

# **A GUIDE TO THE CONSUMER PRICE INDEX: 15th Series**

**2005**



# **A GUIDE TO THE CONSUMER PRICE INDEX**

**15th Series**

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**AUSTRALIAN BUREAU OF STATISTICS**

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Produced by the Australian Bureau of Statistics.

## INQUIRIES

- For further information about statistics in this publication and the availability of related unpublished statistics, contact Steve Whennan on (02) 6252 6251.

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**SECTION 1****INTRODUCTION**

*CPI a widely used economic indicator released quarterly*

The Consumer Price Index (CPI) is an important economic indicator. It provides a general measure of changes in prices of consumer goods and services purchased by Australian households. The CPI is used for a variety of purposes, such as in the development and analysis of government economic policy, the adjustment of some government benefits and in individual contracts. Because of this, the CPI directly or indirectly affects all Australians.

CPI figures are produced by the Australian Bureau of Statistics (ABS) for each quarter (three months ending March, June, September and December) and are typically released within one month of the end of the quarter. They appear in the publication *Consumer Price Index, Australia* (cat. no. 6401.0). In addition, key CPI results appear on the ABS website <http://www.abs.gov.au>

*CPI introduced in 1960. Now comprises 15 linked series*

The CPI was first compiled in 1960 (with index numbers backcast to 1948). It was initially designed to measure quarterly changes in retail prices of goods and services purchased by metropolitan wage earner households. The CPI was preceded by five series of retail price indexes compiled by the (then) Commonwealth Bureau of Census and Statistics. These series were titled the A, B, C, and D Series, and the Interim Retail Price Index respectively. The C Series Index, which began in 1921, was the principal retail price index in Australia prior to the introduction of the CPI.

The introduction of the CPI heralded a change in the approach to measuring retail price movements. Instead of the former emphasis on long-term, fixed-weight indexes, the CPI comprises a series of shorter-term indexes which are chain linked together to form a continuous long-term series. This approach allows changes in expenditure patterns to be reflected in the CPI. The CPI now comprises fifteen linked indexes.

*This guide*

The purpose of this guide is to provide a broad overview of the CPI; how to use the CPI; and how the CPI is calculated. It takes into account changes made with the introduction of the 15th series CPI in the September quarter 2005 and is suitable for general users. This publication is also available online at <http://www.abs.gov.au>

SECTION 2

WHAT IS THE CPI?

SEPTEMBER QUARTER 2005

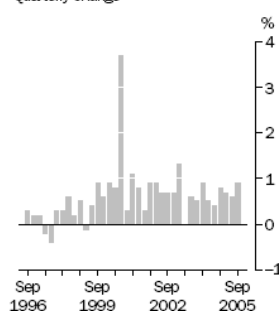
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CONSUMER PRICE INDEX

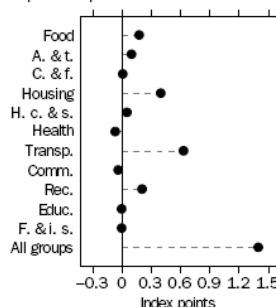
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All Groups  
Quarterly change



Contribution to quarterly change  
September quarter 2005



For further information about these and related statistics, contact Steve Whennan on Canberra (02) 6252 6251 or the National Information and Referral Service on 1300 135 070.

KEY FIGURES

WEIGHTED AVERAGE OF EIGHT CAPITAL CITIES

	Jun Qtr 2005 to Sep Qtr 2005 % change	Sep Qtr 2004 to Sep Qtr 2005 % change
Food	0.8	3.3
Alcohol and tobacco	1.0	3.5
Clothing and footwear	0.2	-1.8
Housing	1.4	3.9
Household contents and services	0.3	0.8
Health	-1.1	4.6
Transportation	3.3	5.9
Communication	-0.7	-1.0
Recreation	1.2	1.4
Education	0.0	6.3
Financial and insurance services	0.1	..
<b>All groups</b>	<b>0.9</b>	<b>3.0</b>
All groups excluding Housing and Financial and insurance services	1.0	3.0

KEY POINTS

THE ALL GROUPS CPI

- rose 0.9% in the September quarter 2005 compared with 0.6% in the June quarter.
- rose 3.0% through the year to September quarter 2005.

OVERVIEW OF CPI MOVEMENTS

- Contributing most to the overall increase this quarter were automotive fuel (+11.6%), house purchase (+1.2%), domestic holiday travel and accommodation (+3.4%), property rates and charges (+5.0%), beer (+1.8%), overseas holiday travel and accommodation (+2.0%), fruit (+3.0%), restaurant meals (+1.4%), rents (+0.6%), electricity (+1.7%) and water and sewerage (+3.0%).
- Partially offsetting these increases were falls in pharmaceuticals (-4.8%), deposit and loan facilities (-0.7%), audio, visual and computing equipment (-1.7%) and telecommunication (-0.7%).
- Using the points contribution data presented in table 7, the All groups CPI would have risen 0.5% in the September quarter 2005 if the effect of automotive fuel was excluded.

## OVERVIEW OF THE 15TH SERIES CPI

Consistent with the 13th and 14th series, the 15th series CPI has been specifically designed *as a general measure of price inflation for the household sector as a whole*. The CPI measures the changes in the price of a fixed basket of goods and services acquired by household consumers.

*CPI measures price change of a fixed basket of goods and services*

The simplest way of thinking about the CPI is to imagine a basket of goods and services comprising items bought by Australian households. Now imagine the basket is purchased each quarter. As prices change from one quarter to the next, so too will the total price of the basket. The CPI is simply a measure of the changes in the price of this fixed basket as the prices of items in it change.

*CPI reference population is all metropolitan private households*

The CPI measures price changes relating to the spending pattern of all metropolitan private households. This group is termed 'the CPI population group', and includes a wide variety of subgroups such as wage and salary earners, the self-employed, self-funded retirees, age pensioners, and social welfare beneficiaries. The term 'metropolitan' means the six State capital cities, Darwin and Canberra. The current series CPI population group represents about 64% of all Australian private households.

Ideally the CPI population group should encompass all Australian households, but this is not possible due to the substantial additional resources that would be required to collect prices outside the capital cities. ABS research has shown that, in general, price movements (as distinct from price levels) are similar across regions.

*Base period index number is 100.0*

The price of the CPI basket in the reference base period is expressed as an index by assigning it a value of 100.0 and the prices in other periods are expressed as percentages of the price in the base period. For example, if the price of the basket had increased by 35% since the base year, then the index would be 135.0; similarly, if the price had fallen by 5% since the base year, the index would stand at 95.0. The current reference base period for the CPI is 1989–90, although some component series have a base period other than 1989-90.

