PROCEDURES FOR UPDATING THE RESULTS OF INTERNATIONAL COMPARISONS

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This article reviews the problems involved in updating the results of international comparisons, in terms of an analytic framework focusing upon the sources of differences between various forms of extrapolation and direct comparisons. The factors identified as important are conservation of prices of the base period and weight inconsistency. The reliability of updating is undoubtedly affected by the length of the period over which the data are extrapolated. A program of regular benchmark comparisons at approximately five-year intervals with updating for the intervening years is attractive, since it permits checking by forward and backward interpolation. Where there are large deviations, however, averaging is not an acceptable solution.

1. GENERAL CONSIDERATIONS

1.1. *Introductory Remarks*

Updating or extrapolation of the results of international comparisons seems to be of growing importance along with the increasing interest in the comparisons. It is recognized that exercises in this field, especially those carried out with relatively large numerical bases and quite sophisticated methods, need a relatively long time even with the best organization of work and most developed computing techniques. Policy or other purposes however often require up-to-date figures. In these cases the results of earlier benchmark comparisons have to be "refreshed." Refreshment procedures have been discussed in the last five years in some basic papers, and practical calculations have also been carried out. The most important are Summers–Kravis–Heston [1980], Krijnse Locker and Faerber [1981] and the relevant chapters of the International Comparison Project (ICP) phase III report. In the present paper some problems of updating as such are discussed, with special attention to errors inevitably committed by this operation. Relatively little attention is paid to subjects discussed in detail in the above mentioned papers. The following subjects are categorically avoided: (1) the GDP versus GDY approach together with the treatment of net foreign balance, which has been sufficiently dealt with by Summers–Kravis–Heston and (2) the various "smoothing" methods developed by Krijnse Locker and Faerber in order to get space and time consistent parities and temporal indices. From this point of view the concept of the present paper is the acceptance of national intertemporal indexes as they are or as they can be produced by national statistical services for the sake of international comparisons. I appreciate the sophisticated smoothing systems, but I am rather interested in what can be done using "traditional" national indices.

The discussion requires an overview of quite a large set of index formulae with a number of characteristics of each of them. Therefore, it seems necessary to introduce a special set of symbols, in addition to the traditional q—quantity, p—price, and v—value of index numbers.

The general form will be

$$(1) \qquad {}_{\delta}I^{\gamma_i}_{\beta/\alpha}$$

where I can be

Q: intercountry or intertemporal quantity index
P: purchasing power parities or intertemporal price index
V: intercountry or intertemporal value index
α, β: countries ($A, B, C, \ldots$) or periods of time ($0, 1, \ldots, t$) being compared
γ: country the development of which is expressed, or period of intercountry comparison
δ: method of weighting
i: item or subaggregate ($i = 1, \ldots, n$)

From among these parameters the irrelevant ones are omitted. For example, an overall index does not have the symbol i, a V index does not need reference to a weighting scheme, etc. So, for instance ${}_0Q^A_{t/0}$ means the Laspeyres-type overall quantity index of country A between periods 0 and t etc. Estimates obtained by extrapolation are marked by $\hat{}$.

In the most general terms, the updating procedure means

$$(2) \qquad I^0_{B/A}\frac{I^B_{t/0}}{I^A_{t/0}} = \hat{I}^t_{B/A}$$

($I^0_{B/A}$ is the result of a benchmark comparison for year 0).

1.2. *Quantity Versus Price Approach*

In formula (2) Q's and P's can both be used. In this paper emphasis is laid on the quantity approach, but the difference between the two concepts is relatively small. In the previous works already mentioned priority is given to the price approach, and this is one of the reasons I am putting forward quantity indexes. It is interesting to mention, however, that the price-updating concepts differ slightly in the two papers previously cited. In Krijnse Locker and Faerber purchasing power parities are updated for the sake of PPP comparison; and in Summers–Kravis–Heston and in the ICP phase III report the extrapolated PPP's are computed first to derive extrapolated quantity indexes:

