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PROBLEMS IN THE COLLECTION OF COMPARABLE WHOLESALE PRICE SERIES

(Memorandum by the Secretary-General)

TABLE OF CONTENTS

	<u>Page</u>
I. Introduction	2
II. Changes in Quality	3
A. Nature of the required adjustment in price series	3
B. Character of common differences in quality	5
C. Methods of estimating the economic worth of differences in quality	7
III. Unique Goods	15
A. The pricing problem	15
B. Price index numbers	16
C. Total cost or producer's asking price	16
IV. Discontinuities	17
A. The nature of the difficulty	17
B. Irregular discontinuities	18
C. Seasonal discontinuities	20
V. Seasonality	20
VI. Action by the Statistical Commission	21

ANNEX. Construction of Hedonic Price Index Numbers

PROBLEMS IN THE COLLECTION OF COMPARABLE WHOLESALE PRICE SERIES

(Memorandum by the Secretary-General)

I. INTRODUCTION

1. At the ninth session, the Statistical Commission decided to discuss, at its tenth session, the question of compiling comparable price series for goods which are highly fabricated or which are subject to marked changes in quality or supply, seasonally or otherwise. This question is considered in this paper with respect to (i) abrupt, as well as more gradual, changes in the characteristics of highly fabricated or other types of goods, (ii) unique goods, such as heavy machinery and buildings, (iii) discontinuities in transactions in commodities and (iv) seasonal variations in the supply of commodities. In each case, the difficulties encountered in compiling continuous series are described and the advantages and disadvantages of the alternative techniques which have been employed in making the price series comparable are discussed.
2. The difficulties of compiling comparable price series have, in recent years, increased as countries have extended the prices which they gather to highly fabricated as well as imported and exported goods and have sought to compute price statistics on individual commodities or particular flows of goods. Countries have also become more aware of this problem as they have developed, in order to gather comparable price data, more exact specifications for the varieties and circumstances of sale for which price series are to be collected.
3. As compared to price indexes of wider compass, considerably more distortion will be introduced into price series for individual commodities or particular flows of commodities by changes in the quality (e.g., economically significant characteristics, circumstances of sale) of any of the varieties priced, as well as by discontinuities or seasonal variations in the supply of any of these varieties. Extension of price series to highly fabricated goods has often raised serious problems with regard to the collection of comparable price series since not only are highly fabricated goods subject to greater and more frequent changes in characteristics than raw materials or semi-finished goods, but also it is more

difficult to measure the economic worth of changes in characteristics for highly fabricated commodities than for other types of goods. For heavy goods which are fabricated to order, such as large turbines, locomotives or buildings, the incomparabilities between different transactions become so great that direct comparisons in price are not feasible. Imports and exports of highly fabricated goods, as well as other types of commodities, are often intermittent, especially in the case of relatively small countries. It should be noted that discontinuities, as well as fluctuations over a year in the supply of agricultural commodities, have created difficulties in compiling comparable price data for some time.

II. CHANGES IN QUALITY

4. In order to discuss methods of adjusting price quotations for an item to a comparable basis when changes have occurred in its quality, it will be useful to define the nature of these adjustments and to describe the typical circumstances in which such adjustments are needed.

A. Nature of the Required Adjustment in Price Series

5. An adjustment for the economic worth of any change in the quality of an item being priced is required in the ratio of the price quotations gathered before and after the change in quality if this ratio is to measure the "pure" change in price.^{1/} The adjustment for the economic worth of the change in quality, "g", is the quotient of the prices which would prevail for the two variants of the item (i.e., the one before the change in quality and the other after this change)

^{1/} This may be expressed symbolically as follows: $r_{12} = \frac{1}{g} \frac{p_{b2}}{p_{a1}}$ where

r_{12} is the relative for the "pure" change in price from period 1 to period 2
 $\frac{1}{g}$ is the measure of the economic worth of the change in quality of the item, which has occurred between period 1 and period 2; and p_{a1} and p_{b2} are the price quotations gathered before and after, respectively, the change in the quality of the item. A more convenient method, in practice, of expressing r_{12} may be:

$$r_{12} = \frac{\frac{p_{b2}}{g}}{p_{a1}}$$

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if each variant were sold at the same time in the same competitive but stable market. In order for the market to be considered stable, the two variants must have been on sale at the same time over a relatively extended period without marked changes in relative prices - i.e., one variant should not be driving the other off the market because of consumers' preferences or manufacturers' dictates.^{2/} Two variants of an item may differ in circumstances of sale or intrinsic physical or other characteristics.^{3/} It is important to note that such differences become differences in quality only if the two variants of the item would sell, at the same time, for different prices in the same stable market. In other words, differences between the two variants in characteristics or circumstances of sale which do not find expression in differences in market price are not differences in quality. Differences in characteristics or circumstances of sale which are correlated with differences in market price reflect, of course, differences in consumer preferences and/or conditions of supply.