*CPI does not measure price levels*

It is important to remember that the CPI measures price movements (i.e. percentage changes) and not actual price levels (dollar amounts). For instance, the index for Breakfast cereals of 143.4 and for Bread of 186.6 in the September quarter 2005 does not mean that Bread is more expensive than Breakfast cereals. It simply means that the price of Bread has increased at about twice the rate of the price of Breakfast cereals since the base period.

*CPI is not a purchasing power or cost-of-living measure*

Although the CPI is also commonly referred to as a measure of changes in purchasing power or a cost-of-living index, in an economic context these terms are not strictly interchangeable with a measure of price inflation. Their measurement would require separate, purpose built

indexes. A single index cannot be expected to adequately fulfil all these roles.

An index designed to measure changes in the purchasing power of household incomes would need to be concerned with changes in the costs of all expenditures made from household income. Such a measure would include items like income tax and interest payments.

A true cost-of-living index, among other things, would need to be concerned with changes in standards of living and with the substitutions that consumers make in order to maintain their standard of living when faced with changing market conditions (for instance, buying chicken rather than beef when beef prices are high).

The CPI on the other hand is constructed by reference to a basket consisting only of actual goods and services acquired by households. Further, as the composition of this basket is held fixed from period to period, it cannot accurately reflect changing consumer preferences and substitutions made in response to changes in relative prices.

In recognition of the widespread interest in the extent to which the impact of price change varies across different groups in the community, the ABS compiles and publishes analytical indexes specifically designed to measure changes in living costs for four selected population subgroups: Employee households; Age pensioner households; Other government transfer recipient households; and Self-funded retiree households. The indexes are released annually in *Australian Economic Indicators* (cat. no. 1350.0)

These indexes represent the conceptually preferred measures for assessing the impact of changes in prices on the disposable incomes of households. In other words, these indexes are particularly suited for assessing whether or not the disposable incomes of households have kept pace with price changes. The most notable difference between these indexes and the CPI is that the living cost indexes include interest charges but do not include new house purchases, while the CPI includes new house purchases but does not include interest charges.

## HOW IS THE CPI USED?

*The CPI is used as a macroeconomic indicator and for adjusting dollar values*

The CPI affects almost all Australians because of the many ways in which it is used. The two most common uses of the CPI are:

- as a macroeconomic indicator. The CPI, and other index series derived from CPI data, are used by the Government and economists to monitor and evaluate levels of inflation in the Australian economy. Inflation (and inflationary expectations) play a major role in determining various aspects of Government economic policy, and in the business and investment decisions of private firms and individuals.
- as a means of maintaining dollar values. The value of many types of fixed payments such as social welfare benefits can be reduced over time when prices rise. The CPI is often used to adjust these payments to counter the effects of inflation. This process is referred to as 'indexation'. Indexation arrangements are also often applied to such things as rental agreements, insurance cover and child support payments.

*There are many different price indexes available*

Although the CPI is the best known price index, it is but one of many produced by the ABS. Examples of other price indexes include:

- producer price indexes
- labour price indexes
- house price indexes
- chained price indexes produced in conjunction with the Australian national accounts.

Having determined that a price index is required for a particular application it is important to carefully consider the range of available indexes and select the index which best meets the specific requirement. While the ABS can provide technical and statistical guidance, it does not provide advice on indexation practices and it cannot tell users which index they should use. These are matters for users to determine.

A general description of the range of issues that should be taken into account by parties considering an indexation clause have been published in, "*Price Indexes and Contract Price Indexation.*" This article is available on the ABS website, as Appendix 2 in the *CPI Concepts Sources and Methods* (cat. no. 6461.0) and as Appendix 3 in this Guide.

## THE CPI BASKET OF GOODS AND SERVICES

*CPI basket based on 2003-04 HES data*

The composition of the CPI basket is based on the pattern of household expenditure in the 'weighting base period', which is 2003-04 for the 15th series CPI. Information on the spending habits of Australian households during 2003-04 was obtained from the Household Expenditure Survey (HES) conducted by the ABS. The HES results provide the starting point for selecting the basket of goods and services to be priced for the CPI.

*CPI basket includes items representative of all consumer goods and services*

For practical reasons, the basket cannot include every item bought by households, but it does include all the important kinds of items. It is not necessary to include all the items people buy since many related items are subject to similar price changes. The idea is to select representative items so that the index reflects price changes for a much wider range of goods and services than is actually priced. Examples of the types of items included in the basket are shown in Appendix 2.

When determining what items are to be priced for the CPI basket, various factors are taken into consideration. Items:

- must be representative of purchases made by the CPI population group
- must have prices which can be associated with an identifiable and specific commodity or service (e.g. a 420g can of baked beans, or adult general admission to a league football game)
- are not excluded on the basis of moral or social judgements. For example, some people may regard the use of tobacco or alcohol as socially undesirable, but both are included in the CPI basket because they are significant items of household expenditure and their prices can be accurately measured.

Income-based taxes, however, are not included in the CPI because they cannot be clearly associated with the purchase or use of a specific good or service.

*Financial services*

Financial services provided by financial institutions and services associated with the acquisition and disposal of shares and real estate have been introduced into the CPI in the 15th series. Financial service costs are of two broad types: direct and indirect. Direct costs include fees and charges on credit cards, bank accounts, and service fees such as commissions charged by real estate agents. Indirect costs are essentially the interest margins applying to deposits and borrowings of households with financial institutions.

*The CPI groups*

The total basket is divided into 11 major groups, each representing a specific set of commodities:

- Food
- Alcohol and tobacco
- Clothing and footwear
- Housing
- Household contents and services
- Health
- Transportation
- Communication
- Recreation
- Education
- Financial and insurance services

These groups are divided in turn into 33 subgroups, and the subgroups into 90 expenditure classes. An expenditure class is a grouping of similar items, such as various types of motor vehicles.

See Appendix 1 (page 30) for a full list of groups, subgroups and expenditure classes and the figure on page 20 for an illustration of the CPI structure.

THE RELATIVE IMPORTANCE OF CPI ITEMS

The overall (or All groups) CPI provides a measure of the average rate of price change. In calculating an average measure of this type it is necessary to recognise that some items are more important than others. Price changes for the more important items should have a greater influence on the average than price changes for less important items. For example, if household expenditure on bread is three times as large as expenditure on cheese, then a 10% price increase for bread should have a similar impact on the CPI as a 30% price increase for cheese.

