A MANUAL FOR THE COMPILATION OF SUB-NATIONAL PURCHASING POWER PARITIES

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1. Introduction

1.1 Background

The International Comparison Program (ICP) has completed 50 years since the first set of comparisons undertaken by Professor Irving Kravis and his associates at the University of Pennsylvania. Starting as a small research project in collaboration with the UN Statistical office covering 10 countries, it has grown into a global statistical initiative covering 177 countries in the 2017 round of the ICP. A major contribution of the project has been the regular compilation of purchasing power parities (PPPs) of currencies and estimates of internationally comparable national income aggregates in PPP terms. Purchasing power parities provide a framework for comparing price levels across different countries. PPP of currency of a given country is the number of currency units of the currency of the country required to buy a basket of goods and services that can be bought for one of currency of a reference country. Details of the ICP framework for the compilation of PPPs can be found in World Bank (2013) and Rao (2013).

A large majority of the current uses of PPPs are essentially international in nature. PPPs from the ICP are used in making cross-country comparisons of price levels, real incomes and standards of living and in assessing economic performance of nations and catch-up and convergence. PPPs are currently used by international organizations such as the IMF, the World Bank, European Union and the OECD as well as by researchers, policy makers and national governments around the world (see Chapters 21 to 24 in World Bank, 2013). The PPPs from the ICP have been used in the measurement and analysis of global inequality and poverty; human development index; World Development Indicators; and in the estimation of global growth and inflation.

1.2 Need for sub-national PPPs

The PPPs in concept and by construction are designed for making price comparisons across countries. Broadly, PPPs are anchored on national annual average prices for a large basket of comparable and representative goods and services and expenditure weights from the national accounts.[1] For example if PPP for India is INR 20 per US dollar, this means that the basket of goods and services that can be purchased for one dollar in the US can be purchased in India with 20 rupees. Suppose the market exchange rate between these currencies is INR 60 per US dollar, then the price level in India is the ratio of PPP to exchange rate (20/60) which implies that prices in India are roughly one-third in India.

While the India-USA PPP is useful for comparing price levels and real incomes across countries, the PPP from ICP is of limited use if one is interested in comparing prices in, say, New York with prices in Mumbai. PPP from the ICP is a broad country-level measure which cannot inform the user when it comes to comparisons of entities which are sub-national. A single PPP for the whole of India has the implication that this PPP is representative prices in all regions within India and in the USA. However, it is well recognized that there can be significant variation in price levels across different regions within a country. For example, price in rural India are generally believed to be lower than those in urban India. PPP from the ICP is not designed to capture such sub-national price level differences. For example, the World Bank makes adjustments to ICP PPPs to account for rural-urban differences in its estimation of regional and global poverty using international poverty lines like $1/day or $2/day.

[1] The actual implementation of ICP and the process of compilation of PPPs of currencies of all the participating countries is quite complex – a description of the framework for the ICP is presented in Rao (2013) and the full set of procedures are discussed in various chapters of World Bank (2013), *The Real Size and Structure of the World Economy*.

Policy makers and researchers interested in the nature of development process and assessing the degree of competitiveness and productivity in different regions within the country will find PPPs from of ICP to be of limited use. What is needed in such instances are measures of price level differentials across regions or cities within a country – pointing toward the need for PPPs at a sub-national level.

1.3 Nature and Scope of the Manual on Sub-national PPPs

At the conclusion of the 2011 round of ICP, the UN Statistical Commission and Friends of the Chair (FOC) conducted an evaluation of the Program and made a number of recommendations. The Global ICP Unit at the World Bank formulated a Research Agenda in response to the recommendations and identified a number of topics for research. Compilation of sub-national PPPs is included in the Research Agenda with the following brief:

"Agenda Item 4. Estimation of sub-national PPPs using CPI information

A considerable effort is underway to estimate price levels at the sub-national level using available CPI information (World Bank jointly with Asian Development Bank and African Development Bank). Using the CPI to produce sub-national PPPs contributes both to the sustainability of the ICP in countries and to closer alignment of the ICP and CPI processes. Sub-national PPPs can also be extended to cover estimation of subnational poverty levels. The following needs to be done:

i. Analyze Asian and African experience with sub-national PPPs and provide guidelines on the use of the CPI to compute within country sub-national PPPs.
ii. Analyze temporal consistency of CPI and sub-national and poverty PPPs.
iii. Expand work on sub-national and poverty PPPs to more countries."

This manual is designed to provide guidance to countries embarking on the compilation of PPPs at the sub-national level. As price comparisons within a country are anchored on price data collected as a part of the compilation of the consumer price index (CPI), this manual has a symbiotic relationship with the Manual on CPI-ICP integration. National statistical offices involved in the compilation of sub-national PPPs are advised to consult both of these manuals.

2. Sub-national Purchasing Power Parities

2.1 The concept

The concept of sub-national Purchasing Power parities, hereinafter referred to as *SN-PPPs*, is similar to the concept of PPPs used in the context of international comparisons. SN-PPP measures the amount of money that is needed in a sub-national geographical area required to buy the same basket of goods and services than can be purchased with one unit of currency of the area used as the reference or base. SN-PPPs are in essence spatial price level comparisons within a country whereas ICP-PPPs compare prices across countries. The temporal equivalent of SN-PPP is the *consumer price index* (CPI) where price levels are compared over time within a country or within a region in a country.

The SN-PPPs measure price levels in one sub-national geographical area compared to that in another area. A significant difference between SN-PPPs and ICP-PPPs is that within a country there is a common currency whereas the unit of currency is likely to vary across countries. Though there is a common currency within a country, it does not mean that prices are the same across different geographical areas within the country. Consequently, SN-PPPs serve as spatial price index numbers for comparisons within a country where as ICP-PPPs need to be compared with market exchange rates, PPP/XR, in order to measure price

levels in different countries. The differences in the level of prices in the different areas emphasize the need for the computation of sub-national PPPs regardless of the size and denomination of the areas really considered.

2.2 The scope

The scope and coverage of sub-national PPPs differ from those of PPPs from ICP. As the main purpose of the ICP is to compile internationally comparable national accounts aggregates such as the gross domestic product (GDP); household consumption by individuals; actual consumption by households which includes consumption by individuals and consumption of government and non-profit organizations on behalf of households; government expenditure; and gross fixed capital formation.
The scope of SN-PPPs must depend on the purpose for which these PPPs are compiled. The general purpose of SN-PPPs is to make comparisons, in real terms, of household expenditure, expenditure on food, clothing and housing; and these PPPs are in turn used in the measurement and analysis of well-being, inequality and poverty across different geographical areas within a country.

2.2 Scope of sub-national PPPs

In comparison to the scope of PPPs from ICP which is within the confines of the national accounts framework and the aggregates within GDP, sub-national PPPs can be tailored to the purpose for which these are being compiled. However, the scope of SN-PPPs could be limited by the nature of data available in different geographical regions within the country. Suppose purpose of the SN-PPPs is to make price level comparisons between rural and urban areas. In this case, the scope of SN-PPPs cannot be at the GDP level as national accounts statistics are not compiled separately for rural and urban areas. However, it may be feasible to construct SN-PPPs at the state or provincial level only if national accounts are available at that level. The possibility to compute the complete set of SN-PPPs depends on the availability of prices and expenditures data for the various aggregate of GDP at sub-national level, and on the availability of detailed products classification and on the possibility to collecting data necessary for compilation of SN-PPPs. This possibility is also affected by the territorial organization of each National Statistical Organizations (NSOs) or on the national statistical systems.

2.2.1 SN-PPPs by coverage of expenditure categories

GDP versus household consumption

Taking into account the difficulties in estimating SN-PPPs for all the aggregates of GDP, the computation of PPPs at the GDP level may not be feasible, unless that the NSO of each country may conduct new specific surveys. In this case, scope of SN-PPPs may be restricted Household Consumption. This should be feasible since in almost all the NSOs collect price data for the computation of CPI on a regular basis.

Housing or dwelling

Comparisons of housing across different geographical regions is just as important as comparisons of housing expenditure across countries. Housing expenditure comparisons even within a country present difficulties due to the varying mix of owner-occupied versus rented dwellings and due to present of rental subsidies or subsidized housing. Imputations for non-market rents and owner-occupied housing are necessary. Despite the challenges in measuring PPPs for housing expenditure, such PPPs have autonomous relevance as they are critical inputs into evaluation of cost of living across cities and regions; in assessing and comparing poverty, and, above all in the analyses of housing rental markets and in designing housing policies at the local level.

Government salary comparisons

SN-PPPs can be compiled by using data on government compensation/salaries for government employees. Government salaries are usually the same in different regions within the country, and for this reason SN-PPPs depend only on differences in structure of government occupations and differences in the composition and characteristics of the employees such age, qualification etc. Also in this case, the computation of SN-PPPs depends on the availability of territorial disaggregation of data used for the compilation of national PPPs-ICP.

Construction and Machinery and Equipment

The comparison of construction prices poses special problems because most construction outputs are unique, and they differ in many characteristics. Two alternative pricing methods are used at international level for comparing construction prices: the so-called input pricing and output pricing. Both methods are complex and costly for implementation at sub-national level.

The pricing of machinery and equipment, could be similar to that used for household goods and services, by using a list of products to be priced, with their detailed description. However, the product specifications are very technical and difficult to describe, and some equipment goods are unique because they are designed for a specific location or purpose. Moreover, most of the machinery and equipment are purchased by producers (private enterprises, government, and nonprofit institutions) and it is quite impossible to do surveys to obtain information on the prices from them. On the other hand, the use of prices collected from the sellers from the geographic areas may not be adequate since purchasers can buy machinery and equipment outside their territorial area.

2.2.2 Different types of SN-PPPs according to Territorial Coverage

Several different SN-PPPs can be considered depending on the specifications of the geographical areas involved in the price comparisons.

