

Revision of international recommendations for index of industrial production

Background Paper

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Table of contents

Abbreviations	3
<i>Abstract</i>.....	4
I. Introduction.....	5
II. Objectives and title of the publication.....	7
III. Scope and coverage of the IIP Manual.....	8
V. Weights	15
VI. Compilation of production indices.....	19
A. Measurement problems	19
B. Data collection.....	22
C. Introduction of seasonal new products and production units.....	23
D. Non-response and missing data.....	24
E. Rebasing and linking the index series	25
VII. International Comparison	27
Annex 1: An overview of existing recommendations and questions under discussions ..	28
Annex 2: References	33

Abbreviations

CEC	Commission of the European Communities
CPI	Consumer price index
CVA	Census value added
EGM	Expert group's meeting
Eurostat	Statistical Office of the European Communities
IIP	Index of industrial production; <i>production index</i>
ILO	International Labour Organization; <i>International Labour Office</i>
IMF	International Monetary Fund
IRIS	International recommendations for industrial statistics
ISIC	International standard of industrial classification of all economic activities
ISP	Indices for services production
IWGPS	Inter-secretariat Working Group on Price Statistics
MVA	Manufacturing value added
OECD	Organization for Economic Cooperation and Development
PDA	Personal digital assistant
PPI	Producer price index
PPS	Probability proportional to size
ROK	Republic of Korea
SNA	System of national accounts
UN	United Nations
UNIDO	United Nations Industrial Development Organization
UK	United Kingdom

Abstract

The last UN publication on production index methodology dates back to 1950. It preceded several other related UN publications including SNA, IRIS and different classification standards, thus various terms and concepts used are outdated. In the context of recent publications of manuals on other areas of application of index method such as PPI and CPI, a new publication on production index has been very timely. Moreover, the UN Statistics Commission has decided to revise the existing UN recommendations for industrial statistics, which defines the basic concepts of industrial statistics used in the index of industrial production. There are many questions to be resolved in the new publication starting right from the very scope and coverage of production index in the context of its increasing demand for service sectors.

The publication of 1950 presumed that production statistics would not be available annually due to the limited statistical capacity of many national statistical offices. Most of the countries conducted a large-scale industrial survey or census every 5 to 10 years that provided necessary data for weight calculation. The fixed weight based index was an appropriate combination with periodic surveys. Therefore, it prescribed the Laspeyres method for production index. However, the situation has changed ever since and Laspeyres method itself has undergone different modifications. Many countries do conduct the annual surveys or possess the data sources that allow more frequent update of weights. On the other hand thanks to technological process, industrial products and their qualities change very fast that makes the basket as well as the base weights quickly outdated. In order to meet the new requirements preference has been given to chained Laspeyres method with more frequently (annually or bi-annually) updated weights. It also means that the new products/qualities and production units are timely incorporated in index. Frequent change of weights requires an efficient method of linking and rebasing, for which some superlative indices type of Fisher and Törnqvist are under discussion.

I. Introduction

1. Index of industrial production (IIP) has been widely used to measure the change of volume of industrial production over time and territories. While measured by comparing the quantities in two different situations, IIP shows the real change of production that is free of price fluctuation. For this reason IIP has been an important short-term economic indicator in official statistics especially for estimation of national accounts at constant prices. IIP is also widely used by business community to assess the current economic situation of the country. It has always been one of the key indicators for international comparison.

2. It was more than half a century ago when United Nations brought out its first and only publication on this topic *Index Numbers of Industrial Production* 1950 (Studies in methods No. 1). More recent UN publications on related subject were *Guidelines of a System of Price and Quantity Statistics* 1977 (Series M, No. 59), *Manual on Producers' Price Indices for Industrial Goods* 1979 (Series M, No. 66) and *Chapter XVI of 1993 SNA*. There have been many developments in methods and practice of IIP in recent decades. Nowadays, basic computing facilities are available almost in every country that has enhanced the possibility of the use of technology in index compilation.

3. Despite the importance of IIP in its own rights, it cannot be considered completely out of SNA, thus it is imperative that terms and concepts used in the IIP publication be uniform and compatible to SNA as well as International Recommendations of Industrial Statistics. Existing manual and guidelines on production index precede IRIS-83 and SNA-93. So various concepts and methods used in these publications were outdated long ago. Presently, SNA-93 is being updated while revision of IRIS is on its way. In this context, it is necessary that the publication on IIP be brought in line with other related methodological recommendations of United Nations and other international organisations.

4. International recommendations on methods of index numbers have already been updated in other areas of its application. In 2004, ILO and IMF together with other international agencies through IWGPS published new manuals on CPI and PPI. IMF is currently working on the manual on Export and Import Price Index. Publication of PPI manual has been especially relevant to IIP, because change of the volume requires its decomposition to price and quantity changes. Unlike the axiomatic approach to index numbers, SNA does not consider price and quantities as independent variables of each other. Subsequently, it is necessary to maintain an acceptable degree of methodological uniformity in manuals of PPI and IIP. Perhaps, it would also be relevant to recommend a common data source from which both sets of indices are compiled.

