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Are integration and comparison between CPIs and PPPs feasible?

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Are integration and comparison between CPIs and PPPs feasible?[1]

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Abstract: The integration and comparison between the Consumer Price Indices (CPIs) and the Purchasing Power Parities (PPPs) has been widely discussed in literature and the need of a more integrated approach for calculating these indices has been emphasized. The paper focuses on these issues, both from a theoretical and practical point of view, suggesting the use of a broader definition of the comparability of products for the PPP calculation and a simple statistical method for investigating the advantages of broadening the definition of comparability to include additional products in the PPP calculation.

Concerning the comparisons between CPIs and PPPs, the paper illustrates price index decomposition methods in order to measure the factors (essentially due to the evolution of prices and to the share of consumption expenditure concerning the different products and services) which explain the divergences between the CPIs of two countries from time *t-1* to time *t*, and the variations over the same period of the PPPs concerning these countries calculated at time *t-1* and time *t*. However, it is clear that for achieving the integration of PPP computation with CPI activities an increased amount of information should be collected and processed at least in a benchmark year. Therefore, is necessary to carry out more research on these topics at an international level in order to agree on a broader definition of comparability of products for the computation of the PPPs by using the analyses that we have suggested in this paper.

***Keywords**:* consumer price indices, purchasing power parities, price data collection, price index decomposition.

[1] Paper to be published in Biggeri and Ferrari (editors), "Price Indexes in Time and Space: Methods and Practice", Sprinter –Verlag, 2009

I. Introduction

The importance of integration and comparison between the Consumer Price Indices (CPIs) and the Purchasing Power Parities (PPPs) has been widely discussed in literature (Heston, 1996; Rao, 2001a; ILO, 2004; Ferrari et al. 2005), and recognised in two critical reviews of ICP (International Comparison Program) and PPP computation by international organisations (Castels, 1997; Ryten, 1998) as well.

A more integrated approach to CPI and PPP for household consumption is required in order to: (i) explore the feasibility of integrating the PPP activities with the streamlined activities of the National Statistical Offices (NSOs) for the compilation of CPIs; (ii) examine the relationship between the PPPs for international comparisons with the evolution of CPIs in the countries in question. Integration and comparison are very advantageous both among different countries and different areas or cities within a country (ILO/IMF/OECD/UNECE/Eurostat &The World Bank (2004), 2004).

Over the last decades there has been very little harmonization of the activities and surveys of NSOs involved in both CPI and PPP work while the need for comparisons of CPIs and PPPs depends on the possibility of providing complete matrices of temporal-spatial price differences (ILO, 2004) which can be used for a better comprehension of the factors which influence price levels and their changes in different countries.

Therefore the feasibility of integration and comparison between CPIs and PPPs is an important issue which we will deal with in this paper considering only household consumption aggregates and binary comparisons between two areas or countries.

Firstly, in section 2 we will examine the integration issues considering the content of the different consumption baskets, which can be used for computing the CPIs in two countries and the PPPs between these countries, in order to verify the overlapping of the baskets, to identify a basis for integrating the price and expenditure share data for the CPI and PPP computation and to compare these results in a consistent space-time comparison of consumer prices. The potential problems and benefits that may arise from developing an integrated approach to collect the necessary information are also specified.

However, the integration approach may be hampered by using the “identity products principle” which is commonly applied for the calculation of PPPs and can seriously influence the representativeness of the PPP product list of the consumption baskets in different countries or regions within a country, and negatively affect the comparisons between PPPs and CPIs. For these reasons it is also advisable to include less comparable products in the PPP baskets.

Section 3 illustrates a simple statistical approach for investigating the advantage of broadening the definition of comparability in order to include additional products in the PPP calculation, in terms of coverage and representativeness of the computed PPPs and to evaluate the importance of different factors which affect the results of the computations.

Regarding the comparison between CPIs and PPPs it is also important to examine how the changes in consumer price levels over time in the two countries (computed by the CPIs) affect the movements over time of the PPPs calculated for household consumption.

It is not possible to totally integrate and link the commonly computed CPIs and PPPs and to carry out a direct comparison for the time being, because these indices differ in the basket of products and services in question and in the formulae used.

Section 4 illustrates a methodological approach based on the decomposition of the formulae in order to approximately evaluate the economic factors which explain the divergences between the CPIs of the two countries from time t-1 to time t, and the movement of the PPPs concerning the two countries in the same period.

Finally, the concluding remarks in section 5 explain how to carry out the integration of data collection and increase the comparability of CPIs and PPPs and then underline the usefulness of the methods suggested. Lastly, a huge organisational and costly effort by the NSOs is required in order to obtain the amount of data to be collected and estimated at least in a benchmark year for achieving the desired results.

II. Integration of CPIs and PPPs

CPIs and PPPs share conceptual similarities. CPIs measure changes in price levels of products and services over time within a country, whereas PPPs measure differences in price levels across countries or regions within a country. Therefore, CPIs and PPPs refer respectively to time and spatial dimension of price differences. However, the results obtained are different according to the baskets of goods and services considered and formulae used.

In order to analyse the possible integration of CPI and PPP activities, Rao (2001a) discussed the issue of optimizing the flow of data from CPI to PPP and presented a figure of the intersection of price data sets at a national level of a generic country, in order to verify the comparisons of sets of products and services between CPI and PPP lists within the country.

Bearing in mind the aims of this paper and considering two different countries, we are interested both in the integration of the price data collection for calculating the two indices and in the comparison between CPIs and the change in the level of PPPs. Therefore, also the CPIs of the two countries should be comparable.

In the following sub-sections, we will analyse the comparison of the CPI baskets of products in the two countries in question, then the comparison of the different baskets used for calculating the CPIs and PPPs in the two countries, and finally the potential problems and benefits involved in developing an integrated approach for collecting the required information.

A. The comparison of CPI baskets in the two countries

With the aim of comparing the items included in the CPI baskets of two countries, it may be necessary to divide the products and services included in the baskets into two parts: non-comparable and comparable items (with at least a minimum degree of comparability). In this way it is possible to verify the degree of overlapping of the sets of elementary items (products and services) representative of the elementary household expenditure aggregate, included in the consumption baskets used for the CPI calculations. The items priced in different countries could be identical or quite different depending on the heterogeneity level of the two countries concerning the population's consumption behaviour.

