Chapter VIII

VIII. PPP production process

How are PPPs produced?

In PPP calculations, a base country should be specified, where PPP = 1, and to which other countries are compared. For instance, in the regional PPP computations of the Arab region, Oman is the base country. At the global level, the United States of America is the base country.

One of the properties of PPPs is base country invariance. This means that the results are not affected by the choice of the base country.

Another property of PPPs is transitivity. This signifies that the PPP obtained through direct comparison between two countries should be the same as the one obtained by indirect comparison through a third country. This could be expressed as:

$$PPP_{A/C} = \frac{PPP_{A/B}}{PPP_{C/B}}$$

These two properties play a role in the choice of the PPP computation methodology. PPPs are calculated in different stages, from the bottom of the classification, or most detailed level, to the top. In other words, PPPs are first calculated at the level of goods and services, then for the item groups, all the way up to the different GDP aggregates and finally to GDP.

What are the ICP data requirements?

Box 8.1. What is the ICP conceptual framework?

The conceptual framework for an ICP comparison is determined by the definition of GDP. The ICP 2017 cycle adopted the internationally agreed definition provided by the 2008 System of National Accounts as its framework for the common ICP expenditure classification. The previous 2005 and 2011 cycles used the definition provided by the 1993 System of National Accounts.

The System of National Accounts defines GDP from the expenditure side as the sum of expenditures on final consumption, gross capital formation and net exports. Final consumption is total expenditure on the goods and services consumed by individual households or the community to satisfy their individual or collective needs. Gross capital formation is the total expenditure on gross fixed capital formation, changes in inventories and acquisitions less disposals of valuables. Net exports are the difference between the value of goods and services exported and the value of goods and services imported. ICP comparisons are based largely on PPPs calculated using prices collected for the expenditure components of final consumption and gross fixed capital formation. Prices are not collected for changes in inventories, the acquisition and disposal of valuables, or net exports, because they are deflated using reference PPPs.

Computing PPPs, PLIs, and real measures of GDP and per capita GDP requires the following data:

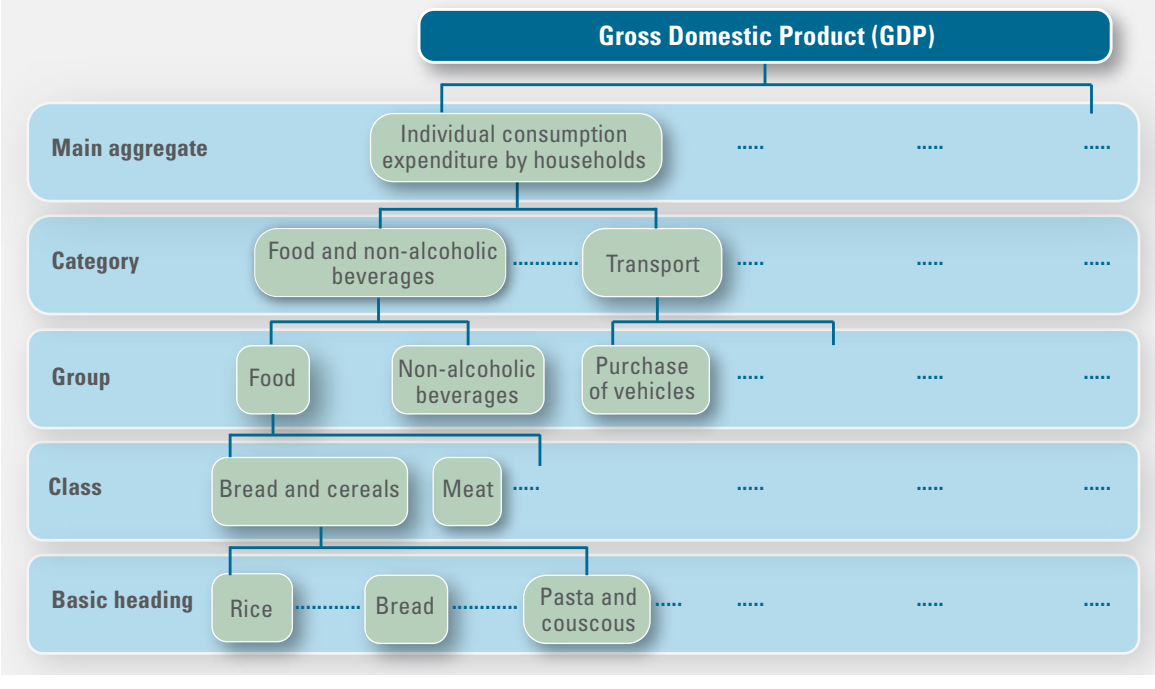
- ***Price*** data: Prices are required for a comprehensive list of household consumption items in addition to a range of special surveys for non-household consumption items. Some prices are collected on a quarterly basis, others on a semi-annual basis and others on an annual basis. Prices are compared among countries, and price ratios are calculated for the computation of elementary aggregate PPPs.
- ***Expenditure*** data: National accounts expenditure data are required for the level of the GDP and its aggregates down to the 155 basic headings (figure 8.1). These data are required for the ICP benchmark year and any year for which PPPs are produced. They are estimated by national accountants in participating countries with the help of the ICP's Model Report on Expenditure Statistics (MORES). Expenditure data are used to weigh elementary aggregate PPPs for higher-level aggregation. They are also used for calculating real expenditures and real per capita expenditures.
- ***Market*** exchange rates: Exchange rate data do not enter into the computation of PPPs but are used to compute PLIs. Market exchange rates are also used for computing nominal measures. Annual average market exchange rates are provided by national statistical offices.
- ***Population*** data: Mid-year population data are required to compute per capita measures of GDP and its aggregates. These data are provided to the regional office by national offices.
- ***Metadata:*** Other metadata and quality assurance data are also required.

