





A Guide to the Compilation of Subnational Purchasing Power Parities (PPPs)¹

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¹ This guide was prepared by Luigi Biggeri, University of Florence, Italy, and D.S. Prasada Rao, the University of Queensland, Australia, with case study contributions from Bettina Aten, Bureau of Economic Analysis, United States; Sharne Bailey, Office for National Statistics, United Kingdom; Tiziana Laureti, University of Tuscia, Italy and Federico Polidoro, Italian National Institute of Statistics; and Đỗ Thị Ngọc, General Statistics Office, Vietnam. Nada Hamadeh, Yuri Dikhanov, Marko Rissanen, William Vigil Oliver, Elizabeth Purdie, and Rui Costa, World Bank, provided inputs to this work. The guide was reviewed by the International Comparison Program (ICP) Inter-Agency Coordination Group. Cover design by Will Kemp.

Contents

Preface	4
1 Introduction	5
1.1 Purchasing power parities (PPPs) from the International Comparison Program.....	5
1.2 Need for subnational PPPs	7
1.3 Nature and scope of the guide on subnational PPPs	8
2 Subnational purchasing power parities	8
2.1 The concept	8
2.2 The scope of subnational PPPs	8
3 Uses of subnational PPPs	12
3.1 Uses of subnational PPPs at the national level.....	12
3.2 Uses of subnational PPPs at the international level.....	14
4 Frequency of compilation of subnational PPPs	15
5 Governance and administrative structure for subnational PPPs	15
5.1 Benefits of integrating CPI and subnational PPP activities.....	17
6 Compilation of subnational PPPs.....	18
6.1 Construction of product lists	18
6.2 Framework for price collection.....	20
6.3 Availability of regional level data for GDP structure	24
7 Price data and validation	25
7.1 Price data	25
7.2 Validation of price data	26
7.3 Treatment of outliers.....	27
8 Expenditure data and weights.....	27
8.1 National accounts versus household expenditure survey data	27
8.2 Household expenditure surveys and national accounts.....	27
8.3 Classifications of household expenditures	28

9	Aggregation methodology and price and real expenditure comparisons.....	28
9.1	Hierarchical structure for compilation of PPPs	29
9.2	Aggregation of item level prices to basic heading level	30
9.3	Aggregation of basic heading level PPPs to PPPs for higher level aggregates	30
9.4	Index number methods for multilateral comparisons – desirable properties.....	31
9.5	Country-product-dummy (CPD) method	33
9.6	Gini-Éltető-Köves-Szulc (GEKS) method	34
9.7	Specification of the reference region for subnational PPPs.....	35
10	A survey of studies computing subnational PPPs and spatial consumer price index numbers ..	35
10.1	Subnational PPPs computed at national level using the ICP framework	36
10.2	Spatial adjustment factors and the Eurostat-OECD PPP Programme	37
10.3	Subnational spatial CPIs for household consumption based on CPI data	38
11	Conclusion.....	41
12	References	43
13	Appendices: Country Case Studies	47

Preface

The purchasing power parities (PPPs) and real income comparisons from the International Comparison Program (ICP) are well established and have been used by researchers, policy makers and international organizations for over three decades. It is also well recognized that in many countries there can be variation in price levels across different areas within the country (states, regions, provinces, etc.). Policy makers and researchers interested in the nature of subnational development processes—such as assessing intra-country inequality and the incidence of poverty and analyzing catch-up and convergence and productivity performance of different areas within the country—may find country-level PPPs from the ICP to be of limited scope and applicability, as these PPPs are broad economy-level measures designed to facilitate cross-country comparisons. As such, ICP PPPs cannot inform the user when it comes to comparisons of entities which are subnational, because they are not designed to capture such subnational price level differences. Hence, 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 or spatial price index numbers at a subnational level.

While there have been several experimental studies by researchers and national statistical offices (NSOs) during the last two decades, it is only recently that the role and significance of subnational PPPs and spatial Consumer Price Indices (CPIs) has come into prominence. The World Bank's report on the ICP to the forty-seventh Session of the United Nations Statistical Commission (UNSC) recognized the importance of subnational PPPs: "... To meet the growing demand for official estimates of PPPs at the subnational level, selected countries in various regions have undertaken the compilation of subnational PPPs in the interim period. The ICP Global Office, in collaboration with the ICP regional implementing agencies, is compiling an inventory of subnational PPP projects and exploring future expansion and harmonization of the exercises to maximize synergies and comparability."² Compilation of subnational PPPs is also included in the ICP Research Agenda.³ As such, the World Bank in its submission to the forty-ninth Session of the UNSC reported: "...The first meeting of the Task Force on Country Operational Guidelines and Procedures⁴ was held on 25 October 2017 in Washington, D.C. Participants discussed the topics assigned to the task force, including moving towards rolling price surveys, CPI-ICP synergies to improve spatial and temporal price consistency and subnational PPPs." The Task Force has subsequently been entrusted with the preparation of a guide on the compilation of subnational PPPs.

² Names of the organizational units and technical terms have been harmonized in this document, including direct quotes from existing reports, papers and documents.

³ <http://pubdocs.worldbank.org/en/774201507663170526/pdf/ICP-GB02-Doc-ICP-Research-Agenda.pdf>

⁴ Prasada Rao, University of Queensland; Brian Graf, International Monetary Fund; David Roberts, Independent Expert; Dilip Kumar Sinha, India Ministry of Statistics and Program Implementation; Levan Gogoberishvili, International Monetary Fund; Luigi Biggeri, University of Florence; Majed Skaini, United Nations Economic and Social Commission for Western Asia; Patrick Kelly, National Statistical Office of South Africa; Yuri Dikhanov, World Bank; and William Vigil-Oliver, World Bank.

This guide is presented within the methodological framework of the ICP and it is designed to provide guidance to the regional implementation agencies of the ICP and to the NSOs that may decide to embark on a program of compilation of spatial price indices at the subnational level, taking into account their large dimension and/or the significant variation in price levels across different subareas within the country. As price comparisons within a country are anchored on price data collected as a part of the compilation of the CPI, this guide has a symbiotic relationship with the guide on CPI-ICP integration⁵ (International Comparison Program, 2021). NSOs involved in the compilation of subnational PPPs are advised to consult both guides.

This guide on subnational PPPs has several objectives. First, to communicate effectively to potential users such as NSOs, price statisticians, policy makers, politicians, academics, and others the objectives and outcomes of a program for the computation of subnational PPPs and/or spatial CPIs. Second, to serve as a guide to ICP and CPI practitioners, whatever their role, in planning, coordinating, and monitoring the implementation of a subnational PPP program and, as such, providing basic reference materials. Third, to advise the users of subnational spatial price indices on the use and interpretation of the resulting price level and real expenditure comparisons. Finally, but equally importantly, the guide discusses challenges in terms of the scope and applications, establishment of the survey framework, and methodological guidelines, and highlights some of the practical issues that arise in setting up such a program. A few country case studies highlighting the experience gained from the compilation of subnational PPPs are included in the [appendices](#).

1 Introduction

1.1 Purchasing power parities (PPPs) from the International Comparison Program

Country-specific data on economic aggregates are regularly produced and disseminated by NSOs and other producers of official statistics, such as central banks. However, direct cross-country comparability of national data is limited because such data are usually expressed in their respective national currency units. The incomparability of published data on national economic aggregates also stems from differences in price levels, which imply differential purchasing powers of currencies. At the other end, the conversion of currencies through market exchange rates (MERs) are not adequate to make comparisons in ‘real terms’, because they do not reflect differences in price levels and are largely determined by the forces determining the demand for, and supply of, currencies. PPPs from the ICP provide a framework for comparing the price and volume of gross domestic product (GDP) and its expenditure components and other economic indicators across countries.

PPPs as a concept, and by construction, are designed for making price comparisons across countries. Broadly, PPPs are anchored on both national annual average prices for a given large basket of comparable and representative goods and services and expenditure weights from the national accounts. Therefore, price data and national accounts expenditure data are the two key inputs for the estimation of PPPs.

⁵ <https://thedocs.worldbank.org/en/doc/2b29c1445d7fa006e5f4ca00087dbe36-0050022021/original/Guide-CPI-and-ICP.pdf>

A PPP for a given country represents the number of currency units required to buy a similar basket of goods and services in the given country in relation to a reference or base country. For example, if the PPP for India is 20 INR (Indian rupees) per one United States (U.S.) dollar, this means that a given basket of goods and services that can be purchased for one dollar in the U.S. can be purchased in India for 20 rupees. Suppose the MER between these currencies is 60 INR per one U.S. dollar, then the price level (PL) in India is the ratio of PPP to exchange rate (20/60) which implies that prices in India are roughly one-third of the prices in the US.

The ICP was established to provide PPP conversion factors as an alternative to the conversion of currencies based on MERs, so as to facilitate comparisons of economic aggregates and indicators between countries in real terms. The actual implementation of the ICP and the process of the compilation of PPPs for all the participating countries is quite complex. A description of the framework for the ICP is presented in Rao (2013a) and the full set of ICP procedures are discussed in various chapters of World Bank (2013), “Measuring the Real Size of the World Economy: The Framework, Methodology, and Results of the International Comparison Program (ICP)”.

A brief overview of the concept, principles, computation of PPPs and their uses is presented here in order to facilitate the reader in the understanding of different parts of this guide.

PPPs from the ICP refer to the GDP and its components from the expenditure side. These include: household consumption expenditure; government expenditure; gross capital formation; changes in inventories and net acquisition of valuables; and balance of exports and imports. For the purpose of the ICP, it is necessary to break down total expenditures into sub-groups in order to be able to deal with relatively homogeneous groupings of products. This is necessary from the price collection point of view as well as to establish weights. The smallest group of homogeneous products considered in the ICP is called a *basic heading* and is defined as the lowest level of aggregation within the national accounts at which expenditure and expenditure share data are available. Therefore, it is the lowest level at which elementary PPPs are calculated, based on underlying prices for each basic heading. The current ICP classification comprises 155 basic headings.

Basic headings fall into three main categories. The first category is those basic headings covering goods and services for which prices can be typically easily collected. The second category covers basic headings for which prices are more difficult to obtain, such as dwelling rents, health, education, government compensation, construction and civil engineering, and machinery and equipment. The third category is those basic headings for which prices are either not available or relevant, or are too difficult or expensive to obtain, and therefore PPPs for these headings are imputed.

A critical step in the ICP is the definition of the list of items or products to be priced. The choice of the products is dictated by criteria of comparability, representativity and importance. The focus of the ICP is a cross-country comparison of prices of goods and services comprising the GDP and its components. Given the diversity of products which are consumed in different countries, it is typically not possible to use national CPI baskets as they are, not least because goods and services in the national CPI baskets are not usually specified in the required detail for inter- or intra-country price comparisons to be made. Therefore, the ICP utilizes *Structured Product Descriptions* (SPDs), which contain generic descriptions of the characteristics relevant to a particular narrow cluster of products to be priced. The key concept is comparison of “like with like”. However, strict

comparability is difficult to achieve, as a product which is comparable may not be representative of the national consumption habits in one or more countries. In this case there is a conflict between comparability and representativity and it is important to strike a balance between these two requisites. This issue has been in part resolved by asking each country to specify whether a product is important or less important within the basic heading. Unimportant products should not be priced, although they may be available but consumed by a very small share of residents within a country.

As noted earlier, PPPs from the ICP are broad country-level measures. This implies that the survey frames used for price collection relate to the entire country. However, countries may collect prices only in the capital city and/or only in urban areas, in which case spatial adjustment factors are needed to arrive at national average prices. In general, greater variability of prices across the country requires wider survey frames, in order to ensure the representativity of the PPP for the entire country.

From a methodological point of view, computation of PPPs at various levels of aggregation, being referred to as multilateral comparisons, requires the use of index number methods which satisfy various properties such as transitivity, base invariance, characteristicity, and additivity. A specific section towards the end of this guide is devoted to the main methods for aggregation at the elementary or basic-heading level and for aggregation at higher levels.

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 International Monetary Fund (IMF), the World Bank, the European Union (EU), and the Organisation for Economic Co-operation and Development (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; as inputs into the human development index; and in the estimation of global growth and inflation, among other uses, and are included in many of the indicators curated through World Development Indicators (WDI). In particular, PPPs for household consumption are a critical input into the determination of the international poverty lines used by the World Bank. The PPPs and real expenditures from the ICP are also used in monitoring progress towards the United Nations Sustainable Development Goals or SDGs (United Nations, 2015).

1.2 Need for subnational PPPs

As noted above, it is generally recognized that in many countries there are variations in price levels across different areas within the country. For example, while the India-USA PPP (20 INR per U.S. dollar in the example considered) is useful for comparing price levels and real incomes between the two countries, these broad country-level measures cannot inform users when it comes to comparisons of prices or price levels across states, regions, provinces within a country. For example, the World Bank makes adjustments to ICP PPPs to account for rural-urban differences for some countries in its estimation of regional and global poverty using international poverty lines like \$1/day or \$2/day. Hence, 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 or spatial

CPIs at a subnational level. Given the limited resources, this goal is most feasibly achieved through using information from the national CPIs.

The computation of subnational PPPs, through the integration of the CPI and ICP activities within the process of CPI collection of price data, as well as satisfying the mentioned needs, will also increase the awareness of the ICP and their application for additional uses at the national and subnational levels.

1.3 Nature and scope of the guide on subnational PPPs

At the conclusion of the 2011 ICP cycle, the UNSC established the Friends of the Chair (FOC) group to evaluate the Program and to make recommendations for the future rounds of the ICP. The ICP Technical Advisory Group formulated a Research Agenda in response to the recommendations of the FOC and the resolutions of the UNSC, and identified a number of topics for research, including the compilation of subnational PPPs.

This guide is designed to provide guidelines for the compilation of PPPs at the subnational level. As price comparisons within a country are anchored on price data collected as a part of the compilation of CPIs, this guide has a symbiotic relationship with the guide on CPI-ICP integration, as noted earlier. NSOs involved in the compilation of subnational PPPs are advised to consult both guides.

2 Subnational purchasing power parities

2.1 The concept

The concept of subnational PPPs, hereinafter referred to as SN-PPPs, is similar to the concept of PPPs used in the context of international comparisons. SN-PPPs measure the amount of money that is needed in a subnational geographical area to buy the same basket of goods and services than can be purchased with one unit of the same currency in the reference region or area. As the currency unit is the same across all the sub-regions or areas within a country, SN-PPPs are in essence spatial price level comparisons within a country. Spatial price level comparisons between countries need to take into account the different currencies in the countries being compared. ICP PPPs relative to the market exchange rates, PPP/MER, are used for this purpose, and are published by the ICP as price level indexes (PLIs). The temporal equivalent of SN-PPP, when restricted to consumer goods and services, is the CPI, where price levels are compared over time within a region in a country or over time for the whole country.

2.2 The scope of subnational PPPs

The scope and coverage of subnational PPPs differ from those of the ICP PPPs. As the main purpose of the ICP is to compile internationally comparable national accounts aggregates, PPPs from the ICP refer to broad national accounts aggregates, such as GDP, household consumption, government expenditure, gross capital formation, and lower-level aggregates such as expenditures on food, clothing, housing, transport, and others.

In comparison to the scope of the ICP PPPs, which is within the confines of the national accounts framework and the aggregates within GDP, subnational PPPs can be somewhat open in their scope and can be tailored to the purpose for which they are being compiled. Further, the scope of SN-PPPs is necessarily limited by the nature of the data available in different geographical regions within the country. Suppose the purpose of the subnational PPPs is to make price level comparisons between rural and urban areas. Then, 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 GDP level SN-PPPs at the state or provincial level if state level accounts and GDP estimates are available. This possibility essentially depends on the territorial organization and capacity of a country's national statistical system.

2.2.1 Subnational PPPs by coverage of expenditure categories

This section discusses the scope of SN-PPPs and the types of possible aggregates for a range of policy purposes at the national and subnational level.

2.2.1.1 Household consumption

An important objective of SN-PPPs is to make comparisons, in real terms, of household expenditure headings, such as food, clothing, and transport. These SN-PPPs and real expenditures are, in turn, used in the measurement and analysis of material well-being, inequality, and poverty across different geographical areas within a country. Compilation of SN-PPPs for household consumption should be feasible, since almost all NSOs collect data on consumer prices for the computation of their national CPI on a regular basis.

2.2.1.2 Expenditure on housing

Comparisons of housing costs across different geographical regions is just as important as comparisons of price levels and real expenditure on housing across countries. The computation of SN-PPPs for housing expenditures is critical to evaluating the cost of living across cities and regions, in assessing and comparing poverty, in analyzing housing markets, and in designing housing policies at the local level. However, challenges arise due to the varying mix of owner-occupied housing versus rented dwellings and due to the presence of rental subsidies or subsidized housing. Imputations for non-market rents and owner-occupied housing are necessary.

2.2.1.3 Health and education

Health and education are two areas that are considered important by governments and policy makers in both developed and developing countries. Providing equitable access to health and education are major aspirations for most governments, more so in developing countries. Consequently, reliable data on price levels and real expenditures on health and education in different geographical regions of the country is a critical input into evidence-based policy making, designed to achieve the objectives and goals of national governments. These

data assume special significance when it comes to devising strategies to achieve the various targets set by the SDGs. Assessing performance against the SDGs at the national level as well as at provincial or state level requires the collection of appropriate data, and health and education form two of the most important components for such analysis.

Comparisons of price levels and expenditures on health and education are somewhat difficult and are usually classified as comparison-resistant services. The ICP has devoted significant resources to devise appropriate methods for the measurement of both. Blades (2013) discusses in detail issues concerning the measurement of health and education and the recommended procedures for price and real expenditure comparisons.

2.2.1.4 Government compensation

SN-PPPs can be compiled by using data on government compensation and salaries for government employees in different provinces or regions. Government salaries of employees working for the federal or central government are likely to be the same in different regions within the country while salaries of provincial or state government employees may differ. In addition, SN-PPPs depend on differences in structure of government occupations and differences in the composition and characteristics of the employees such as age and qualifications etc. Computation of SN-PPPs for government compensation depends on the availability of data on both salaries and the appropriate weights at the regional level.

2.2.1.5 Machinery and equipment and construction and civil engineering

The compilation of SN-PPPs for machinery and equipment, construction, and civil engineering is particularly important from an economic development perspective. Construction, relating to infrastructure development, is a major consideration in policy formulation and hence it is important to assess price level differences across regions for residential and non-residential construction as well as for civil engineering in different regions. However, the comparison of construction prices is just as challenging at the subnational level as it is for cross-country comparisons. The methodology used for comparing construction prices and expenditures within the ICP can be implemented in the case of subnational comparisons.

Collection of prices for machinery and equipment could be similar to that used for household goods and services, that is, based on a list of products along with their detailed description. However, product specifications under machinery and equipment are usually quite 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 not possible to conduct surveys to obtain information on prices from them. On the other hand, the use of prices collected from the sellers from the different geographic areas may not be adequate since purchasers can buy machinery and equipment outside their territorial area. Given these considerations, it is likely that price levels for machinery and equipment are likely to be similar across different geographic regions within a country.

2.2.2 Different types of subnational PPPs according to geographical coverage

It is possible to conceptualize different types of SN-PPPs depending on the specification of the geographical areas for the purpose of price comparisons. A few examples, by no means exhaustive, are described below.

2.2.2.1 Spatial adjustment factors

Spatial adjustment factors (SAFs) are scaling factors used in converting prices collected in different geographical areas into national level prices. These factors are one way of reducing the cost of collection of price data for the computation of national average prices as required by the ICP. Countries participating in the Eurostat-OECD PPP Program mainly collect prices of items from capital cities and then convert them to the national level by applying spatial adjustment factors.

According to the Eurostat-OECD PPP Manual⁶ there are at least two main approaches that can be followed by countries in the computation of SAFs: (i) calculation on the basis of available CPI data; or (ii) by conducting specific price surveys aimed at measuring subnational differences in consumer price levels. The second approach is likely to be more resource intensive. 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 comparable to those collected for PPP purposes. Alternatively, one can search CPI data for products that are comparable across subnational areas and base the SAFs on the prices of the identified 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.

2.2.2.2 Capital city PPPs

In countries with several major metropolitan cities or cities which serve as capitals for different regions, comparison of prices across regional capital cities are of interest for businesses with employees located in different cities. Capital city PPPs can be used for making adjustments for differences in the 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. Capital city PPPs may be feasible and more relevant for aggregates like machinery and equipment, as purchases of machinery and equipment items are mostly recorded in capital cities.

⁶ Eurostat-OECD PPP manual: <https://ec.europa.eu/eurostat/web/products-manuals-and-guidelines/-/KS-RA-12-023>

2.2.2.3 Regional 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 the measurement of inequality and poverty are high priorities for governments and policy makers. Regional SN-PPPs may be used in the compilation of the Human Development Index and in assessing growth performance and catch-up and convergence of different regions. Generally, the compilation of SN-PPPs is similar to the compilation of PPPs for international comparisons, especially in countries which are large and where regions are economically and geographically diverse, such as in China and India.

2.2.2.4 Rural-urban price differences

Measures of rural-urban price level differences are essential inputs into the measurement of inequality and poverty. Poverty lines established at the national level need to be adjusted for rural-urban price differences prior to the estimation of incidence of poverty. While SN-PPPs for rural and urban areas are important, compilation of PPPs for these purposes is operationally challenging and it poses serious methodological problems. These range from differences in the list of goods and services sold and purchased in rural and urban areas through to identifying what areas are “rural” and what are “urban”. Dijkstra, Hamilto, Lall and Wahba (2020) discuss issues surrounding the definition and identification of rural and urban areas.

The main conclusion from this section is that in the case of SN-PPPs it is important to carefully identify the geographic areas or regions reflecting the purpose for which the SN-PPPs are being compiled. This, in turn, implies that it is important to frame the main objectives and the purpose for which SN-PPPs are being compiled. Once the geographic areas are identified for the purpose of price and real expenditure comparisons, the usual ICP procedures can be applied with necessary modifications.

3 Uses of subnational PPPs

Regular compilation of SN-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. National institutions and international organizations such as the World Bank, the IMF, and the United Nations and its many agencies, are interested in the compilation of indicators for the SDGs; the Human Development Index; and estimates of regional and global inequality and poverty. These organizations can extend the scope of these measures to cover sub-regions within countries.

3.1 Uses of subnational PPPs at the national level

Comparisons of prices and real expenditures at the subnational level for different expenditure aggregates provide policy makers with valuable input into formulating evidence-based policy making. Commercial firms

and business enterprises as well as researchers and the general public are likely to benefit from the results from subnational price and real expenditure 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 their respective countries. Monitoring the efficacy of government policies in delivering equitable outcomes is critical in identifying issues and in forging effective policies. The availability of reliable price comparisons across the country through subnational PPPs enables 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 and to reduce regional disparities. Availability of real per capita household expenditure and real per capita regional GDP, where available, are useful inputs into the process of assessing economic performance in terms of relative levels of income and productivity. Comparative analysis of the performance of regions will help assess regional inequality and to examine catch-up and convergence among different regions of the country. Moreover, policy makers are interested in the computation and comparisons among different subareas, including urban and rural areas, of real disposal income of households, salaries, labor costs, productivity, health, and education etc.
- The SN-PPPs contain valuable information on price level differences across different regions and for different components of expenditure. Such detailed information on differential price levels can be used for spatial price level analysis (to verify market structures and to measure price distortions); for inequality and poverty analyses that involve spatial comparisons for which price level differences are important; and for assessing the material well-being of people in different territorial areas and to calibrate poverty lines and other economic 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, regional governments will be able to compare and contrast relative prices of important services such as transport, health, and education. Sector-specific SN-PPPs will enable provincial governments to undertake comparative analysis of the source of price differentials by comparing price levels in 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 can help assessment of 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.
- National and local governments are interested in calibrating regional poverty lines using information on price level differences through SN-PPPs and to obtain reliable estimates of the number of poor in different regions so that a proper allocation of financial and other resources can be made. Inequality and poverty analyses are increasingly focusing on local and small areas.
- To conduct analyses of the incidence and extent of poverty at the regional and national level, researchers may need to compile estimates of *poverty-specific SN-PPPs*, because general PPPs may not be adequate

for spatial price comparisons that involve the poor. This means that in a program for computing SN-PPPs it is important to consider the compilation of poverty-specific SN-PPPs.

- The private firms operating in different subnational 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 regions. A major component of living costs is the cost of housing in different metropolitan cities and urban centers. Regular publication of SN-PPPs for housing will help in determining appropriate compensation for employees.
- In an era of increased labor mobility, individuals considering employment opportunities in different regions can rely on SN-PPPs to assess cost of living differences in their salary negotiations when moving from one place to another.

3.2 Uses of subnational PPPs at the international level

Regular compilation and dissemination of SN-PPPs will help achieve the strategic objectives of many international organizations as well as multinational companies as they formulate global strategies for their business operations. A few applications and uses of SN-PPPs at the international level are discussed below.

- With the general mission of a world without poverty, the World Bank regularly compiles estimates of the incidence and severity of extreme poverty in different regions of the world. The World Bank uses international poverty lines to estimate regional and global poverty. The current international poverty line (IPL) is set at \$1.90 per day based on revised ICP 2011 results. 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 directly converted IPL expressed in national currency units cannot be used in counting the number of poor in a large country, where price levels in different regions may differ significantly from the average national prices. For example, food prices in rural areas may be lower than the national average while urban prices may be higher. In counting the poor, it is important to account for these regional differences. Chen and Ravallion (2010) and Ferreira et al. (2016) provide details of adjustments made for spatial differences in prices in estimating global poverty. SN-PPPs would eliminate the need for using any ad hoc or guess-estimates for making adjustments for within country differences in prices.
- A related application is in the analysis of global and regional inequality, which currently uses PPPs from the ICP to convert average incomes in each country into U.S. dollars. The use of PPPs from the ICP implicitly assumes that price levels are the same across all the regions within a country which is an untenable assumption. SN-PPPs can help further fine-tune and improve inequality measures by accounting for within-country 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. If SAFs were available, the ICP PPPs could be adjusted to account for differences in prices across different cities in the world.

- Policy makers may use SN-PPPs also for operational purposes. The European Commission uses GDP and other indicators expressed in real terms to allocate funds at the subnational areas of the EU for the allocations of structural and cohesion funds.
- Finally, the compilation of SN-PPPs on a regular basis is likely to enhance the statistical capacity of the participating countries. In some cases, CPI compilation itself may be improved when the NSO involved in the compilation of SN-PPPs is also actively integrating ICP and CPI activities.

4 Frequency of compilation of subnational PPPs

The optimal frequency for the 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 ICP have been made available in roughly six-year intervals. However, Eurostat and OECD publish PPPs and real expenditures on an annual basis, compiled using the rolling price survey approach.⁷ The recommendation of the UNSC to increase the frequency of the ICP to be conducted every three years is consistent with the ultimate aim to produce ICP PPPs on an annual basis. Given the nature, scope and likely uses of subnational PPPs, it is recommended that countries compile subnational PPPs on an annual basis.

5 Governance and administrative structure for subnational PPPs

An efficient and well-organized governance and administrative structure is essential for successful implementation of a program for the production and dissemination of subnational PPPs. As SN-PPPs are essentially spatial price index numbers, the governance structure for SN-PPPs 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:

- the structure must ensure the production and dissemination of timely and reliable SN-PPPs;
- as SN-PPPs are measures of spatial price levels, structures for SN-PPPs should recognize the relationships with ICP approaches;
- the structure must exploit the overlap and similarity in the survey framework and subsequent validation, editing, and computational procedures used in the ICP; and
- the structure must ensure that SN-PPP activities are not disruptive to the work associated with compilation of the CPI and at the same time exploit any possible synergies from the integration of CPI, SN-PPP, and ICP activities.

⁷ See section 11.5 of <https://www.oecd.org/sdd/prices-ppp/PPP%20manual%20revised%202012.pdf>

Countries are advised to refer to the CPI-ICP guide⁸ (International Comparison Program, 2021) and follow the principal recommendations for the integration of CPI and ICP activities and implement them in the context of SN-PPPs.

Figure 5.1 serves as an illustrative guide to the establishment of governance and administrative structures. The structure shown below is only an example of many possible structures and it is not meant to be prescriptive.

Figure 5.1: Governance and administrative structures for temporal and spatial price comparisons

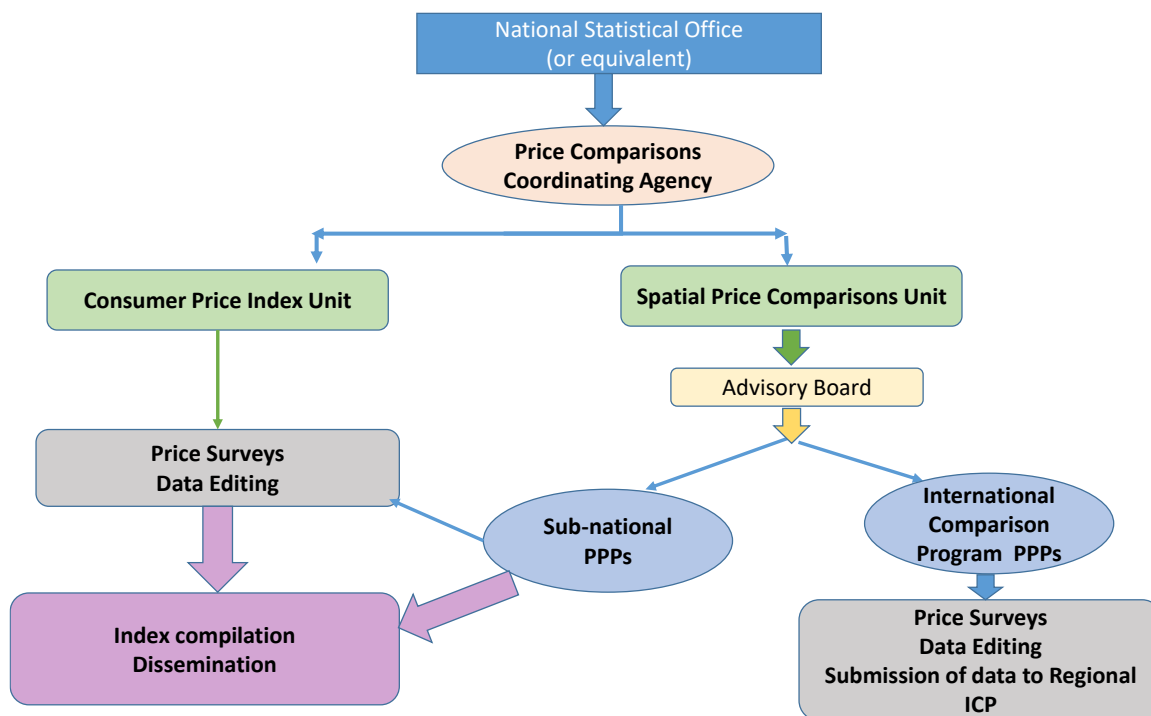


Figure 5.1 shows an indicative structure designed to integrate activities associated with the compilation of the CPI with activities associated with spatial comparisons. All price comparison activities will be coordinated by a single Price Comparisons Coordinating Agency which is responsible for setting procedures and operational guidelines and for the compilation and dissemination of CPI and SN-PPPs in a timely manner. Spatial price comparisons are classified into those dealing with price comparisons across regions within the country (SN-PPPs) and price comparisons across countries (ICP PPPs). As the compilation of subnational PPPs and

⁸ <https://thedocs.worldbank.org/en/doc/2b29c1445d7fa006e5f4ca00087dbe36-0050022021/original/Guide-CPI-and-ICP.pdf>

participation in the ICP are not regular activities associated with the CPI, it may be beneficial to establish an advisory board to guide the activities of the NSO. The flowchart shows that CPI and SN-PPPs share a similar survey framework and it may be possible to use the same facilities for processing the price data collected. The grey boxes for price surveys and editing used for CPI and SN-PPPs on the left, and for ICP PPPs on the right, indicates that all these three activities can share the same data storage and facilities and procedures for data verification and editing. Following this general template, each country may establish its own technical and management structures for compiling temporal and spatial price index numbers and to meet its obligations with respect to its participation in the ICP.

5.1 Benefits of integrating CPI and subnational PPP activities

Given the common features of CPI and PPP compilation, there is scope for the integration of CPI and SN-PPP activities. To achieve such an integration, NSOs and organizations involved in the CPI construction should recognize that SN-PPP computation and any results from PPPs are a natural extension of the current CPI. There are several advantages to CPI and SN-PPP integration. A cost-effective approach to the compilation of SN-PPPs for household consumption is to make maximum possible use of price data collected by the NSOs for compiling the CPI. Here the reader is referred to the CPI-ICP guide⁹ (International Comparison Program, 2021) for additional insights into such an integration.