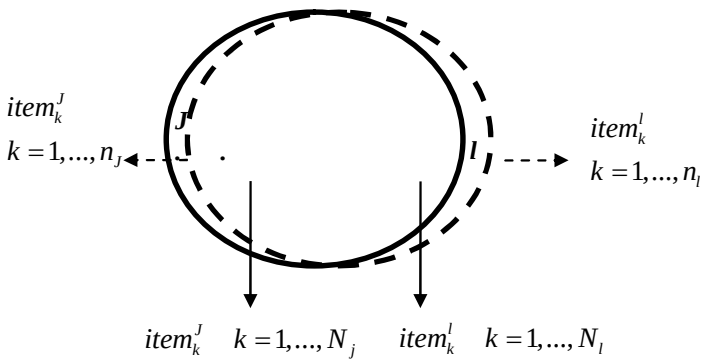
Considering Figure 1, where the CPI baskets of the two countries *l* and *J* are represented, composed by N_j and N_l items respectively, it is clear that there are fewer problems in finding an overlapping area when fairly similar or homogeneous countries are being compared in terms of consumption markets and behaviour. In this case, it is possible that $N_j = N_l$ i.e. the total number of products included in the two CPI baskets of each country in question could be identical. Moreover the characteristics of the products chosen for computing the CPIs and the elementary expenditure aggregates could be similar in the two countries. On the other hand, when comparisons involve countries that are fairly heterogeneous, the overlapping area will decrease.

The problem of identifying identical or similar products in the two countries can be related to the different number of items whose prices are to be collected for computing the CPIs in the two countries ($N_j \neq N_l$). Moreover, the definition and the identification of the elementary aggregates and products in the basket, and in particular the methods and practices used for price data collection, can greatly differ in the two countries according to the local situation of consumption, the differences in the consumer markets, the statistical infrastructures and the available resources.

However, even if the number of the products is the same ($N_j = N_l$), the physical and economic characteristics of the products and services which are used for calculating the CPIs can be different in the two countries due to the different patterns of consumption.

Therefore, the outer sets in Figure 1 consist of n_j and n_l products and services (or groups of products and services) which are *typical or characteristic* regarding the consumption behaviour in country *j* and *l* respectively. These items should be considered separately in the outer sets since they have different price determining characteristics or technical parameters, and cannot be used directly for calculating comparable CPIs in the two countries.

Figure 1 Comparison of CPI baskets in the two countries, j and l



It is worth noting that the above theoretical framework for comparing different consumption baskets is not applied from a practical point of view because the NSO of a certain country when computing national CPIs does not usually consider the comparability of the items included in that country's consumption basket with those included in the consumption basket of the other country in question.

The main components of CPIs are the data on prices of a large range of products and services *representative* of the consumption baskets of households and the information on weights associated with the various product categories reflecting the importance attached to different items.

The collection of prices and the expenditure weights are based on a classification of goods and services obtained by using a standard system such as the Classification of Individual Consumption according to Purpose (COICOP), or similar national classifications. The lowest level of product classification at which expenditure weights are available is used for identifying the *elementary aggregate indices* to be progressively aggregated to the total household expenditure level in order to obtain the general total CPI.

Within the elementary aggregate, *considered as strata sample*, the sample items to be included in the CPI computation are chosen considering the criteria of representativeness in terms both of the importance of all the products included in the elementary aggregate concerning consumption expenditure and their evolution of price changes over time. The elementary price index is computed using only price data, meaning that the index is estimated without using any weights within the elementary aggregate.

In this context, it is obvious that the items included in the CPI baskets of two countries can be quite different and it is not easy to compare these CPIs if no specification of the characteristics of products and services is given in order to harmonise the computation of the CPIs.

For this purpose the European HICPs (Harmonised Indices of Consumer Prices) are computed (ILO, IMF, OECD, UNECE, Eurostat &The World Bank, 2004)., 2004, Annex 1) to measure inflation on a comparable basis taking into account differences in national definitions. They are based on the prices of goods and services available for purchase in the economic territory of each EU Member State for the purpose of directly satisfying consumer needs. The definitions of prices to be collected and of the groups of products and services to be considered are harmonised and agreed on.

The European HICPs are classified according to the four-digit categories or sub-categories of the COICOP-HICP, which is the classification that has been adapted to the needs of HICPs, in order to have groups of products that are *approximately comparable* in terms of the specific items which must satisfy the same groups of consumers' need.

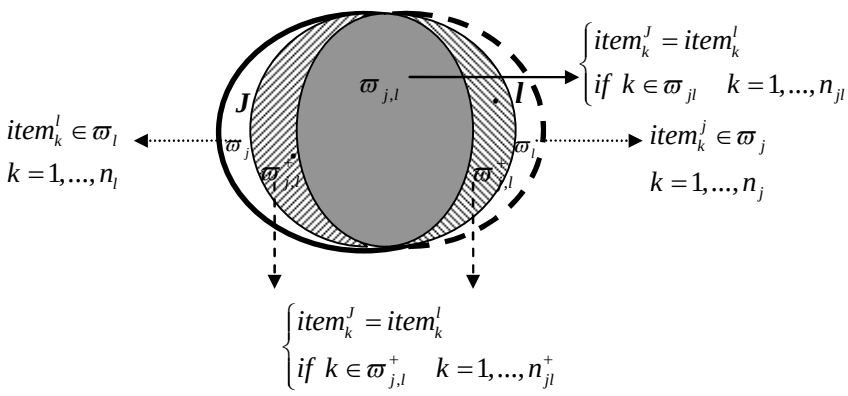
HICPs must also be based on appropriate sampling procedures, taking into account the national diversity of products and prices and among other things they illustrate what national consumer price indices have in common among the various countries. Three important sampling dimensions are considered: the item dimension, the outlet dimension and the regional dimension.

Therefore, the comparability criteria used in the HICPs is quite "weak" in terms of comparability of single products since in the HICP calculation the *representativeness criteria* is the most important aspect.

B. 2.2 The comparison of CPI and PPI baskets in two countries

Considering the above theoretical comparison of the CPI baskets in two countries (Fig. 1), the comparison between CPI and PPP baskets can only refer to the overlapping set of items, and in this case products are defined according to the need of computing adequate PPPs at elementary level. The computation of PPPs and the feasibility of the integration between CPI and PPP activities require the evaluation of the degree of comparability of the products in order to measure the price differential between the two countries in question and the corresponding definition of the representative products used for computing the elementary price indices for CPI estimation. For this purpose Figure 1 can be modified as shown in Figure 2.

Figure 2 Comparison of CPI and PPP baskets in two countries



By following the definitions of comparability and representativeness discussed in Biggeri, De Carli and Laureti (2008), we must underline that for computing PPPs the shaded overlapping area $\varpi_{j,l}$ includes only n_{jl} *identical products* with the same characteristics and are therefore strictly comparable but with different systems of weights in the two countries (*j* and *l*). The prices of these products can be and are usually used for calculating PPPs between the two countries.

The PPPs are computed at level of Basic Heading (BH) which consists of a fairly homogeneous group of items showing a low dispersion of price ratios. The basic heading level is normally the lowest level of aggregation for which expenditure data are available; therefore the PPPs at this level are computed without using weights for the individual items (Hill 1997). The basic heading level may be considered similar to the elementary level used in CPI calculation. For the aggregation of price evolution and price differences above the elementary level or basic heading level, the expenditure share weights are common requirements for both CPIs and PPPs (Balk, 1996, 2001 Diewert 1993).