*CPI weights*

Measures of expenditure on each of the 90 CPI expenditure classes are obtained primarily from the HES. However, some adjustments are made to HES data to account for known instances of underreporting (the most notable being for alcohol and tobacco) and any other anomalies. The adjusted HES data are then used to derive a 'weight' for each expenditure class. The weights for the 15th series CPI expenditure classes at June quarter 2005 prices are shown in Appendix 1.

The weights reflect the relative expenditures of the CPI population group as a whole and not those of any particular type and size of household. As such, the weights are said to reflect expenditures of households on average and **not** the expenditure of an average household.

The description of the CPI as measuring the change in price of a *fixed* basket of goods and services requires some qualification.

*Basket is fixed in terms of underlying quantities at the expenditure class*

First, although the weights are expressed in terms of expenditure shares, it is not the expenditure shares that are held constant (or fixed) from period to period. What is held constant are the quantities of goods and services underpinning these expenditures (where expenditure is the product of quantity and price). Presentation of weights in expenditure terms reflects the fact that it is simply not possible to present quantity weights in a meaningful way. The relative expenditure shares of items will change over time in response to changes in relative prices.

*Weights below the expenditure class can be varied*

Second, while the implicit quantity weights are held constant at the expenditure class level, the weights of items within an expenditure class (e.g. different grades of bread) can be varied between periodic reviews to reflect changed purchasing patterns. Any weight changes are introduced into the CPI in such a way as to not affect the level of the index.

*Update of fixed weights*

The underlying quantity weights for CPI expenditure classes are updated at approximately five yearly intervals with the timing generally linked to the availability of HES data. The introduction of new weights resulting from these updates is signalled by the commencement of a new CPI series (e.g. the 15th series CPI was introduced in September quarter 2005). Updating the weights is a key objective of the overall CPI review process. CPI reviews are discussed on page 10.

#### COLLECTING PRICES FOR THE CPI

The collection of prices in each capital city is largely carried out by trained field staff operating out of the various offices of the ABS, while some prices are collected by special surveys out of the Canberra office.

*CPI goods and services priced at many different types of outlets*

Prices are collected in the kinds of retail outlets and other places where metropolitan households purchase goods and services. This involves collecting prices from many sources such as supermarkets, restaurants, travel agents and schools. Prices are collected via personal visit, telephone or internet as appropriate.

*CPI based on 100,000 price quotations each quarter*

Prices for items such as rail transport services, electricity and gas supply and telephone services are collected from the authorities concerned. Information on rents is obtained from property management companies and from government housing commissions. In total, around 100,000 separate price quotations are collected each quarter.

The frequency of price collection by item varies as necessary to obtain reliable price measures. Prices of some items are volatile (i.e. their prices may vary many times each quarter) and for these prices frequent price observations are necessary to estimate a reliable average quarterly price. Each month prices are collected at regular intervals for goods such as petrol, fresh meat, fruit and vegetables, and women's outerwear.

For most other items price volatility is not a problem and prices are collected once a quarter. There are a few items where prices are changed at infrequent intervals, for example education services where prices are set once a year. In these cases the frequency of price collection is modified accordingly.

Prices collected are what people actually pay

The prices used in the CPI are those that any member of the public would have to pay to purchase the specified good or service. Any taxes levied on goods or services (such as the GST) are included in the CPI price. Similarly, prices include any subsidy or assistance provided directly by government (e.g. Child Care Benefit, Medicare). Sale prices, discount prices and 'specials' are reflected in the CPI so long as the items concerned are of normal quality (i.e. not damaged or shopsoiled), and are offered for sale in reasonable quantities. Any concessions available to particular groups of the population (such as age pensioners) are also taken into account where significant.

The measurement of price inflation has implications for pricing certain items in the CPI. Of particular note are financial services and general insurances (other than hospital and medical). The pricing of financial services is described in *Information Paper: Experimental Price Indexes for Financial Services 1998-2003* (cat. no. 6413.0). For general insurance, where the objective is to price the insurance service rather than the total premiums paid, see Keith Woolford "Treatment of Insurance Services in the Australian Consumer Price Index", *Australian Economic Indicators*, October 2000 (cat. no. 1350.0) for further information.

To ensure that price movements are representative of the experiences of metropolitan households, the brands and varieties of the goods and services which are priced are generally those which sell in greatest volume.

## CHANGES IN QUALITY

In concept quality embraces all the attributes of an item which consumers would consider before making a purchase. For example in the case of tinned tomato soup it would include the volume or weight of the contents as well as the concentration and flavour.

Prices adjusted for changes in quality

As the CPI aims to measure price changes for a fixed basket of goods and services over time, identical or equivalent items must be priced in successive periods. However, products do change; their components or ingredients may change resulting in an improvement or degradation in quality. As the characteristics of products are altered, the statisticians responsible for the price index attempt to separate the effects of a quality change from any underlying price changes so that the CPI measures 'pure' price change. A simple example of quality adjustment is shown on page 12.

Quality change can be difficult to measure

The requirement to take account of changes in quality, to ensure that the index reflects only pure price change, often poses difficult measurement problems and in some cases is impossible in practice. For example, while it is fairly easy to monitor changes in rail or bus ticket prices, it is difficult to attach a dollar value to changes in the quality (e.g. frequency or punctuality of the service).

PERIODIC REVIEWS OF THE CPI

*CPI reviewed at five-yearly intervals*

Like any other long-standing and important statistical series, the CPI is reviewed from time to time to ensure that it continues to meet community needs. The ABS undertakes these reviews at approximately five yearly intervals with timing generally (though not necessarily) linked to the availability of results from the HES.

An important objective of these reviews is to update item weights to reflect changes in the range of available goods and services and changes in household spending patterns. They also provide an opportunity to reassess the scope and coverage of the index and other methodological issues.

Following these reviews, the new CPI series is linked to the old to form a continuous series. This linking is carried out in such a way that the resulting continuous series reflects only pure price change and not differences in the cost of the old and new baskets.

The reference base period for the CPI is also updated, but at less frequent intervals. Changes in reference base periods have no effect (other than rounding) on percentage changes, which are calculated from the index numbers.

*Major review conducted in 1998*

The last significant review of the CPI resulted in the 13th series of the index being introduced in respect of September quarter 1998. A major outcome of that review was the decision that the CPI would change from a measure of the change in living costs of employee households to a general measure of price inflation for the household sector. Consequently the population coverage was expanded from wage and salary earner households to include all metropolitan households. Weights were revised to reflect expenditure patterns from the 1993-94 HES.