- The NSOs are best placed to provide data inputs into the construction of subnational 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. 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 SN-PPPs and ICP PPPs.
- Through the integration of the CPI and SN-PPP activities, the ICP and the NSOs can save resources and time. In the first phase of the implementation, significant work may be needed to prepare the price database for CPI, SN-PPPs, and ICP PPPs. Price data for the CPI are often collected in a manner that makes it difficult for using it in the compilation of subnational PPPs and for estimating spatial price differences. The integration of price data activity will increase the synergies between CPIs, SN-PPPs and ICP PPPs, and will facilitate their simultaneous computation under a unified framework. In this way, the ICP PPPs could be computed frequently, possibly annually, which is a strategic objective of the ICP.

⁹ <https://thedocs.worldbank.org/en/doc/2b29c1445d7fa006e5f4ca00087dbe36-0050022021/original/Guide-CPI-and-ICP.pdf>

- Employing a unified framework would allow the construction of SN-PPPs consistent with CPI movements in the time domain and consistent with PPP comparisons in the spatial domain.

Therefore, it is crucial that the NSOs consider ICP PPP and SN-PPP work as an integral part of a national price comparison program.

6 Compilation of subnational PPPs

The major steps involved in the compilation of SN-PPPs are similar to those involved in the compilation of ICP PPPs. Countries seeking to compile SN-PPPs are encouraged to consult *Measuring the Real Size of the World Economy: The Framework, Methodology, and Results of the International Comparison Program (ICP)* (World Bank, 2013) and *Operational Guidelines and Procedures for Measuring the Real Size of the World Economy* (World Bank, 2015) for detailed descriptions of the procedures involved. This section highlights some important aspects of SN-PPP compilation.

6.1 Construction of product lists

The first step is the construction of a product list consisting of goods and services that are to be priced for the purpose of SN-PPP compilation. A key consideration is that the product list adequately covers 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 ICP PPPs, as regions within a country are likely to be more homogeneous than countries. It is noted, however, that for large countries exhibiting geographic and economic diversity, preparation of the product list may be just as complex as that for inter-country comparisons.

6.1.1 Exploit 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 no region-specific product lists are available, then the CPI product list for the country may be used as a starting point with any products that may be considered important in one or more regions added to this list. This process may not be as simple as it appears, since it may be difficult to obtain a list of products which are regularly priced as a part of the CPI. The CPI, unlike the ICP, does not typically make use of SPDs and does not maintain lists of characteristics and details of the products priced for the CPI. Even when such a list exists, CPI price collection may not require documentation of the specifications of products to be priced. In establishing the product list for SN-PPPs, it is recommended that products appearing in the ICP product list are considered and, if possible, a subset of those products are included in the SN-PPP product list. Such an overlap can lead to synergies between the ICP PPP and SN-PPP production.

6.1.2 Comparability

Comparability of products for spatial price comparisons is, in concept, similar to pricing the same products at different points of time 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 their physical and economic characteristics are identical, or if they 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 the products are defined, the more difficult it becomes to find products meeting the specifications in all the subnational areas. It may be necessary to define products somewhat 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 or region within the country. Representative products are those products that are frequently purchased by resident households and are likely to be widely available throughout the country.

Comparability and representativeness are two competing requirements. Products may be made comparable through tight specification of the products, in which case such products, while available in the outlets, may not be representative of consumption in the regions. In the preparation of the product 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-representative products may differ from representative ones. Though comparability is likely to be a less serious issue in the context of SN-PPPs than it is in the computation of ICP PPPs, the two competing requirements need to be considered carefully and caution is required in the preparation of the product 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 is useful to attach an indicator for each item as to whether the item is considered *important* or whether 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 a basic heading in spatial price comparisons and the ICP, it is at the elementary level within the CPI. Different types of rice like basmati, long grain, short grain, glutinous rice, and parboiled rice all belong to the *rice* basic heading. The price index for this group within CPI is computed using 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 that basic heading price parity.

A strong recommendation is that indicators of *importance* be attached to each item in the product list priced by a region or province used for the compilation of SN-PPPs.

6.1.4 Price determining characteristics and structured product descriptions (SPDs)

Preparation of a structured product description (SPD) for each product to be priced is an important step in establishing a suitable survey framework for price collection. The SPD of each item lists a set of important price-determining characteristics which are designed to assist the price collector in identifying the products for which prices are to be collected. To decide on the product specifications, the agency responsible for this process may be able to utilize information on the collection of price data and the subsequent compilation of the CPI.

The type of information useful in this process may relate to:

- Coverage of the CPI by territorial area (including the classification between urban and rural areas),
- List(s) of products and services (“basket of goods and services”) - it is useful if products included in each elementary aggregate or basic heading are clearly listed.
- Product code and key identifiers, that is, a 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 (such as in SPDs), are developed prior to price collection. In practice, such details for the CPI products may not be available in a documented form. A closer integration of CPI and ICP activities may help bridge this gap. Further discussion and details on this aspect can be found in the CPI-ICP guide¹⁰ (International Comparison Program, 2021).
- There are two strategies to increase the number of comparable products: (i) use loose specifications of products, or (ii) collect more information on the characteristics of the products (include physical and functional properties) and then achieve product comparability by adjusting prices for quality differences. Further, there are two different ways to loosen the product specifications. First, it is possible to reduce the number of characteristics used in comparing products and services priced in different outlets and location within all the subnational 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) sets of characteristics that satisfy the same needs can be identified.
- Classification of products and services by the type of expenditures, such as the Classification of Individual Consumption by Purpose (COICOP) or other classification, would be useful.

6.2 Framework for price collection

To implement an efficient survey framework for building up an “ideal” micro-database to obtain reliable estimates of the SN-PPPs, it is necessary to work within a theoretical and practical framework based on a *multistage stratified sampling design*. Following the principles underlying such a framework, it is possible to take into consideration variability of the sampled population within each stratum to obtain reliable estimates

¹⁰ <https://thedocs.worldbank.org/en/doc/2b29c1445d7fa006e5f4ca00087dbe36-0050022021/original/Guide-CPI-and-ICP.pdf>

of the price index. The survey framework currently used in the compilation of CPIs may be used as a starting point for designing price surveys for SN-PPPs.

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

Once again, the survey framework adopted would necessarily depend on the purpose for which SN-PPPs are compiled. For example, if the purpose is to provide information to national and local policy makers regarding the incidence, nature, and extent of poverty, three additional aspects are important: (i) to consider areas as small as possible (local areas); (ii) the need to compile SN-PPPs separately for urban and for rural areas; and (iii) the possible collection of data on prices and expenditures that facilitate the compilation of poverty specific PPPs.

6.2.1 Conventional sources of price data

The primary source for price data for the compilation of SN-PPPs would be the standard or conventional sources of price data used in the compilation of CPIs, as well as other price indices, such as the wholesale and retail price indices. The conventional sources such as prices of goods and services from different types of outlets used by consumers for their purchases would be the primary source of price data for SN-PPPs. This is also the primary source for price data for ICP purposes. The case study by Aten in [Appendix A1](#) to this guide describes how price data gathered from the CPI sources can be used for inter-area price comparisons in the United States.

6.2.2 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 SN-PPP compilation from a new perspective. The scanner data provide large volumes of data on consumer transactions with specific information on sales, expenditures, quantities, and on quality of the item transacted, along with very detailed information on product characteristics (such as brand, size and type of outlet) provided at barcode level or, more precisely, the Global Trade Item Number (GTIN) code. The scanner data from the modern distribution chains can provide millions of prices for thousands of products. 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, the unit value price per item code can be computed by dividing total turnover for that item by the total quantity sold over a given period. These unit values, based on data from different geographical regions and over a given period of time, are similar to the national annual average prices required by the ICP for price comparisons.

Many NSOs around the world are integrating scanner data with price data collected from traditional sources using standard data collection methods in the process of compiling the CPI. Based on the experience gained, for example in Italy and other countries, this new source of data makes it possible to identify representative and comparable products across subnational areas, resolving the important issue of balancing the two competing requirements of representativity and comparability. The Italian case study by Laureti and Polidoro in [Appendix A3](#) of this guide, illustrates how scanner data can be blended with data from standard sources in the compilation of subnational PPPs.

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 a 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) account for the economic importance of each item in its market by using data on turnover, thus providing a reliable indicator of the importance of items. Finally, it is clear that using scanner data to carry out spatial comparisons will result in cost efficiencies since price data collection can then be limited to traditional outlets thus lowering data collection costs for the NSOs.

Several limitations of scanner data 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 and all the outlets within a country.
- From the view of geographical coverage, there is the advantage that scanner data can cover all the cities across the whole country, but it may also be that rural areas are not adequately covered.
- Coverage of scanner data is just for the purchases made in the outlets of the modern distribution chains, and scanner data may not be used for perishables and seasonal products such as fresh vegetables and fruit, meat, and fresh fish, since many of these products are usually sold at price per piece (e.g. price for one mango or price of a whole fish and not by its weight) and are not pre-packaged with GTIN codes.
- The traditional CPI surveys covering other outlets and markets (as hard discount, small shops, and open markets) must be used for the compilation of the SN-PPPs to attain complete coverage of the markets and for the kind of grocery products sold in these outlets. It is important to evaluate the share of total expenditure of consumers covered by scanner data and how to integrate PPPs compiled using scanner data with PPPs obtained for 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 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, following *post-stratification* of the existing CPI micro-data.

6.2.3 Outlet selection

The recommendations here are similar to the guidelines for the ICP. NSOs are responsible for price collection:

they are required to collect prices from a sample of outlets chosen to reflect consumer purchasing patterns for the types of products and services being surveyed. Therefore, it is necessary to select the outlets that are to be visited by price collectors using a well-defined sampling frame and then contacting the outlets selected to explain why they are to be visited.

Households purchase products and services from a range of outlets that tend to vary from country to country and across different subnational areas. The ICP classification of outlet by type is the following: (1) Large shops; (2) Medium and small shops; (3) Markets; (4) Street outlets; (5) Bulk and discount shops; (6) Specialized shops; (7) Private service providers; (8) Public or semi-public service providers; and (9) Other kinds of trades and outlets. For each price observation, the NSO must identify the type of outlet the price is collected from.

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 refer to a stratified sample by products and services, by type of outlet, and by location within each subnational area. The selection should consider 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, although this last piece of information is often 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 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. A challenge may be that the CPI surveys in many countries are urban based and in such cases these data need to be supplemented with data on prices from rural areas.

6.2.4 Seasonal products

Seasonal products are defined as those products for which both prices and quantities sold vary appreciably throughout the year. Typically, the patterns of variation are repeated from one year to the next. By this definition, certain fruits, vegetables, fish, and flowers 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.

The approach to be adopted for seasonal food products is to collect prices at more frequent time intervals, for example collecting prices monthly instead of quarterly. Annual average prices are computed using quantity weighted averages of the price data collected. Where prices are collected less frequently, it may be necessary to use temporal adjustment factors based on CPI price movements.

Neither the selection of seasonal food products, nor their seasonality, are necessarily the same for all the regions within a country or for different metropolitan cities when it comes to large and geographically diverse countries. It is left to the NSOs to decide which of the items specified are regarded as seasonal.

6.2.5 Housing and rental price surveys

The approach recommended for housing is similar to the ICP recommended approach. Heston (2013) describes the ICP practice in dealing with dwelling services. 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 special rental surveys or by extracting them from existing statistical sources, like household budget surveys, housing censuses, and other national data sources. Data are collected on 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 the 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, and heating and lighting, etc., in multi-apartment building complexes.

6.3 Availability of regional level data for GDP structure

In order to use household expenditure share data as weights to compute the SN-PPPs, it is necessary that the national accounts be compiled at the desired subnational geographical level and by classes of expenditure. However, NSOs do not typically provide such detailed breakdown. Given their national coverage, household expenditure surveys (HES) are often a reliable source of expenditure weights. It is possible that the sample size used for HES may not be sufficiently large to obtain accurate estimates of expenditure by commodity groups at local level. In such cases there are two possible options. One option is to restrict the scope of subnational PPPs to larger geographical areas for which reliable expenditure weights are available. An alternative approach is to obtain the matrix of expenditure shares by territorial areas and basic headings using *small area estimation* (SAE) methods, which provide imputed weights based on indirect indicators such as population.

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

- source(s) of data used: household expenditure or budget surveys; surveys for national and regional account compilation; retail surveys and others;
- methods of estimation of expenditure 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; and
- periodicity and method of updating the system of weights.

6.3.1 Validation of expenditure share data

The agencies involved in the compilation of SN-PPPs need to examine spatial consistency of expenditure shares. Though expenditure patterns across regions may exhibit significant differences, it is important to eliminate inconsistencies arising out of differences in interpretation and implementation. For example, some regions may include the cost of food from restaurants under food expenditure, while others may include it

under restaurants. Such discrepancies are likely to be discovered by a comparative assessment of expenditure share data from different regions. Another example is rental data for housing. Rents should not normally include charges for heating or for miscellaneous services relating to the dwelling such as refuse collection or co-proprietor charges in dwellings in multi-apartment building complexes.

7 Price data and validation

7.1 Price data

The objective of the SN-PPP price surveys is to collect prices that purchasers actually pay to acquire 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 delivery and installation costs, value added taxes (VATs) and other indirect taxes on products and invoiced service charges and voluntary gratuities. These principles need to be established in advance to ensure consistency in the approach used by price collectors.

7.1.1 Annual average prices

The ICP advocates the use of annual average prices for the purpose of PPP computations. The same notion is applicable in the case of SN-PPPs. 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 average prices are computed for each product at the level of territorial or geographical area. If the survey framework utilizes a self-weighting design, a simple unweighted average of all the price quotations can be used in computing national average prices. Otherwise, it is necessary to use weights based on quantities or expenditures.

7.1.2 Number of quotations, average prices, and standard deviation

The number of prices to be collected for a product will vary 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 prices of the product vary. The number of prices to be collected for each product could be decided using random sampling techniques, but the number of price observations to be collected per product could be decided by taking into account the type of specification being priced, the conditions prevailing in its market, and experience gained from previous survey rounds. It is a sound practice to collect more price quotations for products in basic headings with large expenditure weights and/or with larger price variations than prices of items in other basic headings.

In addition to supplying average prices, 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. These can serve as a measure of the reliability of price data. The current practice with the ICP is that the national implementing agencies provide such information to the regional implementing agencies.

7.2 Validation of price data

Once price data are collected from 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 errors and non-sampling errors. Sampling errors can be controlled through the use of an appropriate statistical 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 correct or correcting them if they are not. Validation is an iterative process requiring several 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 acceptable bounds.

Validation is a two-stage process. In the first stage, prices collected are edited and verified within a region or territorial area, referred to as intra-regional validation. The second stage involves inter-region validation where prices collected by all the regions involved in the comparison are used in the process of editing and verification. In each of these stages, validation has the same aim which is to identify and eliminate non-sampling errors, product error and price error, from the survey price data.

7.2.1 Validation at the regional and national level

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

In the next stage, the inter-regional validation is designed to screen average prices from different regions. The objective is to verify that the average prices are for comparable products and that the price collectors have interpreted product specifications in the same way and that they have also priced them accurately. This is done by comparing 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 measures of price variation suitable for validating price data. Details of

these diagnostic tools along with illustrative examples can be found in Chapter 9 (Blades, 2013) and in Chapter 10 (Vogel, 2013) of *Measuring the Real Size of the World Economy* (World Bank, 2013), and in Chapter 14 of *Operational Guidelines and Procedures for Measuring the Real Size of the World Economy* (World Bank 2015).

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 help identify outlier outlets.

Correction of price observations and deletion of prices: prices that have extreme values suggest that they could be wrong and need to be investigated if they are genuine observations. If they are genuine outliers and are not due to product or pricing errors, such prices should be retained. However, if errors are found then those prices are either corrected or dropped.

8 Expenditure data and weights

As already noted, there are two main stages in the calculation of SN-PPPs. The first is the collection of price data and the calculation of spatial price indices, or in other words PPPs at the basic heading level. The second stage is where basic heading price indices are further aggregated leading to PPPs at higher levels of aggregation up to the overall SN-PPP itself. Expenditure data are needed irrespective of the index number formula used for aggregation purposes.

8.1 National accounts versus household expenditure survey data

Expenditure share weights, for the aggregation of price differences above the elementary level or basic heading level, are a common data requirement for both CPI and PPP compilation. The CPI weights are usually based on data collected through household expenditure surveys (HES). Weights used in the calculation of ICP 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 compiled through the commodity flow approach. Therefore, common ground exists, and an integrated approach can result in more reliable estimates of both the CPI and PPPs. 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 the HES, 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. 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 conducted every year on a continuing basis.

The use of the commodity flow method within the supply and use tables of the System of National Accounts (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 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 detailed enough for SN-PPP purposes.

Countries that conduct continuous expenditure surveys can 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 used for SN-PPP compilation. In any case, it may be preferable to use expenditure weights that are averages of expenditure shares over periods of two or three years in order to reduce “noise” caused by errors of estimation (the expenditure surveys are based on 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 and pandemics.

8.3 Classifications of household expenditures

The individual consumption expenditure by 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 ICP, the CPI and the HES are different. This compromises comparability across the three statistical domains, and can make the expenditure data reconciliation difficult, and can make it difficult to use the CPI expenditure weights for the computation of PPPs.

To address the issue, a good starting point is the COICOP Classification at five-digit, or subclass, level which can be used as the basis to harmonize the three different classifications. The aim at the five-digit level is to draw up a master classification with subclasses defined to meet the needs of the ICP, the CPI and the HES.

9 Aggregation methodology and price and real expenditure comparisons

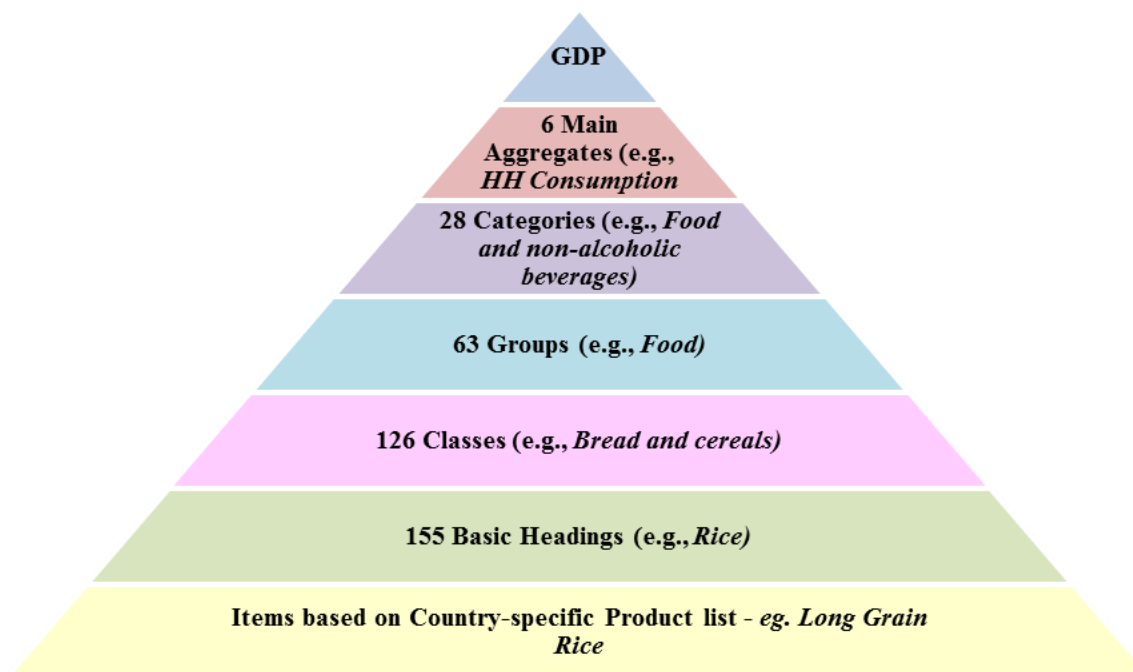
The methodology for the compilation of PPPs within the ICP is well established. Detailed discussion on the framework for PPP compilation and the methods for aggregation at the elementary or basic heading level and for aggregation at higher levels are available, respectively, in chapters 1, 4 and 5 (Rao 2013a; Rao, 2013b; and Diewert 2013) in *Measuring the Real Size of the World Economy* (World Bank, 2013). Estimation of SN-PPPs

and real expenditures at the regional level is like estimation of ICP PPPs and therefore all the methods used in the context of ICP are equally applicable in the case of subnational comparisons. The recommendations below focus on several important aspects of the estimation of PPPs for subnational comparisons of prices and real expenditures.

9.1 Hierarchical structure for compilation of PPPs

The compilation of PPPs for household consumption or for higher levels of aggregation can follow a pyramid-like structure that starts with item-level prices and progressively aggregates to higher levels eventually reaching a desired level of aggregation. In the context of SN-PPPs, it may be appropriate to consider individual consumption expenditure by households (ICEH) and by non-profit institutions serving households (NPISHs); government expenditure; and gross fixed capital formation. The sum of these three major aggregates constitutes domestic absorption – an aggregate that is a meaningful concept for subnational price and real expenditure comparisons. Figure 9.1 shows the structure of higher-level aggregates used in the most recent ICP cycles in 2005, 2011 and 2017.

Figure 9.1: Hierarchical Structure for Different Level Aggregates



Source: Based on a similar figure on page 17, World Bank (2013)

A complete list of basic headings belonging to different classes, groups, categories, six main aggregates and the GDP are available in recently released reports for the ICP 2017 cycle (World Bank, 2020; and Asian Development Bank, 2020). For the purpose of compiling SN-PPPs, it is sufficient to identify the part of the

pyramid that is of relevance for the particular subnational PPP under consideration. For example, if PPPs for *food* are of interest, then prices of all items and basic headings classified under food along with expenditure weights would be considered.

9.2 Aggregation of item level prices to basic heading level

Basic heading (BH) 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 is aggregating prices of items that belong to the basic heading level. For example, *Rice* is a basic heading and different 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 is 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 briefly described in Section 9.3 below. At the end of this step, PPPs are available for all the basic headings that belong to a particular aggregate under consideration

9.3 Aggregation of basic heading level PPPs to PPPs for higher level aggregates

The estimated PPPs for the basic headings are matched with expenditure data either from household expenditure surveys or from national accounts. At this level, price and expenditure (and hence quantity data) are available for index computation.

The recommendation is to use data on PPPs and expenditures for all the basic headings belonging to a certain group. For example, if the PPP for the class *Bread and Cereals* is to be computed, then only BH PPPs for the 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-Éltető-Köves-Szulc (GEKS) method for aggregating BH PPPs and expenditure data. The GEKS method is explained in Section 9.6 below.

A further recommendation for aggregation above basic heading level is to always use PPPs and expenditure data for all the basic heading levels belonging to the group considered for aggregation. For example, suppose SN-PPPs for the Food group are being compiled. Then the recommendation is to make use of all BH PPPs that belong to the Food group for computations and NOT to use PPPs from higher level aggregates. For example, PPPs for Bread and Cereals, Non-alcoholic Beverages, and Alcoholic Beverages should not be aggregated leading to Food PPP. Instead, all the BHs like Rice, Other cereals, Bread, and others that comprise the Food aggregate should be used.

9.4 Index number methods for multilateral comparisons – desirable properties

Aggregation of price data leading to PPP estimation requires the use of index number formulae. Not all index number methods are suitable for the purpose of making spatial comparisons. Since multilateral comparisons involve comparisons between all pairs of subnational regions, only index number methods satisfying important properties can be employed for compiling SN-PPPs. There are many desirable properties but a subset of three properties are considered desirable. These are transitivity, base invariance, and additivity, described briefly below.

9.4.1 Transitivity

Suppose there are R regions involved in the comparison indexed as $r = 1, 2, \dots, R$. Let $\{PPP_{jk} : j, k = 1, 2, \dots, R\}$ represent purchasing power parity (PPP) or the spatial price index for region k relative to the base region j . Multilateral spatial price comparisons require that PPPs for all pairs of regions need to be computed thus filling the following price comparison matrix **PPP** :

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

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

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

Suppose prices in region C are on average 10 percent higher than in region A and if prices in region B are 20 percent higher than in region C, then transitivity implies that prices in region B must be 32 percent higher than prices in A ($1.10 \times 1.20 = 1.32$).

If the matrix of PPPs satisfies transitivity, all the elements of the matrix can be filled if the values of PPPs in the first row are known. That is, if PPPs for all regions expressed relative to a reference or base region 1 are known, it is possible to derive PPP for any other pair of regions, j and k , by using

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

For example, when cross-country comparisons in the ICP are considered, the transitivity property of the aggregation method implies that PPPs for all the countries expressed relative to USA as the reference country (with the U.S. dollar as the reference currency) can be used to find PPPs for currencies relative to another reference currency. World Bank (2020) has published PPPs for the reference year 2017 in May 2020 for all the

participating countries with USA as the base country. Suppose the PPP for India with Japanese Yen as the reference currency is needed, then it can simply be obtained as:

$$PPP_{Japan,India} = \frac{PPP_{USA,India}}{PPP_{USA,Japan}}$$

9.4.2 Base invariance

In simple terms, base invariance requires all the participating regions to be treated symmetrically and no region is given special prominence. Suppose, SN-PPPs for regional capital cities in India are compared to New Delhi, which is the capital of India. Comparisons between any other pair of capital cities is done through New Delhi using the Fisher binary price index number formula. The resulting SN-PPP comparisons are transitive but not base invariant as New Delhi is given special status in the comparisons. Here, New Delhi is like a star or pivot in the price comparisons. If New Delhi is replaced by Mumbai as the star or the pivot, the resulting set of SN-PPPs will once again be transitive, but they will be different from those obtained using New Delhi as the pivot.

9.4.3 Additivity

Additivity is a useful accounting requirement, which ensures that the PPP-converted (real) expenditures for different components of an aggregate add up to the real expenditure for the aggregate. Additivity can be observed for expenditures in local currency units and for aggregates converted using market exchange rates. An index number method satisfies additivity if the sum of real expenditures for components adds up to real expenditure for the aggregate. While it is an attractive property, additivity comes at a cost. Additive methods use a common set of prices (or, as they sometimes called, international prices) at which quantities are valued. However, it has been shown that constant price comparisons that underpin additive methods violate important economic theoretic properties (see Diewert (2013) for a detailed explanation). Such comparisons result in a bias (the Gerschenkron effect) which could be significant in international comparisons where price and quantity structures can differ greatly. Based on these considerations, the ICP discontinued the use of the Geary-Khamis method, which is an additive method, and replaced it with the GEKS method in 2005. However, within a country price structures differ much less, and the effects from additive methods are consequently much smaller, which explains why CPI and SNA mostly use such indexes as the Paasche and Laspeyres in their compilation without much of an adverse effect. In this paper, Appendix A1 describes the U.S. Bureau of Economic Analysis (BEA) methodology for SN-PPPs within the USA using a Geary-Khamis type additive index.

Based on the discussion above, it is recommended that if additivity is not required, then the GEKS-type indices are to be used in the compilation of SN-PPPs. If additivity is required a Geary-type system can be

used (that is, the Geary-Khamis index, or the Ikke-Dikhanov-Balk (IDB) index)¹¹. Those indices satisfy transitivity and base invariance, in addition to additivity. It should also be noted that formulae commonly used by the NSOs, such as the Laspeyres, Paasche, Fisher, and Tornqvist indices, do not satisfy transitivity. As the GEKS-based comparisons do not satisfy additivity, users must be careful when comparing real expenditures at the aggregate level and at the component level.

9.5 Country-product-dummy (CPD)¹² method

The country-product-dummy (CPD) method is the recommended method for aggregating item level price data to estimate PPPs at the basic heading level. The method was first 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, 2013b).

Suppose there are N items belonging to a particular basic heading. Let $\{p_{ij} : i = 1, 2, \dots, N \text{ and } r = 1, 2, \dots, R\}$ represent the price of the 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 the i -th commodity and purchasing power parity for the basic heading for the region r respectively. Taking logarithms on both sides, the model can be re-written and expressed in terms of item and region dummy variables (see Rao, 2013a for details):

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

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

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

Parameters of the CPD model 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 PPP for region r is estimated as:

¹¹ Diewert (2010) describes these indices in detail (<https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1475-4991.2010.00398.x>)

¹² 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, and provinces.

$$P\hat{P}P_r = \exp(\hat{\pi}_r) \quad \text{and} \quad P\hat{P}P_{jk} = \frac{\exp(\hat{\pi}_k)}{\exp(\hat{\pi}_j)} \quad \text{for all } j, k$$

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

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

which is the simple geometric average of price relatives of all the items included in the basic heading.

The CPD method is the method recommended by the ICP Technical Advisory Group (TAG) for aggregation of item level price data leading to PPPs at the basic heading level. However, in the Eurostat and OECD regions a slightly different set of aggregation procedures which are similar to the GEKS method are used. Rao (2013b) describes these methods in detail. A distinct advantage of the CPD model is that it allows for the use of weights, such as importance weights, in the estimation of PPPs. Furthermore, the CPD model can also accommodate additional information on characteristics of products priced when loose specifications are used in product descriptions.

9.5.1 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 is applied when using weighted least squares to estimate the CPD model. This is equivalent to running ordinary least squares after transforming the CPD model as:

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

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

where w_{ir} is equal to 3 if the item is important and equal to 1 if the item is not important.

However, for SN-PPPs, it may be difficult to come up with reliable importance information. Additionally, if the SN-PPPs are based on CPI information, it can be assumed that all the price observations are important, as CPI includes only representative items. In this case the regular unweighted CPD should be used.

9.6 Gini-Éltető-Köves-Szulc (GEKS) method

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

Let $\{p_{ir}, e_{ir} : i = 1, 2, \dots, N; \text{ and } r = 1, 2, \dots, R\}$ represent, respectively, 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:

$$PPP_{jk}^{GEKS} = \prod_{l=1}^R [F_{jl} \cdot F_{lk}]^{\frac{1}{R}} \quad \text{where} \quad F_{jk} = \left[\frac{\sum_{i=1}^N p_{ik} q_{ij}}{\sum_{i=1}^N p_{ij} q_{ij}} \cdot \frac{\sum_{i=1}^N p_{ik} q_{ik}}{\sum_{i=1}^N p_{ij} q_{ik}} \right]^{\frac{1}{2}}$$

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

9.7 Specification of the reference region for subnational PPPs

ICP PPPs are expressed relative to the U.S. dollar as a matter of convention (World Bank, 2020). Relative price comparisons and PPPs for a country with another reference country are not affected by the choice of the reference or numeraire country. In subnational 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 subnational 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 the regions are expressed such that PPP for the whole country is equal to 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 subnational PPPs. However, this approach does not apply in the case of comparisons across capital cities as the collection of capital cities does not equal the whole country. In this case, SN-PPPs may be expressed relative to *all capital cities* instead of the whole country.

In view of this discussion, it is recommended that SN-PPPs within a country are expressed with the whole country as the numeraire.

10 A survey of studies computing subnational PPPs and spatial consumer price index numbers

This section provides an overview of studies and experiments on the computation of subnational PPPs and spatial consumer price indexes conducted by individuals and national statistical organizations over the last two decades. This survey is designed to provide insights into these studies, and it is by no means exhaustive. There have been several reviews of exercises on subnational PPPs by researchers (Biggeri, Laureti and Polidoro (2017); Laureti and Rao (2018); Biggeri and Rao (2018); and Weinand and von Auer (2019)). Countries embarking on the compilation of subnational PPPs based on the guidelines in this document may find it instructive and useful to closely examine and follow studies surveyed in this section.

The review offered in this section is divided into three broad categories. The first set are attempts to compile subnational PPPs with methodology comparable to that of PPPs computed within the ICP framework. The

second set of studies covered are the attempts made in different countries to compile *spatial adjustment factors* (SAFs) which are required for the implementation of the *rolling price survey approach* used in the Eurostat-OECD PPP Programme. The last set of studies show how subnational spatial consumer price indexes for household consumption are compiled using CPI data and data from household expenditure surveys.