6. The adjustment factor, "g", may be determined directly from available prices when the two variants of the item are, in fact, sold in the same market over a considerable period of time before the earlier variant, for which price quotations have been gathered, becomes unimportant or disappears. In other words, this is feasible when one variant is gradually replaced in the market by the other variant. The problem in this type of case is to decide at what point in the overlapping period of sale for the two variants, the prices for them should be compared in order to compute "g". It would seem most desirable to make this comparison when both the earlier and the later variant command a considerable part of the market for the item - for example, when roughly equivalent quantities of them are being sold. By that time the later variant will have been on the market

^{2/} The importance of this condition may be noted in the case of automobiles, where if the dictated change from an old to a new model, as well as the similarity of the situation to rationing, is ignored in comparing the actual prices at which the two models are sold at the time of change-over, a continual decline would be shown in the "pure" price of automobiles.

^{3/} In the latter case the two variants of the item are, in reality, different varieties of it.

long enough to be known and produced efficiently and the earlier variant will not have become too unimportant. In practice, however, the statistical authority may become aware of the situation much later in the process of replacement, and it may be difficult to gather all of the required price information for the period which is most appropriate for evaluating the adjustment factor, "g". It may, therefore, be useful to inquire into the practices of countries in this regard and the question of arrangements which might be made in order to detect the replacement of one variant of an item by another early in this process.

7. More commonly, the adjustment factor, "g", must be estimated because the shift from one to the other variant of the item occurs too rapidly. Estimating "g" in these circumstances consists of identifying the differences (e.g., in physical composition, components, style, performance or circumstances of sales) between the two variants of the item which would result in a difference in price if they were offered on the same market and assessing the amount of this difference in price from the magnitude of the economically significant differences in characteristics between the two variants. The facility with which this can be done depends, therefore, on the character and measurability in terms of market value of the differences between the two variants of the item.

B. Character of Common Differences in Quality

8. The adjustment factor, "g", is perhaps least difficult to estimate when the two variants of an item differ in magnitude in one or more physical characteristic. In some of these instances - for example, a change in the weight of a loaf of bread or a bar of chocolate or in the number of pages in a copy book - the relative value of the two variants may be taken to be directly proportional to the relative magnitude of the characteristic. Although this simple relationship between economic worth and the characteristic is unlikely to hold in other instances - for example, a change in the strength of beer, in the fat content of milk, in the number of threads per unit of length in a textile fabric or in the denier and gauge of nylon stockings, it should be feasible to establish the way in which value on the market does vary with the magnitude of the characteristic. This approach may also be practicable in the case of changes in magnitude in a component of a complex item - for example, the power of the motor in a vacuum cleaner.

9. In many instances the significant difference in physical characteristics between the two articles under comparison is easily ascertained but is not measurable. For example, the difference may consist of the substitution of one textile fibre for another in cloth, the way in which the textile fibre has been processed, a change in the chemical composition of a paint or plastic material or the replacement of bulk, unpasteurized milk by bottled, pasteurized milk. The difference may also relate to the composition of a component of an article - for example, the type of textile fibre in a dress or the material in the dustbag of a vacuum cleaner - or to the addition of a component or system to a highly fabricated item - for example, a radio or power steering to an automobile. In these cases it may still be feasible to establish, objectively, the relationship between value on the market and the difference between the two articles under comparison.

10. The adjustment factor, "g", is most difficult to evaluate in the case of changes in the general design of articles. Such changes are common for highly fabricated goods. It is very difficult to assess the economic worth of a change in the design of an article because of the complication of isolating the economically significant differences, if any, between the two variants and the lack of information for purposes of determining the market value of these differences. A number of changes in design will be introduced for the sake of novelty or fashion and may not result in significant differences in utility to the purchaser or cost to the supplier. Illustrations of such changes in design are provided by alterations in dresses, in the packaging of processed foods, or in the appearance of automobiles or radios. Other changes in design will be the consequence of technological and related developments and will result in significant differences in the utility and perhaps the cost of production of the article. Such changes in design often occur in durable consumer goods and industrial machinery. In a number of these instances it will be difficult to evaluate the change in performance of the article resulting from the change in design because of the immeasurability or radical nature of the change in its operating characteristics. An even greater obstacle to determining the worth of the change in the design of an article is likely to be the lack of information for establishing the relationship between the significant changes in the article and market value.

