6429.0

Australian Bureau of Statistics

Information Paper

Producer and International Trade Price Indexes

Concepts, Sources and Methods

2006

www.abs.gov.au

New Issue

Information Paper

Producer and International Trade Price Indexes

Concepts, Sources and Methods

2006

Dennis Trewin
Australian Statistician

AUSTRALIAN BUREAU OF STATISTICS

EMBARGO: 11.30AM (CANBERRA TIME) TUES 15 AUG 2006

ABS Catalogue No. 6429.0

ISBN 0 642 47972 0

Produced by the Australian Bureau of Statistics

INQUIRIES

- For further information about these and related statistics, contact the National Information and Referral Service on 1300 135 070 or Christine McLaughlin on Canberra (02) 6252 5842.

CONTENTS **Page**

PREFACE

AIM OF THIS PUBLICATION

This publication provides a comprehensive description of the concepts, sources and methods used by the Australian Bureau of Statistics (ABS) in compiling the producer and international trade price indexes. It explains what the indexes measure and how they relate to other economic series, how the indexes are used and the source of the price information used to compile the indexes. It also provides some insight into the kinds of conceptual and practical difficulties that the ABS encounters in compiling the producer and international trade price indexes, and how it deals with these challenges.

Australia's producer and international trade price indexes are compiled in broad agreement with the guidelines contained in the International Monetary Fund's (IMF) *Producer Price Index Manual, Theory and Practice* (2004). The IMF standards provide the detailed conceptual background to producer price indexes, but they are not written specifically from an Australian perspective. Accordingly, this publication aims to provide users of Australia's producer and international trade price indexes with an explanation of:

- the historical background of producer and international trade price indexes;
- their relationship to other economic statistics;
- the underlying conceptual framework;
- the data sources and methods used to compile the indexes; and
- the presentation and publication of these statistics.

RELEASE OF PRODUCER AND INTERNATIONAL TRADE PRICE INDEX DATA

The producer and international trade price indexes are compiled quarterly by the ABS for quarters ending in March, June, September and December each year. The quarterly index numbers are published between three and four weeks after the end of the quarter in *Producer Price Indexes, Australia* (cat. no. 6427.0), and *International Trade Price Indexes, Australia* (cat. no. 6457.0).

ABS CONTACTS

The ABS intends to periodically update this document. The ABS invites comments on the usefulness of this publication as guide to Australian international trade and producer price indexes. Comments can be provided, preferably in writing, to the Director, Producer Price Indexes, whose contact details appear below.

Comments and requests for more information about the topics covered in this publication should be directed to:

Director
Producer Price Indexes
Australian Bureau of Statistics
PO Box 10
Belconnen, ACT, 2616

Fax: (02) 6252 7060
Email: **matthew.berger@abs.gov.au**

CHAPTER 1 INTRODUCTION

NATURE OF PRODUCER AND INTERNATIONAL TRADE PRICE INDEXES

1.1 Producer price indexes (PPIs) measure the changes in the prices of goods and services as they either leave the place of production or enter the production process. The Australian international trade price indexes measure the changes in the prices of goods either as they cross the customs frontier entering Australia (i.e. imports) or leaving Australia (i.e. exports) bound for another country.

1.2 The ABS compiles a suite of quarterly input and output price indexes (see paragraph 2.1 for definitions) for different sectors of the Australian economy. As well as indexes relating to fairly narrowly defined components of the economy (such as the materials used in house building), more broadly based indexes are produced that cover significant parts of the economy. In particular, the "Stage of Production" price indexes cover the whole of the economy for each of the three stages of production (preliminary, intermediate and final commodities). These measures show both the changes in the prices that producers receive for their outputs, as well as the changes in prices that producers pay for their material inputs. The following indexes are the major PPIs released by the ABS:

- Stage of Production (SOP) Producer Price Indexes

  presented by stage of production, industry of origin and destination within the economy
- Manufacturing Industries Producer Price Indexes

  Materials Used in Manufacturing Industries (MUMI) - an input price index

  Articles Produced by Manufacturing Industries (APMI) - an output price index
- Construction Industries Producer Price Indexes

  Materials Used in House Building - an input price index

  General Construction Industry - an output price index
- Mining Industries Producer Price Indexes

  Materials Used in Coal Mining - an input price index
- Service Industries Producer Price Indexes

  Transport (freight) and storage industries - an output price index

  Property and business services industries - an output price index
- Copper Materials Price Indexes

  Copper Materials Used in the Manufacture of Electrical Equipment - an input price index
- International trade price indexes

  Import Price Index (IPI) - an input price index

  Export Price Index (EPI) - an output index.

1.3 Further details on PPI outputs produced and dissemination methods are outlined in Chapter 14.

STRUCTURE OF THIS PUBLICATION

1.4 This manual has been constructed to provide a logical sequence of discussion of the concepts, sources and methods used in the compilation of producer and international trade price indexes. The following layout has been used:

- Chapter 1 Introduction;
- Chapter 2 describes the purpose and use of producer and international trade price indexes;
- Chapter 3 provides the historical background to producer and international trade price indexes presented by the ABS;
- Chapter 4 provides a brief overview of price index theory;
- Chapter 5 describes the classifications that underpin the producer and international trade price indexes;
- Chapter 6 discusses the role of weights in price indexes and the sources used to produce the weights;
- Chapter 7 describes how the prices used in compiling the producer and international trade price indexes are sampled;
- Chapter 8 describes how prices are collected by the ABS;
- Chapter 9 describes the concept of "pricing to constant quality" and how quality change is accounted for;
- Chapter 10 describes how the producer and international trade price indexes are calculated in practice;
- Chapter 11 describes how "baskets" of goods and services are maintained;
- Chapter 12 describes reweighting and linking price indexes;
- Chapter 13 contains examples of Australian producer and international price indexes;
- Chapter 14 describes how producer and international price indexes are disseminated; and
- Chapter 15 describes the system of price statistics, placing the producer and international price indexes in context with other economic statistics.
- Appendix 1 provides information regarding the use of producer and international price indexes in contracts.

1.5 A glossary of terms used in the manual is provided at the end of the publication.

CHAPTER 2 PURPOSE AND USES OF PRODUCER PRICE INDEXES (PPI)

2.1 In general terms, a PPI can be described as an index designed to measure the average change in the price of goods and services either as they leave the place of production or as they enter the production process. Thus, PPIs fall into two categories: input prices (that is, at *purchasers' prices*), and output prices (that is, at either *basic* or *producers' prices*). In practice, the output prices of one producer (e.g. a steel producer) may be the input prices of another producer (e.g. a car manufacturer). Producer price indexes (PPIs) measure the changes in the prices of goods and services bought and sold by producers. An *input* PPI measures the rate of change in the prices of goods and services purchased by the producer. ABS examples include the price index of materials used in house building, and the price index of materials used in manufacturing industries. An *output* PPI measures the rate of change in the prices of products sold as they leave the producer. ABS examples include the price index of the output of the general construction industry, and the price index of articles produced by the manufacturing industries.

WHAT PRODUCER PRICE INDEXES DO

2.2 A PPI provides a weighted average of the price changes in a group of products between one time period and another. The average price change over time is estimated by measuring actual prices at different points in time and weighting together the price changes in accordance with the relative importance of the products that are priced. Price index numbers are compiled from price observations collected at various pricing points (that is, various times during the pricing period). Price indexes compare changes in the price of a basket of goods or services between a particular period and a reference, or base, period. For an index to provide information on price changes, at least two index numbers from the same series need to be available, and the index numbers must relate to the same basket of goods or services.

2.3 PPIs do not measure price levels; rather, they are a measure of average changes in prices from one period to another. The PPI does not measure the value of production or the cost of production.

2.4 The prices of goods and services do not all change at the same rate. Because price changes can vary considerably from product to product, the level of the price index will depend on the precise set of goods and services selected and the price behaviour of the elements of the set. It will also depend on the weights used to combine the prices of the individual products within the set.

Input prices

2.5 Inputs are valued at purchasers' prices, which are defined as the amounts paid by the purchaser inclusive of any non-deductible taxes on products, and transport and trade margins (that is, the prices recorded in the index should be those relating to the price of goods and services as delivered into store, delivered on site, etc.).

2.6 Input price indexes measure the change in the prices of intermediate inputs used in production by a specified sector of the economy (such as the construction or manufacturing industries). Intermediate inputs are inputs into the production process of an establishment that are produced elsewhere in the domestic economy, or are imported. An input PPI measures changes in the cost of the basket of purchases required as inputs into the production process. Primary inputs such as land, labour and capital are excluded from PPIs.

2.7 Input prices should exclude deductible taxes on products but include the retail or wholesale margins of the supplier, since they aim to measure the actual cost of the good or service to the producer.

Output prices

2.8 The valuation basis of output prices is either *basic* or *producer* prices, which are defined as the amounts received by the producer exclusive of any taxes on products and transport and trade margins (that is, the point at which prices are measured is ex-factory, ex-farm, ex-service provider, etc.).

2.9 The main difference between basic and producer prices is generally any per unit subsidy that the producer receives. Basic prices are preferred in the PPI because they represent the per unit revenue received by the producer. However, on occasions producer prices may have to be used when information on subsidies is not available. In most instances, producers in the Australian economy do not receive subsidies, in which case the producer prices (which exclude subsidies) and basic prices (which include subsidies) will be the same.

2.10 Australian output price indexes aim to measure the prices received by producers irrespective of where their products are sold. Hence, output price indexes measure the average price change of produced goods and services that are sold on the domestic market and also on export markets.

Sources of inflationary pressure and price change

2.11 The essential difference between input and output PPIs is that an input PPI can provide a measure of potential inflation, by indicating the price pressures that producers are facing. However, the producer faces many other costs such as labour and capital costs and also has to consider how much of any overall price change the market will bear, so it is unusual to see the full effect of an intermediate input price rise being transmitted directly to the output price.

2.12 Output price indexes measure the price change that actually takes place and are therefore a more direct measure of inflation. However, output prices themselves can also be an input further along in the production process, and as such they represent a measure of potential inflation in further stages of production, for example, at the wholesale and retail levels.

2.13 Output price indexes measure prices of domestically produced products, whether sold on domestic or international markets. Similarly, input price indexes will also include import prices for imports that are used in the manufacturing process, such as crude oil and agricultural produce. In this manner both the input and output indexes reflect price changes resulting from both domestic and international supply and demand.

Scope of price indexes: gross sector or net sector?

2.14 The scope of a producer price index determines which transactions are to be included in the measure of price change. Several PPIs constructed by the ABS are constructed on a "net sector basis". Such an index is obtained by netting out any intra-sector transactions in a manner similar to the process used by accountants in consolidating a set of accounts for a group of enterprises. The advantage of the net sector approach over the alternative inter-sector approach (under which the intra-sector transactions would be in-scope) is that it avoids potential distorting effects that may result from multiple counting of changes in transaction prices as commodities flow through different production processes within the sector.

2.15 For example:

- Within the producer price indexes, the price index of articles produced by manufacturing industries (APMI) is an output index for the manufacturing division of ANZSIC. APMI measures changes in prices of articles produced by establishments classified to ANZSIC division C, manufacturing, that are sold or transferred to domestic establishments outside the manufacturing division for intermediate use, used as capital equipment, or exported.

  The index excludes intermediate transactions in articles produced by establishments within the manufacturing division and sold or transferred to other establishments within the manufacturing division for further processing. Therefore the index reflects the prices of sales and transfers of articles at their point of exit from the manufacturing division.

2.16 In contrast, although conceptually valid, excluding the internal intermediate transactions from the net sector indexes for the whole division results in incomplete coverage of the targeted sector of the economy. The ABS approach to increase coverage, while still avoiding the multiple counting issues, has been to develop independent net sector price indexes for more detailed sectors of the economy.

- Continuing the APMI example from above, independent net sector measures have been constructed for ANZSIC manufacturing subdivisions and groups. While having intermediate transactions between different manufacturers within a given subdivision or group netted out, intermediate transactions with manufacturers in other subdivisions/groups are in-scope.

Import and export prices

2.17 Import and export prices are important extensions of domestic PPIs. They are used in deflating external trade values to provide indicators of the volume of international trade. Also, import prices feed into producer input indexes, since these are an important contribution to producer costs. Similarly, export prices feed indirectly into producer output indexes, since exports frequently represent a significant component of producer revenue.

USES OF PRODUCER PRICE INDEXES

2.18 Price instability introduces uncertainty into economic analysis and decision making, so the main uses of the PPI relate to efforts to minimise that uncertainty. The PPI has the following main uses:

- components are used as deflators in a number of parts of the national accounts;
- as a short-term indicator of inflationary trends;
- for indexation in legal contracts in both the public and private sectors;
- by international organisations such as the OECD and IMF for economic monitoring and comparison.

National accounts deflator

2.19 Although PPIs are an important economic indicator in their own right, a vital use of the PPIs is as a deflator of the values of a number of components in the Australian national accounts, including industry inputs and outputs, sales, capital expenditure and inventory data. The deflation process is integral to the compilation of chain volume estimates of GDP and its components. As a result, the concepts underlying the PPI are often related to those underlying the national accounts. This can lead to conflicts in the requirements, for example, for contract escalation, where users would prefer maintaining fixed weights for a long period. The ABS gives priority to the use of PPIs in the national accounts due to their importance in macroeconomic analysis.

2.20 Price deflation is achieved by dividing the current price value for a period (quarter or year) by an indicator of the price component in the value (usually in the form of a price index) for the same period. This technique revalues the current price value in the prices of a base period (in the Australian volume measures this is generally the previous year). The result is equivalent to quantity revaluation (i.e. directly revaluing individual products by multiplying their quantity produced or sold in each period by their price in a related base period), since it removes changes in the price component of the current price value, leaving a measure that reflects the volume (or quantity) component valued at the base period prices.

2.21 National accounts use the ratio of consecutive price indexes (either consecutive quarters, or for consecutive years) to derive chain volume estimates.

2.22 Revaluation of the current period *values* using earlier period *prices* is defined in the following format:

$$\frac{V^t}{\left(\frac{P^t}{P^{t-1}}\right)} = P^{t-1}Q^t$$

$$\Delta Q = \frac{P^{t-1}Q^t}{P^{t-1}Q^{t-1}}$$

Where V refers to value, P refers to price, Q refers to quantity (or in national accounts terminology, volume), and the superscripts *t,t -1* refer to current and previous periods respectively.

2.23 More information on the use of price indexes in the production of the Australian national accounts can be found in *Australian National Accounts: Concepts, Sources and Methods* (cat. no. 5216.0) and *Information Paper: Australian National Accounts, Introduction of Chain Volume and Price Indexes* (cat. no. 5248.0)

Short-term indicator of inflationary trends

2.24 A quarterly PPI with detailed product and industry data allows short-term price inflation to be monitored through different stages of production and is a key use of the PPI. The main users of the PPI for this purpose are the Reserve Bank of Australia (RBA) and federal and state treasury and finance departments. Also, many companies (including investment banks and brokerage firms) and government agencies require the data for macroeconomic forecasting. The data are also used to build models to assess the price pressures that different sectors of the economy are facing, with the aim of assisting private sector business in investment decisions.

2.25 Other federal and state government agencies (including Treasuries) use price index data in determining and assessing macroeconomic policy.

