methods used in deriving PPPs at the BH level and at higher levels of aggregation. These procedures are applicable when international comparisons of a group of countries, such as the ICP regions, are considered. These methods were used by the Asia-Pacific, South America, OECD-Eurostat, Africa, and Western Asia regions within the 2005 ICP. The global comparisons reported in World Bank (2008) were obtained by linking the regional comparisons using a set of Ring countries. The process of linking is the topic for the next section.

[43] The global comparisons for the 2005 ICP were all derived using the GEKS method. The Asia-Pacific region published results based on the GK method in the appendix of its report (Asian Development Bank 2007).

1.4 Regional and Global Comparisons

The 2005 ICP embraced a totally regionalized approach to global comparisons. The global comparison had participation from 146 countries from all the regions of the world. Based on the analytical considerations that underpin the preparation of the product lists for prices surveys where *representativity* and *comparability* are important, it is indeed difficult to construct product lists that can truly represent the whole world. Recognizing this need, the 146 participating countries were classified by geographical regions with the exception of the OECD-Eurostat countries, which included countries from several continents. The distribution of the countries by region is presented in table 1.3.

Table 1.3 Participating Countries, by Region, ICP 2005

Region	No. of countries
Africa	48
Asia-Pacific	23
CIS	10
OECD-Eurostat	46
South America	10
Western Asia	11
Total	*148*

Source: World Bank (2008).

Even though table 1.3 lists 148 participating countries, the actual number was 146, with the Arab Republic of Egypt participating in both the Africa and Western Asia regions and Russia participating in both the CIS and OECD-Eurostat regions. Of the 23 participating countries in the Asia-Pacific region, three were economies: Hong Kong SAR, China; Macao SAR, China; and Taiwan, China.[44]

The regional ICP comparisons were undertaken under the auspices of the regional coordinating bodies: African Development Bank, Asian Development Bank, Statistics Canada, Economic Commission for Latin America and the Caribbean (ECLAC), Economic and Social Commission for Western Asia (ESCWA), Statistical Office of the Commonwealth of Independent States (CIS-STAT), Federal State Statistics Service of the Russian Federation (Rosstat), and Eurostat-OECD. The procedures discussed in section 1.3 were generally followed by the regions in compiling region-specific PPPs at the BH level as well as at the higher levels of aggregation listed in table 1.2. Thus within each region, the relativities of

[44] This is the main reason why the 2005 ICP final report on the Asia-Pacific region refers to participating economies rather than countries (Asian Development Bank 2007). In this chapter, all the economies are simply referred to as countries.

countries with respect to real GDP and to other aggregates such as consumption were determined by the results of the regional comparisons. The Global Office of the ICP coordinated compilation of the global comparisons using a linking methodology developed specifically for the 2005 ICP.

Linking Regional Comparisons and Fixity

The compilation of global comparisons, which was obtained through linking the regional comparisons, was undertaken with strict adherence to the principle of *fixity*. The fixity principle stipulates that the relative volumes in the global comparisons between any pair of countries belonging to a given region should be identical to the relative volumes of the two countries established in the regional comparisons to which they belong. For example, consider Malaysia and Singapore in the Asia-Pacific region. The real GDPs of these two countries in the regional comparison were HK$1,703,958 million and HK$1,024,330 million, respectively.[45] The implied relative GDP level is that Malaysia's GDP is 1.663 times Singapore's GDP. The corresponding real GDP figures from the global comparisons[46] are US$299,582 and US$180,093, respectively. These figures also show the same relative GDP level at which Malaysia's level is once again 1.663 times that of Singapore.

The principle of fixity is applied at all levels of comparisons, starting at the BH level. The methodology for generating global comparisons respecting fixity was developed during the 2005 ICP round and can be found in Diewert (2004).[47] Because of their adherence to the fixity principle, the regions were able to publish their regional comparison results, expressed in their own numeraire currencies, as the results became available. The global comparison results, which were the last to be published, were consistent with the previously published regional results.

Use of Ring Countries for Linking

In contrast to some past comparisons in which regions were linked essentially through price data collected by one or two bridge countries, the 2005 ICP followed a more robust approach. Eighteen countries— the Ring countries—were selected to provide links between regions. The selection of the Ring countries was based on a set of criteria designed to ensure that prices in those countries were not

[45] These figures are taken from table 4 in *Purchasing Power Parities and Real Expenditures: 2005 International Comparison Program in Asia and the Pacific* (Asian Development Bank 2007, 27). The numeraire currency for the Asia-Pacific region was the Hong Kong dollar.
[46] These figures are drawn from table 4 in *Global Purchasing Power Parities and Real Expenditures: 2005 International Comparison Program* (World Bank 2008, 60).
[47] Chapters 4 and 6 provide further details on this methodology.

distorted in any way and that a wide range of goods and services were likely to be found and priced in those countries. A fuller description of the criteria appears in chapter 7 of this volume.