10.1 Subnational PPPs computed at national level using the ICP framework

The first and the most comprehensive experiment in this direction was carried out by the Asian Development Bank (ADB) and by McCarthy (2010) and Dikhanov et al. (2011). Their study was aimed at the plausibility of integrating the ICP methodology with the Philippine CPIs by computing subnational PPPs using regional prices and expenditure weights from the CPI. The purpose of the research study was to examine whether and to what extent the prices collected for the CPI could be used to provide reliable estimates of price levels for a range of products in each region (subnational area) and to verify if the results are consistent with the information obtained from the ICP process. Experiments were conducted to compute PPPs for 17 major regions of Philippines. The CPD method was used at the basic heading level and GEKS formula to aggregate the detailed PPPs to higher level aggregates for each of the 17 regions. Dikhanov et al. (2011) describe all the necessary phases for constructing regional PPPs, underlining the main issues and solutions for overcoming them, both concerning data preparation and methods of index computation and aggregation. This experimental study paved the way for further experiments in the Asia-Pacific Region. The ADB also conducted experiments for Bangladesh and Malaysia (Capilit and Dikhanov, 2017). Preliminary results of these studies reinforce earlier findings and confirm that it is possible to integrate the ICP with the national statistical program.

A second important pilot project was implemented by the United Nations Economic and Social Commission for Western Asia (UN-ESCWA) for the computation of subnational PPPs for the seven emirates in the United Arab Emirates (UAE) for the year 2015 (Skaini, 2016; Skaini and Samara, 2017). The results from these studies are valuable, because the project evaluated the feasibility of subnational PPP production, by exploring the synergies between CPI and ICP methodologies. Because the organization and computation of the CPIs in the UAE emirates were different, the UN-ESCWA prepared a unified product list, based on the subnational CPI and ICP product lists. In addition, special surveys were developed or improved for categories such as construction and housing rentals, based on the ICP methodology. The seven UAE emirates collected prices from this unified product list, covering all the components of GDP expenditure, and the data were subsequently validated using ICP software. The computation of subnational PPPs for 2015 was successfully concluded, providing measures of differences in price levels of goods and services across the seven emirates. Moreover, the adoption of a unified framework harmonizing with ICP methodology, improved the CPI infrastructure and coordination of subnational statistical offices.

10.2 Spatial adjustment factors and the Eurostat-OECD PPP Programme

The computation of the spatial adjustment factors (SAFs) is an essential element in the Eurostat-OECD PPP Programme. SAFs are in concept like subnational PPPs.

In the Eurostat-OECD PPP Programme each country collects price data mainly from capital cities. This is one of the principal elements of the rolling price survey approach and is designed to reduce the burden and cost of collecting price data. The prices observed in the capital cities may not adequately represent price levels in the remaining areas of the countries and, therefore, may not reflect national average prices. Consequently, in order to have an accurate measure of price levels and PPPs at the country level, Eurostat requires¹³ the participant countries to produce SAFs once every six years.

Currently, two countries produce and publish information on SAFs. The United Kingdom's (UK) Office for National Statistics (ONS) and the Turkish Statistical Institute (TurkStat). It is possible that NSOs in some other countries also produce SAFs, as is the case with the Italian Statistical Institute (Istat), but do not publish these results. The ONS computed SAFs for the year 2016, for 167 BHs, 10 Divisions (of COICOP classification) and 5 regions, then enlarged to 12 (ONS, 2018). ONS compiled the "relative regional consumer price levels of goods and services (RRCPLs)", the results of its computation and detailed information on the methodology, prices and weights data sources used are included in ONS (2018).

ONS started experiments for the computation of RRCPLs in 2001 using CPI data, supplemented with a purpose-designed regional price level survey for products and services not covered by CPI data. ONS carried out successive experiments in 2004 and 2005 in order to improve the quality of the results obtained. ONS subsequently published a report on UK 2010 SAFs for use in the PPP calculations (ONS, 2011). From the two publications of ONS (2011 and 2018) it is apparent that the ONS created a small team in order to compute the SAFs; replicated the sampling methodology used by Eurostat for the European Comparison Program (ECP) both for the items and locations, but using sub-samples of items and locations, in order to reduce costs.

The ONS implementation in 2016 used a sub-sample of 539 PPP items spread across 168 BHs. The ONS used CPI data for 129 items; and in 2016 engaged an external research company to conduct field data collection for 324 items spread across 21 locations in UK. For several categories of goods and services, in particular, in the groups of health and education, motor vehicles, property rents and owner occupiers' housing costs, special treatment or exclusion was used focusing on representative and non-representative products. At the basic heading level (BH), price relatives of the items included in the BH were combined with Jevons index which is an equally weighted geometric mean of price relatives. The RRCPLs at BHs were then aggregated to successive COICOP levels by using regional expenditure weights obtained and adapted from the ONS's Costs and Food survey and applying the GEKS formula. A case study based on the ONS experience is included in [Appendix A2](#) of this guide.

The Turkish Statistical Institute (TurkStat) carried out three experiments and published "Regional Price Level Indices" and Regional Purchasing Power Parities for the years 2008, 2012, and 2017 for 26 regions and 12 main

¹³ The request is in accordance with Regulation (EC) No 1445/2007 of the European Parliament and of the Council.

aggregates of COICOP (TurkStat, 2009, 2013 and 2018; Daskiran, 2011). The main objective was to estimate “regional price level differences” for consumer goods and services and to estimate “spatial adjustment factors” for Turkey. TurkStat has undertaken a special study to select a basket of goods and services based on the CPI basket items appropriate for subnational price comparisons. These have been divided into comparable items with strict specifications; comparable items with special cases; non-comparable items; and a specific item group (rent). The representativity information was surveyed and based on the availability of items in each region. In the computation for 2017, among the 1,005 total items included in the basket, 597 items are from the regional purchasing power parity basket (prices were collected using special price surveys), and 408 from the CPI (using prices from the CPI database). Different types of surveys were conducted to collect data for different categories of products: food and beverages (which was the most successful category); household equipment and furniture; clothing and footwear products; and services. The collection of price data covered the city centers of 81 provinces in 26 regions. Regional expenditure weights on consumption goods and services were used to aggregate price indexes at the region level. The computation of the spatial price indices is based on the Eurostat-OECD PPP methodology.

10.3 Subnational spatial CPIs for household consumption based on CPI data

Computation of subnational spatial price indexes for household consumption, using mainly CPI data (sometimes called subnational household consumption PPPs) have been conducted by some NSOs and many researchers, using the national COICOP classification of products without any formal link to the structured product descriptions (SPDs) used in the ICP specification of products.

Experimental estimates of spatial price indexes began in the early 2000’s with a formalized relationship between the Bureau of Economic Analysis (BEA) and the Bureau of Labor Statistics (BLS). The estimates used the CPI microdata collected by the BLS to calculate interarea price indexes for 38 geographic sampling areas and about 200 item strata or basic headings (Aten 2005, 2006). The work was later expanded to include data on rent price levels and expenditures from a new annual survey by the Census, the American Community Survey (ACS), which enabled estimates to cover the entire U.S., at the level of 366 metropolitan areas and 50 states plus the District of Columbia (Aten and Figueroa, 2014). Since 2014, these subnational PPPs, termed Regional Price Parities (RPPs), have become official annual statistics published by the BEA. Details of the U.S. approach are included as a case-study in [Appendix A1](#) of this guide.

In summary, the CPI price quotes are averaged over the year and then entered into a weighted CPD or a hedonic regression, with the resulting area coefficients, or class means, aggregated to 16 expenditure classes using the Geary multilateral index. The subsequent stage merged the results with the more geographically detailed rent data from the ACS, expanding the scope of the RPPs to states and metropolitan areas. In 2020, BEA began revising its National Income and Product Accounts to include estimates of housing expenditures for both tenant and owner-occupied homes using the ACS. These revisions include an imputation for owner-occupied homes using a new methodology called an owner-premium approach (Aten and Heston, 2020, Aten, Figueroa and Rassier, 2021). Final all-item RPPs incorporate both expenditures and price levels using the new approach.

The Australian Bureau of Statistics (ABS) compiled and disseminated experimental indexes on the cost of living in the eight regional capital cities of Australia using price data collected for CPIs. Spatial price indexes were computed using the GEKS formula (Waschka et al, 2003). ABS continued to compute and disseminate data on the average retail prices of selected items in the eight capital cities, advising a careful interpretation of the results. However, in 2011, the ABS discontinued the publication. Separately from the efforts of the ABS, in 1998, the Government of Western Australia Department of Primary Industries and Development started to compute a Regional Price Index (RPI) with a common basket with Perth as the basis for comparison with each regional location. The RPIs are indicative of the differences of cost of living at different locations. The computation of the RPI was repeated in the following years seven times (Government of Western Australia, 2017). The 2017 RPI comprised a basket of more than 600 goods and services, which were priced in 27 centers around Western Australia. The RPI is formally used in setting the district allowance.

At the beginning of 2000s, the Italian National Statistical Institute (Istat) conducted experiments on the use of CPI data to calculate regional consumer price level indexes and disseminated results on two occasions: in 2008 with reference to price data from 2006; and in 2010 with reference to 2009 data. Istat used the same procedures that were used in the ICP following the principle of strict comparability of products which required a lot of work because of the vague definitions of the products in CPI data. Moreover, ad-hoc surveys were designed and carried out for the product groups “Clothing and Footwear” and “Furniture” - products groups for which the CPI data are not adequate. The complete computations involved 1,865 item products and the collection of 717,200 elementary quotations (prices). The subnational SPIs were compiled for all the COICOP expenditure divisions (and published for eight divisions) and 20 Italian regional capital cities. The GEKS approach was used for the computation of PPPs, with the exception of rents for which the spatial comparisons were carried out using CPD model and Household Budget Survey (HBS) data which includes some detailed information about the characteristics of the dwellings. Further research studies have been implemented by Istat in cooperation with the University of Florence and the University of Tuscia. These research studies had the following objectives: (i) to establish a data warehouse collecting data from various available sources of data (to avoid the need to conduct ad hoc surveys that are costly); (ii) to verify if and how much the methods of subnational PPPs computation are affected by the type of data; and (iii) to examine the possibility of using electronic devices, scanner and web data (scraped by automatic procedures and robots) for the prices of some products purchased by the households. These experiments have been completed and Istat is building up a database suitable for constructing subnational consumer SPIs on a regular base (for detailed information see: Biggeri, Laureti and Polidoro, 2017; Laureti and Polidoro, 2017; Laureti and Rao, 2018; Biggeri and Laureti, 2018). A case study based on the Istat experience is included in [Appendix A3](#) of this guide.

The General Statistical Office (GSO) of Viet Nam started a pilot research project in 2010 to compute subnational PPPs in terms of SCOLI (spatial cost of living) index, supported by the World Bank, based on CPI data available. The GSO produced and published SCOLI indices for the period 2010 to 2017 (GSO, 2019). The SCOLI indices have been compiled for six geographical regions and 63 provinces/cities. These comparisons were made, respectively, with the average price of the Red River Delta and Hanoi City, covering 11 groups of consumer goods by purpose (COICOP) with 572 goods and services. Moreover, GSO (2019) describes the methodology used, outlines the sources of price and weights data, and details the survey framework and on the identification

of products overlapped among provinces/cities. This work in Viet Nam demonstrates that prices of commodity items from CPI surveys are adequate to compute the SCOLI indices and that the use of CPI data can be used in assessing performance of poverty alleviation programs and in the computation of a human development index at a regional level.

In France, the National Institute of Statistics and Economic Studies (INSEE) has conducted special prices surveys in 1985, 1992, 2010 and 2015 and published analyses based on these surveys. INSEE (2016) published results from the 2015 survey comparing prices between the Paris agglomeration and the provinces and between the five overseas départements (DOMs). In 2015 (INSEE, 2016), the collection of prices, for the same basket of about 400 groups of products and services, has been realized in representative agglomerations and all types of outlets in each territory (more than 90,000 prices in Metropolitan France, and from 4,000 to 7,000 for each DOM). The comparison covered products that are consumed significantly in different territories and the methods applied are the same as those used in the Eurostat-OECD PPP Programme. The main findings published in INSEE (2016) are that: in 2015, prices in the overseas DOM are higher than in Metropolitan France; and that prices in the Paris region are 9 percent higher than in the provinces. INSEE has decided to conduct these studies every five years from now on (INSEE, 2019).

As far as the estimation of subnational consumer spatial price index numbers using CPI data and/or COICOP classification, many researchers have compiled subnational price comparisons in various countries, such as Brazil, China, the Czech Republic, Poland and Germany, publishing their results as research papers in academic journals (Jansky and Kolcunova, 2017; Biggeri, Ferrari and Zhao, 2017; Menggen, Yan and Rao, 2018; Rokicki and Hewings, 2019; Weinand and von Auer, 2019).

A recent estimation of Regional Price levels (RPIs) for the Czech Republic was conducted by Kocourek, Simanov, and Smida (2016). Their study covered 35 districts (Local Administrative Unit-1, LAU 1, formerly Nomenclature of Territorial Units for Statistics-4, NUTS-4) and the Capital of Praha. Price comparisons were made for 12 CZ-COICOP Headings using raw data from price surveys carried out by the Czech Statistical Office. Their study analyzed 1,717,102 surveyed prices, from years 2011-2013, and split the prices representative for 4,673 varieties. For the computations of the RPIs at regional level (NUTS-2 and NUTS-3), the authors used the Jevons index obtaining unweighted price parities. Then, geometric Laspeyres and Paasche indexes have been computed and synthesized by the Tornqvist price index to obtain the RPIs. The choice of this superlative index is justified by the fact that it can be decomposed so that the share of each price representative in the total price level can be easily determined. However, the Tornqvist index is not a transitive index. Because, at the district level, price data were uneven and the expenditure weights were not available, the authors estimate these data at the district level using auxiliary variables and SAE (Small Area Estimation) methods.

Regional Price Deflators in Poland were recently estimated by Rokicki and Hewings (2019). The computation of the so-called PPP deflators has been done for the years 2000-2012, for 11 COICOP categories and for the 16 regions (NUTS-3) and for the 66 NUTS-3. The authors used price data obtained by the Polish Central Statistical Office for over 300 consumer goods and services collected from up to 26 locations in each of the 16 NUTS-2 regions. All those 300 products were supposed to be representative and the structure of spending within the main expenditure categories was assumed to be homogeneous within the 16 regions. The estimation of the

regional PPP deflators was based on the Eurostat-OECD methodology and the GEKS aggregation method. The estimated regional price deflators at the NUTS-2 level and the regressors identified as significant determinants of RPDs at the NUTS-2 level were used in a multiple imputation approach leading to estimates of regional price levels for the 66 NUTS-3 regions.

Finally, turning to Germany, the most complete and interesting research on this topic appeared as a Discussion Paper of the Deutsche Bundesbank (Weinand and von Auer, 2019). The authors use a highly disaggregated and reliable micro price dataset that has been collected, through a kind of stratified sample, for the computation of the CPIs by the Statistical Offices of the Länder and the Federal Statistical Office of Germany. The German territory is subdivided into 402 regions (295 counties and 107 cities) and the dataset from 2016 included 366,401 consumer prices for goods and services and 15,582 for rents classified into 650 categories of the COICOP classification, denoted as basic headings (645 for goods and services and 5 for rents). The database contains not only the prices, but also their precise specifications and the outlet types where the products are purchased. The prices assigned to the same group cannot be considered as directly comparable, therefore the authors introduced an alternative automated compilation process that identified pairs of only perfectly matching products, rejecting all products that have been observed in only one of the regions. This procedure defines for each individual product so determined (identical for characteristics and outlet type) its own vector of regional prices. To compute the Regional Price indexes (RPIs) for the 12 divisions of COICOP classification at regional level, the authors applied a methodology that they called a multi-stage version of the CPD method. First, they computed unweighted CPD regression of prices to the same basic headings and outlet type. Then, having the expenditure weights for most of the basic headings and the eight types of outlets, the authors computed, successively, weighted CPD regression of prices relating to the same BH; weighted CPD regressions for goods, services and rents; and aggregated them further leading to RPIs. A separate hedonic regression of regional rent levels has been computed, because in Germany price levels are largely driven by the cost of housing. Finally, interesting experiments have been conducted to verify whether and how much simplified compilation procedures affect the results.

In summary, there have been a number of studies conducted by national statistical institutes/organizations as well as individual researchers with the objective of estimating credible subnational PPPs. These studies differ in the type of price data used for PPP compilation as well as in the aggregation methodology used. It suffices to note that the existing studies are a source of confidence and optimism for the compilation of subnational PPPs in countries around the world.

11 Conclusion

Subnational 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 of subnational PPPs is coming into prominence. Methods for the compilation of PPPs from the ICP have been well established and are available through the World Bank (2013) 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 subnational PPPs raises its own challenges in terms of the scope and establishment of the survey framework necessary for the compilation of subnational PPPs. The main objective of this guide is to highlight some of the practical issues that arise in setting up a program for subnational PPPs including establishing the use and applications of subnational PPPs. Where possible, clear recommendations have been made throughout the guide, but users are advised to use this guide in conjunction with the existing material and guidelines for the compilation of PPPs in the ICP. Four case studies summarizing their experiences with compilation of subnational PPPs are included as appendices to this guide.

12 References

- Asian Development Bank (2020), “2017 International Comparison Program for Asia and the Pacific: Purchasing Power Parities and Real Expenditures — Results and Methodology”, Asian Development Bank, Manila, <https://www.adb.org/publications/international-comparison-program-2017-results-methodology>.
- Aten B. (2005), ‘Report on Interarea Price Levels, 2003’, working paper 2005–11, *Bureau of Economic Analysis*, May.
- Aten B. (2006), ‘Interarea Price Levels: an experimental methodology’, *Monthly Labor Review*, Vol. 129, No.9, Bureau of Labor Statistics, Washington, DC, September.
- Aten B and Eric Figueroa (2014), “Regional Price Parities and Real Regional Income for the United States: 2008-2012”, Paper presented at the IARIW 33rd General Conference Rotterdam, the Netherlands, August 24-30, 2014.
- Aten B. and Alan H. (2020), “The Owner-Premium Adjustment in Housing Imputations”, *Bureau of Economic Analysis*, June.
- Aten B., Dylan R. and Eric F. (2021). “Improved Measures of Housing Services for the U.S. Accounts”, *Bureau of Economic Analysis*, forthcoming.
- Biggeri L., Ferrari G. and Zhao, Y. (2017), Estimating cross province and municipal cities price level differences in China: Some experiments and results, *Social Indicators Research*, 131 (1), pp. 83-121
- Biggeri L., Laureti T. and Polidoro F. (2017). Computing subnational PPPs with CPI Data: An Empirical Analysis on Italian Data Using Country Product Dummy Models. *Social Indicators Research*, 131(1), 93-121.
- Biggeri L. and Rao D.S.P. (2018), Background Paper on subnational PPPs, paper presented at the meeting of ICP Task Force on the Country Operational Guidelines and Procedure, held in March 2018.
- Biggeri L. and Laureti T. (2018), Publications, experiments and projects on the computation of spatial price level differences, in Italy, paper presented at the 3rd meeting of ICP Task Force on the Country Operational Guidelines and Procedure, September 2018.
- Blades, Derek (2013), “Health and Education”, Chapter 11 in *Measuring the Real Size of the World Economy*, World Bank, Washington D.C.
- Capilit E. and Dikhanov Y. (2017), Subnational Purchasing Power Parities in Asia: Prospects and Feasibilities, *Proceedings of the 60th World Statistics Congress of the International Statistical Institute*, 2017.
- Daskiran M. (2011), Regional PPPs for Consumer Goods and Services: Turkey Experience, paper presented at PPP Workshop in Paris, 23-24 May 2011
- Chen, Shaohua and Martin Ravallion (2010), “The Developing World is Poorer than We Thought, But No Less Successful in the Fight Against Poverty”, *Quarterly Journal of Economics*, Volume 125, Issue 4, November 2010, Pages 1577–1625.

Deaton, Angus and Olivier Dupriez (2011), "Purchasing Power Parity Exchange Rates for the Global Poor", *American Economic Journal (Applied Economics)*, Vol. 3, No.2, pp. 137-66.

Diewert, W.E. (2010), "New Methodological Developments for the International Comparison Program", International Association for Research in Income and Wealth.

Diewert, W.E. (2013), "Methods of Aggregation above the Basic Heading Level within Regions", Chapter 5 in *Measuring the Real Size of the World Economy*, World Bank, Washington D.C.

Dijkstra, Lewis, Ellen Hamilton, Somik Lall and Sameh Wahba (2020), "How do we define cities, towns, and rural areas?" Blog on World Bank website, 10th March, 2020.

Dikhanov Y., Palanyandy C., and Capilit E. (2011) subnational purchasing power parities toward integration of international comparison program and the consumer price index: The case of Philippines. ADB Economics Working Paper Series, No. 290, Asian Development Bank.

Eurostat (2017), Spatial adjustment factors in PPP surveys, Paper presented at the Meeting of the PPP working Group held in Luxembourg on 14-15 November 2017, (<https://circabc.europa.eu/w/browse/eaf0fc12-3e9a-43d7-b1ba-b5821fa7a72b>)

Eurostat (2012), Eurostat-OECD Methodological Manual on Purchasing Power Parities, European Union/OECD, Luxembourg and Paris.

Eurostat (2017), Spatial adjustment factors in PPP surveys, Paper presented at the Meeting of the PPP working Group held in Luxembourg on 14-15 November 2017, (<https://circabc.europa.eu/w/browse/eaf0fc12-3e9a-43d7-b1ba-b5821fa7a72b>).

Francisco H. G. Ferreira & Shaohua Chen & Andrew Dabalen & Yuri Dikhanov & Nada Hamadeh & Dean Jolliffe & Ambar Narayan & Espen Beer Prydz & Ana Revenga & Prem Sangraula & Umar Serajuddin & Nobuo Yosh, (2016). "A global count of the extreme poor in 2012: data issues, methodology and initial results," *The Journal of Economic Inequality*, Springer; Society for the Study of Economic Inequality, vol. 14(2), pages 141-172, June.

Government of Western Australia (2017), Western Australia Regional Price Index, Department of Primary Industries and Regional Development, data.wa.gov.au

GSO, General Statistical Office of VietNam (2019), Subnational PPPs in Vietnam, paper presented at the 4th meeting of ICP Task Force on the Country Operational Guidelines and Procedure, May 2019

Insee (2016), Price difference in France, <https://www.insee.fr/en/statistiques/Fihier>

Insee (2019), Enquete de comparaison spatiale des niveaux de prix à la consommation entre territoires français, [www.insee](http://www.insee.fr)

Jansky, P. and Kolcunova, D. (2017), Regional differences in price levels across the European Union and their implications for its regional policy: The Annals of Regional Science, Springer; Western Regional Science Association, vol. 58(3), pages 641-660, May.

International Comparison Program (2021), A Guide to the Integration of Consumer Price Index (CPI) and International Comparison Program (ICP) Production Activities, World Bank, Washington D.C. <https://thedocs.worldbank.org/en/doc/2b29c1445d7fa006e5f4ca00087dbe36-0050022021/original/Guide-CPI-and-ICP.pdf>

Kocourek A., Simanova J. and Smida J. (2016), Estimation of Regional Price Levels in the Districts of the Czech Republic, *Statistika: Statistics and Economy Journal*, 96(4), pp.56-70

Laureti T. and Polidoro F. (2017), Testing the use of scanner data for computing subnational Purchasing Power Parities in Italy, *Proceedings of 61st ISI World Statistics Congress*, Marrakesh.

Laureti T. and Rao D.S.P. (2018), Measuring Spatial Price Level Differences within a Country: Current Status and Future Developments, *Estudos de Economia Aplicada*, vol. 36-1, 119-14.

McCarthy P. (2010), Asia and Pacific Region: subnational Purchasing Power Parities. Case study for the Philippines, 2011 ICP Round, 2nd Technical Advisory Group, Document 10.02.

Menggen C., W. Yan and D.S.P Rao (2018), Measuring the Spatial Price Differences in China with RPPs Method, ppt of the paper presented at the Conference on International Comparisons – Fifty Years of International Comparison Program: Achievements and Moving Forward, Beijing , Normal University, 29-30 October.

ONS (2011), UK 2010 Spatial Adjustment Factors for use in the PPP Calculation, Final Report to Eurostat, authors Johnston S., Bailey S. and Merrington L., Office for National Statistics, London.

ONS (2018), Relative regional consumer price levels of goods and services, UK:2016, 1 March 2018.

Rokicki, B. and Hewings, G. J. D. (2019), Regional Price Deflators in Poland: Evidence from NUTS-2 and NUTS-3 Regions, *Spatial Economic Analysis*, 14 (1), 88-105.

Rao, D.S. Prasada, (2013a), “The Framework of the International Comparison Program”, Chapter 1 in *Measuring the Real Size of the World Economy*, World Bank, Washington D.C.

Rao, D.S. Prasada, (2013b), “Computation of Basic Heading PPPs for Comparisons within and between Regions”, Chapter 4 in *Measuring the Real Size of the World Economy*, World Bank, Washington D.C.

Roberts, D. (2013), “Validation of ICP Regional Prices and Basic Heading PPPs”, Chapter 9 in *Measuring the Real Size of the World Economy*, World Bank, Washington D.C.

Skaini M. (2016), Synergies between CPIs and PPPs and Integration of Survey Activities, Paper presented at the ILO/UNECE meeting of CPI experts, Geneva, 2-4 May 2016.

Skaini M. and Samara A. (2017), Synergies between CPIs and PPPs and Integration of Survey Activity. UNSVWA, paper presented at the meeting of ICP Task Force on the Country Operational Guidelines and Procedure, held in October 2017.

Summers, R. (1973). “International Price Comparisons Using Incomplete Data.” *Review of Income and Wealth* (19): 1–6.

TurkStat (2009), Regional Purchasing Power Parity, Regional Price Level Indices, 2008, Press Release, April 2, 2009.

TurkStat (2013), Regional Purchasing Power Parity, 2012, Press Release, 26 June 2013.

TurkStat (2018), Regional Purchasing Power Parity, 2017, Press Release, 19 March 2018.

United Nations (2015), *Transforming our world: the 2030 agenda for Sustainable Development*, Resolution 70/1 adopted at the 70th Session of the General Assembly, United Nations, New York.

Vogel, Fred (2013), "Validation of Basic Heading and Aggregated PPPs: When Does Validation End and Estimation Begin?" Chapter 10 in *Measuring the Real Size of the World Economy*, World Bank, Washington DC.

Waschka A. M., W. Khoo, J. Quirey T. and Zhao S. (2003) Comparing Living Costs in Australian Capital Cities. A Progress Report on Developing Experimental Spatial Price Indexes for Australia, Australian Bureau of Statistics.

Weinand S. and Von Auer L. (2019), Anatomy of regional price differentials: Evidence from micro price data, Discussion Paper No 04/2019, Deutsche Bundesbank.

World Bank (2013), "Measuring the Real Size of the World Economy: The Framework, Methodology, and Results of the International Comparison Program (ICP)", World Bank, Washington, DC.

World Bank (2015), "Operational Guidelines and Procedures for Measuring the Real Size of the World Economy: 2011 International Comparison Program", World Bank, Washington, DC.

World Bank (2020), "Purchasing Power Parities and the Size of World Economies: Results from the 2017 International Comparison Program", World Bank, Washington, DC

13 Appendices: Country Case Studies

A.	United States	48
A.1	Introduction and Scope	48
A.2	Methodology and Source Data	48
A.3	Empirical Results	51
A.4	Summary	51
A.5	References	52
B.	United Kingdom	59
B.1	Data collection	59
B.2	Validation and Data cleaning	77
B.3	Synergies between CPI and PPPs	81
B.4	Calculation of spatial adjustment factors and relative regional comparative price levels	84
B.5	Importance and uses of SAFs and regional price levels	88
C.	Italy	93
C.1	Introduction and Scope	93
C.2	Methodological approaches and results	95
D.	Vietnam	114
D.1	Introduction	114
D.2	Scope and uses of subnational PPPs	114
D.3	Methodology used	115
D.4	Price and weights data	118
D.5	Empirical Results	120
D.6	Conclusions	123

A. United States

A.1 Introduction and Scope

The subnational PPPs in the United States are called Regional Price Parities (RPPs) and are estimated by the Regional Prices Branch of the Bureau of Economic Analysis (BEA). Annual results are published in the Survey of Current Business.¹⁴ Experimental estimates began in 2003 (Aten 2005, 2006). The current methodology is available at https://www.bea.gov/system/files/methodologies/RPP2020-methodology_1.pdf.

The RPPs are published annually at the state level (50 states plus the District of Columbia) and at the Metropolitan Statistical Area level (384 MSAs), as well as for the metropolitan and non-metropolitan portions of states. They reflect household consumption only. The RPPs are estimated independently of the national price averages provided by the Bureau of Labor Statistics for Eurostat-OECD PPP computations and are thus not currently part of the ICP.

A.2 Methodology and Source Data

The RPP methodology is based on those developed in Kravis, Heston & Summers (1982) for the Penn World Table (PWT) and from the ICP. It includes the CPD approach below the basic heading, and Geary multilateral aggregations above the basic heading.²

A.2.1 Major data sources

The source data are the Consumer Price Index (CPI) microdata collected by the Bureau of Labor Statistics (BLS) which are *not* publicly available, and housing data from the Census that *are* publicly available to users.¹⁵ In addition, bi-annual expenditure data from the Consumer Expenditure survey are converted to annual cost weights by the CPI branch and are the relative weights used in aggregating prices at the item-strata level. These item-strata correspond roughly to basic headings in the ICP.

The CPI microdata consist of approximately one million product quotes per year, for about 200 basic headings. Tenant rents, imputed owner-occupied rents and total expenditures on rents are estimated from the Census Bureau's housing survey, called the American Community Survey (ACS). The ACS microdata has over 2 million housing observations annually, weighted to represent about 44 million tenant-occupied and 76 million owner-occupied homes in the U.S. Lastly, the current dollar expenditure

¹⁴ Last year's results, for reference year 2019, can be found at: <https://www.bea.gov/data/prices-inflation/regional-price-parities-state-and-metro-area>. Work has been done comparing Geary results to other multilateral spatial indexes (Aten & Reinsdorf, 2010).

¹⁵ The CPI microdata are available to us through an interagency agreement, between the Bureau of Labor Statistics (BLS) and BEA. The housing are annual surveys called PUMS (Public Use Microdata Sample) downloadable from the Census Bureau website

weights above the basic heading level are the Personal Consumption Expenditure (PCE) series published by BEA.

A.2.2 Survey Framework

The CPI uses a probability sampling framework to price products that covers all urban areas in the U.S., representing about 93% of the population.¹⁶ The subnational geographies are 23 metropolitan areas and nine Census divisions. Indexes are available for major groups of consumer expenditures (food and beverages, housing, apparel, transportation, medical care, recreation, education and communications, and other goods and services), for items within each group, and for special categories, such as services (<https://www.bls.gov/cpi/overview.htm>).

The publicly available ACS housing data is a 1% sample weighted to represent all housing units in the U.S. with a state level and a sub-state level identifier called a PUMA (Public Use Microdata Areas), comprised of about 2870 areas with a population greater than 100,000.

A.2.3 Estimating relative price levels using CPI data

The products priced below the basic heading level in the CPI are not identical, although they have sample weights associated with each observation. This is one of the main issues in using the U.S. CPI: the survey is not designed for place-to-place surveys and requires additional work to obtain matching product specifications. To make the products as comparable as possible, we estimate a hedonic regression, below the basic heading, that is an extension of a CPD regression: the log of the price is regressed against the geographic areas and with class variables that include the product's characteristics, such as type, size, packaging and brand.¹⁷

The estimation of detailed hedonic regressions is feasible because the price quotes are collected in a way that allows the product's specification to be easily transformed into class variables. For example, observations on Milk may have two checklist variables: A for type and B for size, where A1 is Whole Milk, A2 is Skim Milk, B1 is a quart container, B2 is a gallon container. Thus, even if the same exact product is not priced in all areas, it is possible to estimate the relative price of milk holding constant the type and container size.¹⁸ The disadvantage is that hedonic regressions can be time-consuming and labor intensive, requiring analyst judgment to determine which variables should be part of the regression. One way to maintain consistency is to create decision protocols that favor simplicity, and to document each regression

¹⁶ See also <https://www.bls.gov/cpi/questions-and-answers.htm>,

¹⁷ We estimate detailed hedonic regressions for about 80 individual item-strata (basic headings), those corresponding to roughly 85% of expenditure weights. In practice, the regressions are at a more detailed level, called the Entry Level Item Cluster or ELIC level. For the remaining strata, we run simple weighted CPDs at either the Item Strata or the ELIC level.

