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COMPUTATION OF COST-OF-LIVING INDEXES IN DEVELOPING COUNTRIES

DEPARTMENT OF STATE

AGENCY FOR INTERNATIONAL DEVELOPMENT

COMMUNICATIONS RESOURCES DIVISION

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THE COMPUTATION OF COST OF LIVING INDEXES IN DEVELOPING COUNTRIES

prepared by

U.S. DEPARTMENT OF LABOR

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PREFACE

The purpose of this manual is to serve as a guide for statisticians, particularly those in developing countries, who are beginning to develop a statistical series of cost-of-living indexes or who are revising or improving an existing series.

Today, most countries recognize the importance of a cost-of-living index even though their available resources may be small and their experience in statistics slight. This manual is intended in just such a situation to enable the person in charge of compiling these indexes to carry out the work economically and with confidence that he is using practicable and valid methods.

The procedures recommended have been developed on the basis of extensive experience with problems encountered in the developing countries. It is not the aim of this manual to present new techniques, but rather a systematic plan for organizing and setting up on a practical basis the operational procedures for computing the index.

This manual was prepared in the Bureau of Labor Statistics' Division of Foreign Labor Conditions, William C. Shelton, Chief. The first edition of this manual was written in 1957 jointly by Thomas F. Mosimann, Chief, Branch of International Technical Cooperation; and Marion H. Gillim, Associate Professor of Economics, Barnard College, Consultant. The present edition which contains minor revisions was the responsibility of Evelyn R. Kay.

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The Computation of Cost-of-Living Indexes in Developing Countries

Chapter 1. Introduction

Despite the complexity of the subject of cost-of-living indexes and the extensive literature in the field, the basic procedures used in most countries today are remarkably simple and uniform. This manual, therefore, will outline one carefully tested method. Occasionally, the experience and ingenuity of a statistician may enable him to introduce variations and modifications to suit the special circumstances in his particular country.

Although there is usually no lack of competent statisticians in national statistical offices, it is believed that practical guides dealing with operational and clerical aspects of statistics can be useful to these statisticians, particularly for instructing members of the statistician's staff, some of whom may not have had formal statistical training. With this purpose in mind, a final chapter is included which explains in elementary terms how the computations and the formula are related.

Schedules, worksheets, and practical details of calculation, which are presented here, have not been readily available to the student of index numbers. A good statistical library contains numerous volumes which give the formulas and characteristics of index numbers but which give little information on how data are collected and handled in a statistical office. The present manual should be considered as a step toward filling this need.

In the interest of brevity, the manual concentrates on one method of compiling the index. In explaining that method, full details are given as the analysis proceeds step by step. Back of this presentation of detail is the thought that the person who does not wish to have a given step spelled out so minutely can omit that section, but that the reader who wants a full description will find it. Not every question of every reader could be anticipated, but it is believed that every question that is answered will save some readers from wasteful trial and error procedures.

The presentation of the method used assumes that a cost-of-living index has been compiled for a single city in an imaginary country. The hypothetical index for this city, called Capital City, measures the changes in the prices of goods and services bought by workers' families.

This manual begins with the publication of the index for Capital City in a given period and traces the work on the index back through its calculation. Starting with the completed index and analyzing it in reverse chronological order has certain advantages. To the person inquiring into the construction of an already existing index, it is the logical approach to learn the origin of the figures successively until he has traced them back to their source. The order followed has advantages, also, that will help the person seeking instruction to compile an index in

that, as he comes to the description of each earlier step in the index, the usefulness of operations which otherwise might have been obscure or seemed to him unnecessary will already have been observed in the finished product. By studying the end product first, the person who later starts to make an index will anticipate the final steps more fully and be able to save himself much error and wasteful procedure in the early stages of his work.

The subject of the calculation of the index will be treated in the following. order: (1) The publication of the index, (2) the final computation of the index, (3) the calculation of "costs," (4) the calculation of price ratios, and (5) the formula. A uniform organization is followed in each chapter which includes an introductory paragraph, an exhibit or illustration, the definitions of technical terms introduced in that chapter, a series of comments on important features to be observed in the example presented, and finally a summary of the material covered in the chapter.

Since the present manual is limited to discussing methods of calculating the index, various other problems involved in the preparation of the index are beyond its scope. For example, the selection of the sample, the collection of prices, and the derivation of the weights are not covered.

Chapter 2. The Publication of the Index

The statistician responsible for compiling the cost-of-living index presents and interprets it to the public periodically. This is usually done in the form of a release to the press and the public. The regularity in publication of this release and the manner and form of its presentation are highly important in determining the public's attitude toward the index and the uses made of it. The style of the release and the emphasis given to different items will vary considerably depending on the needs of the country, the specific use for which the index is intended, and the actual price movements themselves.

The release shown on page 4 applies specifically to one city, Capital City. The style employed in writing this release is similar to that used in many countries, but the reader should not consider the exhibit as being in any way a rigid model. It will be necessary for each statistician in his own country to choose a style and form of presentation which seems most suitable to his own needs. The chief purpose of the exhibit is to illustrate the statistical content of a typical cost-of-living index release, and to show the kinds of information customarily presented in such releases.

Technical Terms Used in this Chapter

Cost-of-Living Index. An index number to measure changes from one period of time to another in average prices paid by a specified group of consumers for a given quantity and quality of goods and services is often called a cost-of-living index. The term, cost-of-living index, has meant different things to different persons. Sometimes, it has been wrongly interpreted as measuring a change in expenditures arising from a change in the conditions of living, including changes in the quantity and quality of goods and services bought. To avoid misunderstanding and to emphasize that the index measures the change in prices--not expenditures--some countries have substituted the term Consumer Price Index. This manual retains the better known and widely used term, cost-of-living index.

Market Basket. The cost-of-living index measures changes in the cost of a number of important consumer goods and services, which are selected to represent the living conditions of a specified group of consumers. The choice of those goods and services is frequently, but not always, made on the basis of a survey of expenditures of workers' families.

As nearly as possible, the same amount and quality of each item is used every time the index is calculated. The aggregation of these goods and services in the constant amounts and qualities sought for the index is often figuratively called a market basket. The index can be thought of as measuring the changes in the amount of money required to buy the contents of the market basket in successive periods of time. The concept of the market basket is an aid to popular understanding of the meaning of the index.

EXHIBIT

September 2, 1963

Central Statistical Office
Department of Labor Statistics
Capital City

Cost-of-Living Index for July 1963

This index measures the average change in the prices of a fixed "market basket" of goods and services bought by the wage earners in Capital City. The index is calculated quarterly.

Consumer prices in Capital City rose 0.7 percent between April 1963 and July 1963. The all-items index was 123.5 (1960=100) in July. The index of each of the four major categories--food, housing, clothing, and the miscellaneous group--increased over the 3-month period.

FOOD. The increase of 0.7 percent in the average retail prices of food was largely seasonal. The index of food prices as compared with 1960 continues to be the highest of the four component groups of the index.

HOUSING. Housing showed the smallest percent increase over the period, and its index has risen least since the base period. The lag in the price of housing is due largely to the control of rents by the Government.

CLOTHING. The greatest percent increase was in clothing which showed an average price rise of 3 percent. The increase in this group was in part attributable to a rise in the prices of cotton and wool in the domestic market.

MISCELLANEOUS. The index of the miscellaneous group rose by 0.5 percent. Within this group there are several subgroups. Slight decreases occurred in medical care and in reading and recreation; whereas increases occurred in transportation, personal care, and other goods and services. The higher street car fares since June caused the rise in transportation, and the new sales tax levied on cigarettes was responsible for the rise in the prices of other goods and services.

Cost-of-living index and percent change by commodity group (1960=100)

Commodity group	July 1963	April 1963	Percent change
All items	123.5	122.6	+ 0.7
Food	131.7	130.8	+ 0.7
Housing	105.2	105.1	+ 0.1
Clothing	122.2	118.6	+ 3.0
Miscellaneous	126.8	126.2	+ 0.5

Points of Change and Percent Change. The terms "points of change" and "percent change" in the index do not mean the same thing. The former is the difference between the indexes at two dates; the latter is the difference expressed as a percent of the index at the earlier of the two dates. For example, the rise in the index from 122.6 in April 1963 to 123.5 in July 1963 (see Exhibit) represents an increase of 0.9 points, or an increase of 0.7 percent. The increase of 0.9 points is the difference between 123.5 and 122.6, while the 0.9 points of increase is 0.7 percent of the index of 122.6 in April.

Group Index. The items included in the index are classified into four groups--food, housing, clothing, and miscellaneous--for each of which a separate index is calculated.

All-Items Index. The all-items index combines the four group indexes. The all-items index is not a simple average of the group indexes since the groups are of unequal importance. For example, a given percent change in the food index will affect the all-items index more than the same percent change in the clothing index because food items have greater importance in the market basket than clothing.

The Base Period (1960=100). This expression identifies the base period which in this example, is the year 1960. The index for the base period is 100. The July 1963 index of 123.5 means that, in July 1963, the price of the market basket was 23.5 percent greater than in 1960, or that, in July 1963, its price was 123.5 percent of what it had been in 1960.

The base period of an index is usually chosen in view of the particular purpose of the index and other factors peculiar to the country. For example, a year or period of years representing relatively normal business activity may be selected. At the start of an index, the first year may serve as the base until the index has been computed for several years.

Comments on Publication of the Index

Frequency of Publication. The agency preparing a cost-of-living index should plan to publish the index regularly and with reasonable promptness. Once the index has become established, it will be used by the public for many important purposes which will require its regular issuance, and any unusual delay may cause inconvenience and criticism. It is customary not to reveal the results of each period's computations prior to publication.

Many such indexes are calculated and published monthly, but it is generally more economical to prepare and publish the index quarterly or semiannually. The hypothetical index of Capital City presented in this book is assumed to be computed quarterly from the prices of January, April, July, and October and is published early in the second month following; namely, in March, June, September, and December.

Contents of the Release. As in the release for Capital City, the publication of the index ordinarily gives the following information:

1. The current group indexes and the all-items index.

2. The percent change from the index of the preceding period for each of the group indexes and for the all-items index.

3. An explanation of the price movements largely responsible for the change in each group index.

4. A statement of what the index is designed to measure. The social or economic groups to which the index refers should be mentioned.

5. (Sometimes published) The percent change from the preceding year's index for each of the group indexes and for the all-items index.

6. (Sometimes published) Average prices of food items; average prices of items in other groups are not commonly released.