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11. The problems of assessing economic worth of changes in quality of items being priced are often aggravated by the practice of producers of linking together shifts in quality and "pure" price. For example, manufacturers of durable consumer goods may raise prices in association with modifications in design or other aspects of these articles and attribute the rise in prices entirely to these changes. Alternatively, manufacturers may keep prices constant and reduce the quality of their products in not too obvious ways if costs of production are rising slowly. During periods of general price decline, some manufacturers keep prices unchanged or lower them only slightly, over-emphasizing the increases in quality which they have introduced in their products.

12. It should be noted that changes in the quality of items for which price quotations are gathered, sometimes consist of revisions in circumstances of sale rather than changes in intrinsic characteristics, such as described above. For example, a respondent manufacturer may shift his sales of industrial machinery from wholesalers of this equipment to users of it or of other goods from domestic to foreign customers. Or, the size of lots or definition and number of grades in which sales are made may be changed.

C. Methods of Estimating the Economic Worth of Differences in Quality

13. In practice, three major alternatives are utilized in determining the adjustment, "g", when a change occurs in the intrinsic characteristics or circumstances of sale of an item which is being priced. Most frequently, "g" is set equal either to unity (i.e., no economic value is assigned to the change in the item) or to the ratio of the price quotations of the two variants of the item. In other words, common use is made of either substitution or splicing, respectively, of price quotations. In other instances estimates of "g", which fall between the two extremes, are made. These estimates usually involve assessment, based on consultations with the trade and exercise of judgement by the statistical authority, of the market value or the cost of production of the differences in characteristics or circumstances of sale between the two variants of the item. Alternatively, a hedonic index might be computed in order to estimate "g". In the cost-of-production approach, instead of estimating "g", the "pure" change in price may be determined directly by costing a constant model.

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(a) Substitution and Splicing

14. Substitution or splicing is often the soundest method of dealing with changes in the characteristics or circumstances of sale of an item which is being priced. This is of course the case when, from the available facts, it is apparent that one or the other approach is theoretically correct. It is also so when more exact estimates of "g" are too difficult or costly to make and the available information suggests that the more exact estimate would approximate the result of substitution or splicing. Splicing may also be the only practicable method of reaching comparability between successive price quotations because it is almost impossible to gather the information required for an alternative estimate of "g". However, there is a danger of misusing substitution or splicing because of the convenience of either one of these approaches.

15. Substitution is often and appropriately utilized when a change in an item is trivial (e.g., an alteration in the colour of a fountain pen) or involves an appeal to fashion (e.g., a shift in the styling of a class of dresses, hats, automobiles or radios). Changes in "luxury" articles are frequently of this character. Such alterations rarely involve changes in the economic worth of articles, and are sometimes even circular - i.e., a model becomes fashionable again some years after it has been discarded. Substitution also seems suitable in the case of minor improvements in the composition or performance of an item which is linked with an increase in price of the same magnitude as the rise in "pure" price for related articles. On the other hand, substitution is not appropriate when measurable changes occur in the make-up or operating characteristics of articles.

16. Splicing is most appropriate, theoretically, in dealing with price quotations for two variants of an item for which periods of sale overlap in the manner which was discussed earlier in this paper. It is also suitable in case of the abrupt replacement of one variant by another if it is judged that the difference in price between the two variants approximates the market value of the difference in quality between them, especially when "pure" changes in price are not taking place for related items. Splicing may be the only practicable method of attaining comparability when it is necessary to relate price quotations, for two articles, one of them new in the market, which differ markedly in operating

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or other significant characteristics. This is so because of the difficulty, if not impossibility, of measuring the differences between the two articles and assessing the economic value of these differences. Illustrations of such cases are the substantial changes which often occur in the design of industrial machinery, the replacement of radios by television sets, or the substitution in apparel of nylon, dacron or other artificial fibres for natural fibres. An important consideration in these instances is to introduce into the series the price quotations for the new article only after sufficient time has been allowed for efficient production and marketing. At the same time, in this use of splicing, as well as in other instances, care should be taken to make the interval of time between the price quotations for the new and predecessor article as short as possible. For the same reasons as for price quotations for new items, splicing is often used in dealing with the substitution in imports or even exports of one item by another, particularly in countries whose external trade is not diversified.

(b) Judging the magnitude of "g"

17. Judgement by the statistical authority of the relative economic worth of two variants of an item sometimes results in a value for the adjustment factor, "g", different from unity or the ratio of the price quotations for them. Such evaluations of "g" are likely to contain significant errors unless they involve a directly observable, simple relationship between market value and the difference in quality - for example, the market value of a difference in the weight of bread or in the textile fibre of cloth or of the addition of a simple component to a consumer durable good. This is the case because judgements of the value of "g" would probably be based on relatively sketchy, unsystematic study of the market or consultation with the trade in order to determine the variation in market value with the attributes under consideration. Therefore, if the relationship between market value and the difference in quality is not simple in character or if substitution or splicing does not seem appropriate, it may be best to turn to one of the more objective methods of evaluating "g" which are described below.

