INDEX NUMBERS OF INDUSTRIAL PRODUCTION

Memorandum Prepared by the Secretariat for consideration under Item 5 of the Provisional Agenda

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/Introduction
Introduction

1. In 1939 the League of Nations published a report on Indices of Industrial Production (Studies and Reports on Statistical Methods, No. 6) prepared by the Committee of Statistical Experts. The report included recommendations aimed at "providing theoretical and practical guidance for countries intending to compile such indices or to revise their present compilations" and at "securing, as far as possible, the international comparability between them". Since 1939 there have been changes in the industrial structure of many countries and in the nature and amount of data available on industrial production. There has also been a considerable advance in the theory and practice of index-number construction and a development of the study of basic concepts, such as national income, to which index numbers are related.

2. At its third session, the Statistical Commission recommended that the conclusions of the Committee of Statistical Experts be reviewed and, at its fourth session, the Commission reviewed and took note of a memorandum by the Secretariat to which was appended an exploratory study of the problem (E/CN.3/61). The Commission then requested the Secretary-General

"to complete the review of problems involved in the preparation of indices of industrial production, if necessary with the assistance of experts, and to submit proposals to the Commission for consideration at its next session". (E/1312, paragraph 82)

3. The present memorandum has been prepared in response to this request. The Statistical Office of the United Nations has continued its review of the problems involved in the construction of national index numbers of production and in securing international comparability. The exploratory study (E/CN.3/61) was circulated for comment to Member Governments, and to international agencies concerned, and many constructive suggestions were received. The last stages of the review were conducted in the Statistical Office of the United Nations under the direction of an expert consultant (Mr. R. G. D. Allen) appointed for the purpose.

4. The conclusions and recommendations which emerged from the review were largely of a technical character. No attempt is made here to describe and support them in full detail. The object of this memorandum is to set out certain conclusions and recommendations which appear to be of special concern and interest to the Commission and to give such arguments as are necessary to support them.
More detailed aspects will be dealt with separately, in a technical study which the Statistical Office of the United Nations plans to publish. In addition, the review has made it apparent that there are several outstanding questions to which answers can only be given after more research has been devoted to them than has yet been carried out either by national or by international agencies. The most important of these questions are:

(a) The use of substitute data in determining the weighting system (See paragraphs 18 and 19 below).
(b) The suitability of quantum series of various types, e.g. net or gross output at constant prices and such input series as consumption of energy (See paragraph 20 below).
(c) The general problem of allocation of limited resources in the improvement of the accuracy of the total index (See paragraph 25 below).

5. An index of production is a tool of economic analysis of use, in conjunction with other data, in summarizing past developments, forecasting future trends and making decisions on policy. Its various constituents may be related one to another to show relative changes in the development of different industries; it may be related in total or in parts to other economic indicators such as national income, employment and price levels, and to similar indicators in other countries. Further, national index numbers compiled on a comparable basis are needed for aggregation to show changes in total production and in the main industrial categories, both for the world as a whole and for important regions.

6. The general aim is to show changes in the quantum of production, or product in "real" terms; the main requirement is for a general-purpose index to serve a variety of ends and to serve them frequently, regularly and promptly. A money valuation of production is ruled out because of price variations and a measure in common physical units such as tons is not suitable except for special purposes. The problem is one of index numbers in that a diversity of measurements, each covering part of the field, has to be condensed into a few significant figures. Such a general-purpose index of production is subject to all the limitations of index numbers. The series available for combination into an index are always an imperfect representation of the field. Moreover, given the series, they can be combined according to different formulae which give different results. Finally, the use of one particular formula (e.g. one base and set of weights) is valid only for
only for relatively short-run comparisons. The conclusions here are firstly that an index of production is only useful if available promptly and regularly (preferably monthly) and secondly that, like all index numbers, it must be kept constantly under review for improvements in the series available and for re-weighting.

7. It has been objected, most strongly by Australia, that the limitations of index numbers, mentioned in the previous paragraph, are so serious in the field of industrial production that it is not practicable to construct an adequate index. In some part, such objections are against the use of a particular form of index number with a fixed base, objections which apply, strictly interpreted, to all index numbers, for example those of wholesale or retail prices.

For the rest, these objections may be regarded as a reminder of the limitations of index numbers of industrial production. The practical necessity of compiling series which reflect current changes in the volume of industrial production is so compelling that their use cannot be relinquished although their limitations must always be borne in mind.