However, the choice of the items (products and services) to be included in the BH follows different criteria (OECD-Eurostat, 2006, World Bank, 2007).

The main principle used in PPP computation in developing a product list requires a selection of "identical products" for the two countries. Identical products ensure that there are no quality issues in the measurement of the PPPs and the results only provide a measure of price differences. However, this is the most contentious issue in constructing PPPs, because the use of the identity principle can have serious implications for the representativeness of the product list of the consumption baskets in different countries[2].

Therefore, referring to Figure 2 and considering the BHs, the degree of the representativeness of items in the overlapping area $\varpi_{j,l}$ can be different in the two countries compared. In fact, since the patterns of consumption can greatly differ in these two countries, products that are representative and easily found in country *j* may not be easily found in *l*, due to differences in supply conditions, income levels, taste, climate, customs, etc. From a practical point of view it is evident that the strict comparability of products, obtained through a detailed specification, leads to PPPs for which it is possible to measure pure price differences. At the same time, this strict comparability will lower the degree of coverage in terms of products considered and of the general representativeness of a given product in different countries, (and even within a country); therefore the real consumption basket of these countries can be inadequately represented. In this case, the overall accuracy and reliability of the calculated PPPs will be affected.

The two overlapping sets of goods and services marked $\varpi^{+}_{j,l}$ contain n^{+}_{jl} less comparable items, whose prices are used for the computation of CPIs but usually not for PPP calculation. However, they could also be used for calculating PPPs by using a broader definition of comparability or by applying adjustments for quality differences.

The inclusion of the less comparable products in countries *j* and *l* for the computation of PPPs will increase the degree of coverage and probably the degree of representativeness of the comparison. However the calculated PPPs may correspond to different products, thus reflecting both pure price differences and the different representativeness of the selected products in the different countries.

As already mentioned, the outer sets marked ϖ_j and ϖ_l consist of some goods and services (n_j and n_l) which are typical (or characteristic) of the consumption behaviour in countries *j* and *l* respectively. Two products included in the outer areas cannot be considered comparable for PPPs purposes, even if we use a broader definition of comparability, because consumers may be willing to pay more for one product than another[3]. Moreover, these products may not be on sale in one of the two countries and vice-versa.

[2] There are several operational procedures used by international organizations in order to deal with these problems (see among others, Kravis et al, 1975, and more recently Rao, 2001b)

[3] When a characteristic is price determining the absence or presence of that characteristic will affect the price that consumers are prepared to pay for the product. There are several examples of price determining characteristics (Word Bank, ICP handbook, 2007). For example, the possession, or absence, of air conditioning will usually affect the price of an automobile. Consumers in most countries will pay more to obtain it. The size of a packet of rice is price determining as consumers will pay more for a kilo than half a kilo.

The number of typical products in each country is usually different ($n_j \neq n_l$) although in some cases it can be the same in both countries ($n_j = n_l$). It is clear that the higher the number of typical products, the larger the outer areas will be.

As shown in Figure 2 the total number of the items in the CPI basket in each country is obtained as the sum of the items included in the different subsets of products classified according to the imputed degree of comparability. For example, in country *j* the total number of products priced for CPI calculations is expressed as $N_j = n_{jl} + n_{jl}^{+} + n_j$. Similarly, the number of items in country *l* is expressed as $N_l = n_{jl} + n_{jl}^{+} + n_l$.

C. Problems and benefits involved in developing an integrated approach for the collection of the necessary information for CPIs and PPPs

The calculation of PPPs and standard CPIs is based on similar data requirements. From a practical point of view at present it clear that the definitions of the products to be used for PPP computation may be quite different from the definitions of the products used for the computation of CPIs and in any case the price data collection follows different criteria for the computation of the two indices. Even if we refer to the overlapping area of identical products of CPI and PPP baskets (as in Figure 2), the same item in the two baskets can be considered identical in theory but not in practice, since the definition of the products and services in the CPI computation is not usually well specified in terms of their characteristics.

There are several problems concerning the integration of data collection[4] for both CPIs and PPPs. On one hand it is necessary to evaluate the comparability of products and identify the identical products in the two countries, meaning that we must verify the characteristics and the quality of the products chosen for the CPIs and PPPs. On the other hand, it is also essential to verify whether the products priced in different countries are "representative" of their consumption within the basic headings or not. A related problem is whether the coverage of the products priced is adequate[5] concerning the basic heading to which they belong.

There are two different approaches for verifying these conditions, which do not necessarily exclude each other.

The first approach consists in analysing the definition of each item used for each CPI elementary aggregate and comparing it with the similar item used for the BH in the PPP computation. This analysis has been implemented in some experiments in various countries (see for example, Bretell and Gardiner, 2002, Wingfield, Fenwick and Smith, 2005, Aten, 2005, 2006 and Melser and Hill, 2005) and also in Italy in order to compute the PPPs at regional level within the country (De Carli, 2008). The results indicate that these analyses can be very difficult and time-consuming to implement. It is often necessary to review the definitions of the items whose prices are collected for the CPIs while in other cases it is

[4] As far as some useful initiatives that could provide a framework for a practical integrated approach for the integration of PPP and CPI work are concerned we refer to the suggestions of other mentioned authors and, in particular, to the ILO manual which mentions two core strategies to do it: the "Use of characteristics approach" and "linking approach to international comparisons".

[5] These issues are currently being researched, and Rao (2001b) offer a modified approach that attached weights proportional to coverage and representativeness.

necessary to implement specific surveys (for example for clothing, footwear and furniture) in order to obtain adequate price data for PPPs which are coherent with the identity product principle. Moreover, if it is not possible to find the items with the same strictly comparable definitions, methods of spatial quality adjustment must be used in order to compare the products and services of the two countries.

This approach may guarantee the strict comparability of more items included both in CPIs and PPPs, but does not provide any information on the representativeness and coverage of the PPP item list, which represents the consumption baskets in different countries. In order to solve this problem, it is necessary to collect data on expenditure weights for the products and services belonging to each elementary and BH aggregate. However at present the elementary aggregates and BHs are the lowest level aggregate for which expenditure data are available. Therefore, in order to carry out specific analyses to assess the degree of representativeness and coverage of PPPs the expenditure weight data within the elementary aggregates should be collected or evaluated, at least in a benchmark year.

The second approach focuses on the "reconciliation" of the definitions of products in the PPP and CPI baskets, using a broader definition of comparability for the computation of the PPPs (Krijnse-Locker, 1984). In this way a larger number of items included in the CPI baskets become comparable with those considered in other countries and can be used for the computation of new enlarged PPPs, thus achieving a higher level of comparability between CPIs and PPPs.

In our opinion, it is necessary to go beyond the criteria of identical products currently used for computing PPPs, because the cost of living could be misinterpreted if the comparison is based on two identical products which satisfy the same consumer need but are more frequently purchased in one country than the other and vice versa.

