

Consumer Spatial Price Indices

Istat publishes the first results of an experimental project to estimate consumer spatial price indices at regional level (Sub National Spatial Price Indices or Regional Purchasing Power Parities).

Sub National Spatial Price Indices (SN-SPIs) measure the differences in the price level of a basket of products across regions within a country at a given point of time. They are therefore an important tool to have a more accurate reading of the inequalities and living household conditions across territories, due to the differences in the purchasing power.

In this first publication, the results relating to the first three Ecoicop (European Classification of Individual Consumption by Purpose) expenditure divisions, referring to the year 2021, are disseminated: 01 Food and non-alcoholic beverages, 02 Alcoholic beverages and tobacco, 03 Clothing and footwear.

SN-SPIs computation needs many detailed data at local level for a group of products that are representative of the consumer behavior in different areas. The basket of products must guarantee the requirements of representativeness and comparability. Representativeness relates to the importance of the product in consumer expenditures in a geographical area. Comparability, on the other hand, is guaranteed by the presence of products with the same or similar characteristics, so that any differences in the price levels are, in no way, attributable to the differences in quality.

The sources used for compiling these new indicators are mainly those of the consumer price survey complemented by surveys carried out for the specific purpose of calculating the regional spatial indices. In summary, the three data sources are:

- **Scanner data.** A unique identifier (bar code) characterizes each product, therefore the comparability in space is guaranteed. Information on turnover and quantity allows to calculate the unit value (average price) for each bar code and to weigh it, fully guaranteeing the principle of representativeness.
- **CPI (Consumer Price Index) data.** For some product categories (fresh fish, fruit, and vegetables), the definitions in the traditional CPI data collection are detailed enough to allow the use of these data in compliance with comparability. The products of these categories included in the consumer price basket are widely distributed throughout the country.

- **Ad hoc surveys** carried out in 21 cities (19 regional and the two autonomous provincial capitals, except for L'Aquila¹, replaced by Pescara) for products not covered by scanner data or with too generic definitions, which do not guarantee comparability, in the territorial CPI survey. For these products, ad hoc surveys were the only way to ensure comparability and representativeness. Even if the territorial coverage of these surveys does not reach the detailed level of the other sources, it is sufficient to guarantee reliable estimates. The surveys were conducted by the Municipal Statistical Offices of the municipalities involved, on a basket of products selected by Istat considering their share of household expenditure within Ecoicop division and the information on the importance of the single product provided by the municipal coordinator. The surveys are carried out using the CAPI technique (Computer assisted personal interview).

The methodology used to compute SN-SPIs is that recommended by the International Comparison Program (ICP) and used by the World Bank.

Results

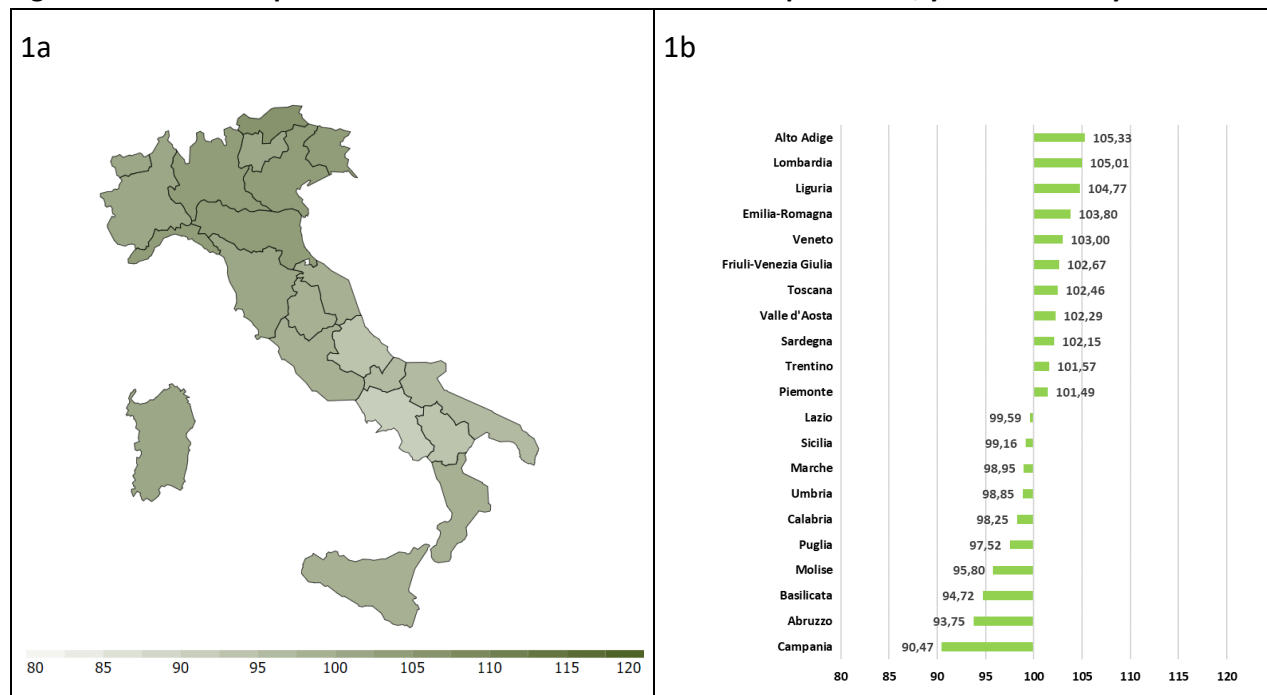
The disseminated results concern the first three expenditure divisions of the Ecoicop classification and represent the first important step to arrive at an overall index of price differences across the Italian regions.