(c) Hedonic index

18. The hedonic index is an estimate of "g" arrived at, in general, by valuing two variants of an item (e.g., before and after a change in quality) in terms of

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the value which would, on the same market, be imputed to each of their significant measurable attributes. For any particular comparison of this kind, the task of estimating the hedonic index can be narrowed to determining the value which would, when either the old or the successor variant of the item was on sale, be imputed to the difference in the significant measurable characteristics between them - e.g., the difference in horsepower of the motor between two varieties of a particular kind of automobile. The value imputed to each of the characteristics under consideration is estimated from an equation expressing market price as a function of each of the attributes. The functional relationship is derived from data on market price and the magnitude of each attribute for varieties of the commodity actually on sale at the same time as either of the two variants being compared. It should be noted that, in general, the results obtained will differ, more or less, with the time selected and that account might be taken of both periods of time and perhaps additional periods by treating time as one of the variables in the price regression. This would also have the advantage of adding to the number of available observations for determining the functional relationship between market price and the attributes.^{4/}

19. Estimation of "g" by means of the hedonic method may, in selected situations, prove advantageous despite the relative costliness of the method. When differences in price between two variants of a commodity reflect differences in the magnitude of attributes (e.g., weight, composition, operating characteristics) which were exhibited by varieties actually on sale, the hedonic technique is an objective and systematic way of evaluating the market value of these differences in quality. The method furnishes, for example, measures of the extent to which the differences in price are accounted for by the selected characteristics. If the regression of price on the attributes is linear and if only a few attributes are under consideration, the difficulties and cost of estimating parameters of the regressor should not be excessive. It should be noted, however, that data would be required on market prices and characteristics for a number of varieties of the commodity, preferably over a short period of time. The shorter the period of time involved, the more likely will the assumption, fundamental to the hedonic as well as other methods of evaluating "g", hold true; namely that consumer

^{4/} See Annex I for a more detailed discussion of the hedonic index.

preferences and conditions of supply for the varieties have not changed materially.^{5/}

20. The hedonic technique has been applied in the case of the price of automobiles and of fruits and vegetables.^{6/} It seems particularly practicable to use the method in dealing with changes in a few significant measurable attributes of an article - for example, changes in the strength of beer or the denier and gauge of nylon stockings. The hedonic method of estimating "g" should also be appropriate in the case of changes which are not too marked in the operating characteristics of mass produced, industrial machinery (e.g., lathes or electric motors) or consumer goods (e.g., household appliances). Experimentation on this score would be valuable.

(d) Cost or supply price data

21. In order to evaluate "g", instead of estimating the relative market value of the two varieties (one before and the other after the change in quality) of a commodity, the relative cost or producer's asking price of the two varieties has often been determined. The use of this approach to evaluating "g" is based on the assumption that relative costs or producer's asking price are proportional to relative market values. The relative cost of the two variants of an article might be estimated from an index of the relative volume of inputs of materials and labour into them or from the cost or producer's asking price of the difference in components, materials, etc. between them. Alternatively, the "pure" change in price for the article between the time of marketing the former and successor variety of the commodity might be determined from a price index of inputs of material, labour, etc. or by pricing a constant model of the article. These methods of measuring the "pure" change in price will be covered under the discussion of the pricing of unique goods, as the methods are most commonly used in that connexion. It should be noted, however, that these measures of the "pure" change in price have been used in dealing with the pricing of commodities, such as women's dresses, which are subject to frequent changes in characteristics.

^{5/} For example, for the effect of the supply position on the price differentials between different varieties of some vegetables see: F.V. Waugh, Quality as a Determinant of Vegetable Prices, Columbia University Press, New York, 1929.

^{6/} For examples, see: A.T. Court, "Hedonic Price Indexes", The Dynamics of Automobile Demands, General Motors Corporation, New York, 1938 and Mordecai Ezekiel, Methods of Correlative Analysis, Wiley and Company, New York, 1940, Chapter 22.

