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SURVEY OF METHODS USED IN THE CONSTRUCTION  
OF PRICE AND QUANTITY INDEXES

(Memorandum prepared by the Secretary-General)

I. Introduction

1. At its seventh session the Statistical Commission recommended that the Secretary-General should continue to study methods of measuring national product and expenditure in constant prices, including a description of methods used by various governments and an examination of the relationship between commodity and other conventional index numbers and the value flows of a system of national accounts. The Commission requested that the Secretary-General should consult with countries on these questions, and submit a progress report to the next session of the Statistical Commission (E/2365).

2. The Statistical Office in 1950 published a report, "Index Numbers of Industrial Production"<sup>1/</sup> which referred to some aspects of this work. In addition, the Statistical Office has for some years collected and examined the available official and semi-official national income estimates in constant prices. These estimates have been published in National Income Statistics of Various Countries, 1938-1947 and 1938-1948: in each issue of Statistics of National Income and Expenditure, Statistical Papers, Series H; in the Statistical Yearbook; and periodically in the Monthly Bulletin of Statistics. Statistical Papers, Series H, No. 5 contains current estimates

<sup>1/</sup> Studies in Methods, No. 1, New York, 15 September 1950.

in constant prices for approximately 30 countries, supported by brief notes on the sources, concepts, methods of estimation and base years employed.

3. The Statistical Office has noted an increase during the last year in the number of countries which produce real income or product data. There are, however, important differences among countries in the emphasis placed upon this work, and therefore in the detail and precision of the estimates. For example, some countries produce simply a single series of the national income or product total in constant prices, useful as an approximate measure of economic growth; on the other hand, the most advanced studies contain detailed component series in constant prices of both national expenditure and the industrial origin of domestic product, which are useful for many purposes of analysis and policy-making. Besides these differences in the scope of the various national studies, there is some diversity in the accounting concepts, classifications and terminology which have been adopted.

4. The Statistical Office has periodically described the scope and methods of the constant price studies carried out by governments in the various publications mentioned in para. 2 above. A further comparative study is made in a later section of this paper (Part II). This study examines some of the alternative uses, accounting structures, classifications and methods of measurement which govern the national estimates in constant prices; extensive references to detailed problems of accounting theory have been omitted. The material given in Part II reveals a process of development in constant price studies which corresponds with that characterizing the development of national income estimates in current prices. The initial work is often concerned primarily with deflation of an aggregate product or expenditure figure. Subsequently, component series are separately expressed in constant prices, and finally the components of a number of distinct but related aggregates are presented within an accounting framework. This section of the paper is followed by a brief description (in Part III) of the uses in national income deflation of conventional price and quantity indexes, and a reference to some of the shortcomings of these indexes for national accounting purposes.

## II. Description of Various National Estimates in Constant Prices

### The uses of accounts in constant prices

5. The intended uses of the national accounts in constant prices have considerable bearing upon the concepts employed and the form of the accounts, as well as upon the detail and accuracy required in the estimates. In several of the 30 countries which prepare constant price estimates, this question of the uses of the data has been discussed in the national income publications or in supporting papers.

6. The major uses listed in these publications include the measurement of the overall rate of economic growth or development and the rate of growth of particular industries, the analysis of inflationary and deflationary processes within an economy, the measurement or indication of changes in welfare and levels of living, and various uses concerned with economic planning. The recent emphasis on the use of monetary policy in a number of countries lends additional importance to price and quantity series in dealing with questions of economic policy. Among other countries, Canada and the United States have referred to the value of price and quantity indexes relating to the main expenditure flows in studying inflationary forces. Colombia, Finland and the USSR have noted the uses of constant price data in measuring rates of economic growth or development; similarly, Burma finds these estimates useful in providing evidence of the economy's recovery from "war and insurrection". Burma also uses certain constant price series to provide an indication of changes in welfare, and Poland to measure changes in levels of living. A number of countries including Canada and the USSR relate constant price data and man-hours worked or other employment series to derive a measure of productivity. Other measures based on these studies include those of changes in the terms of trade and real capital formation. It may be added that the organization of statistical research can often be improved by bringing price and quantity indexes, productivity and other measures within a general accounting framework.

The accounting framework

7. The national accounts in constant prices of the various countries engaged in these studies differ markedly in the amount of detail presented. There is, on the other hand, a considerable measure of uniformity in the conceptual approach underlying the more elaborate estimates. Eight countries show a deflated aggregate figure with little supporting detail; seven countries give detailed expenditure series, and five countries give detailed industrial product series. In addition, Austria, Norway, the United Kingdom and Western Germany produce detailed and co-ordinated expenditure and industrial product series, Puerto Rico gives a limited breakdown of both income shares and expenditure, and there are net material product series available for six countries.