*14th Series Review in 2000*

The 14th series CPI was introduced in September quarter 2000 after a minor review. The item weights were revised in line with 1998-99 HES expenditure patterns and a new utility based commodity classification was introduced to address issues arising from the introduction of The New Tax System (TNTS).

*15th Series Review in 2005*

The 15th series CPI introduced in September quarter 2005 was also a minor review. The item weights were revised in line with 2003-04 HES expenditure patterns and 'Financial services' were included in the index.

HOW DOES THE CPI RELATE TO ME?

*CPI unlikely to reflect the price experience of individual households*

The CPI is designed to measure changes in retail prices experienced by metropolitan private households in aggregate. The composition of the basket and the relative importance of items in it relate to this population group as a whole - it represents the expenditures of all in-scope households, not the expenditure pattern of the average household or of any particular household type or size. The basket comprises all consumer goods and services acquired over a twelve month period. It includes items acquired infrequently by an individual household (e.g. major electrical appliances, new motor vehicles), items that are acquired almost daily by all households (e.g. bread and milk) and items that are only available at certain times of the year. The basket includes, for example, both rent payments of renting households and the amounts paid by owner-occupier households for the purchase of their principal residence — clearly no individual household can incur both expenses at the same time. Therefore, changes in the CPI are unlikely to reflect exactly the price experience of any particular household.

The CPI does not measure those changes in living costs which may be experienced by individual households as a direct consequence of their progression through the life cycle. For example younger households may incur a higher proportion of their expenditure on housing and child care while those households entering the older age groups may incur increasing expenditure on medical services. However, changes in the demographic make-up of households in aggregate and differences in expenditure patterns will affect the pattern of total household expenditure recorded in the HES. In turn, these changes will be incorporated in the weighting pattern in the CPI.

*CPI cannot be used to measure price levels*

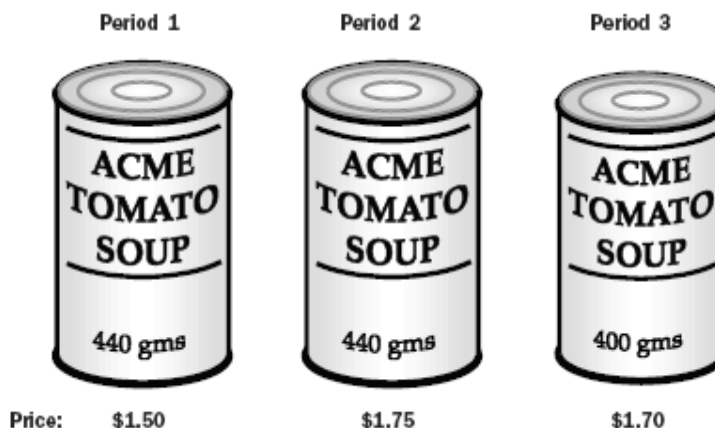
The CPI is not designed to measure price levels; rather its purpose is to measure changes in prices over time. While price levels in country regions often differ from those in metropolitan areas (some higher and others lower), the factors influencing price movements generally tend to be similar. Therefore the CPI can be expected to provide a reasonable indication of the changes in prices in Australia as a whole in the longer term.

Similarly, the CPI cannot be used to compare price levels between capital cities. For example, the fact that the CPI All groups index in the September quarter 2005 for Adelaide (153.4) was higher than in Perth (147.8) does not indicate that Adelaide was more expensive to live in than Perth. Rather, it indicates that prices in Adelaide had risen more than in Perth since 1989-90.

At the end of the day, the CPI is most useful as an *indicator* of price movements, whether it be for specific items, a particular city, or the economy as a whole. The CPI is not a precise measure of individual household price experiences.

EXAMPLE: ADJUSTING FOR QUALITY

To illustrate the process used to adjust for changes in the quality of items priced in the CPI, consider the case of a change in the size of a can of tomato soup. In this example, Acme brand tomato soup is priced in three periods (1, 2 and 3) and the size of the can is reduced from 440gms to 400gms between period 2 and period 3:



Using the observed prices produces the following measures of price change:

<u>Period 1 to Period 2</u>	<u>Period 2 to Period 3</u>	<u>Period 1 to Period 3</u>
$(1.75 - 1.50) / 1.50 \times 100$	$(1.70 - 1.75) / 1.75 \times 100$	$(1.70 - 1.50) / 1.50 \times 100$
= 16.7%	= -2.9%	= 13.3%

However, this does not provide a measure of 'pure price' change because the item priced in period 3 is not identical to the item priced in the previous periods. What is required for period 3 is the 'price that would have been paid for the item that was priced in period 2'. This price can be estimated by adjusting the period 3 price by the ratio of the item's weight in period 2 to its weight in period 3, giving a quality adjusted price of \$1.87 ( $\$1.70 \times 440/400$ ).

Using this adjusted price in period 3 results in the following correct measures of price change:

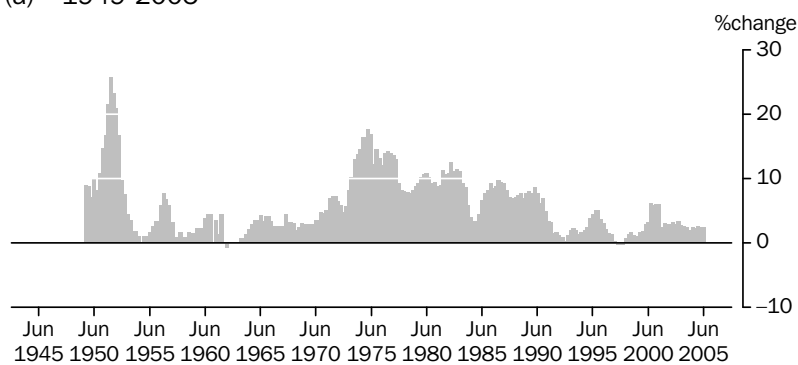
<u>Period 1 to Period 2</u>	<u>Period 2 to Period 3</u>	<u>Period 1 to Period 3</u>
$(1.75 - 1.50) / 1.50 \times 100$	$(1.87 - 1.75) / 1.75 \times 100$	$(1.87 - 1.50) / 1.50 \times 100$
= 16.7%	= 6.9%	= 24.7%

After adjusting for the reduction in quality between periods 2 and 3, the fall in the observed price of 2.9% has been translated into a pure price increase of 6.9%. Similarly, the measure of price change between periods 1 and 3 has been increased from 13.3% to 24.7%.