Spatial Adjustment Factors

Spatial adjustment factors are used in converting prices in different geographical areas into national levels as a way of reducing the cost of collection of data for the computation of national average prices as required by the ICP. In some countries, in particular those participating in the Eurostat-OECD PPP program, collect price data only from capital city and then convert them in the process of computing national average prices by applying spatial adjustment factors. Prices in capital city do not normally reflect national prices. Therefore, in order to have price levels at the national level, Eurostat requires[2] the participating countries to produce Spatial Adjustment Factors (SAFs) every six years. The computation of SAF's is similar to the computation of PPPs for suitably defined geographical areas.

According to the Eurostat-OECD PPP Manual[3] there are at least two main approaches that can be followed by countries in the computation of the SAFs: (i) calculation on the basis of available Consumer Price Index (CPI) data or (ii) conducting of specific surveys aiming at measuring sub-national differences in consumer price levels (this last approach has turned out to costly). Within the first approach, countries can take the PPP product list and try to match it against CPI products. This method has the advantage that the prices are

[2] The request is in accordance with Regulation (EC) No 1445/2007 of the European Parliament and of the Council.
[3] PPP manual: hppt:ec.europa.eu/eurostat/web/products-manual-and-guidelines/-/KS-RA-12_023

comparable to those collected for PPP purposes. Alternatively, one can search the CPI data for products that are comparable across sub-national area and base the SAFs on price of CPI products. Within the first approach, countries can take the PPP product list and try to match it against CPI products.. A combination of available CPI data with additional price collection or the use of additional data sources for products where comparable CPI data are lacking may be optimal. Compilation of SAF's has become a regular activity in some of the Eurostat-OECD countries (Eurostat, 2017; ONS 2011, 2018; and Turkstat, 2018)

Capital city PPPs

In countries with several major metropolitan cities, comparison of prices across regional capital cities are of interest for business with employees located in different cities. Capital city PPPs can used for making adjustments for differences in cost of living in different cities. These are similar to Post Adjustments made by the International Civil Service Commission. Good quality rental data are likely to be available for the purpose of comparing housing expenditures across capital cities.

Regional/province level PPPs

In most countries comparisons of price levels in different regions are important from a policy perspective. Measuring standards of living across different regions and measurement of inequality and poverty is given high priority by governments and policy makers. Regional SN-PPPs are used in the compilation of the human development index and used in assessing growth performance and catch-up and convergence of different regions. Usually compilation of regional SN-PPPs is just as complex as the compilation of PPPs for international comparisons especially in countries which are large and regions are economically and geographically diverse like China and India.

3. Uses of Sub-national PPPs

Regular compilation of sub-national PPPs by countries participating in the ICP will increase the usefulness and applicability of international price comparisons for policy makers and researchers at the national and international levels. International organizations such as the World Bank and the United Nations and national organizations interested in the compilation of indicators for the Sustainable Development Goals (SDGs); the Human Development Index (HDI); and estimates of regional and global inequality and poverty.

3.1 Uses of SN-PPPs at the national level

Comparisons of prices and real expenditures at the sub-national level for different expenditure aggregates provide the policy makers in their pursuit of formulating evidence-based policy making. Commercial firms and business enterprises as well as researchers and the general public are likely to benefit from the information generated and disseminated through sub-national price comparisons.

- The primary focus of governments and policy makers is to improve the living conditions of the general population uniformly across all the provinces and regions within the country. Monitoring the efficacy of government policies in delivering equitable outcomes is critical in identifying issues and in forging effective policies. Availability of reliable price comparisons across the country through sub-national PPPs enables the analysts and policy makers to measure the purchasing power of incomes of households in different geographical locations thus making it possible to identify areas in need of further attention.

- A principal objective in all countries is to achieve balanced development across all the regions. Availability of real per capita household expenditure and real per capita regional GDP (where available) are necessary in the process of assessing economic performance in terms of relative levels of income and productivity. Comparative analysis of performance of regions will help assess regional inequality and gauge catch-up and convergence among different regions of the country. Moreover, the policy makers are interested in the computation and comparisons among the different sub-areas (including urban and rural areas) of real disposal income of the households, salaries, labor costs, productivity, health education, etc.

- The SN-PPPs contain valuable information on price level differences across different regions and also different components of expenditure. Such detailed information on differential price levels can be useful for spatial price level analysis (to verify the market structures and eventual price distortions); for inequality and poverty analyses that involve spatial comparisons for which the different level of prices are important, allowing to assess the real economic material well-being of people in the different territorial areas and to measure the real economic poverty lines and indicators.

- In large economies with federal systems, the regional or provincial governments can benefit from regular regional comparisons of prices and real expenditures. In particular, the regional governments will be able to compare and contrast the relative prices of important services such as transport, health and education. Sector-specific sub-national PPPs will enable the provincial governments to undertake comparative analysis of the source of price differentials by comparing price levels in the geographically contiguous neighboring provinces as well as in provinces which are at similar levels of development.

- Estimates of real government expenditure on behalf of households in education and health help assess inequities in the provision of such services across different provinces. These data also help in the assessment of adequacy of provision of such services in rural, urban and metropolitan areas within a province.

- The national and local governments are interested in calibrating the regional poverty lines using information on price level differences through SN-PPPs and to obtain reliable estimate the number of poor in different regions in order to decide the allocation of financial funds to support the development of the sub-national areas and/or to reduce economic disparities, the poverty and the number of poor. The inequality and poverty analyses are extensively developed and increasingly focusing on local/small areas.

- To conduct analyses of the incidence and extent of poverty at the regional and national level, researchers are asking for the estimation of *poverty-specific SN-PPPs*, because the general PPPs are not adequate to do spatial price comparisons that involve the poor. In fact, the consumer behavior of households and in particular of the poor varies for quality of the commodities, channels of distributions, location of the markets and, above all, it is necessary to account also for the prices payed by the poor, that may be are cheaper. This means that in a program for computing SN-PPPs it is important to consider the compilation of poverty-specific sub-national PPPs.

- The private firms operating in different sub-national areas can apply SN-PPPs for the purpose of comparative analysis involving prices, sales, market share and production costs.

- Firms with employees located in different regions aim to ensure that employees are adequately compensated for differences in living costs in different cities and different regions. A major component of living costs is the cost of housing in different metropolitan cities and urban centers. Regular publication of PPPs for housing expenditure based on rental data will help in identifying appropriate compensation for employees.

- In an era of increased labour mobility, individuals considering employment opportunities in different regions can refer to SN-PPPs to assess cost of living differences in their salary negotiations when moving from one place to another.

3.2 Uses of Sub-national PPPs at the International Level

Regular compilation and dissemination of sub-national PPPs will help achieve the strategic objectives of many international organizations. Strange it may sound, but SN-PPPs have significance not only for international organizations but also for multinational companies which formulate global strategies for their business operations. A few applications/uses of SN-PPPs at the international level are discussed.

- With the general mission of a world without poverty, the World Bank regularly compiles estimates of incidence and severity of extreme poverty in different regions of the world. The World Bank uses international poverty lines such as $1/day and $2/day to estimate regional and global poverty. The current international poverty line (IPL) is set at $1.90 per day in 2011. In the actual process of estimating the number of poor in different countries, the international poverty line is converted to national currency units using PPPs from the ICP. However, PPPs from ICP are based on national average prices and therefore a direct converted IPL expressed in national currency units cannot be used in counting the number of poor in a large country where price levels may differ significantly from the average national prices. For example, prices in rural areas would be lower than the national average and consequently urban prices would be higher than the national average prices. In counting the poor it is important to account for these regional differences. Chen and Ravallion (2010) and Ferreira (2016) provide details of the type of adjustments made for spatial differences in prices in estimating global poverty. If countries were to produce SN-PPPs that would eliminate the need for using any ad hoc or guestimates for making adjustments for within country differences in prices.

- A related topic is the analysis of global and regional inequality which currently relies on the use of PPPs from ICP in converting average incomes in each country into US dollars. The use of PPPs from ICP implicitly assumes that price levels are the same across all the sub-regions and provinces within a country, an untenable assumption. Sub-national PPPs can help further fine-tune the measurement by accounting for regional price differences.

- The United Nations Civil Secretariat devotes resources to measure cost of living differences in different capital cities and major metropolitan areas around the world. The UN Post Adjustment process is based on these differences. If spatial adjustment factors (SAFs) are available for different cities within countries, then the ICP-PPPs can be adjusted using SAFs leading to meaningful indicators of purchasing power parities of currencies across different cities in the world.

- The policy makers may use the SN-PPPs also for operational purposes. The European Commission use the GDP and other indicators in real terms to allocate funds at the Nuts3 areas of the EU for the allocations of Structural Funds and the Cohesion funds.

Finally, the computation of SN-PPPs improves the Statistical Capacity Building of the country. In some cases CPI compilation may be improved when the NSO is involved in the computation of SN-PPPs by integration between ICP and CPI activities.

4. Frequency of compilation of Sub-national PPPs

The optimal frequency for compilation of SN-PPPs is annual. In most countries, CPI is compiled on a monthly basis and estimates of price movements are published on a monthly, quarterly and annual basis. In contrast PPPs from the International Comparison Program are available roughly in five-year intervals. However, in the Eurostat-OECD regions PPPs are published on an annual basis compiled using rolling price survey approach. Compilation of PPPs on an annual basis is consistent with the recommendation of the UNSC to increase frequency of ICP to a benchmark every three years. The ultimate aim is to produce ICP PPPs on an annual basis. The Global Unit of the ICP at the World Bank has identified construction annual time series of PPPs as an important research agenda item.

Given the nature, scope and likely uses of sub-national PPPs, it is recommended that countries compile sub-national PPPs on an annual basis.