5. Various national and regional statistical institutions have developed advanced statistical system of producing index numbers using the recent development of theory and practice of index numbers as well as new information technology. Their experiences and achievements might serve as departing point for preparation of a new manual on IIP providing sound methodological and practical recommendations. This paper intends to initiate a discussion among various producers and users of index numbers, national statistical offices, international agencies, experts and scholars. The paper has raised several questions for future manual and it is expected that the participants of the EGM not only comment on these questions, but also put forward other relevant issues that might have not been adequately covered in this paper. An overview of existing recommendations and new questions are given in Annex-1.

II. Objectives and title of the publication

6. The main objective of the proposed revision is to review the international recommendations on production index stipulated in 1950 UN publication (to be referred further as IIP-50) as well as other related UN publications and formulate the new set of recommendations based on the recent development of index theory and practical experiences of countries. In this context, new recommendations will be made in line with recently updated system of national accounts and international standards of industrial and product classifications. The review will assess the possibility of extending the scope of IIP to service industry, recommend the methods of index construction with more frequently updated weights and illustrate compilation procedure applied by different countries.

7. Depending on the outcome of the review regarding the scope of IIP the manual may be called "*Manual on the Index of industrial production of goods and services*" (*IIP manual*). The new title, if adopted, will reflect the expanded scope and coverage of publication. It will provide a complete guide to the theory and practice of production index. The manual among other things should include a chapter on theoretical aspects of the index number, and separate chapters for production index methods for industrial sectors (goods producing, those traditionally included in the production index) and for service sectors to be included in the new publication.

8. The publication should describe the relation of production index with other economic indices in general and of the quantity index to the price index such as PPI, in particular. Such relation will be described to assist the users of manual in obtaining a coherent structure of change of the volume of production over time and territories. Last but not least, the publication will guide the users to compile the indices that are internationally comparable.

III. Scope and coverage of the IIP Manual

9. The scope of index of industrial production in 1950 publication was confined to the non-agricultural commodities. More precisely, it included mining and quarrying, manufacturing, electricity gas and water and construction (C, D, E, F of ISIC rev-3). IIP-50 had mentioned the difficulties of including construction but recommended to make efforts to overcome such difficulties. It specifically mentioned to exclude agriculture and services. Later publications related to production index mentioned also about the service sectors, but UN recommendations on this topic are yet to be formulated.

10. A number of OECD countries regularly compile the indices for services production (ISP). Detail work on the services statistics has been conducted also in the Voorburg Group on Services Statistics. So far discussions are held around the use of PPI as deflator to obtain ISP. However, there might also be other ways to calculate the production index in service statistics and OECD countries too seem to agree. For example, UK calculates the ISP for railway transport from physical quantities such as passenger/km and freight volume, whereas ROK uses PPI deflator.

11. Even after extending the scope to service sectors IIP might not cover all kinds of economic activities. The manual still needs to define the scope of IIP based on ISIC. General tendency from the early experiences of ISP is to exclude such service activities as general government services and the service activities of non-profit institutions, which are not produced for market. The question also remains for the Agriculture section.

12. Actually, there existed some kind of uniformity between IIP-50 and IRIS with regard to the scope of industrial statistics and the index of industrial production. Currently, many countries have integrated industrial surveys with other economic activities through regularly conducted economic censuses. Similarly, the scope of IIP has to be broadened.

Compatibility to ISIC is necessary not only to define the scope of IIP but also to recommend the level of aggregation. Some terms such as “Census Industry” used in IIP-50 to describe the level of aggregation of indices are not in common use nowadays. For the purpose of international comparison IIP-50 suggested that each country should show separate group index numbers for each of the major groups of the Standard Classification. As it is obvious, major groups of different ISIC versions do not match exactly to each other.

13. Within each ISIC division included in the scope of IIP, it would also be necessary to define the coverage of statistical units based on a precise cut-off point. As it is recognised in existing recommendations it would not be practical to collect the data from small units for regular compilation of production indices. IIP-50 recommended 90% coverage of total production for intercensal or annual index and at least 60% of total net output for monthly indices. Many countries use a cut-off point for annual industrial surveys or periodic economic censuses based on capital or employment (say 10 or more persons engaged). Share of smaller activity units in manufacturing, trade and service sectors might be well above the ten percent mark envisaged in IIP-50.

14. Revision of international recommendations for industrial statistics is underway, which among other things, is supposed to extend the scope of recommendations to other economic statistics. The manual on production index could follow the same principles and recommendations in order to maintain the uniformity in methodological recommendations. If the scope of IIP is recommended, the publication might come up with the new title mentioned in the objectives above.