## SECTION 3

## USING THE CPI

HISTORY OF THE CONSUMER PRICE INDEX, Annual percentage changes  
(a)—1949-2005



Note: (a) Percentage change from corresponding quarter of previous year

Source: *Consumer Price Index, Australia*  
(cat. no. 6401.0)

## INTERPRETING INDEX NUMBERS

*Why use index numbers?*

Deriving useful price measures for single, specific items such as Granny Smith apples is a relatively straightforward exercise. An estimate of the average price per kilogram in each period is sufficient for all applications. Price change between any two periods would simply be calculated by direct reference to the respective average prices.

However, if the requirement is for a price measure that covers a number of diverse items, the calculation of a 'true' average price is both complicated and of little real meaning. For example, consider the problem of calculating and interpreting an average price for two commodities as diverse as apples and motor vehicles. Because of this, price measures such as the CPI are typically presented in index number form.

*Description of a price index*

Price indexes provide a convenient and consistent way of presenting price information that overcomes problems associated with averaging across diverse items. The index number for a particular period represents the average price in that period relative to the average price in some base period for which, by convention, the average price has been set to equal 100.0.

A price index number on its own has little meaning. For example, the CPI All groups index number of 149.8 in the September quarter 2005 says nothing more than the average price in September quarter 2005 was 49.8% higher than the average price in the base year 1989–90 (when the index was set to 100.0). The value of index numbers stems from the fact that index numbers for any two periods can be used to directly calculate price change between the two periods.

*Percentage change is different to a change in index points*

Movements in indexes from one period to any other period can be expressed either as changes in index points or as percentage changes. The following example illustrates these calculations for the All groups CPI (weighted average of the eight capital cities) between the September quarter 2004 and the September quarter 2005. The same procedure is applicable for any two periods.

Index numbers:

September quarter 2005	149.8
<i>less</i> September quarter 2004	145.4
equals change in index points	4.4

$$\text{Percentage change} = 4.4/145.4 \times 100 = 3.0\%$$

*Movements in the CPI best measured using percentage changes*

For most applications, movements in price indexes are best calculated and presented in terms of percentage change. Percentage change allows comparisons in movements that are independent of the level of the index. For example, a change of 2 index points when the index number

is 120 is equivalent to a percentage change of 1.7%, but if the index number was 80 a change of 2 index points would be equivalent to a percentage change of 2.5%—a significantly different rate of price change. Only when evaluating change from the base period of the index will the points change be numerically identical to the percentage change.

*Percentage changes are not additive*

The percentage change between any two periods *must* be calculated, as in the example above, by direct reference to the index numbers for the two periods. Adding the individual quarterly percentage changes will not result in the correct measure of longer-term percentage change. That is, the percentage change between say the June quarter one year and the June quarter of the following year typically will not equal the sum of the four quarterly percentage changes. The error becomes more noticeable the longer the period covered and the greater the rate of change in the index. This can readily be verified by starting with an index of 100 and increasing it by 10% (multiplying by 1.1) each period. After four periods, the index will equal 146.4 delivering an annual percentage change of 46.4%, not the 40% given by adding the four quarterly changes of 10%.

*Calculating index numbers for periods longer than quarters.*

Although the CPI is compiled and published as a series of quarterly index numbers, its use is not restricted to the measurement of price change between particular quarters. Because a quarterly index number can be interpreted as representing the average price during the quarter, index numbers for periods spanning more than one quarter can be calculated as the simple (arithmetic) average of the relevant quarterly indexes. For example, an index number for the year 2004 would be calculated as the arithmetic average of the index numbers for the March, June, September and December quarters of 2004.

This characteristic of index numbers is particularly useful. It allows for comparison of average prices in one year (calendar or financial) with those in any other year. It also enables prices in say the current quarter to be compared with the average prevailing in some prior year.

## ANALYSING THE CPI

The quarterly change in the All groups CPI represents the weighted average price change of all the items included in the CPI. While publication of index numbers and percentage changes for components of the CPI are useful in their own right, these data are often not sufficient to enable important contributors to overall price change to be reliably identified. What is required is some measure that encapsulates both an item's price change and its relative importance in the index.

*Points contribution and points contribution change*

If the All groups index number is thought of as being derived as the weighted average of indexes for all its component items, the index number for a component multiplied by its weight to the All groups index results in what is called its 'points contribution'. It follows that the change in a component item's points contribution from one period

to the next provides a direct measure of the contribution to the change in the All groups index resulting from the change in that component's price.

Information on points contribution and points contribution change is of immense value when analysing sources of price change and for answering 'what if' type questions. Consider the following data extracted from the September quarter 2005 CPI publication:

Item	Index numbers		Percent change	Points contribution		Points change
	June qtr	September qtr		June qtr	September qtr	
All groups	148.4	149.8	0.9	148.4	149.8	1.4
Automotive fuel	182.6	203.7	11.6	5.62	6.26	0.64

#### Using points contributions

Using only the index numbers themselves, the most that can be said is that between the June and September quarters 2005, the price of Automotive fuel increased by more than the overall CPI (by 11.6% compared with an increase in the All groups of 0.9%). The additional information on points contribution and points change can be used to:

- Calculate the effective weight for Automotive fuel in the June and September quarters** (given by the points contribution for Automotive fuel divided by the All groups index). For June, the weight is calculated as  $5.62/148.4 \times 100 = 3.8\%$  and for September as  $6.26/149.8 \times 100 = 4.2\%$ . Although the underlying quantities are held fixed, the effective weight in expenditure terms has increased due to the prices of Automotive fuel increasing by more than the prices of all other items in the CPI basket (on average).
- Calculate the percentage increase that would have been observed in the CPI if all prices other than those for Automotive fuel had remained unchanged** (given by the points change for Automotive fuel divided by the All groups index number in the previous period). For September quarter 2005 this is calculated as  $0.64/148.4 \times 100 = 0.4$ . In other words, a 11.6% increase in Automotive fuel prices in September quarter 2005 would have resulted in an increase in the overall CPI of 0.4 percentage points.
- Calculate the average percentage change in all other items excluding Automotive fuel** (given by subtracting the points contribution for Automotive fuel from the All groups index in both quarters and then calculating the percentage change between the resulting numbers which represent the points contribution of the 'other' items). For the above example, the numbers for All groups excluding Automotive fuel are: June,  $148.4 - 5.62 = 142.8$ ; September,  $149.8 - 6.26 = 143.5$ ; and the percentage change,  $(143.5 - 142.8)/142.8 \times 100 = 0.5\%$ . In other words, prices of all items other than Automotive fuel increased by

0.5% on average between the June and September quarters 2005.