Scope and grouping

8. The scope of the index is to be the production of non-agricultural commodities and the grouping of the index is 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). The production of non-agricultural commodities corresponds to divisions 1, 2, 3, 4 and 5 (except group 52) in this classification and the appropriate main grouping is as follows:

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<th>Group</th>
<th>Industry</th>
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<tr>
<td>1</td>
<td>11, 12, 13, 14, 19</td>
<td>Mining and quarrying</td>
</tr>
<tr>
<td>2 and 3</td>
<td>20, 21, 22</td>
<td>Manufacturing</td>
</tr>
<tr>
<td></td>
<td>23, 24</td>
<td>Food, drink and tobacco</td>
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<td></td>
<td>25, 26</td>
<td>Textiles, footwear and apparel</td>
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<td></td>
<td>27, 28</td>
<td>Manufactures of wood and cork, furniture and fixtures</td>
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<td></td>
<td>31, 32</td>
<td>Paper and printing</td>
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/33 Pottery, glass
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<tr>
<th>Division</th>
<th>Group</th>
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<tr>
<td></td>
<td>33</td>
<td>Pottery, glass, clay products, etc.</td>
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<tr>
<td></td>
<td>34</td>
<td>Basic metal industries</td>
</tr>
<tr>
<td></td>
<td>35, 36, 37, 38</td>
<td>Metal products, machinery and transport equipment</td>
</tr>
<tr>
<td></td>
<td>29, 30, 39</td>
<td>Miscellaneous manufacturing</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Construction</td>
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<td></td>
<td>5</td>
<td>Electricity and gas</td>
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9. The standard classification is one of all economic activities and, even within the groups listed above, there are certain activities which are not appropriately included in an index confined to the production of non-agricultural commodities. The scope of the index should be further limited as follows.

Firstly, manufacturing should be limited to work in establishments of a type generally employing power-driven machinery and should exclude handicrafts and work in the home or farm (but see paragraph 26 below). On the other hand, there should be no limitation according to size of establishment, whether by number employed, turn-over or another such measure. Secondly, repair work should be excluded from a manufacturing group if it is generally performed in connexion with a service trade (e.g., boot and shoe repair), and included only if it involves the same type of activity as new production (e.g., ship and locomotive repairs, building repairs and demolition).

10. The classification proposed in paragraph 8 is to be regarded as the minimum for analysis. In addition, each country is to be encouraged to compile separate series for individual industries which are important in its economy. In doing this, countries should bear in mind that international comparability is best served by the use of the major (two-digit) groups of the International Standard Industrial Classification, e.g. groups 23 (textiles), 31 (chemicals) and 38 (transport equipment). Another question is what should be done when data for some groups are inadequate. First, any omission should be a whole group since this is clearer, tidier and more convenient than including part of a group. Next, the absence of some groups raises the question whether a total or general index should be compiled at all, and if so, how it should be described. Construction is a group which may be expected to cause difficulties in practice. If this is the only group omitted, then a total index can be compiled provided it is clearly described.
deemed as excluding construction. If other groups are omitted, it is
dangerous to compile a total index. However, if one or two groups are omitted
not because of lack of data but because there is practically no activity in some
industries, then such a group can be indicated as "production negligible" and a
total index compiled without it.
11. The proposals here apply to all countries with industrial production, but
particularly and immediately to countries with well-developed and diversified
industries. They are less immediately relevant to a country whose economy is
dominated completely by agriculture, forestry and fishing, or to a country whose
industrial development is concentrated in a few directions, such as extractive
industry or the simple processing of a few raw materials. In these circumstances,
the country may be well advised to concentrate on the improvement of statistics
on output in agriculture, mining etc. and to postpone compilation of an index of
industrial production for the time being.
12. The title "index of industrial production" is in general use at present and
it should be retained. The word "industrial" sometimes has a rather wider scope
than is proposed here, but it is not likely to be misleading in practice. The
word "production" is of neutral connotation and is to be preferred to "activity"
since the index is intended to measure "work done" or the result of activity
rather than the activity itself. It is desirable that the index should be
related to the concept of national product and the word "production" suggests this
link.

Formula

13. For purposes of international comparison and aggregation it is essential
to have the same formula for all national index numbers. Preference must be for
a simple form which has a clear interpretation. Moreover, it must be easily
computed as a general-purpose index to be available monthly or quarterly as
promptly as possible. Such a general-purpose index should be of the base-weighted
(Laspeyres) form in which quantity (quantum) relatives are averaged with fixed
weights determined for the base period.

