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**METHODS OF CALCULATING INDUSTRIAL PRODUCTION INDICES,
THE UNITED NATIONS STATISTICS DIVISION INDUSTRIAL
PRODUCTION INDEX PROJECT**

by

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Methods of calculating industrial production indices, the United Nations statistics division industrial production index project

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The general aim of an index number of industrial production is to indicate changes over time in the volume of production of industrial commodities. The index numbers compress many facts into a few simple figures and, in conjunction with other data, their use in economic analysis is in summarizing past developments, forecasting future trends and making decisions on policy.

In micro-economic analysis, an index number of production shown with an industrial grouping enables comparisons to be made of changes in the output of different industries, as between themselves and in relation to such other data on separate industries as employment, wages and earnings. A specific example is the analysis of relative changes in productivity, measured statistically as output per man or per man-hour. In macro-economics, the index serves to assess the significance for the economy as a whole of changes in the volume of industrial output in relation to corresponding changes in population, gross national product, foreign trade, prices and other aggregates.

No direct aggregation of work done is possible, at least for general use. A money valuation is ruled out because of price movements and a summation in common physical units is not suitable, except for special purposes. The problem is one of index numbers, in this case of combining a diversity of measures of changing products in various sectors of industry. An index of production is subject to the familiar limitations of all index numbers. The series available are generally an imperfect and incomplete representation of the whole field. Further, given the series, they can be combined according to different formulae what give different results. Given one form of the index (e.g., with fixed base and set of weights), its use is valid only for relatively short-run comparisons. An index of production is only useful if it is available promptly and regularly (preferably monthly) for short-run comparisons and that it is only valid for longer-run comparisons if, at intervals,

it is reviewed, revised and related to bench-mark data derived from extensive information, e.g., obtained at a census of production.

The scope of the index of production is commonly understood to be limited to the production of non-agricultural commodities. The scope needs more precise definition with reference to the practicability as well as the desirability of including various activities. Further, the grouping of the index to be based on an industrial classification, i.e. a classification of establishments by types of activity. The appropriate classification is the International Standard Industrial Classification of all Economic Activities (Statistical Office of the United Nations, Statistical Papers, Series M, No. 4, Rev.3.). This can be taken as the frame for the definition of the scope and grouping of the index.

The index formulae

Many formulae have been used, and more suggested, for the compilation of index numbers; some of them are very complicated in form and require extensive data in compilation. A good deal of attention has been given to the definition of an "ideal" index number. This is a matter which may be usefully pursued when the problem is to compile index numbers at intervals (e.g. annually) with the aid of detailed and extensive data. It is not practicable to use a complicated formula for an index of production which has to be computed promptly, frequently and regularly from data of the kind readily available monthly and quarterly. What is then needed is some simple formula what has a clear interpretation, what is easily computed and which makes use only of data likely to be available promptly and regularly. Moreover, for purposes of international comparison and aggregation, it is important to have a single formula adopted for the national index numbers. Particular refinements of formulae may be used by those countries fortunate enough to have the necessary data regularly to hand; but these should be in addition to (and not instead of) the compilation of a simple, single form which can be adopted by all.

There can be little doubt about the nature of the formula to be proposed for index numbers of industrial production to be computed regularly on an internationally comparable basis. The formula must be one of the well-known aggregate forms in which quantities are valued and aggregated at constant prices. Each of these formulae can be written in equivalent form as a weighted arithmetic mean of quantity relatives. The general form can be written:

$$Q_{01} = \frac{\sum pq_1}{\sum pq_0} = \frac{\sum pq_0 \left(\frac{q_1}{q_0} \right)}{\sum pq_0} = \frac{1}{\frac{\sum pq_1 \left(\frac{q_0}{q_1} \right)}{\sum pq_1}}$$

Two obvious selections are prices in the base period (p_0) and prices in the current period (p_1). These give rise to the familiar base-weighted (Laspeyres) form:

$$Q_{01} = \frac{\sum p_0 q_1}{\sum p_0 q_0} = \frac{\sum p_0 q_0 \left(\frac{q_1}{q_0} \right)}{\sum p_0 q_0}$$

and current-weighted (Paasche) form:

$$Q'_{01} = \frac{\sum p_1 q_1}{\sum p_1 q_0} = \frac{1}{\frac{\sum p_1 q_1 \left(\frac{q_0}{q_1} \right)}{\sum p_1 q_1}}$$

One general property which the volume or quantum index should possess is that if multiplied by a price index it should yield an index of change in value. The change in value of total output from period 0 to period 1, V_{01} , needs to be split into a price component P_{01} and a volume component Q_{01}

$$V_{01} = Q_{01} \times P_{01}$$

This can never be done uniquely; there is always a choice of components.