**d) Estimate the effect on the All groups CPI of a forecast change in the prices of one of the items** (given by applying the forecast percentage change to the items points contribution and expressing the result as a percentage of the All groups index number). For example, if prices of Automotive fuel were forecast to increase by 25% in December quarter 2005, then the points change for Automotive fuel would be  $6.26 \times 0.25 = 1.6$ , which would deliver an increase in the All groups index of  $1.6/149.8 \times 100 = 1.1\%$ . In other words, a 25% increase in Automotive fuel prices in December quarter 2005 would have the effect of increasing the CPI by 1.1%. Another way commonly used to express this impact is 'Automotive fuel' would contribute 1.1 percentage points to the change in the CPI.

#### *ABS rounding conventions*

To ensure consistency in the data produced from the CPI, it is necessary for the ABS to adopt a set of consistent rounding conventions or rules for the calculation and presentation of data. The conventions strike a balance between maximising the usefulness of the data for analytical purposes and retaining a sense of the underlying precision of the estimates. These conventions need to be taken into account when using CPI data for analytical or other special purposes.

Index numbers are always published to a reference base of 100.0. Index numbers and percentage changes are always published to one decimal place, with the percentage changes being calculated from the rounded index numbers. Points contributions are published to two decimal places, with points contributions change being calculated from the rounded points contributions. Index numbers for periods longer than a single quarter (e.g. for financial years) are calculated as the simple arithmetic average of the relevant rounded quarterly index numbers.

#### SOME EXAMPLES ON USING THE CPI

The following questions and answers illustrate the uses that can be made of the CPI.

**Question:** *What would \$200 in 2000 be worth in September quarter 2005?*

*CPI can be used to compare money values over time*

**Response:** This question is best interpreted as asking 'How much would need to be spent in September quarter 2005 to purchase what could be purchased in 2000 for \$200?' As no specific commodity is mentioned, what is required is a measure comparing the general level of prices in September quarter 2005 with the general level of prices in calendar 2000. The All groups CPI would be an appropriate choice.

Because CPI index numbers are not published for calendar years, two steps are required to answer this question. The first is to derive an index for calendar 2000. The second is to multiply the initial dollar amount by

the ratio of the index for September quarter 2005 to the index for 2000.

The index for calendar 2000 is obtained as the simple arithmetic average of the quarterly indexes for March (125.2), June (126.2), September (130.9) and December (131.3) 2000 giving 128.4 rounded to one decimal place. The index for September quarter 2005 is 149.8.

The answer is then given by:

$$\$200 \times 149.8/128.4 = \$233.33.$$

**Question:** *Household Expenditure Survey data show that average weekly expenditure per household on the purchase of motor vehicles increased from \$42.64 in 1998–99 to \$49.47 in 2003–04 (i.e. an increase of 16%). Does this mean that households, on average, purchased 16% more motor vehicles in 2003–04 than they did in 1998–99?*

*Indexes used should be representative of specific items*

**Response:** This is an example of one of the most valuable uses that can be made of price indexes. Often the only viable method of collecting and presenting information about economic activity is in the form of expenditure or income in monetary units (e.g. dollars). While monetary aggregates are useful in their own right, economists and other analysts are frequently concerned with questions related to volumes, for example, whether more goods and services have been produced in one period compared with another period. Comparing monetary aggregates alone is not sufficient for this purpose as dollar values can change from one period to another due to either changes in quantities or changes in prices (most often a combination).

To illustrate this, consider a simple example of expenditure on oranges in two periods. The product of the quantity and the price gives the expenditure in any period. Suppose that in the first period 10 oranges were purchased at a price of \$1.00 each and in the second period 15 oranges were purchased at a price of \$1.50 each. Expenditure in period one would be \$10.00 and in period two \$22.50. Expenditure has increased by 125%, yet the volume (number of oranges) has only increased by 50% with the difference being accounted for by a price increase of 50%. In this example all the price and quantity data are known, so volumes can be compared directly. Similarly, if prices and expenditures are known, quantities can be derived.

But what if the actual prices and quantities are not known? If expenditures are known and a price index for oranges is available, the index numbers for the two periods can be used *as if they were prices* to adjust the expenditure for one period to remove the effect of price change. If the price index for oranges was equal to 100.0 in the first period, the index for the second period would equal 150.0. Dividing expenditure in the second period by the index number for the second period and multiplying this result by the index number for the first period provides an estimate of the expenditure that would have been observed in the second period had the prices remained as they were in the first period. This can easily be demonstrated by reference to the

oranges example:

$$\$22.50/150.0 \times 100.0 = \$15.00 = 15 \times \$1.00$$

So, without ever knowing the actual volumes (quantities) in the two periods, the adjusted second period expenditure (\$15.00), can be compared with the expenditure in the first period (\$10.00) to derive a measure of the proportional change in volumes  $\$15/\$10 = 1.50$ , which equals the ratio obtained directly from the comparison of the known quantities.

We now return to the question on expenditure on motor vehicles recorded in the HES in 1998-99 and 2003-04. As the HES data relates to the average expenditure of Australian households, the ideal price index would be one that covers the retail prices of motor vehicles for Australia as a whole. The price index which comes closest to meeting this ideal is the index for the Motor vehicles expenditure class of the CPI for the weighted average of the eight capital cities. The Motor vehicles index number for 1998-99 is 105.9 and for 2003-04 it is 103.1. Using these index numbers, recorded expenditure in 2003-04 (\$49.47) can be adjusted to 1998-99 prices as follows:

$$\$49.47/103.1 \times 105.9 = \$50.81$$

The adjusted 2003-04 expenditure of \$50.81 can then be compared to the expenditure recorded in 1998-99 (\$42.64) to deliver an estimate of the change in volumes. This indicates a volume increase of 19.2%.