22. In constructing a price-weighted index of the relative volume of inputs per unit for two varieties of a commodity, the inputs which it is practicable to include are the materials consumed and the labour directly involved in manufacturing them. This is a consequence of the difficulties of measuring and allocating quantities for overhead and related costs. Ignoring overhead and related costs should not significantly limit the usefulness of indexes of the relative volume of inputs as long as indirect costs are approximately proportional to direct costs or small relative to direct costs. It should be noted that this may not be so in the case of a very marked difference in character or design between the succeeding article and the one replaced by it because substantial developmental and re-tooling costs may be incurred in producing the new article and considerable advertising expense may be involved in marketing it. Perhaps a more common problem in constructing these indexes is whether the time to which they are to relate, with regard to both quantities and prices of materials and labour, should be when the old variety of the commodity was being produced or when its successor was being made. The value of the volume index of inputs will differ significantly with the period of reference chosen if there has been a marked change, between the time of production of the former variety and its successor, in the relative prices or efficiency of use of the different materials consumed in the production of either variety or in the wage rates or efficiency of the different occupations involved in producing either variety. In view of this, it is important that the interval of time between the use in price series of price quotations for the old variety and its successor be kept as short as possible. If, despite this precaution, the index numbers for the two periods of reference still differ substantially, a geometric average of the two indexes would seem to be the best theoretical estimate of "g". However, at best, computation of the volume index of inputs for only one of the two periods of reference - either before or after the change in quality - is likely to be practicable.

23. In place of a volume index of direct inputs, an estimate of the relative total cost or producer's asking price for the old and successor variety of a commodity might be utilized in evaluating "g". In this approach to estimating the relative cost of the two varieties, it should be feasible, although difficult, to include overhead costs and other additions to direct costs, such

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as expected profits, which enter into setting the producer's asking price. The difficulties would arise out of the differences between producers in the way in which they assess the overhead and related burden and allocate it to individual products. As in the case of the volume index of direct inputs, it will generally be practicable to obtain an estimate of the relative total cost or producer's asking price for only one time - either when the old or the successor variety was being produced - although there may be a marked difference in the estimate between the two periods. It should be noted that the task of determining the relative total cost or producer's asking price of two varieties may be reduced to estimating the difference between them in total cost or producer's asking price attributable to the difference between them in characteristics, such as components, material, processing, etc. This is a common approach to evaluating "g" from cost data.

24. As noted above, the evaluation of "g" from cost data is based on the assumption that the relative cost or producer's asking price for two variants of a commodity would be proportional to the relative market price for them. This assumption will hold when the market for the article is stable. It is likely to be true in the case of industrial machinery and equipment, for which market prices do closely reflect costs of production, and even in the case of consumer goods, provided producers are not replacing the former variety of the article because they can realize a higher margin of profit on the succeeding variety. Producers could realize a higher margin of profit if the market for the commodity were not competitive and if the successor variety were cheaper to produce than the former variety (e.g., because of the use of different materials, processes, etc.) but, despite this, the preferences of consumers for the successor variety were not significantly less than for the former variety. In many of the changes encountered in the quality of priced articles, the correspondence between relative unit cost and relative market price is likely to be close enough so that the cost approach to evaluating "g" may be utilized. In cases involving abrupt changes in quality which are not measurable (e.g., differences in type or finish of material) or widespread alterations in design or composition (e.g., of industrial machinery or consumer durable goods), the cost approach is the sole objective way of evaluating "g". This method of determining "g" may also be less costly than the hedonic technique.

25. Estimates of relative cost or producer's asking price have often been utilized by statistical authorities in evaluating the economic worth of the addition of individual components or systems to complex articles (e.g., a heater, radio or power steering to a line of automobiles) or of changes in the design and characteristics of mass-produced industrial machinery and equipment or consumer durable goods. Utilizing cost data in evaluating "g" requires extensive co-operation from important producers of the varieties of the commodity under consideration. In a number of instances estimates of the relative total cost or price for the two varieties have been furnished directly by one or a few producers who have not made systematic calculations from primary data for this purpose. In evaluating "g" from cost data, it is desirable that the statistical authority decide whether use is to be made of a volume index of direct inputs or relative total cost or producer's asking price, and calculate the measure chosen from detailed data gathered from key producers. This would ensure meaningful, unbiased and representative results but would necessitate detailed knowledge of the market, methods of production and accounting records for the article under consideration, as well as willingness on the part of key producers to supply the data. If it is not feasible for the statistical authority to do the calculations, the authority should at least come to agreement with respondents as to the methods to be utilized for this purpose and be able to examine the source materials used and the computations made. Whether a volume index of direct inputs or relative total cost for the two varieties under consideration should be computed will depend, to a great extent, on the nature of the detailed data that are available. Although it is desirable to take account of overhead and other additions to direct costs, as in an estimate of relative total cost or producer's asking price, data may be readily available only for computing a volume index of direct inputs.