For a correct reading of the data illustrated below, it is worth to recall that when the price level index of a region is greater than 100 it means that this region is relatively more expensive than the Italian average (100) and vice versa. If the price level index of one region is higher than that of another region, it means that this region is relatively more expensive than the other for the product categories considered and vice versa. Therefore, in the following cartograms the colors used are dark for the more expensive regions and light for the less expensive ones.

The analyses show significant differences in consumer price levels between the Italian regions, in 2021. In general, considering the aggregation of the first three Ecoicop expenditure divisions, the prices recorded in the Northern regions are higher than those of the Centre, except for Toscana, and of the South and Islands, except for Sardegna (Fig.1a). The most expensive region is Alto Adige (105,33) and the least expensive is Campania (90,47) as it is shown in Fig 1b.

¹ Due to the persistent difficulties in carrying out the CPI survey in the Municipality of L'Aquila, Pescara was preferred as the city in the Abruzzo region where to collect data for the product categories in the ad hoc surveys (Clothing and Footwear and some fresh food products).

Figure 1 - Consumer Spatial Price Index for the first three Ecoicop divisions, year 2021 - Italy=100

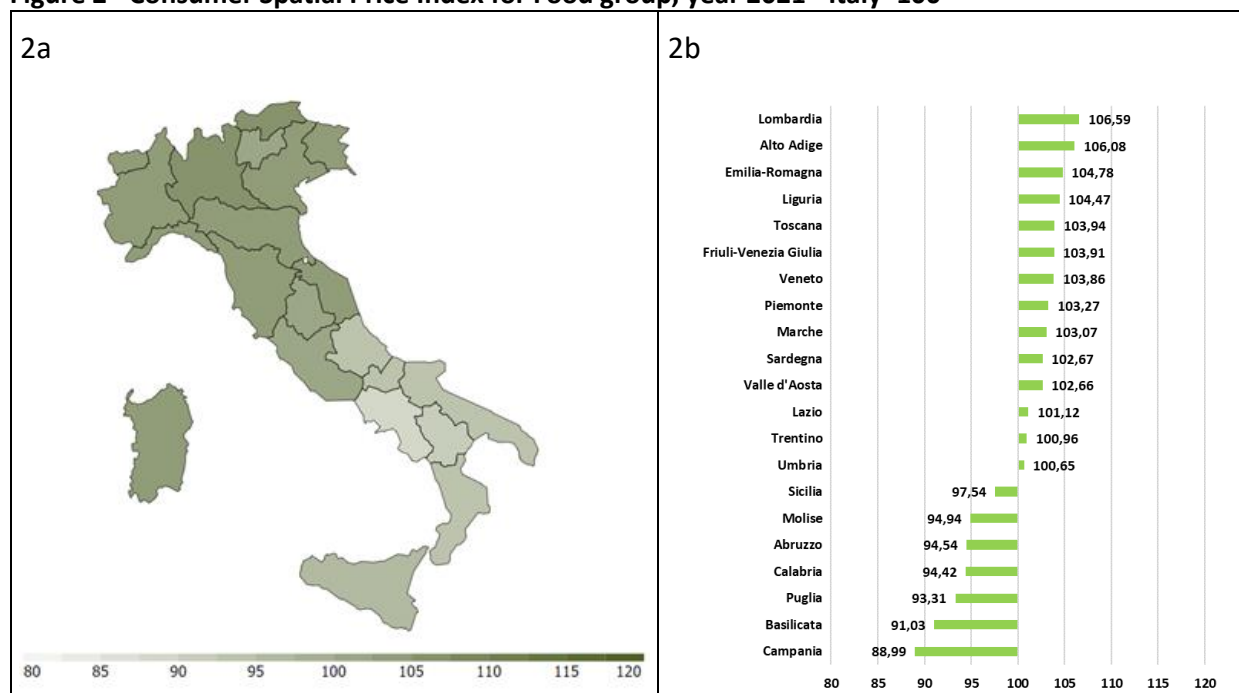


Source: Istat

Among the most expensive regions, after Alto Adige (prices 5,3% higher than the national average) there are Lombardia (+ 5%) and Liguria (+ 4,7%); among the least expensive regions, compared to the national average, after Campania (prices 9,5% lower than the average), appear Abruzzo (-6,2 %) and Basilicata (- 5,2%). Thus, the difference in price levels between Campania (least expensive) and Alto Adige (more expensive) is almost 15 percentage points.