**Question:** *What would be the impact of a 10% increase in vegetable prices on the All groups CPI in the September quarter 2005?*

*Forecasting impact of price changes on the CPI*

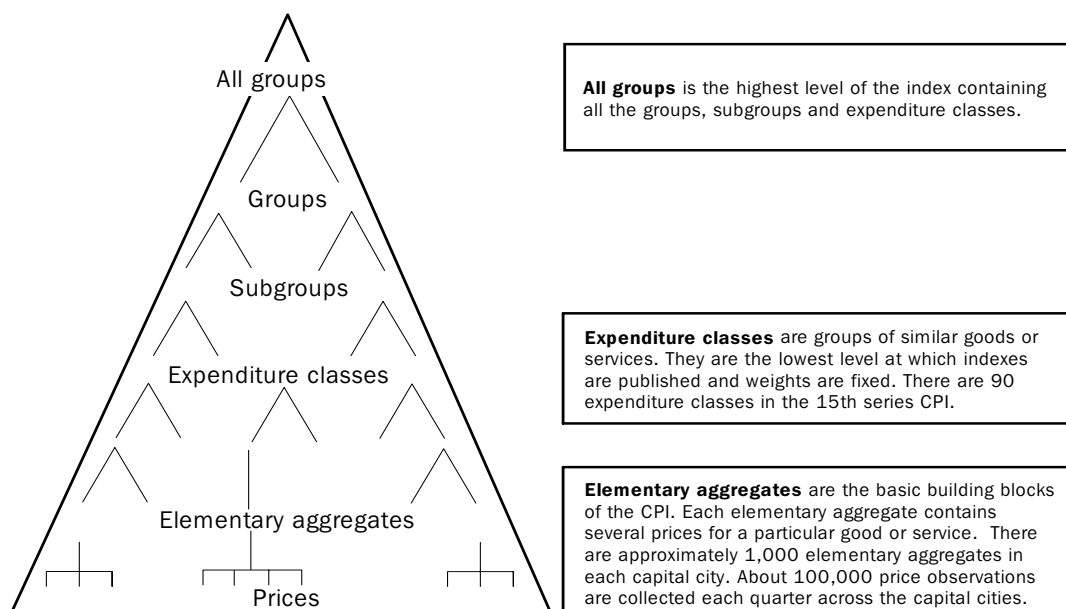
**Response:** Two pieces of information are required to answer this question; the All groups index number for September quarter 2005 (149.8), and the September quarter 2005 points contribution for Vegetables (1.71).

An increase in vegetable prices of 10% would increase vegetables points contribution by  $1.71 \times 10/100 = 0.17$  index points which would result in an All groups index number of 150.0, an increase of 0.1%.

## SECTION 4

## CALCULATING THE CPI

## CONSUMER PRICE INDEX STRUCTURE



## OVERVIEW

The CPI has previously been described in terms of a basket of goods and services which is 'purchased' each quarter. As prices change from one quarter to the next so too will the total cost (or price) of the basket. Of the various ways in which a CPI could be described, this description conforms most closely with the procedures actually followed.

Using this description, the construction of the CPI can be thought of as being done in four major steps:

1. subdividing the total expenditure into individual items for which price samples can be selected
2. collecting price data
3. estimating price movements for individual items
4. calculating the current period cost of the basket.

SUBDIVIDING THE  
BASKET

*Expenditure aggregates*

Based mainly on the HES, estimates are obtained for total annual expenditure of private households in each capital city for each of the 90 expenditure classes in the CPI. As these estimates relate to the expenditure of households in aggregate, they are referred to as 'expenditure aggregates'.

While these expenditure aggregates are derived for well defined categories of household expenditure (e.g. bread), they are still too broad to be of direct use in selecting price samples. For this purpose, expenditure aggregates need to be subdivided into as fine a level of commodity detail as possible. As the HES is generally not designed to provide such fine level estimates, it is necessary to supplement the HES data with information from other sources such as other official data collections and industry data. The processes involved are illustrated below by reference to a stylised example for the Bread expenditure class of the CPI.

Suppose that, based on information reported in the HES, the annual expenditure on bread by all private households in a particular city is estimated at \$8m. Further, suppose that there exists separately some industry data on the market shares of various types of bread. In combination these two data sources can be used to derive expenditure aggregates at a much finer level of detail than that available from the HES alone. The results are shown in the following table.

<i>Type of bread</i>	<i>Market Share</i>	<i>HES data</i>	<i>Derived expenditure aggregates</i>
	%	\$' 000	\$'000
1 White, sandwich, sliced	30	—	2,400
2 White, sandwich, unsliced	2	—	160
3 White high fibre	20	—	1,600
4 White high top	3	—	240
5 Wholemeal	10	—	800
6 Multigrain	15	—	1,200
7 Bread rolls	15	—	1,200
8 Specialty	5	—	400
<b>Total Bread</b>	<b>100</b>	<b>8,000</b>	<b>8,000</b>

The next stage in the process involves determining the types of bread for which price samples should be constructed. This is not as simple an exercise as might be imagined and relies heavily on the judgement of the prices statisticians. In reaching decisions about precisely which items to include in price samples, the prices statisticians need to strike a balance between the cost of data collection (and processing) and the accuracy of the index. Factors taken into account include the relative significance of individual items, the extent to which different items are likely to exhibit similar price behaviour, and any practical problems associated with measuring prices to constant quality.

In this example, a reasonable outcome would be to decide to construct price samples for items 1, 3, 5 and 6. Separate price samples would not be constructed for items 2 and 4 due to their relatively small market share. Price samples would also not be constructed for items 7 and 8 (bread rolls and specialty breads) as they would prove difficult to price to constant quality due to the tendency for these items to be sold by number rather than weight.

*Elementary aggregates must have a price sample*

The items for which it is decided to construct specific price samples are referred to as 'elementary aggregates'. (There are approximately 1,000 elementary aggregates for each of the eight capital cities, or approximately 8,000 price samples at the national level.) The expenditure aggregates for the items that are not to be explicitly priced are reallocated across the elementary aggregates in such a way as to best preserve the representativeness of the price samples. In this example, this would be done in two stages. First, the expenditure aggregate for item 2 would be allocated to item 1 and the expenditure aggregate for item 4 would be allocated to item 3. In the second stage, the expenditure aggregates for items 7 and 8 would be allocated, on a proportional basis, across the four elementary aggregates. This process is illustrated in the following table.

Type of bread	Expenditure aggregates			Elementary aggregate
	Initial	Stage 1	Stage 2	
	\$'000	\$'000	\$'000	
1	2,400	2,560	3,200	White sandwich
2	160	—	—	
3	1,600	1,840	2,300	White high fibre
4	240	—	—	
5	800	800	1,000	Wholemeal
6	1,200	1,200	1,500	Multigrain
7	1,200	1,200	—	
8	400	400	—	
<b>Total</b>	<b>8,000</b>	<b>8,000</b>	<b>8,000</b>	

The rationale for this allocation is as follows. Price behaviour of item 2 (white, sandwich, unsliced) is likely to be best represented by the price behaviour of item 1 (white, sandwich, sliced). Similarly for items 4 and 3. Price behaviour for items 7 and 8 (bread rolls and specialty bread) is likely to be best represented by the average price behaviour of all other breads.