¹⁸ Of course, there must be some overlap of characteristics across the areas, or the regressions will not be estimable.

specification so that prior years can be referenced. We also run a comprehensive outlier checking procedure based on the EU's Quaranta tables. Details of these stages of estimation, including the Quaranta analysis, are described in Aten, Figueroa and Martin (2011).¹⁹

The areas in the CPI are not directly comparable to those in the Census ACS, nor to administrative areas used by the BEA. This means that the CPI price levels must first be allocated to a smaller geographic unit, such as a county, then re-aggregated to states and metropolitan areas. We assume that all counties within a sampled area-size CPI combination have the same price level, a process described in detail in Figueroa, Aten and Martin (2014). Expenditure weights based on BEA's Personal Consumption Expenditure series are also allocated to counties from published state level estimates.

A.2.4 Estimating Housing price levels and expenditures using the ACS

Current-dollar rental values for tenant units and imputed owner units will follow the new housing methodology described in Rassier, Aten & Figueroa (2021) beginning with publication of the 2020 RPPs in December 2021. Tenant rents are sums of actual observations while imputed rental values for owner units include two components: a rental equivalence and an owner premium component.²⁰

The background paper for the owner premium is described in Aten & Heston (2020). The premium is the ratio of the owners' reported values of their homes to the median of homes with similar characteristics, as long as the ratio is one or higher. In other words, it is the maxima of the rental equivalence and the premium. Because the ACS consists of actual housing unit observations, both relative price levels and expenditures can be estimated simultaneously.

¹⁹ The process is modeled after the Quaranta method used by the Organisation for Economic Co-operations and Development and Eurostat (OECD 2012), and the International Comparison Program of the World Bank (World Bank 2015).

²⁰ Rental equivalence is calculated from stratified averages of reported tenant rents applied to owner-occupied units following Aten (2017). For each year and PUMA (Public Use Microdata Area), stratified rental equivalence for owner units is imputed by regressing tenant rents, from which utilities have been excluded, on characteristics of tenant units reported in the ACS. A PUMA is a Census Bureau statistical geographic area defined for the dissemination of Public Use Microdata Sample (PUMS) data, including the ACS. PUMAs are built on census tracts and counties, contain at least 100,000 people, cover the entirety of the United States, and do not span more than one state. The characteristics include structure type, number of rooms, number of bedrooms, and age of structure. ACS data on the same characteristics of owner units are then applied to the parameter estimates from the tenant regressions to calculate the imputed owner rental value. These imputations are done at the unit level.

A.2.5 Final aggregation

Once the CPI-derived price levels for consumption goods and services at the basic heading level have been allocated to counties, a five-year rolling average is obtained using a weighted Country-Product-Dummy (CPD-W) procedure, yielding relative prices for states and metropolitan areas for fifteen major expenditure groups of the CPI (Food and Beverages, Apparel, Transportation, for example). These groups are then aggregated with the annual housing price levels and expenditures from the PCE to a single overall RPP using the Geary method.

A.3 Empirical Results

Table 1 shows subnational RPPs for 3 major private consumption expenditure groups: rents, goods and services, and the overall RPP for each state in 2019. One main result is the much wider range for rents (from 0.600 in Mississippi to 1.536 in California) than for goods, and to a slightly lesser extent, to services. These are also published for 384 Metropolitan Areas and for the metropolitan and nonmetropolitan portions of states.²¹ All tables are indexed so that the U.S. overall RPP is equal to one.

Table 2 shows the overall RPPs for state metro and nonmetropolitan portions for 2019. Subnational data on RPPs are available from 2008 to 2019.²² The range is larger for the metropolitan portions in 2019 (from 0.864 in Arkansas to 1.221 in Hawaii) than for nonmetropolitan areas (0.774 Arizona to 1.091 in Massachusetts). As expected, the RPPs for the metropolitan portions of states is much higher than for the nonmetropolitan portions (1.01 versus 0.86 respectively). This is driven primarily by rent price level differences.

A.4 Summary

The U.S. CPI microdata lends itself to subnational comparisons because of the way prices are collected and recorded, through a set of checklists that describe the product characteristics. This facilitates the use of hedonic regressions to control for differences in the outlet, type, packaging, size and other product characteristics. It is not an ideal method as some products and characteristics are thinly dispersed across areas. Ideally one would have dedicated surveys with products specified more narrowly, together with corresponding surveys on the relative expenditures on these products. However, attempts at securing funding for such surveys have not succeeded in the past. We hope that in the future, other data sources or external surveys will augment and improve our current RPPs.²³

²¹ The full tables are available on the web at www.bea.gov.

²² The 2020 RPPs will be released on December 14th, 2021.

²³ Research is underway using J.D. Power marketing data on new automobile and truck prices, for example, and BEA is also searching for a new comprehensive medical prices survey. A revision of the medical services group in the CPI unfortunately resulted in price quotes that no longer lend themselves to robust hedonic specifications.

The second major data source in the RPPs is the annual housing survey of the Census Bureau (ACS). This is a nationwide survey that has a wealth of information on rents and housing characteristics, and its sample size and coverage is comprehensive and well-suited to subnational comparisons. This has enabled BEA to update its current dollar tenant- and owner-occupied housing output estimates at the national and regional levels, as well as to improve its subnational RPPs for rents.

A.5 References

Aten, Bettina (2005), 'Report on Interarea Price Levels, 2003', working paper 2005–11, *Bureau of Economic Analysis*, May.

Aten, Bettina (2006), 'Interarea Price Levels: an experimental methodology', *Monthly Labor Review*, Vol. 129, No.9, Bureau of Labor Statistics, Washington, DC, September.

Aten, Bettina (2008), 'Estimates of State and Metropolitan Price Parities for Consumption Goods and services in the United States, 2005', *Bureau of Economic Analysis*, October.

Aten, Bettina and Marshall Reinsdorf (2010), 'Comparing the Consistency of Price Parities for Regions of the U.S. in an Economic Approach Framework.' 31st General Conference of the International Association for Research in Income and Wealth, August.

Aten, Bettina, Eric Figueroa and Troy Martin (2011), 'Notes on Estimating the Multi-Year Regional Price Parities by 16 Expenditure Categories: 2005-2009', *Bureau of Economic Analysis*, April.

Figueroa, Eric, Bettina Aten and Troy Martin (2014), 'Expenditure Weights in the Regional Price Parities', *Bureau of Economic Analysis*, August.

Aten, Bettina H. (2017), 'Regional Price Parities and Real Regional Income for the United States', *Social Indicators Research*, March 2017, Volume 131, Issue 1, pp 123-143.

Aten, Bettina H. (2018), "Valuing Owner-Occupied Housing: an empirical exercise using the American Community Survey (ACS) Housing files", Bureau of Economic Analysis, May.

Aten, Bettina H. and Alan Heston (2020), "The Owner-Premium Adjustment in Housing Imputations", Bureau of Economic Analysis, June.

Aten, Bettina H., Dylan Rassier and Eric Figueroa (2021). "Improved Measures of Housing Services for the U.S. Accounts", Bureau of Economic Analysis, forthcoming.

BLS Handbook of Methods (2011), *Bureau of Labor Statistics*.

<http://www.bls.gov/opub/hom/homtoc.htm>

Kravis, Irving B., Alan Heston and Robert Summers 1982), *"World Product and Income, International comparisons of real gross product"*, John Hopkins University Press.

Table 1. State RPPs for 2019 for Rents, Goods, Services and Overall

	State	Rent	Goods	Services	Overall
	United States	1.014	0.992	1.000	1.000
1	Alabama	0.619	0.959	0.903	0.858
2	Alaska	1.223	1.023	0.991	1.051
3	Arizona	0.941	0.948	0.997	0.963
4	Arkansas	0.609	0.947	0.910	0.847
5	California	1.536	1.049	1.083	1.164
6	Colorado	1.247	0.971	0.960	1.019
7	Connecticut	1.076	1.024	1.062	1.050
8	Delaware	0.950	0.983	1.036	0.994
9	District of Columbia	1.464	1.052	1.065	1.152
10	Florida	1.094	0.978	0.990	1.010
11	Georgia	0.826	0.968	0.967	0.932
12	Hawaii	1.526	1.118	1.050	1.193
13	Idaho	0.806	0.962	0.958	0.922
14	Illinois	0.947	0.990	0.974	0.974
15	Indiana	0.728	0.961	0.918	0.887
16	Iowa	0.730	0.949	0.916	0.890
17	Kansas	0.727	0.951	0.931	0.892
18	Kentucky	0.677	0.948	0.906	0.874
19	Louisiana	0.721	0.958	0.910	0.879
20	Maine	0.917	0.994	1.036	0.993
21	Maryland	1.193	1.024	1.048	1.077
22	Massachusetts	1.243	1.029	1.092	1.104
23	Michigan	0.802	0.969	0.947	0.923
24	Minnesota	0.961	1.017	0.953	0.980

25	Mississippi	0.600	0.944	0.903	0.844
26	Missouri	0.724	0.955	0.917	0.887
	State	Rent	Goods	Services	Overall
	United States	1.014	0.992	1.000	1.000
27	Montana	0.853	0.970	0.944	0.935
28	Nebraska	0.756	0.949	0.916	0.895
29	Nevada	1.018	0.939	0.985	0.974
30	New Hampshire	1.139	1.014	1.071	1.065
31	New Jersey	1.307	1.036	1.176	1.160
32	New Mexico	0.781	0.948	0.974	0.911
33	New York	1.300	1.082	1.152	1.163
34	North Carolina	0.788	0.958	0.949	0.917
35	North Dakota	0.752	0.949	0.916	0.893
36	Ohio	0.717	0.958	0.915	0.884
37	Oklahoma	0.686	0.952	0.911	0.872
38	Oregon	1.097	1.018	0.982	1.022
39	Pennsylvania	0.868	0.997	1.003	0.970
40	Rhode Island	1.012	0.994	1.035	1.013
41	South Carolina	0.782	0.960	0.949	0.915
42	South Dakota	0.690	0.948	0.915	0.878
43	Tennessee	0.768	0.959	0.903	0.897
44	Texas	0.949	0.967	0.974	0.965
45	Utah	0.982	0.945	0.978	0.965
46	Vermont	1.098	0.993	1.034	1.031
47	Virginia	1.074	0.989	1.001	1.013
48	Washington	1.229	1.058	1.030	1.084
49	West Virginia	0.609	0.946	0.960	0.871

50	Wisconsin	0.837	0.962	0.923	0.919
51	Wyoming	0.824	0.967	0.948	0.928
	maximum	1.536	1.118	1.176	1.193
	minimum	0.600	0.939	0.903	0.844

Source: Regional Prices Branch, Bureau of Economic Analysis

Table 2. Metro and Nonmetropolitan portions of States 2019

Metropolitan		2019	Nonmetropolitan		2019
	United States	1.019		United States	0.869
1	Alabama	0.869	1	Alabama	0.803
2	Alaska	1.056	2	Alaska	1.030
3	Arizona	0.972	3	Arizona	0.774
4	Arkansas	0.864	4	Arkansas	0.801
5	California	1.169	5	California	1.004
6	Colorado	1.027	6	Colorado	0.960
7	Connecticut	1.053	7	Connecticut	1.040
8	Delaware	0.995	-	-	-
9	District of Columbia	1.157	-	-	-
10	Florida	1.015	8	Florida	0.913
11	Georgia	0.952	9	Georgia	0.835
12	Hawaii	1.221	10	Hawaii	1.056
13	Idaho	0.931	11	Idaho	0.886
14	Illinois	0.991	12	Illinois	0.832
15	Indiana	0.897	13	Indiana	0.837
16	Iowa	0.904	14	Iowa	0.864
17	Kansas	0.909	15	Kansas	0.851
18	Kentucky	0.895	16	Kentucky	0.827
19	Louisiana	0.893	17	Louisiana	0.797
20	Maine	1.010	18	Maine	0.955
21	Maryland	1.087	19	Maryland	0.885
22	Massachusetts	1.107	20	Massachusetts	1.091
23	Michigan	0.932	21	Michigan	0.862

24	Minnesota	1.004	22	Minnesota	0.884
25	Mississippi	0.877	23	Mississippi	0.800
Metropolitan		2019	Nonmetropolitan		2019
	United States	1.019		United States	0.869
26	Missouri	0.899	24	Missouri	0.831
27	Montana	0.948	25	Montana	0.919
28	Nebraska	0.912	26	Nebraska	0.860
29	Nevada	0.979	27	Nevada	0.934
30	New Hampshire	1.087	28	New Hampshire	1.022
31	New Jersey	1.164	-	-	-
32	New Mexico	0.924	29	New Mexico	0.876
33	New York	1.184	30	New York	0.926
34	North Carolina	0.927	31	North Carolina	0.849
35	North Dakota	0.897	32	North Dakota	0.883
36	Ohio	0.891	33	Ohio	0.844
37	Oklahoma	0.888	34	Oklahoma	0.828
38	Oregon	1.032	35	Oregon	0.954
39	Pennsylvania	0.979	36	Pennsylvania	0.900
40	Rhode Island	1.015	-	-	-
41	South Carolina	0.925	37	South Carolina	0.828
42	South Dakota	0.899	38	South Dakota	0.852
43	Tennessee	0.908	39	Tennessee	0.833
44	Texas	0.978	40	Texas	0.857
45	Utah	0.972	41	Utah	0.901
46	Vermont	1.060	42	Vermont	1.004
47	Virginia	1.036	43	Virginia	0.856

48	Washington	1.096		44	Washington	0.970
49	West Virginia	0.877		45	West Virginia	0.847
50	Wisconsin	0.930		46	Wisconsin	0.870
51	Wyoming	0.916		47	Wyoming	0.928
	maximum	1.221			maximum	1.091
	minimum	0.864			minimum	0.774

Source: Regional Prices Branch, Bureau of Economic Analysis

B. United Kingdom

The main aim of the note is to provide practical guidance for countries wishing to undertake data collection for the calculation of regional purchasing power parities (PPPs) and spatial adjustment factors (SAFs). It aims to cover all levels of experience and/or knowledge from very limited experience (or indeed none) to countries that have some level of understanding on how to undertake an effective and efficient successful data collection process. The main aim is to concentrate primarily on data collection for regional PPPs and SAFS although it will touch lightly on data collection for the Consumer Price Index (CPIs) as there are close synergies between PPPs and CPIs.

Although the note will primarily concentrate on the data collection process it will also present practical guidance on how to clean the data file and discuss the stages of the validation process and how to undertake them. The paper will also briefly present synergies between the CPI and PPPs and integration of the two although this will be covered in more detail in the integration of CPI-ICP component of the Task force.

The final section will look at future developments, specifically in the UK, that will be undertaken as part of a wider initiative within the Office of National Statistics (ONS) to introduce new ways of capturing data via, for example, web scraping and scanner data, and explore how these new data sources could be used to strengthen price data used in SAFs and PPPs in general.

B.1 Data collection

This section will aim to discuss the theory, sources and methods and practicalities of the actual data collection for calculating average prices for use in SAFS and Regional indices. The aim of this section is to provide practical guidance for regions/countries who want to conduct successful data collection for use in PPPs generally, specifically SAFs and regional price levels. Areas covered will include:

- Sampling of items (covering how many items to include in the sub-sample, which items to include in sub-sample, treatment of representative and non-representative items, and use of proxy items in the absence of not being able to collect certain items).
- Sampling of locations/regions (covering method used to sample locations and how many locations to sample to ensure adequate coverage, to ensure each country that makes up the UK was represented accordingly).
- Pre-enumeration prior to the survey (practical guidance of how to conduct pre-enumeration and its importance in the whole process, including item descriptions).
- Method of data collection (to cover areas such as paper collection, handheld devices (as used by UK), use of IT to collect data such as web scraping and scanner data).

One serious consideration for any SAF project is to ask the question ‘do we need to conduct a full SAF project data collection for all elements of consumer spend, with the nationalization and globalization of the market with many key retailers and service providers dominating the market. Additionally, the way in which consumers purchase goods and services is changing and therefore the approach to the price collection should reflect this changing market.

B.1.1 Sampling of items

There is very little guidance provided by Eurostat on the calculation of spatial adjustment factors including the processes from sample design of items and retailers and service providers through to validation and the actual calculation of SAFs. Therefore, to some extent, at least as far as the data collection is concerned, a similar format was followed as for the regular PPP consumer surveys.

B.1.1.1 Sampling of items – how many to sample

The UK took responsibility for sampling of the items for the SAF basket of goods and services. The starting point was the regular PPP survey item lists with consideration being given to representative items, non-representative items, and the use of Proxy items (these are covered in more detail below). It was not feasible or practical from a financial and/or resource perspective to collect the complete PPP item list. Therefore, the process used was to create a sub-sample of the total items that were both representative and non-representative (and indeed proxy items).

Design of the sub-sample of the total PPP item list required two questions to be asked. Firstly, how MANY items to be sampled and secondly WHICH items to sample.

The UK made the decision to create a sub-sample of items; two important factors were WHICH items and how MANY items to include in the basket. From a practical level, there was a debate on this as some members of the Project Board (which was the main decision-making body of the SAF project) had mixed opinions. A decision was made to design and replicate the sampling methodology used by Eurostat-OECD for the European Comparison Programme (ECP). The number of items or products priced for each basic heading was very much dependent on the heterogeneity of items covered by the item and the importance of the basic heading. For each basic heading, the number of representative items selected was commensurate (proportionate) with the price variation within the basic heading and its expenditure at the basic heading level. This information was taken from the latest UK National Accounts data; where the expenditure is greater this is where resources should be invested. Additionally, if historically we knew that there were basic headings with a lot of variation in the dataset, resources were also directed here. In order to establish this, we looked at the variation coefficient of the CPI data and also knowledge and

metadata from the PPP regular surveys and price collectors to identify those items with high levels of variance.

Example – Table 1 Shares of household expenditure

GDP expenditure weights [millions of national currencies]				
Code	Description	YEAR		
		2014	2015	2016
GDP	Gross Domestic Product	1837062	1888737	1961125
A	Individual consumption expenditure by households	1143919	1181868	1233323
A.03	Clothing and footwear	61815	65064	67697
A.03.1	Clothing	52653	54842	56334
A.03.1.1	Clothing materials	728	721	676
A.03.1.1.0	Clothing materials	728	721	676
A.03.1.2	Garments	47305	49739	51078
A.03.1.2.1	Garments for men	13245	13927	14302
A.03.1.2.2	Garments for women	24599	25864	26560
A.03.1.2.3	Garments for infants (0 to 2 years) and children (3 to 13 years)	9461	9948	10216
A.03.1.3	Other articles of clothing and clothing accessories	3610	3510	3687
A.03.1.3.0	Other articles of clothing and clothing accessories	3610	3510	3687
A.03.1.4	Cleaning, repair and hire of clothing	1010	872	893
A.03.1.4.0	Cleaning, repair and hire of clothing	1010	872	893
A.03.2	Footwear	9162	10222	11363
A.03.2.1	Shoes and other footwear	9107	10168	11311
A.03.2.1.1	Footwear for men	3252	3631	4039
A.03.2.1.2	Footwear for women	4283	4781	5319
A.03.2.1.3	Footwear for infants and children	1572	1756	1953

A.03.2.2	Repair and hire of footwear	55	54	52
A.03.2.2.0	Repair and hire of footwear	55	54	52

As you can see the share of individual household consumption of GDP is approximately 63%. Of the household consumption, the division of Clothing and Footwear of £67,697m accounts for approximately 5.5% - the biggest share of which is attributed by the aggregate of Garments for Women which accounts for nearly 50% of the total Clothing aggregate. With this in mind, more resource was dedicated to Clothing and specifically Clothing for Women. This is a difficult aggregate as not only is the division an important one in terms of expenditure but also notoriously difficult due to high variation and therefore it required more prices to be collected.

Individual household expenditure and high levels of variation in prices are key factors in determining how many prices to collect for each item. **ONE** in **FOUR** (25%) of items from the total PPP list was sampled.

Returning to the subject of the actual number of items to collect, the UK decided, based on resources, to select a fixed proportion of items from the PPP item list, selecting, in the main, the same proportion of items from each basic heading. However, there were some exceptions. The sub-sample contained a minimum of **ONE** in **FOUR** or 25% of the items under each basic heading in the PPP items list. However, there were some exceptions and CPI data were used extensively, particularly for food items where the specification for both PPPs and CPI were very comparable and therefore more than 25% of PPPs items were sampled. This ensured a more robust dataset particularly for the COICOP division of Food, Beverages and Tobacco.

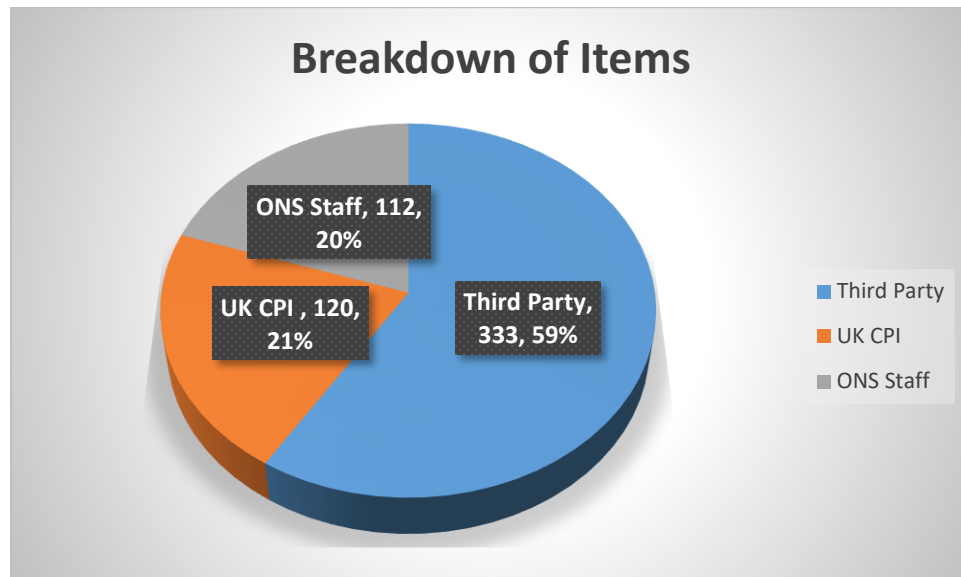
Breakdown of items

The sub-sample for the SAF calculations consisted of **565 PPP items** across 167 basic headings.

A total of 565 PPP items were included in the sub-sample covering the following COICOP aggregates:

- i. House and Garden
- ii. Personal Appearance
- iii. Services
- iv. Transport, Recreation, Hotels and Restaurants
- v. Food, Beverages and Tobacco
- vi. Health and Furniture
- Overall, the UK sampled 333 items out of a total sub-sample of 565 for the third-party sub-contractor, TNS UK Ltd, to collect in the shops or outlets covering all aspects of consumer spend.

- Of the 565 PPP items, data from the UK national Consumer Price Index (CPI) were used for 120 items.
- The ONS (primarily Prices division where the UK PPP team and UK National CPI team was situated) collected prices for the remaining 112 items. These were either collected using the internet and telephone, or collectors went out to locations locally to collect for those items that the third-party subcontractors had difficulty pricing.



Once we decided on how MANY items to include the next key question was WHAT items to include.

B.1.1.2 Sampling of items – which items to include in sub-sample

Once the number of items has been established the next challenge was to establish which items to include in the sub-sample of 565.

Items were selected purposively from the PPP item list. Firstly, items were selected if they had a direct specification match with the CPI item with the intention that CPI items could be used instead of having to collect prices for that particular item. Initially the intention was to produce some coding that would allow for matching of the specifications, but this proved to be a challenge. Unfortunately, the final matching undertaken was done manually as this was the only method where it could be certain that it was an absolute match. For future SAF projects it is hoped that coding that the UK PPP team are developing in Python will be used for matching purposes, therefore saving resources at this stage of the process.

If more items were needed to make up the required sample size, items were initially randomly selected so that there was sufficient coverage of items across all the basic headings.

B.1.1.3 Treatment of representative and non-representative items

When considering the sample, it was important to consider both representative and non-representative items.

What are representative items?

Representative items are those which are important in terms of relative total expenditure within a basic heading or, in other terms, among the most important items purchased in the national market. However, for many countries, including the UK, it is sometimes difficult to ascertain which ones are important (or not) as there is no national accounts expenditure below the basic heading. Therefore, the UK relied on several criteria to determine if an item was representative or not. They include the following non-exhaustive criteria:

- a. The amount of shelf space that an item occupied. The larger the amount of shelf space relative to similar products, it could be assumed the more important the item was.
- b. The experience of the price collectors who had practical experience of working with the CPI and were very knowledgeable of both the regional and the national market.
- c. The use of the UK national CPI. Items that were in the CPI sample are deemed as being representative of the UK market and therefore could be marked as such for the SAFs.
- d. Reports from research companies such as Mintel, research papers, and publications such as The Grocer (a monthly publication detailing trends and items in the UK retail and service market).

What are non-representative items?

In contrast, non-representative items are those items that are not considered important in terms of total expenditure within a basic heading and are not among the more important items purchased in the market.

For the 2016 SAF project, the UK took a different approach to the treatment of non-representative items in the sample design. For previous rounds (2004 and 2010) the UK priced a higher proportion of non-representative items. For 2016 the proportion was reduced.

For SAF projects or rounds previous to 2016, namely 2004 and 2010, both representative and non-representative items were sampled. The reasoning behind this approach at the time was that the UK was adhering to Eurostat guidelines as per the regular PPP surveys, where it was instructed that both representative and non-representative items were sampled and priced to ensure that there were adequate prices to allow for comparison between countries. However, this approach caused major challenges in 2010 for the UK price collectors out in the shops in the regions as time was spent looking for items that were not freely available the UK across all the regions. This was a key lesson learnt for future SAF projects. Consequently, a decision was made ahead of the 2016 SAF project to ensure that the non-representative items were freely available on the UK market to ensure efficient use of resources. There was concern by the UK that the latest edition of the Eurostat/OECD Methodological Manual on Purchasing Power Parities states that “representative items usually have a lower price level than unrepresentative items.” That said, however, since the SAFS will only be used to adjust the PPP prices collected in the capital city of London, this would not be a major issue. However it was also felt that it was important to include

some non-representative items in the sub-sample to avoid biasing the SAFs and to remain compliant with Eurostat-OECD PPP methodology.

For the 2010 SAF project the number of non-representative items in the sub-sample was approximately equivalent to the proportion of non-representative items under each basic heading of the PPP item list. However, for the 2016 SAF project, this approach was changed to include a lower proportion of non-representative items to ensure adequate resource was available.

Use of proxy items in the item sample

The use of PROXY ITEMS was a significant development in the calculation of Spatial Adjustment Factors for the UK during the 2016 round. Previous SAF calculations for the UK did not include the use of PROXY ITEMS. This allowed for optimum use of resources both financially and in terms of time.

During the SAF process, the UK experienced issues with the fact that for there were some basic headings, where the UK either had difficulty pricing, particularly in the case of items which had a service element or we did not have the necessary resources. Alternatively, the proxy items could be one that was representative and widely available in the UK but was not collected as part of the regular PPP surveys, i.e. not on the PPP item list. This was discussed with Eurostat at the time of the UK SAF project and was confirmed as a viable approach in ensuring comparability across regions/locations with the aim of calculating SAFs across the regions of the UK. In these instances, a decision was made to use other similar items in the same basic heading where we could make use of CPI data. This was important as it limited the resources required and ensured that maximum use was made of the hundreds of thousands of prices that had been collected for the UK national CPI. Items within the same basic heading have an element of homogeneity and if there is no reason to assume or to perceive that prices for a particular item would not behave in the same way as others within the same basic heading, then it is acceptable to use other items as a proxy.

For the UK one such example was the inclusion of a new item relating to the basic heading **Recreation and Sporting Services A.09.4.1.0, namely Latin Classes**. This is not a PPP item but closely correlates to the established PPP item of **Salsa classes for beginners, 1 lesson**. In this instance, we used the data from CPI.

A variation on the PROXY ITEMS is to change the specification of an existing item to allow for greater coverage of items during the collection period. Such examples included:

Regular PPP survey item specification for TABLE SALT

Brand	Well Known
Reference Qty	1000g
Minimum Qty	500g
Maximum Qty	1200g
Type	Fine table Salt
Package Type	Simple box, bag, <u>without pourer</u>
Exclude	special salts, with pourer

Spatial Adjustment Factor PPP specification

As above but with one significant adjustment to the '**Package Type**', and '**Exclusion**' criteria namely:

Package Type	Simple box, bag, <u>with pourer</u>
Exclude	special salts, with pourer

Being able to collect the salt with a pourer meant that coverage was excellent; the pourer was most popular within the UK and was not a price determining factor. What is important in determining true price difference is comparability.

The exact item must be collected within the same time frame to allow for true spatial comparisons. This was one of the major challenges of the price collection.

In delivering the SAFs the concept of COMPARABILITY is key, and all items collected across the regions within the UK must be comparable to allow for that spatial comparison. The pricing of comparable items (identical or if not identical, then equivalent) ensures that the difference in prices across the regions or locations for a good or service reflect actual price differences between those regions or locations and is not influenced by differences in quality of the product. This was a key concept which was impressed upon the price collectors, specifically, the company that conducted the UK price collection out in the locations. The exact item had to be collected within the same time frame to allow for true spatial comparisons. This was one of the major challenges of the price collection and on many occasions the UK had to discuss with the company undertaking the price collection that this concept was imperative to a successful collection and must not be confused with the collection of items for the UK national CPI. The same company collected data for both the CPI and PPP, and it took a change in mindset for some of the price collectors to adopt this concept. However, overall, the company was successful in their price collection for the SAFs.

B.1.2 Sampling of locations/regions

A different approach was used for the more recent spatial adjustment factor and regional price levels surveys from that of previous surveys. A new technique called 'Hotspot analysis' was introduced.

The sampling or selection of locations was the responsibility of ONS and not the third party contacted to undertake the external price collection. A list of locations for price collection was determined using the Hotspot analysis technique to identify clusters of shopping centres in the UK, and Retail Sales data. There was however, one exception to this, as one location that had been sampled as part of this process, namely Swindon, was replaced by Bristol. The reason was that feedback from the collector involved in the 2010

survey expressed concern of the lack of outlets for Furniture and Clothing items. Each of the locations required the same amount of data to be collected.

The price collection was split into seven broad regions within the UK, with three locations within each of the seven regions, totalling 21 locations in all. The locations and regions are listed in Table 2 – Regions and Locations.

A decision was made to use the same methodology that was used for the 2010 project and retain three locations per region. This would ensure an adequate number of price quotes per item; most of the actual locations are the same as 2010 with the exception of Bristol which has already been covered above and more notably the locations for London. In 2010 the three sampled locations were West End, Knightsbridge, and Baker Street. For 2016 the three London locations sampled were West End, Croydon, and Bromley, all of which are sampled for the UK CPI. Two of three locations, namely Croydon and West End, are sampled locations for the regular PPP survey for Consumer Goods and Services. Bromley is within close proximity of a number of the PPP locations.

Table 2 – Regions and locations used in SAF 2016

Northern	Midlands	Southern	London	Wales	Scotland	Northern Ireland
Leeds	Birmingham	Norwich	West End	Cardiff	Aberdeen	Belfast
Manchester	Leicester	Bristol	Croydon	Swansea	Edinburgh	Londonderry
Newcastle	Nottingham	Reading	Bromley	Torfaen	Glasgow	Coleraine

The locations selected for the SAF project were a sub-sample of those locations currently used in the 2016 UK CPI collection. TNS visits 141 locations each month, collecting prices for use in the CPI. From this list of 141, locations were selected using purposive sampling, where locations with the largest retail turnover in each region were selected (Hotspot analysis). To ensure sufficient coverage, the 12 Government Office Regions (GORs) across the UK contained at least one location each. The eight GORs within England (excluding London) were combined to produce three larger regions. Each of these regions contained three locations. Prices were collected in three locations in Wales, Scotland, and Northern Ireland.

Three locations were selected for London, the reference location. Two of the selected locations feature in the ongoing PPP survey programme, namely West End and Croydon. The third location sampled for London was Bromley.

B.1.3 Pre-enumeration prior for survey

A significant change to the 2016 SAF survey was the use of pre-enumeration. It is highly recommended that any country or region undertaking SAFs incorporate the process

In previous SAF projects, the UK did not undertake any pre-enumeration work. This was included in a 'Lessons Learnt' document from the previous survey in 2010, noting that pre-enumeration was a valuable part of the process and as such should be included. Valuable resources had been spent looking for items that were not readily available on the UK market.

The third party that was subcontracted by the UK to conduct the price collection, on the instruction of ONS, undertook the pre-enumeration work using the item list. They were experienced in this field and had successfully undertaken this process many times. A meeting was held between both parties following the pre-enumeration with the outcome that this process allowed for the change of some of the original items with some changes to the actual item specification. It is recommended that any country or region undertaking a SAF or regional surveys include this use of pre-enumeration as it is highly effective in identifying ahead of the main price collection any items that are either not available or not important or indeed both.