14. The use of fixed (base) weights - the only practicable basis when current
information is not available for weights - does no more than emphasize the
general point that no particular index of production can be expected to remain
valid for more than short-run comparisons. The index should in any case be
tested, reviewed and, when necessary, re-weighted from time to time and it is
/suggested
Suggested that this should be at five-yearly intervals. At times when the index is revised, if not more frequently, opportunity should be taken to compute also the current-weighted (Paasche) form of the index. This will serve to check the validity of any comparison of production by volume over the period reviewed and assist in setting up benchmarks for longer-run comparisons.

**Base**

15. The weight base of the index is the period to which the weights relate. There is little reason to prefer a period less than a year, or an average of a series of years, to a single year as weight base, since data for weights are usually available only for single years and at intervals. The conclusion of the previous paragraph is that there should be a review of the weight base every five years. At each review it will be decided whether to retain the previous weight base (because it is still appropriate) or whether to adopt new weights. In the latter case, there must still be some choice if an unsuitable year is to be avoided but the choice can be limited to one year on either side of the year of review. On each change of weight base, the index should be compiled on each base year for an overlap period of twelve months.

16. The interests of international comparability can only be fully served if all countries synchronize changes of the weight base of their index numbers, i.e., simultaneously adopt new weights all relating to the same year. It is, however, impracticable to lay down hard and fast rules to achieve this exactly. It is proposed that each review of weights should be in the same year for all countries and that the Statistical Commission should make a definite recommendation on change of weight base in each such year. Since most countries have already decided on a weight base for immediate post-war comparisons, it is further proposed that 1952 is likely to be a suitable year for consideration as a weight base, thus commencing a cycle of reviews to follow at five-yearly intervals. Some countries have plans for a census of production relating to a year in or around 1952 (some, indeed, having programmes of annual censuses) and there is sufficient time for others to obtain data from which weights relating to 1952 can be derived. Specifically, the proposals are as follows. As soon after the end of 1952 as practicable, the Statistical Commission would consider the suitability of 1952 as a new weight base for all countries to adopt and make a recommendation on the matter. Five years later, the Commission would again review the position and /recommend
Weights down to the level of census industries can be derived accurately. Internal weights within a census industry may be estimated more roughly from non-census data. In order that index numbers for particular groupings of industries may be derived for various purposes, it is important that the weights for census industries should be shown.

20. The selection of series to be incorporated is the vital part of the construction of the index. There are, however, no rules of general application and no specific proposals can be made. The selection follows the weighting system; each census industry must be examined in turn and one or more series selected to represent the quantum of production or work done in the sector of activity comprising the industry. Each industry is a special case; all possible series must be considered on their merits. In one group, the series are related to output in the industry, i.e., output in some physical units, an index of the volume of output or a deflation of value of output with a price index. Another group includes input series, e.g., of employment, of man-hours worked or of materials used. A still further possibility is a constant-price evaluation of net output as the difference between gross output and materials used. The selection can be made only after canvassing all possibilities and after relating various series to each other and to such benchmarks as more elaborate but less frequent data provide. Finally, if no suitable series can be found for a sector, then the question of imputing the weight of the sector to other sectors must be considered. There are, once again, various ways of imputation and the choice is not determined by any general rule.

Compilation

21. The regular work of compilation of the index, month by month or quarter by quarter, depends for its speed and accuracy on the series used. The form of the base-weighted (Laspeyres) index is easily computed once the weights are fixed. The first factor is the number of different series used. If there are only a few series, or if some of them have large weights, then the index may be unduly affected by inaccurate movements in one or two series. On the other hand, the inclusion of a large number of series may slow down the compilation to a greater extent than the extra accuracy justifies. As a broad rule, it may be suggested that in industrial countries fewer than 100 individual series would not generally suffice for an accurate index and that it would be difficult to justify the
time and labour spent on computing more than 500 series. There may be exceptions
to the suggested minimum in countries with few industries. It is always
undesirable, however, to use series with heavy weights, since errors in the series
are carried into the index with corresponding weight. If a single industry is very
large in the economy of a country, efforts should be made to represent its output
by several series, for different stages of production or for different types or
qualities of product. It is desirable that not more than, say, 5 per cent of
weight (direct and imputed) should be borne by a single series.
22. A second and more important factor is the accuracy and availability of the
series. Each series incorporated in the index should be graded according to some
simple assessment of accuracy. Every effort should be made to replace a lowly
graded series by a better one, particularly if it carries a large weight. For a
sector with a small weight, an inaccurate series may be rejected in favour of
imputing the weight to other sectors. On availability, series will inevitably
differ in the speed at which they appear after the end of each month or quarter.
There is always a conflict between the need for prompt computation of the total
index and the desire to avoid large scale revisions in provisional figures. It
may sometimes be desirable to accept an "inferior" series (on the criterion of
closeness of approximation to quantum of production) if it is available more
easily or more readily in practice.
23. The conclusions so far apply to an index compiled frequently, preferably
monthly. There are, however, difficulties in using monthly index numbers since
calendar months are of unequal length and contain varying numbers of weekends.
The basic unit of time for production is the week, which can be translated (with
only very minor differences) into quarterly and annual rates. Moreover, the
weights of the index are values of net output generally calculated for a year and
hence reducible to weekly or quarterly rates but not to months. It is proposed,
therefore, that the primary index of production should be constructed on the
basis of production per working week. It can be shown for "months" by averaging
out production per working week in each of twelve periods in the year. If the
constituent series are given weekly, there is no difficulty. If they relate to
calendar months, then they need to be adjusted for the unequal lengths of the
months and for the varying numbers of weekends. The adjustment will differ as
between countries and, within one country, as between different industries since