Indexation of contracts

2.26 Indexation of contracts is a procedure whereby contracts for the provision of goods and services include an adjustment to the value of monetary amounts for the goods or services provided based on the increase or decrease in the level of a price index. The purpose of the indexation is to shift the inflationary risk from the contractor(s) to the project developer or owner. A PPI offers an independent indicator of the change in prices of the good or service under contract. Indexation is common in long-term contracts, where even relatively small levels of inflation can have a substantial impact on the real value of the revenue flows, such as in building ships and aircraft. The ABS recognises that the price indexes it produces are used in this way by government agencies and private business. The ABS neither endorses nor discourages such use. The ABS does not advise, comment or assist in preparing or writing contracts. See Appendix 1 for a discussion on the ABS policy concerning the use of price indexes for contract indexation purposes.

International Organisations

2.27 Australia provides PPIs to the IMF and the OECD for economic monitoring and comparison with other countries. A PPI is a required indicator for countries, such as Australia, who subscribe to the IMF Special Data Dissemination Standards (SDDS). The SDDS set out criteria that have to be met by countries concerning the statistics produced, their periodicity, advance notification of release dates etc. A brief overview of these standards can be found on the IMF Dissemination Standards Bulletin Board (http://dsbb.imf.org/).

CHAPTER 3 HISTORICAL BACKGROUND

INTRODUCTION

3.1 Producer Price Indexes (PPIs) are a key economic indicator in most countries, including Australia. This chapter provides a historical background on the development of producer and international trade price indexes for Australia.

3.2 PPIs are used for a variety of purposes. As outlined in Chapter 2, the main uses of Australia's PPIs are as a deflator for the national accounts, as a short-term indicator of inflationary trends, to adjust long-term contracts for changes in material costs, and for economic monitoring and comparison by international organisations.

THE FIRST PRODUCER PRICE INDEXES

3.3 The first price index of this kind compiled by the ABS was the Melbourne Wholesale Price Index, which was introduced in 1912 with index numbers compiled from 1861. Prices were extracted from newspapers and trade publications. These index numbers were compiled up to 1961. That index related chiefly to basic materials and food stuffs, weighted in accordance with consumption in about the year 1910. Neither the list of items nor the weighting was varied during the life of the index. A description of the index and a list of the items included were published in *Labour Report No. 38, 1949.*

3.4 The next index published was the Wholesale Price (Basic Materials and Foodstuffs) Index, which was introduced in 1939 with index numbers available from 1928. The index, which was compiled until 1970, related to commodities in their basic or primary form. Prices were obtained as near as possible to the point where they made their first effective impact on the local price structure. With a few exceptions, prices were obtained from Melbourne sources. The weights were based on estimates of the average annual consumption of the commodities in Australia during the period 1928-29 to 1934-35 inclusive. A list of the commodities included and other information concerning the index were last published in *Labour Report No. 53, 1967.*

MANUFACTURING INDUSTRIES PRODUCER PRICE INDEXES

Articles produced by manufacturing industries

3.5 The price indexes of articles produced by manufacturing industries were first published in June 1976 in the *Price Indexes of Articles Produced by Manufacturing Industry, Australia* (cat. no. 6412.0), with monthly indexes compiled from July 1968. The composition and weighting patterns of the indexes were based on the value of production in 1971-72, as reported in the 1971-72 Census of Manufacturing Establishments. The indexes were published with a reference year of 1968-69 = 100.0.

3.6 The index was reviewed in 1990 with a second series introduced from May 1990. The second series composition and weighting pattern were based on the value of production in 1986-87 (as reported in the 1986-87 Census of Manufacturing Establishments). The indexes were published on a reference base of 1988-89 = 100.0.

3.7 The frequency of these indexes was changed from monthly to quarterly from September quarter 1997.

3.8 These indexes were again reviewed in 2000. The items included in the indexes were selected based on the values of articles produced in 1993-94. The selected items were allocated weights in accordance with the estimated value of manufacturing production in 1993-94 valued at the relevant prices applying in the June quarter 2000. In addition to rebasing these indexes, the index series were also re-referenced to a base of 1989-90 = 100.0.

3.9 Furthermore, commencing with the September quarter 2000 the presentation of these indexes was changed to reflect updated weighting patterns and the adoption of the Australian and New Zealand Standard Industrial Classification, 1993 (ANZSIC). The new weighting patterns for the manufacturing division indexes and the associated ANZSIC subdivision and group price indexes were shown in Appendix B of the September quarter 2000 issue of *Price Indexes of Articles Produced by Manufacturing Industry, Australia* (cat. no. 6412.0).

3.10 The publication *Price Indexes of Articles Produced by Manufacturing Industry, Australia* (cat. no. 6412.0) was combined with several others in a new publication *Producer Price Indexes, Australia* (cat. no. 6427.0) in the June quarter 2001. The latter publication contains integrated key series from several former price index publications to present an economy wide framework for producer price indexes, with the stage of production (SOP) indexes as the headline indicators.

Materials used in manufacturing industries

3.11 The *Price Indexes of Materials Used in Manufacturing Industries, Australia* (cat. no. 6411.0) was first published in April 1975. The indexes were on a reference base of 1968-69 = 100.0 and had a weighting pattern derived from the value of estimated manufacturing materials usage in 1971-72. Monthly index numbers were compiled for the period July 1968 to November 1985. A description of the first series, including its composition and weighting pattern, was given in the April 1975 issue of *Price Indexes of Materials Used in Manufacturing Industries, Australia* (cat. no. 6411.0).

3.12 The indexes were reviewed in 1985, with their composition and weighting pattern derived from values of materials used in 1977-78. These reviewed indexes were introduced from December 1985, and published with a reference base of 1984-85 = 100.0.

3.13 The indexes were reviewed again in 1996. This review saw the introduction of several changes to the indexes. The underlying classification of the indexes was changed from the Australian Standard Industrial Classification, 1983 (ASIC), to ANZSIC. The composition and weighting pattern of the indexes were derived from values of materials used in 1989-90. The indexes were also re-referenced to a base of 1989-90 = 100.0. Index structures and weighting patterns were shown in Appendix A of the July 1996 issue of *Price Indexes of Materials Used in Manufacturing Industries, Australia* (cat. no. 6411.0).

3.14 The frequency of these indexes was changed from monthly to quarterly from September quarter 1997.

3.15 The *Price Indexes of Materials Used in Manufacturing Industries, Australia* (Cat. no. 6411.0) was discontinued and data were included in *Producer Price Indexes, Australia* (cat. no. 6427.0) from the June quarter 2001.

Price indexes of copper materials

3.16 The price indexes of copper materials were first published in the October 1972 issue of *Price Indexes of Metallic Materials* (cat. no. 6410.0) as the *Price Indexes of Copper Materials Used in the Manufacture of Electrical Equipment*. In January 1986, the title of that publication was changed and the series for the other metallic materials (iron and steel, aluminium, copper and brass, and zinc) were transferred to *Price Indexes of Materials Used in Manufacturing Industries, Australia* (cat. no.6411.0).

3.17 The first indexes were published on a reference base of 1968-69 = 100.0 for the period July 1968 to August 1983. A description of these indexes, including their composition and weighting patterns, is given in the October 1972 issue of *Price Indexes of Metallic Materials* (cat. no. 6410.0) and in *Labour Report No. 57, 1972.*

3.18 This publication was discontinued from September 1983 to May 1984 due to deficiencies in the price samples.

3.19 Revised indexes, on a reference base of 1983-84 = 100.0, were introduced in June 1984 and provided monthly index numbers from July 1983. The Appendix to the June 1984 issue of *Price Indexes of Metallic Materials, Australia* (cat. no. 6410.0) provides a detailed description of the revised indexes, including their composition and weighting.

3.20 The indexes have been compiled and released on a quarterly basis since September quarter 1997.

3.21 In 2002 the indexes were re-weighted based on data from the 1998-99 financial year and re-referenced to 1989-90 = 100.0.

3.22 The *Price Indexes of Materials Used in Manufacturing Industries, Australia* (Cat. no. 6411.0) (which contained the price indexes of copper materials) was discontinued and replaced with the *Producer Price Indexes, Australia* (cat. no. 6427.0) from the June quarter 2001. The price index of copper materials was made available only in electronic form from that date.

CONSTRUCTION INDUSTRIES PRODUCER PRICE INDEXES

Output of the general construction industry

3.23 A price index for the output of the building industry, the aggregate of the indexes for the three ANZSIC classes house construction (4111), residential building construction n.e.c. (4112) and non-residential building construction (4113), was first published in the June quarter 2001 issue of *Producer Price Indexes, Australia* (cat. no. 6427.0). The aggregate index was presented with a reference base of 1998-99=100.0. Composition and weights of the index were based on outputs from the industry over the five years ending 1998-99.

3.24 A price index for the output of the general construction industry (ANZSIC Subdivision 41), together with its constituent indexes was published for the first time in the September quarter 2002 issue of *Producer Price Indexes, Australia* (cat. no. 6427.0), with a reference base of 1998-99=100.0. The time series commenced in September 1997. This series differed from the previous aggregate in that it included a component for road and bridge construction (ANZSIC class 4121).

Materials Used in House Building

3.25 The price index of materials used in house building was first published in September 1970 on a reference base of 1966-67 =100.0 using a weighting pattern derived from estimated materials usage in 1968-69. Monthly index numbers were compiled for the period July 1966 to September 1986. A description of the index, including its composition and weighting pattern, was given in the *Price Index of Materials Used in House Building, Six State Capital Cities* (cat. no. 6408.0), and in *Labour Report No. 55, 1970.*

3.26 The index was reviewed in 1986 and a new series introduced from October 1986. This second series was on a reference base of 1985-86 = 100.0 and had a weighting pattern based on estimated materials usage in 1985-86. This series was linked to the previous series. A description of this series was given in the October 1986 issue of *Price Index of Materials Used in House Building, Six State Capital Cities* (cat. no. 6408.0).

3.27 The index was reviewed in December 1995. This review saw the index presented on a reference base of 1989-90 =100.0, and was linked to the previous series.

3.28 The indexes have been compiled and released on a quarterly basis since September quarter 1997.

3.29 The *Price Indexes of Materials Used in House Building, Six State Capital Cities* (cat. no. 6408.0) was discontinued and the data were included in *Producer Price Indexes, Australia* (cat. no. 6427.0) from the June quarter 2001.

3.30 In December 2005, the index was again reviewed. This review saw the composition of the index changed to reflect building material usage observed in the three years ending 2002-03. Capital city weights were updated to reflect building patterns observed in the six state capitals in 2003-04. The resulting weights were "price updated" to September quarter 2005 by adjusting each by the ratio of the price in September quarter 2005 to the average price in 2003-04.

MINING INDUSTRIES PRODUCER PRICE INDEXES

Materials used in coal mining

3.31 The *Price Indexes of Materials Used in Coal Mining, Australia* (cat. no. 6415.0) was first published in February 1989 on a reference base of 1987-88 = 100.0. The indexes were compiled for each month from July 1988.

3.32 The indexes have been compiled and released on a quarterly basis since September quarter 1997.

3.33 In 2001 the indexes were re-weighted to reflect estimated average use of materials in coal mining over the 1999-2000 financial year and re-referenced to a base of 1989-90 = 100.0.

3.34 The *Price Indexes of Materials Used in Coal Mining, Australia* (cat. no. 6415.0) was discontinued and the data were included in the *Producer Price Indexes, Australia* (cat. no. 6427.0) from the June quarter 2001.

SERVICE INDUSTRIES PRODUCER PRICE INDEXES

3.35 Price indexes for the output of service industries are a relatively new development and to date have been constructed for only a subset of service industries.

3.36 Quarterly price index numbers for service industries were first published in March quarter 2000 for the Transport (Freight) and Storage Industries (ANZSIC Division I) and the Property and Business Services Industries (ANZSIC Division L).

3.37 The indexes were first published in *Producer Price Indexes for Selected Service Industries, Australia* (cat. no 6423.0). The index composition and weighting were derived using 1994-95 input-output data, and were presented with a reference base of 1998-99 = 100.0.

3.38 The *Producer Price Indexes for Selected Service Industries, Australia* (cat. no 6423.0) was discontinued and the data were included in the *Producer Price Indexes, Australia* (cat. no. 6427.0) from the June quarter 2001.

3.39 The price indexes for the output of service industries were reviewed in 2002. From June quarter 2002, the index composition and weighting were derived using 1996-97 input-output data. This review also saw significant improvements in coverage of these price indexes.

INTERNATIONAL TRADE PRICE INDEXES

3.40 Export price measures have a long history with an index of export prices in one form or another having been published by the ABS since 1901.

Export price index

3.41 The first index was compiled annually from 1901 to 1916-17 as a current weighted unit value index. The method of calculation was changed in 1918 to incorporate fixed weights. The index was published up to 1929-30.

3.42 An index of export prices was not published again until 1937, when a new series was introduced. This series continued until 1962.

3.43 A fixed weights index was introduced in August 1962 with a reference base of 1959-60 = 100.0. It was replaced by an interim index that was published from July 1969 until June 1979.

3.44 The index then progressed to a reference base of 1974-75 = 100.0 and was published in this format up until August 1990.

3.45 The monthly publication *Export Price Index, Australia* (cat. no. 6405.0) was introduced in September 1990 and index numbers were compiled from July 1989. The index was presented with a reference base of 1989-90 = 100.0.

3.46 The indexes have been compiled and released on a quarterly rather than monthly basis since September quarter 1997.

3.47 The export price index was reviewed in 1999. The main purpose of the review was to ensure that the index satisfied key user requirements. *Information Paper: Review of the Import Price Index and Export Price Index* (cat. no. 6424.0) was released in November 1999.

3.48 The broad outcomes of the review are outlined in an Appendix to the June quarter 2000 issue of the *Export Price Index, Australia* (cat. no. 6405.0). One of the key outcomes was the introduction of annual reweighting and chaining of the index.

3.49 In June quarter 2001 *Export Price Index, Australia* (cat. no. 6405.0) was combined with *Import Price Index, Australia* (cat. no. 6414.0) into a single publication, *International Trade Price Indexes, Australia* (cat. no 6457.0).

Import price index

3.50 Import price measures in Australia have a considerable history, with an import price index published by the Reserve Bank of Australia (RBA) from 1928 until September 1982.

3.51 The first index of import prices produced by the ABS was introduced in May 1983, through the publication *Import Price Index, Australia* (cat. no. 6414.0). This index was compiled quarterly from September quarter 1981 until June quarter 1991 (on a reference base of 1981-82 = 100.0).

3.52 A re-weighted index of import prices was introduced in September 1991 with index numbers compiled monthly from April 1991 until June 1997. This series had a reference base of 1989-90 = 100.0. The weights were based on the average value of merchandise imports landed in Australia during 1988-89 and 1989-90.

3.53 The indexes have been compiled and released on a quarterly basis since September quarter 1997.

3.54 In 1999, a review of the index was undertaken with the findings published in *Information Paper: Review of the Import Price Index and Export Price Index* (cat. no. 6424.0). One of the results of the review was a move to an annually re-weighted chained index, whereby each September quarter the weights of the index are updated to reflect the average value of merchandise imports landed in Australia in the previous financial year. The reference base of the index continues to be 1989-90 = 100.0.