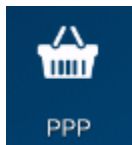
B.1.4 Method of data collection

This section will look at data collection using the handheld device. This will cover the following topics:

- The collection device used to record price data from the different shops/outlets. This section will provide details of the device the ONS use to perform their data collection.
- This section will cover the data security of the prices collected. This will include the entry of Personal Identification Numbers (PIN) to ensure data are secure and only visible for one specific collector.
- Information on data entry and the different types of data entry used – for example, drop down menus, free text.

B.1.4.1 The collection device and programme

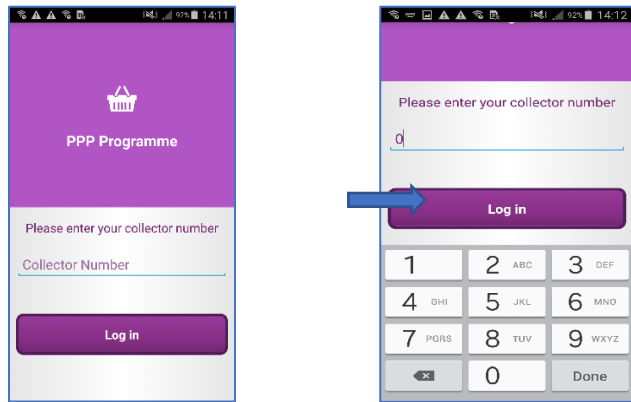
The ONS uses the Samsung Galaxy Note 3 as their collection device. After consultation with their third-party providers, an application (APK file) was created for collection on android devices.



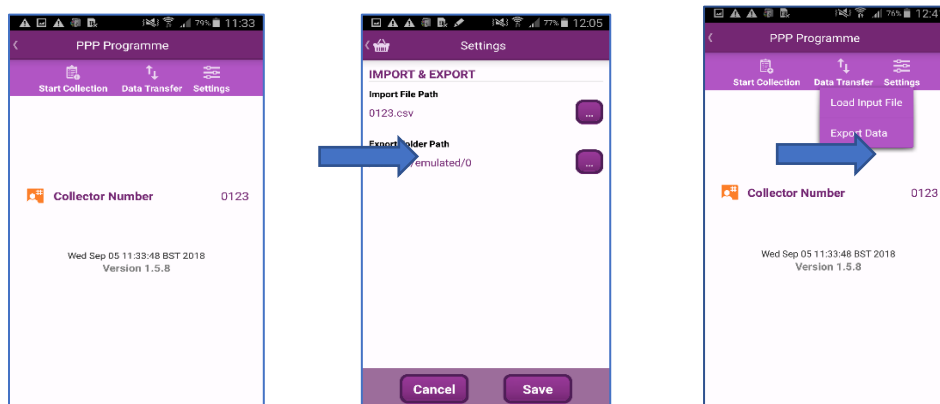
The programme is developed so that it can be used on other similar devices; it is therefore compatible with Android 4.4 and with a UI layout optimised for a 5.7" touchscreen.

B.1.4.2 Data security

This section will detail the security and access codes to ensure that the data collected is only visible to those who have collected the prices, i.e. the price collectors.

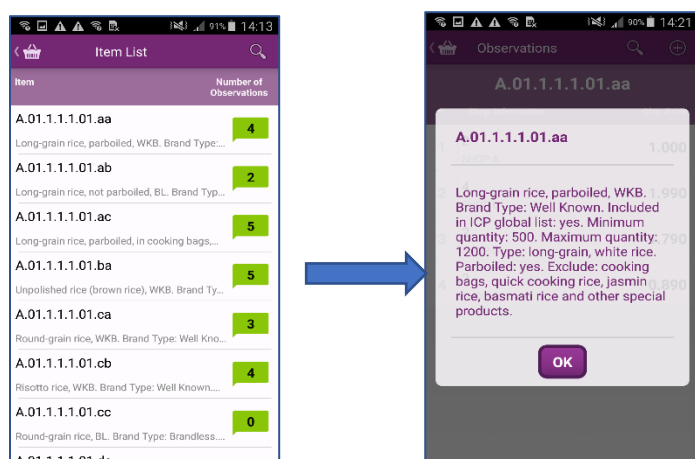


Here you have the main screen on entry to the tool. This is the first stage of data security. Each price collector will enter their unique collectors ID in the 'Collector Number' field, for example "0123". This will allow the collector access to the files stored on the collection application only for the unique code.

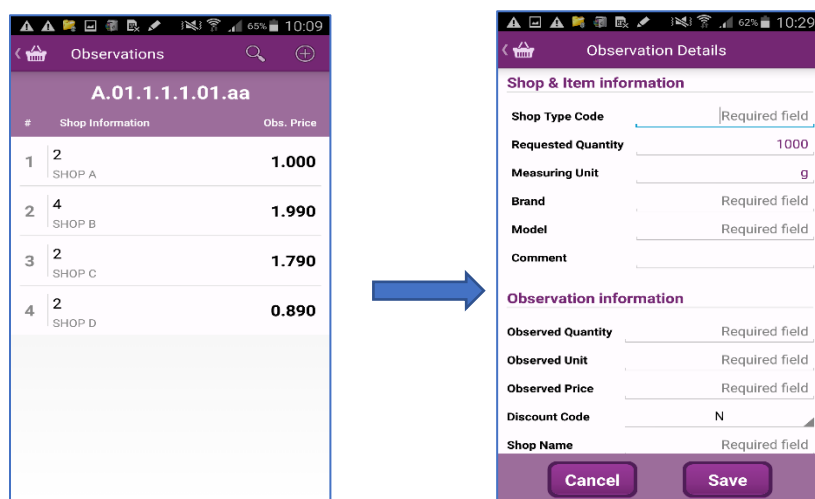


The second stage of security is to import the Item List for collection using a csv file. From the Home Screen, selecting the "Settings" option, you are transferred the Import and Export screen. It is important to ensure that the import file path is coded to match that of the Price Collector. As seen above, the Price Collector code of '0123' is the same on the CSV file to be imported. Once confirmed, this is saved, and you return to the home screen to complete the Data Transfer / Import. This is completed by clicking on the Data Transfer tab and selecting 'Load Input File'.

B.1.4.3 Data collection, data entry



When the Input file is imported, the price collectors can begin their collection. Entering the item list from the home screen using the 'Start Collection' tab. This will bring them to the Item List screen, which lists all item numbers and the start of the item information. To retrieve a more detailed description of the item, the collector can click on an item code which shows the item in more detail.



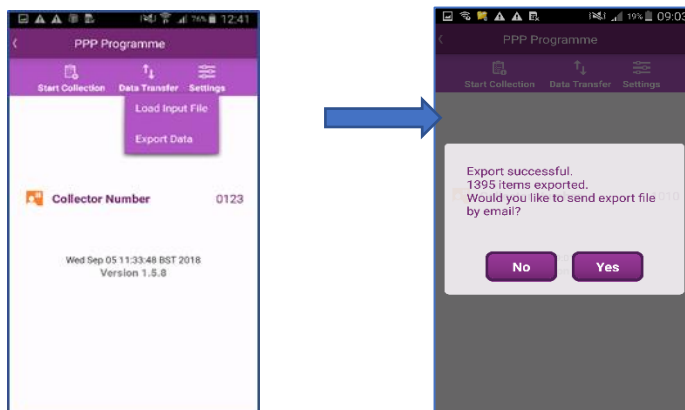
By clicking on the green icon for each item, the price collector is directed to all observations that have already been collected. This screen shows top level information for each observation collected – the outlet type, the outlet name, and the price collected.

To insert a new observation, the price collector will press . This takes them to the 'Observation Details' screen where they are required to collect the following information:

- Shop Type Code – here the collector inputs a numeric value for the type of shop they are collecting from, e.g. 2 for a Supermarket.
- Requested Quantity and Measuring Unit – these are pre-set fields and are automatically updated when the collector inputs their Item List file.
- Brand – here the collector inputs the name of the product brand.

- Model – here the collector inputs the product Model.
- Comment – this is an open text field, here the collector can type extra information they feel is important to the collection.
- Observed Quantity – here the collector is required to put the size of the item they have collected.
- Observed Unit – here the collector inputs the unit that is supplied in the Measuring Unit field.
- Observed Price – here the collector inputs the Price for the item at point of sale.
- Discount Code – this is a drop-down menu allowing the price collector to choose the code that represents the Price they have collected, e.g. N – Normal Price, Q – Quantity Discount, T – Temporary Discount and R – Regular Retail Price.
- Shop Name – the name of the outlet the price is being collected from.
- Location – the price collector inputs the Town, City or Region they are collecting pricing in.
- Once all required fields are completed the price collector can save their information and this observation will be added to the 'Observations' for that specific item.

Once all prices have been collected and inputted into the hand-held device, the Price Collector can navigate back to the home page using , ready for exporting the data back to the National Statistics Office.



From the home page, the collector can again select the data transfer tab, but now select 'Export Data' to begin the email process. This will give the Collector the option to send an email. When clicking Yes, the data stored within the application will be sent to a predetermined email address coded into the software. This allows the collectors to provide a daily update to the office.

B.1.4.4 Paper form

For those who do not have access to handheld or similar devices, there is the option of completing data collection manually, using booklets and manually handwriting each individual observation. (The UK used this method of collection until 2010 when it introduced its firsthand device (SOMO). The current device is a Samsung Galaxy Notebook 3).

Each item will have its own collection sheet, allowing for 10 observations.

A.01.1.4.4.01.ba Yoghurt, multipack, DANONE Activia

4

Brand:	DANONE
Reference Quantity:	g/ml
Model:	Activia (named "Bio" in some countries)
Minimum quantity:	400
Maximum quantity:	1000
Type:	fruit flavoured
Made with:	cow milk, with bifidus
Package type:	multipack
Pieces per pack:	4 - 8
Quantity per piece:	100 - 125 g/ml

SPECIFY: **Pieces per pack |**

Mth.	Shop Type	Shop Id.	Price	Qty.	Ref. Unit	Pieces per pack	Comments
					g/ml		
					g/ml		
					g/ml		

All the details required are entered into a row with any further comments about a product are added into the final column.

A price collector will continue to complete inputs until the close of the survey period / month. They will send the collection booklet back to the National Statistics Office PPP Team to commence validation of the data.

This works differently to the handheld device, where daily validation can be conducted as the data are sent, via email, on a more regular basis.

TO NOTE: Information relating to the IT used for scanner and web scrapped data will be included in final draft as they are still being developed.

B.1.5 Data collection – price data sources

Three main data sources for price observations were used in the calculation of the UK SAFs and relative regional consumer price levels (RRCPLs):

- price observations from the existing monthly Consumer Prices Index collection
- 2016 regional price survey, and
- centrally (ONS) collected price observations.

It should be noted that the RRCPL dataset is fundamentally the same dataset used for the calculation of the SAFs delivered to Eurostat.

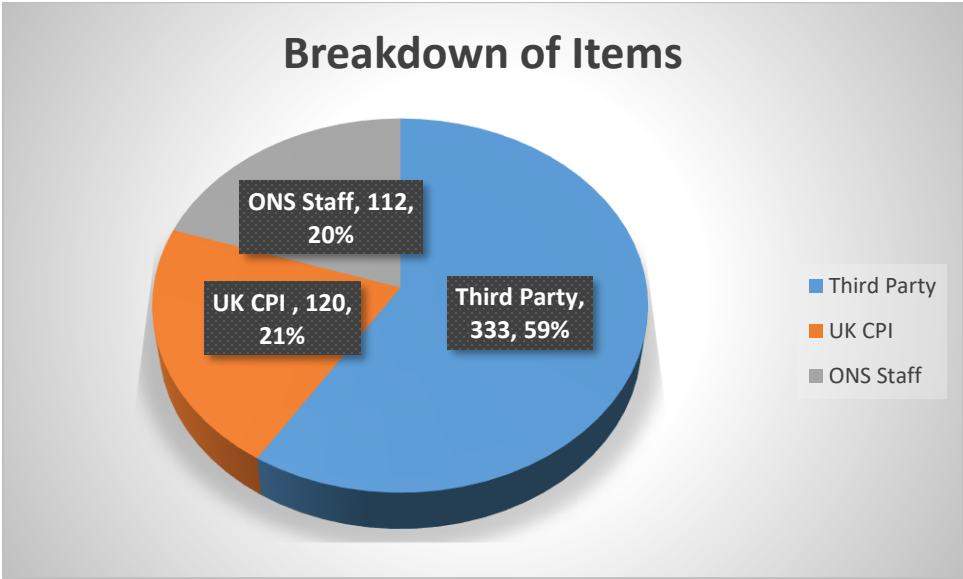
To calculate the SAFs, several approaches to acquire data were used. Refer to Graph 1, Survey by collection method. Where possible, secondary data were obtained from data collected for use in the computation of the UK Consumer Price Index (CPI). One year’s worth of CPI data was used, to remove any effect of seasonality. This was checked to ensure that the item prices were comparable across regions.

Primary data collection focused on those items which had no spatial information, had a relatively high weight, or made a relatively large impact on the final indices.

The data for the SAF project were sourced from three areas: a central collection conducted by ONS staff; a local collection performed by an external contractor TNS; and price data from the UK Consumer Price Index (CPI).

The proportion of items allocated to each collection method is shown in Graph 2. This graph demonstrates the relatively even split between the three collections methods in terms of item coverage.

Graph 2: Number and Proportion of items allocated to each collection method



The decision on the mode of collection was made at the individual item level. The first consideration being if it was suitable to use CPI data. If CPI data was deemed unsuitable but it was relatively simple to collect prices in the field, and regional variation was expected, then local collection in the field for the item was employed. The remaining items were collected centrally from within ONS as they were either viewed as problematic, had no physical outlet, or had national pricing. These mainly related to items in the Services survey as in many cases there was no physical outlet to visit out in the field and prices were taken from the internet or by contacting the service provider directly by telephone. This was time consuming (but necessary) and resource intensive as these were some of the most difficult items to price. The result of these decisions ensured that the various surveys typically had a combination of sources as can be shown in Graph 2 below.

Graph 1 demonstrates the extensive use of CPI for the Food, Beverages and Tobacco survey, while CPI data had limited use in all remaining surveys. It is not unexpected as food, beverages and tobacco items

have very generic and narrow specifications. The opposite can be said for Furniture and Health where approximately 60% of the items were priced centrally, out in the field by TNS with approximately 40% priced centrally by ONS (Prices Division). This was primarily the case for the Health based items and some furniture items where national pricing exists (for example IKEA). The majority of furniture items were collected in the field.

B.1.5.1 Consumer Price Index data

The use of CPI price data formed an important component of the 2016 SAF project. CPI data collection involves collecting the same product month after month. If the product matches the CPI item description, the actual quality of the product being priced can deviate from location to location. Spatial collection, on the other hand, involves collecting prices for a product ensuring comparable quality across regions. It is for this reason that PPP item specifications are much tighter than CPI item descriptions. For the SAF project, CPI data was only used where comparable quality across regions could be ensured for a particular CPI item. CPI/PPP synergy was a must if the CPI was to be used.

Price data are collected for around 700 items for use in the UK CPI. The initial stage to determine whether the use of CPI data was appropriate was to map CPI items to PPP items. On a case by case basis, the CPI item description was compared to the PPP item specification. Decisions were made by the UK project team about whether the CPI item description was comparable to the PPP item specifications. One hundred and twenty CPI items were identified as having a sufficiently comparable item description to be considered for use in the SAF project.

In many cases, the decision to use CPI data was relatively straightforward, particularly for food items. For those CPI items where their suitability was not obvious, the Coefficient of Variation (CV) of the arithmetic mean of CPI prices for each item was used to aid in the decision of whether the use of CPI data was appropriate or not. Prior to analysing the CVs, it was important to understand what these values meant for the purpose of the SAF project. The smaller the CV, the lower the variability, or dispersion of CPI prices. It was not possible to determine whether this dispersion was due to differences in price levels across regions, or differences in the quality of the item being priced. For example, a high CV indicates a large variability in prices for a particular item, which may be due to differences in price levels, differences in quality, or both. It was for this reason that the value of the CV was not the only criteria used in determining the suitability of the CPI, but it was a useful tool.

Care was taken to only use CPI data where appropriate for the SAF project. On a case by case basis, consideration was given to both the tightness of the CPI item description and the value of the item's CV. The use of CPI data (approximately 277,500 prices were used) was suitable for 120 PPP items. Utilising the CPI data meant a significant reduction in the number of items that needed to be collected locally, while ensuring the data was fit for purpose in the calculation of SAFs. This in turn allowed the resources to be effectively employed elsewhere.

To ensure the integrity of the produced statistics, the use of CPI data was limited outside of the Food, Beverages, and Tobacco survey. For the other five consumer surveys, in the main, it was felt that the CPI

descriptions could not ensure comparisons between items of equal quality. This was especially the case with furniture, where the item specifications needed to be followed very precisely to allow for true comparison.

B.1.5.2 Local collection

The external or local collection was conducted by a company called TNS Ltd. This company is currently contracted to collect price data for the UK Consumer Price index. TNS was also engaged in the price collection for both the 2004 and 2010 surveys, collecting the majority of items, 333 (of which 332 were used in the calculations) in total or 59% of the total 564 items. A member of the PPP team collected additional prices in Swansea (Wales) to improve coverage and in Torfaen where staff could be easily deployed from the Newport office (based in Wales) to support the TNS effort.

The external data collection was conducted between the period 26th September to 4th November 2016.

- The external collection was less challenging for 2016 due to 'Lessons Learnt' during the 2010 survey, which has been improved upon including an improvement to the item list (updated to include pictures and important guidance notes by basic heading). The overall process was much better organised, and communication was quicker making the overall process more efficient. The main difference and improvement was field staff working in geographical areas as opposed to specified outlets made the collection much quicker.

Food, Beverages, and Tobacco was the most successful category. This is not unexpected as the items are typically easily sourced and also have some similarity to the items collected for CPI which assisted the collectors. The Services, Personal Appearance, Furniture and particularly Transport, Hotels and Restaurants surveys all proved more challenging in reaching targets. These are the areas that the majority of the price collectors had difficulties.

B.1.5.3 Pre-Survey

From the 2010 SAFs local collection, communication was identified as a key factor in ensuring the success of the 2016 project. The SAF project team initially engaged TNS at their price collector conference at their headquarters in London, giving a high-level overview of the project, highlighting key themes, requirements and lessons learned from 2010. Key of which was the explanation of the differences between CPI and PPP price collection and the application of the Basic Model Rule. This conference was also key in receiving feedback from those collectors who were part of the 2010 exercise and gave guidance on the initial stages of preparation for the project.

Significant time was spent composing and finalising the price collection item list and guidance document for local collection by TNS. This went through several stages in consultation with TNS and the project support team to ensure that the documents were fit for purpose. Confirming all price collectors understood the importance of collecting prices for comparable items against the item descriptions to achieve credible data for use in the calculations.

A pre-survey meeting was held with TNS with supervisor price collectors dialling in via teleconference having received with copies of the draft list in advance. Each item was reviewed in turn and any uncertainty on item descriptions or requirements for the item was queried and refined for ease of price collection in the field. The supervisor price collectors then conducted pre-enumeration in the field and were able to flag unavailable items before price collection commenced to ensure a high level of availability across the regions in the UK in advance of price collection.

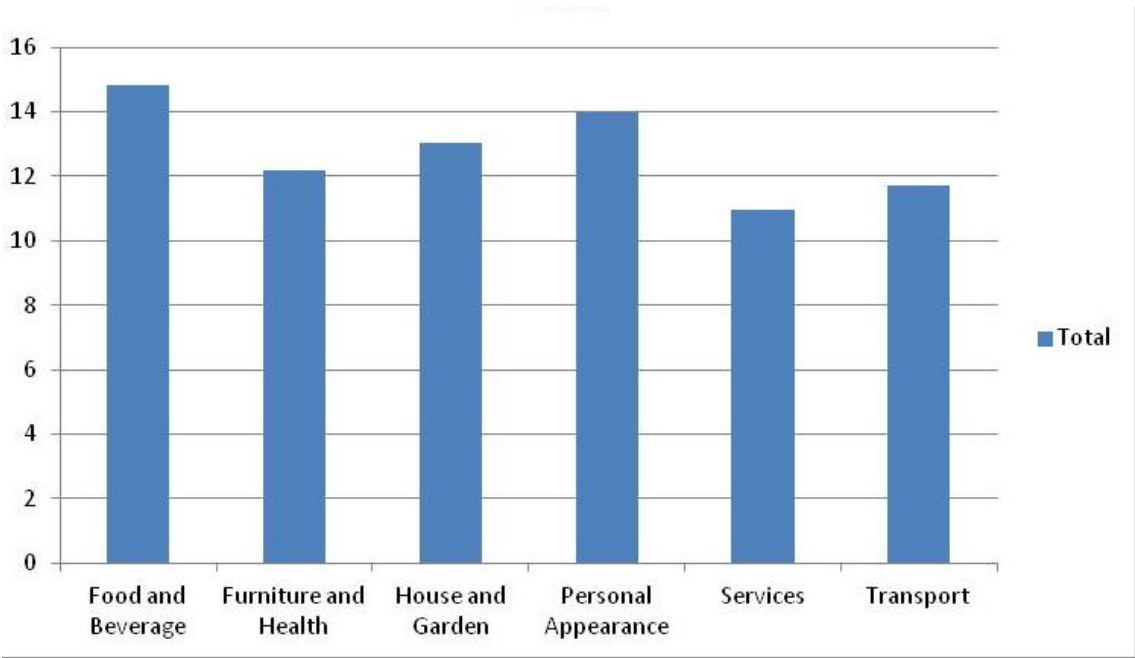
This was a very effective way of preparing the survey materials for the local price collection and was invaluable in ensuring price collectors from TNS understood what was required in terms of quality in the data they provided.

A similar process was applied to the items collected centrally by ONS. Basic headings were checked for items that were most representative for the UK. For those headings where the UK PPP team have historically been challenged in gathering the target number of price quotes per item, i.e. Services for the maintenance and repair of the dwelling, enabled the team to take the opportunity to create a UK item description to ensure success in price collection across all regions.

B.1.5.4 Regional price survey

Graph 3 details the average number of price observations that were collected in the local and central locations by PPP survey. Items where the number of observations was one (due to invariability through national pricing) or zero (due to unavailability of items) have not been included.

Graph 3: Average number of observations per item by survey



B.1.5.5 Central collection based in office, ONS

The final 112 items were collected by ONS staff in an internal central collection. This collection was reserved for items where it was possible to collect reliable quotes by phone or internet such as in transport or service areas, where it was felt that inexperienced PPP collectors may find it difficult to match detailed specifications in stores such as televisions, laptops, and for items that had national pricing.

The central collection was conducted by ONS staff experienced in PPP collection and also utilised other staff across the Prices division.

The collection began on the 26th September and ceased on the 4th November 2016. Before the collection began, certain items were deemed to have national pricing policies. These included 20 items for cars and motorcycles. This brought the number of items to be centrally collected to 112. Further research was undertaken, firstly on items where national pricing policies were in effect and secondly for those items where prices could not be collected; this ensured a targeted central collection.

Where items had a national price, a single price observation was collected and replicated across all regions where the outlet had been sampled. Intelligence on national pricing was collected direct from retailers and through the analysis of prices as they were received from the local collection. In these cases, once national pricing was identified, collection ceased. It was also identified that for the heading A.04.5.5 - "Heat Energy" it would not be possible to provide UK prices as the PPP descriptions of the product provided did not match anything provided in the UK.

It became apparent quite early in the survey process that for many items it would not be possible to collect five price quotes from each location selected. An example of this being items relating to flights. Some regions in the UK do not have a large number of airports, for example, Wales has only one national airport, Cardiff, and the number of flights matching the PPP specifications was limited. As many of these items was collected as possible, but it was impossible to completely fill the initial requirement for collecting 15 price quotes per region.

B.2 Validation and Data cleaning

As with section one, this section will aim to discuss the methods used in the actual validation and cleaning of the dataset and to provide practical guidance for regions/countries undertaking validation and data cleaning once they have received the actual price data. Working examples will be provided. Areas covered will include:

- Methods used in validating dataset at item level, basic heading level and aggregate level. Use of specific criteria in the validation.
- Validation conducted – covering both validation conducted during the price collection period and following the end of the collection
- Future development for validation purposes.
- Checking of data (this covers ONS' internal auditor's actual revisiting the outlets to check the accuracy of the prices and specification of the item). A sub-sample of items and locations are

sampled. This is key for quality assurance purposes and to have trust in the actual data. Working example will be provided.

- Discuss how the procedures used in the UK (fundamentally ECP processes) compare with those used in the ICP (Quaranta Tables and Dikhanov tables, both of which are used to provide similar measures of price variation for both products and countries).

B.2.1 Validation methods

The UK have developed a Management Information System (MIS) in Microsoft Excel, developed specifically for the survey management and validation stages. The MIS is used to store data at specific stages of collection and validation allowing an audit throughout. Data stored will include regional average prices, minimum and maximum prices, number of observations, items with no observations, items with low observations ,and those items with increased variation in data.

The MIS is also used to compare data survey on survey, looking at movements in data. The UK team will research changes and detail these in the spreadsheet. This increases the audit trail and allows the team to comment on changes.

Below is a screen shot of the MIS used by the UK in SAFs and the regular PPP surveys. This illustrates at the top level previous prices compared to new prices (average, minimum and maximum), price variation for each survey, representativity of the items ,and also the percentage change in price from previous to new average price.

Item Code	Item Name	Previous Average Price £s	Previous Min Price	Previous Max Price	?	Previous Representativity	New Average Price £s	New Min Price	New Max Price	New Checking	New Representativity	Average price % change
A.01.1.1.1.01.aa	Long-grain rice, parboiled, WKB	2.88	1.28	4.78	?	*	2.63	1.00	4.98	???	Yes	-8.68%
A.01.1.1.1.01.ab	Long-grain rice, not parboiled, BL	0.43	0.40	0.50		-	0.45	0.45	0.45			4.65%
A.01.1.1.1.01.ac	Long-grain rice, parboiled, in cooking bags, WKB	3.83	1.98	5.98	?	*	4.34	1.49	5.80	?		13.32%

Following on from the top-level data validation, the data are scrutinized further at observation level. The following information is collated, and each price is compared to all others for that specific item. Below is a snapshot of the table used to compare. It illustrates the variance coefficient of a selected item, the ratio of that items minimum and maximum price, the location/region of the price collected, and the ratio of the price collected against the average price of the. As there is a price flag of three question marks (???), this data will be checked and those observations with a high or low-price ratio will be investigated.

The high variation is always the starting point for the validation as high variation can indicate errors in data as well as genuine price divergence.

VAR_COEFF	MIN_MAX_RATI	Region	price_fl	price_ratio
0.536673233	18.45238095	London	???	1.297954033
0.536673233	18.45238095	South East	???	0.759684861
0.536673233	18.45238095	East Midlands	???	1.336129152

B.2.2 Validation stages

This section will cover the validation undertaken both during the price collection period and following the end of price collection period, covering both the validation conducted by the third party subcontracted to collect out in the field and the validation conducted in house by the UK PPP team. Limited validation was conducted on the CPI data as it had already been used in the construction of the UK national CPI and as such had been validated.

B.2.2.1 Third Party Contractor validation

Throughout collection, the third party subcontracted to collect the data complete their own validation before delivery of data to the ONS. This is conducted throughout the collection period and prior to delivery of the final dataset. Based on the top-level data, items are sorted by Item Code, Locations, Shop Names and Collected Date Time and duplicate records were removed.

For each item, the following actions are taken:

- A review that shop and brand levels are correct.
- A review that the model number and comments matched the specification or highlighted where some of the specification are not met.
- A check that observed quantity and unit are generating the correct reference price.
- A review that the highest and lowest prices are not indicating an incorrect item.
- A comparison of prices by shop.

For all data:

- Check on £0 prices
- Check no £0 reference prices
- Check on Price ratio
- Review shop types for consistency
- Review shop names for consistency

All checks are carried out piecemeal as data are received at the office and on the dataset before final data delivery. Attention was made on the more difficult commodity groups, such as clothing, furniture, and electrical items where historically these have a lot of 'noise' or high variation. Interpretation of brands was also an issue, i.e. definition of Well-Known Brand low, medium, and high.

Incorrect items are deleted from the data file and submitted to the ONS separately so that they could be included in the final dataset if they were deemed to be sufficiently close to the item definition as to be acceptable.

B.2.2.2 In-house validation (ONS)

The UK Project team received data files from the third-party contractor every few days. The validation consisted of the following:

- Identification of national pricing. This is where the price for an item is the same in each of the outlets owned by the same company. The number of key retailers and service providers in terms of contributions to the industry adopting national pricing is increasing, particularly with the advent of internet shopping. There are also a number of items, that regardless of which outlet they are purchased from, are identified as having national pricing such as Apple products.
- Unavailability of items. Validation during the early stage of the data collection allows the UK Project team to provide the third-party with alternative items which can be collected thereby ensuring that representative items are included in the final dataset.
- Multiple and Independent retailers. Checks are made to ensure that each item has the correct ratio of multiple and independent retailers.
- Problematic items. The validation conducted during the price collection period proves invaluable in quickly identifying items which price collectors are finding difficult to price. The project team are able to provide the third-party with advice on the way forward.
- Branding. During validation, checks are made to ensure that the items collected adhered to the correct branding.

Once the final data file is received from the third-party, further comprehensive validation is conducted. This involves the following:

- meeting certain validation criteria;
- identification of £'000s errors;
- cross checking of brands;
- validation of reference quantities and the resultant prices; and
- ensuring that the price observation adhere to the item specification.

B.2.3 Future development of validation process

The UK PPP team are currently developing the use of the computer programming tool, Python, to conduct the validation of their collected data. The use of Python enables the team to carry out detailed and quick analysis of the large dataset.

The use of Python allows the UK team to analyse each item and collate all information on the locations/regions that have been priced and those locations that haven't during the collection period. The

team can then allocate resource to those areas where further collection is required, saving time and resource in areas already covered.

B.2.4 Back checking of data

Further analysis of the data can be conducted once all data has been collected. The team will use Python to analyse price movement from location to location which highlights those areas where prices are highest, price changes survey on survey and the team will conduct analysis on the effects of discounts. The analysis on discounts will allow the team to look at whether the inclusion of discounts within the data increase or decrease the average prices.

Back checking or validation of the actual price collected out in the shops is part of the process of validation and is undertaken by the sub-contractor's field supervisors in collaboration with ONS auditors. Back checking is a common term applied to checking the data inputs from a sample of observations, in this case as collected by the sub-contractor. Back checks are carried out before final data are submitted.

For the SAF project, ONS instructed its auditors to pay special attention to the actual specification firstly and then secondly, where possible to confirm the price. Three out of the 21 locations were randomly sampled to be audited. The number of observations to be audited equated to approximately 2% of total prices collected. This level of audit is in line with current data collection practise for the UK CPI. In the case of the 2016 SAF project the majority of observations passed with specification and price check, well within the limits set.

B.3 Synergies between CPI and PPPs

This section will briefly address the issues around the historic lack of synergy between CPI and PPPs and discuss ways in which synergies could be improved as this subject matter is being addressed in detail in a separate agenda item in the third meeting of the Country Operational Guidelines and Procedures Task force. It will also look at the current synergies from a UK perspective between CPI and PPPs.

B.3.1 Historical issues of UK using CPI for PPP purposes and the challenges the UK faced

For the UK, there has been continued historical difficulties in using CPI data for PPP purposes. This is primarily caused by the detailed specifications required in the PPP collection in comparison to broader CPI items specifications. For example, in the UK CPI a "t-shirt" item allows a collector to price for any t-shirt regardless of brand or material composition if it is the same or comparable to the previous month's CPI item. For PPP purposes, the t-shirt will have a more detailed specification, including details such as brand level or the material composition. Due to these differences in the specifications, the PPP team are unable to use the average prices taken from the CPI collection, as it is unknown if observations would meet the PPP specification requirements.

The example below shows the difference between the PPP and the CPI specification and the level of detail required for the PPP collection.

PPP Specification

Men's polo T-shirt, short sleeves, WKB-H

Material – approx. 100% cotton

Collar-style – shirt; placket with 2-3 buttons

Sleeves – short

Colour – one.

CPI Specification

Men's Casual, sleeve Top with Collar, e.g. Polo.

As can be seen from the graph below, Food is the aggregate where most use is made of CPI data for PPP purposes, particularly for the SAF project. This is due to the specification being very comparable if not identical.