Summary

The work of compiling an index for public use is not complete until it has been published and interpreted.

The index should be published regularly and promptly. Users of the index should know approximately when to expect its publication, and should have confidence that it will appear promptly. Both the all-items index and the group indexes should be published. The base year, the percent changes since the last publication, and an explanation of the most important changes should be shown.

The index should be described clearly. Users of the index should be able to explain to others the general concept of the index and what it measures. As in the release for Capital City, a statement describing what the index is should be included.

Chapter 3. Calculation of the Index

Chapter 2 presented an example of the published release showing the all-items cost-of-living index and the indexes of the four groups for July 1963. This chapter presents the final worksheet on which these indexes were calculated, and discusses the last stage of the computation and the relation between the group indexes and the all-items index. Subsequent chapters discuss the source of the data used in the worksheet and the nature and number of items included in each group of the index. The present chapter is restricted to an exposition of the calculation of the index, once the "costs" are at hand.

An Example

Calculation Worksheet I presents a convenient form for calculating and recording the index over a period of four quarters or one year.

Technical Terms Used in this Chapter

Calculation Worksheet. Calculation worksheets are forms prepared for carrying out computations. Each statistical office should devise forms best suited to its own needs and work facilities. The worksheets shown herein are intended to serve only as examples. Once a satisfactory form has been devised, the same form should be used every time the index is calculated. The use of a prescribed form assures that the index will be calculated in the same way each time. It also makes easier the task of preparing the instructions for both the computation and the verification of the results.

Costs. The cost of all-items is the sum of money required to buy all the goods and services making up the market basket. (See Calculation Worksheet I.) Similarly, the cost of any group of items is the sum required to buy that portion of the market basket. The all-items cost and the cost for each group (food, housing, clothing, and miscellaneous) are used to arrive at the final indexes.

Relative Importance of Components. The relative importance of any component item or group of the index is the cost of that item or group expressed as a percentage of the cost of all items in the market basket.

Relative Number. A ratio is sometimes known as a relative or a relative number. Thus, the ratio of the all-items cost for July 1963, $818.83, to the corresponding cost for April 1963, $812.81, if calculated, will be found to be 1.007. (See Calculation Worksheet I.) This manner of writing the relative is sometimes useful. An alternative way of writing this relative is 100.7 percent, and in many statistical texts this form is the accepted manner of writing relative numbers with or without the word "percent" explicitly stated.

Any index is a relative number in that it represents a certain ratio. For example, in computing the all-items index for Capital City in July 1963 the cost for July, $818.83, was divided by the cost for the base year, $662.81. The resulting ratio

was 1.235. Theoretically, the index for July could be expressed simply by this ratio in which case the base-period index would be 1.000. Universal practice, however, expresses indexes on a base of 100. Accordingly, the ratio 1.235 was multiplied by 100 to give the index number of 123.5 for July.

This procedure may be regarded as expressing the index as a percent of the base-year index.

Comments on Calculation and Analysis

Calculating the Index. The method followed in computing the index for Capital City calculates the index for a given date by comparing the cost of the market basket at that date with its cost in the base period.

The steps in the calculation of the index for July 1963 are illustrated on Calculation Worksheet I as follows (assuming that the indexes for January and April have already been computed):

1. The costs for the base year 1960 were listed in the first column on the left-hand side of the worksheet. Base-year costs are used in the calculation of every quarterly index.

2. The corresponding costs for July 1963 were entered in the column of that date under the heading "Cost."

3. The indexes listed under July were computed on Calculation Worksheet I as the quotient of the July costs and the corresponding base-year costs multiplied by 100. The computations were as follows:

All items.. $\frac{\$818.83}{\$662.81} \times 100 = 123.5$

Food..... $\frac{\$405.61}{\$308.03} \times 100 = 131.7$

Housing..... $\frac{\$162.58}{\$154.61} \times 100 = 105.2$

Clothing..... $\frac{\$\ 85.55}{\$\ 69.99} \times 100 = 122.2$

Miscellaneous. $\frac{\$165.09}{\$130.18} \times 100 = 126.8$

Every three months when a new index for Capital City is computed, the same steps will be followed. Only two columns will be used: the cost column for the current quarter and the cost column for the base year.

An Alternative Method. The same result could have been obtained each time the index was calculated by first computing the percent change in costs from the preceding quarter. The index for the preceding quarter would then have been increased or decreased by the percent change in costs.

For example, the all-items index in April 1963 was 122.6. The ratio of the July costs to the April costs would be computed as \$818.83 \$812.81 or 1.007. The July index, therefore, must be 0.7 percent greater than the April index:

122.6 x 1.007 = 123.5 (July Index)

A minor advantage which this alternative method for the final calculation of the index would have, over the method used on Calculation Worksheet I, is that it would be more uniform with other steps in the calculation of the index which will be described in chapter 4.

Cost-of-Living Index
Capital City

CALCULATION OF THE INDEX AND THE GROUP INDEXES

Year 1963 (1960=100)

	1960	January 1963		April 1963		July 1963		October 1963	
	Cost	Cost	Index	Cost	Index	Cost	Index	Cost	Index
All Items	$662.81	$810.44	122.3	$812.81	122.6	$818.83	123.5	$818.68	123.5
Food	308.03	402.74	130.7	403.01	130.8	405.61	131.7	406.02	131.8
Housing	154.61	162.56	105.1	162.55	105.1	162.58	105.2	162.51	105.1
Clothing	69.99	81.53	116.5	82.99	118.6	85.55	122.2	85.42	122.0
Miscellaneous	130.18	163.61	125.7	164.26	126.2	165.09	126.8	164.73	126.5

Calculation Worksheet I

A point to note concerning this method is that an arithmetic error, unless discovered and corrected, would be perpetuated in each succeeding index. The recommended method, used on Calculation Worksheet I, avoids this danger since the calculation of each quarterly index is based upon the base period, and each index is therefore computed, at this stage, independently of other quarterly indexes.

Analyzing Index Trends. The statistician not only must calculate the index but must analyze the changes in the all-items index in terms of the changes in the group indexes. This is essential for interpreting the all-items changes to the public.

It is important, then, to understand the relationship between the group indexes and the all-items index. The effect which a change in the cost of a group has on the all-items index depends on the size of the percent change in the cost of the group and the relative importance of the group.

Percent of Change in Cost of a Group. It is obvious that the effect of a group index on the all-items index depends to some extent on the percent of change in that group. For example, the percent change in housing from April to July was 0.1 percent. If this percent change had been larger, say 5.0 percent, the housing group would have had a greater effect on the all-items index.

Any unusually large percent of change in a group means that that group is having a greater than usual effect upon the all-items index. Such percent changes should be especially noted in analyzing the all-items index. The statistician should attempt to determine the economic explanation behind them and mention the reason in the release.

A first step in the analysis of the all-items percent change might be to copy the costs for the groups from Calculation Worksheet I and to enter their percent changes. (The percentages shown are taken from the release. They were computed from the indexes and may differ in the last decimal place from the percentages computed directly from cost figures.)

From table 1, we may note several facts. The cost of clothing increased 3.0 percent between April and July. This was the largest percent increase in any group. The cost of food increased by only 0.7 percent. Yet, in monetary units,

Table 1. Analysis of Change in Index
April and July 1963

Item	Cost April 1963	Cost July 1963	Percent change April to July	Aggregate change April to July
All items.....	$812.81	$818.83	+ 0.7	+$6.02
Food.....	403.01	405.61	+ 0.7	+ 2.60
Housing.....	162.55	162.58	+ 0.1	+ 0.03
Clothing.....	82.99	85.55	+ 3.0	+ 2.56
Miscellaneous....	164.26	165.09	+ 0.5	+ 0.83

the cost of food increased by $2.60, (the difference between $405.61 and $403.01), whereas the cost of clothing increased by only $2.56 (the difference between $85.55 and $82.99). Thus, a 3.0-percent increase in the cost of clothing caused a smaller increase in the cost of the market basket (and, therefore, the cost-of-living index) than did a 0.7-percent increase in the cost of food.

When the costs of the four groups are unequal, the groups showing the greatest percent change are not always the groups responsible for the greatest change in the all-items index. The true contribution of each group is best shown by the aggregate change in each group as shown in the last column of table 1.

Relative Importance of Component Groups. In the above example, the explanation of the greater effect of the food group lies in the greater relative importance (percent distribution) of the food component in the total cost of the market basket. An explanation of the effect of a change in the index of any group on the all-items index depends, therefore, not only upon the percent of change in the costs of a group, but also upon the relative importance of that group. This concept is the second analytical aspect of the index which may be used for interpreting it to the public. The public will readily understand that a comparatively small increase or decrease in a group can have an important effect upon the all-items index if the group is important in terms of relative cost. A second analytical table which can be usefully compiled from Calculation Worksheet I is shown in table 2.

Table 2. Relative Importance of Component Groups, April 1963

Item	Cost	Percent Distribution
All items..	$812.81	100.0
Food.....	403.01	49.6
Housing.....	162.55	20.0
Clothing.....	82.99	10.2
Miscellaneous.	164.26	20.2

For analytical purposes in connection with the changes in the July index from the preceding period, the relative importance of the groups in April is the information which is most pertinent. Thus, in interpreting for the public the price movements between April and July, we may wish to point out that the food group accounted for about 50 percent of the total costs of the theoretical market basket in April. This will help to emphasize the importance of the apparently small increase of 0.7 percent in food which might otherwise not be given the importance it deserved by the public generally.

Another point to note is that the relative importance of the costs of the groups is not the same for each date. Thus, the costs of the groups and their percent distribution in July 1963 are shown in table 3.

Table 3. Relative Importance of Component Groups, July 1963

Item	Cost	Percent Distribution
All items..	$818.83	100.0
Food.....	405.61	49.5
Housing.....	162.58	19.9
Clothing.....	85.55	10.4
Miscellaneous.	165.09	20.2

The reason that the percent distribution changed between the two quarters is that the costs of the groups changed by different percentages, as we have seen. It is obvious that no group has a fixed relative importance in the index. Reference must be made to a specific date, since the percent will vary through time. Thus, it is correct to say that housing had a relative importance of 19.9 percent in July 1963.