Price data

Economies participating in the ICP collect prices for a selection of goods and services that make up final consumption expenditure and gross capital formation. There are four main surveys:

- Household Consumption Survey: This survey covers the largest expenditure share,

Figure 8.1. GDP breakdown



accounting for more than 60 per cent of GDP in the majority of economies. It includes a wide assortment of goods and services purchased by households for individual consumption. This survey also comprises two additional surveys that are treated separately due to different data requirements:

  - The Private Education Survey collects annual tuition prices for private education institutions at the primary, secondary and tertiary levels as well as other education services, such as foreign language and private tutoring.
  - The Housing Survey and related data entail collecting annual rental prices or dwelling stock data for housing services.

- Government Consumption Survey: This survey compiles administrative or survey data on the compensation of public employees in a variety of collective services, public health services and public education services. This selection of government occupations represents various education and skills levels commonly found among employees working in these three government sectors.
- Machinery and Equipment Survey: This survey is based on a list of industrial, transportation and electronic items, and thus provides information on costs of machinery and equipment commonly used in a variety of industries for the production of goods and services. The items on this list are often paired as brand and non-brand specific to cover generic items with the same characteristics as branded ones.
- Construction and Civil Engineering Survey: This survey is based on a list of common resources for construction work. It provides information on costs of construction material and equipment hire rates and labour costs. It also provides information on resource mixes, typical markups and professional fees.

The last two surveys constitute gross fixed capital formation.

Expenditure data

For ICP purposes, countries are required to provide disaggregated estimates for their annual GDP in line with the 2008 System of National Accounts and in conjunction with relevant expenditure components identified in the ICP expenditure classification. At the lowest level of the classification, the expenditure components are termed basic headings (box 8.2). They are the building blocks of the ICP comparison.

Basic heading expenditures provided by participating countries serve as weights for PPP computation. These weights enter into the computation of PPPs after elementary PPPs are estimated and used for PPP aggregation from the basic heading level up to the GDP level. Aggregation is done through averaging the elementary PPPs, or basic heading PPPs, using the national account expenditures as weights for each heading.