8. In those studies concerned primarily with a total figure, the aggregate most often presented is that of national income. Cuba, Southern Rhodesia, Spain and Turkey have presented official estimates of national income in constant prices. In Turkey the products of agriculture, industry and "all other" sectors, and net income from abroad have been separately deflated; Spain has measured the increases in real income since 1929 by applying a combined index of gross agricultural, mineral and industrial production to the 1929 figures. Cuba and South Rhodesia have used respectively a cost of living index and an index of consumer prices to deflate the current value series. The aggregate of net national product at market prices has been estimated in real terms in Peru, Switzerland and the Union of South Africa by deflating the current value series by a cost of living index in Peru and Switzerland and by a retail price index in the Union of South Africa. Gross national product at market prices has been presented as an aggregate in constant prices by Colombia.

9. Of those countries which have carried out more extensive studies, Belgium, Canada, Guatemala, Japan, Netherlands, Sweden and the United States have produced both totals and deflated component series of expenditure on gross national product at market prices. Some countries including the Netherlands have also estimated or derived certain adjusting items in constant prices, and have shown a number of related aggregates in addition to that listed above. From the industrial product side, Finland and Mexico have

obtained figures of real net domestic product at factor cost by using volume indexes for separate industrial groups or by deflating by suitable price indexes. Denmark and Greece have employed similar methods to estimate gross domestic product at factor cost, and Burma to estimate this aggregate at market prices. Net material product series in constant prices have been computed by Bulgaria, Czechoslovakia, Hungary, Poland, the USSR, and Yugoslavia, on the basis of detailed industry analyses.

10. Austria, Norway, the United Kingdom and Western Germany have estimated real domestic product by using both an industrial product approach and an expenditure approach. In their industrial product estimates these countries have deflated the contribution to domestic product of individual industries by employing price and quantity indexes, employment series and other means. From the expenditure side, they have sub-classified the principal expenditure flows in considerable detail, and have deflated these series usually by price or quantity indexes. The components in constant prices of several distinct aggregates may be shown in these studies. For example, Norway has adopted the concept of net domestic product at market prices both for the product and expenditure approaches, but in addition has given real depreciation estimates by major industry groups. The United Kingdom has shown breakdowns of both gross domestic product and expenditure on gross domestic product at factor cost, and in addition an expenditure breakdown and a product aggregate at market prices.

11. The more general adoption in current value estimates of the accounts and classifications set out in the United Nations report, A System of National Accounts and Supporting Tables<sup>2/</sup> may be expected to contribute also to greater uniformity in constant price estimates. In particular, Account 1 (Domestic product), and Tables I and II (Expenditure on gross national product and Industrial origin of gross domestic product at factor cost) of the report might govern the presentation of product and expenditure studies in constant prices.

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<sup>2/</sup> Studies in Methods, Series F, No. 2, New York 1953.

Industrial and expenditure classifications

12. As suggested by the foregoing sections, there is a growing number of countries which publish industrial and expenditure breakdowns of product or expenditure aggregates in constant prices. Those classifications which have been prepared and the classifications recommended for current value studies in the report cited above correspond fairly closely in most cases.

13. An expenditure classification has been published by several countries including Canada, Netherlands, Norway, the United Kingdom, the United States and Western Germany. In general, the detail given in these classifications beyond a division into personal and general government consumption expenditure, capital formation, imports and exports has not been extensive. In the case of Norway, however, detailed sub-divisions in constant prices of personal consumption expenditure and gross and net domestic fixed capital formation have been made available. These data could readily be re-classified to conform in most respects with the detailed classifications recommended for current value studies in the report. The estimates of Western Germany also include a classification of personal consumption expenditure which is broadly comparable with that of the report.

14. On the production side, several countries have provided a classification of the industrial origin of domestic product. Austria, Denmark, Finland, Greece, Mexico, Norway, the United Kingdom and Western Germany have published industrial breakdowns of real domestic product in from eight to twenty-seven industry groupings, which agree reasonably well with the 'major group' and certain 'group' classes of the United Nations International Standard Industrial Classification of All Economic Activities. The most detailed classification given is that of Greece, which appears to have been based wholly upon the I.S.I.C. recommendations. As with some of the estimates of expenditure in constant prices, greater detail of classification would be shown by the work sheets supporting certain of these studies. In Eastern European countries including Czechoslovakia, Poland and USSR, where extensive use is made for planning and other purposes of production data in constant prices, industrial classifications in considerable detail are prepared.