Summary

The index at a given date is the quotient, expressed as a relative number, of the cost of the market basket at that date and its cost in the base period. This chapter has shown the use of the costs in computing the index. A worksheet facilitates recording costs, computing group indexes and the all-items index over a period of time, and analyzing percent changes in the index. The extent to which a change in a group index affects the all-items index depends on the percent of change of the cost of the group and the relative importance of the group, and both aspects may be mentioned in interpreting the price changes to the public. Therefore, costs are the essential data for the final calculation of the cost-of-living index and its component group indexes.

Chapter 4. The Costs

Chapter 3 showed how the index was computed by comparing the cost of a fixed amount of goods and services at a given time with their cost in the base period. This chapter will show how the costs in each period were derived from the costs of the preceding period by adjusting them to the changes in prices between the two periods. The procedure will be illustrated for Men's and Boys' Clothing, a subgroup of Clothing.

An Example

Calculation Worksheets II, III, and IV show a fragment of the computations immediately preceding the calculation of the index just discussed in chapter 3. The worksheets are the following:

Calculation Worksheet II. The derivation of the costs of (subgroup) Men's and Boys' Clothing in 1963.

Calculation Worksheet III. The total costs of (group) Clothing and its subgroups in 1963.

Calculation Worksheet IV. The derivation of the costs of (subgroups) Men's and Boys' Clothing in 1962.

Technical Terms Used in this Chapter

Code. Each number in the column headed "code" refers to a description which identifies a commodity or service included in the index. The codes used are arbitrary. Each statistical office will wish to adopt codes suitable to its own needs. The codes are particularly useful as a "shorthand" device to avoid writing out on the worksheets the detailed descriptions which the office must prepare for every item.

Item Cost. The cost of each item is the sum of money required to buy the quantity of that item included in the market basket. It is equivalent to the product of the price of an item and the quantity of that item included in the index.

Quantity. The quantity of each item in the market basket is rarely computed, but it remains implicit in the cost. It is almost never necessary to find the quantity implied in the cost; but, if the quantity is obtained, it may be found to be fractional and sometimes less than unity. For example, if, in October 1962 (see Calculation Worksheet II) the average price of the raincoat (H-51), was $8.00, then the quantity must be 0.24 raincoat:

$$\$1.91 \div \$8.00 = 0.24$$

Substituted Code and Substitution. It sometimes becomes necessary to make a substitution of an item for the one identified by the code number in the first column. In such cases, the code number referring to the new item is entered in the column headed "Substituted code" under the appropriate date.

Price Ratio and Average Price. It will be seen in chapter 5 that several prices are collected each period for each item from several sellers. The ratio or price ratio, as the term is used in Calculation Worksheets II and IV, shows the change in the average price of an item in

each period from its average price in the immediately preceding period. The calculation of the price ratios is also discussed in chapter 5.

The price ratio of 1.0024 which appears in Calculation Worksheet II for work trousers (H-21) in January 1963, can be interpreted in any of the following ways:

1. The average price of work trousers in January was 100.24 percent of the average price in the preceding October.

2. The average price of work trousers in January was 1.0024 times the average price in the preceding October.

3. The average price of work trousers in January was 0.24 percent greater than in the preceding October.

4. The average price of work trousers in January was 24/100 of 1 percent greater than in the preceding October.

5. The relative change in the average price of work trousers from October to January was +.0024.

"C". When the average price has not changed between two dates, the price ratio is 1 and is indicated on the worksheet by the symbol "C." The person filling in Calculation Worksheet II, upon finding "C" in the list of price ratios already computed, knows at a glance to record the same cost as in the preceding period. For example, in April 1963, the price ratio corresponding to the work shirt (H-01) was entered as "C" and the resulting cost is $6.61, the same as in January 1963. (See Calculation Worksheet II.)

Comments on Costs and their Adjustment to Changing Prices

Every group is composed of subgroups, and each of these subgroups has its own cost. The cost for each subgroup, as well as for each group, changes through time with the changes in the prices of the items included in the subgroups. Calculation Worksheet III shows the changing cost of Clothing and its subgroups from October 1962 through October 1963. For example, the cost of Men's and Boys' Clothing increased from $28.78 in October 1962 to $29.18 in July 1963 and declined in October 1963 to $29.07. The computation of these costs is examined below.

Computing Costs: Items Available All Year. Calculation Worksheet II shows the calculation of the costs of the eight items of Men's and Boys' Clothing from October 1962 through October 1963. Seven of these items were classified as "Available all year," which means that throughout the year the items were available and were bought by wage earners in Capital City.

Various forms of worksheets may be used for the computation of costs. Calculation Worksheet II, used in the Capital City index, was designed to simplify and standardize the computations so that an inexperienced officeworker could enter the data correctly and perform the required calculations. The order of operations was as follows:

1. The code number for each item included in the index in October 1962 was written in the column headed "Code."

2. The cost for each item in October 1962 was copied from Calculation Worksheet IV which covered the year 1962.

3. There were no substitutions made in January 1963 so the column headed "Substituted code" for this date was left blank.

4. The price ratios listed in the column headed "Price ratio" were copied from other worksheets. Chapter 5 will go a step further back into the construction of the index and will describe how the price ratios were obtained. The present chapter is concerned only with the use of the price ratios to adjust the costs.

5. The costs in January were then computed and entered in the column headed "Cost." The cost for each item in January 1963 equals the product of the price ratio for January and the preceding cost for October 1962. For example, in October 1962, it required $10.01 to buy the quantity of work trousers (H-21) included in the index. By January 1963, the average price of the item had risen 0.24 percent above its price in October. Therefore the cost of the same quantity of work trousers (H-21) in January increased by 0.24 percent. The January costs were obtained as follows:

Code	October cost		January price ratio		January cost
(H-21)	$10.01	x	1.0024	=	$10.03
(H-25)	$ 4.28	x	1	=	$ 4.28
(H-01)	$ 6.47	x	1.0223	=	$ 6.61
		etc.			

6. The total cost in January 1963 of the items "Available all year" is the sum of the costs of the items. On Calculation Worksheet II this appears as $27.04.

The above procedure is the usual one followed for obtaining costs for the items in the index. In certain circumstances the method has to be adapted to meet changing conditions. The remainder of this chapter is devoted to a discussion of such special situations.

Computing Costs: Substitution of One Item for Another. Again referring to Calculation Worksheet II, no price ratio was available for work trousers (H-21) in July 1963. Therefore, a substitute price ratio was obtained for work trousers (H-22) which differed in quality, material, style, or workmanship from those included previously. Reasons for making substitutions will be discussed in chapter 5.

The substitution was made on Worksheet II as follows:

1. The new code number was listed in the column headed "Substituted code" under July 1963.

2. The price ratio showing the change in the price of the substitute, work trousers (H-22), over its own price in April was entered. Note that in anticipation of the substitution to be made in July, prices of work trousers (H-22) had been obtained in the previous quarter. (The problem of anticipating substitutions and of arranging substitutions when an article unexpectedly disappears from the market will be discussed more fully in the following chapter.) The price ratio, 1.0047, showed only that the price of work trousers (H-22) had increased 0.47 percent since April. It made no comparison between the price of work trousers (H-21) and the price of work trousers (H-22). The two types of work trousers differed somewhat in quality and price, but

Cost-of-living Index
Capital City

GROUP Clothing

SUBGROUP Men's and Boys' Clothing

Period Covered Jan. 1963 To October 1963

Item	October 1962		January 1963			April 1963			July 1963			October 1963		
	Item Code	Cost	Substituted code	Price ratio	Cost	Substituted code	Price ratio	Cost	Substituted code	Price ratio	Cost	Substituted code	Price ratio	Cost
Trousers, work	H-21	#10.01		1.0024	#10.03		1.0032	#10.06	H-22	1.0047	#10.11		1.0023	#10.13
Trousers, dress	H-25	4.28		C	4.28		1.0156	4.35		1.0096	4.39		C	4.39
Shirt, work	H-01	6.47		1.0223	6.61		C	6.61		C	6.61		.9864	6.52
Undershirt	H-11	1.69		.9904	1.67		.9849	1.64		C	1.64		C	1.64
Underpants	H-15	2.50		C	2.50		C	2.50		C	2.50		C	2.50
Socks, cotton	H-31	1.92		1.0152	1.95		1.0009	1.95		1.0219	1.99		.9963(B)	1.98(B)
Cap	—													
TOTAL-AVAILABLE ALL YEAR		26.87			27.04			27.11			27.24			27.16
SEASONAL (July and Oct) Raincoat	H-51	1.91	All year Total (B)	1.0063(B)	1.92(B)		1.0026(B)	1.92(B)		(3 months) 1.0176	1.94		.9842	1.91
TOTAL-SEASONAL		1.91			1.92(B)			1.92(B)			1.94			1.91
TOTAL-ALL ITEMS IN SUBGROUP		#28.78			#28.96			#29.03		(excl. H-31) (27.19)	#29.18		(excl. H-31) (27.09)	#29.07

Colors: (B) Written in brown pencil; indicates an estimated figure.
(G) Written in green pencil; indicates a revised figure.

the same procedure would have been used whether the average prices of work trousers (H-21) and work trousers (H-22) had been approximately the same or quite different. The important point to note here is that the price of the article was compared only with the earlier price of an article with the same code number.

3. The July cost, $10.11, was the product of the April cost and the July price ratio even though the price ratio referred to a different type of work trousers from those for which the April cost was computed.

The statistician in Capital City makes as few substitutions in the cost-of-living index as possible. Nevertheless, he recognizes that often it is the result of his country's growth that makes the substitutions necessary. As new patterns of consumption develop, some articles formerly consumed may become unavailable.

The method used on Calculation Worksheets II and IV to get the cost of each item makes substituting easy. The ready adaptability of this method to the process of substitution is the reason it is widely used and selected for this guide. There is, however, an alternative method of arriving at the same costs which the statistician should understand and which may even at first appear more efficient. This method would require, first, the explicit calculation of the quantity of each item in the market basket; and second, the obtaining of the cost of an item at a given date by multiplying the average price at that date by the fixed quantity. Experience has shown, however, that substitutions are more readily made under the method presented here for Capital City.

Computing Costs: Temporarily Unavailable Items. A different procedure was followed when a price ratio was only temporarily unavailable. In this situation, no substitution was made. The item was retained in the index until a price ratio was available again. Two types of unavailability--seasonal and irregular--are discussed below.

Seasonal unavailability.--The item "raincoat (H-51)" illustrates a seasonal item. In Capital City, it is priced only during the rainy season which extends from June through November. The merchants order their stock of raincoats only for the rainy season. During the rest of the year, the stocks of raincoats are likely to be incomplete.