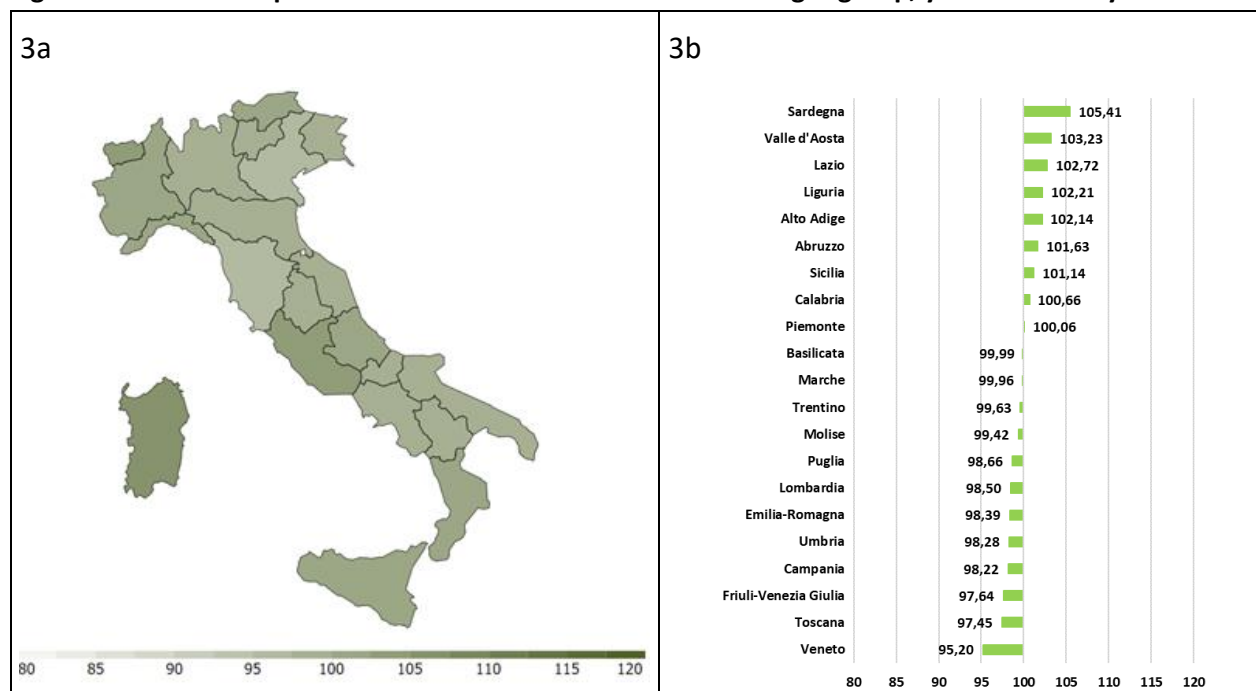
Analyzing the purchasing power parities calculated for the Food Products group, also in this case a breakdown of the regions emerges with a group of regions characterized by systematically higher prices and another group with lower prices than the national average. These results are similar, but with some differences, compared to those emerged for the aggregate index of the top three expenditure divisions. In fact, the regions which show price levels above the national average are both in Northern Italy and in the Centre, while those with price levels systematically lower than the national average are in the South (with the exception, also in this case, of Sardegna). Lombardia and Alto Adige have price levels above the Italian average by more than 6 percent, while Campania and Basilicata have price levels below the national average by 11 and 9 percent respectively (Fig 2b). In this case, the difference in price levels between Campania (the least expensive) and Lombardy (the most expensive) is almost 17 percentage points.