$$(3) \qquad \hat{Q}^t_{B/A} = \frac{V^t_{B/A}}{\hat{P}^t_{B/A}}.$$

1.3. *The Meaning of "Error" in the Case of Updating*

The accuracy requirement for updating procedures can be expressed quite trivially: the result of the updating should approach as close as possible to the result of a direct comparison. That is, the best procedure from two or more possible ones is the one which minimizes the expression

$$(4) \qquad \left| \frac{\hat{I}^t}{I^t} - 1 \right|.$$

In this requirement, the term "approach as close as possible" cannot be replaced by "equal." When the intertemporal indices are products of national

statistics, equality cannot be—except in exceptional cases—expected. Consequently, updating does not yield better result than a direct comparison would do. "Direct comparison" means an intercountry comparison carried out for the reference period in the same way, using the same concepts, the same methods, the same techniques etc. as the benchmark comparison carried out for the base period.

It is well known that every benchmark comparison has its inherent error. Here we are interested in the *additional error only*, committed unavoidably by the extrapolation. In most cases this error cannot be computed (extrapolation is resorted to just because there is no direct comparison), but in the few cases where both direct and extrapolated results are available, the error proves to be important.

For example per capita GDP of Belgium exceeds by 44 percent that of Italy in 1975 according to the 1975 benchmark comparison of ICP, and in terms of extrapolated figures from 1970 to 1975 the corresponding figure is 70 percent. For a relatively short 5 year period this difference is remarkable. Another example: J. Nyers reports in his paper presented to the 1981 IARIW Conference the figures of the Austria-Hungary comparison of industrial productivity. The 1975 benchmark estimate yields a productivity index of 174.7, but when the 1965 comparison is updated to 1975, the amount is only 138.1.

2. A Decomposition Model

The additional error owing to updating can be attributed to a simple duality: international comparisons are carried out by a special numerical and methodological apparatus developed for matching the comparison. Intertemporal indexes, however, which are used for the updating are taken from national statistics. These national indexes

– correspond in content only partially, and to a different extent from country to country, to the indicator(s) being compared (how far we are from internationally uniform statistics!);

– relate to data in terms of national currencies (intertemporal indexes of France are computed in francs, those of Hungary in forints etc.), whereas international comparisons are essentially expressed in common currency;

– use index formulae, weighting systems, basic- or chain-character etc. which differ from country to country and do not fit, except in special cases, the base year of the comparison.

For these reasons the updated indexes $\hat{I}^t_{B/A}$ never coincide with the direct index $I^t_{B/A}$ for period t. In order to illustrate the nature of this error, let us start from the simplest index formulae: benchmark comparison in base country A's prices, Laspeyres-type intertemporal indexes:

$$(5) \qquad {}_AQ^0_{B/A} \cdot \frac{{}_0Q^B_{t/0}}{{}_0Q^A_{t/0}} = {}_A\hat{Q}^t_{B/A}$$

or, in terms of the traditional symbols

$$(6) \qquad \frac{\Sigma\, q_{B0}p_{A0}}{\Sigma\, q_{A0}p_{A0}}\left(\frac{\Sigma\, q_{Bt}p_{B0}}{\Sigma\, q_{B0}p_{B0}} \div \frac{\Sigma\, q_{At}p_{A0}}{\Sigma\, q_{A0}p_{A0}}\right) = {}_A\hat{Q}^t_{B/A}$$

which does not equal ${}_AQ^t_{B/A}$, the index of the (supposed) benchmark comparison for period t:

$$(7) \qquad {}_AQ^t_{B/A} = \frac{\Sigma\, q_{Bt}p_{At}}{\Sigma\, q_{At}p_{At}}.$$

How is the deviation between (6) and (7) to be interpreted? Two factors can be put forward:

1. There is a *conservation* element in the operation: the comparison of period t conserves the base period's price structure.[1]