In order to compare the levels of expenditure between two countries for a specific basket of an elementary aggregate which can fulfil specific consumer demand, it is better to refer to the most frequently purchased products in each country, since even if they are not strictly comparable they will certainly represent the products purchased in these countries. However, it is important that these products are purchased by consumers in order to satisfy the same specific needs.

The use of a broader definition of comparability might be achieved by using the Structured Product Descriptions (SPDs) suggested by the ICP Global office of the World Bank and used in the 2005 ICP (Diewert, 2008). In fact, SPDs provide the framework for selecting the representative items to be priced. These price movements, taken together, can supply a good estimate of the overall change in prices for the group of similar products as a whole. When completing a SPD, collectors are identifying a specific product with all its relevant characteristics and distinguishing it from the other products in the same elementary aggregate. These product characteristics were used to specify a particular product to be included in the calculation PPPs. The SPDs could also be used for collecting product prices in order to construct CPIs thus building a harmonized framework to carry out the comparison among countries.

Apart from increasing the number of items to be included in the computation, the above mentioned analyses can improve the representativeness of the consumption basket of the countries examined. However, disaggregated data concerning expenditure weights within the

elementary aggregates are necessary for evaluating improvements in representativeness and coverage of the PPPs and in comparability between CPIs and PPPs[6].

A successful integration of PPP activity with the CPI compilation depends on to what extent these two activities can be based on a common pool of data and information available at a national level and at a territorial level within a country.

Nevertheless, concerning data collection it is clear that for achieving the integration of PPP computation with CPI activities an increased amount of information to be collected and processed during the construction of the CPI is required and therefore a lot of extra work is necessary (see also Rao, 2001; ILO, IMF, OECD, UNECE, Eurostat &The World Bank,, 2004, Ferrari et al., 2005). So it is clear that the NSOs and organizations involved in CPI construction must believe that PPP computation and any results from PPPs are a natural extension of current CPI activities, and produce much more important statistical information on which possible economic analysis can be performed.

However, the NSOs must be aware that the integration activities could also result in tangible benefits as many authors have underlined. In short the potential benefits are:

- increased coverage in terms of products and share of the household expenditure for the PPPs;
- improved quality of the PPP estimations in terms of the representativeness of the consumption baskets of the countries involved;
- increased coherence between the results of PPP and CPI calculations;
- possibility for computing the PPPs at reduced intervals of time, taking into account the high frequency of collection of data for CPI purposes, thus overcoming the difficulties linked to the use of CPIs for the temporal updating of the PPPs;
- improved research on methods for quality adjustment in order to make more comparable similar products, which could enable us to verify the quality changes over time and quality differences across countries.

One more important advantage is the possible development of PPPs across different cities and/or regions within countries. In this case it is easier to make a reliable comparison and a successful integration of the PPPs and CPIs between two regions within a country because the level of homogeneity concerning consumer behaviour is usually higher and the definitions of all the products are more similar.

However, NSOs must evaluate some of the above mentioned benefits, especially concerning the coverage and the quality improvement of the PPP estimations in order to decide whether it is better to implement the integration of the CPIs and PPPs and more importantly if less comparable products should be included in the PPP computation. Moreover, NSOs must assess the pros and cons in terms of comparability between CPIs and PPPs. In the following sections we will suggest some statistical methods for carrying out these evaluations.

[6] For the international comparisons the integration work also requires the harmonisation of the definitions and classifications of products and of the methods for the collection of data.

III. Methodological approach for deciding whether to include less comparable but more representative products in the PPP calculation

A. Inclusion of less comparable products vs identical products

In order to understand to what extent it is profitable to include less comparable products in the list for the computation of spatial indices, and in particular when they came from the CPI computation, we need a method for measuring the effect caused by their inclusion in the PPP calculation.

On one hand, the inclusion of less comparable products should increase both the coverage referring to the share of the household expenditure of each set of products and the representativeness of PPPs referring to the values of the PPPs concerning different sets of products, on the other hand by doing so the degree of comparability of the same products will decrease. Therefore, there is a sort of trade-off between the concept of representativeness and comparability.

In order to select the right number of products we will propose a simple method based on the calculation of three different indices referring to three different sets of products, already illustrated in Figure 2 and represented by the overlapping areas $\varpi_{j,l}$ (shaded), the $\varpi^{+}_{j,l}$ (striped) and the outer areas ϖ_j and ϖ_l.

By following Biggeri, Laureti and De Carli (2008) the three spatial indices are calculated as ratios of the weighted geometric mean prices of the three sets of products of the two countries in question. The first two indices are called *Average Prices' Parities* (*APPs)* to differentiate them from the currently computed PPPs, and the third is called the *Characteristicity Index (CI)*, because it measures the influence of typical products of the country's basket on spatial comparisons.

It is worth noting that all these spatial indices can be calculated by using country *j* or country *l* as the reference country thus obtaining APPs comparing country *j* to country *l* or vice-versa.

Below only indices, calculated considering country *l* as reference country, are shown since the results are similar but opposite.

By only considering the strictly comparable products, which are those included as identical products in the overlapping area $\varpi_{j,l}$ in Figure 2, we will calculate the following spatial index:

$$APP_{l,j}^{\varpi_{jl}} = \frac{\prod_{k=1}^{n_{jl}} \left(p_k^j\right)^{w_k^j}}{\prod_{k=1}^{n_{jl}} \left(p_k^l\right)^{w_k^l}} \qquad [1]$$

where p_k^j (w_k^j) denotes the price (weight, as share of expenditure) of item specification *k* in country *j*, p_k^l (w_k^l) is the price (weight) of item specification *k* in country *l* , $\sum_{k=1}^{n_{jl}} w_k^j = \sum_{k=1}^{n_{jl}} w_k^l = 1$ and n_{ij} is the number of identical items priced in both countries.

Considering only the less comparable products, which are contained in the two striped areas $\varpi^+_{j,l}$ in Figure 2, a second index $APP_{l,j}^{\varpi^+_{jl}}$ can be computed as a ratio of the *weighted geometric mean prices:*

$$APP_{l,j}^{\varpi^+_{jl}} = \frac{\prod_{k=1}^{n_j^+} \left({}^+p_k^j \right)^{{}^+w_k^j}}{\prod_{k=1}^{n_l^+} \left({}^+p_k^l \right)^{{}^+w_k^l}} \qquad [2]$$

where ${}^+p_k^j$ (${}^+w_k^j$) and ${}^+p_k^l$ (${}^+w_k^l$) are the price (weight) of the less comparable products priced in country *j* and *l* respectively and $\sum_{k=1}^{n_j^+} {}^+w_k^j = \sum_{k=1}^{n_l^+} {}^+w_k^l = 1$.