Figure 2 - Consumer Spatial Price Index for Food group, year 2021 - Italy=100



Source: Istat

Figure 3 - Consumer Spatial Price Index for Non-alcoholic beverages group, year 2021 - Italy=100

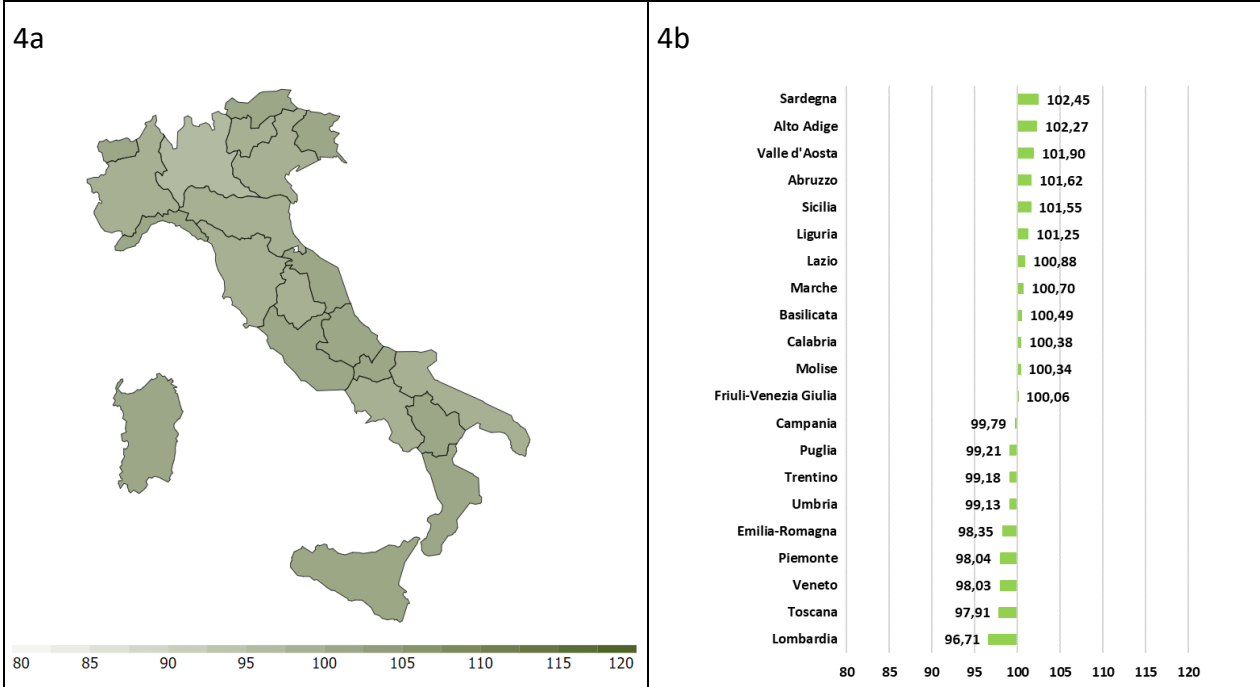


Source: Istat

Soft drinks (Fig. 3) and Alcoholic beverages (Fig. 4) show the least heterogeneity in consumer price levels between regions and low differences in price levels compared to the Italian average. There is not a territorial trend, which characterizes groups of regions as in the other groupings examined. It should be noted, in fact, that in both cases a northern region is the least expensive,

Veneto for soft drinks, Lombardia for alcoholic ones. This seems to highlight how for products with a longer supply chain, greater efficiency in logistics and infrastructure tends to change the traditional comparative geography of price levels between Italian regions.

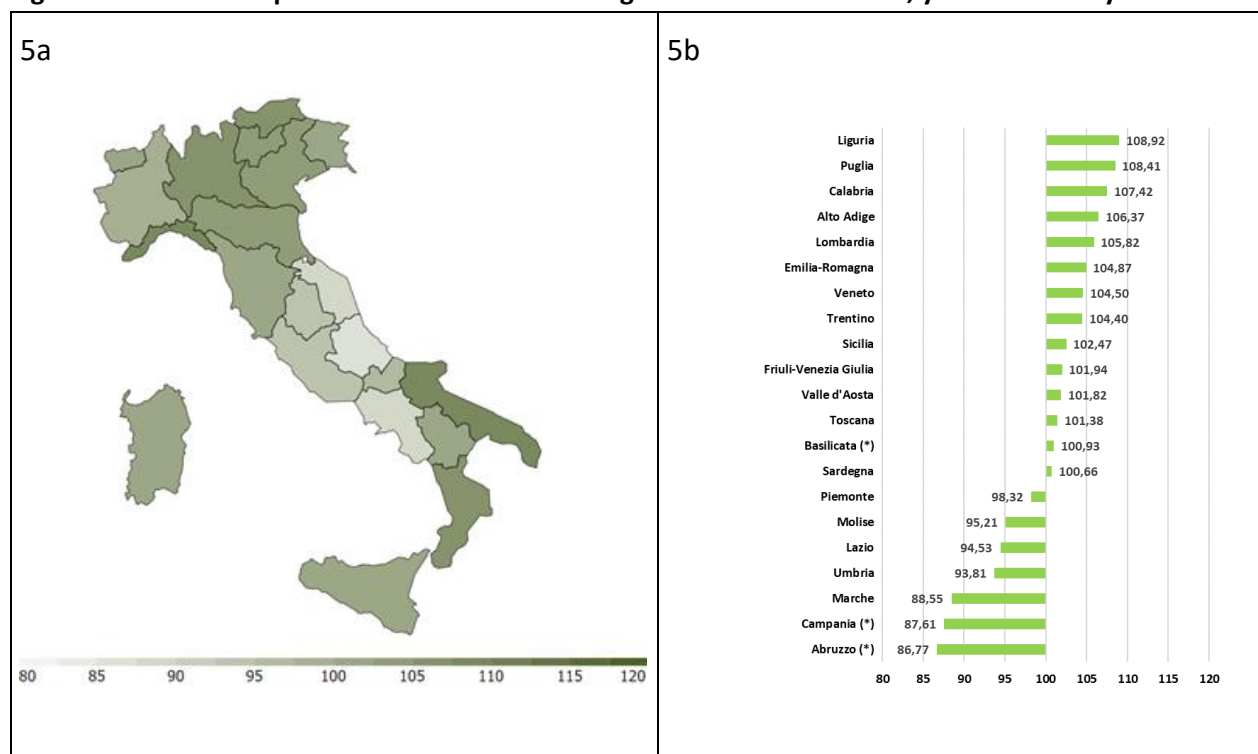
Figure 4 - Consumer Spatial Price Index for Alcoholic beverages group, year 2021 - Italy=100



