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## Calculation and aggregation of PPPs

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**Calculation and aggregation  
of PPPs**

**12**



## 12.1 Introduction

12.1 Previous chapters describe how price and expenditure data are collected and validated for the international price and volume comparisons of GDP that Eurostat and the OECD make with purchasing power parities (PPPs). This chapter explains how Eurostat and the OECD use the validated data to compute multilateral PPPs for GDP and its component expenditures. The computation has two stages. During the first stage, PPPs are calculated for basic headings. In the second stage, basic heading PPPs are aggregated with GDP expenditures as weights to obtain PPPs for each aggregation level up to and including GDP. Many methods have been developed to calculate and aggregate PPPs<sup>1</sup>, but the chapter considers only the methods currently employed for Eurostat and OECD comparisons. It should be read in conjunction with Annex V which provides a numerical example to demonstrate how basic heading PPPs are calculated and subsequently aggregated.

12.2 Eurostat and the OECD use the *Éltető-Köves-Szulc* or *EKS method* both to calculate basic heading PPPs and to aggregate them. The method is named after the three individuals who independently advocated its use in the mid-1960s.<sup>2</sup> The formula was actually proposed by Gini<sup>3</sup> some thirty years earlier and in recent literature the method is also called the *GEKS method*. Eurostat and the OECD have employed the method to calculate PPPs for basic headings since the start of the PPP Programme in 1980. They have used the method to aggregate basic heading PPPs since 1990.<sup>4</sup> Application of the EKS method in Eurostat comparisons is required by the PPP Regulation of 2007.<sup>5</sup>

12.3 Strictly speaking, the EKS is a procedure whereby any set of intransitive binary index numbers are made transitive. The procedure is independent of the method used to calculate the intransitive binary indices. But, as used in the manual and in most literature on the subject, EKS refers both to the way the intransitive binary PPPs are calculated and to the procedure to make them transitive and multilateral.

12.4 Eurostat and the OECD calculate PPPs for basic headings with quasi expenditure weights and PPP for aggregates with explicit expenditure weights. Usually there are no explicit expenditure weights below the basic heading with which to determine the relative importance of the products priced within the basic heading. In the absence of explicit expenditure weights, quasi expenditure weights that take account of the representativity of the products priced are used instead. The EKS method as originally proposed by Éltető, Köves and Szulc did not take the representativity of products into consideration. This refinement was introduced later by Eurostat in its 1980 comparison. As a consequence, there are two versions of the method at the basic heading level: the classic version without representativity and the Eurostat-OECD version with representativity. In current

<sup>1</sup> See, for example, "Estimation of PPPs for Basic Headings within Regions", Chapter 11 of *ICP 2003-2006 Handbook*, [http://siteresources.worldbank.org/ICPINT/Resources/270056-1183395201801/icp\\_Ch11rev.doc](http://siteresources.worldbank.org/ICPINT/Resources/270056-1183395201801/icp_Ch11rev.doc);

"Computation of Basic Heading Purchasing Power Parities for Comparisons within and between Regions", D. S. Prasada Rao, Chapter 4 of *Measuring the Size of the World Economy*, World Bank, [http://siteresources.worldbank.org/ICPINT/Resources/270056-1255977254560/6483625-1291755426408/04\\_ICPBook\\_ComputationBHPPPs\\_Final.pdf](http://siteresources.worldbank.org/ICPINT/Resources/270056-1255977254560/6483625-1291755426408/04_ICPBook_ComputationBHPPPs_Final.pdf);

"Methods of Aggregation above the Basic Heading Level within Regions", E. Diewert, Chapter 5 of *Measuring the Size of the World Economy*, World Bank, [http://siteresources.worldbank.org/ICPINT/Resources/270056-1255977254560/6483625-1291755426408/05\\_ICPBOOK\\_AggregationAboveBH\\_Final.pdf](http://siteresources.worldbank.org/ICPINT/Resources/270056-1255977254560/6483625-1291755426408/05_ICPBOOK_AggregationAboveBH_Final.pdf);

"A Comparison of Ten Methods for Multilateral International Price and Volume Comparison," B. M. Balk, *Journal of Official Statistics*, 12, 1996, pages 199-222, <http://www.jos.nu/Articles/article.asp>;

"A taxonomy of multilateral methods for making international comparisons of prices and quantities", R. Hill, *The Review of Income and Wealth*, March 1997, <http://www.roiw.org/1997/49.pdf>;

"Axiomatic and Economic Approaches to International Comparisons", W. E. Diewert, pages 13-87, in "International and Interarea Comparisons of Income, Output and Prices", A. Heston and R.E. Lipsey (editors), *Studies in Income and Wealth*, Volume 61, University of Chicago Press, 1999, <http://www.econ.ubc.ca/diewert/nber5559.pdf>.

<sup>2</sup> By Lazlo Drechsler in "Weighting of index numbers in multilateral comparisons", *The Review of Income and Wealth*, March 1973, <http://www.roiw.org/1973/17.pdf>.

<sup>3</sup> In "On the circular test of index numbers", *International Review of Statistics*, Vol. 9, No. 2, 1931.

<sup>4</sup> Prior to 1990 the Geary Khamis method was used to aggregate basic heading PPPs.

<sup>5</sup> Regulation (EC) No 1445/2007 of the European Parliament and of the Council of 11 December 2007 establishing common rules for the provision of basic information on Purchasing Power Parities and their calculation and dissemination.

literature, the classic version is referred to as EKS or GEKS and the Eurostat-OECD version as EKS\*<sup>6</sup> or GEKS\*.

12.5 These changes in terminology have not been adopted for the manual. Eurostat and the OECD have always referred to the EKS method as EKS whether discussing the calculation of basic heading PPPs with quasi expenditure weights or the aggregation of basic heading PPPs with explicit expenditure weights. EKS is used in the PPP Regulation. It is also used throughout the papers and reports that Eurostat and the OECD have prepared relating to the PPP Programme. To preserve clarity and continuity, Eurostat and the OECD continue to use EKS instead of GEKS, EKS\* or GEKS\*.

## 12.2 Calculation of PPPs for a basic heading

### 12.2.1 Multilateral PPPs and their required properties

12.6 The methods used to calculate PPPs at the basic heading level should provide multilateral PPPs that have certain properties. These include:

- *Commensurability*: PPPs should be invariant to changes in the units of measurement for quantities. In other words, they do not change when the units of quantity to which their prices refer are changed – for example, when the price of petrol is quoted per gallon rather than per litre.
- *Base country invariance*: All participating countries should be treated symmetrically so that it makes no difference to the final results which country is chosen as the base. The country selected serves simply as the point of reference and its currency as the numéraire.
- *Transitivity*: Requires that every indirect multilateral PPP between a pair of countries calculated via a third country should always equal the direct multilateral PPP between the countries. Transitivity is regarded as a necessary property for a set of multilateral PPPs otherwise they would not be mutually consistent (see Section 12.2.4.).
- *Characteristicity*: A country's PPPs in a multilateral comparison are influenced by the data of all countries participating in the comparison. Characteristicity requires that the country's multilateral PPPs should reflect the essential features of the structure of its input data. For multilateral methods, such as the EKS, that are based on the averaging of the binary PPPs, characteristicity is the property that the resulting multilateral PPPs differ as little as possible from the original binary PPPs.<sup>7</sup>

### 12.2.2 Overview of the calculation procedure

12.7 The lowest aggregation level for which PPPs are calculated is the basic heading level. This level of aggregation is generally determined by the lowest level of final expenditure for which explicit expenditure weights can be estimated. As expenditure weights are not available below the basic heading, the relative importance of the products priced for a basic heading cannot be established by comparing their shares of total expenditure on the basic heading. Instead, quasi expenditure weights that distinguish between representative and unrepresentative products are employed in the calculation. Eurostat and the OECD assign a weight of 1 to products that are representative and a weight of 0 to products that are not representative<sup>8</sup>.

<sup>6</sup> The asterisk denotes *with representativity*. In Eurostat and OECD comparisons asterisks are assigned to the prices of products that are representative. In discussion it is pronounced *star*. Hence *EKS star* or *GEKS star*.

<sup>7</sup> For multilateral methods that are based on average international prices, such as the Country Product Dummy (CPD) method used for the ICP, characteristicity requires the structure of the average international prices to be as close as possible to the country's price structure.

<sup>8</sup> With this choice of weights price relatives that are based on products that are unrepresentative of both countries will be excluded when calculating PPPs between them for a basic heading. Even so, the choice of 1 and 0 is arbitrary. Weights of 2

12.8 Participating countries are required to indicate whether or not the products they priced are representative of their national markets when they report their prices.<sup>9</sup> In this context, a product is said to be representative if it is sold in sufficient quantities for its price to be typical for that group of products in the national market.<sup>10</sup> Representative products usually have lower price levels than unrepresentative products and higher turnovers. By giving representative products a higher weight in the calculation than unrepresentative products, a potential bias is avoided.