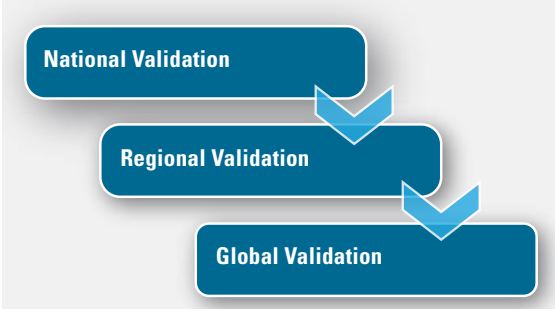
Box 8.2. What is a basic heading?

The ICP expenditure classification has 155 basic headings. A basic heading is the lowest level of aggregation in the expenditure structure for which explicit expenditure weights can be estimated. It consists of a set of items that are similar, and that can include goods or services. Some basic heading examples include rice, bread, pharmaceutical products, or catering services. The basic headings are common for all regions, but the products under them are priced by participating countries within each region and determined by the regional office. They thus vary by region. At the same time, each basic heading should have several global items common to all regions to ensure comparability and allow the computation of global PPPs. This means that a basic heading can include global items and region-specific items.

Box 8.3. What is MORES?

The Model Report on Expenditure Statistics (MORES) is a report designed by the ICP programme to help countries estimate GDP expenditures at the highest level of detail, more specifically, at the level of the 155 basic headings. It simultaneously archives all the data, metadata and estimation methods used.

Figure 8.3. Three levels of validation



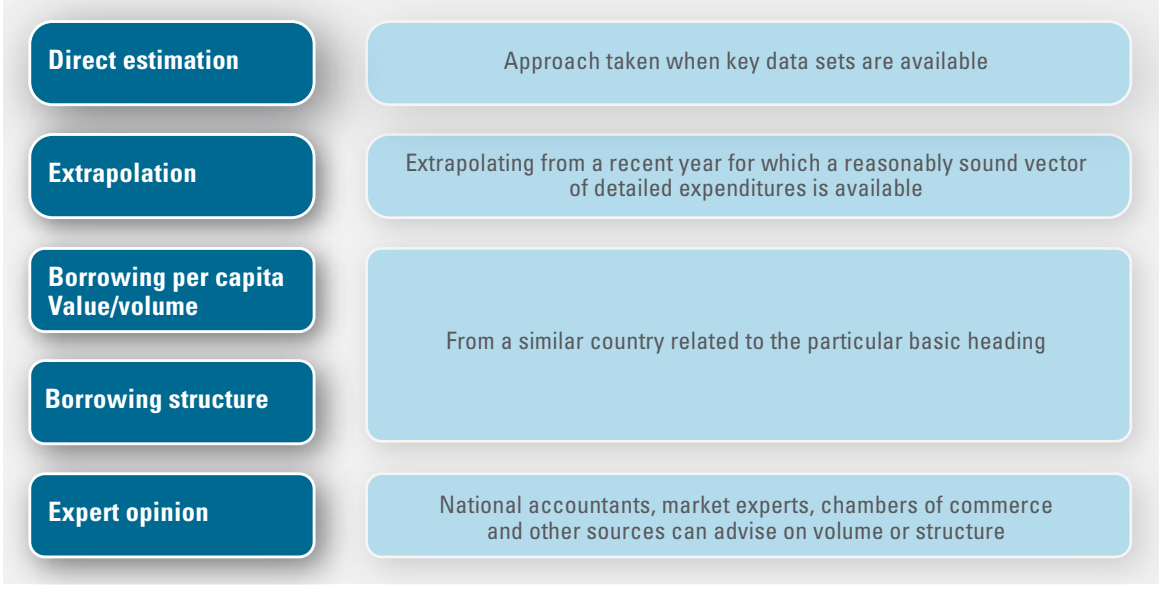
The MORES (box 8.3) facilitates GDP expenditure disaggregation by assisting countries in the estimation of detailed expenditures. Five approaches can be used in the estimation process: direct estimation, extrapolation, borrowing per capita value/volume, borrowing structure and expert opinion (figure 8.2).

How is data quality ensured?

To ensure accurate and high-quality data, several revision and validation rounds are conducted at different stages during each ICP cycle for both prices and expenditures (figure 8.3).