Methods of estimation

15. Detailed methods of estimating national income in constant prices, so far employed by relatively few countries, may be classified broadly into the industrial product method and the expenditure method. Deflation of the various income shares presents some intractable problems and has been undertaken in official studies in only one or two instances. The principle governing these studies should be the valuation of the quantities of goods or services in each expenditure and production flow in the prices of a common base year. In practice, the use in this work of commodity and other conventional indexes with varied base years, devised initially for other purposes, may require some compromise in this regard. This question is discussed further in Part III.

16. Several countries including Canada, Norway, the United Kingdom and the United States have produced constant price series of the components of final expenditure. Three principal methods of deflating the components of final expenditure may be distinguished: deflation by appropriate retail, capital goods, etc. price indexes; the use of quantity indexes; and deflation by price indexes relating to the materials and labour input of industries producing consumer and capital goods.

17. In deflating by price indexes, the practice has been wherever possible to construct price indexes of narrow coverage to deflate comparable expenditure series, but on occasion expenditure classes have been combined into broad flows and deflated by more general indexes. In some cases, especially in deflating series of expenditure on fixed capital formation, price indexes relating to the materials and labour input of certain industries have been employed to deflate expenditure on the products of these industries. This method avoids some of the statistical problems caused by significant short term changes in product specifications, but, unless special adjustments are made, it involves an assumption of constant profit margins and productivity in the producing industry. The problems arising out of changes in product specifications and price sampling have generally been clearly recognized, and sometimes more or less arbitrary solutions have been adopted to minimize their seriousness.

18. The deflation of the expenditure series in some detail has emphasized a number of special problems which may be concealed in a more aggregative approach. These problems include those concerned with the deflation of additions to stocks of raw materials and finished goods, government expenditure, and foreign transactions. The method used for deflation of additions to stocks has usually been determined by reference to the stock accounting practices of the country in question. For example, in Canada business stocks have been classified by industries and each group deflated separately by price indexes appropriate to the contents of stocks, the stock turnover periods, and the predominant method of stock accounting. Changes in farm stocks have been measured in physical terms. Government expenditure on wages and salaries has usually been deflated by wage and salary indexes; this method involves an assumption of constant productivity of government employees. The deflation of government purchases of goods and services has required adaptation to particular central and local government accounting practices. Exports and imports have usually been expressed separately in constant prices, rather than on a net basis, to permit explicit treatment of the adjustment for changes in the terms of trade. Other problems arise in connexion with items such as tourists' expenditure abroad, which in at least one case was deflated by an index composed of appropriately weighted components of foreign consumer prices, adjusted for changes in exchange rates.

19. Countries including Burma, Mexico, Norway and the United Kingdom which have produced estimates in constant prices by the industrial product approach have employed a variety of methods. This approach requires the measurement of the values added in individual industries in base year prices, and their summation to give the domestic product in constant prices. Theoretically, the input and output of goods and services of each industry in the business sector should be separately deflated, and real input deducted from real output to give real product. In practice, it has been assumed in many cases that movements in the real output of an industry are representative of movements in real product (value added). The United Kingdom has referred in its official national income publications to some of the qualifications



attaching to this assumption. In other cases, changes in the input of an industry have been taken to represent changes in the industry's product, which again requires an assumption of constancy in the real input-output ratio of the industry.

20. In measuring the output of an industry in constant prices, appropriately weighted quantity series have often been selected. Measurement of the real output of the manufacturing, mining and construction industries in the United Kingdom has been based upon the data provided in the index of industrial production of that country. In Burma, the products of agriculture (excluding livestock) and forestry have been estimated in real terms by extending the "values added" in the base year by indexes of the physical volume of crop and timber production. An alternative to this method is found in the deflation of the gross production of an industry by appropriate price indexes.

21. The problem of defining the unit of output offers some special difficulties in dealing with the various service industries. In the United Kingdom the products of the transport, government administration and other service sectors are reduced to constant prices by relying in general upon indexes of the quantity of services performed. Changes in the volume of goods distributed are used to indicate changes in the services of retail distribution, and the real product of some insurance and medical services is measured by the number of beneficiaries. The changes in output of government administration are measured by deflating wage and other expenditure series by price indexes.

22. From the input side, deflated value series or selected quantity series may again be used to represent real input. Alternatively, changes in input series such as those of employment may be employed to indicate changes in the real value added of an industry. The use of employment series unadjusted for productivity changes would, however, obscure some of the changes in an economy which real term studies are intended to measure.