12.9 The information on representativity, together with the prices to which it refers, is used to obtain PPPs at the basic heading level as follows:

- For each pair of countries, two binary PPPs are calculated. The first is the geometric mean of the price relatives for products representative of the first or base country – the Laspeyres type PPP. The second is the geometric mean of the price relatives for products representative of the second or partner country – the Paasche type PPP. The geometric mean of these two PPPs is then taken to derive a single binary PPP between the two countries – the Fisher type PPP.<sup>11 12</sup>
- By following this procedure each basic heading is provided with a matrix of Fisher type PPPs. In some cases, the matrix is incomplete because it is not always possible to calculate a Fisher type PPP directly between each pair of countries. Moreover, the Fisher type PPPs in the matrix are intransitive.
- Gaps in the matrix are filled by taking the geometric mean of all the available indirect Fisher type PPPs bridging the pairs of countries for which direct Fisher type PPPs are missing.<sup>13</sup> This process does not always work. The circumstances for it not working and the alternatives employed when it does not work are outlined later in Section 12.2.5.
- The matrix is made transitive by applying the EKS procedure. Transitivity is attained by replacing the Fisher type PPP between each pair of countries by the geometric mean of itself squared and all the corresponding indirect Fisher type PPPs between the pair obtained using the other countries as a bridge (the direct Fisher PPP receives a higher weight than the indirect Fisher PPPs).

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and 1, or any other similar combination, could also be used. Furthermore, when employing weights in this way, there is an assumption that products countries nominate as representative are equally representative and that products they nominate as unrepresentative are equally unrepresentative. In other words, the price differential between representative and unrepresentative products is the same for all countries and for all products within the basic heading.

<sup>9</sup> Prices of representative products are reported with an asterisk. Prices of unrepresentative products are reported without an asterisk.

<sup>10</sup> For a more complete explanation of representativity and the assigning of representativity indicators see Chapter 2, Section 2.3.2 and Chapter 5, Section 5.5.6.

<sup>11</sup> The qualifier *type* is used for two reasons. The first is that standard Laspeyres, Paasche and Fisher indexes are generally used for temporal comparisons rather than spatial comparisons. Standard Laspeyres, Paasche and Fisher indexes have a base period and a current period, whereas Laspeyres, Paasche and Fisher type PPPs have a base country and a partner country. The second reason is that, whereas a standard Laspeyres index is a weighted arithmetic mean and a standard Paasche index is a weighted harmonic mean, the Laspeyres and Paasche type PPPs calculated for a basic heading are quasi-weighted geometric means. In this respect, the terminology is misleading. It would be more accurate and simpler to refer to the Laspeyres and Paasche type PPPs as Jevons type PPPs and to refer to the Fisher type PPPs as Törnqvist type PPPs. This terminology was introduced in "Estimation of PPPs for Basic Headings within Regions", Chapter 11 of *ICP 2003-2006 Handbook*, [http://siteresources.worldbank.org/ICPINT/Resources/270056-1183395201801/icp\\_Ch11rev.doc](http://siteresources.worldbank.org/ICPINT/Resources/270056-1183395201801/icp_Ch11rev.doc).

<sup>12</sup> In principle the binary PPPs between a pair of participating countries should be calculated on the basis of a product list tailored specifically to make a bilateral comparison between them. For practical reasons, the Fisher type PPP between any pair of participating countries in Eurostat and OECD comparisons is based on commonly-priced products selected from a product list designed to facilitate a multilateral comparison. The use of asterisks ensures that the binary PPPs are based only those commonly-priced products which are representative of either one or both countries.

<sup>13</sup> The process is iterative. During the first round only the original Fisher type PPPs are used. If the matrix remains incomplete, there is a second round using both the original Fisher type PPPs and the new Fisher type PPPs derived indirectly during the first round. The process is continued until either the matrix is complete or it becomes clear that the matrix cannot be completed.

### 12.2.3 Calculation of binary PPPs: Fisher type PPPs

12.10 The Laspeyres type PPP for a basic heading is the geometric mean of the price ratios of the products priced in both countries that are representative of the base country:

$$L_{j/h} = \left( \prod_{i=1}^k \frac{{}_h P_j^i}{{}_h P_h^i} \right)^{1/k} = \left( \prod_{i=1}^{(n11+n01)} \frac{{}_h P_j^i}{{}_h P_h^i} \right)^{1/(n11+n01)} \quad (1)$$

And the Paasche type PPP for a basic heading is the geometric mean of the price ratios of the products priced in both countries that are representative of the partner country:

$$P_{j/h} = \left( \prod_{l=1}^m \frac{{}_j P_j^l}{{}_j P_h^l} \right)^{1/m} = \left( \prod_{l=1}^{(n11+n10)} \frac{{}_j P_j^l}{{}_j P_h^l} \right)^{1/(n11+n10)} \quad (2)$$

In both equations,  $h$  is the base country and  $j$  the partner country. In the first equation,  ${}_h P_j^i$  and  ${}_h P_h^i$  are the prices in countries  $j$  and  $h$  of product  $i$  representative of the base country  $h$ .  $k$  is the number of products representative of the base country  $h$  and includes products representative in both countries ( $n11$ ) and products representative in the base country only ( $n01$ ). In the second equation,  ${}_j P_j^l$  and  ${}_j P_h^l$  are the prices in countries  $j$  and  $h$  of product  $l$  representative of the partner country  $j$ .  $m$  is the number of products representative of the partner country  $j$  and includes the products representative in both countries ( $n11$ ) as well as products representative in the partner country only ( $n10$ ).

12.11 The Fisher type PPP is the geometric mean of the Laspeyres type PPP and the Paasche type PPP.

$$F_{j/h} = [L_{j/h} * P_{j/h}]^{1/2} \quad (3)$$

$L_{j/h}$  and  $P_{j/h}$  are given equal weight in calculating  $F_{j/h}$ . Thus, equal weight is given to the average of the price relatives for each country's representative products, irrespective of the number of price relatives (or products) on which each average is based. This implies that, if there is a greater number of  $j$ 's representative products than  $h$ 's, each price relative for a representative product in  $j$  must carry a correspondingly smaller weight in  $F_{j/h}$  than each of the price relatives for  $h$ 's representative products. This prevents the Fisher type PPPs for the basic heading from being dominated by the price relatives of the country which has the larger number of representative products.

12.12 Even though there are no explicit weights in the calculation, there are implicit ones whose pattern depends on the relative numbers of representative products in the two countries and also on the relative size of the overlap between them – that is, the set of products that are representative in both countries. The pattern of weights can vary substantially between different pairs of countries or for different sets of prices. Quite complex systems of weights may be generated even though there is no explicit information about the expenditure on the products (see Box 12.2).

### 12.2.4 Achieving transitivity: EKS PPPs

12.13 The Fisher type PPPs derived above are not transitive. The EKS formula is used to make them transitive. To explain the procedure, it is first necessary to introduce the concept of an indirect PPP. An indirect PPP between two countries is one obtained by calculating it indirectly through a third country. Let the three countries be A, B and C. Denote the direct Fisher type PPP between A on B as  $F_{A/B}$  and the indirect Fisher type PPP for A on B via C as  ${}_C F_{A/B}$ . Then,  ${}_C F_{A/B}$  is defined as follows:

$${}_C F_{A/B} \equiv F_{A/C} / F_{B/C} \quad (4)$$

$F_{AC}$  is the direct Fisher type PPP between A on C and  $F_{BC}$  is the direct Fisher type PPP between B on C.

12.14 More generally, and for a larger set of countries  $N = \{A, B, C, \dots\}$ , transitivity requires that every indirect PPP,  ${}_l PPP_{jk}$  ( $k, j, l \in N$ ), should always equal the direct PPP,  $PPP_{jk}$ . Transitivity is considered to be a necessary property for a set of multilateral PPPs because, if they were not transitive, they would not be mutually consistent.

