ON NATIONAL ACCOUNTS AT CONSTANT PRICES

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"National accounts at constant prices" have not yet been defined with reference to a definite concept of the unit of quantity. The term "at constant prices", therefore, may apply to several different concepts, as shown in the following note, and international data are thus not necessarily comparable. In fact, concepts and procedures to establish the various "quantity" and "price" indices are still insufficiently standardized to yield comparable measurement of different aggregates.

Most national accountants would probably agree that in principle national accounts at constant prices represent values exclusive of mere price changes, while a few would claim that they are quantities at base year prices, which would probably also be the opinion of most users. These two views may appear to refer to the same result, but from a different point of view. Mere price changes and mere quantity changes, however, are not the only components of changes in aggregate values.[1] Yet, the present discussions are still limited to finding a solution by dividing aggregate values into only two components (aggregate "quantity" and aggregate "price"). At the same time it is widely recognized that changes in *aggregate* values of goods and services occur because of movements in a greater number of basic elements, e.g. quantity, quality structure, price structure, and price.

These four elements constitute the basic element of value *changes* in outputs[2] because any one of them may be responsible for a change in the total aggregate without a movement in any of the other three elements, i.e.:

— the element "changes in *quantity*" corresponds to value changes due only to changes in the number of units of given dimensions for given physical[3] qualities;
— the element "changes in *quality structure*" corresponds to value changes due only to changes among physical qualities. If all quantities referred to the same units of certain qualities, the element "changes in quality structure" could as well be called "structural changes in physical quantities"; since this usually is not the case, this element does not represent changes in structure within the same reference frame, but changes among different units;
— the element "changes in *price structure*" corresponds to value changes due only to changes among different price categories of the same qualities (reflecting different

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[1]Though it would be true for value changes of sums of units of a homogeneous product sold at the same price during a period—which probably was taken as model also for more complicated aggregates.

[2]In cases where inputs are taken as proxies for outputs, changes in productivity have to be considered as another basic element. Since total inputs at current prices (including positive, zero, or negative profits) equal output at current prices, prices at the output and the input side must be different, if the change in productivity is not zero. If productivity is measured by the difference between "real" input and "real" output, it is obvious:

—that productivity must be a component of the total, if output is approximated by an input approach, and
—that, in this case, this component must be estimated independently.

Also, while the basic elements may be separated for *changes in flows*, i.e. for *changes* in values, they cannot be given as flows, i.e. as values (unless these are already changes in underlying stocks).

[3]Aggregate quantity, in fact, always refers to an aggregate of different qualities; adding the adjective "physical" therefore means that each same quality is not divided by other criteria (e.g. different prices) into further sub-categories.

markets, conditions, outlets, etc.); it could also be called "structural changes in prices of economic quantities", because structural changes among the same units can occur;

— the element "changes in *price*", finally, corresponds to value changes due only to changes in absolute prices per definite economic quantities (i.e., definite price strata of a certain quality).

The exact coverage of all these elements will have to be decided by convention, in particular with regard to combined effects, e.g., structural effects of price changes in connection with changes among qualities or changes in quality, which, if they are not or cannot be listed separately, may be listed either together with combined quality/quantity changes or together with changes in price structure.

In a two-component system, on the other hand, the components will always be more or less "impure", since at least one of the components will, in fact, be a combination of several of the basic elements. If value changes are divided into only two components, there are seven ways in which the four basic elements may be combined. In view of the underlying elements, however, only three of these possible two-component combinations are relevant in the present context (where the first bracket represents an "aggregate quantity" and the second an "aggregate price"):

I. (quantity) and (quality structure, price structure, price) i.e., "Quantity" in general terms, not taking into account all qualitative or economic changes in the underlying commodities from one period to another; and "implicit unit values".

II. (quantity, quality structure) and (price structure, price) i.e., "Quantity" in terms of the same physical quality, distinguishing as many different categories of quantities (and average[4] prices) as there are different physical qualities; and 'implicit prices", including all effects of structural shifts among the different price categories for same qualities.

III. (quantity, quality structure, price structure) and (price) i.e., "Quantity" in economic terms, distinguishing different categories of prices for same physical qualities, the underlying quantities for these categories becoming distinct weights for an explicit price index. The corresponding implicit volume index then includes all value changes due to structural shifts among the different categories, while the price index shows only effects of actual price changes.

The main conceptual problem, therefore, is the unit of "quantity", i.e., the level of detail for which prices are observed. Since each of the above three "quantities" is literally "at constant prices", this term is not sufficient to describe a definite result.