5. Governance and Administrative structure for Sub-national PPPs

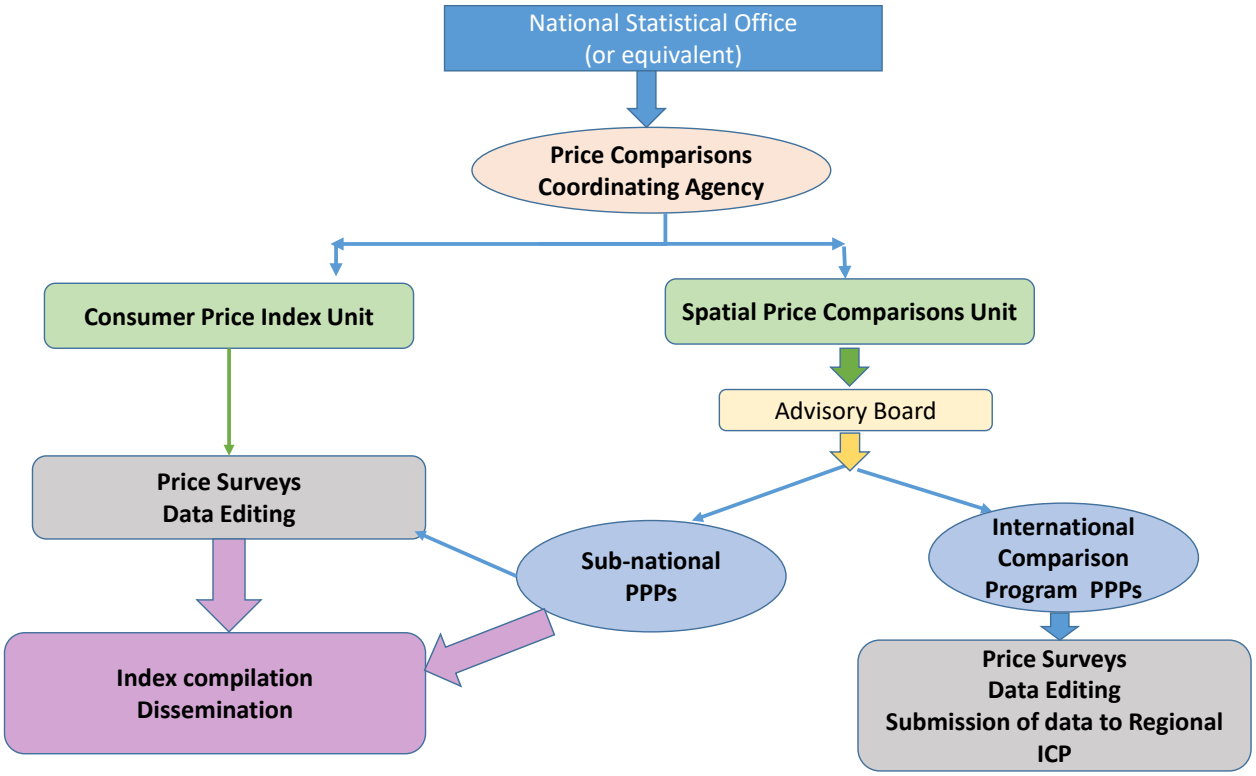
An efficient and well organized governance and administrative structure are essential elements in successful implementation of a program for the production and dissemination of sub-national PPPs. As SN-PPPs are essentially spatial price index numbers, governance structure for SN-PPP must be closely aligned with structures already in existence for the compilation of CPI and for coordinating activities relating to PPPs from the ICP. The guiding principles for the establishment of governance structure for SN-PPPs are:

- Structures must ensure production and dissemination of timely and reliable SN-PPPs;
- As SN-PPPs are measures of spatial price levels, structures for SN-PPPs must recognize its symbiotic relationship with ICP related activities;
- Must exploit the overlap and similarity in the survey framework and subsequent validation and editing and computational procedures;
- Structure must ensure that SN-PPP activities are least disruptive to the work associated with compilation of the Consumer Price Index (CPI) and at the same time exploit any possible synergies from integration of all activities

Countries are advised to refer to the CPI-ICP Manual and follow the principal recommendations for the integration of CPI and ICP activities and implement them in the context of SN-PPPs.

The following schematic diagram provides a guide to the establishment of governance and administrative structures.

Figure: Governance and Administrative Structures



This figure shows an indicative structure that is designed to integrate activities of the consumer price index which is a temporal index with activities associated with spatial comparisons which has two sub-components, viz., sub-national PPPs and ICP PPPs. All the price comparison activities will be coordinated by a single Price Comparisons Coordinating Agency which is responsible for setting procedures and operational guidelines and for the compilation and dissemination of CPI and SN-PPPs in a timely manner. The unit is also responsible for activities associated with the PPP program under ICP. The flow-chart shows that CPI and sub-national PPPs share similar survey framework and facilities for processing price data collected. Using this as a general template, each country establishes its own technical and management structures for compiling temporal and spatial price index numbers and to meet the obligations with respect to its participation in the ICP.

5.1 Integration of CPI and Sub-national PPP activities

The most promising and cost-effective approach to compilation of SN-PPPs for the Household Final Consumption Expenditure (HFCE) is to make as much use as possible of price data collected by the National Statistical Offices (NSOs) for compiling CPI. Given the common features of CPI and PPP there is scope for integration work on CPIs and SN-PPPs. To achieve such an integration, national statistical offices and organizations involved in the CPI construction must be convinced that SN-PPPs computation and any results from PPPs are a natural extension of current CPI activities. There are several advantages in CPI and SN-PPP integration. Here the reader is referred to the CPI-ICP integration manual for additional insights into such an integration.

- The NSOs are best placed to provide data inputs into the construction of sub-national spatial price indexes which are important analytical inputs for national and local policy makers, economists, academics and international organizations.

- The computation of SN-PPPs within the process of CPI collection of price data will increase the awareness of ICP at the country level. In fact, for the time being, the uses of PPP at the national level are less clear and are currently somewhat limited. Providing familiarity with ICP methods and processes, without compromising or disrupting regular statistical priority programs such as the CPI will underscore the importance of the computation of the National PPP for ICP.

- The ICP and the NSOs can save resources and time. In the first phase of the implementation, significant work could be needed to prepare the price database for CPI, SN-PPPs and National PPP for ICP. It may be that the CPI price data are currently collected in a manner that makes it difficult for estimating spatial price differences. The integration of price data activity will increase the synergies between CPIs, SN-PPPs and ICP PPP, and will allow their simultaneous computation under a unified framework. In this way, the ICP PPP could be computed frequently, may be annually, that is a strategic long run objective of the ICP.

- The unified framework could allow the construction of dynamic sub-national PPPs consistent with CPI movement in time domain and consistent with PPP comparison in spatial domain.

Therefore, it is important to convince the national statistical organizations to consider PPP and SN-PPPs work as an integral part of the whole gamut of price comparisons.

6. Guidelines for the Compilation of Sub-National PPPs

There are several major steps involved in the compilation of sub-national PPPs. These steps are similar to those involved in the compilation of PPPs for the ICP. Countries seeking to compile SN-PPPs are encouraged to consult the *ICP Book* (World Bank, 2013), the *Real and Size and Structure of the World Economy*, for detailed descriptions of the procedures involved. This section highlights some important aspects of PPP compilation for purposes of price comparisons within a country.

6.1 Construction of product lists

The first and most important step is the construction of a product list with all goods and services that are to be priced for the purpose of SN-PPP compilation. The most important consideration is that the product list adequately covers the goods and services purchased in different regions of the country. This process is likely to be easier in the case of SN-PPPs compared to PPPs for ICP as regions within a country are likely to be more homogeneous than across countries. Here are a few important considerations and recommendations.

6.1.1Exploit the commonalities in the CPI lists from different regions and the ICP product lists

As the SN-PPPs are measures of price level differences across regions within a country, it is recommended that a starting point for the preparation of the product list is to closely examine the CPI product lists from different regions and identify possible overlaps in such lists. If there are no region specific product lists available, then the CPI product list for the country may be used as a starting point and add any additional products that may be considered important in one or more regions. This process may not be as simple as it appears since it may be difficult to obtain a list of products which are regularly prices as a part of CPI. Even when such a list exists, CPI price collection may not require documentation of specification of products to be priced. In this process, it is recommended that the products in the regional and global product lists are

considered and if possible a subset of those products are included in the SN-PPP product list. Such an overlap enables seamless linking of PPPs from the ICP with SN-PPPs.

6.1.2 Comparability

Comparability of products for spatial price comparisons is in concept similar to pricing the same products at different time points within the context of CPI. Defining and pricing comparable products ensures that differences in prices between areas for a product reflect actual price differences and are not influenced by differences in quality. Two or more products are said to be comparable if either physical and economic characteristics are identical, or they are sufficiently similar that consumers are sufficiently similar that consumers are generally indifferent about the choice of the product. Usually, it is difficult to decide on the level of comparability to be achieved. The more tightly defined the products, the more difficult it becomes to find products meeting the specifications in all the sub-national areas. It may be necessary to define products more loosely to be able to find products that meet the specifications and are purchased in all the areas.

6.1.3 Representativity and Importance Indicators

The products selected must be representative of the products purchased in each area. Representative products are those products that are frequently purchased by resident households and are likely to be widely available throughout the country.

It is clear that comparability and representativeness are two competing requirements. Products may be made comparable through very tight specification of the products in which case such products, while available in the outlets, may not be representative of the consumption in the regions. In the preparation of products list, it is therefore 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 non-representativity products are usually higher than those representative one. Though the issues of comparability are likely to be less serious issue in the context of SN-PPPs, in comparison to the computation of PPPs within the ICP, the two competing requirements need to be considered carefully and caution is required in the preparation of the products list.