12.15 The EKS PPP is defined as the geometric mean of the direct PPP and all the indirect PPPs between a pair of countries, with the direct PPP having twice the weight of each indirect PPP. In the case of three countries A, B and C, the EKS PPP between country A and country B is:

$$EKS_{A/B} = \left\{ F_{A/B}^2 \times \frac{F_{A/C}}{F_{B/C}} \right\}^{\frac{1}{3}} = \left\{ F_{A/B}^2 \times_C F_{A/B} \right\}^{\frac{1}{3}} \quad (5)$$

12.16 A similar expression can be derived for the EKS PPPs between countries A and C, and B and C. The expression in (5) can be generalised for the larger set of countries  $N = \{A, B, C, \dots\}$ . Suppose that the number of countries in  $N$  is  $n$ . Then, the EKS PPP between countries  $j$  and  $k$  is given by equation (6) where transitivity is achieved by estimating the PPP between any pair of countries as a geometric mean of direct Fisher type PPPs and indirect Fisher type PPPs:

$$EKS_{j/k} = \left\{ F_{j/k}^2 \cdot \prod_{l \neq j,k}^N \frac{F_{j/l}}{F_{k/l}} \right\}^{\frac{1}{N}} = \left\{ F_{j/k}^2 \cdot \prod_{l \neq j,k}^N F_{j/l/k} \right\}^{\frac{1}{N}} \quad (6)$$

$$EKS_{j/j} = 1; j, k, l \in N$$

12.17 In addition to being transitive, EKS PPPs also satisfy characteristicity. The EKS procedure minimises the expression

$$\sum_{j \in N} \sum_{k \in N} (\log EKS_{j/k} - \log F_{j/k})^2$$

and the multilateral PPPs that result differ as little as possible from the original binary Fisher type PPPs. The minimisation is for the sum of deviations for the whole set of countries so that the extent to which the EKS PPP and the Fisher type PPP for any specific pair of countries differ depends on the degree of homogeneity among the price structures of the group of countries being compared.<sup>14</sup>

### 12.2.5 Missing PPPs

12.18 The EKS aggregation procedure employed by Eurostat and the OECD requires the matrix of basic heading PPPs to be complete, that there are no missing basic heading PPPs for any country. If the matrix is not complete there is a risk that the resulting aggregate volume indices may be biased. In practice, however, there are basic headings for which PPPs cannot be calculated for a country with the price data available. Either the country has not priced any products for the basic heading or, if it has, it has not priced a representative product or, if it has, other countries have not priced its representative product or, if they have, it has not priced their representative products. Consequently, no direct binary PPP can be calculated between it and any other country. In such cases, the PPPs for the countries and basic headings are taken either from a comparable basic heading - such as *beef* for *veal* - or from the next level of aggregation - such as *meat* for *pork*.

<sup>14</sup> The EKS procedure is applied to intransitive binary Fisher type PPPs in Eurostat and OECD comparisons. But, as already mentioned in paragraph 12.3, the procedure can be applied to any set of intransitive binary PPPs.

**Box 12.1:** Fixity at the basic heading level and the aggregate level

EU-OECD Countries			EU27 Free	ECP37 Free	ECP37 Fixed	OECD47 Free	OECD47 Fixed
			A	B	C	D	E
EU27	01	Austria	1.02	1.04	1.02	1.06	1.02
	02	Belgium	1.00	1.00	1.00	1.00	1.00
	03	Bulgaria	0.91	0.94	0.91	0.95	0.91
	04	Cyprus	0.53	0.55	0.53	0.56	0.53
	05	Czech Republic	18.45	18.90	18.45	19.10	18.45
	06	Denmark	10.02	10.20	10.02	10.30	10.02
	07	Estonia	0.65	0.64	0.65	0.65	0.65
	08	Finland	1.16	1.19	1.16	1.20	1.16
	09	France	1.01	1.01	1.01	1.04	1.01
	10	Germany	1.00	1.00	1.00	1.00	1.00
	11	Greece	0.86	0.86	0.86	0.89	0.86
	12	Hungary	167.38	165.00	167.38	163.00	167.38
	13	Ireland	1.17	1.19	1.17	1.22	1.17
	14	Italy	1.01	1.00	1.01	1.03	1.01
	15	Latvia	0.41	0.43	0.41	0.45	0.41
	16	Lithuania	2.03	2.00	2.03	2.04	2.03
	17	Luxembourg	0.96	0.97	0.96	0.98	0.96
	18	Malta	0.33	0.35	0.33	0.36	0.33
	19	Netherlands	1.00	0.99	1.00	0.98	1.00
	20	Poland	2.64	2.67	2.64	2.70	2.64
	21	Portugal	0.85	0.87	0.85	0.88	0.85
	22	Romania	1.94	1.96	1.94	1.97	1.94
	23	Slovak Republic	0.77	0.77	0.77	0.78	0.77
	24	Slovenia	0.76	0.77	0.76	0.78	0.76
	25	Spain	0.87	0.89	0.87	0.90	0.87
	26	Sweden	10.72	10.87	10.72	10.95	10.72
	27	United Kingdom	0.74	0.73	0.74	0.72	0.74
		Geometric mean EU27 Ratio: 1.4973/1.5150	1.4973	1.5150 0.9883			
ECP37	28	Albania		68.62	67.82	68.9	67.82
	29	Bosnia-Herzegovina		1.08	1.07	1.1	1.07
	30	Croatia		5.53	5.47	5.51	5.47
	31	FYR Macedonia		29.41	29.07	29.7	29.07
	32	Iceland		114.83	113.49	112	113.49
	33	Montenegro		0.59	0.58	0.55	0.58
	34	Norway		11.49	11.36	11.2	11.36
	35	Serbia		41.04	40.56	40.43	40.56
	36	Switzerland		1.91	1.89	1.94	1.89
	37	Turkey		1.23	1.22	1.25	1.22
		Geometric mean ECP37 Ratio 2.3644/2.3818			2.3644	2.3818	
						0.9927	
OECD47	38	Australia				1.60	1.59
	39	Canada				1.39	1.38
	40	Chile				385.00	382.18
	41	Japan				157.98	156.82
	42	Korea				948.18	941.23
	43	Mexico				7.58	7.52
	44	New Zealand				1.77	1.76
	45	United States				1.06	1.05
	46	Israel				4.58	4.55
	47	Russian Federation				16.11	15.99

12.19 For a number of basic headings no prices are collected because, for various reasons, it is difficult to specify and to price products that are comparable across countries for them. PPPs based on price data that have been collected for other basic headings are used for these basic headings. Such PPPs are called *reference PPPs*. They serve as proxies for the PPPs that would have been calculated for the basic headings had prices been collected for them. They are considered in detail later in the chapter in Section 12.3.4.

### 12.2.6 Fixity

12.20 Eurostat results are calculated at average EU price levels and OECD results are calculated at average OECD price levels. The number of countries participating in the comparisons differs between Eurostat and OECD, which means that for countries that are covered by both calculations – that is, countries that are both EU Member States and OECD Member Countries - the relativities between them in the Eurostat comparison could differ from those in the OECD comparison. While it is a statistical fact of life that the relative position of countries can change as the composition of the group of countries being compared changes, the existence of two sets of results can confuse users. Generally, it is desirable to avoid such a situation, but it is particularly desirable if the results are used for administrative purposes as they are in the European Union.

12.21 The results for the European Union are used in the allocation of the Structural Funds which account for a third of the European Commission's budget. For this reason, Eurostat requires that only one set of results – that is, the set it calculates for EU Member States - be recognised as the official results for the European Union. To facilitate this, Eurostat and the OECD have agreed that the official results for EU Member States will remain unchanged when these countries are included in OECD comparisons. The agreement is referred to as the *fixity convention*. It has been observed since the 1980 comparison.

12.22 Fixity is first obtained at the basic heading level. This is done by taking the basic heading PPPs calculated for a specific sub-group of countries, for example the EU27 (in Box 12.1), substituting them for the basic heading PPPs calculated for the sub-group in a comparison covering a larger group of countries, such as the ECP37 or the OECD47 (in Box 12.1), and linking the substitute basic heading PPPs with the basic heading PPPs for the other countries included in the comparison. More precisely, fixity involves two groups of countries, one smaller than the other, with the smaller group being a sub-group of the larger group. There are two sets of basic heading PPPs for the smaller group. The first set is that calculated for the group on its own. The second set is that calculated for the group as a sub-group of the larger group. Fixity requires that the first set replaces the second set in the larger comparison. This is achieved by taking the ratio of the geometric means of the two sets of basic heading PPPs and multiplying the PPPs of those countries in the larger group that are not members of the sub-group by the ratio so as to put them at the same overall level as the first set of PPPs for the sub-group.

12.23 The procedure is illustrated by the worked example in Box 12.1. Column A shows the PPPs for a basic heading from a comparison free of fixity covering the EU27 countries and column B shows the PPPs for the basic heading from a comparison free of fixity covering the ECP37 countries. The object is to replace the PPPs for the EU27 countries in column B by their PPPs in column A. This is done by first calculating the ratio between the geometric mean of their PPPs in column A and the geometric mean of their PPPs in column B and then multiplying the PPPs for the ten non-EU27 countries in column B by the ratio. This rescales the PPPs for the ten non-EU27 countries to the same level as the PPPs for the EU27 countries in column A. The fixed PPPs for ECP37 countries that result are shown in column C. By repeating the procedure as shown in columns C, D and E, the fixed PPPs for the ECP37 countries can be substituted for their PPPs in a free comparison covering the OECD47 countries.