Six Ring countries were selected from Africa (reflecting the size of the continent and diverse nature of the subregions), four from the Asia-Pacific region, and two each from the OECD-Eurostat and Western Asia regions. The CIS region was linked using Russia as the bridge country. Russia priced both the OECD and CIS product lists. Overall, the strategy of using a large group of Ring countries appeared to have worked well in the 2005 ICP.

Ring Product Lists and Surveys

The product list for the Ring country surveys was developed by the Global Office. The product list of household consumption items for those surveys was constructed after a careful examination of the product lists used in different regions. Out of the combined product lists from all the regions, any product that was not priced by a Ring country was discarded, and the remaining products were considered to be potential candidates for inclusion in the Ring product list. The regional SPDs for these products were examined in order to establish their comparability across regions. The list for the price surveys was finalized after a series of consultations with the Ring countries.

This process was not needed for the categories of housing, government consumption, health, construction, and machinery and equipment; global specifications were used in the regional surveys and comparisons. These categories were priced by all countries, including the Ring countries. As a result, the same data were used for both the regional and Ring comparisons for the Africa, Asia-Pacific, South America, and Western Asia regions. Ring countries in the OECD-Eurostat region priced the global specification for the Ring comparison.[48]

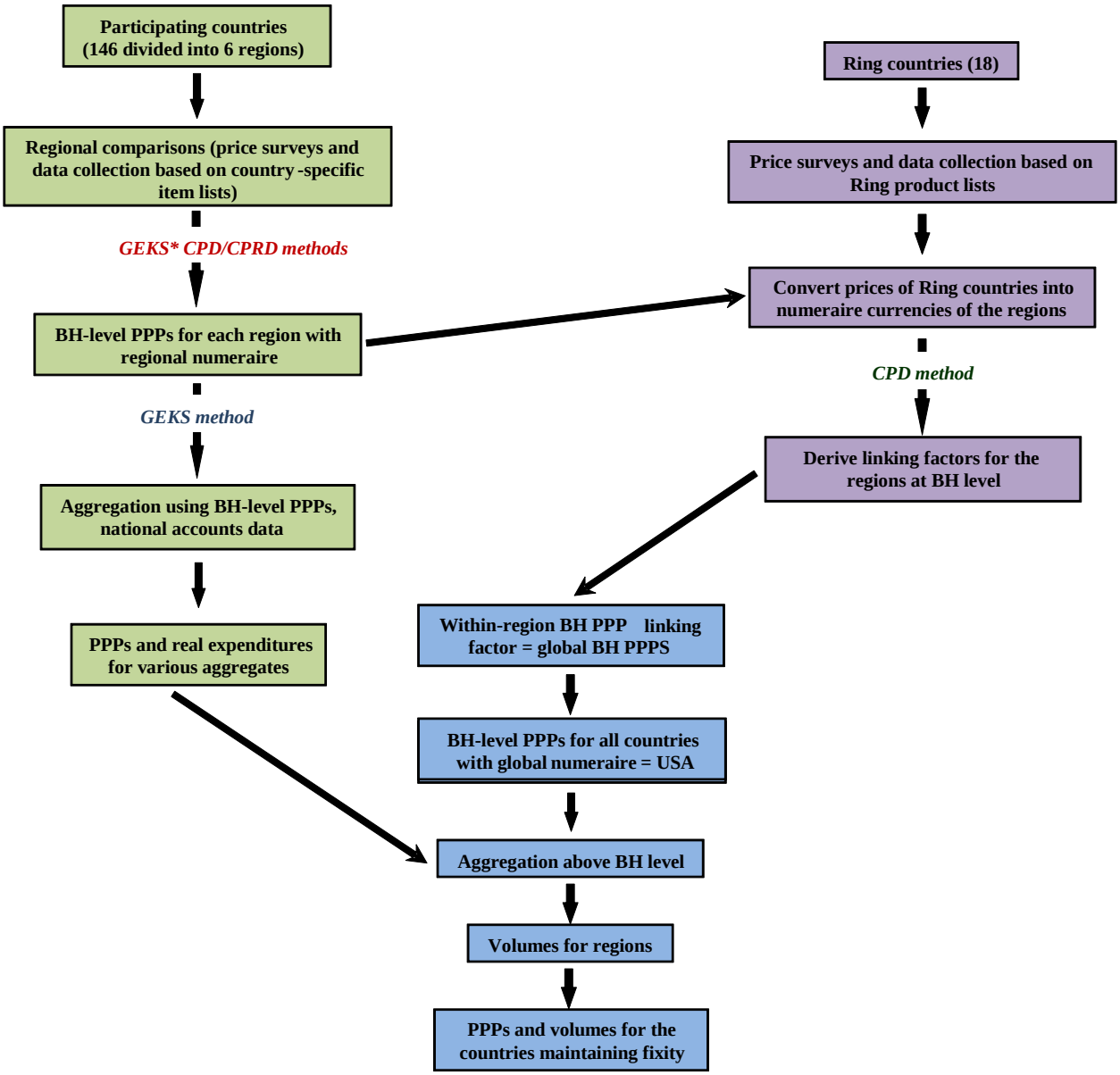
Methodology for Linking Regional Comparisons