2. If this conservation were the only distortion factor, the estimation would be a simple constant price operation:

$$(8) \qquad \frac{\Sigma\, q_{Bt}p_{A0}}{\Sigma\, q_{At}p_{A0}} = R.$$

But the estimation (6) is not like this. The ratio of (6) to (8)

$$(9) \qquad \frac{{}_A\hat{Q}^t_{B/A}}{R} = \frac{\Sigma\, q_{Bt}p_{B0}}{\Sigma\, q_{B0}p_{B0}} \div \frac{\Sigma\, q_{Bt}p_{A0}}{\Sigma\, q_{B0}p_{A0}}$$
$$\uparrow$$
$${}_0Q^B_{t/0}$$

provides the ratio of two intertemporal indexes of country B: the first one is B's "natural" index, the second is an "artificial" index, measuring B's development at A's prices. It means that in addition to price conservation there is another source of error in the extrapolation which can be called *weight inconsistency*: the weights used for updating are inconsistent with the intercountry weights. The reason for this factor is the (unavoidable) use of national intertemporal indexes.

Thus the estimation error can be decomposed into two factors: price conservation (PC) and weight inconsistency (WI).

$$(10) \qquad \frac{\hat{Q}^t_{B/A}}{Q^t_{B/A}} = PC \cdot WI$$

$$(11) \qquad PC = \frac{R}{Q^t_{B/A}}$$

$$(12) \qquad WI = \frac{\hat{Q}^t_{B/A}}{R}$$

PC is relatively small when the dispersion of individual price movements between 0 and t is not very important in the respective countries, or if the change is similar—in extent as well in direction—in A and B. In periods when price ratios change drastically and in different ways in different countries, price conservation will affect the updating unfavourably. Periods like the early seventies or early eighties, when countries' reactions to the world economy's challenge are so different, when, for example export-domestic-import prices change so extremely

[1]This conservation also exists when other formulae (say Paasche type intertemporal indexes) are used; only the form is different and more complicated.

and differently, make the updating of international comparisons very problematic. *WI* works differently. It depends largely on the homogeneity or heterogeneity of the structures of the countries being compared. If these structures differ markedly, extrapolation will bring about considerable error even if the basic comparison is of good quality and without any drastic changes in relative prices.

3. Stepwise Generalization of the Indices

In the previous section, in addition to the general forms (10)–(12), updating error, price conservation and weight inconsistency are demonstrated in terms of the simplest but too specific formulae (5)–(9). In this section updating is discussed in a more general way. In the generalization, restrictions will be lifted step by step. First the assumptions of the base comparison (the use of country *A*'s prices), then that of the time to time indices (Laspeyres-type) will be given up.

a. First Step: Generalization of the Base Comparison

Instead of country *A*'s prices used so far, there are several other possibilities:
- country *B*'s prices
- third country's (*C*) prices
- international average prices
- Fisher-type index
- various changed formulae
- other international averages (e.g. EKS)

In order to avoid the proliferation of indices, only the most relevant cases will be discussed.

In this phase of generalization the updating procedure means:

$$\hat{Q}^t_{B/A} = Q^0_{B/A} \cdot \frac{{}_0Q^B_{t/0}}{{}_0Q^A_{t/0}}. \tag{13}$$

There exists—at least theoretically—an index *R*, similar to (8), expressing the comparison for period *t* at constant period 0 prices:

$$R = \frac{\Sigma\, q_B p_0}{\Sigma\, q_A p_0}. \tag{14}$$

With this index *PC* equals (11). As for *WI*:

$$WI = \frac{\hat{Q}^t_{B/A}}{R} = \left({}_0Q^B_{t/0} \div \frac{\Sigma\, q_{Bt} p_0}{\Sigma\, q_{B0} p_0}\right) \div \left({}_0Q^A_{t/0} \div \frac{\Sigma\, q_{At} p_0}{\Sigma\, q_{A0} p_0}\right) \tag{15}$$

(i) If p_0 is the price system of *A*, the formula reduces to (9). In (15) the source of weight inconsistency is the "substitution" of the basic comparison prices p_0 by national prices of countries *A* and *B* in the intertemporal indexes. The most relevant price system applied in international comparisons is that of *international average prices* (Geary–Khamis, Gerardi and others). It is interesting what effect *WI* may have on the extrapolation of this kind of comparison.