12.24 Fixity as illustrated preserves the relativities between the countries in the sub-group and the relativities between the other countries in the larger group. It also preserves the relativities between the other countries and the sub-group as a whole. But the relativities between individual countries in the sub-group and the individual countries outside the sub-group will not be the same.

**Box 12.2: EKS weights and EKS-S weights**

1. In the EKS, Fisher type PPPs are calculated as the geometric mean of Laspeyres type PPPs and Paasche type PPPs. For a comparison with the EKS-S, it is useful to present the formulas used for the EKS somewhat differently.
2. The formula for the Laspeyres type PPP can be broken down as follows:

$$\begin{aligned}
 (1) L_P &= \left( \prod_{i=1}^{n_{11}} p_{i,11} \times \prod_{i=1}^{n_{10}} p_{i,10} \right)^{\frac{1}{n_{11}+n_{10}}} = \left( \prod_{i=1}^{n_{11}} p_{i,11} \right)^{\frac{1}{n_{11}+n_{10}}} \times \left( \prod_{i=1}^{n_{10}} p_{i,10} \right)^{\frac{1}{n_{11}+n_{10}}} \\
 &= \left( \left( \prod_{i=1}^{n_{11}} p_{i,11} \right)^{\frac{1}{n_{11}}} \right)^{\frac{n_{11}}{n_{11}+n_{10}}} \times \left( \left( \prod_{i=1}^{n_{10}} p_{i,10} \right)^{\frac{1}{n_{10}}} \right)^{\frac{n_{10}}{n_{11}+n_{10}}} = \tilde{P}_{11}^{\frac{n_{11}}{n_{11}+n_{10}}} \times \tilde{P}_{10}^{\frac{n_{10}}{n_{11}+n_{10}}}
 \end{aligned}$$

where:

- $P_{i,11}$  is the price relative for product  $i$  that is representative in both countries.  $n_{11}$  is the total number of these cases;
- $P_{i,10}$  is the price relative for product  $i$  that is representative only in the first country.  $n_{10}$  is the total number of these cases;
- $P_{i,01}$  is the price relative for product  $i$  that is representative only in the second country.  $n_{01}$  is the total number of these cases;

$$\tilde{P}_{11} \equiv \left( \prod_{i=1}^{n_{11}} p_{i,11} \right)^{\frac{1}{n_{11}}}, \quad \tilde{P}_{10} \equiv \left( \prod_{i=1}^{n_{10}} p_{i,10} \right)^{\frac{1}{n_{10}}} \quad \text{and} \quad \tilde{P}_{01} \equiv \left( \prod_{i=1}^{n_{01}} p_{i,01} \right)^{\frac{1}{n_{01}}} \text{ are geometric averages of the initial price relatives.}$$

3. The formula for the Paasche type PPP can be broken down in a similar way:

$$(2) P_P = \tilde{P}_{11}^{\frac{n_{11}}{n_{11}+n_{01}}} \times \tilde{P}_{01}^{\frac{n_{01}}{n_{11}+n_{01}}}$$

4. The formula for the Fisher type PPP is then:

$$\begin{aligned}
 (3) F_P &= \sqrt{L_P \times P_P} = \tilde{P}_{11}^{\frac{0.5 \times n_{11}}{n_{11}+n_{10}}} \times \tilde{P}_{10}^{\frac{0.5 \times n_{10}}{n_{11}+n_{10}}} \times \tilde{P}_{11}^{\frac{0.5 \times n_{11}}{n_{11}+n_{01}}} \times \tilde{P}_{01}^{\frac{0.5 \times n_{01}}{n_{11}+n_{01}}} \\
 &= \tilde{P}_{11}^{\left( \frac{0.5 \times n_{11}}{n_{11}+n_{10}} + \frac{0.5 \times n_{11}}{n_{11}+n_{01}} \right)} \times \tilde{P}_{10}^{\frac{0.5 \times n_{10}}{n_{11}+n_{10}}} \times \tilde{P}_{01}^{\frac{0.5 \times n_{01}}{n_{11}+n_{01}}}
 \end{aligned}$$

5. Thus, the weighting scheme in the EKS is:

$$(4) w_{11} = \frac{0.5 \times n_{11}}{n_{11} + n_{10}} + \frac{0.5 \times n_{11}}{n_{11} + n_{01}}; \quad w_{10} = \frac{0.5 \times n_{10}}{n_{11} + n_{10}}; \quad w_{01} = \frac{0.5 \times n_{01}}{n_{11} + n_{01}}$$

6. The comparison between  $w_{10}$  and  $w_{01}$  shows the possible asymmetry of the EKS. The larger the difference between  $n_{10}$  and  $n_{01}$  the greater the asymmetry.

7. Using the same notation as above, the weights of various PPPs in the EKS-S are the following:

$$(5) w_{11} = \frac{2 \times n_{11}}{2 \times n_{11} + n_{10} + n_{01}}; \quad w_{10} = w_{01} = 0.5 \times \frac{n_{10} + n_{01}}{2 \times n_{11} + n_{10} + n_{01}}$$

### 12.2.7 EKS-S method

12.25 Unrepresentative products normally have higher price levels than representative products. Application of the EKS method as described earlier can lead to a bias in the Fisher type PPP when among the products priced by both countries being compared one country has a larger number of representative products than the other. There can be a downward bias in the Fisher type PPP for the country that provides prices for a larger number of representative products. Conversely, there can be an upward bias in the Fisher type PPP for the country that provides prices for a larger number of unrepresentative products. As explained below, the use of a Laspeyres - Paasche approach does not eliminate this possible bias from the Fisher type PPP.<sup>15</sup> A modified version of the EKS - the *EKS-S method*<sup>16</sup> - is designed to correct for this bias.

12.26 The method starts from the observation that a binary Fisher type PPP,  $F_{j/h}$ , can be regarded as a geometric average of three and not two PPPs - namely, those based on:

- products that are representative in both countries,  $h$  and  $j$ ;
- products that are representative in  $h$  but not in  $j$ ;
- products that are representative in  $j$  but not in  $h$ .

12.27 In other words, as demonstrated in Box 12.2, the two sets of representative products introduced earlier,  $k$  (or  $n11+n01$ ) and  $m$  (or  $n11+n10$ ), can be re-organised into three sets:  $n11$ ,  $n01$  and  $n10$ . The PPP based on the first set should provide an unbiased estimate of the basic heading PPP because representative products are being compared with representative products. The PPP for A relative to B based on the second set is likely to suffer from an upward bias, while the PPP based on the third set is likely to have a downward bias. If the second and the third set do not enter the calculation of the Fisher type PPP with the same weight, it can be argued that the result is a bias in the estimate of the PPP for the basic heading (see equation (4) in Box 12.2). In order to have an unbiased estimate, equal weight should be given to the PPPs for the second and third sets (see equation (5) in Box 12.2). In almost all cases, the weights for the second and third sets cannot be expected to be equal. And it can be argued that the EKS is liable to produce biased results in general.

12.28 The procedure that the EKS-S follows to avoid the bias is this:

- Divide the products and their PPPs into the three mutually exclusive sets defined above;
- Count each price relative in the first set twice on the grounds that PPPs between products that are representative in both countries are unbiased and likely to be more reliable;
- Adjust the total weights for the second and third sets to make them equal while keeping their combined weight unchanged (see equation (5) in Box 12.2);
- Take a weighted geometric mean of the PPPs for each of the three sets using the adjusted weights.

12.29 From a theoretical viewpoint, EKS-S seems to be marginally superior to the EKS. While the two methods are likely to produce similar results in most cases, there may be cases in which they yield significantly different results. Both methods introduce differential weights for the price relatives

<sup>15</sup> As mentioned in footnote 12, the binary PPPs between any pair of participating countries in Eurostat and OECD comparisons are based on a set of commonly-priced products selected from a product list for a multilateral comparison rather than from a product list designed specifically for a bilateral comparison between the two countries in question. The numbers of representative and unrepresentative products among the commonly-priced products depend on what the two countries have priced. And what the two countries have priced is determined by factors other than ensuring that the numbers of representative and unrepresentative products are suitably balanced for the bilateral comparison between them or with any other participating country.

<sup>16</sup> The second "S" stands for Sergey Sergeev who proposed the modification in *Equi-representativity and Some Modifications of the EKS Method at the Basic Heading Level* at the Joint Consultation on the ECP, ECE, Geneva, 2003, <http://www.unece.org/fileadmin/DAM/stats/documents/2003/03/ecp/wp.8.e.pdf>

that are by no means intuitively obvious, and which are liable to vary considerably depending on the relative sizes of each of three sets of products. These methods cannot be applied mechanically as other factors have to be taken into consideration, in particular the absolute number of products priced for the basic heading. Which method to use and when to use it has to be decided case by case. Not being able to specify the circumstances when each method should be used is clearly a disadvantage.