#### *Determining outlet types*

Having settled on the items for which price samples are to be constructed, the next step is to determine the outlet types (respondents) from which prices will be collected. In order to accurately reflect changes in prices paid by households for bread, prices need to be collected from the various types of outlets from which households purchase bread. Data are unlikely to be available on the expenditure at the individual elementary aggregate level by type of outlet. It is more likely that data will be available for expenditure on bread in total by type of outlet. Suppose industry data indicates that supermarkets accounted for about 80% of bread sales and hot bake outlets the remainder. A simple way to construct the price sample for each elementary aggregate that is representative of household shopping patterns is to have a ratio of four prices from supermarkets to every hot bake price.

## COLLECTING PRICE DATA

#### *Selecting respondents*

When price samples have been determined, ABS field staff determine from which individual supermarkets and hot bakes the prices will be collected. The individual outlets are chosen to be representative of the two types of outlets taking into account many perspectives. For example, the outlets should be representative of the socio-economic characteristics of the city. The prices are collected each quarter from the same respondents for the same items.

#### *Selecting items to price*

When a respondent is first enrolled in the collection process the field staff will determine, in conjunction with the outlet management, which specific items are best representative of each elementary aggregate. For example, at one outlet it might be decided that the 680gm sliced white sandwich loaf is best representative of white sandwich bread; at another outlet it might be a 700gm white toast sliced sandwich loaf.

An important part of the ongoing price collection process is the monitoring of the items for quality change. In the stylised bread example quality change could occur in various ways. A possible quality change would be a change in the size (weight) of the loaf of bread. In this case prices would be adjusted to derive a pure price for the item along the lines illustrated in the example on page 12. Individual item prices are also compared with prices collected in the previous period to check their accuracy and to verify any large movements.

ESTIMATION OF PRICE  
MOVEMENTS FOR  
ELEMENTARY  
AGGREGATES

Price samples are constructed for the sole purpose of estimating price movements for each elementary aggregate. These estimates of price movements are required to revalue the expenditure aggregates to current period prices in much the same way as illustrated in the example on using price indexes (see page 17). This is achieved by applying the period to period price movement to the previous period's expenditure aggregate for each elementary aggregate. It provides an estimate of the cost of acquiring the base period quantity of the elementary aggregate in the current quarter.

*Four options for calculating  
price movement*

There is no single correct method for calculating the price movement for a sample of observations. Four commonly used methods are described below, using as an example price observations from two periods for multigrain bread.

	<i>Price observations in</i>		<i>Price</i>	<i>Estimates of</i>
	<i>Period 1</i>	<i>Period 2</i>		
	\$	\$		
	(a)	(b)	(b)/(a)	
<b>Outlet data</b>				
<b>Supermarket A</b>	<b>1.50</b>	<b>1.80</b>	1.200	..
<b>Supermarket B</b>	<b>1.60</b>	<b>1.90</b>	1.188	..
<b>Supermarket C</b>	<b>1.85</b>	<b>1.50</b>	0.811	..
<b>Supermarket D</b>	<b>1.75</b>	<b>1.50</b>	0.857	..
<b>Hot bake</b>	<b>2.00</b>	<b>2.20</b>	1.100	..
<i>Average prices</i>				
Arithmetic mean	1.74	1.78	..	..
Geometric mean	1.73	1.76	..	..
Four methods of calculating price movement:				
<i>Relative of average prices</i>				
Arithmetic mean	..	..	..	1.023
Geometric mean	..	..	..	1.017
<i>Average of price relatives</i>				
Arithmetic mean	..	..	..	1.031
Geometric mean	..	..	..	1.017

The differences between the four methods involve choices as to:

- whether the price movement for the sample is calculated as the average of each period's prices or as the average of price movements between periods for each item
- the type of average used.

The two commonly used forms of average are the arithmetic mean and the geometric mean. For a sample of  $n$  price observations, the arithmetic mean is the sum of the individual prices divided by the number of observations, while the geometric mean is the  $n^{\text{th}}$  root of the product of the prices. For example, the arithmetic mean of 4 and 9 is 6.5, while the

geometric mean is 6 (the geometric mean is always less than or equal to the arithmetic mean).

*Relative of arithmetic mean  
prices*

Based on these options, one method is to construct a ratio of the arithmetic average prices in the two periods. In the above example the arithmetic average of prices in period 1 is \$1.74 and in period 2 it is \$1.78, giving a relative of 1.023 ( $1.78/1.74$ ) or a percentage change of 2.3%. This method is called the 'relative of arithmetic mean prices' (RAP), sometimes referred to as the 'Dutot' index formula.

*Arithmetic mean of price  
relatives*

A second method is to calculate the price movement between periods for each individual item and then take the arithmetic average of these movements. The price movement for each item must be expressed in relative terms (i.e. period 2 price divided by period 1 price as shown in the second column from the right in the above table). In the example above the arithmetic average of the price relatives is 1.031, a price change of 3.1%. This method is called the 'arithmetic mean of price relatives' (APR), sometimes referred to as the 'Carli' index formula.

*Geometric means*

A third method is to construct a ratio of the geometric mean of prices in each period. The geometric mean of the sample prices in period 1 is \$1.73 and in period 2 it is \$1.76 giving a relative of 1.017 ( $1.76/1.73$ ) or a percentage change of 1.7%.

The fourth method is to calculate the geometric mean of the price movements for each individual item. Again, the price movements must be in the form of price relatives. In the above example, the geometric mean of the price relatives is 1.017, indicating a price increase of 1.7%, the same as using the ratio of the geometric mean of prices in each period.

In fact the geometric mean will always produce the same result whether the relative of mean prices or the mean of relative prices is used. These methods are simply referred to as the geometric mean (GM), sometimes called the 'Jevons' index formula.

*Geometric mean is the  
preferred method*

The method of calculating price change at the elementary aggregate level is important to the accuracy of the price index. The arithmetic average of price relatives (APR) approach has been shown to be more prone to (upward) bias than the other two methods. In line with various overseas countries, the ABS is using the geometric mean formula for calculating elementary aggregate index numbers where practical in the 15th series of the CPI. Where the geometric mean is not appropriate the relative of arithmetic mean prices (RAP) is used. The reasoning behind using geometric means is outlined below.

*Geometric mean allows for  
substitution*

At the elementary aggregate level of the index it is usually impractical to assign a specific weight to each individual price observation. The three formulas described above implicitly apply equal weights to each









