The basic process of linking regional comparisons is depicted in the flow chart in figure 1.3. The panel on the left-hand side represents the comparisons undertaken in the six regions. These comparisons essentially follow the procedures described in section 1.3. At the conclusion of the regional comparisons, a set of PPPs for all the basic headings expressed relative to the regional numeraire, and PPPs and volumes at higher levels of aggregation, are available from all the regions. These results represent one component of the inputs into the linking process.

[48] See table 5 in *Global Purchasing Power Parities and Real Expenditures: 2005 International Comparison Program* (World Bank 2008) for more details on the exact number of products priced by region and for the Ring comparison.

The panel on the right-hand side represents the process of linking through the Ring countries. Price data are collected through surveys in the 18 Ring countries based on the Ring product lists prepared by the Global Office. For each BH level, prices collected by the Ring countries are converted into their respective numeraire currencies using the BH parities from the regional comparisons available from the left-hand panel. Once this process is completed, there are 18 vectors of prices for items in the basic heading under consideration, and the prices are expressed in the six numeraire currency units of the six regions. For example, in the 2005 ICP the four vectors of prices from the Asia-Pacific Ring countries were all converted to Hong Kong dollars using the PPPs available from the region. Similarly, the OECD-Eurostat Ring prices were converted into British pounds. The Ring price data in the form of 18 price vectors were then aggregated using the CPD method (discussed in chapter 4), resulting in a single set of between-region parities for a given basic heading, which provide PPPs for each of the regional numeraire currencies expressed in terms of U.S. dollars. These are called the *linking factors*.

Figure 1.3 Methodology for Linking Regional Comparisons



Source: The author.

Once the linking factors are obtained for each of the 155 basic headings, the regional basic heading PPPs are converted into PPPs relative to the U.S. dollar using the linking factors. At the end of this process, as shown in the top step in the middle panel of figure 1.3, a matrix of BH-level PPPs for 146 countries and 155 basic headings are available. In addition, the expenditure data from all 146 countries

are available in national currency units from the respective national accounts. Implicit quantity data could be computed along the lines suggested in equation (1.12).

The next step in the left-hand panel for global comparisons is to combine the BH-level PPPs and expenditure data to derive global comparisons for selected higher-level aggregates. If the principle of fixity were not applied, the next step would be quite simple. Any of the aggregation methods (GEKS, Iklé, or GK) could be employed directly for the full data set in one step, thereby providing an *unrestricted set of global comparisons*. Because of the fixity requirement, in the 2005 ICP the linking factors were aggregated for each level to calibrate the regional volumes to the global level. The unrestricted results were not published as a part of the 2005 ICP.

The application of the *fixity p*rinciple in the derivation of PPPs and volumes or real expenditures at a higher level of aggregation is a complicated process. Following a method proposed by Diewert (2004), the linked global comparisons satisfying the fixity principle were derived. The methodology used for linking above the BH level is described in chapter 6 of this volume. Because the methods discussed there are complex, no attempt is made here to describe them.

Finally, at the end of the aggregation process a complete set of PPPs at the BH level and at higher levels of aggregation and the associated volumes and real expenditures are compiled. These results were presented in the final report for the 2005 ICP (World Bank 2008).

1.5 Concluding Remarks

The 2005 ICP was a major project covering 146 countries in all regions of the world. If comparing prices over time within a country and compiling the consumer price index are considered difficult tasks, comparing price levels across countries is a Herculean one. Reflecting the complex nature of the ICP, the framework and methodology employed by the ICP are also complex. These procedures have evolved over the last four decades, and the methods continue to be refined. The aim of this chapter is to provide an overview of and create an appreciation for the approaches used in the 2005 ICP. The most innovative aspect of the 2005 ICP was the complete regionalization of international comparisons, thereby improving the comparability and representativity of products priced for the purpose of PPP computations. The development of a methodology for linking comparisons to derive global comparisons satisfying *fixity* was a major achievement as well. The new methodology, along with the significant step of using a large number of Ring countries to strengthen the linking process, has helped to improve the quality and reliability of global PPPs. Armed with a working knowledge of the framework of the ICP provided by this chapter, it is hoped that readers will be encouraged to delve into the detailed descriptions provided in the chapters that follow.

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