Therefore, price ratios computed from prices of raincoats are available for only two of the four dates of the index--July and October. In January and April, the price ratios are estimated from the change in the total costs of "Men's and Boys' Clothing, Available all year." The method illustrated on Calculation Worksheet II follows:

1. The list of seasonal items--in this case, a single item, "raincoat (H-51)"--was separated from the other items on Calculating Worksheet II.

2. The total costs of items available all year were $26.87 in October 1962 and $27.04 in January 1963.

3. The ratio was obtained of total costs in January of items available all year to the corresponding figure for October.

$$\$27.04 \div \$26.87 = 1.0063$$

Cost-of-living Index
Capital City

GROUP TOTAL AND SUBGROUP TOTALS

GROUP Clothing

Period Covered Jan '63 To October, 1963

Item	October 1962		January 1963			April 1963			July 1963			October 1963		
	Item Code	Cost	Substituted code	Price ratio	Cost	Substituted code	Price ratio	Cost	Substituted code	Price ratio	Cost	Substituted code	Price ratio	Cost
Total Men's and Boys' Clothing		$28.78			$28.96			$29.03			$29.18			$29.07
Total Women's and Girls' Clothing		30.01			30.25			31.43			33.56			33.53
Infants' Clothing		3.12			3.19			3.23			3.23			3.25
Shoes		10.44			10.46			10.53			10.59			10.56
Yardgoods		8.56			8.67			8.77			8.99			9.01
Total Clothing		$80.91			$81.53			$82.99			$85.55			$85.42

Colors: (B) Written in brown pencil; indicates an estimated figure.
(G) Written in green pencil; indicates a revised figure.

4. The ratio, 1.0063, was entered in colored pencil as an estimate of the price ratio for raincoat (H-51) in January 1963. In Capital City, a brown pencil was used for figures estimated in this way. In the worksheets in this book, brown entries are indicated by (B). This type of estimate is one of several types of special entry which are distinguished on the Capital City worksheets by being entered in different colors.

5. The cost in January 1963 of raincoat (H-51) was estimated by multiplying the October cost by the estimated price ratio of January.

$1.91 x 1.0063 = $1.92

6. The total cost in January 1963 of Men's and Boys' Clothing was the sum of the costs of items available all year and the estimated cost for the seasonal item.

$27.04 + $1.92 = $28.96

7. The same procedure was used to estimate the cost of the raincoat (H-51) for April.

8. In July when raincoats were again available, a price ratio showing the change in the price of raincoat (H-51) over three-quarters of a year from October 1962 to July 1963 was used. The calculation of the July cost went back to the October cost when raincoats were last available. The July cost equaled the product of the price ratio for July (as compared with October) and the October cost.

$1.91 x 1.0176 = $1.94

Thus, in July, the cost of the item "raincoat (H-51)," the total cost of Men's and Boys' Clothing, the Clothing group index, and the cost-of-living index were unaffected by the fact that the cost of the item was estimated in January and April. In January and April, the effect on the index of estimating the cost of the item was the same as would have been achieved by omitting the item and allocating its cost proportionally among all the items of Men's and Boys' Clothing. The method of estimating was used since the raincoat (H-51) was to be retained in the index.

Irregular unavailability.--Occasionally, a price ratio will not be available for an item listed among those available all year because of a temporary shortage not expected to persist or recur. For example, there were no cotton socks (H-31) to be found on the market in October 1963, a protracted labor dispute having closed the factories producing this item. Consequently, no price ratio was available.

The same method was used to estimate the cost of this item in October as was used for estimating the cost of the seasonal item when it was not available. The procedure was as follows: (See Calculation Worksheet II.)

1. The total of Men's and Boys' Clothing, excluding cotton socks (H-31), was $27.19 in July 1963 and $27.90 in October 1963. (See the figures written in parentheses above the spaces for the totals.)

2. The ratio of the October total (excluding cotton socks) to the July total (excluding cotton socks) was 0.9963.

$27.09 ÷ $27.19 = .9963

Cost-of-living Index
Capital City

SUBGROUP Men's and Boys' Clothing

GROUP Clothing Period Covered Jan'62 To October 1962

Item	October 1961		January 1962			April 1962			July 1962			October 1962		
	Item Code	Cost	Substituted code	Price ratio	Cost	Substituted code	Price ratio	Cost	Substituted code	Price ratio	Cost	Substituted code	Price ratio	Cost
Trousers, work	H-21	$ 9.72		.9970	$ 9.69		1.0084	$ 9.77		C	$ ~~10.01~~ 4.77 (G)		C	$ 10.01
Trousers, dress	H-25	4.20		.9881	4.15		.9904	4.11		1.0049	4.23 (G) ~~4.13~~		1.0118	4.28
Shirt, work	H-01	6.32		C	6.32		C	6.32		1.0110	6.55 (G) ~~6.37~~		.9878	6.47
Undershirt	—		H-11 [a]		1.59 (G)		1.0063	1.60		1.0312	1.69 (G) ~~1.65~~		C	1.69
Underpants	H-15	3.99		.9975	2.98 (G) ~~3.98~~		C	2.39		C	2.45 (G) ~~2.39~~		1.0204	2.50
Socks, cotton	H-31	1.81		.9834	1.78		C	1.78		1.0169	~~1.84~~ 1.86 (G)		1.0323	1.92
Cap	H-62	.72		C	.72		.9722	.70		C	.70 [b]			
TOTAL-AVAILABLE ALL YEAR		26.76			26.64			26.67			26.79 (G) ~~26.84~~			26.87
SEASONAL (Jan and Oct) Raincoat	H-51	1.88	All year Total (B)	.9955 (B)	1.87 (B)		1.0011 (B)	1.87 (B)		(6 months) .9888	1.91 (G) ~~1.86~~		C	1.91
TOTAL-SEASONAL		1.88			1.87 (B)			1.87 (B)			1.91 (G) ~~1.86~~			1.91
TOTAL-ALL ITEMS IN SUBGROUP		$ 28.64			$ 28.51			$ 28.54			$ 28.70			$ 28.78

[a] Undershirt added. The cost of underpants is divided with 40 percent of the cost corresponding to "underpants H-15" being transferred to "undershirt H-11."

[b] The item "Cap H-62" is deleted and its cost is divided proportionately among all the items of men's clothing.

COLORS:
(B) Written in brown; indicates an estimated figure.
(G) Written in green; indicates a revised figure.

3. This ratio was entered in brown pencil as the estimated price ratio for cotton socks (H-31) in October. Entries in brown pencil indicate estimated figures as was mentioned above.

4. The estimated cost for this item in October was the product of the estimated price ratio for October and its July cost.

$1.99 x .9963 = $1.98

5. This figure was included to get the total costs of October.

6. When the item becomes available again, the price ratio at that time will refer back to the last non-estimated price--in this case that of July--and the cost will be the product of the price ratio and the July cost.

As in the case of the seasonal item, the index when cotton socks (H-31) become available again will be unaffected by the fact that the cost of the item has been estimated in October.

Computing Costs: Revisions in the List of Items. Technological change, economic development, and fashion make some revisions in the list of items inevitable. Substitutions, which occur when an item is temporarily replaced by another with a different description and code number, were discussed earlier in this chapter. The present section is not concerned with substitution, but with additions or deletions of items.

Introducing a new item.--The addition of a new item is illustrated on Calculation Worksheet IV. For April 1962, it was decided to include an undershirt in addition to the item "underpants (H-15)" already included. The entire cost of underwear in the base period had previously been allocated only to underpants (H-15). The decision was made to allocate 40 percent of this cost to undershirts (H-11). Such decisions may be made on the basis of information from a variety of sources. In this particular case, inquiries made of the producers of the articles indicated that, in January 1962, 40 percent of the expenditure on men's underwear was on undershirts, and this information was used as the basis of the addition.

The steps taken to add the new item for April 1962 were as follows:

1. The new item was written in the stub of the table.

2. The code number of the undershirt (H-11) was listed in the column headed "Substituted code."

3. The cost of underpants (H-15) computed by the regular procedure of multiplying the October 1961 cost by the January 1962 price ratio was $3.98 for January 1962.

4. For April 1962, a revision was made in the cost of underwear in January. The cost of underpants (H-15) for January, $3.98, was divided so that 40 percent, or $1.59, was given to undershirt (H-11) and 60 percent, or $2.39, to underpants (H-15). The former cost figure was left visible, but a line was drawn lightly through it. The new amounts were entered in colored pencil. In Capital City, all revisions are made in green pencil. Entries in green pencil are indicated in the worksheets of this guide by (G).

5. In April, a price ratio was listed for undershirt (H-11) as well as for underpants (H-15), and the computation of the cost of each item followed the usual procedure.

Removing an Item.--The deletion of an item is illustrated by the removal of the item "cap (H-62)" from the list of items in July. (See Calculation Worksheet IV.) At that time, this item had a cost in the index of $0.70. Its deletion required the allocation of its cost proportionally among all the remaining items of Men's and Boys' Clothing. The steps taken to remove cap (H-62) in July were as follows:

1. The total cost of Men's and Boys' Clothing was divided by the total cost of Men's and Boys' Clothing excluding cap (H-62).

$$\$28.70 \div (\$28.70 - \$0.70) = \$28.70 \div \$28.00 = 1.025$$

2. The cost of each item except cap (H-62) was multiplied by 1.025 to obtain the new costs, the sum of which equals the total costs before the deletion of cap (H-62).

3. A line was drawn lightly through the former costs which were left visible.

4. Each of the new costs was entered in green pencil just above the former cost to indicate a "revision" of an entry, as was explained in the preceding section.

5. The new costs were used in the calculation of the following October costs.

Summary

The cost of each item in each quarter equals the product of its cost in the preceding quarter and the price ratio measuring the change in price between the two dates. When the price has remained constant, the price ratio is 1 and is indicated by "C" on the worksheet. Special procedures are used in cases requiring substitution; the estimation of cost of items temporarily unavailable, either seasonally or for nonrecurring reasons; and additions to or deletions from the list of items.

A worksheet provides space for the list of items, their code numbers, and the calculation of the costs for four quarters. To fill in such a worksheet, the statistician must have the following information: price ratios, costs, a list of items, and a description of each item identified by a code number. Each of these classes of information and its sources will be examined further in the next chapter.

Chapter 5. The Price Ratios

The preceding chapter showed the use of price ratios to adjust the costs to the changes in prices from one period to the next. The present section will go deeper into the construction of the index to show how the price ratios were computed on tabulation sheets. The treatment of two articles, men's work trousers, and a raincoat, will be examined as illustrative of the procedure.