Finally, by considering the typical products we can calculate the *CI* as the ratio between the weighted geometric average prices of the typical products in the two countries in question, included in the outer areas ϖ_j and ϖ_l :

$$CI_{l,j} = \frac{\prod_{k=1}^{n_j} \left({}^*p_k^j \right)^{{}^*w_k^j}}{\prod_{k=1}^{n_l} \left({}^*p_k^l \right)^{{}^*w_k^l}} \qquad [3]$$

where ${}^*p_k^j$ (${}^*w_k^j$) and ${}^*p_k^l$ (${}^*w_k^l$) are the price (weight) of the characteristic products in country *j* and *l* respectively and $\sum_{k=1}^{n_j} {}^*w_k^j = \sum_{k=1}^{n_l} {}^*w_k^l = 1$.

After having calculated these indices we must check their values so assess if they are equal or different to 1 and then compare the results.

For example if $APP_{l,j}^{\varpi^+_{jl}}$ is equal to 1 it seems that the inclusion of less comparable products does not add further information to the comparison of the level of prices between the two countries compared to the information from the $APP_{l,j}^{\varpi_{jl}}$ index although it increases the coverage. When as usual the $APP_{l,j}^{\varpi^+_{jl}}$ is different to 1, the inclusion of less comparable products shows a different behaviour of the prices for these products in the two countries.

Having established that the second APP index, $APP_{l,j}^{\varpi^{+}_{jl}}$, is different to 1 we must compare it to the $APP_{l,j}^{\varpi_{jl}}$ index.

By comparing the values of $APP_{l,j}^{\varpi^{+}_{jl}}$ and $APP_{l,j}^{\varpi_{jl}}$ we can assess whether the computation of the APP for the less comparable products adds further information to the comparison of the level of prices between the two countries.

If the two indices are equal to one another it would be advantageous to compute PPPs by using less comparable products because in this way the representativeness and coverage of the computed PPPs are improved.

When the two indices differ we should evaluate the degree of divergence and the trade-off between comparability and representativity. Moreover in order to include the right number of products we must consider to what extent the two different sets of products weigh on the total household consumption expenditure in both countries. This can be done by considering the total share of expenditure for those products included in the different countries. The cost for applying quality adjustment methods should also be considered when deciding whether to include less comparable products.

The value of the index $APP_{l,j}^{\varpi^{+}_{jl}}$ can be much higher than that of $APP_{l,j}^{\varpi_{jl}}$ meaning that the calculation of spatial indices based only on identical products do not fully represent the consumption baskets of these countries.

The characteristicity index is not useful for deciding whether to include other products in the PPP calculation since the products on which this index is based are so different and typical of each country that they cannot be considered when comparing the price level of the two countries. On the other hand, if we are aware of the value of the CI_{jl} and the corresponding weight in terms of consumer expenditure concerning typical products we can evaluate the loss in terms of the overall representativeness (*characteristicity effect*). If the typical products of each country weigh heavily, a direct comparison between the two countries in question would be impossible.

B. Interpretation of the factors influencing the PPPs based on products with different degree of comparability

Although the information obtained from the computation and comparison of the three indices is sufficient for deciding the number of products to be included in the computation of the PPPs, this evaluation can be improved by using a decomposition technique.

In fact, we can suggest an interesting decomposition of the first two indices which can be used to assess the importance of the different factors that affect the value of binary spatial indices. Considering for example the $APP_{l,j}^{\varpi^{+}_{jl}}$, calculated referring to the less comparable products, the following decomposition is obtained:

$$APP_{l,j}^{\varpi^+_{jl}} = \prod_{k=1}^{n^+_{jl}} \left(\frac{{}^+p_k^j}{{}^+p_k^l} \right)^{w_k^l} \cdot \prod_{k=1}^{n^+_{jl}} \left({}^+p_k^j \right)^{w_k^j - w_k^l} \qquad [4]$$

The first factor on the right hand side of [4] represents the *Pure Price Effect* (PPE), corresponding to a bilateral PPP, using a weighted Jevons index with weights of country *l*.

The *Weight Effect* (WE), expressed by the second factor on the right hand side of [4], concerns the impact of the difference in consumption pattern in the two countries in question. When the products have a similar degree of representativeness concerning consumer behaviour, the difference in the weights corresponding to the item *k* is close to zero.

By introducing the variables $\alpha_k = \ln\left(\frac{p_k^j}{p_k^l} \right)$ and $c_k^{l,j} = \left(w_k^j - w_k^l \right)$, which express the logarithm of price ratio concerning item *k* in country *j* and *l* and the difference between the corresponding expenditure weights, respectively (where $k = 1,...,n^+_{jl}$), after simple algebra, formula [4] can be equivalently expressed as:

$$APP_{l,j}^{\varpi^+_{jl}} = \exp\left(\overline{\alpha}\right) \exp\left(n_{ij} \cdot s_\alpha \cdot s_{w_k^l} \cdot R_{w_k^l,\alpha} \right) \times \exp\left(n_{ij} \cdot s_{\ln P^j} \cdot s_{c_k^{l,j}} \cdot R_{\ln P^j, c_k^{l,j}} \right) \qquad [4bis]$$

Thus it is possible to identify the factors that influence the *Pure Price Effect*, that is $s_{w_k^l}$ the standard deviation of the weighing system of the base country *l*, s_α, the standard deviation of the logarithm of the price ratios, $R_{w_k^l,\alpha}$ the linear correlation coefficient between the log price ratios and the weights of country *l* . It is worth noting that $\exp\left(\overline{\alpha}\right) = \prod_{k=1}^{n} \left(\frac{p_k^l}{p_k^j} \right)$ is the unweighted geometric mean of the price ratios between country *j* and *l*. This index is the Jevons index which is the best estimator when the log - distribution of price changes is Normal. Therefore, the spatial index and the evaluation of the degree of the influence of the factors in which it is decomposed depends on the shape of the distribution of the ratio between the prices of the products in the baskets of the two countries. As the distribution of the ratios of the price levels in two countries may vary according to the choice of the reference country, the influence of the shape of the distribution on the spatial indices could cause problems and therefore further analyses may be required.

Similarly, the *Weight Effect* is influenced by $s_{\ln P^j}$, the standard deviations of prices of country *j*, $s_{c_k^{l,j}}$, the standard deviation of the difference between the weights in the two countries compared $c_k^{j,l} = \left(w_k^l - w_k^j \right)$ and $R_{\ln P^j, c_k^{l,j}}$, the linear correlation coefficient between the prices and the differences in the corresponding weights.

Although it is possible to obtain similar decomposition forms as already mentioned (considering country *j* as the reference country) that give two estimations of the effects which differ slightly, the most important aspect is that we obtain statistical measures (standard deviation, central tendency and correlation coefficient) concerning the variability of price

changes and the consumers' behaviour in the two countries which can be interpretable from a statistical and economic point of view.