/ the effect
the effect of weekends on production varies between countries and between industries. The adjustment is not one to be applied to the total index; the choice is between applying it to individual series or to groups of series. The application to individual series is more accurate but also more laborious and it is often sufficient to adjust groups of series. One point is to be emphasized; the adjustment reduces production to the primary weekly basis and is designed solely to eliminate the vagaries of the calendar. It is not an expression of production per working day (which allows for public and annual holidays) nor an attempt to isolate the trend of production.

24. The movements of this primary index of production over time are affected by seasonal factors including the incidence of holidays. For comparisons involving the trend of production it is desirable to have a secondary index from which these seasonal influences have been removed. Whatever secondary index numbers are computed, the primary index on the basis of weekly production should always be shown and the methods of adjustment from the primary to the secondary index numbers should be indicated.

25. Most work in practice is involved in the original design and in the periodic revision of the index. With only limited resources available, it is highly important that effort should be concentrated where the largest return is to be obtained, in terms of the accuracy of the index as computed monthly or quarterly. Though detailed planning will vary from one country to another, there are two dominating considerations of general application. One is that beyond a point soon reached, attention is better paid to the accuracy of series than to refinement of weights. An accurate index cannot be constructed from inaccurate series no matter how refined the weights. The other is that, in fixing weights or in selecting series, attention should be concentrated on large industries and on large sectors within industries. It avails little if a small sector of an industry is represented by several accurate series while the rest of the industry depends on a single inaccurate series. Top priority in the design or revision of the index should be given to fixing accurate weights down to the level of census industries and to specifying good series to represent the major sectors of the index. Lower priority should be given to refining weights (particularly the internal weights within industries) and to filling out smaller sectors with further series. Another low priority is the attempt to transfer very small /sectors
sectors from one group to another to make the main classification conform more closely to the international standard.

26. An index of production of the type proposed is to be compiled frequently but is to be limited to comparisons in the relatively short-run. It is essential, therefore, to set up bench-marks at regular intervals, and to test and review the index every five years, so that longer-run comparisons are possible (see paragraph 14 above). This raises the question of whether to push the conclusions a little further and to propose the compilation of an annual index separate from, and as a regular bench-mark for, the monthly index. The advantages are clear. An annual index could be on a wider basis, using more series and more elaborate data, without pressure for such immediate compilation. It could be supplemented by the addition of a special category showing annual production in handicrafts and cottage industries. The base-weighted (Laspeyres) and current-weighted (Paasche) forms could both be compiled annually. The constituents of the annual index could be used to adjust, correct or confirm the corresponding items in the monthly index. Further, the monthly index could be confined to the short-run period necessary to link together the annual series and it could be constructed on a narrower basis and computed more quickly and more cheaply. The main difficulty is that an annual series would require, if not an annual census of production, at least fairly elaborate data obtained annually. Many countries find it difficult, at present, to obtain extensive information on production even at five-yearly intervals. No positive proposals are made here; the conclusions of paragraph 14 stand, with the addition of this note on the advantage of an annual series of index numbers of production.

Relation to censuses of production

27. It is possible to compile a useful, even an adequate, index of production without a census of production (except, perhaps, at long intervals) provided that some extensive surveys of the field are taken from time to time. The conclusion is inescapable, however, that the essential basis for a really satisfactory index of production is a frequent (preferably annual) census of production of wide coverage. A frequent census would provide a regular test of a monthly index of production, a means of adjusting the monthly series and of solving most of the imputation problems inevitably encountered in a monthly index. It would provide the weights for a revised index whenever a change of weight base is required.