Since the price data at the item level are aggregated to form an *elementary level index* or form a *basic heading price parity* without the use of any weights, it may be important to attach an indicator for each item as to whether a given item is considered *important* or it is just available for price collection. Elementary level or basic heading level is the lowest level below which no weights data are available. For example, the item group *rice* is considered a basic heading in spatial price comparisons and ICP; and considered elementary level within the CPI. Different types of rice like basmati, long grain, short grain, glutinous rice, parboiled rice all belong to the *rice* basic heading. The price index for this group is a simple unweighted geometric average of prices (Jevons index). If some varieties of rice are not considered important in a particular region, prices of that variety of rice should be given less weight in the computation of the elementary price index.

A strong recommendation is to attach indicators of importance to each and every item included in the product list.

6.1.4 Price determining characteristics and Structured Product Description (SPD)

Preparation of a list of specifications for each product to be priced is an important step in establishing a suitable survey framework for price collection. The list of specifications attached to each product is known in ICP parlance as *structured product description* (SPD). SPD of each item lists a set of important price determining characteristics which are designed to assist the price collector to identify the products for which prices are to be collected. To decide on the product specifications, the agency responsible for this process should have detailed information on the organization for the compilation of the CPI and on the collection of prices. In summary, they include the following:

- Coverage of the CPI by territorial area (including the classification between urban and rural areas
- List(s) of products and services adopted ("basket of products"); the list may be only one that is the same for all the areas or may not be identical in different areas; it is necessary to specify the products included in each elementary aggregate or basic heading.
- Product code and key identifiers, that is description of the characteristics that identify each product and service to be priced in terms of technical features, brand, model, packaging and other aesthetics features (SPDs)
- There two ways to increase the number of comparable products: (i) use loose specifications of the products, or (ii) collect more information on the characteristics of the products (include the use of physical and functional properties) and then achieve product comparability by adjusting prices for quality differences. There are two different ways to loosen the specifications of the product definitions. First, it possible to reduce the number of characteristics used in comparing products and services priced in different outlets and location within all the sub-national areas. Second, having information on the characteristics collected on all the products and services priced in the CPI surveys (usually a large number), clusters of products and of services that have at least a minimum common (overlapping) numbers of characteristics that satisfy the same needs can be computed.
- Classification of the products and services for type of expenditures (COICOP or other classification)

6.2 Survey Framework for Price collection

To implement an efficient survey framework for building up an "ideal" micro data base to obtain reliable estimates of the SN-PPPs, it is necessary to work in a theoretical and practical framework based on a *multistage stratified sampling design*. Following the principles underlying that framework, it is possible to take into consideration variability of the sampled population within each strata to obtain reliable estimates of the price index in each strata. This framework is also useful for evaluating the validity of the existing CPIs surveys.

To satisfy the needs of national and local policy makers that want to use the SN-PPPs, three aspects could be important and are requiring attention: (i) to consider the areas as small as possible (local areas); (ii) need to compile the SN-PPPs separately for urban and for rural areas; (iii) the possible collection of data on prices and expenditures that could allow to compile also the poverty specific PPPs.

Usually, the NSOs collect price data, to compile CPIs, by conducting separate surveys, each covering different aspects: products and services; prices; outlets; geographical location, etc. Most of them are sample surveys based on concepts of simple random sampling, stratified sampling and also judgmental sample schemes. However, for a subset of items prices are collected centrally through administrative sources or via telephone and/or internet, and also when national pricing exists. More recently, prices are also obtained from scanner data from retail trade chains of the modern distribution, or by ad hoc collected data for certain groups of products by means of electronic devices and a dedicated software and by data collected on the web also through web scraping techniques.

6.2.1 Use of scanner data and alternative sources of data

The availability of high-frequency ‘‘scanner data’’ in addition to other sources of data enables price statisticians to deal with the SN-PPPs issue from a renewed approach. These data benefit from an impressive coverage of transactions along with information on: sales; expenditure; quantities; and quality with very detailed information on characteristics of products sold (brand, size and type of outlet) provided at barcode level or, more precisely, the GTIN (Global Trade Item Number) code. The scanner data of the modern distribution can provide millions of prices for thousands of products (GTIN code). They predominantly refer to supermarkets and hypermarkets, especially for food, beverages and personal and home care products. After a process of data cleaning and trimming outliers, unit value price per item code can be computed by dividing total turnover for that item by the total quantity sold.

Many statistical offices around the world are integrating scanner data with price data collected from traditional sources using standard data collection methods in the process of compilation of CPI. Based on the experienced gained (in Italy and other countries), this new source of data, by using the unit value price per item code makes it possible to compare representative and comparable products across sub-national areas, solving the important issue of balancing the two SN-PPPs requirements of representativity and comparability.

Moreover, the scanner data is able to: (i) capture frequent and often large shifts in quantities purchased in response to price changes; (ii) provide information on “quality” characteristics that may influence the price of a product; (iii) add time dimension to multilateral spatial price comparisons since detailed data are usually available at the point of sale and at the time of transaction; and (iv) make it possible to account for the economic importance of each item in its market by using the data on turnover thus providing a more reliable indicator of importance of items. Finally, it is obvious that using scanner data to carry out spatial comparisons will increase cost efficiency since price data collection may be limited to traditional outlets thus lowering data collection costs for the NSIs.

Several limitations must be noted in this context.

- Scanner data may not be available in many developing countries or available data may be limited to one or two retail chains and, therefore, may not be sufficient to provide price data representative of all the areas.
- From territorial point of view there is the advantage that scanner data can cover all the cities across the whole country but it may also be that the rural areas are not covered.
- Coverage of scanner data is just for the purchased made in the outlets of the modern distribution chains, and scanner data cannot be used for perishables and seasonal products such as vegetables, fruit and meat, and fresh fish, since these products are sold at price per quantity and are not pre-packaged with GTIN codes.
- The traditional CPI’s surveys on other outlets and markets (as hard discount, small shops and open markets) must be used for the compilation of the SN-PPPs to attain a complete coverage of the markets and of the kind of grocery products. It is surely important to evaluate how much is expenditures share cover by the scanner data and how to integrate the SN-PPPs compiled using these data with the SN-PPPs obtained for the other products and services.

The general recommendation is to make use of data available from all the sources as long as they meet the requirements and the standards set by the NSOs. Where such data are used, the multistage stratified sampling design, should be followed to attain an effective use of the existing micro-data provided by the actual CPI computation in each country, following a reasoning similar to a *post-stratification* of the existing CPI micro-data. Such a framework is useful also for the implementation of new surveys or for the re-engineering of the existing surveys for computation both SN-PPPs and sub-national CPIs.

6.2.2. Outlet selection

National agencies are responsible for price collection. They are required to collect prices at a sample of outlets chosen to reflect consumer purchasing patterns for the types of products and services being surveyed by the defined list. Therefore, it is necessary to select the outlets that are to be visited by price collectors and contacting the outlets selected to explain why they are to be visited.

The households purchase products and services in a range of outlets that frequently are different from country to country and also among the sub-national areas. Eurostat classification of outlet by type is the following: department store, hypermarkets and supermarkets, discount store, convenient stores, minimarkets, corner shops, kiosks, specialized shop chains, specialized shops, mobile shops, open markets, black market, private service providers, public and semi-public service providers, mail order and internet, other kinds of outlets (Eurostat, 2012). *Each NSO must identify the common type of outlets used by consumers.*

The selection of outlets is of particular importance because of the effect it will have on the efficient estimation of the average prices of the products to be surveyed. Different products have different distribution profiles. In principle, it is necessary to refers to a stratified sample by products and services, type of outlet and location within each sub-national area. The selection should take into account of the variability of prices within outlet type; of the location of outlets within and around each area, and on the volume of the outlet's sales (this last information is difficult to obtain).

A good starting point for the selection of outlets is the sample of outlets used for the CPI, but it is only a starting point. The final product lists for the price surveys used for SN-PPPS may differ considerably from the product lists for the CPI. There will be products that are common to both lists. These will be mainly food items, such as fresh fruit and vegetables, but other products may be covered as well. Prices for such products may not be separately collected because the prices collected for the CPI can be used instead. One problem could be that the CPI surveys in many countries are urban based and in this case it is impossible to take into account of the prices for rural areas.

6.2.3. Seasonal products

Seasonal products are defined as those products for which both prices and the quantities sold vary considerably throughout the year. Typically, the patterns of variation are repeated from one year to the next. By this definition, certain fruits, vegetables, fish and flowwers are obviously seasonal products. Various types of clothing are also seasonal products. So too are those goods that are sold in substantial amounts at prices well below normal prices during seasonal sales. Usually, only seasonal food products warrant special treatment in the computation of SN-PPPs.

The approach to be adopted for seasonal food products is to obtain annual prices by adjusting survey prices with weighted temporal adjustment factors. This requires to national agencies to provide weights in addition to an appropriate spatial price index for each seasonal food product they priced. The weights should be quantity weights reflecting the quantities of the item purchased throughout the survey year.

Neither seasonal food products nor their seasonality are necessarily the same for all the regions within a country or different metropolitan cities when it comes to large and geographically diverse countries. It is left to the national agencies to decide which of the food items specified on the final product list for the food survey they regard as seasonal.

6.2.4 Housing and rental price surveys

Although housing is a part of household consumption expenditure, it is not included in the price surveys for consumer goods and services. Instead, it is covered by a special rent survey or by extracting them from existent statistical sources, like Household's Budget Surveys and, sometimes, from the data base of the Revenue and Tax Agencies. Data are collected on the rents paid by tenants and on the rents imputed to owner-occupiers for a set of broadly-defined types of dwellings. Quantity and quality data on the housing stock are also collected.