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III. UNIQUE GOODS

A. The Pricing Problem

26. The differences between successive transactions in individual kinds of heavy goods, such as particular types of large turbines, ships, railroad rolling stock, dredges, buildings or construction projects, are so great that meaningful and comparable price data cannot be derived directly from information on these transactions. Both the characteristics and dimensions of the piece of heavy machinery or construction project and the circumstances of sale involved in successive transactions are generally incomparable. Each piece of machinery or construction project is generally completed to order, according to a particular set of specifications, and each contract usually extends over a considerable period of time and contains particular guarantees, terms of payment, perhaps escalator clauses and other special provisions. Moreover, long periods of time may elapse between successive contracts for a particular type of heavy goods. In view of the inability to gather price data on heavy goods directly from transactions in those commodities, countries have utilized a number of alternatives to include heavy goods in their indexes of prices. In some instances it has been implicitly assumed that prices for heavy machinery varied in the same way as the over-all index computed from price quotations for most other important commodities. In a number of instances, it has been decided to utilize the fluctuation of price relatives or indexes of cognate items or groups as indicators of the fluctuation in the price of heavy machinery or construction project - for example, small, mass-produced electric motors for large, order-made electric motors; mass-produced metal products for heavy machinery in general; or building raw materials for construction. This has been accomplished by adding the weight in the index of heavy goods to the weight of the cognate item or group for them. Because of the lack of suitable cognate items or groups, as well as the questioning of the assumptions underlying the use of this method, in other instances, specified models for important kinds of heavy machinery or construction projects have been priced. The pricing has consisted of computing a price index of direct inputs for the model or gathering information on the total cost or producer's asking price for the model. In this section of the paper, these methods of pricing are discussed.

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B. Price Index Numbers

27. Index numbers of the prices of the principal raw materials consumed and the labour directly employed have been utilized to measure price trends for construction projects and, to a lesser extent, for other types of heavy goods. These indexes are generally weighted in terms of the estimated quantity of each kind of raw material that would have been consumed and labour that would have been employed in producing model pieces of construction or machinery during a base year. The index numbers, therefore, do not reflect changes, from the base year, in the cost of the models resulting from changes in the productivity of labour, in the efficiency with which raw materials are utilized or in the types of raw materials consumed. The models for which the price indexes are computed may also become outdated and unrepresentative. These deficiencies in the price index numbers can be remedied by changing the base year of the index numbers. However, in view of the work involved in defining the models and in computing the associated price and volume data for raw materials and labour, it is not practicable to make frequent changes in the base year. It should also be noted that these index numbers do not take account of changes in cost which reflect variations in overhead charges or profit margins.

28. Price index numbers of direct inputs may be useful measures of price fluctuations for construction projects. Changes in technology in this industry are not too frequent and the variation in market values probably reflects closely the fluctuation in direct costs. Price index numbers of direct inputs are probably less suitable measures of price movements for other heavy goods than for construction projects. Although the correlation between market value and total cost is high, technological changes are much more frequent in the production of heavy machinery than in the construction industry and overhead, such as research and development and advertising, may make up a larger share of total costs in the former than the latter industries.

C. Total Cost or Producer's Asking Price

29. In the case of heavy machinery or transport equipment, some countries have sought information on the movement in prices by periodically (e.g., every quarter

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or month) gathering data on total costs or producer's asking price for representative models. For example, the Netherlands and United Kingdom utilize this approach for ships and the United States employs it for lifts. The data which are sought on total cost or producer's asking price for the models of pieces of heavy machinery or transport equipment reflect the changes in the value of transactions in or bids made for these items resulting from changes in the productivity of labour, the efficiency with which materials are utilized or in other aspects of the technology of production. Drastic shifts in design might be taken account of by changing the models priced and linking the successor model to its predecessor. The data sought on total cost or producer's asking price should not only include overhead and profits, but also should reflect the overhead and profit margins included in current bids or transactions. In view of the dominance of the costs of key producers in determining the market value of heavy goods, data on total cost or producer's asking price for models should measure the fluctuations in value of actual transactions in these commodities.

30. As was noted earlier, collection of reliable data on the total cost or producer's asking price for complex goods requires extensive co-operation from key producers of these goods as well as knowledge on the part of the statistic authority of the market and production and accounting records for these goods. To furnish the required information, the producer must have an excellent system of cost accounting. He should also be willing to reveal the methods and records from which he arrives at the data provided, and the statistical authority should be in a position to evaluate his methods and records. Although key producers of each kind of heavy machinery or transport equipment are likely to have the records required for costing, it may not be easy to obtain their detailed co-operation in this.