12.30 There can be difficulties in implementing either EKS or EKS-S if the absolute number of products in any of the three sets becomes very small or zero. For example, suppose there are seven products in the second set and one product in the third set. With EKS-S, the geometric mean for third set will be based on a single price relative. An average based on a single observation has to be erratic. It can be argued that it would not be optimal to reduce the seven price relatives in the second set to an average and then to give this average no more weight than the single price relative in the third set. If there are no products in the third set then the question arises of what use, if any, can be made of the price relatives in the second set when there are no counter-balancing price relatives for them in third set. The problem remains even if the EKS is used, although it is probably not as acute as it is for EKS-S. The inclusion of more products in an EKS calculation produces more robust results, but the bias persists if the imbalance between representative products and unrepresentative products is not addressed.

12.31 The EKS is used for the official calculation because the results are expected to be more robust. Even so, parallel calculations by the EKS-S will help their validation. Significant differences between EKS and EKS-S results will indicate that there are problems with input data or the assignment of asterisks which should be investigated and explained.

## 12.3 Aggregation of basic heading PPPs

### 12.3.1 Overview of the aggregation procedure

12.32 The procedure for calculating PPP for aggregates is similar to that for the calculation of PPPs for basic headings. First, a Laspeyres type PPP is calculated between each pair of participating countries, then a Paasche type PPP is calculated between each pair and finally a Fisher type PPP is calculated between each pair. The Fisher type PPP between two countries is the geometric mean of their Laspeyres type PPP and their Paasche type PPP. The Fisher type PPPs are not transitive. They are made transitive by the EKS procedure. Although the procedure followed is the same for both basic heading and aggregates, the definitions of the Laspeyres type PPP and the Paasche type PPP differ between the two processes.

12.33 For a basic heading, the Laspeyres type PPP and Paasche type PPP are geometric means (see equations (1) and (2)). But for an aggregate, the Laspeyres type PPP is the arithmetic mean of the PPPs of its constituent basic headings weighted by base country expenditure on the basic headings:

$$L_{j/h} = \sum_{i=1}^k \left( \frac{PPP_{i/j}}{PPP_{i/h}} \right) * w_{ih} / \sum_{i=1}^k w_{ih} \quad (7)$$

And the Paasche type PPP is the harmonic mean of the PPPs of its constituent basic headings weighted by partner country expenditure on the basic headings.

$$P_{j/h} = \sum_{i=1}^k w_{ij} / \sum_{i=1}^k w_{ij} / \left( \frac{PPP_{i/j}}{PPP_{i/h}} \right) \quad (8)$$

In both equations,  $h$  is the base country and  $j$  the partner country,  $PPP_{i/j}$  and  $PPP_{i/h}$  are the PPPs of basic heading  $i$  in countries  $j$  and  $h$ ,  $w_{ih}$  is the weight for basic heading  $i$  in the base country  $h$ ,  $w_{ij}$  is the weight for basic heading  $i$  in partner country  $j$ , and  $k$  is the number of basic headings making up the aggregate.

### 12.3.2 EKS aggregation

12.34 The aggregation of basic heading PPPs is undertaken separately for each level of expenditure up to the level of GDP as follows:

- For each pair of countries, the basic heading EKS PPPs (see equation (6)) are weighted, summed and averaged using first the expenditures on the basic headings of the first country as weights and then the expenditures on the basic headings of the second country as weights. This gives two weighted PPPs: a Laspeyres type PPP (see equation (7)) and a Paasche type PPP (see equation (8)). The geometric mean of these two PPPs gives a single Fisher type PPP between the two countries.
- By following this procedure each level of aggregation is provided with a matrix of intransitive Fisher PPPs. Application of the EKS formula makes the matrix transitive

$$EKS_{j/h} = \left( \prod_{l=1}^K F_{l/j} / F_{l/h} \right)^{1/K}, \quad \forall h, j \quad (9)$$

where  $EKS_{j/h}$  is the EKS PPP between countries  $h$  and  $j$ ;  $F_{l/j}$  and  $F_{l/h}$  are Fisher PPPs between countries  $l$  and  $j$  and  $l$  and  $h$  respectively;  $K$  the number of countries involved.

- The EKS PPPs are then used to convert the national expenditures in national currencies for the corresponding aggregate to real expenditures in a common currency. The real expenditures are subsequently expressed as volume indices.

### 12.3.3 Specific properties of EKS results

12.35 EKS PPPs and volume indices are base country invariant and transitive. These are properties of most multilateral calculation and aggregation methods. Beside these properties EKS results have several specific properties described below

- *Characteristicity*: The EKS method attempts to provide PPPs that are close to the PPPs that would be obtained if each pair of countries had been compared separately. This is because the EKS procedure in making the Fisher PPPs transitive minimises the differences (in the proper logarithmic least-squares sense) between them and the resulting EKS PPPs.

$$\Delta = \sum_{j=1}^K \sum_{h=1}^K (\log EKS_{h/j} - \log F_{h/j})^2 \Rightarrow \min \quad (10)$$

However the differences are minimized at the general level so differences will not necessarily be small for each pair of countries in the comparison.

- *Absence of the Gerschenkron effect*: The Gerschenkron effect applies to aggregation methods that use either a reference price structure to obtain real values – that is, each country's quantities are valued by a uniform set of prices - or a reference volume structure to obtain PPPs – that is, each country's prices are used to value a uniform set of quantities. With methods employing a reference price structure, a country's share of total GDP - that is, the total for the group of countries being compared - will rise as the reference price structure becomes less characteristic of its own price structure. With methods employing a reference volume structure, a country's share of total GDP will fall as the reference volume structure becomes less characteristic of its own volume structure.

The Gerschenkron effect arises because of the negative correlation between prices and volumes. In other words, expenditure patterns change in response to changes in relative prices because consumers switch their expenditure towards relatively cheap products. The EKS method does not use a reference price structure or a reference volume structure when estimating real expenditures. EKS real expenditures are not subject to the Gerschenkron effect (see also Annex VIII).

- *Non-additive*: The values of the expenditure aggregates of participating countries are equal to the sum of the values of their components when both aggregates and components are valued at national prices. Additivity requires this identity to be preserved when the values of the aggregates and their components are valued at international prices. An aggregation method is additive if, for each country being compared, it provides real expenditures for basic headings that sum to the real expenditures of the aggregates of which they are components. An additive aggregation method provides volumes that satisfy the average test for volumes – that is, the average volume lies between the maximum and minimum volumes.<sup>17</sup>

The EKS provides real expenditures that are not additive. It is for this reason that PPPs have to be calculated for each level of aggregation. The average test does not hold for volumes nor does it hold for price indices. EKS PPPs and real expenditures are not suitable for comparing price and volume structures across countries.

### 12.3.4 Reference PPPs

12.36 EKS aggregation requires the national expenditure of each participating country to be re-valued by the price vector of each of the other participating countries. Therefore, before aggregation can begin, it is necessary to ensure that the matrix of basic heading PPPs is complete and that there is a PPP for every country for every basic heading. If the matrix is not complete, there is the danger that aggregation may produce biased volumes measures.

12.37 In practice there will always be basic headings with missing PPPs because, for the reasons given in paragraph 12.17, it is not always possible to calculate a direct binary PPP between a country and any of the other countries participating in the comparison even though prices were collected for the basic heading. Such gaps in the matrix are filled by taking the PPP from a comparable basic heading or from the next level of aggregation. This step is carried out prior to aggregation.

12.38 There could also be missing PPPs because no prices were collected for the basic heading. This can happen when it becomes difficult to specify comparable products that could be priced across countries for the basic heading. For such comparison resistant basic headings, PPPs based on price data that have been collected for other basic headings are used as proxies for the PPPs that would have been calculated had prices been collected for them. Such proxy PPPs are called *reference PPPs*. Aggregation includes the calculation of reference PPPs.

12.39 The basic headings requiring reference PPPs and the reference PPPs selected for them are listed in Annex 12.1.<sup>18</sup> From the Annex, it will be seen that the reference PPPs can be those of a single basic heading or they can be aggregations of a specified set of basic headings. It depends on which provides the better proxy PPPs for the basic heading in question or, in the absence of corresponding proxies, which provides an acceptable neutral average. Hence, the reference PPP for *package holidays* is a combination of the PPPs for different forms of passenger transport services, the PPPs for various catering services and the PPPs for accommodation services, while the reference PPPs for *narcotics, prostitution, insurance, FISIM, other financial services* and the *intermediate consumption* of various government services are the PPPs for individual market consumption which, as can be seen from Annex 12.2, is an aggregation of the PPPs of 132 basic headings. Similarly, as shown in Annex 12.3, the reference PPPs for *change in inventories* is an aggregation of the PPPs for consumer goods and equipment goods. Exchange rates are used for *net purchases abroad* and for *balance of exports and imports*; they are also used for *aircraft and aeronautical equipment* and for *acquisitions less disposals of valuables*.