IV. Basic formula

15. Existing recommendations recognise two different purposes of IIP, which has certain degree of implications in selection of methods of index numbers. IIP-50 had concluded that a *general purpose* index of production

compiled regularly (preferably monthly) should be of the base-weighted (Laspeyres) form in which quantum relatives are averaged with the values of net output in the base period. Another conclusion was more applicable to the *national account purpose*: 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 the change of value.

16. In contrary to axiomatic approach to the index number quantity variables are not independent of price in SNA. Because, we measure not merely the change of quantity but the change of the volume of production in value terms at constant prices. Increase of production from 10 to 12 thousand meters of cloth in one establishment and from 1000 to 1200 television sets in another establishment result in same quantity relatives, but the contribution of the second establishment to the change of the volume of production would be much higher thanks to the production of items of the higher price. So, the total value of output V at any time t is the product of the quantity of goods and services Q_t and their prices P_t .

$$V_t = P_t Q_t \quad (1)$$

and its change, say from period 0 to t , is given by an index:

$$I_{pq} = \frac{V_t}{V_0} = \frac{\sum p_t q_t}{\sum p_0 q_0} \times 100 \quad (2)$$

17. In order to measure the volume and price changes separately the above formula needs to be decomposed, however it cannot be done uniquely. The volume change with the price remaining same in both periods can be observed either in the price of the base period or of the current period. It also applies to the price changes, so it results in two mutually reciprocal sets of quantity and price indices as shown below.

Change of output	Quantity index	Price index		
$\frac{V_t}{V_0}$	$= \frac{\sum p_0 q_t}{\sum p_0 q_0}$	$\times \frac{\sum p_t q_t}{\sum p_0 q_t}$	(3)	
<i>or</i>				

$$\frac{V_t}{V_0} = \frac{\sum p_t q_t}{\sum p_t q_0} \times \frac{\sum p_t q_0}{\sum p_0 q_0} \quad (4)$$

18. In both types of quantity index the value of production is compared with price remaining unchanged. Further expansion of above indices shows that the quantity index of formulae (3) results in weighted arithmetic mean of quantity relatives (better known as Laspeyres quantity index denoted by L_q), whereas that of formula (4) is weighted harmonic mean of quantity relatives (better known as Paasche quantity index - P_q).

$$L_q = \frac{\sum p_0 q_t}{\sum p_0 q_0} = \frac{\sum p_0 q_0 \frac{q_t}{q_0}}{\sum p_0 q_0} = \sum \left(\frac{q_t}{q_0} \right) w_0 \times 100 \quad (5)$$

$$P_q = \frac{\sum p_t q_t}{\sum p_t q_0} = \frac{\sum p_t q_t}{\sum p_t q_t \frac{q_0}{q_t}} = \sum \left(\frac{1}{q_0/q_t} \right) w_t \times 100 \quad (6)$$

19. Laspeyres index is weighted with the base period value, while Paasche with the current period, which qualifies Laspeyres index as 'backward looking' and Paasche index as 'forward looking'. When both the quantity and price change are measured by one type of index such as Laspeyres quantity and Laspeyres price the index fails the factor reversal test and the product of two does not result in value ratio shown in formula 2:

$$\frac{V_t}{V_0} \neq \frac{\sum q_t p_0}{\sum q_0 p_0} \times \frac{\sum q_0 p_t}{\sum q_0 p_0}. \text{ It is also true for Paasche method, however the}$$

former is common in practice due to the problems related to weight. Many countries construct the production and producers' price indices with the weights derived from a benchmark survey results. When the current price production values are available, it is possible to compute the Paasche index. Existing recommendations for production index recognise that the most appropriate way would be to calculate both type of indices and assess the difference between them.

20. Laspeyres index as an arithmetic mean normally tends to increase the volume changes more than the Paasche index (harmonic mean). The important of this aspect is that these indices provide upper and lower boundaries of the theoretical index. When two sets of indices are not far apart Fisher's ideal index can be obtained by taking their geometric average, which passes both the factor and time reversal test.

$$F_q = \sqrt{\frac{\sum q_t p_t}{\sum q_0 p_t} \times \frac{\sum q_t p_0}{\sum q_0 p_0}} \quad (7)$$

However, if the current period weight is the major practical problem, data demand for Fisher index is even higher, as it requires both Laspeyres and Paasche indices calculated. In recent years, one more symmetric index namely Törnqvist quantity index, has been commonly recommended for production index, which is a geometric mean of the quantity relatives with the arithmetic mean of the weights involved.

$$T_q = \Pi \left(\frac{q_t}{q_o} \right)^{\frac{w_o + w_t}{2}} \quad (8)$$

Although, a symmetric index provides more precise measure of the volume change than Laspeyres or Paasche index, it is true only when the divergence of these two indices, as already mentioned above, is not so great.