On the other hand, the symmetric treatment of countries can be achieved for the pure price effect and for the weight effect by using a geometric mean of the indices and then by applying a geometric average to the results therefore obtaining Törnqvist indices. Considering the PPE calculated by using less comparable products we can state that:

$$ {}^{T}PPE_{l,j} = \sqrt{\prod_{k=1}^{n_{jl}^{+}} \left(\frac{{}^{+}p_k^j}{{}^{+}p_k^l} \right)^{w_k^l} \cdot \prod_{k=1}^{n_{jl}^{+}} \left(\frac{{}^{+}p_k^j}{{}^{+}p_k^l} \right)^{w_k^j}} \qquad {}^{T}PPE_{j,l} = \sqrt{\prod_{k=1}^{n_{jl}^{+}} \left(\frac{{}^{+}p_k^l}{{}^{+}p_k^j} \right)^{w_k^j} \cdot \prod_{k=1}^{n_{jl}^{+}} \left(\frac{{}^{+}p_k^l}{{}^{+}p_k^j} \right)^{w_k^l}} $$

where ${}^{T}PPE_{l,j} = \dfrac{1}{{}^{T}PPE_{j,l}}$

IV. Comparison between the computed CPIs and PPPs

Considering the comparison between CPIs and PPPs and referring to household consumption it is important to examine how the changes in levels of consumer prices over time in the two countries (computed by the CPIs) affect the movements over time of the PPPs calculated for the household consumptions.

As already stated, it is not possible to totally integrate and link the currently computed CPIs and PPPs.

Although CPIs are conceptually very similar to PPPs, since their aim is to measure price level differences over time and across space respectively, the formulae used in the calculations are quite different.

We suggest comparing the CPIs between two countries by considering the Laspeyres type index, which is the formula generally used by most NSOs for the construction of CPIs and comparing the PPPs over time by using the formulae presented above. Following this procedure it is not possible to carry out a direct comparison since the two price indices differ in the formula used and in the basket of goods and services to be included in the calculation. Nevertheless the comparison can be carried out by decomposing the two different formulae used in time and space comparisons. By following this decomposition method, considering country *l* as the reference country, we can compare CPIs across space, thus measuring and interpreting the factors which explain the divergences between the CPIs of the two countries from time *T-1* to time *T*:

$$ {}_{t-1}\mathbf{P}_t^j - {}_{t-1}\mathbf{P}_t^l = \sum_{k=1}^{n} {}_{t-1}P_{k,t}^j \cdot {}_{t-1}w_k^j - \sum_{k=1}^{n} {}_{t-1}P_{k,t}^l \cdot {}_{t-1}w_k^l $$

where ${}_{t-1}P_{k,t}^{j} = \frac{p_{t,k}^{j}}{p_{t-1.k}^{j}}$ and ${}_{t-1}P_{k,t}^{l} = \frac{p_{t,k}^{l}}{p_{t-1.k}^{l}}$ are elementary price indices in area *j* and *l* respectively, ${}_{t-1}w_k^j$ and ${}_{t-1}w_k^l$ are the weights, expressed by expenditure shares on commodity or service *k* in the base period *T-1*, relating to country *j* and country *l*, and $\sum_k {}_{t-1}w_k^j = \sum_k {}_{t-1}w_k^j = 1$.

On the other hand, by using a decomposition approach and considering country *l* as the reference country, we can compare APPs (and in a similar way PPEs or PPPs) over time in order to understand the influencing factors, which refer to the variations from time *T-1* to time t of the APPs comparing the price levels of two countries calculated at time *T-1* and time *T*:

$$\frac{APP^{T}{}_{l,j}}{APP^{T-1}{}_{l,j}} = \frac{\prod_{k=1}^{n_{jl}} \left(p_k^{j,T}\right)^{w_k^{l,T}} \Big/ \prod_{k=1}^{n_{jl}} \left(p_k^{l,T}\right)^{w_k^{l,T}}}{\prod_{k=1}^{n_{jl}} \left(p_k^{j,T-1}\right)^{w_k^{l,T-1}} \Big/ \prod_{k=1}^{n_{jl}} \left(p_k^{l,T-1}\right)^{w_k^{l,T-1}}}$$

A. Comparing CPIs across space

Considering CPIs calculated in fairly homogeneous countries (for example at territorial level across different areas in the same country) it is reasonable to assume that the products purchased are the same (number and characteristics) in the two areas compared[7].

By using the decomposition methods, suggested in Biggeri, Brunetti and Laureti (2008) the divergences between the CPI for country *j* , ${}_{t-1}\mathbf{P}_t^j$, and the CPI for country *l* as reference country, ${}_{t-1}\mathbf{P}_t^l$, for each aggregation level, can be decomposed as follows[8] :

$${}_{t-1}\mathbf{P}_t^j - {}_{t-1}\mathbf{P}_t^l = \sum_k {}_{t-1}w_k^l \left({}_{t-1}P_{k,t}^j - {}_{t-1}P_{k,t}^l \right) + \sum_k {}_{t-1}P_{k,t}^j \cdot \left({}_{t-1}w_k^j - {}_{t-1}w_k^l \right) \qquad [5]$$

It is clear that a divergence emerging from a comparison between the CPIs referring to the two countries depends on two main factors:

- the different evolution of the prices of the products and services (elementary price index effect), which is expressed by the first factor on the right hand side.
- the differences regarding the behaviour of consumers in their purchases, that is on the share of the expenditure devoted to the different products and services (weight effect).

[7] If this hypothesis is not satisfied the results of the decomposition are approximate.

[8] We must underline that by applying similar procedures and considering area j as reference area, after some simple algebra, we can obtain four different forms of the decomposition of the CPI differences, that give two estimations of the effects which differ slightly (see Biggeri et al, 2008). In actual fact a unique measure of the difference could be achieved but it is irrelevant to the aim of this paper so we will leave this issue for further development

By introducing the variables $\delta_k = \left({}_r P_{k,t}^j - {}_r P_{k,t}^l \right)$ and $d_k = \left({}_r w_k^j - {}_r w_k^l \right)$, which express the difference between the sets of elementary price indices in country *j* and *l* and the differences between the expenditure weights respectively, after applying simple algebra, we can identify the various factors which influence the two effects[9]:

$$ {}_r\mathbf{P}_t^j - {}_r\mathbf{P}_t^l = \left[\bar{\delta} + \left(n \cdot s_{w^l} \cdot s_\delta \cdot R_{w^l,\delta} \right) \right] + \left(n \cdot s_{P^j} \cdot s_d \cdot R_{P^j,d} \right) \qquad \text{[5 bis]} $$

The first factor on the right hand side of [5 bis], that is the elementary price effect $\left[\bar{\delta} + \left(n \cdot s_{w^l} \cdot s_\delta \cdot R_{w^l,\delta} \right) \right]$, is influenced by $\bar{\delta} = \frac{1}{n} \sum_k \delta_k$ the distance between the centres of the two distributions of elementary price indices, s_{w^l}, the standard deviation of the weights, by s_δ the standard deviation of the elementary price index differences and by $R_{w^l,\delta}$, the linear correlation coefficient between the weighting system of the index in the country *l* and the difference in the elementary indices in the two countries.