3.55 In June quarter 2001 *Import Price Index, Australia* (cat. no. 6414.0) was combined with *Export Price Index, Australia* (cat. no. 6405.0) into a single publication *International Trade Price Indexes, Australia* (cat. no. 6457.0).

STAGE OF PRODUCTION PRODUCER PRICE INDEXES

3.56 Producer price index numbers for the supply of commodities (goods and services) to the Australian economy in a "stage of production" (SOP) framework were first published in *Stage of Production Producer Price Indexes, Australia* (cat. no. 6426.0). The stage of production framework represents an important element of the strategy for the systematic analysis of inflation. Commencing in July 2000, this publication presented price indexes compiled from September 1998. The SOP index model brings together the range of detailed price data contained in the separate indexes to enhance the analytical value of the data. The SOP framework is based on an economic categorisation of transactions according to their sequencing in the production chain.

3.57 The weighting patterns of the indexes were initially based on the 1994-95 input-output tables, with a reference base of 1998-99 = 100.0.

3.58 The *Stage of Production Producer Price Indexes, Australia* (cat. no. 6426.0) was discontinued and the data were included in *Producer Price Indexes, Australia* (cat. no. 6427.0) from the June quarter 2001.

3.59 The SOP indexes were reviewed in 2002 with a second series introduced from December quarter 2002. The weighting patterns of the second series (the current series) are based on the 1996-97 input-output tables.

CHAPTER 4 PRICE INDEX THEORY

OVERVIEW

4.1 Price indexes of one form or another have been constructed for several centuries and are commonly used for a variety of purposes. However, the complexities of price indexes are not always fully appreciated or understood. This chapter provides an overview of the theory and practices that underpin the construction of price indexes[1].

4.2 The chapter commences by describing how a price index is a practical single number representation of information on many prices. It then discusses the relationship between indexes of prices, quantities and values (expenditure and revenue).

4.3 Various mathematical formulas for constructing these indexes are discussed. The problem for prices statisticians is to select the most appropriate methodology. The advantages and disadvantages of the various formulas are discussed, along with criteria to guide decisions on the most appropriate formula.

THE CONCEPT OF A PRICE INDEX

Comparing prices

4.4 There are many situations where there is a need to compare two (or more) sets of observations on prices. For example, manufacturers might be interested in comparing prices between markets to determine where to sell their output or to compare price movements between two points in time with movements in their production costs, households might want to compare prices today with some earlier period, and economists and market analysts need to be able to compare prices between countries and over time to assess and forecast a country's economic performance.

4.5 In some situations the price comparisons might only involve a single commodity. Here it is simply a matter of directly comparing the two price observations. For example, a bread producer might want to assess how the price of wheat today compares with the price at some previous point in time.

4.6 In other circumstances the required comparison is of prices across a range of commodities. For example, a comparison might be required of clothing prices. There is a wide range of clothing types and thus prices (e.g. toddlers' shoes, women's fashion shoes, boys' shorts, men's suits, etc) to be considered. While comparisons can readily be made for individual or identical clothing items, this is unlikely to enable a satisfactory result for all clothing in aggregate. A method is required for combining the prices across this diverse range of items allowing for the fact that they have many different units or quantities of measurement. This is where price indexes play an extremely useful role.

The basic concept

4.7 Price indexes allow the comparison of two sets of prices for a common item or group of items. In order to compare the sets of prices it is necessary to designate one set the 'reference' set and the other the 'comparison' set. The reference price set is used as the base (or first) period

[1] The literature on price indexes is quite extensive. The intention of this chapter is to present a broad overview of the theory drawing heavily on documents that are in many cases overviews themselves as well as to present some views of the ABS. For a detailed consolidation of producer price index theory and internationally recommended practices, see the *Producer Price Index Manual, Theory and Practice* (International Labour Organization (ILO), International Monetary Fund (IMF), Organisation for Economic Cooperation and Development (OECD), Statistical Office of the European Communities (Eurostat), United Nations Economic Commission for Europe (UNECE), and the World Bank, 2004). Available online: http://www.imf.org/external/np/sta/tegppi/. This chapter draws heavily on material from that manual.

for constructing the index and is generally given an index value of 100[2]. For example, suppose for a single item the average of prices in set 1 was $15 and for set 2 was $30. Then designating set 1 as the reference set gives an index of 200.0 (30/15×100) for the comparison set while designating set 2 as the reference set gives an index of 50.0 (15/30×100) for the comparison set.

Comparison of many items: the purpose of a price index

4.8 The purpose of an output price index[3] may be explained by comparing the *values* of producers' revenues from the production of goods and services in two periods. Knowing that revenues have increased by 5 percent is not very informative if we are trying to measure the change in the volume of output because we do not know how much of this change is due to changes in the *prices* of the goods and services and how much to changes in the *quantities* produced. The purpose of an index number is to decompose proportionate or percentage changes in value aggregates into their overall price and quantity change components. An output PPI is intended to measure the price component of the change in producers' revenues. One way to do this is to measure the change in the value of an aggregate by *holding the quantities constant*. The fixed set of quantities is generally called a "basket."

4.9 Beginning with a fixed basket, price indexes can be constructed for different points in time. Typically the method is to nominate one set of prices as the reference prices and to revalue the quantities (or basket) of items purchased in the reference period by prices in the second (or comparison) period. The ratio of the revalued comparison period basket to the value of the reference period basket provides a measure of the price change between the two periods.

4.10 This simple revaluation, however, does not take account of any changes or substitutions that may be made in quantities consumed (or produced) in response to changes in relative prices between the two periods. Nor does it allow for any change in tastes between the two periods. These changes to the preference orderings of producers are significant in the choice of index methodology.

4.11 Preference orderings are possibly best illustrated with an example. Here we will consider an input index for a particular manufacturer:

- Consider a company producing a certain quantity of an item in the reference period using quantities of various inputs. The input cost of producing the given level of output is simply the sum of the cost of the inputs (i.e. the sum of the quantity of each input used multiplied by its price). Now suppose the prices of the inputs change but the company produces the same level of output. If the company continued to use the same amount of each input, then simply revaluing the inputs by the new prices and expressing this cost relative to the base period cost provides a measure of the change in input prices. However, in manufacturing it is often possible to change the mix of inputs and still produce the same level of output. Thus when input prices change it may be possible for the company to change its mix of inputs to achieve a lower cost of production than if the mix was not changed. In this case the simple revaluation approach overstates the actual price change.

[2] By convention, the initial value for an index series is made equal to 100.0

[3] An input index has a similar purpose, explained by comparing the values of producers' *expenditures*; an input PPI is intended to measure the price component of the change in producers' *expenditure*.

4.12 Handling quantity changes that occur in response to changes in relative prices is fundamental to price index construction. Changes in the relative importance of items in the basket of goods and services can have a significant effect on index movements.

REFINING THE CONCEPT

4.13 The value of an individual item is the product of price and quantity, that is:

$$v^t = p^t q^t \qquad (4.1)$$

where v is value, p is price, q is quantity and the superscript t refers to the periods at which the observations are made. For an output index, the value of concern is revenue. For an input index, the value of concern is expenditure.

4.14 The importance of understanding changes in value was discussed in paragraph 4.8. Changes in the value of the same commodity at different points in time can reflect changes in the actual price, changes in the quantity involved, or a combination of both price and quantity changes. Decomposition of a change in a value can be illustrated using equation (4.1), as in the following example:

- Suppose the price of tinned apples from a particular producer is $2.00 per 440g tin at a particular time. Suppose further that the price rises to $2.50 per 440g tin at a later time. The movement in the price of apples from the first to the later period is obtained from the ratio of the price in the second period to the price in the first period, that is $2.50/$2.00 = 1.25 or an increase of 25% in the price.

  If the producer sold exactly the same quantity of apples in the two periods, the revenue from the sale (the value of the sale) would rise by 25%.

  However, if the amount sold in the first period was 1,000 tins, and the amount sold in the second period was 1,200 tins, the quantity would also have risen, by 1,200/1,000 = 1.20 or 20%. In these circumstances, the total revenue from sale of tinned apples increases from $2,000 in the first period (1,000 tins at $2.00 per tin), to $3,000 in the second period (1,200 tins at $2.50 per tin), an overall increase in revenue (value) of $1,000, or 50%. The overall increase in value is the product of the ratios of the change in price and the change in quantity (1.25 x 1.20 = 1.50).

4.15 For an individual item, the ratio between the price in the current period and the price in the reference period is called a *price relative*. A price relative shows the change in price for one item only (e.g. the price of a tin of processed apples from one particular producer).

In terms of the formula in equation 4.1:

$v^1 = p^1$ ($2.00) $\times q^1$ (1,000 tins) = $2,000, and

$v^2 = p^2$ ($2.50) $\times q^2$ (1,200 tins) = $3,000,

where:

v^1 is the value in period 1; p^1 is the price per tin in period 1; q^1 is the quantity in period 1;
v^2 is the value in period 2; p^2 is the price per tin in period 2; q^2 is the quantity in period 2.

The ratio between the prices in the two periods, p^2 and p^1 ($2.50/$2.00 = 1.25) is the price relative ($= \frac{p^2}{p^1}$)

4.16 It is only necessary to have observations on two of the three components of equation (1.1) in order to analyse contributions to change in the value (in this example, revenue). If, for example, observations were only available on value and price, estimates of the quantity could be derived by dividing the value observations by price. Equivalently, movements in value and price could be used to derive movements in quantity.

4.17 Now consider the case of price and quantity (and value) observations on many products. The quantity measurements can have many dimensions, such as number of units (e.g. tins), kilograms, metres, litres or even time (for service industries). Further, the quantities and prices of items are likely to show different movements between periods. Answers are required to questions like: 'what has been the change over time in the overall quantity of products?' and 'what has been the contribution of price changes to changes in the value of the bundle of products over time?' Answering these questions is the task of index numbers—to summarise the information on sets of prices and quantities into single measures to assist in understanding and analysing changes.

4.18 In essence, an index number is an average of either prices or quantities. The problem is how should the average be calculated.

4.19 More formally, the price index problem is how to derive numbers I^t_{PRICE} (an index of price) and $I^t_{QUANTITY}$ (an index of quantity) such that the product of the two is the change in the total value of the items between the base period (*0*) and any other period (*t*), that is

$$I^t_{PRICE} = \frac{P^t}{P^0}, \text{ and}$$

$$I^t_{QUANTITY} = \frac{Q^t}{Q^0}, \text{ then}$$

$$\begin{aligned} I^t_{PRICE} \times I^t_{QUANTITY} &= \frac{P^t}{P^0} \times \frac{Q^t}{Q^0} \\ &= \frac{P^t Q^t}{P^0 Q^0} \\ &= \frac{V^t}{V^0} \end{aligned} \qquad (4.2)$$

where P^t, Q^t and V^t are respectively, price, quantity and value of all commodities in period *t* and P^0, Q^0 and V^0 are respectively, their prices, quantities and values in period 0 (the base period). Based on equation (4.1), V^t can be represented as:

$$V^t = \sum_{i=1}^{N} v_i^t = \sum_{i=1}^{N} p_i^t q_i^t \qquad (4.3)$$

that is, the sum of the product of prices and quantities of each item denoted by subscript ***i***.

Major index formulas

4.20 One widely used class of price indexes is obtained by defining the index as the percentage change between the periods compared in the total cost of producing (or purchasing) a fixed set of quantities, generally described as a "basket." The meaning of such an index is easy to grasp and to explain to users.

4.21 In presenting index number formulas a simple starting point is to compare two sets of prices (sometimes called bilateral indexes). Consider price movements between two time periods, where the first period shall be denoted as period 0 and the second period as period *t* (period 0 occurs before period *t*). In order to calculate the price index, the quantities need to be held fixed at some point in time. The initial question is what period should be used to determine the basket (or quantities). The options are to use:

(i) *The quantities of the first or earlier period.* This approach answers the question 'how much would it cost in the second period, relative to the first period, to purchase the same bundle of goods and services as purchased in the first period?' Estimating the cost of the basket in the second period's prices simply requires multiplying the quantities of items purchased in the first period by the prices that prevailed in the second period. A price index is obtained from the ratio of the revalued basket to the total price of the basket in the first period. This approach was proposed by Laspeyres in 1871 and is referred to as a *Laspeyres price index*. It may be represented, with a base of 100.0, as

$$I^t_{Laspeyres} = \frac{\sum_{i=1}^{n} p_i^t q_i^0}{\sum_{i=1}^{n} p_i^0 q_i^0} \times 100 \qquad (4.4)$$

(ii) *The quantities of the second (or more recent) period.* This approach answers the question 'how much would it have cost in the first period, relative to the second period, to purchase the same basket as was purchased in the second period?' Estimating the cost of purchasing the second period's basket in the first period simply requires multiplying the quantities of items purchased in the second period by the prices prevailing in the first period. A price index is obtained from the ratio of the total price of the basket in the second period to the total price of the basket valued at the first period's prices. This approach was proposed by Paasche in 1874 and is referred to as a *Paasche price index*. It may be represented, with a base of 100.0, as:

$$I^t_{Paasche} = \frac{\sum_{i=1}^{n} p_i^t q_i^t}{\sum_{i=1}^{n} p_i^0 q_i^t} \times 100 \qquad (4.5)$$

(iii) *A combination (or average) of quantities in both periods.* This approach tries to overcome some of the inherent difficulties of using a basket fixed at either point in time[4]. In the absence of any firm indication that either period is the better to use as the base or reference, then a combination of the two is a sensible compromise. In practice this approach is most frequent in:

a) the *Fisher Ideal price index*[5], which is the geometric mean of the Laspeyres and Paasche indexes:

$$I^t_{Fisher} = \left(I^t_{Laspeyres} \times I^t_{Paasche} \right)^{\frac{1}{2}} = \sqrt{I^t_{Laspeyres} \times I^t_{Paasche}} \qquad (4.6)$$

and

b) the *Törnqvist price index*, which is a weighted geometric mean of the price relatives where the weights are the average shares of total values in the two periods, that is

$$I^t_{Törnqvist} = \prod_{i=1}^{n} \left(\frac{p_i^t}{p_i^0} \right)^{s_i} \times 100 \qquad (4.7)$$

where

$s_i = \frac{1}{2} \left(\frac{v_i^0}{\sum_{i=1}^{n} v_i^0} + \frac{v_i^t}{\sum_{i=1}^{n} v_i^t} \right)$ is the average of the value shares for the *i*th item in the two periods.

---

4 To quote Fisher (1922, p. 45)

"… any index number implies *two* dates, and the values by which we are to weight the price ratios for those two dates will be different at the two dates. Constant weighting (the same weight for the same item in different years) is, therefore, a mere makeshift, never theoretically correct, and not even practically admissible when values change widely.

5 The use of the geometric mean of the Laspeyres and Paasche indexes was first proposed by Pigou in 1920 and given the title 'ideal' by Fisher (1922).

4.22 The Fisher Ideal and Törnqvist indexes are often described as symmetrically weighted indexes in that they treat the weights from the two periods equally[6].

4.23 The Laspeyres and Paasche formulas are expressed above in terms of quantities and prices. In practice quantities might not be observable or meaningful (for example, how would the quantities of legal services, public transport and education be measured?). Thus in practice the Laspeyres formula is typically estimated using value shares to weight price relatives—this is numerically equivalent to the formula (4.4) above.