21. Some countries have adopted the chain Laspeyres method for production index, which greatly reduces the above-mentioned divergence in annual indices. Series of base weighted Laspeyres appears as;

$$\frac{\sum p_0 q_1}{\sum p_0 q_0}, \frac{\sum p_0 q_2}{\sum p_0 q_0} \dots \dots \frac{\sum p_0 q_n}{\sum p_0 q_0} \text{ where } t = \overline{1 \dots n} \quad (9)$$

Using the formula (5), it can be presented as;

$$\sum \left(\frac{q_1}{q_o} \right)_{w_0}, \sum \left(\frac{q_2}{q_o} \right)_{w_0} \dots \dots \sum \left(\frac{q_n}{q_o} \right)_{w_0}$$

While chained Laspeyres connects the series with the changed weights:

$$\frac{\sum p_0 q_1}{\sum p_0 q_0}, \frac{\sum p_1 q_2}{\sum p_1 q_1} \dots \dots \frac{\sum p_{n-1} q_n}{\sum p_{n-1} q_{n-1}} \quad (10)$$

To see the change of weight, it can be presented as;

$$\sum \left(\frac{q_1}{q_0} \right)^{w_0}, \sum \left(\frac{q_2}{q_1} \right)^{w_1} \dots \dots \sum \left(\frac{q_n}{q_{n-1}} \right)^{w_{n-1}}$$

22. Experts favouring the chained Laspeyres index argue that when weights are constantly updated the index better reflects the changing structure of industry. It is especially important for fast growing economy, where new industry and products are coming all the time. Introduction of new establishment or new product to index is troublesome for fixed base weighted index, while for chained index those are automatically incorporated. The chained Laspeyres index requires the annual update of weight. Annual industrial surveys are regularly conducted in many countries, while others possess the other data sources for updating weights. Therefore, the chained Laspeyres index would not be the problem solely for the reason of data availability.

23. When economic growth is significant between two, not consecutive, periods, the chained Laspeyres index better reveals the intermediate conditions of the volume and price changes. However, chained Laspeyres method cannot produce the expected results in certain economic situations. The method is suitable only to economy with a smooth growth during the entire period $\overline{1 \dots n}$ covered by the index. If the rules of choosing a base year are strictly followed, a direct Laspeyres index produces quite reliable measures of growth in compare to a normal year for economy. However, some experts have argued that chained Laspeyres might drift over normal Laspeyres during the time of fluctuation and its divergence might go further apart. It is important to note here that the issue of fluctuations is often raised when chained Laspeyres is examined from the price movement side. The quantity changes are less likely to fluctuate in the same manner as price. Therefore, the concern over drift of chained Laspeyres index could have been exaggerated as far as the quantity indices are concerned.

24. IIP-50 had no mention of chained Laspeyres index. However, many countries have switched to chained Laspeyres method. Materials on their experiences could be used in forthcoming publication with description of merits and demerits of both type of indices. It is not possible to prescribe a

single method for all situations, countries could decide on an appropriate method based on the prevailing economic situations and growth patterns. In general, fixed base weight Laspeyres index would still be preferable for monthly indices, weights cannot be changed every month. For the annual indices different options could be considered.

V. Weights

25. Much of the recommendations of IIP-50 on weighting procedure especially with regard to Laspeyres base weighted method serve as the departure point for further discussion on weights. Weights play key role in compilation of indices. Quantity relatives computed separately for homogenous goods or services are aggregated to the different level using the weights as shown in formula 5 and 6. Whichever method we apply Laspeyres (normal or chained), Paasche and subsequent symmetric indices, the stage of weighting procedure is essential.

26. Existing manual and guidelines have sufficiently described the importance of weight with the value added as recommended variable. However, IIP-50 is based on the concept of the "Census value added". Although, it has described the procedure to derive the net output from CVA, it concluded that in relative terms these two values do not make much difference so could equally be accepted for weights. In the process of the revision of IRIS-83, the "Census value added" is not regarded as a concept consistent to SNA. IIP-50 has also raised some questions on depreciation but left it open to the choice of countries. In the recent experience countries take value added net of the difference of applicable taxes and subsidies (value added at basic prices or at factor cost) but not net of depreciation.

27. Current recommendations on production index are mainly based on the Laspeyres fixed base weight method. In this context, greater emphasise is given to attain the precise baseline information for weights. IIP-50 stressed that the base year for comparison and weight reference year must be the same. It was not recommended to compute the weights from monthly data, it was rather suggested to use a three-year weight base centred on the year selected as the standard weight base. Normally, a five-yearly review period was thought sufficient for weights. Uniformity of the weight base year among the countries might be an advantage for international comparison, but its practical difficulties are obvious. The chained Laspeyres method provides sufficient flexibility in synchronizing the weight base year among the countries, because weights are updated regularly.