The concept of the index of industrial production requires that q should be a series representing the volume of work done in a particular industry. Hence p should not be the gross price of the product of the industry; it should be the net price or margin added by the industry and expressed per unit of work done (q). In fact p is better considered and estimated, not by itself, but in conjunction with q . The product pq represents valuation of net output; for example p_0q_0 is value of net output in the base period 0 and p_1q_1 is value of net output in the current period 1. Hence the weighted average form of Q_{01} or Q'_{01} is preferable for practical purposes to the equivalent aggregate form. Q_{01} is the weighted average of relatives formed from series representing work done (period 1 being compared with period 0), weights being values of net output in the base period 0. The reciprocal of Q'_{01} is similar but worked backwards from period 1 to period 0; the relatives compare period 0 with period 1 and the weights are values of net output in period 1.

The choice is between Q_{01} and Q'_{01} . The best solution would be to calculate both of these index numbers. For the difference between them is of importance in assessing the significance to be attached to any index of industrial production between the two periods compared. If Q_{01} and Q'_{01} are close together, either can serve as a good indicator. If they are far apart, then there is less significance to be attached to any indicator of change between the two periods. For a regular (e.g. monthly) series of index numbers, however, it is not practicable to compute both Q_{01} and Q'_{01} . A choice must be made and it must clearly be for the base-weighted (Laspeyres) form Q_{01} . This is inevitable since the weights, values of net output, are generally available only for particular periods and only

after some time lag. The proposal, then, is that the base-weighted (Laspeyres) form should be used for a regular monthly or quarterly series of index numbers of industrial production.

The weight base of the indices

A form with fixed (base) weights is the only practicable one when current information on weights is not available. Such an index is clearly valid only for short-run comparisons; but this is true of any index number of a given type, of Q'_{01} and of "cross" forms as well as of Q_{01} . One form Q_{01} provides good comparisons between the "base" period 0 and any other period not far removed; the other form Q'_{01} is good for comparisons between the "current" period 1 and any near period. Neither is necessarily valid for comparing two periods far apart. The index in form Q_{01} , as in any form, needs to be tested, reviewed and (when necessary) re-weighted from time to time. Opportunity should be taken, at times of revision, and more frequently if possible, to compute both Q_{01} and Q'_{01} for the pair of periods under review. The relation between them is always of interest and it is an essential part of the process of revising the index. Over the long period, therefore, it is to be expected that there will be several sets of index numbers, each of base-weighted form but with changing base and weights, and each suitable for short-run comparisons. There is still the problem of setting up bench-marks at intervals to link together the index numbers into a continuous chain. It is here that proposals on the use of "cross" or "ideal" forms of the index are relevant and need careful examination.

The weight base of the index is the period to which the weights relate. A period of less than a year (e.g. a month or a quarter) is not generally broad enough for the base. On the other hand, an average of a series of years is not often possible as the base period of an index of production since data for weights are usually available only for single years and at intervals. It is suggested, therefore, that a single year be selected for the weight base of the index. However, countries which take an annual census of industry may use a three-year weight base centred on the year selected as the standard weight base. The weight base needs to be reviewed and (when necessary) the weights need to be changed, from time to time. A review at regular, rather than irregular, intervals is clearly desirable. As a practical rule, it is suggested that a five-yearly review is sufficient. At each such review, a decision is to be taken whether to retain the existing weight base or whether to adopt new weights and, in the latter case, which year to select for the new weight base. There must be some flexibility, if an entirely unsuitable year is to be avoided, but the choice of new base can be limited to the period one year on either side of the year of review. To maintain as much continuity as possible, whenever a change of weight base is made, the index should be compiled on the old and on the new base for an overlap period of twelve months.

International comparability

The interests of international comparability need to be considered in proposals on the change of weight base in national index numbers. It is highly desirable, if index numbers are to be compared and aggregated into regional and world totals, that all countries synchronize the changes of weight base in their index numbers; they should simultaneously adopt new weights and the weights should all relate to the same year. Desirable as this is, it is not practicable to expect that any hard and fast rules can be followed. To achieve an essential minimum of comparability, it is suggested that all countries should agree to review their index numbers at or about the same time and to repeat the review every five years.