Rents do not cover additional payments for maintenance and repair of the dwelling, water supply, refuse and sewage collection, electricity and gas, and heating and hot water supplied by district heating plants. Nor do rents cover co-proprietor charges for caretaking, gardening, stairwell cleaning, maintenance of lifts and refuse disposal chutes, heating and lighting, etc., in multi-occupied buildings

6.3.2 Availability of regional level data for GDP structure

In order to use the household's expenditure share data as weights to compute the SN-PPPs, it is necessary that the national accounts be computed at sub national geographical level and by classes of expenditure. But usually the NSOs do not provide so detailed breakdown. Also the HESs usually have a sample size that is not large enough, in order to obtain accurate estimates of the expenditure by classes of expenditure at local level.

Therefore, to obtain the matrix of expenditure share by territorial areas and basic headings, the responsible coordinating agencies should do the necessary estimations using indirect indicators (as population, etc.) or by using the Small Area Estimation methods (SAE).

In summary, it is necessary to have the following information on the system of expenditure weights:

- Source(s) of data used: Households Expenditure or Budget Surveys; Surveys for National and Regional Account compilation; Retail Surveys and so on
- Methods of estimation of the weights
- Level of disaggregation: availability of weights for each product and/or elementary aggregates by type of outlets and/or by territorial area and or at higher level
- Periodicity and method of updating the system of weights.

6.3.3 Validation of expenditure share data

The matrix of weight should be complete, also doing some necessary hypothesis to fill some missing cells also through "guesstimates". *The responsible agencies should also verify the spatial consistency of the expenditures.* Even though the expenditure patterns of participating regions can vary considerable, the edit allows inconsistencies arising from differences in interpretation and implementation to be identified. For example, some regions included the cost of food purchased in restaurants under food, while others included it under restaurants. This discrepancy is likely to be discovered by comparing the expenditure shares of regions. Another example concerns rentals for housing. Rentals, should not include charges for heating or for miscellaneous services relating to the dwelling such as refuse collection or co-proprietor charges in multi-occupied dwellings.

7 Price Data and Validation

The price survey process has the final objective to construct, at the end of data preparation phase, a big matrix of prices for each product and region (territorial area) at most detailed level as possible. That is, for each sampling stratum (by product, type of outlet and location), within each area. For each cell of the matrix

a certain number of prices or quotations will be collected and then averaged, validated and aggregated to obtain the average prices at Basic Headings level.

7.1. Price data

The object of the price surveys is to collect the prices that purchasers actually pay to acquire the goods and services specified on the final product list at the time of the survey. The prices should be the actual transaction price and should include also: delivery and installation costs, VAT and other indirect taxes on products and invoiced service charges and voluntary gratuities. The method price collection has to be established in advance to be sure that the collectors have the same approach.

7.1.1. Annual average prices

The ICP advocates the use of annual average prices for the purpose of PPP computations. Once the price surveys are conducted, annual average prices should be computed for each product within each type of outlet and within each stratum. Then the averages are computed for each product at level of stratum and each territorial area. If the survey framework involves the use of a self-weighting design, a simple unweighted average of the price quotations can be used in computing. Otherwise it is necessary to use weights based on quantities or expenditures.

7.1.2. Number of quotations; average price and standard deviation

The number of prices to be collected for a product will differ from product to product within a basic heading and it will also differ from one basic heading to another. Normally, the number of prices collected for a product determines the reliability of its average price. The larger the number of price observations, the more accurate the average price. The actual number depends on the degree to which the prices of the product vary. The number of prices to be collected for each product could be decided using random sampling techniques, but it could be decided on the number of price observations to be collected per product by taking into account the type of specification being priced, the conditions prevailing in its market and experience gained from previous survey rounds. Usually more prices should be collected for products in basic headings with large expenditure weights and with larger price variations than in other basic headings, and in basic headings with a small number of product specifications.

In addition to the averages, it is important to have information 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 (which can serve as measure of the reliability of the price data).

7.2. Validation of price data

Once the price data are collected from the price surveys conducted in different regions (territorial areas) an important next step is to ensure the quality of price data through data editing and validation.

It is essential that the prices on which the SN-PPPs are based are rigorously checked and corrected for errors and validated. Two types of errors can affect the collected prices: sampling error and non-sampling error. The sampling error is usually controlled through the use of an appropriate framework for the price surveys. Non-sampling errors occur for reasons such as pricing the wrong product (product error) or incorrectly recording the product's price or unit of measure (pricing error).

Editing consists of checking prices for possible non-sampling errors. Verification consists of either confirming that the prices identified for verification are indeed are correct or correcting them if they are

not. Validation is an iterative process requiring a number of rounds of editing and verification. Possible errors are found by identifying prices that have a measure of divergence that is greater than a given critical value or a value that falls outside a given range of acceptable values.

Validation comprises two separate processes: one to edit and verify the price collected in a single region (territorial area), referred as intra-region validation; the other to edit and verify the prices collected by all regions within the country, referred to as inter-region validation. Both types of validation have the same aim and that is to identify and eliminate non-sampling errors from the survey price data. Both focus on two types of non-sampling error: product error and price error.

7.2.1. Validation at the regional and national level

The intra-region validation is designed to establish that price collectors within the same regions have priced products that match the product specifications and that the prices they have reported are correct. It does this by searching for outliers first among the individual prices that a country has collected for each product it has chosen to survey and then among the average survey prices for these products.

The main diagnostics used to validate prices are:

- Extreme values among price observations are identified by means of two tests, the ratio to average price test and the T-value test;
- Extreme values among average prices are also identified by two tests, the max-min ratio test and the coefficient of variation test.

The inter-region validation test is designed to screen the average prices from different regions. The objective is to verify that the average prices are for comparable products across regions and that the collectors have interpreted the product specifications in the same way and that they have also priced them accurately. This is done by comparing the average prices for the same product across regions and by analyzing the dispersion of the price ratios that the average prices generate between regions across products and across regions.

Two methods have been mainly used in the ICP for the purpose of validation: the Quaranta tables and the Dikhanov tables. Both tables provide similar measures of price variation. Software is available to do the validation's processes.

- Quaranta tables: Quaranta tables were originally employed to edit prices within basic headings and then for a broader application that includes various aggregation methods. It provides a large amount of information about product prices, but this makes it cumbersome when applied to a large number of products such as that priced for an aggregate.

- Dikhanov tables: Dikhanov tables are used to edit prices within aggregates of several basic headings. It contains much of the same information as a Quaranta table, but it is more compact format and the color scheme used to identify different levels of extreme value make it better suited to editing prices across the basic the basic headings and products comprising an aggregate.

Details of these diagnostic tools along with illustrative examples can be found in Chapters 9 and 10 in *Measuring the Real Size of the World Economy* (World Bank, 2013). The usual price diagnostic module produces a multiple of Quaranta tables, one for each basic heading been validated, and one Dikhanov table for the corresponding aggregate.

7.3. Treatment of outliers

Editing for product errors and price errors involves identifying prices that have extreme values. Prices with extreme values that are shown to be accurate observations are "outliers" and should be retained if they are part of the population defined by the rest of the price observations. The selection of outlets can result in choosing outlets that are themselves outliers and not representative of the purchasing patterns of the average consumer. In this case the outlet should be replaced by one whose prices are closer to the average. Intra-region validation of average prices by outlet type and location can helps to identify outlier outlets.

Correction of price observations and deletion of prices: The prices that have extreme values suggest that they could be wrong and need to be investigated if they are genuine observations. Then it can be decided as to how to deal with them. If it is found to be wrong then it should be corrected or dropped.

8. Expenditure data and weights

As already noted, there are two main stages in the calculation of a SN-PPPs. The first is the collection of the price data and the calculation of the elementary spatial price indices (PPPs). The second is the averaging of the elementary price indices to arrive at PPPs at higher levels of aggregation up to the overall SN-PPP itself. Expenditure data are needed for the elementary aggregates that can be used as weights in the second stage. These weights are needed whatever index number formula is used for aggregation purposes.

8.1 National accounts versus household expenditure survey data

Expenditure data provides information that is necessary for the formulation of the weights to be used in the aggregation of price data. Gross domestic product and its expenditure side components form the basis for ICP work. Thus all the expenditure data used for the purpose of weighting prices is based on the national accounts of the countries.

Expenditure share weights, for the aggregation of price differences above the elementary level or basic heading level, are a common requirement for both CPI and PPP. The CPI weights are usually mainly based on data collected through household expenditure surveys (HES). Weights used in the calculation of PPPs refer to the shares in the national accounts. The share of household expenditure recorded in the national accounts are based on data from HES and on data calculated through the commodity flow approach. Therefore, common ground exists, and an integrated approach can result in more reliable estimates of both CPI and PPP. An assessment has to be made on a country-by-country basis.

8.2 Household expenditure surveys and national accounts

The principal data source for household consumption expenditures in most countries is a household expenditure survey (HES). An HES is a sample survey of thousands of households that are asked to keep records of their expenditures on different kinds of consumer goods and services over a specified period of time. The size of the sample obviously depends on the resources available, but also on the extent to which it is desired to break down the survey results by region or type of the household and kind of expenditure. Household expenditure surveys may be taken at specified intervals of time, such as every five years, or they may be taken each year on a continuing basis. The use of the commodity flow method within the supply and use tables of the SNA enables data drawn from different primary sources to be reconciled and balanced against each other. The commodity flow method may be used to improve estimates of household consumption expenditures

derived from by adjusting them to take account of the additional information provided by statistics on the sales, production, imports and exports of consumer goods and services. By drawing on various sources, the household expenditure data in the national accounts may provide the best estimates of aggregate household expenditures, although the classifications used may not be fine enough for SN-PPPs purposes.