28. Both the Laspeyres and Paasche method discussed in the paper are based on a representative set of selected goods and services for which quantity relatives can be computed and indices can be constructed. When the sampling approach is followed representation of commodities for production index is achieved through PPS method of selection. In economic approach, how far the index is representative is measured by the share of selected commodities in total value of production. What is the desired level of representation for production index in terms of the value added? Existing recommendations require more than two-third of value added. However, this question can be answered only in relative terms. First of all, selected products for production index cannot be separated from establishments, higher share of selected commodities in index would lead to the larger number of establishments required for observation. In ISIC groups with the large number of establishments, it is not always possible or not even necessary to achieve that level. In other sectors, where few establishments account for a larger part of the production, establishments in sample index might cover quite high share. Therefore, it would be more appropriate to define a range rather than a single value, say the percentage of coverage should be within the range [1/3, 2/3] of value added at 4-digit ISIC level. The percentage could also be applicable only to industries above the cut-off point designated for the establishment survey.

29. There is no specific recommendations from IIP-50 with regard to an appropriate ISIC level for initial computation of value added share for weight, but many countries use 4-digit level of ISIC rev-3. Further, weights are distributed to products. Value added data are not available for products, but the sector rate of value added can be used for this purpose. Hence the product value added would be;

$$\text{Product value added} = \text{Quantity of product} \times \text{basic price} \times \text{VA rate of product}$$

$$\text{Value added rate of sector} = \frac{\text{Value added of ISIC group}}{\text{Output of ISIC group}}$$

Since the value added rate of the ISIC group is applied to all products (i.e. as an approximation of VA rate of product for each product produced by the ISIC group under consideration), the sum of the value added of all

products so applied is equal to the value added of the ISIC group. However, the census or survey might not provide the production data in such details, in such case a significant amount of value added remains as residual for unspecified or not adequately classified goods and services.

30. Alternatively, ISIC 4-digit weights could be distributed to establishments selected on the basis of their share to sector value added or by sampling using PPS to value added. PPS method allows to designate a threshold above which establishments are selected with certainty. For this purpose, establishments in the list are arranged in the descending order of the size measure (value added) and the cumulative value of the size measure is given in an extra column. In the list, a serial number (j) is located that satisfies the following condition.

$$m_j \geq \frac{M - M_j}{n - j} \geq m_{j+1} \quad (11)$$

Where,

- m_j and m_{j+1} value added of j -th and $j+1$ -th establishment in the list
- M and M_j total value added and cumulative value added for j -th establishment
- n sample size

All units up to j are selected with certainty, while other units (the number of units to be sampled equals $n - j$) are selected with PPS. ISIC 4-digit weight is distributed to establishments so selected in proportion to their value added contribution. Establishment weight is further distributed to selected products, but in this case establishment rate of value added can be applied to obtain the product value added, in an analogous way as in paragraph 29 where ISIC group rate of value added is applied for the value added rate of products produced by that ISIC group.

31. Weighting procedure can be different for chained Laspeyres index, when weights are changed every year. Annual survey results might not be as comprehensive as periodic census data and weights might simply be updated without going for major changes in structure. One of the main advantages of chain Laspeyres is that new establishment or product can be

timely introduced to the index. However, there must be sufficient justification of inclusion of new products. In today's rapid technological change not every new product lasts long. For instance, when the mobile telephone became easily accessible pagers disappeared from the market quickly and its operation lasted in some countries much less than 5 years. From the experiences of the countries already producing chained Laspeyres indices it would be necessary to describe the most likely situations when the new establishment and product should be introduced to the annual update of weights.

VI. Compilation of production indices

32. While the basic formula and weights can be decided in advance index compilation deals with the day-to-day problems encountered in practice. These problems vary depending on the index method applied, organization of data collection and processing and long-term comparison of index series and various other issues. A number of general problems that could be addressed in the production index manual are given below.

A. Measurement problems

33. Ideally, production index should measure the change of the 'work done' in production units. Let v be the value of a single product made in a production unit from a single material, then the value of work done in the unit is given by;

$$v = pq - \pi m \quad (12)$$

where, p and q price and quantity of goods produced
 π and m price and quantity of materials consumed

Hence, Laspeyres quantity index would appear as;

$$L_q = \frac{\sum p_0 q_t - \sum \pi_0 m_t}{\sum p_0 q_0 - \sum \pi_0 m_0} \quad (13)$$

This index shows the actual growth of value added at the base period prices of output and materials. It can also be shown at the current period prices to construct the Paasche quantity index.

$$P_q = \frac{\sum p_t q_t - \sum \pi_t m_t}{\sum p_t q_0 - \sum \pi_t m_0} \quad (14)$$

34. However, there are difficulties of such measurement. There is no one-to-one correspondence of input and output. Amount spent for goods and services in input side such as fuel, electricity, water, repair and maintenance and different kind of non-industrial services are common expenditures of producing unit and can be calculated only at the establishment level.

Therefore, production index calculated as weighted average of the quantity relatives shows the growth of output not of value added. In a normal economic condition, we can assume that changes both in output and input sides are proportionate and index constructed from output correctly reflects the change in value added. This assumption can hold also for input side. In case, when output cannot be quantified or cannot be considered as appropriate to show the value added growth, it is possible to use the input (material or labour) change as a production index.