Source: Istat

For Clothing and Footwear (Fig 5a), five regions of the South are more expensive than the national average, almost in line with the northern regions. Instead, the central regions show price levels lower than the national average (except for Toscana, which ranks slightly above). There are more than 20 percentage points of difference between the least expensive region (Abruzzo) and the most expensive one (Liguria). The most expensive regions are Puglia and Liguria, with values more than 8 points above the average, whereas Campania and Abruzzo are the least expensive. Likely, this more accentuated dispersion of the results, relating to clothing and footwear, is due to the greater volatility in the elementary data, attributable to the limited number of price observations recorded (especially in Campania, Basilicata and Abruzzo) and deserving for further insights.

Figure 5 - Consumer Spatial Price Index for Clothing and footwear division, year 2021 - Italy=100



(*) Due to the low number of observations data of Basilicata, Campania and Abruzzo regions are not reliable.
Source: Istat

Methodological Note

The production of consumer spatial price indices or regional purchasing power parities is part of the National Statistical Program (PSN code IST-01905), which contains statistics of national interest.

The classification adopted for the consumer spatial price indices is the European Classification of Individual Consumption by Purpose (Ecoicop). According to this classification, the hierarchical structure has four levels of disaggregation: Divisions, Groups, Classes, and Subclasses.

For the purposes of calculating both spatial and temporal consumer price indices, the Subclasses are further broken down into Consumption Segments and then into Product aggregates, called Basic Heading² (BH). Within each Basic Heading, individual product definitions are specified.

Based on the classification structure, regional purchasing power parity indices are published at the division and group level in this study. Data of the first three expenditure divisions of the Ecoicop classification for the year 2021 were considered, using a multi-source and multi-

² The Basic Heading is the lowest level of aggregation at which expenditure share data are available and the lowest level at which consumer spatial price indices are calculated.

technique approach like for the consumer price survey, which estimates their changes over time. The data sources used are:

- Scanner data
- CPI data
- Ad hoc surveys

The tobacco products whose prices have no variability across the Italian territory (but have different weights in the regions) have been included in the calculation with parity equal to 100.

Data sources

Scanner data

Scanner data, employed for several years to estimate inflation, has been used for all the BH for which they are available, starting from the elementary data that pass the quality checks implemented in the consumer price process. Nielsen, according to an agreement between Istat and the Association of large-scale retail trade distribution (ADM), provides turnover and quantities sold for each bar code and outlet, included in the outlets sample, on a weekly basis for all 107 Italian provinces. The overall outlets sample is approximately 4,000 units, extracted with probabilistic sampling stratified by province and outlet type (supermarket, hypermarket, self-service, discount, specialist drug). The extraction probability is proportional to turnover. The scanner data use for the construction of spatial price indices has been the subject of numerous research projects (Laureti, Polidoro; 2017; 2022; Pratesi et al., 2021; Biggeri, Pratesi, 2022).

The data used to estimate consumer spatial price indices is the average annual price for bar code and province. For each barcode and outlet, annual unit value is obtained by dividing the sum of the barcode turnover by the sum of the barcode quantities sold in the outlet.

The annual average price by barcode and province is calculated as a weighted average of the barcode annual unit value in the outlets (obtained in the previous step), by using the sampling weight.