<sup>17</sup> Additive aggregation methods generally use a reference price structure to value national expenditures on basic headings at international prices. The reference price structure consists of an international price for each basic heading. An international price for a basic heading is defined as the average of the national prices for the basic heading prevailing in participating countries. The average may be weighted or unweighted, PPP adjusted or PPP-unadjusted. It may be an average of prices or an average of price structures. For example, in the GK method which is discussed later, the average is defined as a quantity-weighted arithmetic average of the national prices adjusted by the global PPPs across all countries.

<sup>18</sup> The basic headings requiring reference PPPs are listed in the order they appear in the expenditure classification. But the reference PPPs are not necessarily calculated in that order. Some reference PPPs are used in the calculation of other reference PPPs and these have to be calculated first.

### 12.3.5 Fixity

12.40 Fixity is obtained at the level of an aggregate in the same way as it is obtained at the basic heading level. This has already been described in Section 12.2.6 and will not be repeated here.

**Annex 12.1: Reference PPPs by basic heading**

Basic Heading		Reference PPP
<b>INDIVIDUAL CONSUMPTION EXPENDITURE BY HOUSEHOLDS</b>		
11.01.12.5	Other meats and edible offal	11.01.12.1 Beef and veal
		11.01.12.2 Pork
		11.01.12.3 Lamb, mutton and goat
		11.01.12.4 Poultry
11.02.31.1	Narcotics	Individual market consumption (Annex 12.2)
11.04.42.1	Miscellaneous services relating to the dwelling	11.04.32.1 Services for the maintenance and repair of the dwelling
11.05.13.1	Repair of furniture, furnishings and other floor covering	11.05.11.1 Kitchen furniture
		11.05.11.2 Bedroom furniture
		11.05.11.3 Living-room and dining-room furniture
		11.05.11.4 Other furniture and furnishing
		11.05.12.1 Carpets and other floor covering
11.06.31.1	Hospital services	13.02.21.1 Physicians
		13.02.21.2 Nurses and other medical staff
		13.02.21.3 Non-medical staff
		13.02.22.1 Pharmaceutical products
		13.02.22.2 Other medical goods
		13.02.22.3 Therapeutic appliances and equipment
		13.02.22.4 Intermediate consumption n.e.c.
		13.02.23.1 Gross operating surplus
13.02.24.1 Net taxes on production		
11.07.14.1	Animal drawn vehicles	Individual market consumption (Annex 12.2)
11.07.35.1	Combined passenger transport	11.07.31.1 Passenger transport by railway
		11.07.32.1 Passenger transport by road
11.08.21.1	Telephone and telefax equipment	11.09.11.1 Equipment for the reception, recording and reproduction of sound and pictures
		11.09.13.1 Information processing equipment
11.09.21.1	Major durables for outdoor recreation	11.07.11.1 Motor cars with diesel engine
		11.07.11.2 Motor cars with petrol engine of cubic capacity of less than 1200cc
		11.07.11.3 Motor cars with petrol engine of cubic capacity of 1200cc to 1699
		11.07.11.4 Motor cars with petrol engine of cubic capacity of 1700cc to 2999
		11.07.11.5 Motor cars with petrol engine of cubic capacity of 3000cc and over
11.09.22.1	Musical instruments and major durables for indoor recreation	11.09.11.1 Equipment for the reception, recording and reproduction of sound and pictures
11.09.23.1	Maintenance and repair of other major durables for recreation and culture	11.07.23.1 Maintenance and repair of personal transport equipment
		11.09.15.1 Repair of audio-visual, photographic and information processing equipment
11.09.43.1	Games of chance	Individual market consumption (Annex 12.2)

Basic Heading		Reference PPP	
11.09.61.1	Package holidays	11.07.31.1	Passenger transport by railway
		11.07.32.1	Passenger transport by road
		11.07.33.1	Passenger transport by air
		11.07.34.1	Passenger transport by sea and inland waterway
		11.07.35.1	Combined passenger transport
		11.07.36.1	Other purchased transport services
		11.11.11.1	Restaurants services whatever the type of establishment
		11.11.11.2	Pubs, bars, cafes, tea rooms and the like
		11.11.12.1	Canteens
		11.11.21.1	Accommodation services
11.12.21.1	Prostitution	Individual market consumption (Annex 12.2)	
11.12.41.1	Social protection	13.05.11.1	Social protection
11.12.51.1	Insurance	Individual market consumption (Annex 12.2)	
11.12.61.1	FISIM		
11.12.62.1	Other financial services n.e.c.		
11.12.71.1	Other services n.e.c.		
11.13.11.1	Net purchases abroad		
INDIVIDUAL CONSUMPTION EXPENDITURE BY NPISHs			
12.01.11.1	Housing	11.04.11.1	Actual rental for housing <sup>1</sup>
12.02.11.1	Health	11.06.31.1	Hospital services
12.03.11.1	Recreation and culture	11.09.41.1	Recreational and sporting services
		11.09.42.2	Other cultural services
12.04.11.1	Education	11.10.11.1	Education <sup>2</sup>
12.05.11.1	Social protection	13.05.11.1	Social protection
12.06.11.1	Other services	12.01.11.1	Housing
		12.02.11.1	Health
		12.03.11.1	Recreation and culture
		12.04.11.1	Education
		12.05.11.1	Social protection
INDIVIDUAL CONSUMPTION EXPENDITURE BY GOVERNMENT			
13.01.11.1	Housing	11.04.11.1	Actual rental for housing <sup>1</sup>
13.02.11.1	Health benefits and reimbursements - Pharmaceutical products	11.06.11.1	Pharmaceutical products <sup>1</sup>
13.02.11.2	Health benefits and reimbursements - Other medical products	11.06.12.1	Other medical products <sup>1</sup>
13.02.11.3	Health benefits and reimbursements - Therapeutic appliances and equipment	11.06.13.1	Therapeutic appliances and equipment <sup>1</sup>
13.02.12.1	Health benefits and reimbursements - Out-patient medical services	11.06.21.1	Medical services <sup>1</sup>
13.02.12.2	Health benefits and reimbursements - Out-patient dental services	11.06.22.1	Dental services <sup>1</sup>
13.02.12.3	Health benefits and reimbursements - Out-patient paramedical services	11.06.23.1	Paramedical services <sup>1</sup>
13.02.12.4	Health benefits and reimbursements - Hospital services	11.06.31.1	Hospital services

Basic Heading		Reference PPP
13.02.22.1	Health services - Pharmaceutical products	11.06.11.1 Pharmaceutical products
13.02.22.2	Health services - Other medical goods	11.06.12.1 Other medical products
13.02.22.3	Health services - Therapeutic appliances and equipment	11.06.13.1 Therapeutic appliances and equipment
13.02.22.4	Health services - Intermediate consumption n.e.c.	Individual market consumption (Annex 12.2)
13.02.23.1	Health services - Gross operating surplus	The 29 basic headings listed for 15.03.11.1 <u>Products of agriculture, forestry, fisheries and aquaculture</u> (see below) plus the following 3 basic headings: 15.03.11.1 Products of agriculture, forestry, fisheries and aquaculture 15.03.12.1 Software 15.03.13.1 Other products n.e.c.
13.02.24.1	Health services - Net taxes on production	13.02.21.1 Physicians 13.02.21.2 Nurses and other medical staff 13.02.21.3 Non-medical staff 13.02.22.1 Pharmaceutical products 13.02.22.2 Other medical goods 13.02.22.3 Therapeutic appliances and equipment 13.02.22.4 Intermediate consumption n.e.c. 13.02.23.1 Gross operating surplus
13.02.25.1	Health services -Receipts from sales	11.06.31.1 Hospital services
13.03.11.1	Recreation and culture	12.03.11.1 Recreation and culture
13.04.11.1	Education	11.10.11.1 Education <sup>2</sup>
13.05.11.1	Social protection	13.01.11.1 Housing 13.02.11.1 Pharmaceutical products 13.02.11.2 Other medical products 13.02.11.3 Therapeutic appliances and equipment 13.02.12.1 Out-patient medical services 13.02.12.2 Out-patient dental services 13.02.12.3 Out-patient paramedical services 13.02.12.4 Hospital services 13.02.21.1 Physicians 13.02.21.2 Nurses and other medical staff 13.02.21.3 Non-medical staff 13.02.22.1 Pharmaceutical products 13.02.22.2 Other medical goods 13.02.22.3 Therapeutic appliances and equipment 13.02.22.4 Intermediate consumption n.e.c. 13.02.23.1 Gross operating surplus 13.02.24.1 Net taxes on production
<b>COLLECTIVE CONSUMPTION EXPENDITURE BY GOVERNMENT</b>		
14.01.11.1	Collective services relating to defence - Compensation of employees	14.01.11.2 Collective services other than defence – Compensation of employees