/If taken annually,
If taken annually, moreover, it would set up annual benchmarks, or support a
widely biased annual index to go with a monthly index on a narrow base. However,
in line with the conclusion of the previous paragraph, it is only proposed at
the present stage that a census of production, or some substitute in the form of
extensive surveys of production, be taken at five-yearly intervals or more
frequently. Specifically, and following the conclusions of paragraphs 15 to 17,
it is proposed that all countries should plan to take a census of production, or
a wide sample survey, in or around 1952 and thereafter at five-yearly intervals
or more frequently.

28. A programme of the kind outlined here can be greatly facilitated, and
reduced in cost, by judicious use of sampling techniques. The data required from
a census of production, for purposes of compiling an index of production (e.g. for
weights and adjustments), need be obtained completely only from larger
establishments. Supplementary information can be asked of a sample of smaller
establishments and not all questions need be put to each establishment. The
series incorporated in the index can be based primarily on returns received from
larger establishments, and the number of returns can be permitted to vary from
month to month, provided that supplementary information is derived at intervals
by sample. Experiments on the validity of alternative types of series for the
same industry can be made on a sample basis for selected industries.

Conclusions

29. The Statistical Commission may wish to adopt the following specific
recommendations based on the conclusions reached above.

(a) Countries compiling index numbers of industrial production are
recommended to adopt as coverage major groups 11 to 51 inclusive of the
International Standard Industrial Classification of all Economic Activities,
and to arrange the grouping so that index numbers for at least the twelve
categories listed in paragraph 8, and if possible for all major groups, are
shown or can be derived. The coverage should exclude repair work generally
performed in connexion with a service trade and (for monthly and quarterly
compilations) handicrafts and work in the home. The compilation should be
called "the index of industrial production".

(b) If, pending the collection of more comprehensive series, a country is
compelled by absence of data to omit certain industries from the index, it is
recommended that such omission be whole major groups. If construction is
excluded,
excluded, this should be made clear in the title of the compilation. If other major groups are excluded, countries are recommended to consider carefully whether any total or general index should be compiled.

(c) Countries are recommended to adopt, for a monthly or quarterly index of production, the base-weighted (Laspeyres) formula in which quantity (quantum) relatives are averaged with fixed weights determined for the base period.

(d) Each country should review the weights of its index and, if necessary, adopt a new weight base, in the light of recommendations on the general suitability of different years for this purpose. These recommendations will be made at approximately five-yearly intervals by the Statistical Commission, starting with 1952. To facilitate this programme, each country is recommended to plan to take a census of production in or around 1952 and thereafter to take censuses at five-yearly intervals or more frequently.

(e) Whenever a country adopts a new weight base, it is recommended to compile its index on both the old and the new basis for an overlap period of twelve months.

(f) Each country is recommended to show the weights of the index down to the level of industries as defined in their census of production.

(g) Each country is recommended to compute the index on the basis of rates of production per working week shown preferably for "months" (i.e. twelve times a year), otherwise for quarters. If, in addition, this primary index is adjusted to eliminate the influence of seasonal factors, including holidays, the method of adjustment should be indicated.

(h) In order to construct the most accurate index possible with available resources, countries are recommended, in designing or revising the index, to pay most attention to accuracy of weights down to the level of census industries, and to adequacy of series representing major industrial activities.

(g) It is recommended that the attention of Member Governments be drawn to the advantages of

(i) a separate annual index on a broader base than the monthly or quarterly index,

(ii) censuses or extensive surveys of production taken more frequently than every five years, and

(iii) the use of sampling techniques in obtaining data for the derivation of weights and the construction of series.
30. The Statistical Commission may also wish to keep the subject of index numbers of industrial production under review, and to request the Secretary-General to draw the attention of Governments to the Commission’s recommendations on this subject, and to the technical study to be issued, and under appropriate circumstances to provide technical advice and assistance on the application of the recommendations and of the study.

31. Finally the Statistical Commission may wish to recommend that the Economic and Social Council adopt a resolution in the following terms:

The Economic and Social Council,

Taking note that the Statistical Commission has drawn up a series of recommendations aimed at improving the compilation of national index numbers of industrial production and making them more comparable, and

Taking note that the Secretary-General, with the advice of Member Governments and of the specialized agencies, has reviewed the problems involved and plans to issue a technical study on the subject for the guidance of Member Governments,

 Recommends

(1) That the attention of Member Governments be drawn to the importance of periodic calculation of the volume of industrial production on an internationally comparable basis.

(2) That Member Governments at present compiling index numbers of industrial production should review their compilations with a view to improving their comparability with those of other countries.

(3) That other Member Governments in whose countries industrial production is important, should undertake to compile such index numbers.