Only barcodes sold in at least two provinces were selected for the analysis: 14.197 barcodes for division 01 and 25.121 for division 02.

In the food products group, scanner data were used for 47 BHs, whereas data from the territorial CPI survey and ad hoc surveys were used for the other BH. On average, the number of barcodes per BH was over 2.700, but with a minimum of 65 barcodes for margarine, other vegetable fats, and a maximum of 13.699 for packaged pastry products (Table 1).

Table 1 - Descriptive statistics by product group. Scanner data

| Group Code | Group Description | Nr of. BH | Bar code by BH | | | Standard deviation | Coefficient of variation |
|------------|--------------------------|-----------|----------------|------------|------------|--------------------|--------------------------|
| | | | Mean number | Min number | Max number | | |
| 01.1 | Food product | 47 | 2.793 | 65 | 13.699 | 2.666 | 95 |
| 01.2 | Non- alcoholic beverages | 7 | 2.122 | 255 | 3.515 | 1.036 | 49 |
| 02.1 | Alcoholic beverages | 9 | 2.791 | 68 | 9.094 | 2.749 | 98 |

Source: Istat

Soft drinks group products are entirely processed by using scanner data. The average number of barcodes per BH is 2.122 and is more homogeneous than the other two groups, with a minimum number of 255 and a maximum of 3.515.

For the alcoholic beverages group, all BHs are recorded by using scanner data, too. Compared to the group of non-alcoholic beverages, there is greater variability between the BH: the minimum number of barcodes present is 68 (low-alcohol and non-alcoholic beers) and the maximum 9.094 (quality wines).

A relevant issue in using scanner data for spatial price indices calculation is the presence of direct connections (products shared between two territories) or indirect connections (two territories do not have products in common, but another territory has at least one product in common with both). The number of barcodes present in each pair of regions was considered, for each aggregate, and the average number for all pairs of regions was analyzed, as well as the minimum and maximum value.

Table 2 - Descriptive statistics of the barcodes for aggregate present in each pair of regions by product groups

| Group Code | Group Description | Mean Number | Min Number. | Max Number. | Standard Deviation | Coefficient of Variation |
|------------|--------------------------|-------------|-------------|-------------|--------------------|--------------------------|
| 01.1 | Food product | 623 | 3 | 7.460 | 631 | 101,42 |
| 01.2 | Non- alcoholic beverages | 564 | 36 | 2.139 | 275 | 48,79 |
| 02.1 | Alcoholic beverages | 412 | 12 | 4.223 | 313 | 75,85 |

Source: Istat

For the food products group, in each BH the average number of barcodes available simultaneously in two regions is 623 (Table 2). The minimum direct connection occurs for whole milk where for two regions the number of barcodes in common is only three. Soft drinks do not present overlapping problems, with an average of 564 and a minimum of 36 barcodes. The aggregate of low-alcohol and non-alcoholic beers is the one with the least overlap (12) in the group of alcoholic beverages, while the maximum is found for quality wines.

Overall, the number of bar codes per BH and the diffusion at territorial level is good. The BH that presents the greatest problems is whole milk, but direct overlapping is guaranteed, in any case,

and therefore it was not excluded from the analysis.

CPI data

The data from the traditional consumer prices survey have been used for the classes Fish and fish products, Fruit, and Vegetables since the definitions of the products belonging to these classes are sufficiently detailed to satisfy the comparability requirement. The prices collected for all months by all 80 provinces participating in the territorial survey of consumer prices were included in the calculation. For fresh fruit and vegetable products, only the prices of the months in which these products are "in season"³ have been included. All the prices of the product light or dark green peas have been eliminated, because after a detailed analysis they were found not to comply with the comparison between territorial areas. The total number of references (product and outlet combination) after eliminating outliers was 87.784.

The annual average price by product at the provincial level is calculated as the simple mean of all the prices collected since the weights relating to the quantities sold are not available.

Table 3 - Descriptive statistics by product class. CPI data

| Class Code | Class description | Nr. Of BH | References by BH | | | Standard deviation | Coefficient of Variation |
|------------|------------------------|-----------|------------------|------------|------------|--------------------|--------------------------|
| | | | Mean number | Min number | Max number | | |
| 01.1.3 | Fish and fish products | 6 | 2.604 | 1.339 | 6.368 | 1.795 | 69 |
| 01.1.6 | Fruits | 20 | 1.604 | 607 | 5.273 | 1.100 | 69 |
| 01.1.7 | Vegetables | 6 | 1.432 | 669 | 3.750 | 898 | 63 |

Source: Istat

Overall, the data from consumer prices survey do not have many problems (Table 3). The average number of references per BH is high in all the classes considered. Even the BH with the minimum value (607) has enough observations for the analyses.