35. The main defect of this assumption for both output and input series is that indices so constructed entirely ignores the productivity changes. Although, output series are often preferred to those based on input, it is not proven that the productivity distortion in input series is higher than in output series. Some experts have recommended the productivity adjustments of input series indices to derive more precise growth estimates. Importance of the productivity measure, especially of the labour productivity was mentioned also in IIP-50. If the productivity adjustment is made input series can produce highly reliable production indices and it is especially important for service sector where products cannot be easily quantified in many cases.

36. A single type of series based on one particular type of indicator cannot be recommended for all activities. While output based indices are suitable to most of the manufacturing activities, other activities might require different approach. For example in construction activities, the final product might take several years to materialise and the volume of work done in short periods of time, say in months or quarters, cannot be expressed in production quantities. Similar problems might arise also in some manufacturing activities such as shipbuilding and aircraft manufacturing. In such cases, 'volume of work done' might be replaced by the 'cost of work done'. Or the input indicator could be compiled from the change in labour input or material input in different situations. It might be necessary to list the type of goods and services for which material or labour input would be

more appropriate for index compilation. Such recommendations can be made based upon national and regional experiences.

37. Measurement problems can arise due to the quality differences even if the quantity units are obvious. The price range of some industrial goods is very wide thanks to the latest technological development. The producer may shift from one type of products to another for relative advantage, thus the decline in production quantity of a particular product quality does not necessarily mean the negative growth in overall production. In the example given below the volume of production increased by 2% even though production quantity decreased in the current period.

Production of mobile sets in two periods

	p_0	q_0	q_1	p_0q_0	p_0q_1
Type A	100	40	28	4000	2800
Type B	200	30	37	6000	7400
Total		70	65	10000	10200
		Quantity change		Volume change	
		100.00	92.86	100.00	102.00

Even though the number of mobile sets produced in a particular period seems to be an additive value simple aggregation would be misleading due to the quality difference. In practice, it is often difficult to monitor because new qualities are emerging all the time thereby affecting the reliability of indices. This example illustrates that changes in output measured as changes in physical units do not ultimately reflect correctly the quantum (volume) growth of the work done. Quote from para. 16.12 of SNA 1993: “It is not legitimate to add together quantities that are not identical with each other, even though they may be measured in the same kinds of physical units”.

38. When the production index is defined as the volume change, the price becomes the determinant of quality of a good regardless of its physical characteristics. The same goods with the same physical characteristics might possess different qualities in different times and locations. More complications arise in index compilation when the quality of the same type of a good or a service changes not only in the course of a longer period, but also more frequently, even within a day. For example, many countries

differentiate the rate of electricity supply or the rate of telephone calls to normal and peak hours. However, data are not always available for different rates, as the respondents tend to combine. From the combined data say for electricity, we could get only unit value index which would not yield the volume index.

B. Data collection

39. Existing guidelines including IIP-50 recommended to produce production index every month, however quarterly indices are also common in many countries. IIP-50 stated that primary index should be on the basis of production per working week, in order to eliminate the effect of the varying length of months and varying number of weekends per month. Compilation and dissemination of indices is still recommended for monthly basis. Monthly or quarterly data collection programme has its own pros and cons. Monthly indices better reveal the production trend providing more space for analysis of any fluctuations. However, monthly programme significantly increases the respondent's burden and often the rate of non-response is higher too. It also depends on the capacity of national statistical offices. Even with the increased automation capacity, data collection and data editing occupy significant time of statistical staffs. Monthly indices would be meaningful if produced without significant time lag, i.e. within the next month. If the national statistical offices lack such capacity then indices are produced either in rush or with significant time lag and in both cases there would be compromise with the reliability of indices. In such case, quarterly indices would be more preferable, as it gives sufficient flexibility of time for index compilation. However, effects of current market condition, seasonal changes and other factors on production are often diluted when the production volume is summed up for a quarter.

40. Technological progress has allowed new methods of data collection. Several countries have gained some experiences of web-based surveys for industrial statistics. Handy tools for data entry like PDA also reduce the cost and time of data entry thereby control the errors on time. Whenever, such

facilities as well as technical and human capacities are available, monthly survey would certainly be preferable.

C. Introduction of seasonal new products and production units

41. Production index method under consideration is of the basket type series and the important point to note is that, for many economies the emergence of new products or new production units is a usual phenomenon that makes the basket quickly outdated. Will it be possible to introduce the new product that is not in the original basket? Introduction of new products would mean to include a new elementary index in the system. When the weight structure has a layer for the establishment, its weight can be redistributed to product weights by introducing a new product or replacing the existing one. It would not affect the structure of the indices, because at the higher stage indices are compiled from elementary indices as: $I = i_q \cdot w$.