Countries that conduct continuous expenditure surveys are able to revise and update their expenditure weights each year. Even with continuous expenditure surveys, however, there is a lag between the time at which the data are collected and the time at which the results are processed and ready for use. Thus, even when the weights are updated annually, they still refer to some period that precedes the time reference period. In any case, may be that is preferable to use expenditure weights that are the average rates of expenditure over periods of two or three years in order to reduce ''noise'' caused by errors of estimation (the expenditure surveys are only samples) or erratic consumer behavior over short periods of time resulting from events such as booms or recessions, stock market fluctuations, oil shocks, or natural or other disasters.

8.3 Classifications of household expenditures

The aggregate of the individual consumption expenditure of households is broken down into expenditure categories and subsequently into expenditure groups and so on and finally into elementary sub-classes (basic headings for the ICP). The classifications used for the PPP Program, the CPI and the HES are different. This compromises comparability across the three statistical domains, and can make the expenditure data reconciliation difficult, and difficult to use the CPI expenditure weights for the computation of PPPs.

To try to solve this issue two actions are necessary: (i) be sure that a Harmonized COICOP Classification at five digit or sub classes level is used in all the countries; (i) harmonize the three different classifications. Harmonising COICOP-PPP and COICOP-CPI has particular relevance for the PPP Programme. The object at the five-digit level is to draw up a master classification with subclasses defined to meet the needs of the PPP Programme, the CPI Programme and the HES. The redefinition of basic headings and CPI subclasses required to harmonize COICOP-PPP and COICOP-CPI should result in greater coherence in the presentation of PPP and CPI results and, possibly, in the results themselves.

In case of the extrapolation of PPPs, it should also lead to greater alignment between basic heading PPPs and their CPI extrapolators.

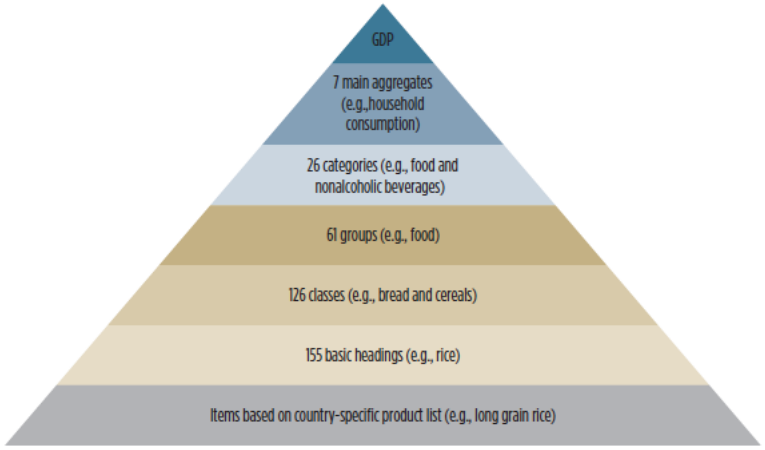
9. Aggregation Methodology and Price and Real Expenditure Comparisons

The methodology for compilation of PPPs within the International Comparison Program is well established. Detailed discussion on the framework for PPP compilation and the methods for aggregation at the elementary or basic heading level and for aggregation at higher levels are available in chapters 1, 5 and 6 of the ICP Book (World Bank, 2013; Rao 2013; Diewert 2013a and 2013b). Estimation of SN-PPPs and real expenditures at the regional level is very similar to estimation of ICP-PPPs and therefore all the methods used in the context of ICP are equally applicable in the case of sub-national comparisons. The recommendations below focus on several important aspects of the estimation of PPPs for sub-national comparisons of prices and real expenditures.

9.1 Hierarchical Structure for Compilation of PPPs

A pyramid-like structure that starts with item-level prices progressively aggregating to higher levels eventually reaching either the GDP or Household Final Consumption Expenditure by individuals. Figure 2 below shows the structure of higher level aggregates used in ICP 2005 and 2011.

Figure 2: Hierarchical Structure for Different Level Aggregates



Source: World Bank (2013), page. 17

Full list of basic headings belonging to different classes, groups, categories, seven main aggregates and the GDP at the top is included in the Annex.

Aggregation of item level prices to Basic Heading Level

Basic heading or the elementary index level is the lowest level at which expenditure share data are available. The initial step in the compilation of BH level PPPs by aggregating prices of items that belong to the basic heading level. For example *Rice* is a basic heading and different types and varieties of rice are items that belong to this basic heading.

The country-product-dummy (CPD) method is recommended for use at this level of aggregation. If information on importance indicators are available, then a weighted CPD (WCPD) method with weights 3:1 attached to important and unimportant items is recommended. The CPD and WCPD methods are described in Section 8.3.

At the end of this step, there are estimated PPPs for 155 basic headings – the second tier from below in the pyramid structure

Aggregation of BH level PPPs to PPPs for higher level aggregates

The estimated PPPs for the 155 basic headings are matched with expenditure data either from household expenditure surveys or from national accounts. From this level, price and expenditure (and hence quantity data) are available for index computation. Suppose we are interested in the *class* Bread and Cereals, then all basic heading such as rice, bread, etc are to be considered.

The recommendation is to use data on BH PPPs and expenditures for all the basic headings belonging to a certain group. For example, if PPP for the class *Bread and Cereals* is to be computed, then BH PPPs for only those five basic headings included in this class: *Rice; Other Cereals, flour, and other cereal products;*

Bread; Other Bakery Products; and Pasta Products, along with expenditures for each of these basic headings are used in PPP computation. *Since expenditure data are available, the ICP recommendation is to use the Gini-Elteto-Koves-Szulc (GEKS) method for aggregating BH PPPs and expenditure data.* The GEKS method is explained in Section 8.4 below.

A further recommendation for aggregation above basic heading level is to always use PPP and expenditure data for all the basic heading level belonging to the group for aggregation. For example, suppose PPP for the *Food* group is required. Then the recommendation is to make use of all BH PPPs that belong to Food group for computations and NOT to use PPPs from higher level aggregates. The recommendation is that PPPs for Bread and Cereals, Non-alcoholic Beverages and Alcoholic Beverages should not be aggregated leading to Food PPP. Instead all BHs like rice, other cereals, bread etc should be used.

9.2 Index Number Properties – Transitivity and Base Invariance

Aggregation of price data leading to PPP requires the use of index number methods. Not all index number methods are suitable for the purpose of making spatial comparisons. *It is recommended that only those index number formulae which satisfy transitivity and base invariance must be used.* Formulae commonly used by the NSOs such as the Laspeyres, Paasche, Fisher and Tornqvist indices do not satisfy transitivity. The GEKS formula explained in Section 8.4 satisfies transitivity as well as base invariance.

Transitivity

Suppose we have R regions involved in the comparison indexed as r = 1,2,…,R. Let $\{PPP_{jk} : j,k = 1,2,...,R\}$ is the PPP or spatial price index for region k relative to the base region k.. Multilateral spatial price comparisons require that PPPs for all pairs of regions need to be estimated thus filling the following price comparison matrix PPP

$$PPP = \begin{bmatrix} PPP_{11} & PPP_{12} & \dots & PPP_{1R} \\ PPP_{21} & PPP_{22} & \dots & PPP_{2R} \\ \dots & \dots & \dots & \dots \\ PPP_{R1} & PPP_{R2} & \dots & PPP_{RR} \end{bmatrix}$$

Transitivity is an internal consistency requirement which guarantees that comparison between two areas, say A and B, is the same whether it is derived through a direct comparison of A and B or through an indirect comparison which compares A with C and C with B. This means that

$$PPP_{AB} = PPP_{AC} \times PPP_{CB}$$

Suppose price level in region C is 10 percent higher than in region A and if price level in region B is 20 percent higher than in region C, then transitivity implies that prices in region B must be 32 percent higher than price level in A (1.10 x 1.20 = 1.32).

If the matrix of PPPs satisfies transitivity, all the elements of the matrix can be filled if we know the values in the first row. That is, if PPPs for all countries with country 1 as base are known, it is possible to derive PPP for any other pair of countries j and k by using

$$PPP_{jk} = \frac{PPP_{1k}}{PPP_{1j}}$$

Base invariance

In simple terms, base invariance requires all the participating regions to be treated symmetrically and no region is given special prominence. For example, suppose all capital cities in India are compared to New Delhi which is the capital of India, and comparisons between two capital cities is done through New Delhi. In this case the resulting comparisons are transitive but not base invariant as New Delhi is given special status in the comparisons.

9.3 The Country-Product Dummy[4] Method and aggregation from item level to Basic Heading Level

The country-product-dummy (CPD) method is the recommended method for aggregation of item level price data to estimate PPP at the basic heading level. The method was proposed by Summers (1973) for the purpose of treating missing price data but it has assumed prominence as a method to aggregate item level price data (Rao, 2013).

Suppose there are *N* items belonging to a particular basic heading. Let $\left\{ p_{ij} : i = 1,2,...,N \ and \ r = 1,2,...,R \right\}$ represent price of *i-th* commodity in region *r*. The CPD model is based on the *law of one price* which states that:

$$p_{ir} = P_i \cdot PPP_r \cdot u_{ir}$$

where $P_i \ and \ PPP_r$ are the average price of *i-th commodity* and purchasing power parity for the basic heading for the region *r*. Taking logarithms on both sides the model can be written in terms of item and region dummy variables (see Rao, 2013 for details):

$$\ln p_{ir} = \sum_{i=1}^{N} \eta_i D_i + \sum_{r=1}^{R} \pi_r D_r^* + v_{ij} \quad where \ \eta_i = \ln P_i \ and \ \pi_r = \ln PPP_r$$

$$for\ all\ i = 1,2,...,N;\ and\ r = 1,2,...,R$$

Here D_i is the dummy variable for commodity *i* which takes value when item considered is *i* and 0 otherwise; D_r^* is the region dummy which takes value 1 if the price quotation is from region *r* and 0 otherwise.