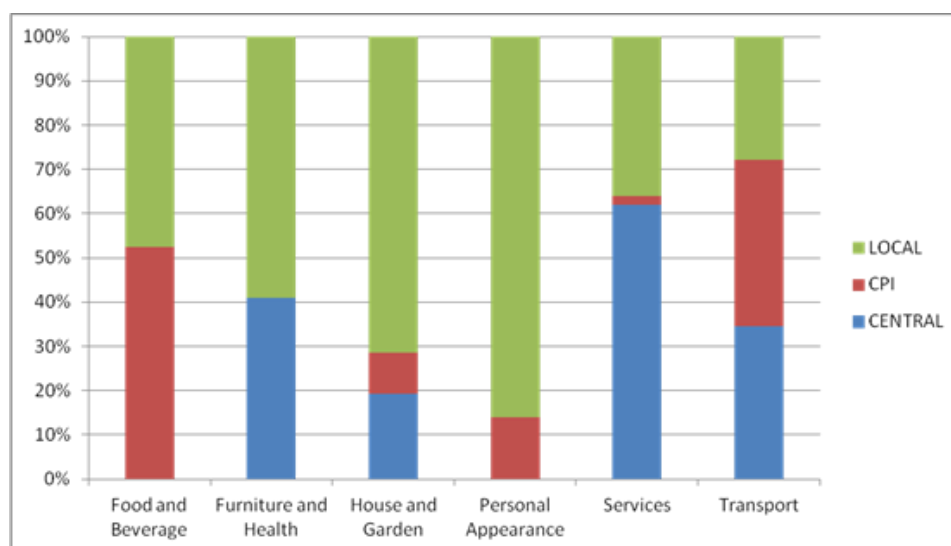
The UK has previously been involved in a Eurostat project called Detailed Average Prices (DAP) to consider using average prices across several different calculations for the food aggregate. The 2015 data collection was the eighth and final exercise. The DAP project has been discontinued given some limitations of the comparability of the results, the existence of other data alternatives for DG JUST (Director General for Justice and Consumers) and the slow decrease of the number of countries taking part in the project.

B.3.2 Current practice on the use of CPI price data in the PPP exercise

As noted, currently the UK PPP team do not use CPI price data in the regular PPP surveys. Due to the detailed nature of the PPP item list, it has been found difficult to find synergies between the data. That said, at basic heading level, movements in the CPI are used for quality assurances purposes during the validation rounds of the PPP regular surveys; movement in CPI is mapped against the movement in PPPs between the three year intervals and any significant divergence is investigated.

However, when conducting the Spatial adjustment project, the UK used CPI data, mainly for food where there was very tight correlation between the specifications. One year's worth of CPI data was used to remove any effect of seasonality. This was checked to ensure that the price of items was comparable across regions.

Graph 1 - Survey by collection method



As seen in the graph above, the CPI was used for most of Food and Beverages, and a large proportion of the Transport basic heading in the UK Spatial Adjustment Project 2016. Care was taken to only use CPI data where appropriate for the SAF project. On a case by case basis, consideration was given to both the tightness of the CPI item description and the value of the item's CV.

B.3.3 Future developments

There are several initiatives being undertaken in ONS which could potentially improve synergies between the CPI and PPPs. These initiatives will be discussed in detail in this section.

The UK are currently in the development stages of acquiring and analysing test data for web-scraped and scanner data. It is hoped that, once data are received directly from websites or companies, then there will be increased synergies between CPI and PPP data.

The use of web-scraped data has progressed further; this provides a snapshot of prices on companies' websites. It is hoped that the data will be used in both CPI and PPP data calculations, as the detail can be specifically collected from the websites. For example, a specific brand of jeans can be collected from a website – this can be used in the monthly CPI under a jean item, but it can also be used in the PPP calculations under the specific item.

The PPP item list asks for the specific items – Men's blue jeans, LEVIS 501. Using web-scraped data, all observations for this item can be used to create an average price for the survey collection month for PPPs. But also, as the web-scraped data will be collected throughout all months, the CPI can use the data for this specific item to help calculate inflation month on month.

The UK CPI and PPPs are in the development stage of including scanner data within their calculations. The inclusion of scanner data will increase the synergies between the CPI and PPP data. The average prices collated from CPI collection of scanner data will be used with PPPs as the data can be provided for specific

items. The individual average prices will be for specific items that can be matched to the PPP specifications and either included or excluded.

B.4 Calculation of spatial adjustment factors and relative regional comparative price levels

B.4.1 Methodology used in constructing SAFs and regional price levels, including the calculation of average prices

Calculation of both the UK SAFS and UK RRCPLs starts with the calculation of the average prices. The calculation of the average prices is the first step in the actual calculation of both SAF and RRCPLs and the same method is adopted for both, albeit the SAFs were primarily concerned with arriving at a correction coefficient for the UK and the UK excluding England, whereby the RRCPLs were concerned with calculating average price levels relative to other regions/countries. For this paper, the calculation and the methods used in arriving at SAFs and RRCPLs have been dealt with separately as the reader might only be interested in one and therefore it makes for easier reading to keep them separate.

B.4.1.1 Spatial Adjustment Factors

As previously explained, there are two main stages to the calculations of the SAFs; namely the calculation of the average prices themselves and secondly construction of the actual SAFs and the method used. Both are described in detail below.

B.4.1.2 Calculating average prices

i. Consumer Prices Index data

One of the advantages of using UK CPI data is that we are able to calculate an annual average price. When using CPI data over a period of 12 months, an annual average price for each region was calculated. This was done by first calculating a monthly average price for each region using an unweighted, arithmetic mean. The annual average price was then calculated by using an unweighted, arithmetic mean of the monthly average prices. The reason for calculating a monthly average price first was due to the fact that the number of prices collected each month differed slightly. Averaging the monthly average prices meant allocating an equal weight for each month. This approach also had the advantage of implicitly weighting by location within a region, as the larger locations generally had more price observations.

ii. Direct collection (in the field and at the desk)

For data collected centrally (collected by ONS) and data collected in the field (collected by subcontractor), the average price for each location was calculated by taking the unweighted, arithmetic mean of all prices collected in each region.

B.4.1.3 Methodology used in constructing spatial adjustment factors

i. Using the EKS method

The methodology ONS used to construct the spatial adjustment factors is consistent with the approach used by Eurostat in calculating their PPPs at the basic heading level. The EKS (Éltető-Köves-Szulc) method was used to impose transitivity on an existing set of intransitive binary indices.

Transitivity is a desirable property as the same result is obtained when comparing PPPs directly between two regions and when comparing PPPs indirectly through the introduction of a third region. In addition to being transitive, the resulting multilateral EKS PPPs differ as little as possible from the original binary PPPs.

The use of EKS can lead to bias when one region has a larger number of representative items than the other region. EKS-S is a modified version of EKS that takes into account the representativity of items in different regions. ONS has assumed equal representativity across the UK; therefore, it was not necessary to use the EKS-S method. This assumption was deemed plausible as the items were being compared within a country rather than across countries where more variation would be expected. Therefore, it was considered that the use of EKS should not lead to bias due to representativity differences between regions.

Due to the unavailability of weighting information for PPP items below the basic heading level, a Fisher-PPP index could not be calculated. Instead, a Jevons-PPP index, or an equally weighted geometric mean of the price relatives, was calculated. Although a Jevons index is usually transitive, the use of EKS was still needed to enforce transitivity because some regions contained missing prices. A weight was then applied at the basic heading level which was sourced from the Living Cost and Food Survey, the UK's equivalent of the Household Expenditure (Budget) survey.

B.4.1.4 Construction of the spatial adjustment factors

The following steps were used by ONS to construct the spatial adjustment factors:

- i. A bilateral comparison of the PPP item's average price was calculated for each combination of regions. With seven regions, this meant 49 different price relatives for each item.
- ii. The price relatives were then mapped to their respective basic heading for each region.
- iii. The unweighted, geometric mean of the PPP item price relatives were calculated for each basic heading.
- iv. EKS applied to enforce transitivity on the binary PPPs.
- v. The weighted geometric mean of each row in the EKS matrix was taken, giving an adjustment factor where UK=1 for each region.
- vi. The inverse of the adjustment factor London (UK=1) was taken to produce the spatial adjustment factor delivered to Eurostat.

B.4.1.5 Relative regional consumer price levels of goods and services

As already commented the construction of UK regional price levels were only calculated as a result of the work undertaken by the UK on updating of the UK SAFs for Eurostat as part of a requirement under the PPP regulation. However, they were a welcomed-by-product and it did not require a significant amount to work to produce; the same dataset was used for both the SAFs and RRCPLS outputs.

B.4.1.6 Calculating average prices

Consumer Prices Index data

The use of CPI price data formed an important component of the RRCPLs calculations. CPI data was obtained for approximately a quarter (124) of the items in the basket used in the calculation of the RRCPLs. The majority of the items where CPI data was used were for the Food and Non-Alcoholic Beverages and Alcohol and Tobacco divisions; for these two divisions, just over 50% of the data used were CPI items. These divisions contain items that are well defined in the CPI item description and which ensure a like for like comparison across different regions. A major consideration in choosing items from the CPI basket was their closeness in specification to items in the PPP basket of goods and services. Those CPI items that align very closely to the PPP specification were selected and their existing price observations were included in the dataset.

The prices extracted from the CPI database refer to the twelve-month period July 2015 to June 2016 and accounted for approximately 277,500 observations. An average price for the item in each region was calculated for each month. An annual average price was then calculated by taking an unweighted average of the monthly average prices.

B.4.1.7 Methodology used in constructing relative regional consumer price levels

The approach used to construction relative regional consumer price levels is consistent with that adopted by Eurostat in the calculation of the PPPs.

It is important to note that the methodology adopted by the UK in the calculations of RRCPLs is consistent with that used by Eurostat in the calculation of PPPs for the Eurostat-OECD Programme. As commented previously, it is important to note that while RRCPLs compare regions and countries within the UK to each other, the ECP produces PPPs which compare participating countries to each other within the Programme.

The basic approach to calculating relative regional consumer price levels is to measure the cost of purchasing a common basket of goods and services in each region and express that cost relative to buying the same basket nationally (where the UK=100). That is, how much more (or less), relatively speaking, does it cost to buy the basket in one particular region, compared with a UK average cost for the same basket. Similar to the CPI, it is not feasible to collect prices for every type of good and service that consumers spend their money on. Nor is it possible to collect prices from every single outlet or service

provider that consumers make purchases from. Therefore, it is necessary to sample for items, locations, outlets, and service providers. The main difference compared with the CPI, and important to note, is that regional price level comparisons are designed to compare prices of a common basket of goods and services at one particular point in time, i.e. a spatial comparison, in different regions in the UK, whereas the CPI measures the difference in prices of the same basket of goods and services throughout the UK over a period of time, i.e. temporal comparison. This is a significant difference that is important to understand. It is important to note that the RRCPLs cannot be compared over time as they are a spatial comparison and not a temporal one.

To be able to compare prices at a particular point in time, it is important to ensure that an identical basket of goods and services is priced for all of the regions. This is critical in developing comparable outputs and ensures that observed price differences in the regions are due to price alone and not influenced by variability in the quality of items priced across regions. For example, a comparison of an observed price of a branded item in one region with the observed price of an unbranded item in another region will reflect in part that the items are not comparable and that unbranded items are typically cheaper.

Having collected observed prices for the goods and services included in the basket an average price is calculated in each region for each item. Two stages were employed to calculate and aggregate the RRCPLs. The first stage was below the elementary aggregate level, referred to here as the basic heading. Basic headings are the building blocks for the RRCPLs and are the lowest level for which expenditure weights can be obtained. A basic heading comprises a group of similar, well-defined goods or services. In total, 168 basic headings have been defined for this process. A few examples of basic headings are; *Ladies Coats and Jackets*, *Jewelry*, *Wine*, *Wardrobes* and *Chocolate*. Above the basic heading level, RRCPLs were calculated and aggregated using the Classification of Individual Consumption according to Purpose (COICOP) used in the CPI. Regional expenditure was obtained from ONS's Living Costs and Food survey and adapted to create regional weights for the 168 basic headings.

As there is no data available on the expenditure on the individual items below a basic heading, a basic heading RRCPL has to be calculated from price data only. Below the basic heading, price relatives for each pair of regions were first calculated; with five regions (London, England (excl London), Wales, Scotland and Northern Ireland), this resulted in 25 unique price relatives. To combine the price relatives of the items at the basic heading level, an equally weighted geometric mean of these relatives was calculated for each pair of regions.

Once the RRCPLs had been calculated at the basic heading level, regional weights were used to aggregate the basic headings to successive COICOP levels. For each pair of regions, the basic heading RRCPLs are weighted, summed and averaged using first the expenditures on the basic headings of the first region as weights, and then the expenditures on the basic headings of the second region as weights. This gave two weighted RRCPLs: a Laspeyres-like RRCPL and a Paasche-like RRCPL. The geometric mean of these two RRCPLs was then calculated, which produced a single Fisher-like RRCPL between the two regions.

Once each level of aggregation is provided with a matrix of Fisher-like RRCPLs, it was necessary to apply a method to impose transitivity on the Fisher-like RRCPLs. Transitivity is a desirable property for spatial price

indices as the same result is obtained when comparing RRCPLs directly between two regions and when comparing the RRCPLs indirectly through the introduction of a third region.

The method used by Eurostat, and adopted by ONS, to impose transitivity is the EKS (Ëltetö-Köves-Szulc) method. The RRCPL that results from application of the EKS method (the EKS RRCPL) is defined as the geometric mean of the direct RRCPL and all the indirect RRCPLs between a pair of regions, with the direct RRCPL having twice the weight of each indirect RRCPL. To produce the data in Table 1, England (excl. London) and Wales would need to be compared directly and through London, Scotland and Northern Ireland.

In addition to being transitive, the resulting EKS RRCPLs differ as little as possible from the original Fisher-like RRCPLs. After applying EKS, we are left with a 5x5 matrix of the bilateral EKS RRCPLs. Standardization of the EKS RRCPLs is required in order to obtain a set of RRCPLs that has the UK as its base. This is done by dividing each RRCPL by the geometric mean of the RRCPL in its column of the matrix. This results in five EKS RRCPLs, one for each region (all the entries in each row have the same value after standardization), with the UK as the base, where UK=100.

B.5 Importance and uses of SAFs and regional price levels

B.5.1 Use of SAFs

B.5.1.1 Allows for true comparability across countries/regions

Producing comprehensive SAFs is always going to be a challenge for any country or region but it is important that they are calculated if there are known differences in prices across the country. SAFs are an important element of the calculation of national annual average prices. For many regions or countries, price collection for consumer goods and services are restricted to the 'capital city'. For example, in the case of the UK, prices are collected only in the UK capital city of London. However, to arrive at national average prices that are representative of the country and which can then be compared across all countries, SAFs should be produced.

Regular surveys are administered on a three-year rolling basis (this is the case for the European Comparison Programme) (ECP) and it is being considered for adoption for the International Comparison Programme (ICP). That said, for both the ECP and ICP, national annual average prices are required. It is for this reason why SAFs are used and are key to the calculation of a national average price; the fundamental aim is to take average prices to national average prices. In the case of the UK, to take average London prices for specific goods and services to a UK national average price.

B.5.1.2 Reduces burden on National Statistical Institutes

Another important factor is that producing SAFs say, every six years reduces the burden on National Statistical Institutes (NSIs) both in terms of finances and resources. As previously mentioned, annual national average prices are required and for most countries it would be an impossible task to conduct a nationwide price collection every year for consumer goods and services. In the most cases, the prices

submitted by the NSIs to Eurostat and OECD are not national as they generally refer only to the capital city of the country in question. However, there are several member states in the ECP that do not have any regional price variation and therefore do not supply SAFs to Eurostat. They do however, provide TAFs (Temporal Adjustment Factors).

B.5.1.3 Regulated by Eurostat/OECD

For countries participating in the ECP (members of the European Union, EFTA countries and candidate countries) they are regulated²⁴ by the Purchasing Power Parities Regulation, in the absence of average national prices, to undertake a Spatial Adjustments Factor exercise to supply SAFs that take city prices to national prices. For information – there is a second stage of this process - temporal factors will take monthly prices to annual prices. The regulation stipulates that spatial adjustment fact (which are to be supplied at basic heading level) should be no more than six years old at the reference period of the survey.

B.5.2 Uses of regional indices

Regional price levels have been produced several times by the UK and involve comparing price levels across regions – a spatial index. Refer to section 1.2.2 '*Demand for regional price data*'. This was also the focus of other regional prices published and shows the relative costs of a fixed basket of goods and services in different regions. Many prices varied very little by region and some prices that are set nationally may not vary at all. Indeed, some items have national pricing such as postage and communications and some brands have national pricing such as APPLE products. With strong competition on the UK market, particularly among the top four supermarkets there is very little divergence or variation. Indeed, many of SAFs for the aggregate of Food, Beverages and Tobacco are close to 1, due to this competition and national pricing. A few commodities may behave very differently in different regions and the most key one is housing. This would not be needed for CPI but is a key major component of CPIH and therefore would be a major component of regional differences in the UK.

The existing publication of Relative Regional Consumer Price Levels (RRCPLs) as already commented previously is derived from the information used in the six yearly calculations of the Spatial Adjustment Factors (SAFs). This information used in the calculations also provides estimates of regional; price levels for a fixed national basket of goods and services, excluding n housing. Regional weights for the aggregation of each basic heading are derived from the UK household budget survey, namely the Living Costs and Food survey, reflecting at least part of the differences in expenditure patterns by region.

An alternative approach is to produce a temporal price index in each region, in effect regional price inflation. However, such indices will not produce information that is suitable for comparing price levels between regions. To have both regional inflation and regional levels, it will necessary to produce two types of index.

²⁴ Regulation (EC) No 1445/2007 of the European Parliament and of the Council establishing common rules for the provision of basic information on Purchasing Power Parities and for their calculation and dissemination.

For the UK one of the major by-products or benefits of conducting the Spatial Adjustment Factor project was the opportunity to produce Relative Regional Consumer Price Levels (RRCPLs). An article was published by the UK providing analysis of price levels for consumer goods and services for many regions in the UK (including the composite countries of Wales, Northern Ireland, and Scotland) as well as London and other key regions within England. The analysis primarily focused on price level indices which provided a comparison of regions price levels in the UK relative to the UK average.

As commented, the results were based on a sample of a large sample of observations using the underlying price data from the three main sources that was used in the SAF calculators; namely CPI data, a nationwide regional survey of prices conducted by a third part, and finally data collected internally by the UK statistical office, ONS. It therefore took minimal work, (relative to the importance of the outputs) to undertake an analysis of regional price levels as the dataset had been validated and SAFs already calculated. Comparability across regions was ensured by having tightly defined specifications for each of the items in the basket.

B.5.2.1 Allows for comparison of price levels across regions

The main use of Relative Regional Consumer Price Levels (RRCPLs) and the reason the UK made the decision to publish such data was to allow for a comparison of price levels across regions of the UK. Supplementary data was published to a more detailed regional level within England but only at the aggregate level as it was not felt that the dataset was robust enough for more detailed disaggregated data. Data were published at total and division level (based on COICOP classification) for five regions (London (England (excluding London)), Scotland, Wales, and Northern Ireland).

B.5.2.2 Demand for regional price data

There has always been a demand and interest for regional price levels from the devolved assemblies of Wales, Scotland and Northern Ireland and England as well as other government departments, policy makers, academics, researchers, etc. The latest data published by the UK was in March 2018, Relative regional consumer price levels of goods and services, UK:2016 (refer to link below).

In the 2003 budget, the then UK Chancellor of the UK government announced plans to produce regional price levels for the UK. We published our plans for addressing this need the same year. More recently regional price data were published in 2011 and now in 2018. Both datasets were produced because of the requirement by Eurostat for the UK to deliver SAFs.

The UK has also responded to user demands for regional price data in recent years;

- i. 2001 - produced indicative figures for 2000 on the variation in prices between regions
- ii. 2004 - published estimates of 2003 regional price levels, partial update on 2000
- iii. 2005 - published regional price levels for 2004, similar to 2003 estimates
- iv. 2011 - published regional price levels for 2010, regions price levels compared with UK
- v. 2018 – published regional price levels for 2016, [regions price levels compared with UK](#)

In November 2017, ONS commissioned work by Southampton University to conduct a feasibility study into producing a regional CPIH (Consumer Price index, including owner occupied housing costs. Refer to section 6 Future developments.

B.5.3 Development of UK CPIH - calculating at regional level

There is great user demand for regional data, both regional price levels and Consumer Price Index at regional level

The UK CPIH (Consumer Prices Index, including owner occupiers housing costs) is used to measure consumer price inflation in the UK. It was introduced in 2013 as a more complete measure of inflation as it included owner occupiers housing costs (OOH), which make up a major proportion of household budgets in the OOH calculations.

There is a demand within the UK for regional data, whether this be price levels or inflation.

Users of price statistics have for a long time suggested that regional indices of consumer prices would be valuable statistics in helping to understand how inflation varies across the UK, and whether there are important differences in regional inflation (RPI Advisory Committee 1971, Fenwick and O'Donoghue 2003, UK Statistics Authority 2013). The assumption has been that the number of price quotes is too small at a regional level to support the calculation of indices, and it has not been a sufficiently high priority to invest in additional price collection for this purpose. Some limited information on variation in regional prices has been made available through ONS publications on RRCPLs. These publications have used information from additional price collections made every six years for the purposes of adjusting PPP statistics.

PPP prices are collected in the capital city of the country, and a periodic exercise is undertaken to adjust to the whole country. RRCPLs show the differences in price levels between regions but are not designed to show price change (inflation), and because of the methodology and differences in the weights, they cannot be used even for a once-every-six-years approximation to regional inflation. Therefore, the ONS has commissioned some work to investigate the potential for the existing consumer price collections to support the calculation of regional price indices for CPIH at regional level for the nine regions of England and the devolved assemblies of the UK, Wales, Scotland. and Northern Ireland. This is the same regional breakdown as for the RRCPLs.

A regional CPIH measure would provide valuable insight for policy makers into the nature of how variable inflation rates are within the UK and the potential causes of inter-regional inflation differences

There are however major hurdles or restriction; that is whether the currently available data sources for the CPIH lead to sufficiently reliable measures at the regional level. The feasibility study concluded that regional CPIH are not suitably reliable statistics when using the same methods currently used for the national CPIH. The main challenges were inadequate sample size at regional level, a modification of

region-based weights within strata and lack of expenditure weights at item level. However, the regional CPIH does capture the general trends similar to that of the CPIH which show that there is potential for it to be developed to be more useful. It is proposed that a study into alternative statistical methods is suggested to overcome the limitations of the smaller regional sample sizes. Such statistical methods which may provide improved regional CPIH reliability are estimation methods, smoothing methods, and finite population corrections. Also aggregating the available data into larger categories may provide more robust, but less sensitive indices.

B.5.4 Next steps for development of regional price inflation and regional price levels

There continues to be a demand for regional price data. A limitation of the approach for example used to construct SAFs is that due to the need to have a large field-based collection to address the areas where CPI data is insufficient, it can only reasonably be completed every six years. This is when, as previously noted, ONS is required to meet its obligations to Eurostat in updating SAFs.

At the time of writing this article, there are no immediate plans to assess the feasibility and usefulness of developing and publishing annual results for the areas where CPI data can be used for spatial comparison or to produce regional price data more regularly. That said, however, as already mentioned, ONS has recently commissioned work by Southampton University to conduct a feasibility study into producing a regional CPIH.

It is important to note that these are different from the RRCPLS which show the relative difference in price levels between regions. In comparison, the regional CPIH consistent (referred to as rCPIH) inflation rates are designed to show price change over time (inflation). The aim of the feasibility study was to investigate the potential for the existing consumer price collections to support the calculation of regional price indices. More specifically, it assesses the feasibility of calculating the CPIH at a regional level for the nine regions of England, and Wales, Scotland, and Northern Ireland from existing data. A reasonable rCPIH measure would provide valuable insight into the nature of how variable inflation rates are within the UK and the potential causes of inter-regional inflation differences. However, the major restriction is whether the currently available data sources lead to sufficiently reliable measures at the regional level.

In brief, the study found that it is possible to construct rCPIH series from the available data sources. The basic patterns in the series are similar to those in the national CPIH. The individual rCPIHs differ in ways that could be expected, for example, with London prices increasing at a greater rate than other regions, driven primarily by housing. Although these provisional rCPIH are somewhat useful, the reliability of specific components of the data and procedures are relatively low. Small sample sizes create a great deal of irregularities and uncertainties in the indices as measured by approximate variances, which is the main issue. Therefore, although it is feasible to construct rCPIHs, considerable further development is required to ensure that the rCPIH can reliably represent the inflation within each of the regions. ONS will continue to work with Southampton University to progress some of the recommended next steps at outlined in the feasibility study, including investigating the assumptions of the provisional rCPIH such as using national item indices when regional data are not available. Further updates will be published as the work progresses.

C. Italy

C.1 Introduction and Scope

Several players of the economic and social debate recognize the need for compiling subnational household consumption purchasing power parities indexes (SPPPs) for Italy due to the high socio-economic heterogeneity across its geographical areas.²⁵

Compared to other OECD countries, the Italian regions vary widely in terms of household economic conditions. Italy has an almost dualistic economy with all Southern regions attaining a lower level of household income on average than the Centre and Northern regions.

Some key indicators clearly show this situation.

Looking at the geographical areas (NUTS 1 level), on the side of income, in 2004 the households' average annual income without imputed rents (including imputed rents the situation is the same), derived from the European harmonized survey on income and living conditions (EU-SILC), was €22,657 in the Islands, €23,308 in the South, €29,729 in the Centre, €30,132 and €30,416 respectively in the North East and the North West. Therefore, the households' average income in the Islands was 25% less than that in the North West. After 13 years, in 2017, the average household annual income in the Islands was €24,065, in the North East (that overcame the North West) €35,386 (the gap increased to more than 33% for the two economic crises, in 2008-2009 and 2012-2013, that enlarged the territorial differences).

In terms of regions (NUTS 2 level), in 2017 the highest households' average annual income was recorded in the autonomous province of Bolzano/Bozen (€37,892), in the North East and the lowest one in Sicilia (€22,745), in the South, with a gap of 40% between the two.

On the side of expenditures, the difference amongst the geographical areas of Italy are similar. In 2017 in the North West the households' average monthly expenditure (net of imputed rents) was €2,249.19 (the highest one) whereas in the Islands it was €1,558.04 (the lowest one) with a gap of more than 30%, with the North East where it recorded €2,186.11, the Centre €1,970.56 and the South €1,638.86.

At the level of regions, in 2017 the autonomous province of Bolzano/Bozen recorded an average monthly households' expenditure almost double of that of Calabria (in the South).

Moreover, indicators concerning absolute poverty (measured on the expenditure side) confirm the differences across the Italian territory. In 2007, before the two economic crises, the absolute poverty rate in terms of households was 3.1% in the North, and 4.6% in the South and Islands. In 2017, the gap between

²⁵ The second territorial level of the Nomenclature of territorial units for statistics (NUTS 2) divides Italy into 19 regions and the two autonomous provinces of Trento and Bolzano, which make up the Trentino-Alto Adige region. More specifically, Italy is subdivided into the following 20 regions, each of which has its own regional capital (specified in brackets): Aosta Valley (Aosta), Piedmont (Turin), Liguria (Genoa), Lombardy (Milan), Adige Trentino-Alto Adige (Trento), Veneto (Venice), Friuli-Venezia Giulia (Trieste), Emilia-Romagna (Bologna), Tuscany (Florence), Umbria (Perugia), Marche (Ancona), Lazio (Rome), Abruzzo (L'Aquila), Molise (Campobasso), Campania (Naples), Apulia (Bari), Basilicata (Potenza), Calabria (Catanzaro), Sicily (Palermo), Sardinia (Cagliari).

the two geographical areas had increased. In the framework of a general worsening of the absolute poverty in Italy, its rate arrived at 10.3% in the South and Islands, almost doubling that of the North (5.4%). In the more recent data (2019) this gap narrowed (8.6% vs 5.8%) but remained wide. This gap becomes huge if we consider the households' relative poverty rate (in expenditure terms). In 2017, this rate was 5.9% in the North and 24.7% in the South, 6.8% and 21.1% respectively in 2019. It means that the households in relative poverty in the South still in 2019 are (in percentage terms) three times those in the North, whereas in absolute poverty they are about 1.5 times.

This difference between the two indicators (absolute and relative poverty rate) provides further evidence (beside those already emerging from the data regarding the level of income and expenditure) that strengthen the reasons for measuring spatial price indices (SPIs) for Italy. The Italian National Institute for Statistics (Istat) calculates absolute poverty indicators taking into account thresholds that differ by household and municipality typology and by geographical areas. In terms of geographical areas, the differences amongst the thresholds are due, above all, to the consumer price component that was considered in their estimation. For the relative poverty, the threshold is unique for the entire Italian territory and thus it does not consider the differences of prices amongst regions. Thus, the different width of gap between the North and the South of Italy in terms of absolute (on one side) and relative (on the other side) poverty is an indirect indicator of the need of compiling SPPPs.

Therefore some crucial indicators (income, consumption, poverty rates) together with the evidence coming from the current survey on consumer prices to estimate inflation, prove that households' purchasing power is different across Italian regions and that one of the main reason of this difference is ascribable to consumer prices.

SPPPs are a crucial tool to measure how much consumer prices differ between Lazio and Toscana, Sicilia and Bolzan/Bozen, Marche and Puglia and between each region and the national average level of prices.

Indeed, Italy is one of the few European countries that carried out official experimental SPPPs estimations (using CPI data and ad-hoc surveys) referring specifically to household consumption and considering regional capitals.

In particular in 2005 the Italian National Institute for Statistics (Istat,) in cooperation with Unioncamere and Istituto Tagliacarne, launched a research project aimed at testing the possibility of using and integrating the statistical information currently supplied by CPI surveys. Experimental estimates were produced in 2008, with reference to 2006 data, and the GEKS formula was adopted for computing spatial price indices (SPIs) concerning three expenditure divisions: Food and Beverages, Clothing and Footwear, and Furniture, which represented approximately 34% of the total consumer expenditure (Istat, 2008). To calculate subnational PPPs for consumer prices for 20 Italian cities (the regional chief towns), Istat used the same procedures as those used in the ICP by following the principle of strict comparability of products. Moreover, ad-hoc surveys were designed and carried out for the Clothing and Footwear, and Furniture categories.

The second project (whose results were disseminated in 2010 with reference to 2009 data) to compile subnational PPPs was compiled for all the COICOP²⁶ expenditure divisions. The source of data and methodology remained the same with the exception of rents for which spatial comparisons were carried out using Country Product Dummy (CPD) models and Household Budget Survey data that include some detailed information on the characteristics of the dwellings (Istat, 2010).

The 2010 results showed significant differences in the level of consumer prices across the regional capitals (Istat, 2010). Consumer price levels in the Northern cities are generally higher than in the Centre and especially in South of Italy. Bolzano (105.6) and Milano (104.7) showed the highest prices compared with the Italian average (100) while the least expensive city proved to be Napoli (93.8).

C.2 Methodological approaches and results

The SPPPs obtained from the first two experimental estimates encouraged Istat to go ahead with the project of regularly producing spatial indices of consumer prices at the regional level. To this aim, further research studies were implemented by Istat in cooperation with the University of Florence and the University of Tuscia providing interesting results (Biggeri et al, 2016; Laureti and Polidoro, 2017; Laureti et al, 2017).

These studies have mainly focused on exploring the use of two different sources of data for constructing spatial price indexes: CPI and scanner data. However, it is worth noting that, in order to produce subnational PPPs for the entire household consumption expenditure, other sources should be considered in addition to scanner data and CPI data as we will explain in section 3 below.

C.2.1 The use of CPI data: methods and SPPPs estimation results

In order to use traditional CPI data an in-depth analysis of the basket of goods and services and of the micro data has to be carried out. One of the main issues in using the Italian CPI data is that the survey is not designed for place-to-place comparisons and using these data for spatial price index estimations requires additional work to obtain matching product specifications based on detailed specifications which define the type of product (size, brand) and the type of outlet from which the product is purchased. By definition, the prices used for constructing CPIs belong to specific products that are representative of the expenditures in that geographical area, otherwise these products would not have been included in the basket of goods and services priced. Therefore, products whose prices are collected for compiling CPIs could not be comparable across different areas due to differences in local consumer behavior. For spatial comparison aims, it is essential to match the prices for those items that not only meet the CPI specifications, but which have the same brand, package, and model (variety) if they are price-determining

²⁶ The Classification of individual consumption by purpose, abbreviated as COICOP, is a classification developed by the United Nations Statistics Division to classify and analyze individual consumption expenditures incurred by households, non-profit institutions

characteristics. Therefore, when identifying the products to be compared, a “tight” product specification can be adopted but it will produce a price matrix (regions by products) with several missing values, thus resulting in a poor coverage of spatial price indexes. On the other hand, using “loose” product specifications reduces the number of missing values, but may result in price comparisons of dissimilar items with price differences that may be contaminated by quality differences (Silver and Heravi, 2005; Silver 2009).