In the case of basic comparison of a pair of particular countries *A* and *B*, the international average price system computed for *m* countries can be relatively

good or relatively bad, depending on the "similarity" of price systems A and B and the international average. If the price systems of A and B are more similar to each other than to the international average prices, then their comparison in terms of the international price system will not meet the "country characteristicity" test.[2] Peculiarly enough, extrapolation works in the opposite direction. With such a price system the terms in the two pairs of brackets in (15) will deviate from unity either both upward or both downward and the two deviations offset each other so their ratio (WI) will be relatively close to 1 preserving the distortion of the basic comparison. On the contrary if the international price system is characteristic of countries A and B, it will increase WI and distort the updated result.

This is a "ceterum censeo" case: the relatively good basic estimate is spoiled and the distorted one is preserved, as seen in the following scheme:

Basic comparison	*Updating operation*	*Updated results*
relatively good	distorting	distorted
distorted	relatively good	distorted

(ii) If the basic comparison is of the binary Fisher-type, then an approach to a Fisher-type extrapolated index is expected for period t. Under this assumption it can be demonstrated[3] that

- the extent of price conservation equals the geometric average of those of A and B weighted indexes;
- the extent of weight inconsistency also equals the geometric average of those of A and B weighted indexes.

b. Second Step: Generalization of the Intertemporal Indexes

It has been assumed up to now that the intertemporal indexes are of the same type: Laspeyres quantity indexes in which the constant price base period coincides with the year of the basic comparison (0). In order to come closer to real life, this assumption should be abandoned, because, as already mentioned, there is no choice among different types of intertemporal indexes; only those of national statistics are available. This step of generalization is done in two parts:

(i) First assume that the constant price period is the same in all countries. If this period is denoted by s, then the updating formula is:

$$Q^0_{B/A}\frac{{}_sQ^B_{t/0}}{{}_sQ^A_{t/0}} = \hat{Q}^t_{B/A}. \tag{16}$$

If $s = 0$, the form (16) is reduced to the cases discussed so far.

It is to be stressed that the concept of PC is the same whether s relates to the benchmark year (0), to the reference year (t) or to any other period. From the point of view of comparison of quantities in real terms, the relative prices and not the absolute price levels are relevant. In the updating procedures relative prices of the base period are conserved.

[2]Country characteristicity means that the weights assigned to the items should correspond as closely as possible to the relative importance of the items in the countries.

[3]Formal demonstration omitted.

WI however is now affected by an additional factor, namely the deviation of relative prices of the base period (0) from the relative constant prices (s). This factor is likely to bring about a *considerable* error if period 0 and period s are *far from each other.*

(ii) It cannot be assumed in all cases that constant price base periods are uniform all over the world. So the last half-step in the generalization leads to a form, in which the constant price base period in the statistical system of country A is a, and in country B, b:

$$Q^0_{B/A}\frac{{}_bQ^B_{t/0}}{{}_aQ^A_{t/0}} = \hat{Q}^t_{B/A}. \tag{17}$$

This index will not differ substantially from (16), unless drastic structural changes occur between periods a and b and/or the two periods are very far from each other. In this case the country with "older" constant price base can be expected to be overestimated by extrapolation.

4. Aspects of Technical Development

Updating procedures mean the combination of an intercountry comparison with intertemporal development. The question arises if and to what extent these combinations are able to follow technical development and express it in the estimated results. Technical change can be expressed in the indexes discussed in this article with three factors:

(i) the change of general level;
(ii) shifts in the productivity level of various products and/or countries which lead to an adequate or not adequate shift in price ratios; and
(iii) the appearance of new products.

It goes without saying that the first factor is expressed by indexes of growth and in this way by the updating procedure as well. The second factor is not covered by index numbers. This shortcoming is one of the reasons of price conservation.