- ***National*** validation or intracountry validation: At this stage, each country performs data validation checks for its own data, whether for prices or national accounts.
- ***Regional*** validation or intercountry validation: After national validation is complete, the regional office performs intercountry validation. Data outliers or errors are then treated by national statistical offices. This stage is repeated until the data are found clean and reliable, and free of unjustified discrepancies or outliers.
- ***Global*** validation or interregional validation: After regional validation, rounds of global validation are performed through interregional

Figure 8.2. The five approaches to estimating detailed expenditures



comparisons. This process is similar to the regional validation.

The three stages of validation are performed for both price and expenditure data. Below is a summary of the validation process for each type of data.

- ***Price*** data: At the national level, countries review their collected price data by examining indicators such as standard deviation, minimum to maximum price ratio, price inconsistencies and other outlier indicators for each item. When PPP computation takes place for interim years, where the regional list has not changed from the benchmark year, an additional type of national validation is conducted for temporal comparison of prices between different years. At the regional level, the same validation is conducted with additional data consistency checks among countries of the same region to locate and correct for any discrepancy. Regional validation flags existing data outliers and shows whether countries are pricing the correct items as per the structured product descriptions. The regional office also validates data by examining PPPs as well as different ratios through the use of special tools. The same validation process is performed at the global level, with consistency checked among all participating countries in the different regions. The main difference between regional and global validation is that the latter examines prices collected for the global core list (GCL) items only, excluding region-specific items.
- ***Expenditure*** data: At the national stage of expenditure data validation, participating countries perform some basic data checks, such as for data completeness and data additivity, or the applicability of positive and negative data values. Additional checks ensure the correct estimation of certain GDP components such as expenditure by non-profit institutions serving households (NPISHs) and its breakdown, financial intermediary services indirectly measured (FISIM), net purchases abroad, the breakdown of expenditures on machinery and equipment basic headings, and others. Once the national validation is complete, the regional office performs regional validation rounds on expenditure data to check data soundness and reliability. Data consistency among countries is checked during the regional validation by examining similar economies. Furthermore, the regional validation requires that countries also review basic heading GDP shares and per capita expenditures based on intra- and intercountry comparisons. For instance, in the Arab region, the regional office divides the participating countries into two subregions for expenditure data validation, namely, the GCC and non-GCC countries, based on economic similarities in consumption patterns within each subregion and divergence between the two subregions.

The validation stages are repeated numerous times until data are considered reliable, and results can be finalized. The repetition of the validation process is necessary as any change in data, whether in prices or national accounts, for any country, results in a change in PPPs for all economies. That's why after each revision and update of national data, new results are computed and verified through a new validation round, as the updated data may reveal errors not previously noticed.

The PPP computation methodology simplified

The computation of PPPs commences only after finalizing the computation and validation of annual average prices of each priced item for each country at the national level on one side, and the GDP breakdown and its estimated aggregates at the 155 basic heading levels on the other side. Only then can the regional office start computing regional PPP estimates, after which the global PPP computation can begin.

- ***Choice*** of PPP computation methodology

In a bilateral comparison of two economies, basic heading PPPs can be computed directly by taking

the geometric means of price relatives between them for the items under each basic heading. As the ICP is a multilateral comparison, however, PPPs between two economies can also be computed indirectly through a third economy, as follows:

$$PPP_{C/A} \times PPP_{B/C} = PPP_{B/A}$$

A multilateral comparison is achieved by using both direct and indirect PPPs, meaning that the PPPs between any two countries are affected by the PPPs between them and other countries in the comparison. Therefore, a change in the country composition in a comparison will result in a change in the PPPs for all countries in that comparison. Many methods can be used for computing multilateral PPPs. The choice of method is based on two PPP properties, namely, transitivity and base country invariance. As mentioned previously, PPPs are transitive if they are the same between two countries whether computed directly or indirectly, and PPPs are base country invariant if they are the same between two countries regardless of the base country chosen. Another property underlying PPP computation is that all countries are treated equally regardless of their GDP sizes.