The use of CPI data for comparing prices across geographical areas in Italy has been hampered by the complex and time-consuming analyses needed for capturing and processing the information contained in CPI data in order to make them suitable for comparing product prices. Therefore, after the 2008 and 2010 experimental releases, various studies focused on products, such as fruit and vegetables, fresh fish and meat, that are comparable by definition and whose prices, indeed, can be used for compiling spatial price indexes.

Biggeri et al (2016) focused on seven basic heading (BH) groups of products belonging to the Food and non-alcoholic beverages CPI group for carrying out further experiments with the aim of investigating the performance of various CPD models estimated using data characterized by various levels of aggregation.²⁷ More specifically, the authors selected fresh meat, all fresh fish species, all types of fresh fruit and vegetables, which accounts for 5.2 % of the entire CPI basket.

Subnational household consumption PPPs for the above mentioned BHs were estimated by using a dataset composed of 218,228 monthly price quotes collected in the 19 regional chief towns considered in the 2014 CPI survey. Although the varieties available in the different regional markets may change due to distinct local consumer and production behavior, the products considered were characterized by a high degree of overlap across the Italian regional chief towns. After having obtained annual individual price quotes for each product in the seven BHs, hedonic CPD models, which include the characteristics of the outlet where products are sold, were estimated for compiling regional price indexes for Italy.

Table 1 shows the results obtained. These show significant consumer price level differences across the various Italian regions and support the notion that price levels are higher in the Northern-Central regions than in the South, especially for the Fresh or chilled fruit BHs and Fresh or chilled vegetables other than potatoes BHs.

Moreover, after data quality controls and preliminary analyses of the basket, Laureti et al (2017) considered CPI data including annual average prices for 151 vegetable products collected in the 20 regional chief towns. They ran hedonic CPD by including retail chains. Table 2 shows SPPP results for the “Fresh and chilled vegetables” BH based on CPI data referring to the six most important modern distribution chains. It is possible to observe significant differences between the results obtained from the

²⁷ The dataset was provided by the Italian Statistical Institute (Istat) and the elementary price quotes were treated in order to respect the statistical confidentiality and the authors worked at Istat in order to test the various hypotheses of the CPD approach.

CPD and the hedonic CPD. These results appear to be coherent with our expectations and the territorial characteristics of the Italian macro areas.

C.2.2 The use of scanner data: methods and SPPPs estimation results

Over the last decade, there has been a growing interest in using scanner data for constructing official price indexes due to the increasing availability of this new data source. In the last few years, several EU countries have started to use scanner data for compiling CPIs adopting different methods (Italy in 2018, France in 2020). They acquire scanner data either directly from retail chains or indirectly from market research companies, such as Nielsen and GfK. Regardless of which provider scanner data come from, NSOs must reclassify them in order to make them suitable for constructing official CPIs and to achieve this they followed various procedures. Since the primary use of scanner data is not to measure temporal and spatial price differences, methodological and empirical issues regarding scanner data quality need to be addressed. This reclassification and data cleaning phase is essential and consumes a lot of IT resources.

The characteristics of scanner data where elementary items, whose prices are available, are clearly identified through Global Trade Item Number (GTINs) and the contextual availability of information concerning quantity sold and turnover make these data specifically fit to the aim of building PPPs as they evaluate both comparability and representativeness of each product.

Therefore, scanner data may enable countries to compile also SPPPs and improve international spatial comparisons.

For the time being, few studies have been carried out on using scanner data for compiling spatial prices indexes (Heravi, Heston, and Silver, 2003; Laureti and Polidoro, 2017; Laureti and Polidoro, 2018, Laureti and Rao, 2018) and many of them are focused on Italian cases.

C.2.2.1 The Italian project on scanner data

Istat has recently introduced scanner data to the official CPI computation and has been exploring the possibility of using them for compiling subnational PPPs.

Since 2014 scanner data have been regularly collected and provided by the market research company ACNielsen (Istat project on scanner data) that is authorised to do it by the chains of modern distribution in the framework of an agreement with the Association of Modern Distribution. ACNielsen provide Istat with scanner data on a weekly basis by uploading the data files on a dedicated Istat web portal.

As aforementioned, the itemized information contained in scanner data through GTINs and the availability of information concerning turnover and quantities for each item code may be fruitfully used in order to compile weighted spatial price indexes at the detailed territorial level.

Istat has initiated a research project, in collaboration with Tuscia and Florence Universities, focused on using scanner data for producing SPPPs on an annual basis, thus filling a gap in the statistical information

concerning consumer prices in Italy. Although official estimates have not yet been published, several analyses have been carried out since 2016.

C.2.2.2 Preliminary phase

In a first phase of the research project (Laureti and Polidoro, 2016; Laureti and Polidoro, 2017) the potential advantages and the empirical issues deriving from the use of scanner data for constructing SPPPs have been addressed by using data for the 20 Italian regional chief towns.

Laureti and Polidoro (2017) focused on computing Italian subnational PPPs at the BH level. After a process of data cleaning and trimming outliers, unit value prices per item code were computed by dividing the total turnover for that item by the total quantities sold over the week. Several analyses were carried out in order to understand how best to aggregate the detailed information contained in the Italian scanner data for constructing spatial price indexes. More specifically, by referring to each Italian regional chief town, ANOVA and t tests on a sample of items were carried out in order to verify if the price of the same item could reflect auxiliary services provided by the seller. Indeed, within each city, the same item is found in different supermarket chains and in different stores, which belong to the same retail chain. Results showed significant differences in prices of the same items thus suggesting product differentiation which is embodied in the range or quality of services offered by different retailers across chains.

Therefore, with respect to item groupings, the most detailed classification of item that is available within the BH, that is the GTIN, which is identical across the Italian territory, was chosen. As regards the time dimension, annual regional average prices for each GTIN code and outlet were used (Ivancic et al, 2011). Results obtained from the estimation of Time-interaction-Country Product Dummy models (TiCPD) confirm the high variability of SPI based on monthly data.

One issue considered in the first phase was how to use the available information on turnover to compute unit value price per item code. The unit value index should be used for a single homogeneous product. This is a basic axiom underlying the use of scanner data. Therefore, unit values for each GTIN code and outlet were calculated by dividing the total turnover for that item code by the total quantities sold over the week.

In order to compile the SPI for the 20 regional chief towns at BH level, 931 points of sale of the six most important modern distribution chains (Coop Italia, Conad, Selex, Esselunga, Auchan, and Carrefour), that cover approximately 57% of the turnover of total modern distribution, were considered. The dataset used consisted of 3,659,286 annual price quotes from the 20 regional chief towns covering 69 BHs for a total of 49,489 products (GTIN codes). They refer to 2015 and to grocery products.

From a methodological point of view, the CPD regression-based methodology, which is also used by the ICP at the World Bank for aggregating price data at BH level, was adopted. Due to the characteristics of the scanner data, which allow for including weights when computing subnational PPPs, as well as to the results of preliminary analyses, the authors used various CPD model specifications. More specifically, in order to account for the economic importance of each item in its market, which is essential in index

number literature as demonstrated also by our analyses, they estimated weighted CPD models using both expenditure share and quantity as weights.

Moreover, in order to explore the effects of including information on the type of outlet and retail chain they estimated hedonic weighted CPD models.

C.2.2.3 Second phase

In a second phase of the research project (Laureti and Rao, 2018; Laureti and Polidoro, 2018) household consumption subnational PPPs for Italy were estimated by using a larger scanner dataset constructed for experimental CPI computation after having carried out data by cleaning and trimming outliers processes. The dataset used refers to a random sample of approximately 1,800 hypermarkets (more than 500) and supermarkets (almost 1,300), concerning the grocery products sold in 2017 in the most important retail chains (95% of modern retail chain distribution that covers 55.4% of total retail trade distribution for this category of products). Since data are available for the 107 Italian provinces, within-regional and between-regional spatial price indexes for the food and non-food consumption aggregates included in the scanner dataset were estimated.

To this aim, Laureti and Polidoro (2018) referred to a list of products derived from the dataset that specifically covers 54 grocery product aggregates, belonging to five divisions of the ECOICOP (01, 02, 05, 09, 12). By aggregating the weekly prices of each GTIN code sold in the supermarkets and hypermarkets of 16 modern distribution chains located in the 107 Italian provinces using turnover weights, a total of 487,094 annual provincial prices was obtained, each one referred to a specific GTIN. These data come from a stratified random sample of outlets and items. More specifically the universe of about 9,000 outlets belonging to the 16 most important retail chains (94% of modern retail chain distribution) was stratified by province, distribution chains and kind of outlets (888 strata). Outlets are selected with probabilities proportional to the 2016 turnover (thus obtaining 1,781 outlets composed of 510 hypermarkets and 1,271 supermarkets). The identification of the items is based on barcodes (GTINs), which univocally classify the products across the entire national territory. In each outlet, items were selected with probabilities proportional to the 2016 turnover for each product aggregate in order to cover up to 60% of the total turnover of the product aggregate²⁸.

²⁸ Although this dataset was constructed for CPI compilation, it can also be used for making spatial price comparison among Italian regions bearing in mind that only the best selling products, which are typically consumed in each Italian province and region, may have been included according to the CPI selection procedure. Therefore these products may not be strictly comparable across different provinces and regions. It is useful to note that not all of the listed products must be priced in all of the regions. However, reliable regional price comparisons can be made as long as there is reasonable overlap in the items priced in different regions. We checked this requirement by verifying if product overlaps exhibit a chain structure.

On the basis of the results of the first phase of the research project, annual averages of weekly prices (average of prices paid by consumers) for each item and outlet were computed using turnover as weights. Then provincial averages using sampling weights for each outlet were calculated.

In order to estimate regional spatial indices for products sold in modern distribution chains by using data for the 107 Italian provinces, a two-step procedure similar to the one used in the ICP was adopted whereby provinces are grouped into regions (World Bank, 2013). In the first step, within-region PPPs are computed by comparing price and quantity data referring to products sold in the various provinces within each region while in the second step, between-region PPPs are obtained for each region by using deflated price data for each province.

Moreover, as in international practice, subnational PPP compilation is undertaken at two levels: at the BH level and at a more aggregated level (Food and Non-Food products that are personal and home care products). The methods selected for making multilateral comparisons is based on several axiomatic properties, including two basic properties: transitivity and base region invariance. Transitivity simply means that the PPP between any two regions should be the same whether it is computed directly or indirectly through a third region. The second requirement is that the PPPs be base region-invariant, which means that the PPPs between any two regions should be the same regardless of the choice of base region.

C.2.2.4 Aggregation methods at the BH level. First step: within-region PPPs

Let us assume that we are attempting to make a spatial comparison of prices between R regions, $r=1,...,R$, with M_r provinces in each region r . In the first stage of aggregation of price data at item level, which leads to price comparisons at BH level, and represent price and quantity of i -th item in j -th province and in r -th region $i=1,2,...,N$; $j=1,2,...,M$; $r=1,2,...,R$.

In order to compute within-region PPPs, we explored different methods.²⁹ However, due to lack of space, we only illustrate the *Region-product-dummy (RPD) method* which was also used to compute between-regional PPPs. All methods are implemented using R. If product overlaps exhibit a chain structure thus the RPD method exhibits some aspects of spatial chaining.

The RPD is the regional version of the country-product-dummy (CPD) method used in international comparisons. This method suggests that price levels are estimated by regressing logarithms of prices on provinces for each *province* and product dummy variables; the model is given for each BH by:

$$\begin{aligned} \ln p_{ijr} &= \ln PPP_j + \ln PPP_i + \ln u_{ijr} \\ &= \pi_j + \gamma_k + v_{ij} \end{aligned}$$

²⁹ We used various spatial index formulae, including Fisher-based GEKS, Geary-Khamis and CPD (World Bank, 2013; Laureti and Rao, 2018). We found interesting results which suggest a high variability of prices within various regions. However, they cannot be reported here due to lack of space.

$$= \sum_{j=1}^{M_r} \pi_j D^j + \sum_{i=1}^N \gamma_i D^i + v_{ijr}$$

(1)

where D^j is a provincial-dummy variable that takes value equal to 1 if the price observation is from j -th province in the r -th region; and D^i is a i -dummy variable that takes value equal to 1 if the price observation is for i -th commodity.

The random disturbance is assumed to satisfy the standard assumptions of a multiple regression model. In order to estimate parameters of this model we impose normalization $\sum_{j=1}^{M_r} \pi_j = 0$ thus treating all regions in a symmetric manner. If $\hat{\pi}_j = (1, 2, \dots, M_r)$ are estimated parameters, the within-regional PPP for the province j in region r is given by $WR_PPP_j = e^{\hat{\pi}_j}$. The RPD method-based price comparisons are transitive and base-invariant. With the aim of taking into account the economic importance (representativeness) of each product expressed by expenditure weights w_{ijr} based on turnover we used a weighted RPD model:

$$\sqrt{w_{ijr}} \ln p_{ijr} = \sum_{j=1}^{M_r} \pi_j \sqrt{w_{ijr}} D^j + \sum_{i=1}^n \eta_i \sqrt{w_{ijr}} D^i + \sqrt{w_{ijr}}$$

(2)

C.2.2.5 Aggregation methods at BH level. Second step: between-region PPPs

In order to use provincial prices adjusted for differences among provinces within the r -th region, item prices in all the provinces of region r are converted by using:

$$\hat{p}_{ijr} = \frac{p_{ijr}}{WR_PPP_{jr}}$$

(3)

The deflated prices (in log form) were used for estimating a weighted RPD model with regional dummies and weights defined by deflated expenditure for each item in the r -th region.

$$\sqrt{w_{ijr}} \ln p_{ijr} = \sum_{j=1}^R \pi_k \sqrt{w_{ijr}} D^k + \sum_{i=1}^N \eta_i \sqrt{w_{ijr}} D^i + \sqrt{w_{ijr}} v_{ijr}$$

(4)

The between-region PPP for the region r is given by $R_PPP_r = e^{\hat{\pi}_r}$ and transitive price comparisons based on RPD method are given by:

$$P_{rk}^{RPD} = \frac{\exp(\hat{\pi}_k)}{xp(\hat{\pi}_r)} \text{ for all } r, k = 1, 2, \dots, R$$

(5)

C.2.2.6 Aggregation method above basic heading level

The next and final step for compiling regional price comparisons is to aggregate the results from BH level comparisons to higher level aggregates. Let us assume that there are L basic headings ($l=1, \dots, L$) and e_i^r expenditure for i -th BH in region r . We decided to use the Fisher price index since it has a range of axiomatic and economic theoretic properties.

The Fisher index is given by:

$$P_{rk}^{Fisher} = \sqrt{P_{rk}^{Laspeyres} \cdot P_{rk}^{Paasche}}$$

(6)

Where

$$P_{rk}^{Laspeyres} = \frac{\sum_{l=1}^L p_l^k q_l^r}{\sum_{l=1}^L p_l^r q_l^r} = \sum s_l^r \left(\frac{p_l^k}{p_l^r} \right)$$

$$P_{rk}^{Paasche} = \frac{\sum_{l=1}^L p_l^k q_l^k}{\sum_{l=1}^L p_l^r q_l^k} = \left[\sum_l s_l^k \left(\frac{p_l^k}{p_l^r} \right)^{-1} \right]^{-1}$$

$$\text{With } s_l^r = \frac{e_i^r}{\sum_{l=1}^L e_l^r} = \frac{p_l^r q_l^r}{\sum_{l=1}^L p_l^r q_l^r}$$

As the Fisher binary index in (6) is not transitive, it is possible to use the procedure suggested by Gini (1931), Elteto and Koves (1964) and Szulc (1964) referred to as the GEKS index to generate transitive multilateral price comparisons across different regions.

The resulting index is given by:

$$P_{rk}^{GEKS-FISHER} = \prod_{r=1}^R [P_{rs}^{Fisher} \cdot P_{sk}^{Fisher}]^{1/R}$$

(7)

The GEKS-Fisher based formula is used in cross-country comparisons made within the ICP at the World Bank (2015) and the OECD-Eurostat comparisons. In order to obtain a set of R_PPPs that refer to the group of regions (Italy) we standardized the GEKS-Fisher based PPPs (S-GEKS).

C.2.2.7 The Italian project on scanner data: main results of second phase

As shown in Figure 2 and Table 3, Southern regions appear to have price levels that are below the national average both for Food and Non-Food products, with the exception of Abruzzo (101.90 and 101.33, respectively), Molise (102.90 and 101.24), and Sardegna (101.93 and 101.57). However, it is worth noting that some Northern regions also show lower price levels than the national average, such as Emilia-Romagna (98.31 and 98.40), Veneto (99.09 and 98.48) and Piemonte for Food products (99.80). On average, Toscana proved to be the less expensive region for both product aggregates (96.24 and 95.17).

These results seem to suggest that when considering the retail trade modern distribution, the expected relationship in terms of price levels between the North and South of Italy partially changes and propose an interesting line for future research on the influence of the various distribution channels when defining subnational PPPs.

Caution is required when interpreting these results since: a) they may be influenced by the characteristics of the modern retail trade which is not uniformly distributed across Italian territory in terms of types of retail chains and market share; b) we excluded two groups of products “Whole Milk” and “Low-Fat Milk” since there were no reliable overlaps among regions enabling spatial price comparisons; and c) these results are based on data selected for CPI compilation and hard discounts are excluded.

In some BHs, the usual divide between North and South is not confirmed. Regional spatial price indexes for two specific groups of products, that is “Pasta products” (BH1), which belongs to the aggregate Food products, and “Non-electrical appliances” (BH2, e.g. razors, scissors, hairbrushes, toothbrushes, etc.) included in the Non-Food aggregate are illustrated in Table 4. Our findings confirm large differences in price levels among Italian regions even if BH2 shows a higher territorial heterogeneity than BH1 (range is equal to 19.03 and 13.23 respectively). In the case of BH1, five regions located in the South and Islands (out of 8) and two Northern- Central regions (out of 11) show lower prices than Lazio while for BH2 higher price indexes are observed in three Southern regions and eight regions in Northern and Central Italy. This different territorial pattern of consumption spatial price indexes is not confirmed when aggregated regional PPPs are computed for Food and Non-food products (Italy=100).

Price levels can also vary greatly within a region. Figure 2 shows within-region household consumption PPPs for Tuscany where Siena proved to be the most expensive province for Food products compared to Tuscany as a whole while Prato is the cheapest. A higher heterogeneity in price levels can be seen for Non-Food products as Livorno is the most expensive province. In contrast to Tuscany, Lombardy, whose results are illustrated in Figure 3, is more homogeneous for both product aggregates as we can see from the results.

These findings could be used for obtaining spatial adjustment factors to be used when prices for other product categories are collected using traditional survey (on-field price collection) or ad-hoc surveys carried out in the regional capital.

C.2.3 Future projects and concluding remarks

The encouraging results obtained using scanner data strengthen Istat strategy to achieve the aim of regularly producing SPPPs for Italy comparing consumer prices amongst different regions.

The key of this project is the multi-source approach to estimate SPPPs, replicating in the field of spatial comparison what is already done in the field of temporal comparison.

C.2.3.1 Implementing data base in the framework of multi-source approach to SPPPs estimation

To build up a database that could allow the estimation of SPPPs related to the entire universe of household consumption, Istat is working on the following sub databases:

A) An appropriate use of CPI data starting from a deep analysis on one hand of the basket and on the other hand of the microdata.

The analysis of the basket is aimed at selecting all the products which, by definition, are comparable and indeed they do not need further specifications in additions to those ones already present in the basket. This is the case of fresh fish, all the different varieties of fresh fruit and fresh vegetables that are well specified in the CPI basket, laundry and repair services for clothing, repair services for footwear, some goods and services relating to the dwelling and its maintenance (as gas, water supply, sewerage, waste collection, electricity, heating oils, etc.), some medicines, some medical services, some paramedical and hospital services, fuels, car rental and car parking, some urban transportation services, some catering services, canteens, some accommodation services (for a total weight on the consumer price basket that is about 20%).

Thus, the analysis of microdata is aimed at selecting all the elementary products that are present in a sufficient number of regions and in a remarkable amount (it has to be established in how many regions and when considering remarkable the amount of elementary quotes available) in order to be both representative and comparable.

B) Scanner data for grocery products (about 10% of the basket if we do not take into account food products listed in the previous point). As aforementioned, scanner data should bring the detailed information about the characteristics of the elementary product and the information about turnover of that specific product, allowing the comparison of representative “like to like”.

C) Administrative data that are already used for CPI purposes (in particular those concerning automotive and heating fuels) and other administrative data that are on the way to be used (the database of rents provided by Italian Tax Office).

D) Excluding the products for which it does not make sense to compare among different geographical areas (because the prices are the same or the differences not relevant such as tobacco products or telecommunications, for a total weight of about 8%).

E) For the remaining CPI products (or for a part of them where the microdata analysis has not provided or will not provide satisfactory results), specific price data collection will be carried out.

Since 2013 Istat has focused the attention on this fifth point whose implementation is crucial for the subnational comparison, by building on the results, in terms of use of electronic devices, obtained for the monthly territorial data collection for CPI.

At the end of 2013 Istat started the design and the implementation of a new software that translated in the field of the spatial comparison the technical advancements achieved in the field of temporal comparison (for the territorial data collection it was designed and developed a software dedicated to manage all the statistical issues of the consumer price data collection, that is P1J).

The software to collect price data for spatial comparison aims was tested (and then currently used) in the recent years to collect prices in the capital, Rome, for international PPPs, taking into account the Eurostat basket in terms of list of products and their description.

In 2020, it will start the use of this software (P3A) to collect prices across different regions (at the beginning in the chief towns) to fill the gap of basic information that is not covered by CPI, scanner or admin data. The architecture of the IT system for the use of P3A is based on a web oriented client server system where:

- data collectors download the workload of each cycle of the survey from a dedicated server using UMTS. In this occasion, they download the basket including all the specific descriptions of the products. The basket is the same (in a reduced version) of that adopted for the ICP;
- data collectors visit the same outlets where the data collection for CPI is carried out;
- data collectors send to the server the elementary prices collected and their notes together with the information about new brands and varieties;
- data collectors will receive, via the server, information coming from other data collectors in order to check their work in the field and return the information checked and possibly revised;
- Istat statisticians monitor the entire production process through a web application that will produce the necessary qualitative indicators.

The basic idea is that the data collector who visits a shop for the monthly CPI survey, in certain occasions will be asked, before leaving the shop, to make another tour of data collection for the basket of SPPPs, using the same tablet but launching a different application (the realization of this perspective requires adequate training of the data collectors).

C.2.3.2 Compiling SPPPs at BH and upper level of classification

As illustrated in the previous paragraph, Istat's strategy to implement currently the database to compile spatial indices of consumer prices is actually quadruple: use of CPI data (already representative and in some cases comparable and in other cases made comparable through appropriate ex-post treatments),

of scanner data, of administrative data and the implementation of ad hoc data collection for certain groups of products using electronic devices and a dedicated software.

The objective of building up and regularly updating at least four matrices (one for each of the above data sources) where regions crosses the products and whose sum covers the entire household consumption universe.

The matrices will have different contents, depending on the data that are referred to and their granularity.

In each cell of the matrix of data coming from territorial data collection and comparable on their own (sub-database A), BH SPPPs index should be available, provided that it is obtained through the use of the unweighted version of RPD model (as described in paragraph 2.2.4), exploiting the prices collected in the provinces of each region (given that, generally speaking, just a limited amount of prices in each province are available and that have to be grouped at a more aggregated level with respect to the GTINs details). RPD could be used for the second step to estimate between region PPPs.

In each cell of the matrix of sub-database B (scanner data) SPPPs index should be available, provided that it is obtained through the weighted version of RPD. Also in this case, RPD could be used for the second step to estimate between region PPPs.

In the matrix of the sub-database C for each fuel product, average prices should be available, allowing the direct compilation between region PPPs. For the data of rentals for housing, each cell should be more granular taking into account some further stratification (by type of contract, type and size of dwelling) allowing the, also in this case, the direct compilation of between region PPPs.

Also in the case of sub-database E, in each cell of the matrix average prices of the data collected should be available, given that the products in the basket for which data collection will be carried out are well specified in order to make them comparable across Italian regions. To make them completely representative of the regions (at the beginning they are collected just in the chief towns), special spatial coefficients (derived from other sources such as scanner data) could be used to take into account the variability amongst the provinces within each region.

For the aggregation from BH level to higher level of comparison (BHs aggregation), GEKS indices should be compiled. In this passage, data coming from different sources could be used (i.e. from BHs calculated using scanner data and BHs calculated using territorial data collection). In all these cases, an intermediate aggregation has to be carried out before going up to further level.

SPPPs that will result from this strategy should be released preliminarily in 2021 through experimental statistics in order to allow the scientific debate to develop, providing suggestions and improvements before starting the official production of such a crucial indicator.

References

Biggeri, L., Laureti, T., and Polidoro, F.(2017) Computing subnational PPPs with CPI data: an empirical analysis on Italian data using country product dummy models. Soc Indic Res, 131(1), pp. 93-121.

- Heravi, S., Heston, A., and Silver, M. (2003). Using scanner data to estimate country price parities: A hedonic regression approach. *Review of Income and Wealth*, 49(1), 1-21.
- Ivancic, L., Diewert, W. E., and Fox, K. J. (2011). Scanner data, time aggregation and the construction of price indexes. *Journal of Econometrics*, 161(1), 24-35.
- Laureti T. and Polidoro F. (2017) "Testing the use of scanner data for computing subnational Purchasing Power Parities in Italy", *Proceeding of 61st ISI World Statistics Congress*, Marrakech.
- Laureti T, Ferrante C and Dramis B. (2017) "Using scanner and CPI data to estimate Italian subnational PPPs" *Proceeding of 49th Scientific Meeting of the Italian Statistical Society*, Florence.
- Laureti, T., and Polidoro, F. (2018) Big data and spatial comparisons of consumer prices Testing the use of scanner data for computing subnational Purchasing Power Parities in Italy, *Proceeding of 49th Scientific Meeting of the Italian Statistical Society*, Palermo.
- Laureti, T., and Rao, D.S.P.(2018) Measuring Spatial Price Level Differences within a Country: Current Status and Future Developments. *Estudios de economía aplicada*, 36(1), pp.119-148.
- Silver, M. (2009). The hedonic country product dummy method and quality adjustments for purchasing power parity calculations. IMF working paper WP/09/271.
- Silver, M., and Heravi, S. (2005). Purchasing power parity measurement and bias from loose item specifications in matched samples: An analytical model and empirical study. *Journal of Official Statistics*, 21(3), 463.
- World Bank (2015) *Purchasing Power Parities and the Real Size of the World Economies-A Comprehensive Report of the 2011 International Comparison Program*, Washington, DC

TABLES AND FIGURES

Table 1 Estimates of subnational PPPs for regional capitals using hedonic CPD models and CPI data, ROME=100

	Beef	Other meats	Pork	Lamb	Fruit	Vegetables	Fish and seafood	
	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	
North								
Aosta	106.1	109.8	111.1 **	95.6	125.2 ***	125.5 ***	93.7 *	
Torino	112.9 **	105.9	100.1	104.7	102.3	98.8	100.7	
Genova	110.0 **	98.5	93.6 **	95.5	113.7 ***	111.1 ***	97.5	
Milano	87.2	105.5	96.3	97.0	150.6 ***	155.0 ***	125.2 ***	
Trento	105.4	106.1	87.6	100.3	125.2 ***	119.7	92.4 **	
Venezia	104.5	98.9	94.9	108.9	123.2 ***	116.3	76.1 ***	
Trieste	102.5	123.3 *	98.1	116.9 *	121.5 ***	121.4	91.1 ***	
Bologna	99.9	104.1	103.0	101.3	126.8 ***	123.8 ***	82.5 ***	
Centre								
Firenze	87.7 **	92.5	87.7	97.6	108.9 ***	98.2	97.6	
Ancona	107.3 **	103.2	105.3	110.0 ***	122.6 ***	112.5 ***	86.3 ***	
Perugia	101.6	87.3	95.9	110.4	111.1 ***	101.7	111.1 ***	
South and Islands								
Aquila	100.7	113.9	100.1	98.4	92.1 ***	87.3 ***	85.2 ***	
Campobasso	92.5	96.2	95.8	95.5	93.9 ***	89.2 ***	85.3 ***	
Napoli	81.2 ***	92.6	87.1 ***	87.2 **	96.0 *	86.0 ***	76.9 ***	
Potenza	77.9 ***	86.3	87.4 **	88.3 ***	99.3	96.6	74.4 ***	
Bari	89.1 **	81.6	96.4	101.8	89.2 ***	84.4 ***	74.6 ***	
Catanzaro	78.8 ***	85.2 **	82.4 ***	76.5 ***	81.4 ***	82.3 ***	79.7 ***	
Palermo	87.1 **	90.4	85.1 ***	80.1 ***	101.9	102.5	104.1	
Cagliari	86.1 ***	87.5	86.9 ***	74.5 **	104.2 *	98.3	91.5 **	
Obs.	177	74	89	42	1673	2018	888	
Root MSE	0.176	0.147	0.148	0.105	0.181	0.246	0.194	
AIC	-89.70	-56.26	-69.18	-57.08	-879.98	167.93	-340.52	

Table 2 Estimates of subnational PPPs for regional capitals using hedonic CPD models and CPI data, ROME=100

	Fresh and chilled vegetable			
	HEDONIC CPD		HEDONIC CPD	
	PPPs	Sig.	PPPs	Sig.
North				
Aosta	100.44		101.43	***
Torino	101.50		96.37	***
Genova	108.20	**	103.96	***
Milano	92.45	***	98.01	***
Trento	94.14	***	103.26	***
Venezia	108.26	***	95.14	***
Trieste	99.42		102.16	***
Bologna	103.47		99.63	*
Centre				
Firenze	100.98		89.72	***
Ancona	108.22	***	100.04	
Perugia	101.57		100.51	**
South and Islands				
L'Aquila	86.55	***	101.37	***
Campobasso	84.63	***	100.78	**
Napoli	75.37	***	96.01	***
Potenza	88.33	***	97.08	***
Bari	97.47		94.62	***
Catanzaro	103.67	*	98.15	***
Palermo	103.70		98.57	***
Cagliari	102.87		98.57	***
Obs.	3,327		66,604	
Root MSE	0.17573		0.1170	

Table 3. SPIs estimation results for Food and Non-Food products (Italy=100) using scanner data

	Food products	Non-Food products
North-Center		
PIEMONTE	99.80	100.35
VALLEDAOSTA	104.95	107.86
LIGURIA	102.44	102.65
LOMBARDIA	100.18	100.59
TRENTINO	101.56	102.41
VENETO	99.09	98.48
FRIULI	100.77	100.70
EMILIA- ROMAGNA	98.31	98.40
TOSCANA	96.24	95.17
UMBRIA	98.53	98.02
MARCHE	101.08	101.44
LAZIO	100.23	99.82
South and Islands		
ABRUZZO	101.90	101.33
MOLISE	102.90	101.24
CAMPANIA	98.65	97.20
PUGLIA	97.74	97.78
BASILICATA	97.53	99.54
CALABRIA	98.02	98.22
SICILIA	101.93	101.57
SARDEGNA	98.61	97.88

Table 4. WRPD estimation results for “Pasta products” and “Non-electrical appliances” Italy=100