Nor is the third factor, new products, reflected. The scope of extrapolation is the same as the scope of the benchmark comparison. As a matter of fact an additional source of error ought to be included beside *PC* and *WI* which would depend on the relative importance of new products and the deviation of their behaviour in the reference period from the rest of the aggregate concerned. This third factor is omitted for the sake of simplicity and with the assumption that its effect is by and large expressed in *WI.*

5. Disaggregation—Advantages, Limits and Problems

In all the procedures discussed above a single overall index has been extrapolated by means of a single overall intertemporal index. In most cases of everyday practice these kinds of procedures are indeed adapted and it is this simplicity which makes extrapolation attractive. On the other hand the global approach is one of the main reasons for errors.

Disaggregation seems to be an effective method of limitation of errors. The extent of both *PC* and *WI* can be decreased by it. The advantage of disaggregation was recognized in the early phases of ICP: phase II was derived from phase I through extrapolation at the 36 summary category level. But the time span was too short (1970–73) to judge the efficiency and practical advantages of the method, i.e. the results of global and disaggregated extrapolation did not differ significantly.

The underlying principle of extrapolation at a disaggregated level is this: suppose extrapolation can be carried out at the most detailed level, that of individual items (an assumption not realisable in practice). Then for each item i

$$Q^{0i}_{B/A}\frac{Q^{Bi}_{t/0}}{Q^{Ai}_{t/0}}=Q^{ti}_{B/A} \tag{18}$$

means a "perfect" estimate of the reference period (the sign $\hat{}$ can be omitted). If these individual items are weighted with the reference-period weight, the global estimate will be "perfect" as well.

$$E_{vt}(Q^{ti}_{B/A})=Q^{t}_{B/A} \tag{19}$$

where E_{vt} means the operation of averaging with weights of the t period's expenditures (I do not want to repeat here the various weighting formulae).

This is however a purely theoretical consideration. Such possibilities of detailed extrapolation do not exist. On the other hand this theoretical procedure is, as a matter of fact, no longer extrapolation; form (19) equals the direct (benchmark) comparison for period t.[4] Coming back to the ground of realities: extrapolation can often be carried out at the level of certain aggregation categories. In this case i means an aggregated category which is however more homogeneous than the global indicator. Extrapolation at that level means:

$$Q^{0i}_{B/A}\frac{Q^{Bi}_{t/0}}{Q^{Ai}_{t/0}}=\hat{Q}^{ti}_{B/A} \tag{20}$$

and weighting with category expenditure structure of period t:

$$E_{vt}(\hat{Q}^{ti}_{B/A})=\hat{Q}^{t}_{B/A}. \tag{21}$$

Errors—*PC* and *WI*—affect *within* categories only, not *among* them.

The choice between global and detailed extrapolation is however not free. Detailed extrapolation can be applied under certain conditions only:

1. The benchmark comparison belongs to the type of detailed conversion, like ICP, CMEA comparison, SOEC project, etc. For short-cut type comparisons, global updating is the sole possible procedure.

2. Intertemporal national indices are available in uniform breakdowns, and this breakdown is the same as that of the benchmark comparison, or can be adjusted to it.

3. The same breakdown is valid for the expenditures of the reference period.

Under these conditions the efficiency of disaggregation can be raised by

[4]Except for one aspect of technical development: new products.

optimal breakdown. Optimal breakdown means a two-dimensional homogeneity:

(a) Homogeneity of price development within the individual categories—minimization of *PC*;

(b) Homogeneity of relative prices within the individual categories in the base period—minimization of *WI*.

Unfortunately these requirements can hardly be satisfied simultaneously. Products with similar relative prices in the base period do not keep their similarity over time. If there is any option (which is not a very frequent case) it is advisable to minimize the factor with the bigger distortion effect. For example, in a period of drastic changes of relative prices, an increase in the distorting effect resulting from price conservation is to be expected. In such case, increased attention to homogeneity of type (a) is advisable.