IV. DISCONTINUITIES

A. The Nature of the Difficulty

31. In contrast to a change in quality where, in effect, the sale of an item being priced is permanently discontinued, in the case of discontinuities in price quotations, an item being priced disappears from the market but is expected to be on sale again at some future time. Discontinuities in the sale of items may be unforeseen and irregular or may follow seasonal or other regular

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patterns in the supply or demand for them. The suspension of imports of an article being priced because of a special quota or duty involves an irregular discontinuity in price quotations. The bunching of sales of fertilizers or summer clothing during particular seasons of the year results in seasonal discontinuities in price quotations for these commodities. Most of the difficulties arising out of discontinuities in price quotations are due to the fact that first excluding and then including the type of quotation in a price index or relative, results in showing unreal changes in price in either of these indicators if the weight of the involved item in the price index or relative is not negligible. Methods, therefore, are needed for dealing with discontinuities in price quotations so that the price indexes or relatives into which they enter will portray the real short-run fluctuations, as well as long-run relationships, in prices. It should be noted that difficulties are greater if the discontinued price quotation is utilized to compute a price average as arrangements must be made to show the real level as well as the real movements of prices.

B. Irregular Discontinuities

32. The method of dealing with an irregular discontinuity in price quotations which is most appropriate depends, to a great extent, on the relative importance of the price quotations in the price indexes or relatives in which they are used and the past relationships in price between the item which is temporarily not on sale and other items for which price quotations are included in the price statistics. If the temporarily discontinued price quotations have negligible weights in the indexes or relatives or if they have shown little fluctuation in the past, it is appropriate to drop the price quotations temporarily from the indexes or relatives or, better, to carry forward the last available price quotation. The second alternative is easier to effect and is less likely to result in illusory changes in the indexes or relatives because of, firstly, the exclusion and, then, the inclusion of the discontinuous price quotation. The latter is particularly the case if the discontinued price quotations are utilized in computing price averages.

33. When the foregoing conditions do not hold, it has generally been necessary to include the item for which price quotations are temporarily unavailable in the price statistics, based on price quotations for a cognate item or group of

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items. If the item is one among a number of varieties of a commodity being priced, it is best to use for this purpose the price quotations for the variety with high correlation in the past to the discontinued variety in price fluctuations and level. If one variety is not to be preferred from this point of view, in computing price indexes or relatives, the movement in price for all of the varieties of the commodity which remain on sale might be imputed to the variety which is temporarily not on the market. If this procedure is followed in computing price averages, it would be essential to utilize the last price quotation for the temporarily discontinued variety, adjusted by the change in price for the cognate varieties. It should be noted that if the temporarily discontinued variety does not have negligible weight in the average price, the dangers of this procedure resulting in a misleading average price are great enough to stop publication of the average price series.

34. If the temporarily discontinued variety is the only one of a commodity being priced, it will be necessary to impute to it movements in price of a cognate commodity or even of the group of commodities of which it is part. The considerations in choosing the cognate commodity are similar to those in selecting a cognate variety. If a commodity meeting these specifications is not available or the difference has been considerable in the past in fluctuations in price between the discontinued variety and the group of commodities of which it is a part, it may be best to include in price indexes or relatives the last available price quotation for the temporarily discontinued variety. In any of the foregoing instances it is desirable to stop publication of average price series in which the temporarily discontinued item is included.

35. In any of the alternatives outlined above for dealing with irregular discontinuities in price quotations, again including in the price series the actual price quotation for the item when it reappears in the market, may result in a sharp illusory change from the immediately preceding periods in the price indexes or relatives and particularly the price averages in which the sum is included. This would be the case, for example, if the summation of the movements in price imputed to the item were materially different from the change in level of the price quotations for the item between the time of its disappearance and reappearance. In these circumstances the sharp unreal change

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in the price indexes or relatives might be eliminated by proportioning the change in the level of price quotations for the item over each month or other interval utilized in computation, of the period during which the item was not on sale.

In the case of an integrated system of price index numbers, this is a laborious procedure and it probably should not be carried out except where the reintroduction of the temporarily discontinued price quotations results in very marked distortion in published price data.

C. Seasonal Discontinuities

36. Problems and methods are similar in dealing with seasonal or other periodic discontinuities in price quotations as in dealing with irregular discontinuities in price quotations. In addition, in the case of seasonal discontinuities in price quotations, it is desirable to compile the price indexes, relatives or averages in which these quotations are used, to compare prices between one year and the next, either for the year as a whole or for the months during which the seasonal items are sold, as well as to show month-to-month or other current changes in price.