4.24 To derive the *price relatives form of the Laspeyres index*, multiply the numerator of equation (4.4) by $\frac{p_i^0}{p_i^0}$ and rearrange to obtain:

$$I^t_{Laspeyres} = \sum_{i=1}^{n}\left(\frac{p_i^t}{p_i^0}\right)\frac{p_i^0 q_i^0}{\sum_{i=1}^{n} p_i^0 q_i^0} = \sum_{i=1}^{n}\left(\frac{p_i^t}{p_i^0}\right)s_i^0 \qquad (4.8)$$

where s_i^0 represents the value share of item *i* in the reference (or, more commonly labelled, base) period.

$$s_i^0 = \frac{p_i^0 q_i^0}{\sum_{i=1}^{n} p_i^0 q_i^0} \qquad (4.9)$$

4.25 The important point to note here is that if price relatives are used then value weights must also be used. On the other hand, if prices are used directly rather than in their relative form, then the weights must be quantities.

4.26 An example of creating index numbers using the above formulas is presented in Table 4.1. For purposes of the exercise, a limited range of the types of products producers might sell has been used. The quantities in which these items would typically be measured may vary. There are likely to be differences in price behaviour of the commodities over time. Further, the quantities of these items producers purchase may vary over time in response to changes in prices (of both the item and other items) and producer incomes.

4.27 Differences that might arise in price changes (and, by implication expenditure and revenue patterns) are illustrated by the following:

- prices of high labour content items, such as clothing, will tend to show relatively steady trends over time;
- prices of high technology goods, such as computers, tend to decline over time, either absolutely or relative to other items, reflecting productivity and technological advances;
- prices of some items, such as fresh fruit, are affected by climatic and seasonal influences.

[6] See Diewert (1993) for a discussion of symmetrical averages.

4.28 Price changes influence, to varying degrees, the quantities of items producers purchase. For some items such as basic foods, the quantities purchased may show little change in response to price changes. For other items the quantities producers purchase may change by a similar or greater proportionate amount than the price change[7].

4.29 The scenarios presented in table 4.1 are merely reflective of some of these possibilities.

TABLE 4.1: COMPILING PRICE INDEXES OVER TWO PERIODS

	Period 0				
Item	Price p_i^0	Quantity q_i^0		Value $p_i^0 q_i^0$	Price relatives p_i^0 / p_i^0
	$		$	Shares	
Bread (loaves)	2.50	2000	5000	0.4310	1.0000
Fresh fruit (kgs)	3.00	500	1500	0.1293	1.0000
Beer (litres)	4.50	200	900	0.0776	1.0000
Computers (units)	1500.00	2	3000	0.2586	1.0000
Clothing (units)	30.00	40	1200	0.1035*	1.0000
	Period t				
Item	Price p_i^t	Quantity q_i^t		Value $p_i^t q_i^t$	Price relatives p_i^t / p_i^0
	$		$	Shares	
Bread (loaves)	2.75	2000	5500	0.4532	1.1000
Fresh fruit (kgs)	4.00	450	1800	0.1483	1.3333
Beer (litres)	6.50	130	845	0.0696	1.4444
Computers (units)	1000.00	3	3000	0.2472	0.6667
Clothing (units)	33.0	30	990	0.0817*	1.1000

* In order to have value weights summing exactly to unity, the weight for clothing has been derived as a residual.

Index formula	**Index numbers**	
	Period 0	Period t
Laspeyres	100.0	104.5
Paasche	100.0	98.4
Fisher	100.0	101.4
Törnqvist	100.0	101.6

[7] Economists measure the change in the quantity of an item in response to a change in price (or income) by elasticities, which is the ratio of the percentage change in the quantity to the percentage change in price (or income). An item is price inelastic if the percentage change in the quantity is less than the percentage change in price. It has unit elasticity if the percentage changes are the same and is price elastic if the percentage change in the quantity is greater then the percentage change in price. If an item is price inelastic, the change in expenditure will be in the same direction as the change in price. If the item has unit elasticity then expenditure is unchanged. If the item is price elastic the change in expenditure will be in the opposite direction to the price change (i.e. if price increases, expenditure decreases).

The following illustrate the index number calculations:

Laspeyres $(0.4310 \times 1.1000)+(0.1293 \times 1.3333)+(0.0776 \times 1.4444)+(0.2586 \times 0.6667)+(0.1035 \times 1.1000)$

Paasche $$\frac{1}{(0.4532/1.1000)+(0.1483/1.3333)+(0.0696/1.4444)+(0.2472/0.6667)+(0.0817/1.1000)}$$

Fisher $(104.500 \times 98.400)^{1/2}$

Törnqvist best calculated by first taking the logs of the index formula

$(1/2)x(0.4310+0.4532) \times \ln(1.1000)$

$+ \quad (1/2)x(0.1293+0.1483) \times \ln(1.3333)$

$+ \quad (1/2)x(0.0776+0.0696) \times \ln(1.4444)$

$+ \quad (1/2)x(0.2586+0.2472) \times \ln(0.6667)$

$+ \quad (1/2)x(0.1035+0.0817) \times \ln(1.1000)$

$= \quad 0.015422$

and then taking the exponent multiplied by 100.

4.30 In Table 4.2 the different index formulas produce different index numbers and thus different estimates of the price movements. Typically the Laspeyres formula will produce a higher index number than the Paasche formula, with the Fisher Ideal and the Törnqvist of similar magnitude falling between the index numbers produced by the other two formulas. In other words the Laspeyres index will generally produce a higher (lower) measure of price increase (decrease) than the other formulas and the Paasche index a lower (higher) measure of price increase (decrease)[8].

Generating index series over more than two time periods

4.31 Most users of price indexes require a continuous series of index numbers at specific time intervals. There are two options for applying the above formulas when compiling a price index series:

(i) select one period as the base and separately calculate the movement between that period and each other period, which is called a fixed base or *direct* index, or

(ii) calculate the period to period movements and *chain link* these (i.e. calculate the movement from the first period to the second, the second to the third with the movement from the first period to the third obtained as the product of these two movements).

4.32 The calculation of direct and chain linked indexes over three periods (0, 1, and 2) using observations on three items, is shown in Table 4.2. The procedures can be extended to cover many periods.

[8] The relationship between the Laspeyres and Paasche indexes holds while ever there is a 'normal' relationship (negative correlation) between prices and quantities, that is, quantity declines (increases) if price increases (declines) between the two periods.

TABLE 4.2 CONSTRUCTING PRICE INDEX SERIES

Item	Period 0 Price ($)	Period 0 Quantity (kg)	P x Q
1	10	20	200
2	12	15	180
3	15	10	150
	Period 1 Price ($)	Period 1 Quantity (kg)	P x Q
1	12	17	204
2	13	15	195
3	17	12	204
	Period 2 Price ($)	Period 2 Quantity (kg)	P x Q
1	15	12	180
2	14	16	224
3	18	8	144

Σ P0Q0 = 200+180+150 = 530
Σ P0Q1 = 170+180+180 = 530
Σ P0Q2 = 120+192+120 = 432
Σ P1Q0 = 240+195+170 = 605
Σ P1Q1 = 340+195+204 = 603
Σ P1Q2 = 144+208+136 = 488
Σ P2Q0 = 300+210+180 = 690
Σ P2Q1 = 255+210+216 = 681
Σ P2Q2 = 180+224+144 = 548

Laspeyre's index:
La0: Base period (Period 0) = (Σ P0Q0/Σ P0Q0) x 100.0 = (530/530) x 100.0 = 100.0
La1: Period 0 to period 1 = (Σ P1Q0/Σ P0Q0) x 100.0 = (605/530) x 100.0 = 114.2
La2: Period 1 to period 2 = (Σ P2Q1/Σ P1Q1) x 100.0 = (681/603) x 100.0 = 112.9

Chain Laspeyre's index:
Base period (Period 0) = (La0 x La0)/100.0 = (100.0 x 100.0)/100.0 = 100.0
Period 1 = (La1 x La0)/100.0 = (114.2 x 100.0)/100.0 = 114.2
Period 2 = (La2 x La1)/100.0 = (112.9 x 114.2)/100.0 = 128.9

Direct Laspeyre's index:
Base period (Period 0) = Σ P0Q0/Σ P0Q0 x 100.0 = 530/530x100.0 = 100.0
Period 1 = Σ P1Q0/Σ P0Q0 x 100.0 = 605/530x100.0 = 114.2
Period 2 = Σ P2Q0/Σ P0Q0 x 100.0 = 690/530x100.0 = 130.2

Pasche index:
Pa0: Base period (Period 0) = (Σ P0Q0/Σ P0Q0) x 100.0 = (530/530)x100.0 = 100.0
Pa1: Period 1 to period 0 = (Σ P1Q1/Σ P0Q1) x 100.0 = (603/530) x 100.0 = 113.8
Pa2: Period 2 to period 1 = (Σ P2Q2/Σ P1Q2) x 100.0 = (548/488) x 100.0 = 112.3

Chain Paasche index:
Base period (Period 0) = Pa0 x Pa0/100.0 = 100.0 x 100.0/100.0 = 100.0
Period 1 = Pa1 x Pa0/100.0 = 113.8 x 100.0/100.0 = 113.8
Period 2 = Pa2 x Pa1/100.0 = 112.3 x 113.8/100.0 = 127.8

Direct Paasche index:
Base period (Period 0) = (Σ P0Q0/Σ P0Q0) x 100.0 = (530/530) x 100.0 = 100.0
Period 1 = (Σ P1Q1/Σ P0Q1) x 100.0 = (603/530) x 100.0 = 113.8
Period 2 = (Σ P2Q2/Σ P0Q2) x 100.0 = (548/432) x 100.0 = 126.9

Fisher Index:
Fi0: Base period (Period 0) = √ (La0 x Pa0) = √ 100.0 x 100.0 = 100.0
Fi1: Period 1 = √ (La1 x Pa1) = √ (114.2 x 113.8) = 114.0
Fi2: Period 2 = √ (La2 x Pa2) = √ (112.9 x 112.3) = 112.6

Chain Fisher index:
Base period (period 0) = (Fi0 x Fi0)/100.0 = (100.0 x 100.0)/100.0 = 100.0
Period 1 = (Fi1 x Fi0)/100.0 = (114.0 x 100.0)/100.0 = 114.0
Period 2 = (Fi2 x Fi1)/100.0 = (112.6 x 114.0)/100.0 = 128.4

Direct Fisher index:
Base period (Period 0) = √ (La0 x Pa0) = √ 100.0 x 100.0 = 100.0
Period 1 = √ (La1 x Pa1) = √ (114.2 x 113.8) = 114.0
Period 2 = Square root direct Laspeyre's and Paasche = √ (130.2 x 126.9) = 128.5

4.33 An index formula is said to be *transitive* if the index number derived directly is identical to the number derived by chain linking. In general no weighted index formula will be transitive because period-to-period calculation of the index involves changing the weights for each calculation. The index formulas in table 4.2 will only result in transitivity if there is no change in the quantity of each item in each period or all prices show the same movement[9]. In both these cases all the formulas will produce the same result.

4.34 The direct Laspeyres formula has the advantage that the index can be extended to include another period's price observations when available, as the weights are held fixed at some earlier base period. On the other hand, the direct Paasche formula requires both current period price observations and current period weights before the index can be extended.

Unweighted, or equal-weight indexes

4.35 In some situations it is not possible or meaningful to derive weights in either quantity or value terms for each price observation. This is typically so for a narrowly defined commodity grouping in which there might be many sellers (or producers). Information might not be available on the overall volume of sales of the item or for the individual sellers or producers from whom the sample of price observations is taken. In these cases it seems appropriate not to weight, or more correctly to assign an equal weight, to each price observation. It is a common practice that the price indexes at the lowest level (where prices enter the index) are calculated using an equal-weights formula, such as an arithmetic mean or a geometric mean.

4.36 Suppose there are price observations for n items in period 0 and t. Then three approaches[10,11] for constructing an equal weights index are:

---

[9] This is illustrated mathematically for the Laspeyres index. Chaining the indexes for the period 0 to period 1, and period 1 to period 2 movements produces:

$$I^{t=2}_{Laspeyres,Chained} = \frac{\sum_{i=1}^{n} p_i^1 q_i^0}{\sum_{i=1}^{n} p_i^0 q_i^0} \times \frac{\sum_{i=1}^{n} p_i^2 q_i^1}{\sum_{i=1}^{n} p_i^1 q_i^1}$$

which is not the same as the directly estimated index:

$$I^{t=2}_{Laspeyres,Direct} = \frac{\sum_{i=1}^{n} p_i^2 q_i^0}{\sum_{i=1}^{n} p_i^0 q_i^0}$$

unless the quantities q_i^0 , q_i^1 are constant for each item or the individual prices show the same proportional change between periods (the trivial case of this being where there is no change in the individual prices between periods).

[10] Use of the RAP approach was first suggested by Dutot in 1738, the APR approach by Carli in 1764 and the geometric mean by Jevons in 1865 (see Diewert (1987)). Fisher (1922) described the RAP approach as the 'simple aggregative'. These are not the only possible formulas - another formula often mentioned in the literature is the harmonic mean. The harmonic mean of price relatives is given by the inverse of the arithmetic averages of the inverses of the relatives of the individual item prices, that is:

$$\frac{1}{\frac{1}{n}\sum_{i=1}^{n} \frac{p_i^0}{p_i^t}}$$

The harmonic mean is equal to or lower than the geometric mean. Fisher (1922) also discusses use of the median and mode.

1. calculate the arithmetic mean of prices in both periods and obtain the relative of the second period's average with respect to the first period's average (i.e. divide the second period's average by the first period's average). This is the relative of the arithmetic mean of prices (RAP) approach, also referred to as the *Dutot* formula:

$$I^t_{Dutot} = \frac{\frac{1}{n}\sum_{i=1}^{n} p_i^t}{\frac{1}{n}\sum_{i=1}^{n} p_i^0} \qquad (4.13)$$

2. for each item, calculate its price relative (i.e. divide price in the second period by the price in the base period) and then take the arithmetic average of these relatives. This is the arithmetic mean of price relatives (APR) approach, also referred to as the *Carli* formula:

$$I^t_{Carli} = \frac{1}{n}\sum_{i=1}^{n} \frac{p_i^t}{p_i^0} \qquad (4.14)$$

3. for each item, calculate its price relative and then take the geometric mean[12] of the relatives. This is the geometric mean (GM) approach, also referred to as the Jevons formula:

$$I^t_{Jevons} = \prod_{i=1}^{n}\left(\frac{p_i^t}{p_i^0}\right)^{\frac{1}{n}} = \frac{\left(\prod_{i=1}^{n} p_i^t\right)^{\frac{1}{n}}}{\left(\prod_{i=1}^{n} p_i^0\right)^{\frac{1}{n}}} \qquad (4.15)$$

[11] The implicit weights applied by the three formulas are equal base period quantities (RAP), equal base period values (quantities inversely proportional to base period prices) (APR) and equal value shares in both periods (GM).