On the other hand the degree of breakdown and choice are very often limited by practical reasons. Disaggregation systems are not uniform from country to country. If for example a breakdown in a benchmark comparison shows separately

fresh tropical fruit
other fresh fruit
fresh vegetables
canned and dried fruit
canned and dried vegetables

but the year to year national statistics of country *A* break this category into

fruit
vegetables

and those of country *B* into

fresh fruit and vegetables
canned and dried fruit and vegetables,

then for the extrapolation one single category is the only choice: fresh, canned and dried fruit and vegetables.

6. Updating the Results of Short-Cut Comparisons

Short-cut methods of international comparisons are numerous and ever growing; it is not intended here to discuss them individually.[5] But it is possible to pick out the common features that are relevant from the point of view of extrapolation. Short-cut methods use a set of indicators $x_1, x_2, \ldots, x_i, \ldots, x_n$. These indicators can be non-monetary, as in the case of Beckerman, Jánossy, Ehrlich or the ECE [1980]; monetary, as in Kravis–Heston–Summers [1978], or mixed, as in S. Ahmad. A function or a set of functions is set up to express internationally prevailing relationships among the independent variables x and the dependent variable y to be estimated (in most cases real GDP). As we are not concerned with specifying the functions, the basic comparison between any pair of countries *A* and *B* for a certain period 0 can be expressed in a general way:

$$Q^{y0}_{B/A} = f_0(X^0_{B/A}) \tag{22}$$

where $X^0_{B/A}$ is the vector of relative (B/A) magnitudes of independent variables.

[5] As a matter of fact updating itself is a kind of short-cut method, as well as procedures with reduced information.

Comparisons of this type carried out for a base period 0 can be extrapolated to a period t in two ways:

(a) direct extrapolation of the dependent variable

(b) extrapolation of the independent variables.

(a) *Direct extrapolation of the dependent variable* is the same procedure as the global extrapolation discussed in section 1.

(b) *Extrapolation of the independent variables* is a specific short-cut procedure. Its importance lies in the fact that it is generally much easier to find the value of the independent variables for any selected period t than to set up a new function. That is why only the values of independent variables are put into the old function:

$$\hat{Q}^{yt}_{B/A} = f_0(X^t_{B/A}). \tag{23}$$

This procedure implies the relationship of period 0 is still valid in period t. The reliability of the procedure depends on the correctness of that assumption. It can be assumed that the relevant relationships among economically important indicators are more constant than any *ad hoc* links.

A remarkable example can be found in ECE [1980], the only short-cut comparison carried out and published officially by an international agency. Comparing about thirty countries for six different benchmark years from 1950 to 1973, a function with the *average* of the *parameters* obtained for the six years is used over the total period. In this way extrapolation is given priority over a set of direct short-cut comparisons.

It is difficult to judge which of the two updating procedures labelled by (a) and (b) above is more reliable. The number of comparisons made using both methods is very small. A nice test is offered by Kravis–Heston–Summers [1978] for 1973:

PER CAPITA GDP IN 1973 WITH U.S. = 100

	Extrapolation Scheme (a): Short-cut Results for 1970 Extrapolated for 1973	Extrapolation Scheme (b): 1970 Parameters with 1973 Independent Variables
Sweden	83	77
Canada	85	77
Denmark	74	75
F.R. Germany	74	84
Australia	72	81
Norway	69	70
France	75	75
Belgium	65	67
Holland	63	68
Finland	65	64
United Kingdom	61	61
Austria	55	64
Japan	63	74
Italy	47	49
Greece	43	46
Spain	43	49
Mexico	25	30
Brazil	27	28

In some cases the two estimates are very close, but remarkable deviations can be also found (FRG, Austria, Japan). In the Sweden-FRG comparison, version (a) shows Sweden's GDP 13.8 percent greater than FRG's, while version (b) shows that of FRG 9 percent greater than Sweden's. Did the changes in the world economy in three years disturb to such extent the relationship prevailing in 1970? Or is the relationship underlying the function not constant and steady enough? The available information is not sufficient to answer these questions.

7. Updating Converted Figures

The results of international comparisons are expressed most commonly in terms of index numbers (Q and P). It has become more and more popular, however, to express them in terms of various kinds of common currency, either the currency of a particular country or an artificially constructed international currency. Comparisons with detailed conversions like ICP make it possible, in addition to the relative levels, to derive structural comparisons in terms of percentage distribution figures.