An Example

The Tabulation Worksheets V, VI, and VII show the calculations of some representative price ratios used in the derivation of the costs in Chapter 4. The tabulation sheets are the following:

Tabulation Worksheet V. The computation of the price ratios for Work Trousers (H-21), 1962-63.

Tabulation Worksheet VI. The Computation of the price ratios for Work Trousers (H-22) substituted Work Trousers (H-21), 1963.

Tabulation Worksheet VII. The Computation of the price ratios for Raincoat (H-51), a seasonal item, 1962-63.

Technical Terms Used in this Chapter

Outlet Code. On the tabulation worksheets, a code number is used to identify each seller (retail sales outlet). Every price paid, of course, relates to a transaction between a buyer and a seller. Information regarding prices is usually obtained from the sellers rather than from the buyers. Whatever the source of the prices, it is usually desirable (unless a large number of prices is obtained for each item) that each price be identified with a seller in order to prevent erroneous comparisons between prices collected from different sources. For example, on Tabulation Worksheet V, Outlet code M-1 refers to a certain stall in the central market; D-1 refers to a certain department store; and S-1 refers to a certain store specializing in men's clothing. The use of code numbers instead of the names of the sellers serves both to provide a convenient abbreviation and to help keep the individual prices confidential.

Linking. When prices are not available in each period for the same item from the same sellers, the price ratios are computed by a process known as linking. By this process, when a item is to be substituted for another, the average price of the original item in a given period is compared with its average price in the preceding period, and the average price of a substitute item in the following period is compared with its average price in the given period. As an example of linking (see Calculation Worksheet II), the price ratios for work trousers, 1.0032 in April 1963 and 1.0047 in July 1963, refer to different types of work trousers. In April, the ratio referred to the prices of work trousers (H-21) and, in July, to the substitute work trousers (H-22). Nevertheless, these price ratios were used at successive dates to ad-

just the "cost" of one item, work trousers, to the change in prices. The device of linking excludes effectively from the price ratios and from the index the effect of any price differential existing between the two types of work trousers. In this chapter, the linking process will be examined in the substitution of one item for another and in the substitution of one seller for another.

Comments on the Price Ratios

The Prices. Since the scope of this manual is confined to a description of the calculation of a particular cost-of-living index after the basic data have already been assembled, many important principles underlying the construction of index numbers cannot be dealt with in detail. In some ways, the most important aspect of the construction of a price index is the collection of the prices. The accuracy of the cost-of-living index depends, in the final analysis, upon the accuracy of the prices themselves. Furthermore, the price series are of value in themselves. Even if lack of resources were to force a delay in the compilation of the index, the establishment and maintenance of continuing price series would be of immediate and lasting value in the statistical program of any country. The following are some of the questions which must be considered by the statistician in planning the selection of the items and the collection of the prices:

1. Are the prices used in the index the prices actually paid? In some countries, almost all the prices can be efficiently obtained from the sellers; in others, it may be necessary to learn the prices of some items from the purchasers. But as nearly as possible, the prices used in the index should be the prices actually paid by the purchasers, even when some bargaining over the prices may have preceded the transactions.

2. Are the prices used in the index representative of those paid by the group of persons to whom the index relates? It is important that the items to be included in the index and the qualities defined in their descriptions be selected as characteristic of the purchases of the specified group and, also, that the prices pertain to sellers representative of those patronized by the group.

3. Are the prices used in the index comparable through time? Unless the prices used in each computation of the index for successive quarters correspond to the same quantity and quality of each item, to the same or equivalent sellers, to the same conditions of sale (e.g., cash payments), and sometimes even to the same part of the day, week, and month, spurious price changes may be recorded.

4. Have substitutions been properly made when required by changes in the pattern of consumer buying and by the replacement of the original sellers by new ones? The way in which substitute items and sellers are introduced can affect the representativeness of the items, the comparability of their prices through time, and the validity of the index.

Form of the Tabulation Worksheets. The tabulation worksheets used as examples in this guide conform to the price-collection practices which were used in Capital City. If other methods of collecting prices should be used, the design of the tabulation worksheets should be carefully reviewed to see whether convenient or efficient modifications might be introduced.

Standardized tabulation worksheets are useful in providing a convenient and uniform system for assembling the prices reported to the statistical office and for computing the price ratios. The particular form used in the Capital City index has the further advantage of limiting the price comparisons from one period to the next to comparisons between prices of the same products sold by the same sellers.

In Capital City, prices were collected from the same sellers in each period, since frequently the price of the same commodity varies with different sellers depending, in part, on the location of the outlet in this city.

Occasionally, however, some substitutions of items or sellers are necessary. A second major advantage of the form of tabulation worksheet illustrated for Capital City is that it allows such substitutions to be made while at the same time it prevents price comparisons between non-comparable prices. The use of a separate sheet for each item avoids the possibility that a clerk might inadvertently make a comparison between the price of the new quality and the price of the former quality. The design of the tabulation worksheet with two columns for each date similarly avoids the possibility of any comparison between the price charged for an item by a new seller and the price charged by the former seller.

Details of the Tabulation Worksheets. Each tabulation worksheet is designed for only a single item. For example, only the prices of work trousers (H-21) are recorded on Tabulation Worksheet V.

A separate line is provided for the prices corresponding to each outlet code listed in the stub at the left of the tabulation sheet. The list of outlets appears twice in the stub, since the upper half of the sheet is for entries of the year 1962 and the lower half for those of 1963.

Each of the tabulation sheets has space for prices over the same period of time. For example, in Capital City each tabulation worksheet covers the same two-year period. For indexes calculated more frequently than each quarter, the tabulation worksheets may be arranged with more columns or to cover a shorter period of time. The uniform periods provided for on each sheet helps in systematizing the work in the statistical office and in filing the tabulation worksheets by date when they are completed.

There are two columns for each quarter. The double column facilitates the correct computation of the price ratios in cases where prices have not been obtained from precisely the same list of sellers in both quarters. For example, on Tabulation Worksheet V, the prices listed in column 1 of April 1963 were compared with column 2 of January 1963. Column 2, in the example, shows the deletion of two prices because nothing was available in two outlets to meet the specifications.

Occasionally the person who collects the prices includes explanatory notes in his report, such as "nothing to meet description," "no longer selling this item," etc. Experience in Capital City revealed that certain comments were made frequently. Accordingly, a list of these was made and they appear as notes in the right-hand margin of the tabulation sheet. Upon encountering one of these comments, the person entering price information on the tabulation sheet need only write

next to the price the number assigned to the comment in the margin. Additional space has been left in the right-hand margin for writing in comments not already provided for in the list of notes. Certain editing instructions are also printed in the right-hand margin of the tabulation sheet.

The ruled space in the lower right-hand corner is used to indicate in each quarter of the year whether a price ratio calculated from the prices reported for the item has been used in the index or whether an estimated price ratio has been used, as in the case of an article temporarily unavailable. (For two cases of the use of estimated price ratios for items temporarily unavailable, see pages 19 and 21.)

Calculation of the Price Ratios

The calculation of the price ratio for an item in a given quarter involves prices in the given quarter from a number of sellers and prices in the preceding quarter from the same sellers.

The simplest form of computation when prices are available for the same item in both quarters for every seller from whom prices are customarily collected is illustrated on Tabulation Worksheet V and is outlined in the following section.

It will often occur, however, that prices are no longer reported for a certain seller. The procedure for computing the price ratio, when a new seller is substituted, is illustrated on Tabulation Worksheet V and is outlined on pages 27-29.

Another difficulty in the computation of price ratios occasionally arises when an article which has been priced in previous quarters becomes unavailable. The procedure for computing the price ratio when a substitution of a new item is made is illustrated on Tabulation Worksheets V and VI and is outlined on pages 29-31.

The seasonal pattern of availability for certain items prevents the calculation of a price ratio for the special class of items in every quarter of the year. The computation of price ratios for a seasonal item is illustrated on Tabulation Worksheet VII and is outlined on pages 31-33.

The Calculation: Prices Reported for Identical Sellers. In the absence of any complications, the price ratio for an item is calculated by dividing the average of the collected prices for one quarter by the average of the collected prices for the preceding quarter. In Capital City, the prices of most items were found for five different outlets representative of those selling to workers' families. For certain items, of course, there were fewer than five sellers available, as in the case of pricing electricity or telephone service.

The steps in the computation of the price ratios for work trousers (H-21) in 1962 on the upper half of Tabulation Worksheet V were as follows:

1. The outlet codes identifying the sellers and the prices charged by each in the last quarter of the preceding year, October 1961, were copied from the tabulation worksheet of that year (not included in this manual).

2. The prices which had been obtained for January 1962 were recorded in column 1 for that quarter. Before being entered, the prices were edited. The work of editing consisted in examining the prices

and the information accompanying them to see that the item, as reported, fitted the description of work trousers (H-21) and that there were prices from each seller or a note explaining their absence. If any of the prices had appeared to be in error, the editor would have referred them for verification to the person who had obtained them. In the case of the prices for January 1962, the editor found that they were acceptable and that they represented the same sellers as had been included in October 1961. The person recording the prices also edited the information collected from the various outlets. Note that, in order to minimize errors, a person other than the collector of the prices should edit and record them.

3. The October 1961 total $20.30 and the January 1962 total $20.24 were entered in the line labelled "sum of prices used."

4. The January price ratio 0.9970 was obtained by dividing the January total by the October total and was entered in the line corresponding to price ratio. Note that since the same number of prices was used in October and January, the quotient of the totals is the same as would have been obtained by taking quotient of the average price for each date.

5. In April 1962, there were five prices from the same five sellers. These prices were listed in column 1 for April, and their total was divided by the January total to get 1.0084, the April price ratio. Note that column 1 for January was used and that column 2 for January was left blank. The latter would have been used only if a price had been lacking or a price from a new seller had been added. The use of column 2 is shown in later sections.

6. In the computation of the July price ratio, it happened that the July prices were identical with the April prices. In this case, it was not necessary to add the prices to know that there had been no change and that the price ratio for July was 1. The symbol "C" was entered to indicate the price ratio for that quarter. (See the key to symbols in the right-hand margin of the tabulation worksheet.)