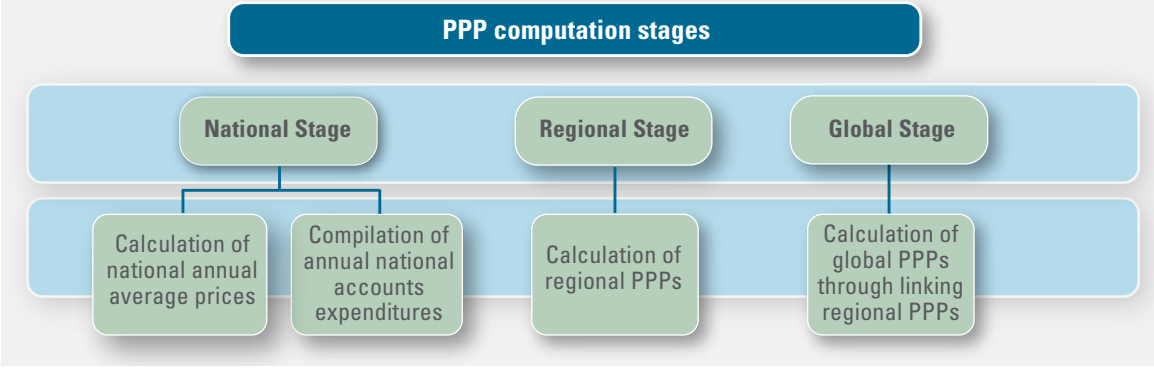
Basic heading expenditure weights are used to weigh basic heading PPPs in the computation of higher aggregate PPPs. In this computation, PPPs are first weighted by country A's weights, computing the Laspeyres index, and then weighted using country B's weights, computing the Paasche index. Each index provides a weighted average of the PPP between A and B. The geometric mean of the two aggregated PPPs is then taken for every pair of countries in the comparison, resulting in the Fisher index. Multilateral PPPs are the geometric mean of the direct and indirect Fisher indices.

Additivity – which occurs when the sum of real expenditures of basic headings constituting an aggregate equals the real expenditures based on the PPPs for the aggregate – is not satisfied with this method. The disadvantage of additive methods is that they are subject to the Gerschenkron effect, which means that they narrow the gap between high-income countries and low-income countries as they give more weight to the prices of bigger, more developed countries, making the real expenditures of poorer countries appear larger and moving them closer to the real expenditures of the rich countries. For this reason, non-additive methods are preferred.

Another concept determining the choice of method is fixity. Fixity means that the relative volume, or the ratio of real expenditures, between any pair of economies in a region remains the same after the regional results have been combined into a set of global results including all economies.

This report contains a brief overview of the PPP computation methodology followed by the Arab region for the computation of regional PPPs. After regional PPP computation, extensive work is

Figure 8.4. PPP computation stage



performed at the global level to link regional PPPs for the computation of global PPPs (figure 8.4). This report does not dwell on the global PPP computation beyond providing a general overview of it.

At the regional level, PPP computation is performed in two stages:

- Computation of PPPs at the elementary aggregate level, and
- PPP aggregation.

- ***Regional*** PPP computation

PPP computation at the elementary aggregate level

The regional office at ESCWA performs PPP computation at the elementary level to compute basic heading PPPs. Elementary aggregates are the lowest level of aggregation for which expenditures are available. Below that level is the item level, and expenditures are not estimated at that level. Additionally, not all countries price all items under each basic heading. Therefore, the computation of PPPs for the elementary aggregates does not use expenditure weights, but for household consumption, the PPPs at this level are still weighted by the importance of each item specified by national offices. Hence, the computation of elementary PPPs uses only price and importance data, and computes PPPs for each basic heading.

The formula used at this stage has to satisfy the PPP properties of transitivity and base-country invariance. The method recommended by the ICP Technical Advisory Group and used since the infancy of the ICP is the country product dummy (CPD) regression. This method computes the elementary aggregate indices while dealing with the existing gaps in price data caused by missing prices of some items in some countries. The CPD method entails regressing the natural logarithm of the reported average prices on country and product dummy variables.