Basic Heading		Reference PPP
14.01.12.1	Collective services relating to defence - Intermediate consumption	The 18 basic headings listed for <u>15.01.22.1 Ships, boats, steamers, tugs, floating platforms, rigs</u> (see below) plus the following 2 basic headings:
		15.01.22.1 Ships, boats, steamers, tugs, floating platforms, rigs
		15.01.22.2 Locomotives, rail-cars vans and wagons, other rail equipment
14.01.12.2	Collective services other than defence - Intermediate consumption	Individual market consumption (Annex 12.2)
14.01.13.1	Collective services - Gross operating surplus	The 29 basic headings listed for <u>15.03.11.1 Products of agriculture, forestry, fisheries and aquaculture</u> (see below) plus the following 3 basic headings:
		15.03.11.1 Products of agriculture, forestry, fisheries and aquaculture
		15.03.12.1 Software
		15.03.13.1 Other products n.e.c.
14.01.14.1	Collective services - Net taxes on production	14.01.11.1 Collective services relating to defence - Compensation of employees
		14.01.11.2 Collective services other than defence - Compensation of employees
		14.01.12.1 Collective services relating to defence - Intermediate consumption
		14.01.12.2 Collective services other than defence - Intermediate consumption
		14.01.13.1 Collective service - Gross operating surplus
14.01.15.1	Collective services - Receipts from sales	The 5 basic headings listed for <u>14.01.14.1 Collective services - Net taxes on production</u> plus the following basic heading:
		14.01.14.1 Net taxes on production
<b>GROSS FIXED CAPITAL FORMATION</b>		
15.01.22.1	Ships, boats, steamers, tugs, floating platforms, rigs	15.01.11.1 Fabricated metal products, except machinery and equipment
		15.01.12.1 Engines and turbines, pumps and compressors
		15.01.12.2 Other general purpose machinery
		15.01.13.1 Agricultural and forestry machinery
		15.01.13.2 Machine tools
		15.01.13.3 Machinery for metallurgy, mining, quarrying and construction
		15.01.13.4 Machinery for food, beverages and tobacco processing
		15.01.13.5 Machinery for textile, apparel and leather production
		15.01.13.6 Other special purpose machinery
		15.01.14.1 Office machinery
		15.01.14.2 Computers and other information processing equipment
		15.01.14.3 Electrical machinery and apparatus
		15.01.14.4 Radio, television and communications equipment and apparatus

Basic Heading		Reference PPP
		15.01.14.5 Medical, precision and optical instruments, watches and clocks
		15.01.15.1 Other manufactured goods n.e.c.
		15.01.21.1 Motor vehicles, trailers and semi-trailers
		15.01.21.2 Other road transport
		15.01.22.3 Aircraft, helicopters and other aeronautical equipment
15.01.22.2	Locomotives and rolling stock	15.01.22.1 Ships, boats, steamers, tugs, floating platforms, rigs
15.01.22.3	Aircraft, helicopters and other aeronautical equipment	Exchange rate to euro
		15.01.11.1 Fabricated metal products, except machinery and equipment
		15.01.12.1 Engines and turbines, pumps and compressors
		15.01.12.2 Other general purpose machinery
		15.01.13.1 Agricultural and forestry machinery
		15.01.13.2 Machine tools
		15.01.13.3 Machinery for metallurgy, mining, quarrying and construction
		15.01.13.4 Machinery for food, beverages and tobacco processing
		15.01.13.5 Machinery for textile, apparel and leather production
		15.01.13.6 Other special purpose machinery
		15.01.14.1 Office machinery
		15.01.14.2 Computers and other information processing equipment
		15.01.14.3 Electrical machinery and apparatus
		15.01.14.4 Radio, television and communications equipment and apparatus
		15.01.14.5 Medical, precision and optical instruments, watches and clocks
		15.01.15.1 Other manufactured goods n.e.c.
		15.01.21.1 Motor vehicles, trailers and semi-trailers
		15.01.21.2 Other road transport
		15.01.22.1 Ships, boats, steamers, tugs, floating platforms, rigs
		15.01.22.2 Locomotives and rolling stock
		15.01.22.3 Aircraft, helicopters and other aeronautical equipment
		15.02.11.1 Residential buildings
		15.02.21.1 Non-residential buildings
		15.02.31.1 Civil engineering works
15.03.13.1	Other products n.e.c.	15.03.11.1 Products of agriculture, forestry, fisheries and aquaculture

Basic Heading		Reference PPP
<b>OTHER EXPENDITURES</b>		
16.01.11.1	Change in inventories	Change in inventories (Annex 12.3)
16.02.11.1	Acquisitions less disposals of valuables	Exchange rate to euro
17.01.11.1	Balance of exports and imports	

<sup>1</sup> Not strictly speaking a reference PPP. PPPs are estimated according to the full market price concept and thus apply to all sectors. See Chapters 6 and 7.

<sup>2</sup> Not strictly speaking a reference PPP. PPPs are estimated for total economy expenditure on education and then applied to the three sectors. See Chapter 8.

**Annex 12.2:** Basic headings comprising individual market consumption

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11.01.11.1	Rice
11.01.11.2	Other cereals, flour and other cereal products
11.01.11.3	Bread
11.01.11.4	Other bakery products
11.01.11.5	Pasta products
11.01.12.1	Beef and veal
11.01.12.2	Pork
11.01.12.3	Lamb, mutton and goat
11.01.12.4	Poultry
11.01.12.5	Other meats and edible offal
11.01.12.6	Delicatessen and other meat preparations
11.01.13.1	Fresh, chilled or frozen fish and seafood
11.01.13.2	Preserved or processed fish and seafood
11.01.14.1	Fresh milk
11.01.14.2	Preserved milk and other milk products
11.01.14.3	Cheese
11.01.14.4	Eggs and egg-based products
11.01.15.1	Butter
11.01.15.2	Margarine
11.01.15.3	Other edible oils and fats
11.01.16.1	Fresh or chilled fruit
11.01.16.2	Frozen, preserved or processed fruit and fruit based products
11.01.17.1	Fresh or chilled vegetables other than potatoes
11.01.17.2	Fresh or chilled potatoes
11.01.17.3	Frozen, preserved or processed vegetables and vegetable-based products
11.01.18.1	Sugar
11.01.18.2	Jams, marmalades and honey
11.01.18.3	Confectionery, chocolate and other cocoa preparations
11.01.18.4	Edible ice, ice cream and sorbet
11.01.19.1	Food products n.e.c.
11.01.21.1	Coffee, tea and cocoa
11.01.22.1	Mineral waters
11.01.22.2	Soft drinks and concentrates
11.01.22.3	Fruit and vegetable juices
11.02.11.1	Spirits
11.02.12.1	Wine
11.02.13.1	Beer
11.02.21.1	Tobacco
11.03.11.1	Clothing materials
11.03.12.1	Men's clothing
11.03.12.2	Women's clothing
11.03.12.3	Children's and infant's clothing
11.03.13.1	Other articles of clothing and clothing accessories
11.03.14.1	Cleaning, repair and hire of clothing
11.03.21.1	Men's footwear
11.03.21.2	Women's footwear
11.03.21.3	Children's and infant's footwear
11.03.22.1	Repair and hire of footwear
11.04.11.1	Actual rental for housing