7. The price ratios for work trousers (H-21) were used in the index in every quarter of 1962 and in January and April 1963. (See Calculation Worksheets II and IV.) When the price ratios were transcribed to Calculation Worksheets II and IV, checks were made in the appropriate boxes in the lower right-hand corner of Tabulation Worksheet V. These checks furnished a record on the tabulation worksheet that the price ratios had been carried forward to the worksheet for the calculation of the costs.

The Calculation: Substitution of One Seller for Another. The computation of the price ratios is sometimes complicated by the loss of one of the sellers for any one of a variety of reasons, including going out of business or no longer carrying the item. When it appears that the loss of the seller is permanent, another similar seller is usually substituted.

An illustration of the substitution of one seller for another is given on Tabulation Worksheet V in the comparison between the prices of October 1962 and January 1963 in the lower half of the sheet. The linking procedure was as follows:

Cost-of-living Index
Capital City

SUBGROUP Men's and Boys' Clothing
Item Work trousers. (H-21)

GROUP Clothing

Period Covered Jan'62 To October 1963

Outlet code	October '61 (2)	January '62 (1)	January '62 (2)	April '62 (1)	April '62 (2)	July '62 (1)	July '62 (2)	October '62 (1)	Footnotes
M-1	$3.89	$3.89		$3.98		$3.98		$3.98	1. Nothing to meet description.
M-2	3.89	3.89		3.89		3.89		3.89	
D-1	4.12	4.10		4.10		4.10		4.10	2. No longer selling this item.
S-1	4.25	4.25		4.25		4.25		4.25	
S-2	4.15	4.11		4.19		4.19		4.19	3. Going out of business.
S-3							F	(4.27)	
Sum of prices used	$20.30	$20.24		$20.41					
Price ratio		0.9970		1.0084		C		C	

Outlet code	October '62 (2)	January '63 (1)	January '63 (2)	April '63 (1)	April '63 (2)	July '63 (1)	July '63 (2)	October '63 (1)	Codes
M-1	$3.98	$3.98	($3.98) 1/	$—					
M-2	3.89	3.89	(3.89) 1/	—					
D-1	4.10	4.15	4.15	4.15					C- No change.
S-1	(4.25) 3/	—	—	—					F- First price.
S-2	4.19	4.18	4.18	4.22					0- Not used this quarter.
S-3	4.27	4.28	4.28	4.28					
Sum of prices used	$20.43	$20.48	$12.61	$12.65					✓- used index; E- estimated
Price ratio		1.0024		1.0032					Jan'62 ✓ April'62 ✓ July'62 ✓ Oct'62 ✓
									Jan'63 ✓ April'63 ✓ July'63 Subst. H-22 Oct'63

1. In October 1962, the person gathering the prices reported that Seller S-1 expected to go out of business before the next quarter. The statistical office selected a substitute, Seller S-3, to be visited. The price charged for work trousers (H-21) by the new Seller S-3 was found to be $4.27 and was listed in column 1 for October in the upper half of the sheet. A circle was drawn around the price to indicate that it was to be omitted in getting the October price ratio. The code "F" was entered to the left of the new price to indicate that it was a "first price" for Seller S-3. (See key to code symbols in the right-hand margin of the tabulation sheet.)

2. In January 1963, Seller S-3 was substituted for Seller S-1 who had gone out of business. At this point, the use of column 2 of October in the lower half of the tabulation sheet became necessary, since list of prices in column 1 of January did not include precisely the same sellers as the list in column 1 of October. The prices for October were copied from column 1 to column 2. Because there was no January price corresponding to Seller S-1, who had gone out of business, the October price for Seller S-1 was circled to indicate that it was not to be included in the sum of the prices.

3. The five uncircled prices were totaled for both column 2 of October and column 1 of January, and the price ratio, 1.0024, for January was computed. The totals of both columns included prices for Seller S-3, and neither included prices from Seller S-1. Note that, in this substitution of Seller S-3 for Seller S-1, at no time was a comparison made between the price from S-1 and the higher price charged by S-3; and, in particular, no comparison of prices between the two sellers entered into the price ratio, 1.0024, of January.

Note that the method of substitution presented above does not require advance warning that the seller is going out of business, but can be applied even when a seller goes out of business unexpectedly. For example, if the person collecting prices in October had no notice that Seller S-1 was going out of business and, therefore, collected no price in that quarter corresponding to Seller S-3, the price from S-1 in column 2 for October would have been circled as in the previous example. The price ratio for January would have been 1.0025, computed as the ratio between the totals of only four prices at each date (those charged by Sellers M-1, M-2, D-1, and S-2). The substitute Seller S-3 could then have been introduced in the following quarter, April, in exactly the same way as it was introduced in January on Tabulation Worksheet V. The procedure of computing the price ratio from fewer prices can also be followed, instead of substituting a new outlet, if the price is only temporarily unavailable from a given seller.

The Calculation: Substitution of One Item for Another. In April 1963, it became apparent to the person collecting prices that the type of work trousers indicated by the code H-21 was disappearing from consumer use, and that another type was taking its place in the selling outlets. This information was transmitted by the price collector to the statistical office which then drew up a description of the new type designated by the code H-22 and instructed the person collecting the prices to report prices for both types until further notice.

No price for work trousers (H-21) was reported in April 1963, corresponding to either seller M-1 or M-2. Even with the recently added Seller S-3, there were only three

Cost-of-living Index
Capital City

SUBGROUP Men's and Boys' Clothing
Item Work trousers (H-22)

GROUP Clothing

Period Covered Jan'62 To October 1963

Outlet code	October '61 (2)	January '62 (1)	January '62 (2)	April '62 (1)	April '62 (2)	July '62 (1)	July '62 (2)	October '62 (1)	Footnotes
									1. Nothing to meet description.
									2. No longer selling this item.
									3. Going out of business.
Sum of prices used									
Price ratio									

Outlet code	October '62 (2)	January '63 (1)	January '63 (2)	April '63 (1)	April '63 (2)	July '63 (1)	July '63 (2)	October '63 (1)	Codes
M-1					$4.15	$4.15		$4.20	
M-2					4.10	4.10		4.10	C- No change.
D-1					4.29	4.29		4.29	F- First price.
S-1									O- Not used this quarter.
S-2					4.39	4.49		4.49	
S-3					4.39	4.39		4.39	
									✓- used index; E- estimated
Sum of prices used					$21.32	$21.42		$21.47	Jan'62 Apr'62 July'62 Oct'62
Price ratio						1.0047		1.0023	Jan'63 Apr'63 July'63 ✓ Oct'63 ✓

prices for this item in April. Furthermore, there was no reason to expect that more prices for this item would be available in the future since most workers were now buying the new type of work trousers.

In accordance with instructions from the statistical office, prices were obtained in April for the new type of work trousers as well as for the old. In July, work trousers (H-22) were substituted in the statistical office for work trousers (H-21), and instructions were given to collect prices only for H-22 in the future. (This substitution made on Calculation Worksheet II was explained in chapter 4.) The procedure of substitution through linking on the Tabulation Worksheets V and VI was as follows:

1. In column 1 for April, on Tabulation Worksheet V, a dash and a reference number indicating the appropriate footnote were entered in each of the spaces where the prices of work trousers (H-21) from Sellers M-1 and M-2 would have been written. The price ratio, 1.0032, for April was then computed as a ratio between the totals of only three prices.

2. The prices for work trousers (H-22), which also had been obtained for April, were recorded on a separate sheet. (See Tabulation Worksheet VI). The prices were entered in column 2 of April and corresponded to the same list of sellers whose prices had been used for work trousers (H-21).

3. In July, five prices were recorded in column 1 for work trousers (H-22). It was decided this time to use work trousers (H-22) instead of work trousers (H-21) in the index. Accordingly, the ratio between the July total and the April total of the prices of work trousers (H-22) was computed, and this price ratio, 1.0047, was adopted as the July price ratio for work trousers. The substitution has already been noted in chapter 4 when this price ratio was entered on Calculation Worksheet II as the July price ratio for work trousers.

Note that the price of work trousers (H-22) was at no point ever compared with the price of work trousers (H-21).

If an item should become unavailable from all the sellers before a substitution has been made, an estimated price ratio would have to be used until prices for the new item have been obtained in two quarters of the year. An example of an estimated price ratio is that for cotton socks (H-31) in October 1963 on Calculation Worksheet II. (See pages 21 and 22 for an explanation of the method of estimating the price ratio.)

In the case of a gap in a price series, an estimated price ratio is recommended instead of the attempt to get prices for a past period. Although approximate data can sometimes be obtained, the results are frequently unsatisfactory. It is usually preferable to use an estimated price ratio which assumes that the average price of the item has changed by the same percentage as the average of the prices of a group of related items, and to devote available resources to obtaining the best possible current prices.

The Calculation: Seasonal Items. The calculation of the price ratios of seasonal items is illustrated in the case of raincoat (H-51), on Tabulation Worksheet VII. In Capital City, the prices of raincoats were obtained only in July and October.

Cost-of-living Index
Capital City

SUBGROUP Men's and Boys' Clothing
Item Raincoat (M-51)

GROUP Clothing

Period Covered Jan '62 To October 1963

Outlet code	October '61 (2)	January '62 (1)	January '62 (2)	April '62 (1)	April '62 (2)	July '62 (1)	July '62 (2)	October '62 (1)	Footnotes
M-4	$ 7.50					$ 7.50		$ 7.50	1. Nothing to meet description.
M-6	6.98					6.98		6.98	2. No longer selling this item
D-1	7.98					7.98		7.98	3. Going out of business.
S-2	8.95					8.50		8.50	
S-3	8.79					8.79		8.79	
Sum of prices used	$ 40.20					$ 39.75 (9 months)		$ 39.75	
Price ratio						.9888		C	

Outlet code	October '62 (2)	January '63 (1)	January '63 (2)	April '63 (1)	April '63 (2)	July '63 (1)	July '63 (2)	October '63 (1)	Codes
M-4						$ 7.69		$ 7.49	
M-6						6.98		6.80	C- No change,
D-1						8.19		8.14	F- First price.
S-2						8.75		8.75	O Not used this quarter.
S-3						8.84		8.63	
									✓- used index; E- estimated
Sum of prices used						$ 40.45 (9 months)		$ 39.81	Jan '62 E, Apr '62 E, July '62 ✓, Oct '62 ✓
Price ratio						1.0176		0.9842	Jan '63 E, Apr '63 E, July '63 ✓, Oct '63 ✓

In the January and April quarters, price ratios for this seasonal article were estimated as a regular procedure on the worksheets for computing the costs. (See pages 17-21 and Calculation Worksheet II.) The estimated price ratios for January and April attributed to the average price of the raincoat the same percent of change that had occurred in the average of the prices of Men's and Boys' Clothing.