42. Similarly, products/qualities losing the significance for the index of industrial production can be removed or replaced within the establishment. The effects of such movements on the reliability of the overall index are limited and proportionate to the weight assigned to the establishment. At the same time, it is necessary to distinguish the permanent and temporary disappearance of a product or quality. This phenomenon is less visible in production as compared to consumer price observations. However, production of highly seasonal goods may decline, subsequently stop and reappear after some time, while production of some other goods and services might be stopped permanently. Replacement or introduction of new goods is associated with one more problem related to continuity of indices. Replacement in some cases can be adjusted using some ratio to link the index of 'old' and 'new' products. Often there might not be any comparable product in the past, which complicates index construction. Theoretically, the regression method allows the calculation of an estimate for the value of the past period, but it is difficult to explain such assumptions to the users at large. Therefore, it does not seem practical to change or replace the goods and services in the basket more frequently than once per year.

43. A different sort of problem is encountered when a new establishment has to be introduced. It requires the redistribution of establishments' weights within the pertaining industry to derive the weight for the new establishment. An arbitrary decision to include a new establishment would undermine the coherent structure of weights. When the information for the redistribution of weights, for the establishments of the industry within which the new establishment belongs is available, then a statistician might prefer to compute the new weight structure rather than changing for one or few establishments. When the list of establishments and product basket are updated annually or even biannually, problems pertaining to introduction of new products and establishments are less relevant. It is a clear advantage of the Laspeyres chained index method.

D. Non-response and missing data

44. Non-response is a problem of any survey, however, in the frequent inquiries such as monthly or quarterly, it is compounded with the limited time for follow-up calls/visits to non-respondents. General recommendations concerning non-responses in economic surveys exist in various UN publications and statistical literature. The manual on production index will have to focus on types of non-responses and specific methods of treatment for non-responses in index compilation procedure. For the purpose of index compilation, it is imperative that the response is obtained in successive occasions and failure of obtaining the data in any one of two periods prevent the computation of elementary indices.

45. When data are missing for any item in the list quantity relatives cannot be computed. There are different solutions applied to this problem:

Carry forward: figures for earlier period are copied to the current assuming no change during these periods.

Imputed growth: production change of one unit is estimated from other units producing similar products.

Matched cases: Aggregated index is computed only from those items for which data were reported in both periods.

It is necessary to distinguish the non-response from non-existence of products or producing units. Data might be missing not necessarily because of non-response. Product data might go missing temporarily or permanently. When the data are temporarily missing, it could also be a seasonal effect. However, when data are not reported for relatively longer period, it could well be the case that the particular product is not produced any more and the necessary changes should be made in the basket.

E. Rebasing and linking the index series

46. Existing guidelines have not adequately covered the methods and procedures to be followed for rebasing and linking of the production index series. IIP-50 recommended base weighted Laspeyres method with a fixed reference year and base weights for that reference year. The base weights are updated every five years. Recently published PPI and CPI manuals can also serve as reference materials wherever a common approach is applicable. Most of the other publications on the topic are also primarily focused on price specific questions and specialised methodological papers on quantity indices are relatively limited.

47. New index series are started with changed weights for which a link with the old series is essential in order to obtain a long-term comparative index series. Rebasing and linking exercises are involved even if the weights are updated every year. Since it is not possible to change the weight every month, the short-term series (monthly or quarterly) will still be calculated according to Laspeyres method with fixed weights of the base (previous) year. At the end of the year, index series are re-weighted and rebased. For this purpose, monthly index series are ‘annualised’ for which different methods exist. A simple chronological average of monthly indices can be applied when the growth is evenly distributed throughout the year

$$L_q^{CA} = \frac{\frac{1}{2}m_1 + m_2 + m_3 + \dots + m_{11} + \frac{1}{2}m_{12}}{11} \quad (12)$$

However, when the production varies from month to month, annual average could be a weighted average from monthly indices. In the example of

Laspeyres index, we weight the monthly weighted index of formula (5) with the share of monthly production s_m .

$$L^{WA}_q = \sum_{m=1}^{12} \sum_{i=1}^n \left(\frac{q_{t+1}}{q_t} \right)_i w_i \cdot s_m$$

Once the current year data are available annual indices can be calculated for Paasche and Fisher. Special attention should be paid when monthly indices are affected by seasonal fluctuation. The standard procedure in this case is to take the average of indices over the year i.e. the current month is compared not to previous month but to the same month of the previous year. Annual indices so obtained might be different from the one computed directly by comparing annual production values and deflated by PPI.

48. For long term comparisons two index series (with old and new weights) are chained into a single series through a link factor, which is the ratio of two series for a specified period.

$$\text{Link factor} = \frac{\text{Index (past series)}}{\text{Index (new series)}}$$

In the example below, link factor is calculated for overlapping month of December 2004. To continue the series with base period January 2002 index of new series with weights of 2004 are multiplied by link factor, while to keep the base period Dec 2004, past index series are divided by the link factor.