From an economic point of view the factor $\bar{\delta} = \frac{1}{n} \sum_k {}_r P_{tk}^{\ j} - \frac{1}{n} \sum_k {}_r P_{tk}^{\ l} = {}_r \bar{P}_t^{\ j} - {}_r \bar{P}_t^{\ l}$ plays an important role both in determining the "price effect" and influencing the overall difference between the two CPIs considered.

This factor expresses the differences between the unweighted arithmetic mean of the period *r* to *t* price relatives , which is the Carli index and can be considered the best estimator when the price change distribution is Normal (Roger, 2000). Therefore, the divergence between the CPIs of two different countries, and the evaluation of the degree of the influence of the factors in which it is decomposed, depends on the shape of the distribution of the two elementary indices compared. Departures from normality can arise from either kurtosis, skewness, or a combination of both.

When the price change distribution is negatively skewed in country *j* and symmetric or positively skewed in country *l* , for example, the overall difference between the CPIs will be mainly influenced by the "weight effect" and in particular by the correlation between price changes and weights. In this case the value of $\bar{\delta}$ is negative and this shows that the products which are more widely consumed and therefore have a higher expenditure weight, experience a major increase in price and this has a rising effect on the aggregate price index.

On the other hand, the "weight effect" $\left(n \cdot s_{P^j} \cdot s_d \cdot R_{P^j,d} \right)$ is determined by similar factors, that is by s_{P^j}, the standard deviations of elementary indices of country *j*, by s_d, the standard deviation of the difference between the weights in the two countries compared and $R_{P^j,d}$, the linear correlation coefficient between the elementary price indices and the difference in the corresponding weights.

Once again statistical measures (standard deviation, central tendency and correlation coefficient) are obtained which express the different characteristics of the price change

[9] Once again by applying similar procedure we can obtain similar decomposition forms by changing the reference country. However the results may differ slightly.

distributions and the consumers' behaviour in the two countries. By understanding how the dispersion of the elementary price index distribution affects the difference between CPIs at territorial level we get an important insight of the behaviour of consumers and the process of inflation.

B. Comparing APPs over time

The movement in the spatial price indices referring to countries *j* and *l* from time *T-1* to time *T* is expressed by:

$$\frac{APP^{T}{}_{l,j}}{APP^{T-1}{}_{l,j}} = \frac{\prod_{k=1}^{n_{jl}} \left(p_k^{j,T}\right)^{w_k^{l,T}} \Big/ \prod_{k=1}^{n_{jl}} \left(p_k^{l,T}\right)^{w_k^{l,T}}}{\prod_{k=1}^{n_{jl}} \left(p_k^{j,T-1}\right)^{w_k^{l,T-1}} \Big/ \prod_{k=1}^{n_{jl}} \left(p_k^{l,T-1}\right)^{w_k^{l,T-1}}} \qquad [6]$$

By taking the natural logarithms and by adding and subtracting the ratio between the two hybrid means (for countries *j* and *l*) obtained for each country by using the weights of the base period *T-1* and the price of the corresponding country at time *T*, we can state that:

$$\ln\left(\frac{APP^{T}{}_{l,j}}{APP^{T-1}{}_{l,j}}\right) = \left[\sum_{k=1}^{n_{jl}} w_k^{j,T} \ln\left(p_k^{j,T}\right) - \sum_{k=1}^{n_{jl}} w_k^{l,T} \ln\left(p_k^{l,T}\right)\right] - \left[\sum_{k=1}^{n_{jl}} w_k^{j,T-1} \ln\left(p_k^{j,T-1}\right) - \sum_{k=1}^{n_{jl}} w_k^{l,T-1} \ln\left(p_k^{l,T-1}\right)\right] +$$
$$+\left[\sum_{k=1}^{n_{jl}} w_k^{j,T-1} \ln\left(p_k^{j,T}\right) - \sum_{k=1}^{n_{jl}} w_k^{l,T-1} \ln\left(p_k^{l}\right)\right] - \left[\sum_{k=1}^{n_{jl}} w_k^{j,T-1} \ln\left(p_k^{j,T}\right) - \sum_{k=1}^{n_{jl}} w_k^{l,T-1} \ln\left(p_k^{l}\right)\right]$$

By applying the exponential function, after simple algebra the above decomposition can be equivalently expressed as:

$$\frac{APP^{T}{}_{l,j}}{APP^{T-1}{}_{l,j}} = \frac{\prod_{k=1}^{n_{jl}} \left(p_k^{j,T} / p_k^{j,T-1}\right)^{w_k^{j,T-1}}}{\prod_{k=1}^{n_{jl}} \left(p_k^{l,T} / p_k^{l,T-1}\right)^{w_k^{l,T-1}}} \cdot \frac{\prod_{k=1}^{n_{jl}} \left(p_k^{j,T}\right)^{w_k^{j,T} - w_k^{j,T-1}}}{\prod_{k=1}^{n_{jl}} \left(p_k^{l,T}\right)^{w_k^{l,T} - w_k^{l,T-1}}} \qquad [7]$$

The first product on the right hand side of [7] represents the divergence between the movement in price changes from time *T-1* to time *T* in the two countries compared (*price effect).* In fact, this factor is the ratio between two consumer price indices in the two countries *j* and *l*, calculated following the weighted Jevons index using the weights of each country.

From an economic point of view, by examining this formula it is possible to understand the link between temporal and spatial variations of consumer prices and to measure to what extent the changes in price levels over time, measured by the CPIs, influence the changes over time of the spatial indices computed at time *T*and *T-1*.

The second product, which refers to the *weight effect (WE)*, is related to the impact of the difference in consumer behaviour in the two countries.

In order to improve our interpretation of the influence of the various factors, we suggest a further decomposition of the price and weight effect in formula [7].