V. SEASONALITY

37. Although items which are priced may remain on sale throughout the year, as a result of seasonal variations in supply or demand, the price and quantity marketed of these articles may vary seasonally. A number of agricultural products are examples of such commodities. For some uses it may be desirable to eliminate the seasonal fluctuations in the price of these items or to vary seasonally the weights in price indexes or averages of these items in accordance with the amount of them marketed. Eliminating marked seasonal fluctuations in the price of items would, for instance, facilitate analysis of cyclical price movements. Price indexes or averages for which seasonal adjustments have been made in the weight of items which vary seasonally in the amount marketed, would be useful in deflating monthly or quarterly series on the value of sales or receipts.

38. There are, of course, accepted techniques for smoothing price series for individual commodities or groups of them in order to eliminate seasonal fluctuations. All of these techniques involve adjustments based on the seasonal

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pattern of the past, which may be somewhat erratic or change in the future. It is questionable whether seasonal adjustment of wholesale price series is warranted in view of these pitfalls and the work involved as well as the limited demand for such adjustment. It should be noted that no country is known to make seasonal adjustments in wholesale price data.

39. The need for adjusting the weight in indexes or averages of some kinds of commodities - for example, agricultural products - in accordance with seasonal variation in quantity marketed is probably greater than the need for eliminating the seasonal fluctuations in the price of commodities. Also, in theory, the former type of adjustment may be made much more accurately than the latter type of adjustment. However, it would be very difficult to obtain base-period data for purposes of weighting indexes or averages on a monthly or quarterly basis, even for agricultural products. Moreover, it is difficult to interpret month-to-month or quarter-to-quarter movements in price indexes or averages in which weights are varied on a month-to-month or quarter-to-quarter basis. Countries which have adopted variable weights within a year in price indexes - e.g., in cost-of-living index numbers - have often utilized the month or quarter in the base year corresponding to the current month or quarter as the comparison as well as weight base. Such index numbers do not reflect seasonal fluctuations but they cannot be utilized in making comparisons between different months or quarters. In view of the foregoing, except perhaps in price index numbers or averages compiled for special purposes, it is not desirable to utilize seasonally varying weights in wholesale price series.

VI. ACTION BY THE STATISTICAL COMMISSION

40. The Statistical Commission emphasized during its ninth session the importance of studying concepts and methods for dealing with the incomparabilities encountered in wholesale price series. The foregoing survey of the nature of such incomparabilities and the alternatives for dealing with each major type of incomparability suggests that it would be desirable and feasible to formulate guiding principles and indicate appropriate techniques for adjusting series of price quotations for changes in quality and discontinuities and for pricing

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unique goods. For this purpose an exchange of experience and consultations among countries and some experimentation are needed. The Statistical Commission may, therefore, wish:

- (i) To indicate any changes required in the substance of this paper on the nature and significance of incomparabilities in wholesale price series and on the relative advantages and disadvantages of the methods for dealing with these incomparabilities.
- (ii) To request the Secretary-General to circulate the paper, modified in the light of its discussion, in order to obtain the comments of Member Governments on the paper and descriptions of their practices and experiences in dealing with incomparabilities in wholesale price series and to elicit the co-operation of some Member Governments in experimenting with key techniques for adjusting for changes in quality and for pricing unique goods.
- (iii) To request the Secretary-General to continue his work in the field of wholesale price statistics with a view to the Commission considering at the eleventh session principles and appropriate methods for dealing with incomparabilities and related questions in the collection of wholesale price series for purposes of providing technical guidance in this field.

ANNEX

Construction of Hedonic Price Index Numbers

1. As indicated in the text of this paper, the computation of a hedonic price index number is based on the construction of a function relating the market price of each of the varieties of a commodity under consideration to selected measurable characteristics of each of them. This function may be computed for a time when the variety which has disappeared was on sale, when the variety which replaced it was on sale, or for a combination of these and even other periods of time. In the latter case, time, as well as the selected measurable characteristics, would be treated as an independent variable. If the functions relating to each of these periods of time differ markedly in parameters, the underlying conditions of demand and supply have probably changed materially between the time when the old variety was on sale and the time when the successor variety was on sale. Under these circumstances the use of the hedonic index is questionable.

2. The selected measurable characteristics may consist of engineering specifications, operating attributes or the characteristics of the materials utilized. The measurable characteristics chosen will probably be suggested by observation of the market and consultations with the trade. Whether the most appropriate characteristics have been chosen may be determined by the computation of multiple correlation coefficients or ratios or by an analysis of variance. Trial-and-error testing of different measurable attributes may be necessary in order to determine the most appropriate set of measurable characteristics to which to relate market prices. It would be most practicable to work with a linear function between market prices, or perhaps the log of market prices, and the selected measurable attributes. This may not give good results, and it may be necessary to turn to second or third degree functions. Again, trial-and error testing may be necessary. The parameters of the function chosen may, of course, be determined by the method of least squares.