Parameters of the CPD are estimated using ordinary least squares imposing one restriction which is in the form of PPP for the reference region equals 1. Once the parameters are estimated then the PPP for region *r* is estimated as:

$$\hat{PPP}_r = \exp(\hat{\pi}_r) \quad \text{and} \quad \hat{\text{PPP}}_{jk} = \frac{\exp(\hat{\pi}_k)}{\exp(\hat{\pi}_j)} \qquad for\ all\ j,k$$

It is worth noting that if all the items are price in all the regions then the estimated PPP equals the *Jevons Index*, i.e.,

$$PPP_{jk} = \prod_{i=1}^{N} \left[\frac{p_{ik}}{p_{ij}} \right]^{1/N}$$

which is a simple geometric mean of the price relatives.

[4] It may be more appropriate to call this region-product-dummy or RPD but CPD is a generic term which can be used for regions, capital cities as well as provinces.

Weighted CPD with importance indicators

Suppose the regions provide additional information as to whether a particular item priced in their region is important or not, then it is recommended that a system of weights 3:1 for important items be used in using weighted least squares to estimate the CPD model. This is equivalent to running ordinary least squares after transforming the CPD model as:

$$\sqrt{w_{ir}}\ln p_{ir} = \sum_{i=1}^{N}\sqrt{w_{ir}}\eta_i D_i + \sum_{r=1}^{R}\sqrt{w_{ir}}\pi_r D_r^* + v_{ij} \quad where\ \eta_i = \ln P_i\ and\ \pi_r = \ln PPP_r$$

$$for\ all\ i = 1,2,...,N;\ and\ r = 1,2,...,R$$

where w_{ir} is equal to 3 if the item is important and equal to if the item is not important.

9.5 Gini-Elteto-Koves-Szulc (GEKS) Method for Computing PPPs at higher levels of aggregation

It is recommended that the GEKS method be used for aggregation above basic heading level. Details of this method can be found in Diewert (2013). The data used for this purpose are in the form of BH PPPs for all the basic headings that belong to a particular aggregate and expenditure/quantity associated with the particular BH.

Let $\{p_{ir}, e_{ir} : i = 1,2,...,N;\ and\ r = 1,2,...,R\}$ represent the PPP for basic heading i in region R and expenditure associated with the commodity group. The implicit quantity, represented by q_{ir} is simply given by $q_{ir} = e_{ir} / p_{ir}$. Then the GEKS PPP for region *k* relative to reference region *j* is computed as:

$$PPP_{jk}^{GEKS} = \prod_{l=1}^{R}\left[F_{jl}\cdot F_{lR}\right]^{1/M} \qquad where\ F_{jk} = Fisher\ Index = \left[\frac{\sum_{i=1}^{N} p_{ik}q_{ij}}{\sum_{i=1}^{N} p_{ij}q_{ij}} \times \frac{\sum_{i=1}^{N} p_{ik}q_{ik}}{\sum_{i=1}^{N} p_{ij}q_{ik}}\right]^{1/R}$$

The GEKS method is the recommended procedure for compiling PPPs for all aggregates above the basic heading level.

9.6 Specification of reference region

All the PPPs compiled as a part of ICP are expressed relative to the US dollar as a matter of convention. Relative price comparisons (PPP for a country with another reference country) is not affected by the choice of which country is used as reference or numeraire country. In sub-national PPP comparisons, a similar approach can be used by choosing one of the regions or capital cities as the reference. However, it is more practical if sub-national PPPs for geographical regions (rural-urban or for provinces) are expressed with the whole country as the reference or numeraire. This means that PPPs for all regions are expressed such that PPP for the whole country equals 1. Such a choice of numeraire while not affecting relativities across regions will enable easy linking of PPPs from the ICP to sub-regional or sub-national PPPs. However, this approach does not apply in the capital cities as the collection of capital cities does not equal the whole country.

In view of this discussion, it is recommended that all sub-regional or provincial PPPs are expressed with whole country as the numeraire.

10 Conclusions

Sub-national PPPs and PPPs from the ICP are conceptually similar in that both are measures of spatial price differences. While PPPs and real income comparisons from ICP have been widely recognized and used by researchers, policy makers and international organizations for over three decades, it is only recently the role and significance sub-national PPPs is coming into prominence. Methods for the compilation of PPPs from ICP have been well established and are available through the World Bank (2014) publication *Measuring the Real Size of the World Economy: The Framework, Methodology, and Results from the International Comparison Program*. Despite the experience gained through the implementation of ICP over the last 50 years, compilation of sub-national PPPs raise its own challenges in terms of the scope, establishment of the survey framework for the compilation of sub-national PPPs. The main objective of this manual is to highlight some of the practical issues that arise in setting up a program for sub-national PPPs including establishing the scope and applications of sub-national PPPs. Where possible clear recommendations have been made throughout the manual but users are advised to use this manual in conjunction with the existing material and guidelines for the compilation of PPPs in the ICP. The current version is a working draft for circulation and comment by the countries participating in the ICP. Several case studies will accompany the final version of the manual.

References

(to be completed)

ANNEX: ICP CLASSIFICATION
Source: World Bank (2013), pp. 87-91

Code	Description
100000	**GROSS DOMESTIC PRODUCT**
110000	**FINAL CONSUMPTION EXPENDITURE BY HOUSEHOLDS**
110100	**FOOD AND NONALCOHOLIC BEVERAGES**
110110	**Food**
110111	*Bread and cereals*
110111.1	Rice
110111.2	Other cereals, flour, and other cereal products
110111.3	Bread
110111.4	Other bakery products
110111.5	Pasta products
110112	*Meat*
110112.1	Beef and veal
110112.2	Pork
110112.3	Lamb, mutton, and goat
110112.4	Poultry
110112.5	Other meats and meat preparations
110113	*Fish*
110113.1	Fresh, chilled, or frozen fish and seafood
110113.2	Preserved or processed fish and seafood
110114	*Milk, cheese, and eggs*
110114.1	Fresh milk
110114.2	Preserved milk and other milk products
110114.3	Cheese
110114.4	Eggs and egg-based products
110115	*Oils and fats*
110115.1	Butter and margarine
110115.3	Other edible oils and fats
110116	*Fruit*
110116.1	Fresh or chilled fruit
110116.2	Frozen, preserved, or processed fruit and fruit-based products
110117	*Vegetables*
110117.1	Fresh or chilled vegetables other than potatoes
110117.2	Fresh or chilled potatoes
110117.3	Frozen, preserved, or processed vegetables and vegetable-based products

(continued)

Code	Description
110118	*Sugar, jam, honey, chocolate, and confectionery*
110118.1	Sugar
110118.2	Jams, marmalades, and honey
110118.3	Confectionery, chocolate, and ice cream
110119	*Food products n.e.c.*
110119.1	Food products n.e.c.
110120	**Nonalcoholic beverages**
110121	*Coffee, tea, and cocoa*
110121.1	Coffee, tea, and cocoa
110122	*Mineral waters, soft drinks, fruit and vegetable juices*
110122.1	Mineral waters, soft drinks, fruit and vegetable juices
110200	**ALCOHOLIC BEVERAGES, TOBACCO, AND NARCOTICS**
110210	**Alcoholic beverages**
110211	*Spirits*
110211.1	Spirits
110212	*Wine*
110212.1	Wine
110213	*Beer*
110213.1	Beer
110220	**Tobacco**
110221	*Tobacco*
110221.1	Tobacco
110230	**Narcotics**
110231	*Narcotics*
110231.1	Narcotics
110300	**CLOTHING AND FOOTWEAR**
110310	**Clothing**
110311	*Clothing materials, other articles of clothing, and clothing accessories*
110311.1	Clothing materials, other articles of clothing, and clothing accessories
110312	*Garments*
110312.1	Garments
110314	*Cleaning, repair, and hire of clothing*
110314.1	Cleaning, repair, and hire of clothing
110320	**Footwear**
110321	*Shoes and other footwear*
110321.1	Shoes and other footwear
110322	*Repair and hire of footwear*
110322.1	Repair and hire of footwear
110400	**HOUSING, WATER, ELECTRICITY, GAS, AND OTHER FUELS**
110410	**Actual and imputed rentals for housing**

(*continued*)

Code	Description
110411	*Actual and imputed rentals for housing*
110411.1	Actual and imputed rentals for housing
110430	**Maintenance and repair of the dwelling**
110431	*Maintenance and repair of the dwelling*
110431.1	Maintenance and repair of the dwelling
110440	**Water supply and miscellaneous services relating to the dwelling**
110441	*Water supply*
110441.1	Water supply
110442	*Miscellaneous services relating to the dwelling*
110442.1	Miscellaneous services relating to the dwelling
110450	**Electricity, gas, and other fuels**
110451	*Electricity*
110451.1	Electricity
110452	*Gas*
110452.1	Gas
110453	*Other fuels*
110453.1	Other fuels
110500	**FURNISHINGS, HOUSEHOLD EQUIPMENT, AND ROUTINE MAINTENANCE OF THE HOUSE**
110510	**Furniture and furnishings, carpets, and other floor coverings**
110511	*Furniture and furnishings*
110511.1	Furniture and furnishings
110512	*Carpets and other floor coverings*
110512.1	Carpets and other floor coverings
110513	*Repair of furniture, furnishings, and floor coverings*
110513.1	Repair of furniture, furnishings, and floor coverings
110520	**Household textiles**
110521	*Household textiles*
110521.1	Household textiles
110530	**Household appliances**
110531	*Major household appliances whether electric or not*
110531.1	Major household appliances whether electric or not
110532	*Small electric household appliances*
110532.1	Small electric household appliances
110533	*Repair of household appliances*
110533.1	Repair of household appliances
110540	**Glassware, tableware, and household utensils**
110541	*Glassware, tableware, and household utensils*
110541.1	Glassware, tableware, and household utensils
110550	**Tools and equipment for house and garden**
110551	*Major tools and equipment*
110551.1	Major tools and equipment

(continued)