Nevertheless, no uniform terminology in this field has yet been developed. In connection with the new System of National Accounts at current prices the UN and EEC Statistical Offices each propose a two-component system (aggregate "price" and aggregate "quantity" indices); the UN, however, calls its aggregate quantity "quantum" and the EEC proposes the term "volume". The OECD Secretariat feels that these are two distinct kinds of indices which in principle have different magnitudes, and which normally answer different questions; at least, if "quanta" are understood as physical qualities at base year prices and "volumes" as values adjusted for mere price changes. It may very well be that several sets of indices have to be calculated for different uses, e.g., "quantum" indices for productivity analysis and for technical coefficients, "volumes" for other economic analyses.

In addition to differences in concepts, there are also a large number of differences in procedures (e.g., different index formulae), even if the same concept is applied. Each of the above three concepts of aggregate "quantities" and aggregate "prices" may be represented by either Laspeyres or Paasche indices, or any other kind of indices,

[4]In the usual case of indices with incomplete coverage, the *implicit* averages in correct index formulae do not yield proper weights, while proper weights do not yield the same averages and index formulae—as has been pointed out on several occasions by S. H. Khamis and by the author of this paper.

or by a mixture of different indices for different items, thus multiplying the possible differences of the meaning of "at constant prices" (and of corresponding "prices"). Each different index, however, will measure a different "price" and a different "quantity" or "volume", so that comparability will be achieved only if the same procedure is used for each item.

All this applies already at the theoretical level (e.g., to index formulae with complete coverage); in practice, however, an even larger number of differences occur, because of the simplifying assumptions—usually unknown and implicit—which are used to derive actual data. Basically, Laspeyres and Paasche indices are not different kinds of indices: they are indices of the same structure, with the same elements, but based (weighted) in different periods.[5] If, on the other hand, the formulae are rearranged in order to permit the use of available statistics under certain assumptions, as is often the case, the resulting indices may then actually be of different kinds. It is possibly because of these practices that the Paasche index is sometimes thought to represent a different concept. However, if value changes are divided into only two components, one represented by a Laspeyres index and the other by a Paasche index in their original forms, a change in value due to a change in price structure will *not* be linked to the *kind* of index, but to the concept of "quantity" and of "price"; i.e., the effects of structural shifts are fully included in the Laspeyres volume index as well as in the Paasche volume index, although of course with the corresponding weights (cf. Annex 2).

In order to obtain data which are compatible and comparable at the international level, or even within countries, the data must be defined at the conceptual level, and standard procedures must be selected by convention where there are several choices. This could be considered as being the intention and the long-term aim of the recent proposals of the international organizations. Conventions will have to be adopted in particular on:

— the definition of components;
— the level of disaggregation at which units are defined;
— the kind of indices;
— the simplifying assumptions for the construction of actual indices with respect to theoretical concept, i.e., kind of representative elements and weights;
— the weighting period (not necessarily identical with the base period, e.g., in the case of cumulated chain indices),

all of which play an important part in the actual content of data "at constant prices".

Since it will take a long time until such proposals are agreed upon and applied, it may be preferable in the short-run to outline first the different possibilities as a reference framework, in order to be able to distinguish the different kinds of actual data, because otherwise differences from errors in definitions ("in variable") may be interpreted as differences in performance.

[5]It would therefore be wrong to say—as is sometimes maintained—that one represents the arithmetic mean and the other one the harmonic mean. In fact, both Laspeyres and Paasche indices may be rearranged to represent harmonic means of certain weights but it is usually done only for Paasche indices, e.g., when Paasche indices are arranged to represent weighted reciprocals with second period weights, while Laspeyres indices represent direct averages, with first period weights.

ANNEX 1

EFFECTS OF CHANGES IN PRICES AND QUANTITIES ON PRICE AND VOLUME INDICES

	Prices (1)	Quantity (2)	Structure (3)	Value Index (4)	Price Index (5)	Volume Index (5)
A 1	=	=	=	=	=	=
2	=	⊖	+	+	=	⊕
3	=	+	=	+	=	+
4	=	+	+	+	=	+
B 1	+	=	=	+	+	=
2	+	⊖	+	+	+	⊕
3	+	+	=	+	+	+
4	+	+	+	+	+	+

Explication of signs: = no change, + change } in respect of the base period.

The table shows the result of changes of no, several, or all of three basic elements of value changes on the traditional price and volume indices, assuming:

(1) That different prices exist for identical units of a product; that these prices may A: not move, B: change.

(2) That the total quantity may 1 and 2: stay the same, 3 and 4: change.

(3) That same physical qualities sold at different prices may be sold in the same proportion (1 and 3) or that these proportions may change (2 and 4).