ESCWA uses the weighted country product dummy method (CPD-W) to compute PPPs at the elementary level for the Arab region. Since not all items within a basic heading are equally important or representative in each country, national offices specify whether each item in the household consumption regional product list is important - meaning it has a relatively large expenditure share - or less important in the country. In the CPD-W method, items identified as important by each country are assigned higher weights than less important items. In the standard CPD method, however, all items in a basic heading are assigned equal weights of 1. In the CPD-W computation process, important items are assigned a weight of 3, while less important items are assigned a weight equal to 1.

Not all 155 basic headings will have priced items under them. For basic headings with expenditure data but no available price data, reference PPPs are used. There are two different kinds of reference PPPs, namely price-based reference PPPs and exchange rate-based reference PPPs. In general, most of the reference PPPs used are based on other basic heading PPPs, meaning that the reference PPP for a certain basic heading would be equal to or computed from PPPs of other basic headings for which item prices existed. Reference PPPs can be taken from a specific basic heading or from more than one basic heading by taking the Gini-Éltető-Köves-Szulc (GEKS) average of the selected PPPs, weighted by their expenditure shares, and referred to as specific reference PPPs.

In other cases, reference PPPs are the PPPs of a large group of basic headings, such as all basic headings under gross capital formation for which prices have been collected. In this case, the purpose is to ensure that using a reference PPP will not change the PPP for that larger group. These are referred to as neutral reference PPPs, because the intention is to have no impact on the PPPs of the larger group of basic headings. Net purchases abroad, acquisitions less disposals of valuables, exports of goods and services, and imports of goods and services are the four basic headings for which exchange rate-based reference PPPs are used. The full list of reference PPPs is provided in annex II to the present report.

PPP aggregation at higher levels

Once the elementary PPPs are estimated, the next step is aggregation to obtain regional PPPs above the elementary level, which is also performed by the regional office. Aggregation is done through averaging the elementary PPPs and using national account expenditures as weights for each basic heading. For instance, the PPP for the class "fish and seafood" is computed by averaging the PPPs for the two basic headings corresponding to this class, "fresh, chilled or frozen fish and seafood" and "preserved or processed fish and seafood". This aggregation is performed separately for each level from the classes to the groups, then to categories, then to the main aggregates and finally to the GDP level.

The GEKS method is used for averaging PPPs from lower levels to upper levels. This method is non-additive, meaning that the sum of the real expenditure aggregates converted using aggregate PPPs will not add up to higher levels when the higher levels are converted using their corresponding PPPs. For instance, the sum of the real expenditures of the main aggregates converted by PPPs at the aggregate levels will not equal the total real GDP expenditure when converted by PPP at the GDP level. This is not the case for nominal expenditures, which when summed up after being converted using exchange rates would still add up to the higher aggregation level, mainly because exchange rates do not differ among aggregates as opposed to PPPs, which are different for each aggregate level.

The GEKS PPP computation is performed in two steps. The first step is the aggregation of basic heading PPPs using the country's national accounts expenditure structures to obtain the bilateral PPPs for each pair of countries. Fisher-type PPPs are usually used, which are geometric means of Laspeyres-type PPPs and Paasche-type PPPs. The second step involves averaging the Fisher-type PPPs to arrive at the final vector of GEKS PPPs. The GEKS calculations are performed separately for each aggregation level and for each category within a given aggregation level.

Special considerations in regional PPP computation

Some aggregates are considered to be comparison-resistant due to country-specific differences that cannot be fully captured in prices. One such aggregate is government compensation. It is not easily comparable across countries because of differences in labour productivity. Since detailed specifications are taken into account when compiling government compensation data by national offices, the differences in labour productivity are mostly caused by country differences in the availability of capital per worker, such as the availability of machinery like computers. To ensure estimates of real expenditures for government services are reliable and comparable requires making a productivity adjustment. Productivity adjustment factors are calculated using economy-wide capital-labour estimates for each country from the results of the regional comparison and the Penn World Tables. The productivity adjustment shows how much labour productivity in a country would be if that country had the same level of capital as the base country. Therefore, the regional PPPs for government expenditures in the Arab region, and hence real expenditures by government, are adjusted for productivity differences, making them reliable and comparable.