	Weight 02	Jan 02	Nov 04	Dec 04	Weight 04	Dec 04	Link factor	Jan 05
A	0.1703	100.00	119.78	120.73	0.1845	100.00	1.21	101.03
B	0.1297	100.00	127.65	128.10	0.1155	100.00	1.28	100.28
Aggregate	0.3000	100.00	123.18	123.92	0.3000	100.00	1.24	100.74
	Linking forward				Linking back			
	Jan 02	Nov 04	Dec 04	Jan 05	Jan 02	Nov 04	Dec 04	Jan 05
A	100.00	119.78	120.73	121.97	82.829	99.213	100.00	101.03
B	100.00	127.65	128.10	128.46	78.064	99.649	100.00	100.28
Aggregate	100.00	123.18	123.92	124.84	80.697	99.403	100.00	100.74

49. Issues related to rebasing, chaining and linking of index series would need more detail discussions with a chapter in the upcoming publication. IIP-50 recommended one year overlapping period when weights are to be

changed for starting new index series, which might not be necessary when chained method is applied.

50. This paper has only raised this issue in a basic form. Existing manuals of different type of price indices provide sufficient base materials to formulate a set of methodological recommendations specifically to production indices.

VII. International Comparison

51. This very important part of the production index methodology is described here briefly. Much attention in IIP-50 was given to international comparison of production index. For the sake of international comparison, it was recommended 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 same yearthe Statistical Commission of the United Nations should be asked to make a definite recommendation on change of weight base for individual countries to follow”.

52. In the experience of UNIDO, which uses the production indices of countries to estimate the growth and structure of MVA, comparability of production indices has been a challenging issue. The production index of countries varies by the basket of products, by the reference year of weights and by the methods used to compile the indices. Eurostat also has experience of compiling internationally comparable production indices. This paper does not aim to elaborate the international comparability issues except of mentioning that the new publication will have to address this problem based on the recent experiences of international statistics.

Annex 1: An overview of existing recommendations and questions under discussions

Major Topics	Existing recommendations	New questions	Remarks
Scope and coverage	Non-agricultural commodities: Mining Manufacturing Electricity, gas and water Construction	Agriculture, Fishing Service industries	Extension to other goods-producing activities could use the same methodology Extension to service-producing industries requires new guidance on volume measures for services
	Coverage refers to a cut-off point designated for exclusion of smaller establishment but no precise cut-off point is recommended	A cut-off point based on: - Employment, such as 10 or more persons engaged - Legal status, such as incorporated or unincorporated	Scope of recommendations of industrial statistics and the cut-off point for economic surveys is being discussed under the revision of IRIS; should be consistent with that recommendation
Basic method	Fixed base weight Laspeyres method	Different methods for monthly and annual indices: - Normal Laspeyres for monthly indices - Chained Laspeyres for annual indices - Paasche method when current year weights are available	Can the same format satisfy countries' needs and the needs for international comparison and aggregation?

Major Topics	Existing recommendations	New questions	Remarks
Weight variable	Net output	Value added net of indirect taxes plus subsidies	Different methods of valuation for countries with and without value added tax.
	Census value added at factor cost also accepted		Concept of CVA is being revised
Lowest weight and aggregation level	Census Industry	ISIC rev.3 / rev.4 at four digit	ISIC rev-3 itself is being revised. The manual should refer to ISIC rev-4
Product classification	Not specified	CPC	To what extent should product detail be reflected in the manual?
Distribution of weights	Not specified	At single stage: From ISIC group to products At two stages: From ISIC group to establishments and to products thereafter	How are secondary products allocated?

Major Topics	Existing recommendations	New questions	Remarks
Updating the weights	Every 5 years	<p>Conceptual questions on diversion of actual indices from theoretical over time</p> <p>Practical problems pertaining to new products/qualities and production units</p>	
Compilation of indices	<p>Three series are recognised</p> <ul style="list-style-type: none"> - Output; production quantity - Input; consumption quantity (materials, energy etc.) - Labour; man-hours worked <p>No specific recommendations for service sectors</p>	<p>Can series be made sector or product specific</p> <p>For input series, can indices be adjusted with productivity change (especially with labour productivity index)</p> <p>Measurement units for service industry products</p> <p>Calculation method</p> <ul style="list-style-type: none"> - Direct quantum relatives - Deflated by PPI 	<p>Two broad categories of services under discussion:</p> <ul style="list-style-type: none"> - Services provided by industrial sectors (C, D, E, F of ISIC rev-3) - Services provided by tertiary sectors

Major Topics	Existing recommendations	New questions	Remarks
Rebasing and linking index series	<p>One year overlapping period when weights are to be changed</p> <p>No detail descriptions for 'annualising' monthly indices</p>	<p>For chained Laspeyres overlapping period could be shorter</p> <p>For normal series</p> <p>For seasonal adjustments</p>	<p>Superlative indices: (Fisher or Törnqvist), when data are available for weights for base and current periods and series should be linked</p>

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