The periodic reviews of the index, and particularly any change of weight base, are dependent on the collection of comprehensive data on production, by quantity and price. Such data are generally to be obtained only in censuses or sample surveys of the whole field. The proposals of the previous paragraph can only be carried out if all countries plan to take a census of production, or a wide sample survey, every five years and in or around same year on every occasion. It is possible to have small differences in timing of censuses without giving up concerted changes in weight base. The weights for a base year adopted by international agreement can be estimated by extrapolation from data obtained at a census or survey in a different year, provided that the base and census years are close together

Description of the United Nations Statistics Division (UNSD) on Index numbers of Industrial Production

Monthly, quarterly and yearly indices of Industrial Production are compiled, processed and published by country and by economic and geographic regions of the world for dissemination through various UNSD publications (Monthly Bulletin of Statistics, Statistical Yearbook, The Pocket Book), the Internet, electronic mail, diskettes and other media.

This activity is unique in the sense that the UNSD is the only international organization publishing aggregated data for the index numbers at world levels as well as by economic and geographical regional groupings. Collection of these index numbers and their publications started at 1953 as of ECOSOC mandate.

Value added is used in constant US dollar term as weights in calculating the Laspeyres production indices.

Data collection process:

- Prepare and send pre-filled Index numbers of Industrial Production Questionnaires to some 130 countries in English, French and Spanish every quarter (e.g. 1 February, 1 May, 1 August and 1 November).

- Assemble the index numbers of industrial production at the 1 and 2-digit level of ISIC Rev.3 of the industrial sectors comprising mining and quarrying, manufacturing and electricity, gas and water and their respective subdivisions.
- Monitor national reporting practices, draft relevant correspondence, country notes and footnotes to the tables.
- Verify and screen the new and/or revised data to ensure validity.
- Reclassify country data in accordance with Rev.3 categories and make estimates for missing data where it is feasible and needed.
- Provide methodological support.
- Re-base the indexes if they are not on the official UN Base year to ensure comparability and to be able to aggregate data into ISIC and country groupings and the world.

Publications and other data requests

The monthly, quarterly and yearly indices are submitted for publication of the MBS, of the Statistical Yearbook and some of them of the statistical pocket book.

Respond to individual data requests of internal and external users, international agencies, UNIDO and ESCAP.

Revision of the Base weight Year: a change from 1990 base year to 1995

Currently, the division is in process of changing the base year from 1990 to 1995. The indices are re-based to 1995 and to aggregate them, weights are used. These weights are the value added contribution to the GDP of every ISIC at the two digit level (ISIC rev. 3) during the base year.

The UNSD sends out questionnaires to collect these weights each time the base year is changed. This usually happens about every five years (described in details above). In January 2001, Questionnaires were sent to 177 countries.

The revision exercise is almost complete and the base-year will be changed from 1990 to 1995. For most countries the estimates of value added used as weights are derived from the results of national industrial censuses or similar enquiries.

The overall response to the questionnaire is 37 per cent (16 per cent for Western Asia). Because of the significant non-response a substantial research has to be done using various data sources to ensure a reasonable coverage. The data sources are National Accounts Yearbooks (UN Publication), UNIDO database, Yearbooks and Mining and

Utility Questionnaires, Bulletin of Industrial Statistics for the Arab Countries, Europa World Year book, EIU Country Profiles (internet database).

The indices are aggregated using these weights at the country, economic and regional groupings as described in the part of the paper index methodology is discussed.
For the ESCWA countries, the data sources are given in the following table.

Source for the weights:

Country	Source
Bahrain	C and D totals are taken from Bulletin of Industrial Statistics for the Arab Countries, 1985-1995.
Egypt	C is taken from UNIDO Mining and Utility Questionnaires D is taken from UNIDO database 2001-10-04 Total E is taken from National Accounts Yearbook, 1995.
Iraq	Totals are taken from National Accounts Yearbook
Jordan	Country submission
Kuwait	C and E are taken from UNIDO Mining and Utility Questionnaires. D is taken from UNIDO 1999, Yearbook.
Lebanon	No indices are available and questionnaire was not sent
Oman	Country provided the Totals
Qatar	Totals of C and E were taken from National Accounts Yearbook, 1996-1997. Parts of D were taken from UNIDO database, 2001
Saudi Arabia	Totals of C, D and E were taken from National Accounts Yearbook, 1995.
Syria	The country provided the totals for C, D and E. D was taken from UNIDO database.
United Arab Emirates	Totals for C, D and E are taken from Europa World Yearbook, 1999.
Yemen	Totals for C, D and E are taken from Europa World Yearbook, 1999.