### III. Commodity and Other Conventional Index Numbers

23. Some reference has already been made to certain of the uses in national income deflation of conventional price and quantity indexes. This term is intended to refer to the group of customary indexes such as retail and wholesale price indexes which have been defined without reference to the product or expenditure flows of a national accounting system. The use in the short term of certain price and quantity indexes of this order in national income deflation may represent a necessary economy. In the long term, given the intention to prepare detailed constant price production and expenditure data, economy and consistency in statistical work might be assisted by defining the coverage of certain of these indexes to correspond with the related national income flows. It would be necessary in addition to adopt common weighting formulae for the various indexes. In this connexion, it may be noted that the question of a sector approach to the problem of wholesale price statistics was discussed in a memorandum (E/CN.3/144 and E/CN.3/144/Add.1) which was considered by the Statistical Commission at its seventh session, and at the Third European Conference of Regional Statisticians, document E/CN.3/Conf.3/1. (See also E/CN.3/175).

24. In many of the constant price estimates concerned only with total income or product series, referred to in para. 8, conventional price indexes such as cost of living and retail price indexes, and quantity indexes relating to industrial gross production have been employed to deflate or extrapolate current value estimates. The use of these indexes for such purposes sometimes involves broad assumptions which imply a significant margin of error in the studies.

25. The more detailed estimates referred to in Part II were discussed under the headings of the industrial product and the expenditure approaches. In the product approach, deflation of the output (and where practicable the input) of particular industries by price indexes rather than by quantity series may sometimes represent the preferred method, for statistical reasons.

This deflation of inter-industry flows would be materially assisted by the availability of wholesale price indexes drawn up on a sector basis. It would be equally valuable if the classifications, principles of valuation and weighting formulae of quantity indexes, prepared to measure industrial output in real terms, were to show a similar correspondence with national accounting practices. For sectors such as government whose industrial product is computed simply by summing the wage and other factor payments, it would be useful if the scope and classification of wage indexes followed the same principle.

26. In deflating expenditure series an endeavour has generally been made in the more advanced estimates to deflate separately the detailed components of final expenditure. But in some instances available price indexes of wide coverage have been used to deflate composite expenditure flows. The shortcomings of this more general approach are twofold. First, the expenditure flows to which the general indexes apply are unlikely to correspond with expenditure flows such as personal consumption defined for national income purposes; and secondly, the base years and formulae of these indexes are unlikely to correspond with those adopted in other sections of the study. Again the use of such conventional indexes must rest on arbitrary assumptions involving a margin of error. The United States practice, in such cases, has been to decompose the available price indexes into price series for individual products, and where necessary to convert the index number to a new base period. By this means appropriate weighting procedures may be adopted.

27. As with the deflation of industrial product, work on the deflation of national expenditure would benefit from a wider adoption, in constructing consumer and retail price indexes and other indexes relating to final expenditure flows, of principles of classification and weighting derived from a study of national accounting concepts. (For some studies the retention of other classifications and weighting methods would no doubt be necessary). In turn, the adoption of a national accounting framework in the preparation of price and quantity indexes would assist the co-ordination of statistical effort in this field.

#### IV. Conclusions

28. The review of national estimates in constant prices undertaken in Part II of this paper reveals significant differences among countries in the emphasis placed upon this area of research. There are corresponding differences in the form and accuracy of the constant price estimates which have been published. A growing appreciation of the value of these studies for various purposes of economic analysis and policy making has also been noted. This appreciation is reflected in the increasing number of constant price estimates, and in the development found in both the conceptual and statistical phases of this work.

29. However, many problems remain to be solved. First, further examination is required of the uses that may be made of constant price data in analysis undertaken to assist in the determination of monetary and fiscal policy and for guidance on such matters as wage and foreign trade policy.

A clear formulation of the alternative uses of accounts in constant prices may in turn be expected to encourage further progress in the establishment of accounting forms and classifications. Of perhaps more significance than the question of form, this development would also contribute to the solution of problems concerned with the detail, accuracy and timing of the estimates, which have a direct bearing upon the methods of estimation adopted.

30. The Statistical Commission may therefore wish to recommend:

- (a) that the Secretary-General continue to collect and examine information from countries on current developments in the estimation of national income in constant prices;
- (b) that the Secretariat continue to examine the significant uses, forms and methods governing preparation of these estimates, with due attention to the major problems remaining in this work;
- (c) that the Statistical Office continue to collect and to publish periodically statistics of national income in constant prices and information on methods of estimation.