In the two quarters when prices were collected for raincoat (H-51), the price ratios were calculated from the actual prices by the same method used to get price ratios for articles available throughout the year. The price ratios for these two quarters, July and October, were first obtained on a tabulation sheet and then transcribed to the worksheet used in computing the costs. The procedure of calculating the price ratios on Tabulation Worksheet VII was as follows:

1. The prices of raincoat (H-51) in October 1961 and the outlet codes were entered from the tabulation worksheet for 1961. (Not included in this manual.)

2. The next prices reported for the raincoat were for the July 1962 quarter and were listed in column 1 for July. The price ratio, 0.9888, was computed for the 9-month period from October 1961 to July 1962. The fact that it measured the price change over the preceding 9-month period was noted by writing "9 months" above the ratio in the July column.

3. The price ratio for October 1962 which measures the change in price during a single quarter of the year was found in the usual way. In this particular quarter, the prices had not changed, and symbol "C" was used to indicate no change.

4. The January and April columns were left blank, since no prices of raincoats had been collected for these quarters. At each quarterly calculation of the index, symbols were entered in the spaces provided in the lower right-hand corner of Tabulation Worksheet VII to show whether the price ratios for raincoat (H-51) used on Calculation Worksheets II and IV were derived from actual prices or were estimated. This information was indicated as follows for 1962: January, "E" (estimated); April, "E" (estimated); July, "✓" (actual price ratio used in the index); and October, "✓" (actual price ratio used in the index).

A review of the method of estimating the price ratios will show that, in July and October, neither the value of the price ratios calculated from collected prices nor the costs were affected by the use of estimated price ratios in January and April. (See pages 17-21.) The effect of using the estimated price ratios in January and April is corrected in July when an actual price ratio is used because:

1. The price ratio for July measures the change in the average price over the entire 9-month interval since the preceding October when prices of raincoats were last collected; and

2. When the price ratio for July was used to compute the costs for July, it was applied also over a 9-month interval to the cost of the preceding October. (See Calculation Worksheet II.)

The result was that the same cost was found for the raincoat in July that would have been obtained if no price ratios and costs had been estimated between October 1961 and July 1962.

Summary

This chapter has shown the method of calculating the price ratios necessary to compute the costs in chapter 4. The procedure, in brief, is to list the prices collected for each item and to find the ratio of the average of the prices in one period to the average of the preceding period.

In every case, the principle was followed of making comparisons only between prices of articles with the same description and sold by the same sellers. Special tabulation sheets facilitated the carrying out of this objective through several devices: namely, the use of a separate tabulation sheet for every article, the provision of a separate line for each outlet, and a double column for the prices of each date. The two columns for a given date permit (a) the comparison of prices of that date with those of the preceding period by using in the first column only prices from the same outlets for which prices are available in the preceding period, and (b) the comparison of a different set of prices of the same date with those of the following period by using in the second column only prices from the same outlets for which prices are available in the following period.

The procedure for calculating price ratios has been illustrated in the simplest case, in which prices collected for the same item from the same sellers in each period. Illustration has also been given of three special cases in which a new outlet is substituted for an old one; a product with a new description is substituted for one which has become obsolete; and seasonal factors prevent the collection of prices at certain periods of the year.

Chapters 3, 4, and 5 have shown the construction of the cost-of-living index in Capital City by computing price ratios; by adjusting the costs with those ratios; by combining the costs into the total cost of the market basket; and, finally, by comparing the new cost of the market basket with its cost in the base period. The next and final chapter of this manual will examine the formula which describes the procedure which has been followed.

Chapter 6. The Formula by Which the Index is Calculated

The cost-of-living index for Capital City is made by (1) adjusting the cost of a market basket of goods and services periodically to allow for increases or decreases in the prices of the items it contains, and (2) comparing its adjusted cost with its cost in the base period. The method as set forth in detail in this manual can be generalized and stated by means of a formula. The present chapter will examine the formula and some of the reasons for its widespread adoption in index number construction.

The Formula

The index in Capital City is calculated as a weighted mean or average of price ratios using fixed weights. The formula, which expresses the procedure in symbols, and the definition of each of the symbols are given below. It is recommended that the reader refer back to this presentation of the formula as he reads the remainder of this chapter which is devoted to an explanation of the formula and its uses. The basic formula for computing the Capital City index is:

$$R_n = \frac{\sum\left(\frac{P_n}{P_{n-1}} \cdot P_{n-1} q_0\right)}{\sum (P_0 q_0)} \times 100$$

This formula is applicable each time the index is computed. The subscripts "n" and "n-1" refer to successive periods (in this case, successive quarters of the year) for which the index is calculated. Since the index is a quarterly one, the definitions below are phrased accordingly:

R_n : the index in a given quarter "n."

P_n : the average price of an item in the given quarter "n."

P_{n-1} : the average price of an item in the quarter immediately preceding the given quarter "n."

P_0 : the average price of an item in the base period "o."

q_0 : the amount of an item included in the market basket.

In Capital City, the quantities in the market basket, as shown by the use of the zero subscript q_0, relate to the same year as that chosen for the base of the index. It is important to note that the quantities in the market basket might have been established in any year.

$P_{n-1} q_0$: the cost of the quantity q_0 of an item in the quarter preceding the given quarter "n."

$\frac{P_n}{P_{n-1}}$: the price ratio showing the quotient of the average price of an item in the given quarter "n" and its average price in the preceding quarter.

$\frac{P_n}{P_{n-1}} \cdot P_{n-1} q_0$: the cost of the quantity q_0 of an item in the given quarter "n."

$P_0 q_0$: the cost of the quantity q_0 of an item in the base period "o."

$\Sigma \left(\frac{P_n}{P_{n-1}} \cdot P_{n-1} q_0 \right)$: the cost of the market basket in the given quarter "n."

$\Sigma (P_0 q_0)$: the cost of the market basket in the base period "o."

Σ : the summation symbol before an expression indicates the total of all the items represented by the symbols enclosed in parentheses. The same formula then is used for the all-items index and for each of the group indexes. The summation covers the entire market basket if the all-items index is being computed, and only a part of the market basket if one of the group indexes is being computed.

Technical Terms Used in this Chapter

Laspeyres' Formula. The well-known formula for making a price index as a weighted aggregate using fixed quantity weights, usually of the base year, is as follows:

$$R_n = \frac{\Sigma (P_n q_0)}{\Sigma (P_0 q_0)} \times 100$$

The formula is named after Etienne Laspeyres (1834-1913), a German statistician and economist. That it is equivalent to the formula used in the index will be shown on the following page.

Weighted Index and Weight. The concept of a weight is that of a number which measures the relative impor-

tance of an item when several items are averaged together. A price index measures the average change in the prices of a number of goods and services, and its weights determine the relative importance in the index of the price changes of each item. In the Capital City index, the weights of the price ratios when computed from the base period are fixed in that they continue at each calculation to represent the costs corresponding to the various items in the base period.

To illustrate the operation of weights in an index, assume that, in Capital City, the average price of a loaf of bread was only $0.10 and the average price of a stove was $80.00 during the base period. Assume further that, during the base period, the average worker's family bought 400 loaves of bread and only 0.05 stoves per year (i.e., on the average, 1 stove every 20 years).

If prices of both these items changed during a given period of time, the index in Capital City would give 10 times as much weight to the change in the price of bread as to the change in the price of stoves. These relative weights would have been determined by the fact that, in the base period, the cost allocated to bread would have been 10 times the cost allocated to stoves, because the average worker's family spent $40.00 (400 loaves x $0.10) on bread or 10 times the sum of $4.00 (.05 stoves x $80.00) spent on stoves.

Comments on the Formula

The Meaning of the Formula: Its Equivalence to Laspeyres' Formula. It can readily be observed that the formula,

$$R_n = \frac{\sum\left(\frac{P_n}{P_{n-1}} \cdot P_{n-1} q_0\right)}{\sum (P_0 q_0)} \times 100$$

gives the same result as Laspeyres' formula,

$$R_n = \frac{\sum (P_n q_0)}{\sum (P_0 q_0)} \times 100$$

The denominators of the two formulas are identical; and, for every item in the index, the numerators of the formula used here and of Laspeyres' formula are equivalent algebraically; since by calculation:

$$\frac{P_n}{P_{n-1}} \cdot P_{n-1} q_0 = P_n q_0$$

and

$$\sum\left(\frac{P_n}{P_{n-1}} \cdot P_{n-1} q_0\right) = \sum (P_n q_0)$$

therefore,

$$R_n = \frac{\sum\left(\frac{P_n}{P_{n-1}} \cdot P_{n-1} q_0\right)}{\sum (P_0 q_0)} \times 100$$

$$= \frac{\sum (P_n q_0)}{\sum (P_0 q_0)} \times 100$$

The statistician can effectively interpret Laspeyres' formula to the public by expressing it in terms of the comparison between the cost of buying the same market basket of goods and services at two different dates, since $p_n q_o$ is the cost of the market basket in period "n" and $p_o q_o$ is its cost in the base period. The market-basket interpretation of the index is equally applicable to the formula used in Capital City. The only difference between the two methods lies in the method of calculation of the cost of the market basket in period "n," as follows:

1. In Laspeyres' index, the cost of each item in the market basket in period "n" is computed by multiplying q_o, the fixed quantity of each item, by p_n, the average price of that item in the period "n." $P_n Q_0$

2. In the formula presented here, the cost of each item in the market basket in period "n" is computed by (a) finding the ratio of the price in that period to the price in the period immediately preceding, and (b) finding the cost of the item in period "n" by multiplying its cost in the immediately preceding period "n-1" by the price ratio. $\frac{P_n}{P_{n-1}}$ $P_{n-1} Q_0$

On first thought, the latter method may appear to be more complicated than the direct application of Laspeyres' formula. The chief advantage of the method used here lies in the fact that the linking process, by which the cost of every item in the market basket is adjusted from each period to each succeeding period by a price ratio, provides a convenient way to compare prices between the periods of time when certain pricing problems arise. For example, it is an important principle that the index should not be affected by price changes resulting from either (1) the substitution of an item having a different average price from the one it replaces, or (2) the distinct price ranges of different sellers. In chapters 4 and 5, the practical advantages of the recommended formula in revising the cost of a given item with the change in its price have been shown for the following situations:

1. The substitution of one seller for another.
2. The temporary lack of prices for one or more sellers.
3. The substitution of one item for another.
4. The temporary absence of prices for a seasonal item.
5. The temporary absence of prices for a nonseasonal item.
6. The introduction of a new item.
7. The removal of an item.