[12] The geometric mean of n numbers is the nth root of the product of the numbers. For example, the geometric mean of 4 and 9 is 6 ($6 = \sqrt{4 \times 9}$), while the arithmetic mean is 6.5 ($6.5 = (4+9)/2$). Although the geometric mean has been presented in terms of price relatives, the same result is obtained by taking the ratio of the geometric means of prices in each period, that is:

$$\frac{\left(\prod p_{it}\right)^{1/N}}{\left(\prod p_{i0}\right)^{1/N}}$$

4.37 Although these formulas apply equal weights, the basis of the weights differ. The geometric mean applies weights such that the value shares of each observation are the same in each period. In other words, it is assumed that as an item becomes more (less) expensive relative to other items in the sample the quantity declines (increases) with the percentage change in the quantity offsetting the percentage change in the price. The RAP formula assumes that each item has the same quantity, i.e. regardless of the price the quantity of each item consumed in the base period is the same. The APR assumes equal values in the first period with quantities being inversely proportional to first period prices[13].

4.38 The following are calculations of the equal weight indexes using the data in Table 4.2. Setting period 0 as the base with a value of 100.0, the following index numbers are obtained in period *t*:

RAP formula: $113.5 = \frac{\frac{1}{3}(12+13+17)}{\frac{1}{3}(10+12+15)} \times 100$

APR formula: $113.9 = \frac{1}{3}\left(\frac{12}{10}+\frac{13}{12}+\frac{17}{15}\right) \times 100$

GM formula: $113.8 = \sqrt[3]{\frac{12}{10} \times \frac{13}{12} \times \frac{17}{15}} \times 100$

4.39 Theory suggests that the APR formula will produce the largest estimate of price change, the GM the least and the RAP a little larger but close to the GM[14]. Real life examples generally support this proposition[15], although with a small sample as in the above example, substantially different rankings for the RAP formula are possible depending on the prices.

4.40 The behaviour of these formulas under chain linking and direct estimation is shown in Table 4.3 using the price data from Table 4.2. It is noted that the RAP and GM formulas are transitive, but not the APR.

---

[13] The assumption underlying the equal weight APR can be illustrated with a simple example. Suppose there is a price sample of two items, selling for $5 and $4 in period 0. Suppose the prices in period *t* are double those in period 0. Assume expenditure on each item is $20 in period 0, giving quantities of 4 and 5 respectively. Then the average quantity weighted price in period 0 is $4.4444 ((4x5+5x4)/(4+5)) and $8.8889 in period *t* ((4x10+5x8)/(4+5)), giving an index of 200.0. This is the same result as taking the unweighted arithmetic average of the two price relatives ((1/2*(10/5+8/4)*100).

[14] For a mathematical proof of this see Diewert (1995). The unweighted indexes will all produce the same result if all prices move in the same proportion (have the same relative). In addition, the RAP and APR will produce the same index number if all base period prices are equal. In general, the RAP formula is expected to produce index numbers above but reasonably close to the GM. Diewert also refers to other studies that compare real world results for elementary aggregate formulas.

[15] For example, Woolford (1994) calculated these indexes for 23 fresh fruit and vegetable elementary aggregates of the Australian CPI over the period June 1993 to June 1994. He found that the GM produced the lowest increase in 16 of the 23 elementary aggregates and the APR produced the highest increase for 19 of the elementary aggregates. The RAP formula produced the middle estimate for 13 of the elementary aggregates. Combining the elementary aggregates to produce the fresh fruit and vegetables index, the index compiled using the APR estimates was 4.7% higher than the index based on GM estimates and the RAP was 1.7% higher than the index based on GM.

4.3 LINKING PROPERTIES OF EQUAL WEIGHT INDEX FORMULAS

Formula	Period 0	Period 1	Period 2
Relative of average prices (RAP)			
period 0 to 1	100.0	113.5	
period 1 to 2		100.0	111.9
chain	100.0	113.5	127.0
direct	100.0	113.5	127.0
Average of price relatives (APR)			
period 0 to 1	100.0	113.9	
period 1 to 2		100.0	112.9
chain	100.0	113.9	128.5
direct	100.0	113.9	128.9
Geometric mean (GM)			
period 0 to 1	100.0	113.8	
period 1 to 2		100.0	112.5
chain	100.0	113.8	128.1
direct	100.0	113.8	128.1

Note: the same price data is used as in table 4.2

Unit values as prices

4.41 A common problem confronted by index compilers is how to measure the price of items in the index whose price may change several times during an index compilation period. For example, in Australia petrol prices change almost daily at the factory gate while the PPI index is quarterly. Taking more frequent price readings and calculating an average is one approach to deriving an average quarterly price. A more desirable approach, data permitting, would be to calculate unit values and use these as price measures[16].

4.42 The unit value for an item for a specified period is the value divided by quantity transacted in the period. The item must be either homogeneous or able to be expressed in terms of some common physical unit. The time period in which unit values are calculated should be the "longest period which is short enough so that individual variations in price within the period are regarded as unimportant" (Diewert, 1995a). The use of unit values is problematic and is not generally recommended, since any change in product quality, product mix, or timing can seriously distort the average unit price. However, for a highly volatile but narrowly defined and homogeneous product like petroleum, this method may be suitable.

DECOMPOSING VALUE AGGREGATES

4.43 Having introduced the major price index formula, it is appropriate to re-examine the decomposition of a value aggregate into price and quantity components introduced in equation (4.1). It is important to know the form of the quantity index when a particular form of the price index is used (and vice versa) to ensure the accurate decomposition of the value change.

[16] See Diewert(1995) for further discussion of unit values.

4.44 A value is the result of a price and a quantity (in its simplest form the price of a single item multiplied by 1 is the value of the item). It follows that changes in the value of an item from period to period are the result of changes in prices and/or quantities concerned. If any two of the value, price or quantity are known, the third can be derived (i.e., V = P x Q, where V = Value, P = Price and Q = Quantity). For example, Q = V/P. The calculation is straightforward when a single item is involved. However, in the case of a value total that consists of several items, decomposing that value into its price and quantity components becomes more complicated.

4.45 Price indexes can be used to decompose changes in value so that the underlying changes in quantity can be estimated. In the Australian national accounts, price indexes are widely used to estimate changes in volumes of expenditure or production etc. The process of using price indexes in this way is known as price deflation, with the index termed a deflator. The form of price index (current or base weighted) will affect the resulting index of quantity change.

4.46 The change in a value aggregate between period 0 and t may be expressed as:

$$\frac{V^t}{V^0} = \frac{\sum_{i=1}^{N} p_i^t q_i^t}{\sum_{i=1}^{N} p_i^0 q_i^0} \qquad (4.16)$$

4.47 Multiplying the right hand side of equation (4.16) by $\frac{\sum_{i=1}^{N} p_i^t q_i^0}{\sum_{i=1}^{N} p_i^t q_i^0}$ allows the equation to be expressed as:

$$\frac{V^t}{V^0} = \frac{\sum_{i=1}^{N} p_i^t q_i^0}{\sum_{i=1}^{N} p_i^0 q_i^0} \times \frac{\sum_{i=1}^{N} p_i^t q_i^t}{\sum_{i=1}^{N} p_i^t q_i^0} \qquad (4.17)$$

where

$\frac{\sum_{i=1}^{N} p_i^t q_i^0}{\sum_{i=1}^{N} p_i^0 q_i^0} = I^t_{Laspeyres\ PRICE}$, a Laspeyres price index and

$\frac{\sum_{i=1}^{N} p_i^t q_i^t}{\sum_{i=1}^{N} p_i^t q_i^0} = I^t_{Paasche\ QUANTITY}$ is a Paasche quantity (or volume) index[17].

[17] In a volume index, prices are held constant between the two periods while the actual quantities from each period are used in the calculation. The change in the index is then measuring the weighted change in the volume of purchases.

This is referred to as the Laspeyres decomposition. In other words, if an index of value change is deflated by a base period weighted price index, then the estimate of quantity change is a current period weighted quantity index[18].

SOME PRACTICAL ISSUES IN PRICE INDEX CONSTRUCTION

To chain or not to chain

4.48 The use of fixed weights (as in a Laspeyres type formula) over an extended period of time is not a sound index construction practice. For example, weights in a producer price index have to be changed to reflect changes in production patterns over time. Production patterns change in response to longer-term movements in relative prices, changes in preference orderings and the introduction of new goods (and the displacement of other goods).

4.49 There are two options in these situations if a fixed-weight index is used. One is to hold the weights constant over as long a period as seems reasonable, starting a new index each time the weights are changed. This means that a longer-term series is not available. The second is to update the weights more frequently and to chain, as discussed above, to produce a long-term series. The latter is the more common practice.

4.50 The behaviour of the various formulas under chaining was introduced briefly above. The behaviours are further explored below in table 4.4 by adding two more periods. In period 3, prices and quantities are returned to their base period values and in period 4 the base period prices and quantities are 'shuffled' between items. The period 3 situation is sometimes described as 'time reversal' and period 4 situation as 'price bouncing'[19].

TABLE 4.4 A CLOSER LOOK AT CHAINING

Item	Period 0	Period 1	Period 2	Period 3	Period 4
		Price ($)			
1	10	12	15	10	15
2	12	13	14	12	10
3	15	17	18	15	12
		Quantity			
1	20	17	12	20	10
2	15	15	16	15	20
3	10	12	8	10	15
Index formula					
Laspeyres					
period 0 to 1	100.0	114.2			
period 1 to 2		100.0	112.9		
period 2 to 3			100.0	78.8	
period 3 to 4				100.0	107.5
chain	100.0	114.2	128.9	101.6	109.3
direct	100.0	114.2	130.2	100.0	107.5

[18] Many alternative decompositions can be undertaken. See, for example, Chapter 3 of *Australian Consumer Price Index, Concepts Sources and Methods* (cat. no. 6416.0)
[19] Szulc (1983) applied the term "price bouncing" to situation 3.

Item	Period 0	Period 1	Period 2	Period 3	Period 4
Index formula					
Paasche					
period 0 to 1	100.0	113.8			
period 1 to 2		100.0	112.3		
period 2 to 3			100.0	76.8	
period 3 to 4				100.0	93.8
chain	100.0	113.8	127.8	98.1	92.1
direct	100.0	113.8	126.9	100.0	93.8
Fisher					
period 0 to 1	100.0	114.0			
period 1 to 2		100.0	112.6		
period 2 to 3			100.0	77.8	
period 3 to 4				100.0	100.4
chain	100.0	114.0	128.3	99.9	100.3
direct	100.0	114.0	128.5	100.0	100.4

4.51 Under the three formulas, the index number under direct estimation returns to 100.0 when prices and quantities of each item return to their base period levels. However, the chained index numbers do not (although the chained Fisher Ideal index might generally be expected to perform better than the chained Laspeyres or Paasche).

4.52 This situation poses a quandary for prices statisticians when using a fixed-weight index. There are obvious attractions in frequent chaining. However, chaining in a fixed-weight index can lead to biased estimates. This can occur if there is seasonality or cycles in the price and chaining coincides with the top and bottom of each cycle. For this reason it is generally accepted that chaining should not be done at intervals less than annual. In effect, the conceptual underpinning of chaining is that the traditionally expected inverse relationship between prices and quantities actually applies in practice (i.e. growth in quantities is higher for those items whose prices increase less in relative terms). The *System of National Accounts, 1993* describes the practical situations in which chaining works best[20].

[20] Paragraph 16.48: "...a chain index should be used when the relative prices in the first and last periods are very different from each other and chaining involves linking through intervening periods in which the relative prices and quantities are intermediate between those in the first and last periods. Relative prices and quantities are described as intermediate when they may be approximated by some average of those in the first and last periods. This will happen when the opening prices and quantities are transformed into those of the final period by the gradual accumulation of successive changes which tend to be in the same direction. In this case, the individual links in the chain are strong as they involve comparisons between situations that are very similar to each other."

Handling changes in price samples

4.53 All the index formulas discussed above require observations on the same items in each period. In some situations it may be necessary to change the items or outlets included in the price sample or, if weights are used, to reweight the price observations. Examples of changes in a price sample include: a respondent goes out of business; or the sample needs to be updated to reflect changes in the market shares of respondents; to introduce a new respondent; or to include a new item.

4.54 It is important that changes in price samples are introduced without distorting the level of the index for the price sample. This is usually done by a process commonly called 'splicing'. Splicing is similar to chain linking except that it is carried out at the price sample level. An example of handling a sample change is shown in table 4.5, for equal weighted indexes assuming a new respondent is introduced in period t. A price is also observed for the new respondent in period t-1. The inclusion of the new respondent causes the geometric mean to fall from $5.94 to $5.83. We do not want this price change to be reflected in the index but we do want to capture the effect of respondent 4's price movement between period *t-1* and *t*.

TABLE 4.5 A CHANGE IN SAMPLE – INTRODUCING A NEW RESPONDENT

Item	Price			Price relative		
	Period			Period		
	Base	Period t-2	Period t-1	Base	Period t-2	Period t-1
Period t-1						
1	4.00	5.50	6.00	1.000	1.375	1.500
2	4.50	4.50	5.00	1.000	1.000	1.111
3	5.00	5.50	7.00	1.000	1.100	1.400
Geometric mean	4.48	5.14	5.94	1.000	1.148	1.326
Period t	Base	Period t-1	Period t	Base	Period t-1	Period t
1	4.00	6.00	6.50	1.000	1.500	1.625
2	4.50	5.00	5.50	1.000	1.111	1.222
3	5.00	7.00	7.00	1.000	1.400	1.400
4		5.50	6.00	1.000	1.326	1.447
GM (all items)		5.83	6.22	1.000	1.326	1.416
GM (matched sample)		5.94	6.30			

4.55 In the case of the APR and GM formulas, this is done by:

- setting the previous period price relative for period t for the new respondent (4) equal to the average of the price relatives of the three respondents included in period t-1 (1.326)
- applying the movement in respondent 4's price between period *t-1* and *t* to derive a price relative for period *t* (6.00/5.50x1.326=1.447).

4.56 For these two formulas, the average of the price relatives is effectively the index number, so the GM index for period *t-1* is 132.6 and for period *t* is 141.6.

4.57 In the case of the RAP formula, the method is similar but prices are used instead of price relatives. The RAP formula uses the arithmetic mean of prices (not the arithmetic mean of the price relatives). The index for RAP can be calculated from the period to period price movements:

- between the base period and period *t-1*, the movement in the average price was 1.333 (6.00/4.50) without the new respondent
- between period *t-1* and *t*, the movement in the average price was 1.063 (6.25/5.88) including the new respondent in both periods

thus the index for period *t* is 141.7 (1.333 × 1.063 × 100).

CHOOSING AN INDEX NUMBER FORMULA

4.58 As different index number formulas will produce different results, there is a need for some ground rules to determine which formulas are more appropriate. Two main approaches have been used:

- the evaluation of the performance of the formula against a set of predetermined desirable mathematical properties or tests, the so-called 'axiomatic' approach
- economic theory.

Axiomatic approach

4.59 The use of tests to assess index number performance is a useful guide. However, a number of practical issues need to be considered. These include: how relevant are the tests for the application at hand; are some tests more important than others; and, even if an index formula fails a test, how close in practice is the index likely to be to the 'best' measure.

4.60 The range of tests developed for index numbers has expanded over the years. Diewert (1992) describes 20 tests for weighted index formula, while Diewert (1995) provides 17 tests for equal weighted (or elementary) index formula and attributes the tests to their original authors. It is beyond the scope of this manual to describe all the tests, but several important and relevant ones for current purposes will be discussed.