Updating the results of these sorts of comparisons does not cause any new theoretical problem. From a practical point of view, however, some considerations can be useful. For example, one of the simplest results of a benchmark comparison is $\sum q_{A0}\bar{p}_0$, that is data of country A in international currency. Extrapolation of such figures from year 0 to year t by the quantity index of the reference country A:

$$\Sigma q_{A0}\bar{p}_0 \cdot Q^A_{t/0} = \hat{\Sigma} q_{At}\bar{p}_0 \tag{24}$$

brings about quite a correct result which is however not too easy to interpret: it is data of country A for period t at international price level of period 0. The reason for this clumsy interpretation is that in addition to the conservation of *relative prices* of the benchmark period—a source of error all kinds of updated figures are exposed to—the *absolute price level* of the benchmark period is also conserved. This does not affect the country to country quantity indexes (Q), but does affect the converted figures.

To make interpretation easier, the price level should also be updated. How? It depends on the nature of the common currency used in the comparison.

The common currency for an international comparison can be developed in several ways. Instead of discussing all of them it seems to be useful to consider two main types:

(a) Some international currencies are products of the operations of the comparison algorithm and have *nothing to do with exchange rates* (for example the Geary–Khamis international dollar used in ICP).

(b) Another group of international currencies *does have something to do with exchange rates* (which is not to say they are simply exchange-rate-converted figures). The uses made of exchange rates differ, but they often play a certain role, generally as the starting point. Examples are some short-cut methods (like ECE [1980]) or the early OEEC comparison (Gilbert–Kravis [1954][6]).

[6]In this project all individual price and detailed expenditure data were first converted to dollars by official exchange rates and this step was then followed by the well known procedure.

(a) It follows from the statements mentioned above that for updating of the first type *the overall price index of the numeraire country* has to be used, so in this case for country A:

$$\Sigma q_{A0}\bar{p}_0 \cdot Q^A_{t/0} \cdot P^{NUM}_{t/0} = \hat{\Sigma} q_{At}\bar{p}_t. \tag{25}$$

The overall price index is generally the implicit price deflator of the relevant aggregate (for example GDP).

(b) Updating of the second type is quite different. Here we need the price changes of *all countries* included in the comparison except the numeraire country. In addition *changes in exchange rates* have to be taken into account.[7] Thus the new variables are

$\bar{P}_{t/0}$: average of the overall price index of all relevant countries except the numeraire

e^0_j, e^t_j: exchange rate of currency j to the numeraire country's currency in periods 0 and t.

The updating for country A will be (with E, symbol of the operation averaging):

$$\frac{\Sigma q_{A0}\bar{p}_0 \cdot Q^A_{t/0}\bar{P}_{t/0}}{E(e^t_j \div e^0_j)}. \tag{26}$$

8. Some Concluding Remarks

Updating procedures belong to the set of tools of international quantitative estimates. Their methods are not complicated at all but it is very difficult to predict their degree of accuracy. The reliability of updating is undoubtedly affected by the *length* of the period over which data are extrapolated. The longer this period the stronger the effects of price conservation and weight inconsistency. It is however difficult to tell what length keeps the quality of the benchmark comparison to acceptable levels (2 years?, 3 years?) and what length makes the procedure unacceptable even as a rough estimate (10 years?) Presumably the conclusion depends not only on the number of years but on the character of the period as well (smooth development or drastic changes in the world economy).

For example regular benchmark comparisons every five years and updating for the periods between, as scheduled in some long term projects for international comparisons, seems to be attractive from the point of view that "forward" and "backward" extrapolation might check each other. But in the case of significant deviations I would accept neither estimate nor any kind of average.

Finally it is to be stressed again that competent selection from among the possible updating methods and correct interpretation are indispensable to avoid misleading conclusions.

[7]Reference should be made here to the three year moving average of exchange rates used by the World Bank Atlas.

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