Nothing that has been said here should be interpreted as indicating that the use of Laspeyres' formula would rule out the handling of substitutions and problems of missing prices. But it should be recognized that the linking process included in the numerator of the recommended formula treats such statistical problems with ease and in a readily intelligible manner.

The Meaning of the Formula: An Arithmetic Example. To clarify what the terms of the formula stand for in the numerical computation, table 4 summarizes figures taken from Calculation Worksheets I and II and Tabulation Worksheet V in the computation of the all-items index for April 1963.

Table 4 illustrates the use of numerical values of the terms of the formula and the combining of them in the process of computing the all-items index. The April cost of each item was found, by multiplying the January cost of that item by the ratio of its April price to its January price. The cost of the market basket in April was the sum of the costs of the items which it comprised. The quotient (expressed as a relative number) obtained by dividing the April cost of the market basket by its cost in the base period gives the index for April.

Table 4. Parallel Between Formula and Numerical Computation

IN SYMBOLS					
Each item	Price Ratio April 1963 or $\frac{P_n}{P_{n-1}}$	times	Cost in Jan. 1963 or $P_{n-1} q_0$	equals	Cost in April 1963 or $P_n q_0$
IN NUMERICAL FORM					
Work trousers	1.0032	x	$10.03	=	$10.06
Dress trousers	1.0156	x	4.28	=	4.35
Workshirt	C	x	6.61	=	6.61
Etc.	...	x	...	=	...
Etc.	...	x	...	=	...
All items	xxx		xxx	Total	812.81

In the base period, 1960, the all-items cost had been $662.81 or $\sum (P_0 q_0)$

Hence, the index for April 1963 was $\frac{\$812.81}{\$662.81} \times 100 = 122.6$.

Total in Symbols: $\sum \left(\frac{P_n}{P_{n-1}} \cdot P_{n-1} q_0 \right)$

or

$\sum (P_n q_0)$

The Fixed Weights of the Index. Practical methods of computing an index often conceal the true nature of the weights used. In the recommended method the cost of the market basket is computed for the given period "n." Each price ratio comparing the average price in the given period with that in the preceding period, $\frac{p_n}{p_{n-1}}$, is given the relative importance determined by the cost, $p_{n-1}q_0$, of the item in the preceding period. It is important to realize, however, that the use of the costs from period "n-1" does not make these costs the weights of the index. The index in Capital City measures the average change in prices from the base period, and the weights used in averaging the price ratios showing this change, $\frac{p_n}{p_o}$, are the costs of each item in the base period p_oq_o. The use of price ratios to adjust the costs of each item may obscure the actual weights. But, no matter which of the many equivalent formulas is used, the true weight of the price change from the base period of each item in the index is the price of that item in the base period multiplied by the quantity of that item theoretically included in the market basket.

The formula which would show this most clearly would be:

$$R_n = \frac{\sum\left(p_oq_o \cdot \frac{p_n}{p_o}\right)}{\sum(p_oq_o)} \times 100$$

In this variation of the formula, it is obvious that the price increase or decrease from the base year is multiplied by (i.e., has a weight of) p_oq_o which is the "value weight" corresponding to that item.

In Capital City, this formula was not used; however, the formula used is equivalent to it, as will be shown below. To demonstrate that the formula in each quarter can be reduced by the cancellation of like terms to the same generalized form having as weights the "costs" of the various items in the base period, the formula as applied to each of the first three quarters after the base year 1960 of the Capital City index is taken as an illustration.

$$R_{JAN'61} = \frac{\sum\left(\cancel{P_{'60}}q_{'60} \cdot \frac{P_{JAN'61}}{\cancel{P_{'60}}}\right)}{\sum(P_{'60}q_{'60})} \times 100 = \frac{\sum(P_{JAN'61}q_{'60})}{\sum(P_{'60}q_{'60})} \times 100$$

$$R_{APR'61} = \frac{\sum\left(\cancel{P_{JAN'61}}q_{'60}\frac{P_{APR'61}}{\cancel{P_{JAN'61}}}\right)}{\sum(P_{'60}q_{'60})} \times 100 = \frac{\sum(P_{APR'61}q_{'60})}{\sum(P_{'60}q_{'60})} \times 100$$

$$R_{JULY'61} = \frac{\sum\left(\cancel{P_{APR'61}}q_{'60}\frac{P_{JULY'61}}{\cancel{P_{APR'61}}}\right)}{\sum(P_{'60}q_{'60})} \times 100 = \frac{\sum(P_{JULY'61}q_{'60})}{\sum(P_{'60}q_{'60})} \times 100$$

An examination of the above applications of the formula to three specific periods shows that the formula in each period can be reduced to an expression in which the weight corresponding to each item is the value p_0q_0.

$$R_n = \frac{\Sigma\left(p_0 q_0 \cdot \frac{p_n}{p_0}\right)}{\Sigma\left(p_0 q_0\right)}$$

Even when substitutions are made, the weights remain fixed. Although the quantity is not computed separately, the cost of an item at any date may be thought of as representing the product of the price of that item and the quantity q_0. If a higher priced quality is substituted for the original quality of an item, the quantity of the item figuratively included in the market basket will be reduced; but the cost corresponding to that item in the base period p_0q_0 will remain unchanged.

In this chapter several reasons are given why the recommended formula was chosen for Capital City, rather than Laspeyres'. The question still arises whether Laspeyres' formula, or one equivalent to it, is the best choice for an index of this type.

Why This Formula Was Chosen. An examination and appraisal of the numerous formulas for making index numbers would be beyond the scope of this manual, but the fact that Laspeyres' formula or its equivalent utilizes fixed weights results in several advantages which are listed below. These advantages are so cogent that this type of index is in widespread use throughout the world.

1. The meaning of an index made by Laspeyres' formula or its equivalent can be conveyed clearly and accurately to the public and to users of the index in general as a measure of the changes in the cost of a market basket. Written in fractional form, the numerator of the formula expresses the cost of the market basket in a given period and the denominator, its cost in the base year. The public readily understands that the index represents the comparison between these two costs.

2. There is an economy in the production of an index of this type since the fixed weights, once established, can be expected to serve for a considerable period of years without major revision. This is justifiable since, although no market basket can ever be permanent, the pattern of expenditures of a social group usually changes slowly.

3. The base of an index constructed by Laspeyres' formula can readily be shifted from one period to another. This is an advantage of the formula since, in practical statistical work, many occasions arise when it is convenient to change the base of the index.

4. A cost-of-living index with fixed quantity weights is especially suitable for use by economists in deflating time series expressed in monetary terms, such as income or expenditure series. An example of such a use is shown in the next section.

Shifting the Base of the Index and Using the Index for Deflating a Time Series. A cost-of-living index can be used to remove the effect of changes in the purchasing power of the monetary unit from a time series expressed in monetary units, provided the series relates to the group of persons whose purchases are represented in the index or one whose pattern of expenditures is assumed to be approximately the same. This procedure is known as deflation. Since Laspeyres' formula or its equivalent is based upon a market basket involving fixed quantities of goods and services, it reflects only changes in price levels. For this reason, it can be used to convert a time series in monetary units of shifting value to another expressed in terms of constant-value monetary units. As a preliminary step to deflating a time series, the base of the index, in table 5, will be shifted from 1950 to 1960.

Table 5. Average Hourly Earnings of Bus Drivers in Current Monetary Units and in 1960 Monetary Units, Capital City, 1950-63

Year	Cost-of-living index		Average hourly earnings	
	1950=100 (1)	1960=100 (1) X $\frac{100.0}{126.1}$ (2)	In current dollars (3)	In 1960 dollars (3) ÷ (2) X 100 (4)
1950.....	100.0	79.3	$0.51	$0.64
1955.....	112.8	89.5	.61	.68
1960.....	126.1	100.0	.70	.70
1961.....	120.4	95.5	.70	.73
1962.....	121.7	96.5	.74	.77
1963.....	123.0	97.5	.75	.77

In Capital City, there was interest in the 1963 average hourly earnings for bus drivers in terms of 1960 monetary units. Table 5 shows the procedure by which the wage series in current monetary units (col. 3) was converted to 1960 monetary units (col.4); the steps were as follows:

1. Each annual index with 1950 as base (col. 1) was multiplied by a ratio $\frac{100.0}{126.1}$, or 100 divided by the index for 1960, to shift the base of the index to 1960 (col. 2). For example, to calculate the index for any year; e.g., 1955, with respect to the new base year, 1960:

$$\frac{\text{Index for 1955 with 1960=100}}{\text{Index for 1955 on previous base}} = \frac{\text{Index for 1960 with 1960=100}}{\text{Index for 1960 on previous base}}$$

and substituting figures which can be read from Table 5,

$$\frac{\text{Index for 1955 with 1960=100}}{112.8} = \frac{100.0}{126.1}$$

and,

$$\text{Index for 1955 with 1960=100} = 112.8 \times \frac{100.0}{126.1} = 89.5$$

2. Each year's average hourly wage in current monetary units (col. 3) was divided by the corresponding index with 1960 as base (col.22) to get the wage series expressed in a constant monetary unit--that of 1960 (col. 4). Note that the answer must be multiplied by 100 to locate the decimal correctly, because of the form in which index numbers are written; e.g., 89.5 rather than .895. (See "Relative Number," page 7.)

Thus, in 1963, the average money earnings of $0.75 per hour are equivalent to earnings of $0.77 per hour in terms of the 1960 monetary unit. The average hourly earnings in 1963 will buy 10 percent more than the corresponding earnings of 1960, since $0.77 ÷ $0.70 = 1.10.

Summary

The formula used was a weighted average of price ratios expressed as a relative which gives the same index as Laspeyres' formula. The particular formula used here was chosen in preference to a direct use of Laspeyres' because its linking process provides a more convenient method of handling substitutions and gaps in the list of prices than does Laspeyres' formula. Among the reasons for the widespread adoption of Laspeyres' formula or an equivalent one (such as the one used for Capital City) are (1) the ease with which it can be interpreted, (2) the relatively low expenditure of man-hours and money required to make it, and (3) its usefulness for deflating time series.

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COMPUTATION OF COST OF LIVING INDEXES IN DEVELOPING COUNTRIES

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