4.61 Many of the tests apply to both the equal and unequal weighted formulas. The tests include:

- *Time reversal.* This test essentially requires that the index formula produces consistent results whether it is calculated going from period 0 to period 1 or from period 1 to period 0. More specifically, if the price observations for period 0 and 1 are interchanged then the resulting price index should be the reciprocal of the original index[21].
- *Circularity* (often called transitivity). This is a multi-period test (essentially a test of chaining). It requires that the product of the price index obtained by going from period 0 to period 1 and from period 1 to period 2 be the same as going directly from period 0 to period 2[22].
- *Permutation* or *price bouncing*. This test requires that, if the order of the prices in either period 0 or period 1 (or both) is changed but not

[21] If $I_{0,1}$ is the price index for period 1 using period 0 as the base and $I_{1,0}$ is the index for period 0 using period 1 as the base, then this test requires $I_{0,1} = 1/I_{1,0}$ *or* $I_{0,1}I_{1,0} = 1$. Fisher (1922) refers to $1/I_{1,0}$ as the 'time antithesis' of the index formula.

[22] The concept of chaining was outlined earlier in the section on 'Generating index series over more than two time periods'.

the individual prices, the index number should not change[23]. This test is appropriate in situations where there is considerable volatility in prices, for example because of seasonal factors or sales competition.

- *Commensurability*. This test requires that if the units of measurement of the item are changed (e.g. from kgs to tonnes), then the price index should not change.

- *Factor reversal test*. This test is not appropriate for the elementary index formulas. It requires that the product of the price index number for any period and an index of quantity obtained from the formula by interchanging the price and quantity terms should equal the ratio of value in that period to the base period value[24].

4.62 The Fisher Ideal index formula passes tests on time reversal, circularity, commensurability and factor reversal, whereas the Laspeyres and Paasche only pass the test of commensurability[25].

4.63 In regard to the three equal weight price index formula discussed earlier, the APR fails the first three tests, the RAP fails the commensurability test while the GM approach passes all tests[26]. In terms of Diewert's 17 tests for elementary index formulas, the RAP passes 15 tests and the GM 16 tests.

4.64 While the equal weighted GM appears to have considerable appeal as an elementary index formula, there are some situations in which it produces an undesirable result. The GM cannot handle zero prices, which might occur if the government introduced a policy to fully subsidise a good or service. In addition, the GM may not produce acceptable movements when a price falls sharply. For example, consider a price sample of two items, each selling for $10 in one period, the price of one of the items falling to $1 in the second period. The GM produces an index of 31.6 for the second period (assuming it was 100 in the first period), a fall of around 68 per cent. Because the GM maintains equal value shares in each period, it effectively gives a larger weight to lower prices[27].

---

[23] A simple way to apply this test is to have the same prices in the two periods but change the order of the prices in the second period, in which case the index value should be 1.

[24] Fisher's (1922) factor antithesis is obtained by interchanging prices and quantities in the formula and then dividing this expression into the 'value ratio'. Diewert (1992, p. 222) notes that various researchers have objected to this test and does not count it in his list of 20 tests.

[25] Although neither the Laspeyres or Paasche index pass the factor reversal test on their own, the combination of a Laspeyres price index and a Paasche quantity index (or vice versa) will satisfy the test.

[26] Fisher (1922) summarised the poor performance of the APR approach in the following terms

> "...the simple arithmetic average (APR) produces one of the very worst of index numbers. And if this book has no other effect than to lead to the total abandonment of the simple arithmetic type of index number, it will have served a useful purpose." (pp. 29-30).

[27] The RAP and APR formulas both produce an index of 55.

4.65 There is another aspect to indexes that is worth considering, although not rated as a test in the literature. In most countries price indexes are produced at various levels of aggregation, there typically being three or more levels between the lowest published level and the total all goods and services. In practice it is desirable that the same result is obtained whether the total index is compiled directly from the lowest level or in a staged way, using progressively higher levels of aggregation. Diewert (1978) shows that the fixed weight Laspeyres and Paasche indexes have this 'consistency' in aggregation property, while the Fisher and Tornqvist indexes are (very) closely consistent[28].

OTHER PRACTICAL ASPECTS

4.66 There are several other practical aspects of price index construction that draw on the theory of price indexes. These are discussed in later chapters as follows:

- dealing with quality change in discussed in Chapter 9;
- maintaining samples of products is discussed in Chapter 11;
- weighting of price indexes is discussed in Chapter 6 and Chapter 12;
- compilation of price indexes, including dealing with missing prices, is discussed in Chapter 10.

[28] The aggregation property of the Laspeyres and Paasche indexes allows the indexes to be broken down into points contributions which is very useful for analysing the relative significance of items in the index and their contribution to changes in the aggregate index. However, Diewert (2000) has produced an approach for similarly decomposing superlative index formula.

CHAPTER 5 COVERAGE AND CLASSIFICATION

WHAT ARE PRICES?

5.1 Producer Price Indexes (PPIs) are designed to measure price change. In describing and defining a PPI, it is essential to ensure that the definition of price is both consistently measured and understood by the users of the index.

5.2 Price is defined as the value placed on a product at the point of transaction.

5.3 However, the buyer and seller may place a different value on the product, depending upon how indirect taxes, subsidies and transport charges are recorded. For example, the price a manufacturer receives for the direct retail sale of a product such as a motor vehicle is not the same price that a consumer would pay for the product because the consumer must pay goods and services tax (GST).

5.4 The system of national accounts (SNA) refers to three special types of valuation bases: basic prices, producers' prices and purchasers' prices.

Basic prices and producers' prices

5.5 The SNA uses two kinds of output prices, namely, basic prices and producers' prices.

5.6 The *basic price* is the amount receivable by the producer from the purchaser for a unit of a good or service produced as output, minus any tax payable, plus any per unit subsidy receivable on that unit as a consequence of its production or sale. It excludes any transport charges invoiced separately by the producer. However, delivery charges that are not separately invoiced are included in the basic price.

> *Basic price* = the amount received by the producer from the purchaser *plus* any subsidies received on a product
>
> Includes: subsidies on products and taxes on production
>
> Excludes:
>
> (i) taxes on products and subsidies on production
>
> (ii) retail and wholesale margins
>
> (iii) insurance and transport charges separately invoiced.

5.7 The *producers' price* is the amount receivable by the producer from the purchaser for a unit of a good or service produced as output, including any tax that is incorporated within the sales price and excluding any subsidy that reduces the sales price, on that unit as a consequence of its production or sale. It excludes any transport charges invoiced separately by the producer but includes delivery charges not separately invoiced.

> *Producers' price* = the amount received by producer from purchaser
>
> Excludes:
>
> (i) deductible taxes on products (e.g. GST) invoiced to the purchaser
>
> (ii) retail and wholesale margins
>
> (iii) insurance and transport charges separately invoiced.

5.8 The producers' price and the basic price are two measures of output prices (that is, prices receivable). They differ in the way they treat non-deductible taxes on products, and producers' subsidies on products.

Producers' price = Basic Price

plus (Producers') non-deductible taxes on products

minus (Producers') subsidies on products.

5.9 Neither the producers' nor the basic price includes any amounts receivable in respect of GST, or similar deductible tax, invoiced on the output sold. The difference between the two is that to obtain the basic price, any other tax payable per unit of output is deducted from the producers' price while any subsidy receivable per unit of output is added.

5.10 In the context of the ABS PPIs, the output price indexes measure changes in *basic prices*. Thus, output is recorded at basic prices; any tax on the product actually payable on the output is treated as if it were paid by the purchaser directly to the government instead of being an integral part of the price paid to the producer. Conversely, any subsidy on the product is treated as if it were received directly by the purchaser and not the producer. The basic price measures the amount retained by the producer and is, therefore, the price most relevant for a producer's decision-taking.

Purchasers' prices

5.11 The purchasers' price is the amount paid by the purchaser in order to take delivery of goods or services. Purchasers' prices include any taxes payable (less any subsidies receivable) on production and imports, and any transport charges paid separately by the purchaser to take delivery of goods. In the context of the ABS PPIs, which measure purchases by producers, the input price indexes exclude the GST, since the GST is generally deductible from the purchaser's own GST tax liability.

Free on board

5.12 Both the import price index and the export price index are valued using a *free on board* (f.o.b.) pricing basis[29]. The value of goods measured on an f.o.b. basis includes all production and other costs incurred up until the goods are placed on board the international carrier for either export or import. Free on board values exclude international insurance and transport costs. They include the value of the outside packaging in which the product is wrapped, but do not include the value of the international freight containers used for transporting the goods.

PPI POPULATIONS OF INTEREST

5.13 The ABS PPIs measure price changes in two ways:

(i) The *input price indexes* measure the prices producers pay for materials consumed in production, valued at purchasers' prices;

(ii) The *output price indexes* measure the prices producers receive for the sale of their products, valued at basic prices.

[29] The import price index measures price changes for commodities entering the Australian economy, and is frequently used as an indicator of inflationary pressure arising from international supply and demand. As noted the IPI is priced on an f.o.b. basis and so excludes measurement of freight and insurance. It is clear that freight and insurance costs may be sources of inflationary pressure to individual purchasers of imported products; however, since such services may be provided by Australian establishments as well as establishments outside the customs frontier, the inclusion of insurance and freight in the IPI would distort the inflationary impact of international trade.

5.14 Therefore there are two populations of interest for the ABS PPIs - the transactions that result in the purchase of materials to be consumed in production, and the sale of products by producers.

5.15 The ABS output PPIs measure changes in prices received by the manufacturing, construction, and service industries[30]. These indexes measure the change in prices received by domestic establishments regardless of whether the sale of the product was to a domestic purchaser or as an export. The PPIs for service industries are restricted to transport (freight) and storage industries, and property and business services.

5.16 The ABS input PPIs measure changes in prices paid by the manufacturing and construction industries. These indexes measure the change in prices paid by domestic establishments regardless of whether the purchase was of a domestically produced good or as an import.

5.17 The international trade price indexes measure the change in prices of merchandise that crosses the Australian customs frontier. The populations of interest for these price indexes are all imported products (for the import price index) and all exported products (for the export price index). Neither the export price index nor the import price index attempts to measure the change in price of internationally traded services.

Whole of economy measures

5.18 The ABS produces a set of economy wide price indexes using a stage of production (SOP) approach, which in concept measures outputs at basic prices. As the focus in the use of the PPIs is on domestic inflation, exports are excluded from the headline stage of production (SOP) series *final (Stage 3) commodities*. Imports have been incorporated within the framework, recognising that they represent an important potential source of inflationary pressure (imports are allocated to the competing domestic industry of origin but measured on an f.o.b. pricing basis).

Non-market goods and services

5.19 Most countries, including Australia, define non-market activities as falling outside the scope of PPIs. Examples of these activities include general government services such as national defence and the value of owner-occupied dwellings.

5.20 A different issue is whether to include in the scope of the PPI any revenue-generating activity, even if it accounts for a small proportion of the economic activity of an establishment. For example, should the gift shop sales of a government-owned museum fall within the scope of the PPI, or should the establishment be deemed to be out of scope because most of its activities are funded from taxation revenue? Establishments and/or entire industries with few market-priced activities are generally excluded from the PPIs on the basis that the value of the information provided is outweighed by the cost of data collection, for both the ABS and the respondent businesses.

[30] The output producer price indexes compiled by the ABS measure the prices received by producers regardless of the destination of the good or service. Thus, producer price indexes measure business-to-business transactions but also include transactions, where appropriate, to the household sector, to government and to non-profit institutions serving households. This scope aligns with the use of the PPIs as measures of inflation and as deflators in the national accounts. Some national statistical offices in other countries limit their PPIs to business-to-business transactions only, and comparisons with such measures should be made with caution.

Export and import coverage within the PPI

5.21 On a conceptual basis, the inclusion of exports and exclusion of imports conforms to the measurement of output price change consistent with index use for the purpose of deriving chain volume estimates of gross domestic product (GDP). In contrast, the inclusion of imports and exclusion of exports is consistent with demand-based index use. Both formulations are highly meaningful for a variety of important data users (see Chapter 2). Consequently, the ABS includes exports (on an f.o.b. basis) in output price indexes, and imports (on a c.i.f. basis) in input price indexes[31], since the key use of such indexes is in the production of the national accounts. On the other hand, the whole of economy inflationary measures provided by the Stage of Production producer price indexes exclude exports and include imports[32] on an f.o.b. basis.

TRANSACTION PRICES

5.22 PPIs attempt to measure actual transaction prices for the exchange of goods and services; that is, the actual price received by a producer or paid by a purchaser. The price includes the impact of all discounts, surcharges, rebates, etc. for a unique customer or unique class of customer. It is not always possible to obtain a transaction price net of all discounts and inclusive of all surcharges. Of greatest concern is the ability to secure a type of price with a movement which closely proxies the *movement* of a net transaction price.

Contract prices

5.23 *Contract* pricing generally refers to a written sales instrument that specifies both the price and shipment terms. The contract may include arrangements for a single shipment or multiple shipments. The contract usually covers a period in excess of one quarter. Contracts are often unique in that not all the price-determining characteristics in one contract can be expected to be repeated exactly in any other contract. The challenge is to maintain a constant quality methodology over time, especially when the contract expires and selection of a replacement item is necessary.

5.24 Contract terms may be unique to each agreement in terms of customised product features, negotiated price tied to the unique buyer/seller relationship, or quantity differences. In addition, contracts reflect supply and demand conditions at the time of entering into the contract.

5.25 To maintain an accurate index where contract pricing is widespread, the ABS employs larger samples. This is to reflect the proper proportion of new contracts or renegotiated contracts being entered into each pricing period.

[31] Unlike the situation with the import price index itself (which measures the inflationary impact of international trade on the Australian economy), the input price indexes, such as materials used in manufacturing industries, measure the inflationary impact on a particular sector, regardless of whether the source is domestic or not. Following this concept, imports are measured c.i.f. This is an example where the same transaction is measured on two different pricing bases, for two different purposes: f.o.b. for the import price index, and c.i.f. for the price index of materials used in manufacturing.

[32] Although the headline Stage of Production index excludes exports, an equivalent measure including exports (f.o.b.) is also compiled and published electronically in Tables 26 & 27 of *Producer Price Indexes, Australia* (cat. no. 6427.0)

Spot market prices

5.26 *Spot market price* (or simply spot price) is a generic term referring to any short-term sales agreement. Generally, this refers to single-shipment orders with delivery expected in less than one month. Goods sold on this basis usually are off-the-shelf and, therefore, are not subject to any customisation. These prices are subject to discounting and directly reflect current market conditions. Spot market prices can be extremely volatile; in the case where this volatility is not experienced in actual transactions, the ABS adopts pricing methodologies that minimise this spot price volatility. For example, for crude petroleum oils, the ABS incorporates an average of daily prices into the price measurement for each quarter. Another solution the ABS adopts for homogeneous products that exhibit price volatility is to use *average unit values*.

Average unit values

5.27 Average unit values (or simply average prices) reflect multiple shipments of a given product within a consistently defined period, for which data are usually readily available. The advantage of average unit values is that they effectively increase the number of price observations used to calculate the index, thereby reducing sample variance. The reduction in variance is achieved because average unit values explicitly represent the entire population of transactions for a particular good or service, and so the concern when pricing a handful of single transactions does not apply. An average unit value should reflect prices in the current period, and the price should relate to homogeneous transactions.