Considering the price effect in the APP movement from time *T-1* to time *T*, after applying simple algebra, we obtain the following decomposition:

$$\frac{\prod_{k=1}^{n_{jl}}\left(p_k^{j,T}/p_k^{j,T-1}\right)^{w_k^{j,T-1}}}{\prod_{k=1}^{n_{jl}}\left(p_k^{l,T}/p_k^{l,T-1}\right)^{w_k^{l,T-1}}}=\prod_{k=1}^{n_{jl}}\left(\frac{p_k^{j,T}/p_k^{j,T-1}}{p_k^{l,T}/p_k^{l,T-1}}\right)^{w_k^{l,T-1}}\cdot\prod_{k=1}^{n_{jl}}\left(\frac{p_k^{j,T}}{p_k^{j,T-1}}\right)^{w_k^{j,T-1}-w_k^{l,T-1}}$$

[8]

In order to obtain an equivalent decomposition form of [8], which highlights various statistical measure concerning of log- price rations and weights in the two countries in question, we denote $\eta_k=\left[\ln\left(\frac{p_k^{j,T}}{p_k^{j,T-1}}\right)-\ln\left(\frac{p_k^{l,T}}{p_k^{l,T-1}}\right)\right]$ the differences between the set of logarithms of elementary price indices in countries *j* and *l*, and $v_k=\left(w_k^{j,T-1}-w_k^{l,T-1}\right)$ the difference between expenditure weights in the two countries at time *T-1* decomposition [8] is equivalently expressed as:

$$\frac{\prod_{k=1}^{n_{jl}}\left(p_k^{j,T}/p_k^{j,T-1}\right)^{w_k^{j,T-1}}}{\prod_{k=1}^{n_{jl}}\left(p_k^{l,T}/p_k^{l,T-1}\right)^{w_k^{l,T-1}}}=\exp\left(n_{ij}\cdot s_{w_k^{l,T-1}}\cdot s_\eta\cdot R_{w_k^{l,T-1},\eta}+\bar{\eta}\right)\cdot\exp\left(n_{ij}\cdot s_{\ln\frac{p_k^{j,T}}{p_k^{j,T-1}}}\cdot s_v\cdot R_{\ln\frac{p_k^{j,T}}{p_k^{j,T-1}},v}\right)\qquad\text{[8bis]}$$

Regarding the weight effect in the APP movements, a similar procedure can be applied in order to obtain the following decomposition form:

$$\frac{\prod_{k=1}^{n_{jl}}\left(p_k^{j,T}\right)^{w_k^{j,T}-w_k^{j,T-1}}}{\prod_{k=1}^{n_{jl}}\left(p_k^{l,T}\right)^{w_k^{l,T}-w_k^{l,T-1}}}=\prod_{k=1}^{n_{jl}}\left(\frac{p_k^{j,T}}{p_k^{l,T}}\right)^{w_k^{j,T}-w_k^{j,T-1}}\cdot\prod_{k=1}^{n_{jl}}\left(p_k^{l,T}\right)^{\left[\left(w_k^{j,T}-w_k^{j,T-1}\right)-\left(w_k^{l,T}-w_k^{l,T-1}\right)\right]}\qquad\text{[9]}$$

By expressing $g_k=\left(w_k^{j,T}-w_k^{j,T-1}\right)$ the difference between expenditure weights in country *j* over the period from *T-1* to *T*and $h_k=\left[\left(w_k^{j,T}-w_k^{j,T-1}\right)-\left(w_k^{l,T}-w_k^{l,T-1}\right)\right]$ the difference between the movements in the weighting system in country *j* and *l* respectively, we obtain:

$$\frac{\prod_{k=1}^{n_{jl}}\left(p_k^{j,T}\right)^{w_k^{j,T}-w_k^{j,T-1}}}{\prod_{k=1}^{n_{jl}}\left(p_k^{l,T}\right)^{w_k^{l,T}-w_k^{l,T-1}}}=\exp\left(n_{ij}\cdot s_{\ln\frac{p_k^{j,T}}{p_k^{l,T}}}\cdot s_g\cdot R_{\ln\frac{p_k^{j,T}}{p_k^{l,T}},g}\right)\cdot\exp\left(n_{ij}\cdot s_{\ln p_k^{l,T}}\cdot s_h\cdot R_{\ln p_k^{l,T},h}\right)\qquad\text{[9bis]}$$

As clearly shown in the formulae above the factors affecting price and expenditure share changes are once again statistical measures concerning the characteristics of price and weight distributions.

It is worth noting that similar decompositions can be obtained for the PPP and WE indices.

In short, the comparisons of the CPIs across countries and of the PPPs over time show that the differences and ratios can be decomposed into two components which refer to the prices and to the system of weights respectively. The two components are affected by the same factors which can be described by using statistical measures concerning the distributions of price changes and of the consumption expenditure shares in the two countries. The smaller the share of typical products the higher the levels of accuracy and reliability of the comparisons (of the CPIs across countries and of the PPPs over time). If the formulae used for the CPIs and PPPs were the same (for example Jevons type formula) the comparisons and the links would be exact.

V. Concluding remarks

It is difficult and expensive to integrate price data collection for computing CPIs and PPPs that allow a coherent comparison between CPIs and the change of PPPs level at the same time.

From a theoretical and practical point of view this paper presents a more integrated approach for the computation of CPIs and PPPs, which involves inter-temporal and inter-country comparisons of consumer prices.

Regarding the debated issue of integration, we have illustrated the feasibility of integrating PPP and CPI activities undertaken by NSOs. At the same time we have underlined the benefits and examined the problems which arise when developing an integrated approach for the collection of the required information.

We have pointed out that the identity product principle used in the computation of the PPPs does not guarantee the representativeness of the chosen basket for both the countries involved in the comparison. A broader definition of the comparability of products increases the comparability between CPIs and PPPs and gives possibilities and advantages which may require more data (i.e. the expenditure weight data within the elementary aggregates should be collected or evaluated, at least in a reference year) in order to verify if these advantages truly exist. We have suggested a simple statistical method for investigating the advantage of broadening the definition of comparability thus including additional products in the PPP calculation. This can be done by computing binary spatial indices for the comparison of consumer price levels between the two countries, through the ratio of the weighted geometric mean prices of the two countries, and then by decomposing them according to the different sub-sets of products with various degrees of comparability (strictly comparable, less comparable and characteristic or typical of each country). Besides, the computed spatial indices could be decomposed to evaluate the importance of the different factors that affect their value - price effect, consumption basket (weighting) effect and characteristicity effect. Whenever the NSOs collect all the necessary information on prices and weights at a product level within the elementary aggregate to compute these indices at least in one reference period, we can obtain valuable information which is useful for deciding the optimal number and the specific characteristic of the items to be included in the computation of the PPPs.

Concerning the results of the comparisons between CPIs and PPPs, at present it is not possible to fully integrate and link the commonly computed CPIs and PPPs. However, it is possible to obtain some insight on the factors that affect the differences between them. In fact, the formulae can be decomposed in order to approximately measure the factors

(essentially due to the evolution of prices and to the share of consumption expenditure concerning the different products and services) which explain the divergences between the CPIs of the two countries from time *t-1* to time *t*, and the movement of the PPPs concerning the two countries in the same period. These decompositions give us a better understanding of the links between the CPIs and PPPs from an economic point of view. However, as shown in the last part of this paper, the links between the CPIs and PPPs and their explanation would only be exact if weighted geometric means were also used for the computations of CPIs.

In conclusion, the integration and comparison between CPIs and PPPs are certainly feasible and methods can be found for achieving our objective even if it is not always easy, and above all it is necessary to carry out more research on these issues at an international level in order to agree on a broader definition of comparability of products for the computation of the PPPs by using the analyses that we have suggested in this paper.

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