Ad hoc surveys

The ad hoc surveys are carried out for product categories for which the use of other types of sources has comparability problems that are difficult to overcome. A specific basket of products is defined as a subset of that used for international parities, which allows to solve this problem.

The Municipalities involved in the survey are the regional and autonomous provincial capitals except for L'Aquila, replaced by Pescara, for a total of 21. The outlet sampling design in each municipality is the one defined for the local consumer prices survey.

³ For more information: Istat (2021)

The ad hoc price surveys are based on a cyclical system of surveys coinciding with those of international purchasing power parities. Overall, there are 6 surveys, each on a specific basket of goods and services, which take place over a 3-year cycle.

To guarantee an overall coherence framework, a basket of products highly comparable between the municipalities was defined for each survey. The basket of food products included in the index calculation is made up of 39 items, while 79 items for clothing and footwear.

The number of quotations entered in the calculation of the indices for food products was 8.945, while for clothing and footwear 7.885. The trimming of invalid quotations had an impact above all on clothing and footwear (16% vs. 5.5% in food division).

Food BHs have an average of 994 quotations. Among the different BHs, there is a wide variability: the minimum value is presented for edible entrails and offal with only 152 values, while the quotations for adult bovine meat are 1.618 (Table 4). Overall, the fresh food data does not have many problems.

The clothing and footwear BHs on average have 215 and 242 quotations respectively. The lower number of quotations for clothing and footwear than food can be attributed to the intrinsic differences of the product types, which make collection particularly difficult. In general, ad hoc surveys involve a considerable effort by the Municipalities involved in terms of organization, time for the survey and dedicated human resources. It was not always possible to collect an adequate number of price quotations. The collected and validated quotations for the municipalities of Naples, Pescara, and Potenza, in clothing and footwear, is small for some products. Therefore, the results for Campania, Abruzzo and Basilicata regions must be read by taking into consideration this limit and require significant further study. Despite these difficulties, the BHs with the greatest weight are overall well represented.

The search for alternative sources and/or the inclusion in the surveys of other municipalities will be the basis to sort out the problem of the limited number of quotations collected for some products. In this way, wider database on which to carry out analyses will be available.

Table 4 - Descriptive statistics by product group. Ad hoc survey.

| Group code | Group description | Nr. of BH | Quotations by BH | | | Standard deviation | Coefficient of variation |
|------------|-------------------|-----------|------------------|------------|------------|--------------------|--------------------------|
| | | | Mean number | Min number | Max number | | |
| 01.1 | Food Products | 9 | 994 | 152 | 1.618 | 501 | 50 |
| 03.1 | Clothing | 30 | 215 | 56 | 729 | 163 | 76 |
| 03.2 | Footwear | 6 | 242 | 67 | 463 | 129 | 53 |

Source: Istat

Given that the prices collected through *ad hoc* surveys refer to the two months in which each survey was conducted, the monthly data were made representative of the year, by considering the inflation recorded in the Municipality in the other months of the year. Temporal Adjustment Factors (TAFs) were calculated based on HICP (Harmonized Index of Consumer Price) data.

If the reporting month is generically 'month', the TAF is calculated with the following formula:

$$TAF = \frac{(I_{(gen)} + I_{(feb)} + \dots I_{(may)} + \dots I_{(dic)})}{12 * I_{(month)}}$$

Where I is Hicp with base December (t-1).

While the annual price P_{year} is calculated as:

$$P_{year} = P_{month} * TAF$$

Data sources relevance

The first three Ecoicop expenditure divisions represent about 32% of household expenditure based on the 2021 Hicp basket. The first division (20,5%) is affected by all three data sources, even if with different importance: 53% scanner data, 27% ad hoc survey and 20% CPI traditional price collection. The second division represents about 3,8% of Italian consumption and the drinks are entirely covered by scanner data. The third division data (approximately 7,5% of the basket) comes entirely from *ad hoc* surveys.

Methodological Approach

Purchasing power parity indicators are calculated by using recognized methodological tools and used in numerous international studies and in empirical experiences conducted in various countries (USA, Brazil, India, Indonesia, China, Australia, Great Britain). The ICP (International Comparison Program) in 2021 published a guideline (ICP, 2021), to which Italy contributed, for the calculation of regional purchasing power parities. In accordance with these guidelines, the methods used are:

- **RPD (Regional product dummy)** model at BH level
- **GEKS (Gini - Èltetö-Köves-Szulc)** method to aggregate RPPP calculated at BH level (using household expenditure as weights).