Counterpart pricing

5.28 Counterpart pricing is a term to reflect utilisation of a transaction price observed on a pricing basis that differs from the conceptual base of the price index. For example, consider an input price index that measures the price of plumbing materials purchased by builders for use in house construction. The conceptual basis for such a price index is to measure the purchasers' price paid by the builder, inclusive of delivery charges. A *counterpart price* for this transaction would be the price received by the producer of the plumbing materials; that is, the basic price. This basic price would differ from that paid by the builder in the case due to delivery costs. A counterpart pricing methodology is employed whenever a purchaser's price is represented by a basic price, or vice versa.

5.29 Note that the use of a counterpart pricing methodology has the implicit assumption that transport and distributive trade margins move proportionally with the basic price.

WHEN IS A TRANSACTION PRICE DETERMINED?

5.30 The appropriate price to obtain from a theoretical perspective should be the price at the time there is a change in ownership from the producer to the buyer. Unfortunately, it is frequently difficult to adhere to this theoretical requirement uniformly in practice. Therefore, the ABS generally uses the concept of shipment price for the actual transaction occurring as close to the survey pricing date as possible. In most circumstances, the shipment price is final at the time of delivery to the customer. An important caveat is made for the import price index in this case.

Import price index and imports into Australia

5.31 The import price index measures the price of merchandise that is imported into Australia. A transaction is in scope of the import price index if the merchandise crosses the Australian customs frontier during the reference quarter. However, that transaction, and hence the change of ownership, may have occurred prior to the reference period, with the difference in timing due to shipping times. For example, a shipment of cars may change ownership during the last week in March, but not arrive in Australia until early in April. In this instance, although the change of ownership occurred in the March quarter, the price measurement would be included in the June quarter import price index.

5.32 This "crossing customs frontier" basis is the same as that adopted for ABS international merchandise trade statistics. It slightly differs from the conceptual bases of both the Australian national accounts and balance of payments statistics. However, since both national accounts and balance of payments data use international trade data as a source, the data sets are consistent in practice. Adjustments for timing are made to national accounts or balance of payments in the case of large one-off purchases, typically of capital goods (for example, the purchase of a fleet of jet aircraft). Since by its very nature the import price index cannot determine a price movement for one-off purchases, the import price index is consistent with the compilation of both the Australian national accounts and Australian balance of payments statistics.

CLASSIFICATION

5.33 Classifications are a set of defined groupings or categories, based on common relationships, into which all members of statistical units can be divided or arranged. These groupings or categories can be ordered systematically, and must be mutually exclusive and exhaustive.

Importance of classifications in price statistics

5.34 The classification structure largely determines the scope of price collection when conducting a survey for price indexes. The classification structure forms the index structure, and determines which commodities from which sectors of the economy are needed to construct price indexes. Further, the classification serves as the basic language allowing sources of value data and price indexes to have a direct concordance.

5.35 Classifications enable an exact definition of which commodities are to be included in an index, and provide a meaningful and cohesive structure for reporting on price movements for different subsets of the price basket.

5.36 The ABS uses many international and local classification systems. The availability and nature of the data will also affect the design of a classification system. In the price index context, the availability of value data will dictate the lowest level of detail that might be possible. Although a classification may be conceived according to economic theory or user requirements using a top-down approach, in application the ABS collects data about individual products and then aggregates them according to the classification structure (i.e. a bottom-up approach).

5.37 In application, products in the producer and international trade price indexes are classified according to several classifications.

Australian and New Zealand Standard Industrial Classification (ANZSIC)

5.38 The ANZSIC was produced by the ABS and Statistics New Zealand for use in both countries for the production and analysis of industry statistics. It was developed to improve the comparability of industry statistics between Australia and New Zealand, and international comparability has been enhanced by aligning the ANZSIC with the International Standard Industrial Classification (ISIC), Revision 3, wherever possible.

5.39 ANZSIC is used for three purposes in the production of ABS producer and international trade price indexes. First, in both the output and stage of production price indexes it is used to classify the industry of a producer of a given commodity (in an industry-of-origin role). Second, for input price indexes ANZSIC is used to classify the industry of a purchaser of a given commodity (in an industry-of-consumption role). Third, for imports, in both the import price index and the stage of production producer price indexes, ANZSIC is used to identify a domestic competing industry of origin.

Australian Standard Geographical Classification (ASGC)

5.40 The main purpose of the ASGC is for collecting and disseminating geographically classified statistics, which are statistics with a 'where' dimension. This classification system provides seven hierarchies of geographical areas, with each structure designed to suit different statistical purposes. Several ABS producer and international trade price indexes use the top levels of the main structure of the ASGC, in particular the state/territory levels and the statistical division level. The price index of building materials used in house building in particular is restricted in scope to the six state capital cities, which are the capital city statistical divisions as defined within ASGC. This price index measures prices in the capital city in which the materials are purchased.

Standard International Trade Classification (SITC, Rev.3)

5.41 SITC is the United Nations recommended trade classification for international statistical purposes. The SITC groups goods according to the level of manufacturing or processing the goods have undergone; that is SITC is a degree of transformation classification. The ABS uses the SITC as its primary classification for the publication and dissemination of both broad level international trade statistics and the international trade price indexes. The design (structure) of the import price index is based on SITC.

Harmonized Tariff Item Statistical Code (HTISC)

5.42 The HTISC provides tariff and statistical information for the Customs entry of goods imported into Australia. The classification of goods within this system is governed by the legal provisions of the Customs Tariff Act 1995. The HTISC groups commodities according to the material of which the goods are composed. It provides the most detailed breakdown of imported goods, and facilitates the analysis of imported commodities. The classification is jointly compiled by the ABS and Customs, and is based on the six digit international Harmonized Description and Coding System (Harmonized System or HS) developed by the World Customs Organisation (WCO) for describing internationally traded goods. The Australian Customs Service (Customs) extends the six digit international HS by two digits to allow for different rates of duty to be applied to particular goods. Australia then extends the eight digit HTISC by two digits to provide a finer level of detail to meet Australian statistical requirements. The classification is maintained by Customs, with the ABS having responsibility for the maintenance of all aspects of the statistical code components. The import price index uses this classification for secondary dissemination purposes.

Australian Harmonised Export Commodity Classification (AHECC)

5.43 The AHECC classification is both a material composition and a degree of transformation classification. Under AHECC, goods obtained from the same material are generally grouped together and are arranged progressively from the raw material or less manufactured product through to the finished or more highly manufactured product. This classification was designed for use by exporters, customs brokers and freight forwarders in the classification of goods when providing export declarations to Customs, and to assist users interpret export statistics published by the ABS. The classification is compiled by the ABS and based on the six digit international Harmonized Description and Coding System (Harmonized System or HS) developed by the World Customs Organisation (WCO) for describing internationally traded goods. Australia extends the six digit international HS by two digits to provide a finer level of detail to meet Australian statistical requirements. AHECC is used in the design (structure) of the export price index, although data are disseminated on a SITC basis.

Australian and New Zealand Standard Product Classification (ANZSPC)

5.44 The ANZSPC provides a framework for grouping all goods and services in the Australian and New Zealand economies. It is used to classify products based on the physical characteristics of goods or on the nature of the services rendered. ANZSPC includes products that are an output of economic activity, including transportable goods, non-transportable goods, and services. It aids comparability between production, import and export statistics; links between products and the industries that produce them; comparability between Australia, New Zealand and international statistics; the compilation of product data for use in the national accounts; and construction of alternate views based on product rather than industry. All ANZSPC product categories are linked to the appropriate categories of the ANZSIC, Central Product Classification (CPC), SITC, and the HS.

Input-Output Product Classification (IOPC)

5.45 As the input-output system describes the production and subsequent use of all goods and services, the IOPC needs to be defined in terms of characteristic products of industry sectors. The structure of the IOPC therefore arises from its industry-of-origin basis. In an industry-of-origin classification, each product item is shown according to the industry in which it is primarily produced. Thus, the structure of the IOPC consists of industry-of-origin headings with detailed product items shown under each heading. The overall principles for the preparation of such an industry-of-origin product classification are:

- *Homogeneity of input*s - each product or product group should consist of items that have similar input structures or technology of production. This principle is generally applied through the definition of each IOPC item in terms of the ANZSIC industry sector in which it is mainly produced.

- *Homogeneity of disposition* - each product or product group, having satisfied the first criterion, should consist of items that have similar patterns of disposition or usage. This principle is applied by reference to the description of source data items and information about the transport, distribution, and product taxation margins applying to particular products.

5.46 The IOPC plays an important role in both the input and output PPIs as the basis of classification of all individual goods and services.

Classification by Broad Economic Categories (BEC)

5.47 This classification system groups commodities according to their main end use, namely capital goods, intermediate goods, and consumption goods. The BEC was designed as a means for converting data compiled in terms of SITC, into end-use categories. These categories are aligned as far as practicable with the System of National Accounts (SNA) framework. The BEC classification is used for economic analysis of international merchandise trade statistics, and the international trade price indexes, and it facilitates the use of these data in conjunction with other national and international economic statistics.

CHAPTER 6 WEIGHTS AND THEIR SOURCES

INTRODUCTION

6.1 As index numbers, the producer and international trade price indexes are computed as averages of the price relatives of the many products for which prices are collected. For an input price index, the average is weighted to reflect the importance of each priced product in terms of its share of total purchases in the market. For an output price index, the average is weighted to reflect the importance of each priced product in terms of its share of total market revenue.

6.2 In the construction of the producer and international trade price indexes a weight is attached to almost every price collected. In some circumstances, this is not always feasible or cost effective (such a case occurs for the accommodation price index that is produced as part of the stage of production producer price indexes). This chapter explores the statistical issues underlying the determination of weights. It outlines the objectives and criteria for determining weights, and both describes and evaluates the varying data sources which are used to generate the weights.

THE ROLE OF WEIGHTS

6.3 The producer and international trade price indexes are calculated from many prices collected from all types of establishments, covering the selected economic activities and products. The collected prices are first combined to compile indexes for each individual product. For example, 20 prices for different types of transactions for a detailed type of product may be collected from a range of establishments, and these prices have to be combined in order to produce the price index for the product. Once this has been done, the product price indexes are combined to produce the class, sub-group, group and subdivision indexes, and eventually the all-product index. (See Figure 6.1 below.) As some products have greater production or sales than others, each product is given a "weight" to represent its importance in total revenue (or expenditure, for an input index) during the base period for the weights. To arrive at the aggregate index figure the price relatives of the individual products are multiplied by these "weights" to derive a weighted average aggregate index.

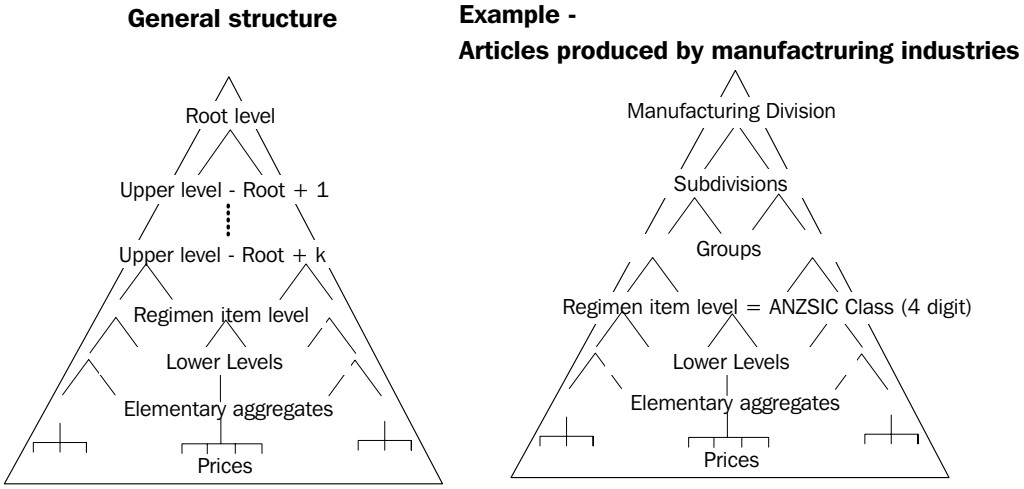
6.4 The weights are key elements in the construction of producer and international trade price indexes. They determine the impact that a particular price change will have on the overall index. For example, a 5% rise in the price of crude petroleum products has a much greater impact on the average rate of price change for purchases of the manufacturing sector than a 5% increase in the price of paper products, because the expenditure value of crude petroleum products is higher than that for paper. Without explicit weights, relative price changes for all commodities in the price basket would be given equal importance in calculating the index above.

6.5 Over time, establishment production levels shift in response to economic conditions. Some products and industries become more important while others become less important. The ABS periodically updates the weights in the producer and international trade price indexes to reflect these changes in market structure. For example, both the import price index and the export price index are re-weighted annually. Details on how new weights are introduced into price indexes appear in Chapter 12.

6.6 In discussing the importance of weights, it is necessary to refer to the structure of the producer and international trade price indexes. A diagrammatic overview of the typical structure of the producer (or international trade) price index is provided in Figure 6.1. At the top is the total value of products represented by the index (corresponding to the *value aggregate* as discussed in Chapters 4 and 15). This is progressively divided into finer product groupings, following the structure of the

classification until, at the lowest level, there are samples of prices for individual products. These highly detailed price samples are called *elementary aggregates*. Indexes are only published down to the *regimen item level* as this is the level at which the structure and weights remain fixed between index reviews[33].

6.1 EXAMPLE OF STRUCTURES OF PRODUCER AND INTERNATIONAL PRICE INDEXES



6.7 The division of products into finer product groupings is intended to reflect increasing levels of substitutability of the items in response to changes in relative prices. For an output index, the index structure reflects substitutability in terms of production, reflecting how producers change their outputs in response to the prices they are receiving in the marketplace. For an input index, the index structure reflects substitutability in terms of consumption, reflecting how producers change their inputs in response to the prices they are paying in the marketplace.

6.8 For example, consider the APMI example in Figure 6.1. At the upper levels, such as subdivision level, there is likely to be little substitution between, say, output of food beverages and tobacco, and non-metallic mineral products in response to changes in their relative prices. Within the oil and fat manufacturing ANZSIC class it would be expected that producers are more likely to substitute between, say, margarine and refined oils in response to changes in their relative prices.

COMBINING PRICE SAMPLES

6.9 The top level of a price index (such as the Manufacturing Division for the APMI example above) is compiled by weighting price movements (or price relatives) between the base and current period by their shares of total value in the base period. This is simply the alternative way of calculating a Laspeyres index as described in Chapter 4.

6.10 In practice the producer and international trade price indexes are compiled using value aggregates rather than value shares. The concept of a value aggregate is described in Chapters 4 and 15, where the value aggregate for a product in period t is calculated by multiplying the base period value aggregate p^0q^0 by the price relative for period t (p^t / p^0). In effect, this is simply the product of the (unobserved) base period quantity and the period t price. Summing the value aggregates in period t and dividing by the sum of the value aggregates in the base period yields the Laspeyres price index.

[33] See Chapter 11 for a detailed discussion of index reviews.

6.11 Price indexes are described as measuring the change over time in the total price of a fixed basket of goods and services (products) when considered in aggregate. For an input index, the aggregate is of all products purchased and, for an output index, the aggregate is of all products sold. It is important to note that the use of the term 'fixed' relates to the *quantities underlying the base period values* (or more formally, the quantities in the base period value aggregate) — it is, after all, the base period quantities that are fixed in a Laspeyres index. Weights are usually expressed in terms of value shares because quantities are not meaningful or consistent across commodities and services. Further, value shares will change over time as the rate of price change varies across products.