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11.04.21.1	Imputed rentals for housing
11.04.31.1	Materials for the maintenance and repair of the dwelling
11.04.32.1	Services for the maintenance and repair of the dwelling
11.04.41.1	Water supply
11.04.42.1	Miscellaneous services relating to the dwelling
11.04.51.1	Electricity
11.04.52.1	Gas
11.04.53.1	Liquid fuels
11.04.54.1	Solid fuels
11.04.55.1	Heat energy
11.05.11.1	Kitchen furniture
11.05.11.2	Bedroom furniture
11.05.11.3	Living-room and dining-room furniture
11.05.11.4	Other furniture and furnishing
11.05.12.1	Carpets and other floor covering
11.05.13.1	Repair of furniture, furnishings and other floor covering
11.05.21.1	Household textiles
11.05.31.1	Major household appliances whether electric or not
11.05.32.1	Small electric household appliances
11.05.33.1	Repair of household appliances
11.05.41.1	Glassware, tableware and household utensils
11.05.51.1	Major tools and equipment
11.05.52.1	Small tools and miscellaneous accessories
11.05.61.1	Non-durable household goods
11.05.62.1	Domestic services
11.05.62.2	Household services
11.06.11.1	Pharmaceutical products
11.06.12.1	Other medical products
11.06.13.1	Therapeutic appliances and equipment
11.07.11.1	Motor cars with diesel engine
11.07.11.2	Motor cars with petrol engine of cubic capacity of less than 1200cc
11.07.11.3	Motor cars with petrol engine of cubic capacity of 1200cc to 1699
11.07.11.4	Motor cars with petrol engine of cubic capacity of 1700cc to 2999
11.07.11.5	Motor cars with petrol engine of cubic capacity of 3000cc and over
11.07.12.1	Motor cycles
11.07.13.1	Bicycles
11.07.21.1	Spare parts and accessories for personal transport equipment
11.07.22.1	Fuels and lubricants for personal transport equipment
11.07.23.1	Maintenance and repair of personal transport equipment
11.07.24.1	Other services in respect of personal transport equipment
11.07.31.1	Passenger transport by railway
11.07.32.1	Passenger transport by road
11.07.33.1	Passenger transport by air
11.07.34.1	Passenger transport by sea and inland waterway
11.07.35.1	Combined passenger transport
11.07.36.1	Other purchased transport services
11.08.11.1	Postal services
11.08.21.1	Telephone and telefax equipment
11.08.31.1	Telephone and telefax services
11.09.11.1	Equipment for the reception, recording and reproduction of sound and pictures
11.09.12.1	Photographic and cinematographic equipment and optical instruments

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11.09.13.1	Information processing equipment
11.09.14.1	Pre-recorded recording media
11.09.14.2	Unrecorded recording media
11.09.15.1	Repair of audio-visual, photographic and information processing equipment
11.09.21.1	Major durables for outdoor recreation
11.09.22.1	Musical instruments and major durables for indoor recreation
11.09.23.1	Maintenance & repair of other major durables for recreation & culture
11.09.31.1	Games, toys and hobbies
11.09.32.1	Equipment for sport, camping and open-air recreation
11.09.33.1	Gardens, plants and flowers
11.09.34.1	Pets and related products
11.09.35.1	Veterinary and other services for pets
11.09.41.1	Recreational and sporting services
11.09.42.1	Photographic services
11.09.42.2	Other cultural services
11.09.51.1	Books
11.09.52.1	Newspapers and periodicals
11.09.53.1	Miscellaneous printed matter, stationery and drawing materials
11.09.61.1	Package holidays
11.11.11.1	Restaurants services whatever the type of establishment
11.11.11.2	Pubs, bars, cafes, tea rooms and the like
11.11.12.1	Canteens
11.11.21.1	Accommodation services
11.12.11.1	Hairdressing salons and personal grooming establishments
11.12.12.1	Electric appliances for personal care
11.12.13.1	Other appliances, articles and products for personal care
11.12.31.1	Jewellery, clocks and watches
11.12.32.1	Other personal effects

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**Annex 12.3:** Basic headings comprising inventories

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11.01.11.1	Rice
11.01.11.2	Other cereals, flour and other cereal products
11.01.11.3	Bread
11.01.11.4	Other bakery products
11.01.11.5	Pasta products
11.01.12.1	Beef and veal
11.01.12.2	Pork
11.01.12.3	Lamb, mutton and goat
11.01.12.4	Poultry
11.01.12.5	Other meats and edible offal
11.01.12.6	Delicatessen and other meat preparations
11.01.13.1	Fresh, chilled or frozen fish and seafood
11.01.13.2	Preserved or processed fish and seafood
11.01.14.1	Fresh milk
11.01.14.2	Preserved milk and other milk products
11.01.14.3	Cheese
11.01.14.4	Eggs and egg-based products
11.01.15.1	Butter
11.01.15.2	Margarine
11.01.15.3	Other edible oils and fats
11.01.16.1	Fresh or chilled fruit
11.01.16.2	Frozen, preserved or processed fruit and fruit based products
11.01.17.1	Fresh or chilled vegetables other than potatoes
11.01.17.2	Fresh or chilled potatoes
11.01.17.3	Frozen, preserved or processed vegetables and vegetable-based products
11.01.18.1	Sugar
11.01.18.2	Jams, marmalades and honey
11.01.18.3	Confectionery, chocolate and other cocoa preparations
11.01.18.4	Edible ice, ice cream and sorbet
11.01.19.1	Food products n.e.c
11.01.21.1	Coffee, tea and cocoa
11.01.22.1	Mineral waters
11.01.22.2	Soft drinks and concentrates
11.01.22.3	Fruit and vegetable juices
11.02.11.1	Spirits
11.02.12.1	Wine
11.02.13.1	Beer
11.02.21.1	Tobacco
11.03.11.1	Clothing materials
11.03.12.1	Men's clothing
11.03.12.2	Women's clothing
11.03.12.3	Children's and infant's clothing
11.03.13.1	Other articles of clothing and clothing accessories
11.03.21.1	Men's footwear
11.03.21.2	Women's footwear
11.03.21.3	Children's and infant's footwear
11.04.31.1	Materials for the maintenance and repair of the dwelling
11.04.53.1	Liquid fuels
11.04.54.1	Solid fuels

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11.05.11.1	Kitchen furniture
11.05.11.2	Bedroom furniture
11.05.11.3	Living-room and dining-room furniture
11.05.11.4	Other furniture and furnishing
11.05.12.1	Carpets and other floor covering
11.05.21.1	Household textiles
11.05.31.1	Major household appliances whether electric or not
11.05.32.1	Small electric household appliances
11.05.41.1	Glassware, tableware and household utensils
11.05.51.1	Major tools and equipment
11.05.52.1	Small tools and miscellaneous accessories
11.05.61.1	Non-durable household goods
11.06.11.1	Pharmaceutical products
11.06.12.1	Other medical products
11.06.13.1	Therapeutic appliances and equipment
11.07.11.1	Motor cars with diesel engine
11.07.11.2	Motor cars with petrol engine of cubic capacity of less than 1200cc
11.07.11.3	Motor cars with petrol engine of cubic capacity of 1200cc to 1699
11.07.11.4	Motor cars with petrol engine of cubic capacity of 1700cc to 2999
11.07.11.5	Motor cars with petrol engine of cubic capacity of 3000cc and over
11.07.12.1	Motor cycles
11.07.13.1	Bicycles
11.07.21.1	Spare parts and accessories for personal transport equipment
11.07.22.1	Fuels and lubricants for personal transport equipment
11.08.21.1	Telephone and telefax equipment
11.09.11.1	Equipment for the reception, recording and reproduction of sound and pictures
11.09.12.1	Photographic and cinematographic equipment and optical instruments
11.09.13.1	Information processing equipment
11.09.14.1	Pre-recorded recording media
11.09.14.2	Unrecorded recording media
11.09.21.1	Major durables for outdoor recreation
11.09.22.1	Musical instruments and major durables for indoor recreation
11.09.31.1	Games, toys and hobbies
11.09.32.1	Equipment for sport, camping and open-air recreation
11.09.33.1	Gardens, plants and flowers
11.09.34.1	Pets and related products
11.09.51.1	Books
11.09.52.1	Newspapers and periodicals
11.09.53.1	Miscellaneous printed matter, stationery and drawing materials
11.12.12.1	Electric appliances for personal care
11.12.13.1	Other appliances, articles and products for personal care
11.12.31.1	Jewellery, clocks and watches
11.12.32.1	Other personal effects
15.01.11.1	Fabricated metal products, except machinery and equipment
15.01.12.1	Engines and turbines, pumps and compressors
15.01.12.2	Other general purpose machinery
15.01.13.1	Agricultural and forestry machinery
15.01.13.2	Machine tools
15.01.13.3	Machinery for metallurgy, mining, quarrying and construction
15.01.13.4	Machinery for food, beverages and tobacco processing
15.01.13.5	Machinery for textile, apparel and leather production

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15.01.13.6	Other special purpose machinery
15.01.14.1	Office machinery
15.01.14.2	Computers and other information processing equipment
15.01.14.3	Electrical machinery and apparatus
15.01.14.4	Radio, television and communications equipment and apparatus
15.01.14.5	Medical, precision and optical instruments, watches and clocks
15.01.15.1	Other manufactured goods n.e.c.
15.01.21.1	Motor vehicles, trailers and semi-trailers
15.01.21.2	Other road transport
15.01.22.1	Ships, boats, steamers, tugs, floating platforms, rigs
15.01.22.2	Locomotives and rolling stock
15.01.22.3	Aircraft, helicopters and other aeronautical equipment

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