Since Egypt, Morocco and Sudan participated in the 2017 ICP cycle in both the Arab and African regions, they required special consideration. Their dual participation called for coordination between ESCWA and the African Development Bank. This was extremely important to ensure consistency in the price data provided by the national statistical offices of these countries to the two regional ICP offices for common items, as well as in expenditure data, exchange rate data, population data and metadata.

- ***Global*** PPP computation

Standard linking of global PPPs

To compute global PPPs and measures of price and volume relatives, the global office at The World Bank conducts a global linking of regional PPPs. The first stage consists of linking

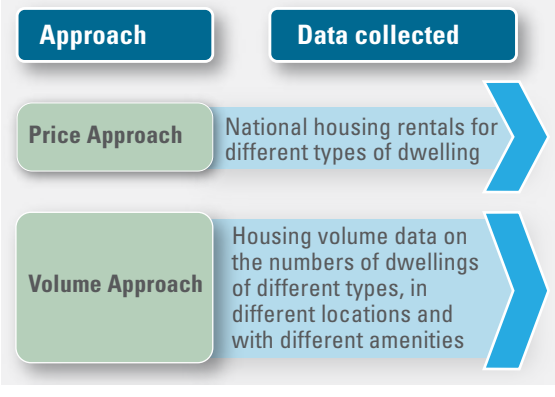
at the basic heading level, which involves the computation of interregional linking factors based on the prices of items from the global core list, and calculation of global PPPs. This preserves regional fixity using the GEKS aggregation method, with redistribution of regional volumes in accordance with an economy's regional volume shares. This stage is followed by linking at the aggregate level to obtain global PPPs at the aggregate levels and up to the GDP.

Special considerations in linking

This section will discuss non-standard linking approaches at the global level for housing and government compensation, and non-standard country participation, specifically the dual participation of countries in both the Arab and African regions.

Countries collect data for housing rentals and housing volumes, and estimate housing expenditures for actual and imputed rentals. The Arab region and couple other regions have computed housing PPPs using the rental-based approach. Other regions have applied the volume approach (the quantity approach), or a mix of both volume and rental approaches. The global office has then proceeded with the linking process for housing PPPs. As for government compensation, although not all regional offices have performed productivity adjustments, these adjustments were made for all regions in the global comparison to maintain consistency.

Figure 8.5. Two approaches to housing PPPs



Special considerations were made at the global level for the dual participating countries in the Arab and African regions. To compute one set of global PPPs for Egypt, Morocco and the Sudan, the global office computed the geometric means of the two global PPPs for each of the three dual participating countries resulting in each of the two regions. Other special considerations were made at the global level for singleton economies that do not participate in the programme as part of a region. Additionally, imputations were made at the global level to compute PPPs for non-participating countries. For instance, in the 2017 ICP cycle, a regression method was used to impute PPPs for non-participating economies such as Lebanon, Libya, Somalia and others.

Limitations in the use of the PPPs

PPPs are statistical estimates. Like all statistics, they are subject to errors related to sampling, measurement and classification. Therefore, they should be treated as approximations to true values. Because of the complexity of the process used to collect the data and calculate the PPPs, it is not possible to directly estimate their margins of error. Therefore, small differences in the estimated values among economies should not be considered significant.

PPPs should not be used as indicators of the under- or overvaluation of currencies. They do not inform what market exchange rates "should be". In fact, lower-income countries are expected to have lower PLIs for non-tradable goods, which in general should result in an overall lower GDP PLI. PPPs do not reflect the demand for currencies as a medium of exchange, speculative investment or official reserves. PPPs should also not be used for international comparisons of flows such as migrant remittances, foreign direct investment, or imports and exports of goods and services, in which case market exchange rates should be used instead.

Moreover, in terms of ranking economies based on real GDP or real GDP per capita, it should be kept in mind that sampling and statistical errors can occur from the PPP calculation methods. Therefore, differences in real GDP of less than 5 per cent should not be considered significant.