Code	Description
110552	*Small tools and miscellaneous accessories*
110552.1	Small tools and miscellaneous accessories
110560	**Goods and services for routine household maintenance**
110561	*Nondurable household goods*
110561.1	Nondurable household goods
110562	*Domestic services and household services*
1105 62.1	Domestic services
110562.2	Household services
110600	**HEALTH**
110610	**Medical products, appliances, and equipment**
110611	*Pharmaceutical products*
110611.1	Pharmaceutical products
110612	*Other medical products*
110612.1	Other medical products
110613	*Therapeutic appliances and equipment*
110613.1	Therapeutic appliances and equipment
110620	**Outpatient services**
110621	*Medical services*
110621.1	Medical services
110622	*Dental services*
110622.1	Services of dentists
110623	*Paramedical services*
110623.1	Paramedical services
110630	**Hospital services**
110631	*Hospital services*
110631.1	Hospital services
110700	**TRANSPORT**
110710	**Purchase of vehicles**
110711	*Motor cars*
110711.1	Motor cars
110712	*Motorcycles*
110712.1	Motorcycles
110713	*Bicycles*
110713.1	Bicycles
110714	*Animal-drawn vehicles*
110714.1	Animal-drawn vehicles
110720	**Operation of personal transport equipment**
110722	*Fuels and lubricants for personal transport equipment*
110722.1	Fuels and lubricants for personal transport equipment
110723	*Maintenance and repair of personal transport equipment*

(*continued*)

Code	Description
110723.1	Maintenance and repair of personal transport equipment
110724	*Other services in respect of personal transport equipment*
110724.1	Other services in respect of personal transport equipment
110730	**Transport services**
110731	*Passenger transport by railway*
110731.1	Passenger transport by railway
110732	*Passenger transport by road*
110732.1	Passenger transport by road
110733	*Passenger transport by air*
110733.1	Passenger transport by air
110734	*Passenger transport by sea and inland waterway*
110734.1	Passenger transport by sea and inland waterway
110735	*Combined passenger transport*
110735.1	Combined passenger transport
110736	*Other purchased transport services*
110736.1	Other purchased transport services
110800	**COMMUNICATION**
110810	**Postal services**
110811	*Postal services*
110811.1	Postal services
110820	**Telephone and telefax equipment**
110821	*Telephone and telefax equipment*
110821.1	Telephone and telefax equipment
110830	**Telephone and telefax services**
110831	*Telephone and telefax services*
110831.1	Telephone and telefax services
110900	**RECREATION AND CULTURE**
110910	**Audiovisual, photographic, and information processing equipment**
110911	*Audiovisual, photographic, and information processing equipment*
110911.1	Audiovisual, photographic, and information processing equipment
110914	*Recording media*
110914.1	Recording media
110915	*Repair of audiovisual, photographic, and information processing equipment*
110915.1	Repair of audiovisual, photographic, and information processing equipment
110920	**Other major durables for recreation and culture**
110921	*Major durables for outdoor and indoor recreation*
110921.1	Major durables for outdoor and indoor recreation
110923	*Maintenance and repair of other major durables for recreation and culture*
110923.1	Maintenance and repair of other major durables for recreation and culture
110930	**Other recreational items and equipment, gardens, and pets**

(continued)

Code	Description
110931	*Other recreational items and equipment*
110931.1	Other recreational items and equipment
110933	*Gardens and pets*
110933.1	Gardens and pets
110935	*Veterinary and other services for pets*
110935.1	Veterinary and other services for pets
110940	**Recreational and cultural services**
110941	*Recreational and sporting services*
110941.1	Recreational and sporting services
110942	*Cultural services*
110942.1	Cultural services
110943	*Games of chance*
110943.1	Games of chance
110950	**Newspapers, books, and stationery**
110951	*Newspapers, books, and stationery*
110951.1	Newspapers, books, and stationery
110960	**Package holidays**
110961	*Package holidays*
110961.1	Package holidays
111000	**EDUCATION**
111010	**Education**
111011	*Education*
111011.1	Education
111100	**RESTAURANTS AND HOTELS**
111110	**Catering services**
111111	*Catering services*
111111.1	Catering services
111120	**Accommodation services**
111121	*Accommodation services*
111121.1	Accommodation services
111200	**MISCELLANEOUS GOODS AND SERVICES**
111210	**Personal care**
111211	*Hairdressing salons and personal grooming establishments*
111211.1	Hairdressing salons and personal grooming establishments
111212	*Appliances, articles, and products for personal care*
111212.1	Appliances, articles, and products for personal care
111220	**Prostitution**
111221	*Prostitution*
111221.1	Prostitution
111230	**Personal effects n.e.c.**

(*continued*)

Code	Description
111231	*Jewelry, clocks, and watches*
111231.1	Jewelry, clocks, and watches
111232	*Other personal effects*
111232.1	Other personal effects
111240	**Social protection**
111241	*Social protection*
111241.1	Social protection
111250	**Insurance**
111251	*Insurance*
111251.1	Insurance
111260	**Financial services n.e.c.**
111261	*Financial intermediation services indirectly measured (FISIM)*
111261.1	Financial intermediation services indirectly measured (FISIM)
111262	*Other financial services n.e.c.*
111262.1	Other financial services n.e.c.
111270	**Other services n.e.c.**
111271	*Other services n.e.c.*
111271.1	Other services n.e.c.
111300	**BALANCE OF EXPENDITURES OF RESIDENTS ABROAD AND EXPENDITURES OF NONRESIDENTS ON THE ECONOMIC TERRITORY**
111310	**BALANCE OF EXPENDITURES OF RESIDENTS ABROAD AND EXPENDITURES OF NONRESIDENTS ON THE ECONOMIC TERRITORY**
111311	*BALANCE OF EXPENDITURES OF RESIDENTS ABROAD AND EXPENDITURES OF NONRESIDENTS ON THE ECONOMIC TERRITORY*
111311.1	Final consumption expenditure of resident households in the rest of the world
111311.2	Final consumption expenditure of nonresident households on the economic territory
120000	**INDIVIDUAL CONSUMPTION EXPENDITURE BY NPISH**
120100	**INDIVIDUAL CONSUMPTION EXPENDITURE BY NPISH**
120110	**Individual consumption expenditure by NPISH**
120111	*Individual consumption expenditure by NPISH*
120111.1	Individual consumption expenditure by NPISH
130000	**INDIVIDUAL CONSUMPTION EXPENDITURE BY GOVERNMENT**
130100	**HOUSING**
130110	**Housing**
130111	*Housing*
130111.1	Housing
130200	**HEALTH**
130210	**Health benefits and reimbursements**
130211	*Medical products, appliances, and equipment*
130211.1	Pharmaceutical products
130211.2	Other medical products
130211.3	Therapeutic appliances and equipment

(continued)

Code	Description
140100	**COLLECTIVE SERVICES**
140110	**Collective services**
140111	*Compensation of employees*
140111.1	Compensation of employees
140112	*Intermediate consumption*
140112.1	Intermediate consumption
140113	*Gross operating surplus*
140113.1	Gross operating surplus
140114	*Net taxes on production*
140114.1	Net taxes on production
140115	*Receipts from sales*
140115.1	Receipts from sales
150000	**EXPENDITURE ON GROSS FIXED CAPITAL FORMATION**
150100	**MACHINERY AND EQUIPMENT**
150110	**Metal products and equipment**
150111	*Fabricated metal products, except machinery and equipment [CPA 28.11 to 28.75]*
150111.1	Fabricated metal products, except machinery and equipment
150112	*General-purpose machinery [CPA 29.11 to 29.24]*
150112.1	General-purpose machinery
150113	*Special-purpose machinery [CPA 29.31 to 29.72]*
150113.1	Special-purpose machinery
150114	*Electrical and optical equipment [CPA 30.01 to 33.50]*
150114.1	Electrical and optical equipment
150115	*Other manufactured goods n.e.c. [CPA 36.11 to 36.63]*
150115.1	Other manufactured goods n.e.c.
150120	**Transport equipment**
150121	*Road transport equipment [CPA 34.10 to 34.30 and 35.41 to 35.50]*
150121.1	Motor vehicles, trailers, and semitrailers
150121.2	Other road transport
150122	*Other transport equipment [CPA 35.11 to 35.30]*
150122.1	Other transport equipment
150200	**CONSTRUCTION**
150210	**Residential buildings**
150211	*Residential buildings*
150211.1	Residential buildings
150220	**Nonresidential buildings**
150221	*Nonresidential buildings*
150221.1	Nonresidential buildings
150230	**Civil engineering works**
150231	*Civil engineering works*

(continued)

Code	Description
150231.1	Civil engineering works
150300	**OTHER PRODUCTS**
150310	**Other products**
150311	*Other products*
150311.1	Other products
160000	**CHANGES IN INVENTORIES AND ACQUISITIONS LESS DISPOSALS OF VALUABLES**
160100	**CHANGES IN INVENTORIES**
160110	**Changes in inventories**
160110.1	Opening value of inventories
160110.2	Closing value of inventories
160200	**ACQUISITIONS LESS DISPOSALS OF VALUABLES**
160210	**Acquisitions less disposals of valuables**
160211	*Acquisitions less disposals of valuables*
160211.1	Acquisitions of valuables
160211.2	Disposals of valuables
170000	**BALANCE OF EXPORTS AND IMPORTS**
170100	**BALANCE OF EXPORTS AND IMPORTS**
170110	**BALANCE OF EXPORTS AND IMPORTS**
170111	*BALANCE OF EXPORTS AND IMPORTS*
170111.1	Exports of goods and services
170111.2	Imports of goods and services

Source: ICP.
Note: Basic headings are shaded gray. NPISH = nonprofit institutions serving households; CPA = Statistical Classification of Products by Activity; n.e.c. = not elsewhere classified.