Regional Product Dummy (RPD)

The idea behind this method⁴ is that the price p_{nr} of an item ($n=1\dots N$, N items belonging to the BH) in an area r ($r=1\dots R$) is function of a specific area factor PPP_r (parity or general price level of the area considered with respect to other areas), of the average price of the n -th product or item P_n and of a random error u_{nr} :

$$p_{nr} = P_n * PPP_r * u_{nr} \quad (1)$$

Considering the logarithms, the previous expression can be written as:

$$\ln p_{nr} = \sum_{r=1}^R a_r D_r + \sum_{n=1}^N b_n D_n^* + v_{nr} \quad (2)$$

Where:

D_r is the dummy variable that takes value equal to 1 if the price quotation is from area r and 0 otherwise,

D_n^* is the dummy variable for product n which takes value equal to 1 when item considered is n and 0 otherwise,

a_r e b_n are, the differences in the effects associated with the areas and the product type, respectively,

v_{nr} are random error normally distributed with a zero mean and variance σ^2 .

Parameters of this model can be estimated using ordinary least squares, imposing a restriction, that a coefficient corresponding to a specific area is set equal to zero ($a_1=0$) or equivalently $PPP_1=1$ thus considering it as reference area to which the coefficient estimates are referred.

The purchasing power parity between an area r and the reference area is $\widehat{PPP}_r = \exp(\widehat{a}_r)$. The parities thus estimated satisfy the property of transitivity and invariance of the basis.

Having weights in terms of value or quantity for each product, the model can be written as:

$$\sqrt{w_{nr}} \ln p_{nr} = \sum_{r=1}^R a_r \sqrt{w_{nr}} D_r + \sum_{n=1}^N b_n \sqrt{w_{nr}} D_n^* + \sqrt{w_{nr}} v_{nr} \quad (3)$$

where:

⁴For more information: Rao (2013), Rao e Hajargasht (2016)

w_{nr} are the weights in terms of value or quantity that reflect the economic importance of the different product consumed in the area.

The model was estimated for each BH, making the most of the information available depending on the data source used. Within each BH, only one of the three considered source was used.

In the case of *scanner data*, they provide information on turnover and quantities sold for each bar code, in all 107 Italian provinces. The turnover-weighted model was then used to obtain the estimates. Furthermore, a two-step procedure was adopted (Laureti, Polidoro, 2022) for each BH:

- Step 1: In each region, a model (eq. 3) was estimated to obtain provincial purchasing power parities. These indicators have been used to 'deflate' the initial prices and the turnover of each barcode within each region.
- Step 2: Models (eq. 3) were estimated to obtain regional purchasing power parities, using the 'deflated' prices and turnover as indicated in step1.

The data from the consumer prices survey do not allow the use of the weighted model, as the quantities sold are not available. For all the 80 provinces participating in the survey, the annual provincial average price was calculated for each product as the simple mean of the individual quotations. The regional average price per product was calculated as a weighted average of mean provincial prices, using population as weights, in line with what occurs in inflation calculating.

The data from the *ad hoc survey*, carried out in 21 Municipalities, do not present data relating to the quantities sold, therefore, as with the data from the traditional consumer prices survey, it is not possible to use the weighted model. The data, collected in two months of the year, were corrected with the TAFs to obtain the annual prices. The model was applied to annual individual data.

The Regional Product Dummy has been adopted to estimate regional parities at BH level.

GEKS (Gini - Èltetö-Köves-Szulc)

Parities at the upper level of the BH are calculated using the GEKS method aggregating RPPP estimated at BH level. The weights, based on household expenditure, are the same used for the calculation of the Hicp. The index compiled by the GEKS method satisfies the properties of transitivity and invariance of the basis. Furthermore, it is as close as possible to the corresponding binary indices⁵. Aggregate regional purchasing power parities (RPPPs) are obtained from as follows:

⁵ For more information: Diewert (2013)

$$RPPP_{jk}^{GEKS} = \prod_{l=1}^R (F_{jl} \cdot F_{lk})^{1/R}$$

The parity for region k with reference to region j chosen as the base is given by the geometric mean of the Fisher type indices of all direct comparisons between region j and region k, and indirect across all possible links between the R regions ($l, k, j \in R$).

Fisher type (F_{jl}) indices are obtained as the geometric mean of the corresponding Laspeyres type and Paasche type indices, calculated based on the parities for BH weighted respectively by the expenses of the base region (Laspeyres) and of the partner region (Paasche).

These first results lack data on some BHs⁶, because of difficulties in data collection. The weights of these BHs were distributed among the BHs of the same consumption segment or at a higher level if it was the only BH of the segment.

To express the parities referring to the national average, each parity is divided by the geometric mean of the price level indices of the participating regions, and conventionally, multiplied by 100.

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⁶ Relevance of not available BH on the division: 01 Food products and non-alcoholic beverages: 3.8%, 03 Clothing and footwear. 11.2%

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