Region	Pasta Products (BH1)				Non-electrical appliances (BH2)			
	Coef	std.error	p.value	RPP	Coef	std.error	p.value	RPP
North-Center								
PIEMONTE	0.0028	0.0027	0.3071	100.28	-0.0550	0.0056	0.0000	94.65
VALLEDAOSTA	0.0367	0.0028	0.0000	103.74	0.0528	0.0059	0.0000	105.43
LIGURIA	0.0323	0.0034	0.0000	103.28	-0.0061	0.0056	0.2829	99.40
LOMBARDIA	0.0104	0.0027	0.0001	101.05	-0.0402	0.0056	0.0000	96.06
TRENTINO	0.0557	0.0029	0.0000	105.73	0.0268	0.0057	0.0000	102.71
VENETO	0.0188	0.0027	0.0000	101.89	-0.0133	0.0056	0.0183	98.68
FRIULI	0.0276	0.0026	0.0000	102.80	-0.0079	0.0057	0.1611	99.21
EMILIA-ROMAGN	0.0068	0.0031	0.0270	100.68	-0.0386	0.0056	0.0000	96.22
TOSCANA	-0.0209	0.0028	0.0000	97.93	-0.1205	0.0057	0.0000	88.65
UMBRIA	-0.0254	0.0029	0.0000	97.50	0.0027	0.0056	0.6357	100.27
MARCHE	0.0398	0.0031	0.0000	104.06	0.0258	0.0056	0.0000	102.61
LAZIO	-0.0159	0.0026	0.0000	98.42	0.0075	0.0056	0.1823	100.75
South and Islands								
ABRUZZO	0.0401	0.0030	0.0000	104.09	0.0036	0.0057	0.5254	100.36
MOLISE	0.0311	0.0031	0.0000	103.16	0.0354	0.0058	0.0000	103.60
CAMPANIA	-0.0256	0.0029	0.0000	97.47	0.0348	0.0057	0.0000	103.54
PUGLIA	-0.0547	0.0029	0.0000	94.68	-0.0071	0.0057	0.2132	99.29
BASILICATA	-0.0570	0.0029	0.0000	94.46	0.0236	0.0057	0.0000	102.39
CALABRIA	-0.0445	0.0029	0.0000	95.65	0.0270	0.0057	0.0000	102.74
SICILIA	-0.0758	0.0034	0.0000	92.70	0.0679	0.0057	0.0000	107.03
SARDEGNA	0.0176	0.0036	0.0000	101.78	-0.0192	0.0057	0.0007	98.10

Figure 1 Annual average price across Italian regional capitals (GTIN/EAN=8001250120113; Item description=«DE CECCO SEM LUNGA SPAGHETTINI N.11 SEM PASTA 500 GR 1 SACCHETTO»

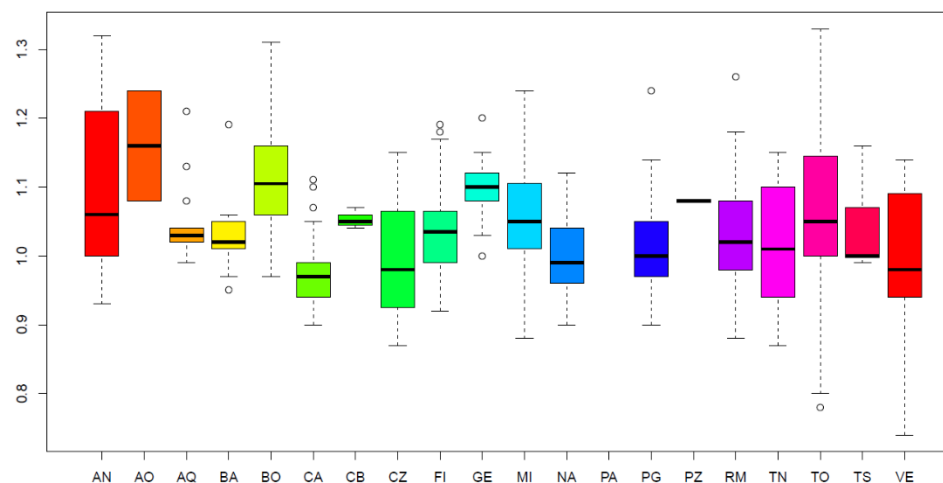


Figure 2 Regional PPPs based on scanner data (Italy=100)

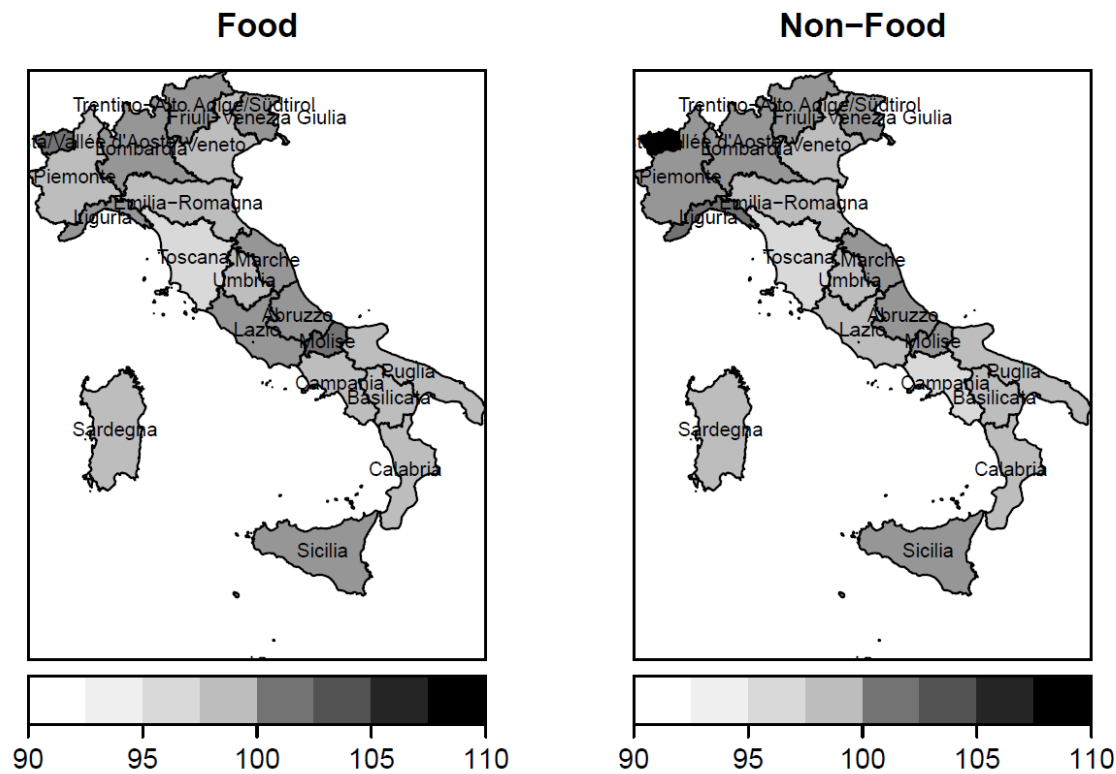


Figure 3 within-Region PPPs based on scanner data for Tuscany (Florence=100)

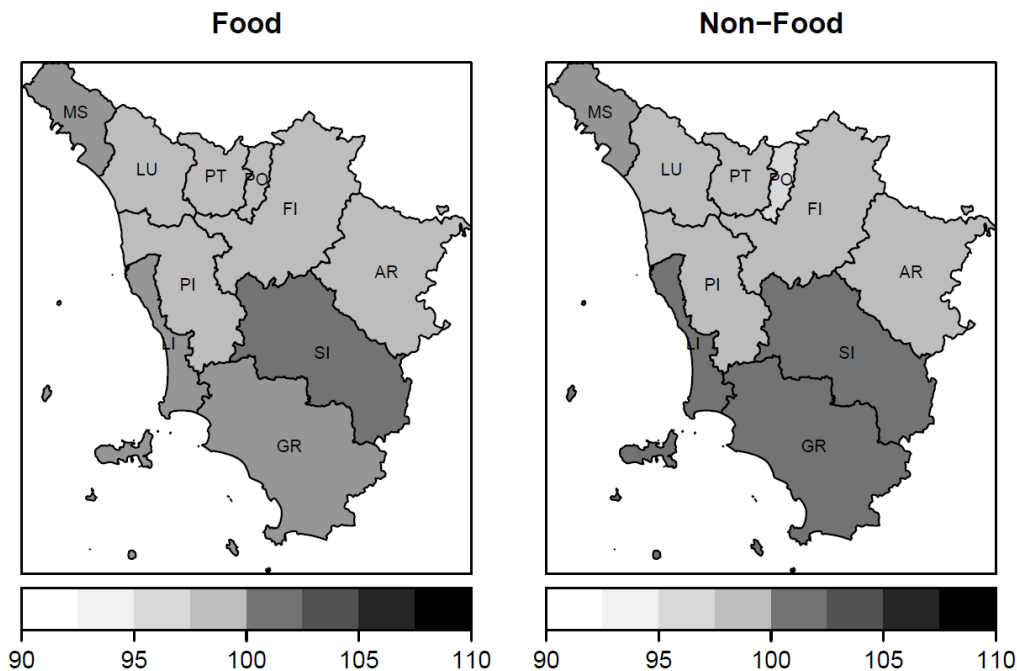
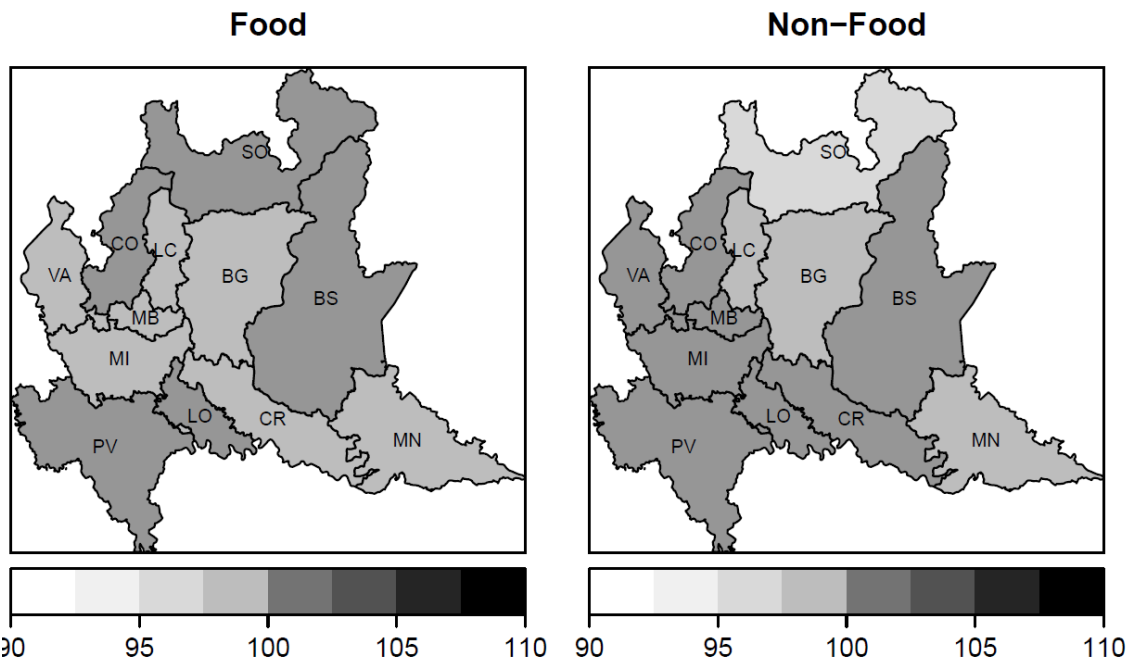


Figure 4 within-Region PPPs based on scanner data for Lombardy (Milan=100)



D. Vietnam

D.1 Introduction

The General Statistics Office (GSO) of Vietnam calculates subnational purchasing power parities (SN-PPPs) for its cities, provinces, and regions. These are used in a *Spatial Cost of Living Index (SCOLI)*, which reflects the difference in price of goods and services consumed by people and households in their daily lives at a point in time (either for a month, quarter, or year). In 2010, the World Bank supported a pilot study by GSO with the aim of calculating the SCOLI for 2012 using a list of 64 goods and services with food and foodstuff making up the majority. Since 2012, GSO has officially conducted surveys and calculated SCOLI by state budget, and increased the number goods and services included by 37 items to now cover 101 in total. These new items are mainly non-food and non-foodstuff goods which improve the representation of SCOLI as well as extends its use to other purposes such as calculating the Human Development Index (HDI). However, there have been many challenges in collecting SCOLI prices in provinces and cities; thus the quality of SCOLI data has not yet reached the desired standard.

In 2011, GSO participated in the ICP 2011 cycle through the Asia and Pacific comparison coordinated by the Asian Development Bank (ADB). World Bank and ADB experts introduced a method to calculate subnational PPPs in each country based on the consumer price index (CPI) data available.

Using CPI data to calculate SN-PPPs has some advantages as follows:

- It avoids an obligation to conduct a subnational PPP survey every two years in 63 provinces and cities. Thus budget, human resources, and time savings can be realized. Furthermore the essential data can be published more frequently such as quarterly or yearly.
- Commodity items in the CPI are adequate, covering food, foodstuff and non-food goods and services.
- Using CPI data to calculate subnational PPPs can better serve analyses and assessments of poverty alleviation programs, HDI calculation, and other purposes.

Given these above advantages of calculating subnational PPPs using CPI data, GSO initiated a project to improve the subnational PPPs calculation method using consumer price data sources. From 2014, the SCOLI price survey will not be conducted in provinces and cities. The budget for the 2014 SCOLI survey will be moved to the estimation for studying the methodology and calculation on a pilot basis of a subnational PPP index using consumer price data source in 2014.

D.2 Scope and uses of subnational PPPs

D.2.1 Scope

The SCOLI index is compiled and grouped according to the following :

- According to 63 provinces: compare with the average price of Hanoi city.
- According to 6 geographical regions: compare with the Red River Delta region.
- According to 11 groups of consumer goods by purpose (COICOP).

D.2.2 Uses of subnational PPPs

Subnational PPPs are used in analyzing the effects of poverty reduction policies, difficulty subsidies, wage subsidies, and living standards studies among provinces and regions throughout the country. These indicators are also the basis for calculating the HDI, calculating PPP-based GDP, assessing the minimum living standards and adjusting regional wages, calculating investment costs, evaluating the competitiveness of prices, diets, accommodation, and working costs according to regional prices.

Currently, the GSO uses the subnational PPPs index to eliminate price differences in household incomes and expenditures across regions. These price-adjusted incomes and expenditures help to determine the number of poor households and the poverty rate.

In order to compile the HDI indicator, the subnational PPPs are used to calculate the PPP-based GDP of the provinces in terms of the overall price level of the whole country or of a selected province, in the local Vietnamese currency, and then to calculate the PPP-based GDP in US dollars (USD) to calculate the relevant component of the composite HDI index.

Subnational PPPs are also used to calculate minimum living standards in regions and in other spatial or geographic comparisons.

D.3 Methodology used

The methodology and processes of the ICP are used to calculate subnational PPPs at the provincial level and to compare price levels among regions or provinces in the country. In fact, comparing prices across regions in the country is easier than across countries. The major difficulty in calculating subnational PPPs is to collect detailed values of product groups in each region. This is also an essential requirement to aggregating the real expenditure (and average expenditure per capita) for expenditure groups and computing the weights of the components of subnational PPPs to tabulate total regional expenditure. On the other hand, comparing related prices across regions in the country is easier than that across countries because the regional comparisons do not need to take into account market exchange rate differences.

CPI data are important analytical tools for decision-makers, economists, universities and economic organizations. Subnational PPPs can be used to determine a national poverty line and compare poverty rates across regions or provinces based on a basket of goods and services.

In order to develop subnational PPPs at the provincial level, we need to consider three main issues:

- (i) compiling data to calculate subnational PPPs at the provincial level;
- (ii) identifying product overlap among provinces/cities; and
- (iii) aggregating Subnational PPPs at the provincial level.

(i) Compiling data to calculate subnational PPPs at the provincial level

Review and code the item list from the consumer price survey database in 2010 to calculate SCOLI; check and convert to the same unit for calculating commodity prices among provinces. Based on specifications,

grades, units, and prices of each item of the same province to put in the same group then add the code to create the code of Subnational PPPs list. Placing Subnational PPPs code was created and used uniformly in compiling Subnational PPPs indexes. Database is first checked to determine the average price of the commodities which are directly comparable among provinces/cities. This process also determines commodities that are considered similar and their average price is not impacted too strictly by the difference in main features, where its specification and package are especially important. For instance, average price of “soft drink” bottled from 300ml to 1.5 liter will unbalance the average price even when the price is converted to unit price because price on one volume unit of a big bottle of soft drink is often much lower than that in a small bottle. In such cases, they should be broken down into two or more commodity groups (for example: bottle less than 600ml and bottle more than 600ml).

Average price, which is extracted from the CPI database, is the basic input information but when used for international comparison it needs further data on expenditure. Accordingly, subnational PPPs data on each commodity will be aggregated into subnational PPPs for larger commodity groups.

(ii) Identifying product overlap among provinces/cities

One of the criteria for selecting products for subnational PPPs compilation is their representation of consumer purchases. It is assumed that all products in CPI basket are representative. However, each province or city has its own “commodity basket” and that basket represents the consumption of the province or city and reflects its consumption patterns. Therefore, it needs to identify the list of representative products for the province or city and collect the price in at least two provinces or cities to set up the overlap. In case datasets are scattered, it cannot calculate subnational PPPs even when the overlap is set up. Thus, it needs to establish to a certain extent that the double combination and its transition are clear and can create subnational PPPs that are more practical and reliable.

The CPI basket of goods and services basket is relatively stable in short-term and mid-term because the main purpose of CPI is to compare prices over time. Changes will arise when old products do not exist and the new ones are not available before. The accurate technical parameters of CPI commodities can be different among provinces and cities depending on local conditions (for example: package size can be different among regions and the diversity of one product can be different). It results in some issues arising when CPI data are used in the subnational comparison. These issues can be addressed simply. Different package sizes can be adjusted by price unit, regulation as package sizes are relatively similar.

Note that the structure of the CPI is as follows:

+ Group level 1, includes:

- Restaurant and catering services
- Beverages and tobacco
- Garments, hats, and footwear
- Housing, electricity, water, fuel, and construction materials
- Household equipment and appliances
- Medicament and health services

- Transportation
- Post and telecommunication
- Education
- Culture, sports, entertainment, and tourism
- Other goods and services

+ 32 groups at level 2; 86 groups at level 3 and 256 groups at level 4

(iii) Aggregating Subnational PPPs at the provincial level

After arranging price data and weight and determining overlapped commodities, national subnational PPPs estimation will be carried out at different levels, including at grass-root and higher-aggregated levels.

Aggregate price index at basic level

Calculating the price index at the lowest level is called basic aggregated level. At this level there is no weight. This is the product level in CPI and the basic group in ICP. In this study, the Country-Product-Dummy (CPD) index is used at basic aggregated level.

The basic dataset needed to calculate CPD is a price matrix of all products with prices in each region. Apparently, there are blank cells in the matrix because it cannot get a price for each product in each province or city due to the unavailability of some products in some provinces and cities and the difference in quantity of products priced in provinces and cities. The CPD's basic model is multiplying, and assumes that the difference in prices of products in provinces and cities is the same rate in all provinces and cities and price differences within a province or city is the same rate for all products.

The CPD index is often used in spatial international comparisons. However, for this study CPD is the basic general combination of space and time. CPD was first introduced by Summers (1973) and presented in two equivalent forms, interception and non-interception. The regression equation for CPD is as follows:

$$\ln p_{cp} = Y_{cp} = x_{cp}\beta + \varepsilon_{cp} \quad (1)$$

Where: p_{cp} : Price of product p in the country c

D_{cj} and D_{pi} : product and country dummy variables

N_p and N_c : number of products and number of countries

$$x_{cp} = [D_{c2} \dots D_{cN_c}; D_{p1} D_{p2} \dots D_{pN_p}]$$

$$\beta = [\alpha_2 \dots \alpha_{N_c}; \pi_1, \pi_2, \dots, \pi_{N_p}]^T \quad (2)$$

In matrix denotation, arrangement by separate observations can be

$$Y = X \beta + \varepsilon \quad (3)$$

Aggregate price index at higher level

Using Laspeyres geometric mean formula, PPP for region k with region j as base is given by

$$PPP_{jk} = \prod_{i=1}^N \left[\frac{p_{ik}}{p_{ij}} \right]^{w_{ij}} \quad (4)$$

D.4 Price and weights data

D.4.1 Sources of data

The GSO uses sources of consumer price survey data to calculate the SCOLI index according to the method of the World Bank (WB) and Asian Development Bank (ADB).

- Consumer price survey is being carried out monthly by the General Statistics Office in 63 provinces with 572 goods and services in the 2014-2019 period.
- Data quality ensures a close reflection of the trend and level of the cost of living price fluctuations among provinces and regions because the list of items has a high level of representation of common consumption of residents and this list is periodically reviewed and updated by the GSO. Consumer prices are surveyed three times per month for twelve months of the year
- The use of available data from the consumer price survey (instead of organizing a separate survey to calculate the subnational PPPs) will realize State budget savings, time savings, and reduce the opportunity cost. Field surveys for the statistics industry, thereby helping to improve the quality of other professional jobs, which improve the quality of periodic surveys on consumer prices.

D.4.2 Survey framework

PSOs review and strengthen the network for price surveys in provinces and cities as follows:

Enumeration area

Based on administrative, geographical and population scope, GSO allocates the number of enumeration areas for provinces/cities (see Annex 3). With allocated enumeration areas, PSOs select and distribute enumeration areas suitable with real conditions of provinces and cities and the following requirements are met:

- Selecting enumeration areas representing whole urban and rural areas of the province;
- It is possible to collect price of all goods and services by list of representative items in the enumeration areas
- Refer to field materials of Household Living standard survey and weight survey in 2014 to select enumeration areas for precisely reflecting reality of price fluctuation of province/city.

Enumeration point

The enumeration point should satisfy two requirements:

- Enumeration point as an establishment with stable business operations;
- If the item has a different price among enumeration points, more enumeration points need to be selected; if the item has relatively similar variation in price among enumeration points, fewer

enumeration points are selected (Annex 2). For example, Market A (enumeration area) has seven pork outlets located in different positions. By observation, the price of griskin (selected item for survey) is different among these outlets. Therefore, in order to reflect the price of griskin correctly in the enumeration area, it is necessary to select three outlets (three enumeration points) to collect prices. Conversely, the retail price of condensed milk “Ong Tho”, 380 gram is quite similar in outlets in the market, and thus one outlet is selected for collecting the price.

To meet the two requirements above, GSO regulated necessary enumeration points for each item in each enumeration area as follows:

- Food and foodstuff: three enumeration points per each item
- Other items: one enumeration point is needed

And the norm for the enumerator is:

- Items for collecting price with one period/month, each enumerator is responsible for gathering price of 80 items (maximum).
- Items for collecting price with three periods/months, each enumerator is responsible for gathering price of 50 items (maximum).

With 572 items and services representing the period 2014-2019, it is necessary to have seven to eight enumerators for one enumeration area.

D.4.3 Weights

The weights in CPI calculations are the expenditure proportions of commodity and services groups in the total expenditure of the people. The weights in CPI calculations for the whole country are the expenditure proportion of each region in comparison with total expenditure of the country by each commodity group. The weights in CPI calculations at regional level are the expenditure proportions of each province/city in the region over total expenditure of the region. The weights in CPI calculations for each province/city are the expenditure proportions of each commodity group over total expenditure of province/city. The weight is calculated by urban and rural area and generally calculated for two areas.

There are two kinds of weights in the CPI:

- Vertical weight: this is ratio of expenditure on each group of items with total expenditure of people. The vertical weight is calculated for urban and rural areas and for two areas of each province, each region and the whole country.
- Horizontal weight: this is ratio of expenditure of each urban and rural area with expenditure of whole province, region or country.

Weights in CPI are stable over five years and for the base year (identical with year updating classification of representative goods and services). In the period 2014-2019, the base year is 2014, thus, price of base period is followed by new classification of representative goods and services, and weight for CPI is data from year 2014.

- 2014 weights are compiled from results of the Household Living Standard Survey and the GSO survey on CPI weight in 2014.
- Groups of weights are classified consistently with the structure of the CPI (including 11 groups of items at level 1, 32 groups at level 2, 86 groups at level 3, and 256 groups at level 4).
- 2014 weights are calculated by the GSO for each province and city, six economic zones and whole country (divided by urban and rural area).

D.4.4 Issues in using CPI Data for subnational PPPs

Determining product overlap among provinces and cities is the most difficult. In CPI, each province and city has a representative list of popular consumer goods and services, so the review of provinces and cities with the same representative item to calculate sub PPP takes a lot of time.

D.5 Empirical Results

1. Spatial cost of living index among regions (Red River Delta = 100)

Unit: %

	2011	2012	2013	2014	2015	2016	2017	2018
Red river delta	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Northern midlands and mountain areas	101.73	102.32	103.02	102.99	104.77	101.34	101.41	100.54
North Central and Central coastal areas	97.37	98.17	99.37	100.09	101.90	100.33	100.43	99.50
Central Highlands	101.16	101.32	100.60	100.81	103.85	101.12	101.01	100.41
South East	103.91	103.35	103.05	103.96	104.31	101.73	101.88	101.57
Mekong River Delta	97.32	96.39	95.62	95.73	96.29	98.29	98.56	98.15

2. Spatial cost of living index among provinces (Ha Noi city = 100)

Unit: %

	2011	2012	2013	2014	2015	2016	2017	2018
Hà Nội	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Vĩnh Phúc	87.48	87.88	87.85	88.37	88.54	94.74	93.17	92.62

Bắc Ninh	87.89	91.84	92.23	92.86	93.62	97.11	94.58	94.95
Quảng Ninh	93.70	93.53	93.12	93.02	95.56	97.05	95.78	96.12
Hải Dương	86.89	87.39	88.24	88.08	89.26	94.52	93.11	92.87
Hải Phòng	91.48	91.53	93.89	94.88	95.53	97.03	95.41	96.13
Hưng Yên	84.08	83.68	83.98	84.47	85.01	93.10	90.44	91.09
Thái Bình	81.48	81.04	80.54	79.40	81.61	93.23	92.87	91.60
Hà Nam	84.29	84.84	85.03	84.63	86.94	93.48	90.63	91.52
Nam Định	81.15	84.29	84.63	84.38	83.23	92.35	92.09	91.80
Ninh Bình	88.75	90.09	89.70	88.44	89.68	95.49	93.51	92.69
Hà Giang	91.17	92.30	93.80	94.30	96.50	97.98	96.10	96.12
Cao Bằng	91.20	90.10	87.90	87.50	91.18	96.15	93.68	94.23
Bắc Kạn	83.57	83.67	84.16	83.61	86.70	94.63	92.84	92.85
Tuyên Quang	87.39	87.12	88.60	88.96	88.91	95.09	94.05	94.33
Lào Cai	94.78	96.60	96.54	96.95	99.02	99.97	96.05	96.25
Yên Bái	90.17	91.22	90.98	91.20	92.90	96.68	93.68	94.23
Thái Nguyên	89.36	90.91	90.71	89.99	92.46	96.98	94.13	93.63
Lạng Sơn	90.02	91.82	92.92	92.40	94.38	98.21	95.84	96.20
Bắc Giang	87.13	87.51	87.28	87.08	88.79	94.86	93.21	92.25
Phú Thọ	86.23	86.34	87.98	87.42	87.66	92.76	89.97	91.20
Điện Biên	94.77	95.82	98.41	99.50	98.85	99.45	95.99	96.04
Lai Châu	96.50	97.61	98.34	99.58	100.30	99.45	96.00	95.96
Sơn La	96.33	97.98	99.46	99.01	99.27	97.49	95.58	96.17
Hoà Bình	89.87	89.18	90.85	90.93	94.83	96.95	94.76	94.40
Thanh Hoá	85.22	84.07	86.22	86.01	87.96	94.46	91.74	90.85
Nghệ An	85.31	84.90	86.92	86.49	87.52	93.00	92.15	92.23
Hà Tĩnh	88.98	90.96	95.21	97.09	97.14	97.89	95.21	95.29
Quảng Bình	88.54	89.14	88.66	89.50	92.10	96.44	95.19	95.77
Quảng Trị	90.34	90.03	90.45	92.21	93.90	96.45	94.18	93.11

Thừa Thiên - Huế	86.52	88.50	91.47	91.55	94.30	96.90	95.43	96.38
Đà Nẵng	91.93	92.42	94.29	93.53	96.44	97.98	96.68	97.81
Quảng Nam	85.20	87.68	86.93	87.14	90.33	95.99	94.59	94.86
Quảng Ngãi	86.05	85.05	83.79	84.24	88.05	94.01	92.33	91.18
Bình Định	86.43	86.48	86.05	87.42	90.04	95.13	93.43	93.68
Phú Yên	82.98	82.65	86.31	87.79	87.79	93.05	92.31	92.03
Khánh Hòa	87.44	88.13	88.69	88.68	91.56	96.15	94.90	95.80
Ninh Thuận	86.63	87.56	88.10	89.13	91.61	95.32	92.55	92.24
Bình Thuận	86.02	87.24	86.75	87.91	91.39	95.84	93.79	93.64
Kon Tum	87.74	89.05	89.58	89.98	94.06	96.33	94.86	95.17
Gia Lai	91.65	91.46	89.45	90.12	90.90	94.30	92.99	92.34
Đắk Lắk	90.02	90.07	90.12	90.53	95.20	96.19	94.85	93.77
Đắk Nông	89.55	90.25	89.37	89.86	93.84	96.63	93.46	92.82
Lâm Đồng	88.34	90.25	90.19	90.52	93.61	97.28	95.79	95.95
Bình Phước	93.80	93.47	92.95	95.09	96.12	96.80	94.55	95.27
Tây Ninh	83.75	83.96	85.02	85.34	89.36	94.63	93.54	93.11
Bình Dương	88.74	89.05	89.70	88.63	93.64	97.49	95.38	95.95
Đồng Nai	87.64	89.41	89.47	88.76	93.13	95.83	93.50	92.98
Bà Rịa-Vũng Tàu	91.27	91.98	91.20	92.17	95.74	97.50	95.54	96.22
TP. Hồ Chí Minh	100.84	99.70	97.80	96.86	97.39	99.67	101.38	101.52
Long An	88.73	88.35	88.20	88.07	92.08	95.29	93.18	93.14
Tiền Giang	86.97	85.47	85.95	86.39	88.40	94.80	92.48	92.27
Bến Tre	90.31	90.67	91.35	91.33	93.02	95.94	92.72	91.72
Trà Vinh	79.12	78.17	79.17	79.33	80.72	92.93	89.45	90.84
Vĩnh Long	84.31	84.55	83.77	83.54	82.93	91.91	91.87	91.32
Đồng Tháp	87.37	87.38	87.27	86.96	87.03	93.26	90.13	90.67
An Giang	90.74	90.46	90.27	89.67	91.82	95.33	93.69	93.08
Kiên Giang	84.27	84.28	84.43	85.09	87.96	93.29	90.89	91.53

Cần Thơ	90.88	89.82	89.24	89.33	92.14	96.88	94.24	94.22
Hậu Giang	83.30	81.89	83.11	83.23	83.53	90.70	89.38	90.50
Sóc Trăng	81.70	80.90	81.67	82.04	83.50	92.41	89.92	91.07
Bạc Liêu	85.61	85.48	84.79	85.45	87.29	94.11	92.70	91.84
Cà Mau	83.61	84.03	84.73	85.24	88.42	93.59	91.51	91.43

D.6 Conclusions

Vietnam's subnational PPPs are compiled by the General Statistics Office in order to provide inputs into the policy making process related to regional socioeconomic development serving research, comparing economic performance results, economic growth rate, general productivity, and price competitiveness. Enterprises use SCOLI indexes to evaluate competitiveness related to price, output, market share, and product cost. Individuals use the SCOLI index to negotiate wage rates and consider inter-provincial migration.

Looking at Vietnam's SCOLI Index from 2010 to 2018, the Southeast region is the most "expensive" in the country, with a price level that is higher than the price level in the Red River Delta region, and the price in this region is increasing. Areas with "expensive" levels are followed by North Central and Central coastal areas, Central Highlands, and Northeast.

The Mekong River Delta region has the lowest price with the price lower than the average price of the Red River Delta, and the price trend is declining. The Mekong River Delta has an average price lower than the average price in the Red River Delta because it is a flat terrain, favorable climate and hydrological conditions for intensive cultivation in agricultural production. Therefore, food and eating out by families are less expensive.

Hanoi and Ho Chi Minh City are the provinces with the highest prices in the country. In addition, the northern mountainous provinces have a relatively high price level and tend to be higher because this is a mountainous area where many goods are not produced locally and must be brought from the lowlands. Furthermore, roads are quite difficult and freight rates are high. In addition, the region's distribution system is very fragmented: the cost of maintaining a high distribution system, along with the cost of stockpiling goods in warehouses, has pushed commodity prices higher than those of other areas.

The publication of a cost of living index for users of statistical information is an effort to improve the quality of statistical information in Vietnam.