(4) $\Sigma P_1Q_1/\Sigma P_0Q_0$.

(5) That the indications: no change (=) and change (+) apply to either Laspeyres or Paasche indices, while the magnitude of changes for a Laspeyres index can be different from that for a Paasche index.

Note: The table does not show separately the effects of changes among physical qualities. Also the case of proportional price changes is not shown separately, since it leads to exactly the same results as all cases of B. A numerical example for case B2 is given in Annex 2.

ANNEX 2

NUMERICAL EXAMPLE FOR CASE B2 OF ANNEX 1 AND CORRESPONDING VALUE CHANGES

	Quantities		Prices		Values		Value Changes	Value Changes Due to Changes in		
								Quantity	Price Structure	Prices
	Q_0	Q_1	P_0	P_1	V_0	V_1	ΔV	$\Delta Q \,.\, \bar{P}_0$		
Different price categories (i) of a same quality	10	15	100	120	1,000	1,800	+ 800	$+ 5 \times \bar{P}_0$	a: $+ 5 \times (100 - \bar{P}_0)$ b: $+ 5 \times (120 - \bar{P}_0)$	$15 \times + 20$ $10 \times + 20$
	20	15	120	140	2,400	2,100	− 300	$- 5 \times \bar{P}_0$	a: $- 5 \times (120 - \bar{P}_0)$ b: $- 5 \times (140 - \bar{P}_0)$	$15 \times + 20$ $20 \times + 20$
Total	30	30			3,400	3,900	+ 500	0	− 100	+ 600
Average ($\bar{P}$)			113.3	130						

Value index $\dfrac{\Sigma P_1 Q_1}{\Sigma P_0 Q_0} = \dfrac{3,900}{3,400} = 114.7$

Laspeyres price index $\dfrac{\Sigma P_1 Q_0}{\Sigma P_0 Q_0} = \dfrac{4,000}{3,400} = 117.6$

Paasche price index $\dfrac{\Sigma P_1 Q_1}{\Sigma P_0 Q_1} = \dfrac{3,900}{3,300} = 118.2$

Laspeyres volume index $\dfrac{\Sigma P_0 Q_1}{\Sigma P_0 Q_0} = \dfrac{3,300}{3,400} = 97.1$

Paasche volume index $\dfrac{\Sigma P_1 Q_1}{\Sigma P_1 Q_0} = \dfrac{3,900}{4,000} = 97.5$

a = at constant prices of period "0"

b = at constant prices of period "1"

$$V_1 = V_0 + \Delta V = V_0 + (Q_1 P_1 - Q_0 P_0)$$
$$= V_0 + \Delta Q \cdot \bar{P}_0 + \Delta P \cdot Q_1 = V_0 + \Delta Q \cdot P_1 + \Delta P \cdot Q_0$$

$$\left\{\begin{matrix}\Sigma P_{i0} Q_{i1} \\ -\Sigma P_{i0} Q_{i0}\end{matrix}\right\} + \left\{\begin{matrix}\Sigma P_{i1} Q_{i1} \\ -\Sigma P_{i0} Q_{i1}\end{matrix}\right\} = \Sigma \Delta Q_i \cdot P_{i0} + \Sigma \Delta P_i \cdot Q_{i1}$$

a: $\Delta V = \Delta Q \cdot \bar{P}_0 + \Delta Q \cdot (P_0 - \bar{P}_0) + \Delta P \cdot Q_1$

b: $\Delta V = \Delta Q \cdot \bar{P}_0 + \Delta Q \cdot (P_1 - \bar{P}_0) + \Delta P \cdot Q_0$

a: $V_1 - \Delta P \cdot Q_1 = V_0 + \Delta Q \cdot P_0 = Q_1(P_1 - \Delta P) = Q_1 P_0$

b: $V_0 + \Delta P \cdot Q_0 = V_1 - \Delta Q \cdot P_1 = Q_0(P_0 + \Delta P) = Q_0 P_1$

Note: The above example refers only to one quality. In the case of several qualities, value changes due to changes between different qualities (of same units) may be combined with the value changes due to changes in price structure (e.g., when averages of prices over all qualities are used), or with the value changes due to changes in quantity (e.g., when this component is given by summing such values over all quantities), or they may be singled out by introducing a separate component, e.g., as: change in quantity times the difference between the average price over all qualities ($\bar{\bar{P}}$) and the average price per quality ($\bar{P}$), e.g., $\Delta V = \Delta Q \cdot \bar{\bar{P}} + \Delta Q \cdot (\bar{P} - \bar{\bar{P}}) + \Delta Q(P_{..} - \bar{P}) + \Delta P \cdot Q_{..}$