6.12 The description of price indexes as fixed-weight indexes requires qualification reflecting the practices adopted by the ABS.

6.13 Holding the weights of products in a basket fixed permanently is neither realistic nor entirely possible. If held constant on a permanent basis, the weights would become less representative of the relative importance of goods and services produced (or purchased) by producers the further the series moved away from the base period. There would also be the problem of products that cease to exist and the entry of new goods and services. Furthermore, the finer the level of detail the less information that exists about the relative importance of items in the basket, which makes it more complicated to calculate weights at lower levels of the index.

6.14 To reduce these problems, weighting practices vary by the level of aggregation. Three distinct practices arise, which will each be discussed in turn:

- Weights for the regimen item level and above, in which the implicit quantity weights are fixed between index reviews[34] (also known as *upper level weights*);
- Weights for the index structure between the regimen item level and the elementary aggregate level (also known as *lower level weights*); and
- Weights for the individual specifications within an elementary aggregate (also known as *micro-index weights*).

UPPER LEVEL WEIGHTS

6.15 Chapters 4 and 15 discuss the value aggregate from the national accounts framework. For an input price index, the value aggregate is the cost of input products to the purchaser. In a supply-use framework, this is the cost of intermediate inputs valued at purchasers' prices. For an output price index, the value aggregate is the value of production at basic prices.

NET SECTOR WEIGHTING FOR THE MANUFACTURING DIVISION

6.16 The output of one activity can often be considered as an input to another activity within the same industrial sector, as discussed in Chapter 3. For example, consider the food, beverage and tobacco manufacturing industry. One of the key outputs of this industry is refined sugar. This product is also an input into many other food and beverage products. The use of gross value weights for both activities would result in multiple counting as the value of output in the first activity (processed materials such as sugar) is an input to the second (manufactured goods such as soft drink), and the value of output of the second activity therefore includes that of the first. This is particularly the case for the manufacturing industries. If the two activities are combined to produce an aggregate index, the importance of the first activity is included twice in the group index. To eliminate this "double counting" effect, *net weights* can be derived.

[34] See Chapter 11

6.17 The advantage of the net sector approach over the alternative gross sector approach (under which the intra-sector transactions would be in-scope) is that it avoids the potential distorting effects that may result from multiple counting of changes in transaction prices as commodities flow through different production processes.

6.18 On the other hand, although conceptually valid, the exclusion of the internal intermediate transactions from the net sector manufacturing division indexes results in incomplete coverage of the targeted sector of the economy. In order to increase coverage, while still avoiding the multiple counting issue, independent net sector measures have been constructed for ANZSIC manufacturing subdivisions and groups. While having intermediate transactions between different manufacturers within a given subdivision or group netted out, intermediate transactions with manufacturers in other subdivisions/groups are in-scope.

6.19 It is important to note that the manufacturing division output and input indexes, and the corresponding subdivision/group indexes, are independent constructs. As such, a division index cannot be derived by simply weighting together the separate subdivision and group indexes as the latter net sector indexes are not a straightforward decomposition of the broader net sector index.

Price index of articles produced by manufacturing industries (APMI)

6.20 The price index of articles produced by manufacturing industries is a set of output price indexes constructed on a net sector basis. The scope of APMI is restricted to transactions in articles produced by the defined part of the manufacturing industry that are sold or transferred to domestic businesses outside that sector, or used as capital equipment, or exported.

6.21 To construct the APMI indexes, multiple sets of net-sector output weights are required. The first set of weights is used to construct the "All Manufacturing" price index, and the weights are the value of transactions for products that are sold or transferred to domestic establishments outside the manufacturing division for intermediate use, or used as capital equipment, or exported. The value excludes intermediate transactions in articles produced by establishments within the manufacturing division and sold or transferred to other establishments within the manufacturing division for further processing.

6.22 The second set of weights for APMI is used to construct a range of ANZSIC sub-division and group output price indexes. The scope of each of these price indexes is restricted to transactions of articles produced by the respective ANZSIC sub-division or group within the manufacturing division, which are sold or transferred to domestic establishments outside that sector, or used as capital equipment, or exported. Note that the scope of the respective sub-division and group price indexes includes those transactions to other parts of the manufacturing division. For example, weights for the paper and paper products price index include the value of those manufactured paper products that are purchased by the food, beverage and tobacco subdivision for the packaging of food.

Price index of materials used in manufacturing industries (MUMI)

6.23 The price index of materials used in manufacturing industries is a set of input price indexes constructed on a net sector basis. The scope of the input index relates to transactions in materials used in the defined sector of Australian manufacturing industry that are produced by domestic establishments outside that sector or imported.

6.24 To construct the MUMI indexes, multiple sets of net-sector input weights are required. The first set of weights is used to construct the "All Manufacturing" price index, and the weights are the value of materials used

by establishments classified to ANZSIC division C, Manufacturing, that have been purchased or transferred in from domestic establishments outside the manufacturing division, or imported. The value excludes intermediate transactions in materials produced by establishments within the manufacturing division and sold or transferred to other establishments within the manufacturing division for further processing.

6.25 The second set of weights for MUMI is used to construct a range of ANZSIC sub-division and group input price indexes. The scope of each of these price indexes is restricted to transactions of materials purchased by the respective ANZSIC sub-division or group within the manufacturing division, which have been purchased or transferred in from domestic establishments outside that sector, or imported. Note that the scope of the respective sub-division and group price indexes includes those transactions from materials manufactured by other parts of the manufacturing division. For example, weights for the food, beverage and tobacco subdivision price index includes the value of those manufactured paper products that are purchased by the food, beverage and tobacco subdivision for the packaging of food.

ROLE OF CLASSIFICATION

6.26 Classifications play a vital role in determining the weights for price indexes. A classification not only helps determine the appropriate scope of the price index (and hence inclusions and exclusions from the value to be covered), but plays a critical role in defining a common language. That is, the classification is the common language that is used to relate the price index structure to its underlying value data.

6.27 Continuing the example of the manufacturing price indexes from above, the Australian and New Zealand Standard Industrial Classification (ANZSIC) describes the structure of the price index as well as allowing a direct concordance between the price index, its value aggregate and the source data upon which it is constructed.

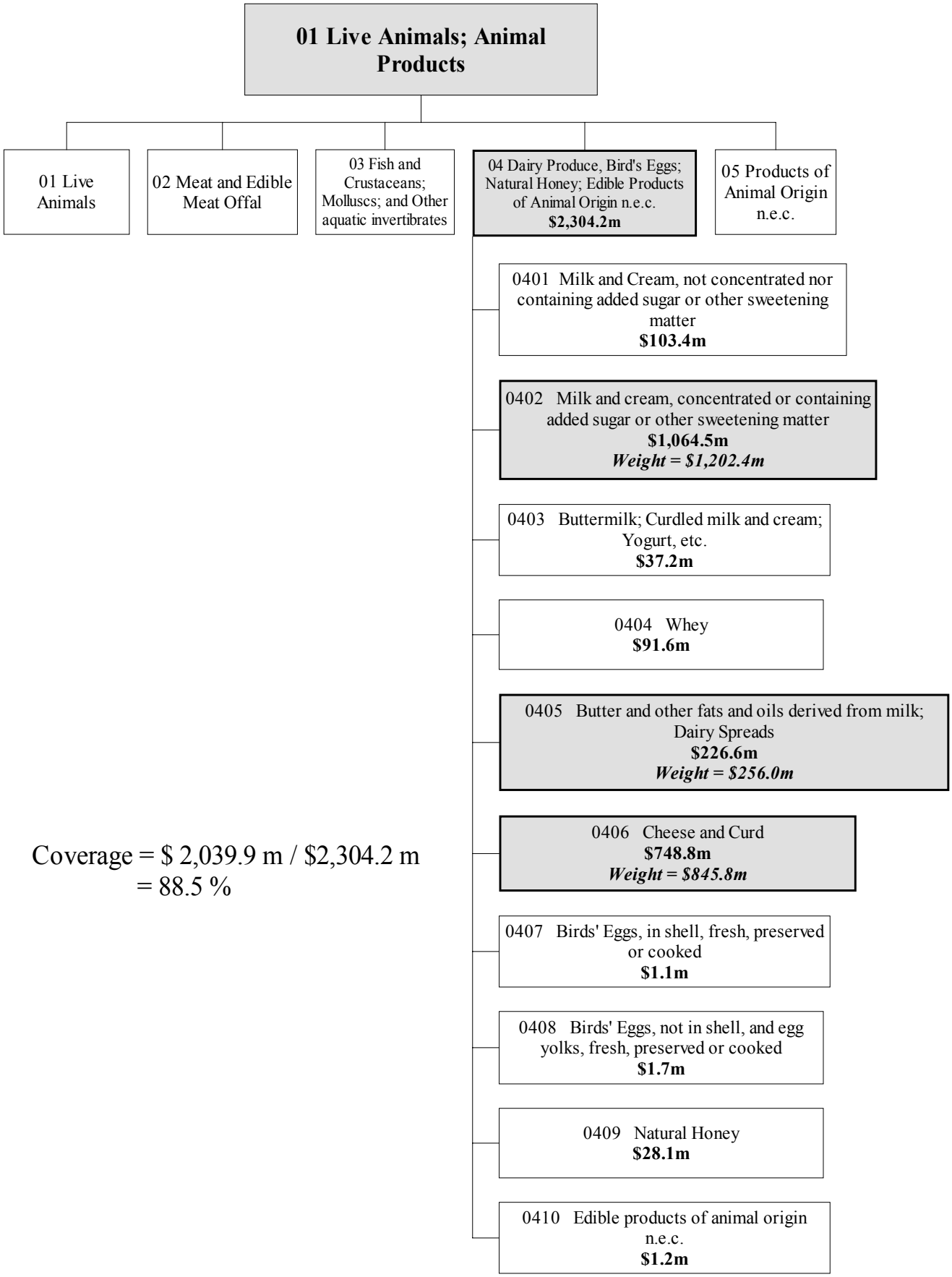
THE CHAIN OF REPRESENTATIVENESS

6.28 Price indexes are constructed using a sample of transactions for a range of product types to represent a broad range of economic activity. This "chain of representativeness" is discussed in more detail in Chapter 7, Sampling. One outcome of using sampling is that selected products will represent not only themselves but also other products not included in the selected sample. Consequently, the weight of individual products not only includes the value of the transactions of that product but also the value of any other products they represent.

6.29 Some industries and products will have very small relative importance in terms of their share of total production. For example, in the SOP indexes, products that represent less than 2 percent of production for a component are excluded from the sample. In such cases, the weight for the non-sampled component needs to be included somewhere in the weighting structure. The output for the product that is excluded is distributed across those that were selected (often called *pro-rating the weight*), or assigned explicitly to a closely related product.

6.30 An example of pro-rating can be illustrated by the export price index (EPI) (see Figure 6.2). Dairy products are part of the sample of products for the export of animals and animal products. However, not all exported dairy products are included in the sample, with the product types covered being limited to concentrated milk and cream products, butters and fats, and cheese. The value of these products was $2,039.9m (2003-04), or 88.5% of the total value of all exported dairy products. In the 2003-04 design of the export price index, the weight of these sampled products was $2,304.2m. In this case the value of the missing products, that is $264.3m, or 11.5% of the total value of all dairy products, was pro-rated across the sampled products.

FIGURE 6.2 CHAIN OF REPRESENTATIVNESS AND THE EXPORT PRICE INDEX, 2003-04 WEIGHTS, DAIRY PRODUCTS.



PERIOD COVERED BY WEIGHTS

6.31 The *weight reference period* is the time, usually a whole year, to which the weights relate. The accuracy and reliability of a price index are determined, in large part, by the weighting structure. For this reason, the choice of the period covered by the weights is crucial. The period chosen to be weight reference period is chosen because:

- The economic activity over the period is reasonably normal/stable and representative of likely future activity and;
- Not too distant from the link period (the period where the weights are introduced to the index series).

6.32 The weight reference period and the link period used in a price index formula are rarely the same period in practice. For reasons of stability and representativity, the weight reference period is frequently a year or even longer period. New weights are introduced during a specific quarter, known as the *link period*. For this reason, weights are *price updated* to account for price changes between the weighting period and the link period. For example, the import price index is reweighted each year using the most recent financial year data; however, this re-weighting is undertaken as soon as the data are available, with application in the September quarter at the start of the next financial year. So weights for the import price index from, say, 2004-05, are price updated to September quarter 2005. This price updating accounts for changes between the average price over the 2004-05 year and the price observed in the three months ending September 2005. This price updating process is discussed further in Chapter 12.

6.33 In satisfying the stability and representativity criteria presented above, weights for producer and international trade price indexes are sometimes taken from multiple periods. This practice is followed in those instances where a single year's data may not be adequate, either because of unusual economic conditions (such as introduction of a new tax system), volatility observed in the marketplace or insufficient sample sizes from survey data. In such cases, an average of several years' data provides the best weight reference period as it reduces the sampling and seasonal variance of the production or sales data for a given size of the annual sample. For example, whereas the import price index uses weighting data from the most recent financial year, the export price index uses data from the previous two years. Similarly, the price index of materials used in house building uses data over a three-year period.

SOURCES OF DATA FOR UPPER LEVEL WEIGHTS

6.34 Upper level weights are the weights that apply to the components of a price index structure between the root level and the regimen item level. The weights, including the weight of the regimen item level, are fixed in terms of underlying quantities between index redesigns. The process of redesigning an index is called an *index review* and is detailed in Chapter 11.

National accounts input-output tables

6.35 The key sources of data for upper level weights for the producer price indexes are the national accounts input-output tables. The supply table from the input-output framework shows the output value of product groups by source industry. The product detail tables show a finer disaggregation of supply, showing a comprehensive breakdown of output values at the product level. These data are used as sources for upper level weights for output price indexes.

- For example, when the supply tables are valued in basic prices the data are used to develop weights for the price index of articles produced by manufacturing, the price indexes for service industries, the price index for output of the general construction industry, and for the stage of production producer price indexes.

- The use table from the input-output framework shows use of product groups by industry of consumption. These data are used as sources for upper level weights for input price indexes. For example, when valued at purchasers' prices these data are used to develop weights for the price index of materials used in manufacturing industries.

6.36 More information on the input-output framework can be found in:

- *Australian National Accounts: Input-Output Tables* (cat. no. 5209.0);
- *Australian National Accounts: Input-Output Tables (Product Details)* (cat. no. 5215.0); and
- *Australian National Accounts: Concepts, Sources and Methods* (cat. no. 5216.0).

International merchandise trade data

6.37 The key sources of data for upper level weights for the international trade price indexes are detailed product level statistics on international merchandise trade. These data are compiled (on a trade basis) from information submitted by exporters and importers or their agents to the Australian Customs Service (ACS).

6.38 The conceptual framework used in compiling Australia's merchandise trade statistics can be found in *International Merchandise Trade, Australia: Concepts, Sources and Methods, 2001* (cat. no. 5489.0).

Bill of quantities approach

6.39 The majority of the producer and international trade price index use national accounts or international merchandise trade as sources for upper level weights. For some producer price indexes, the scope of activity covered by the price index does not align directly with the national accounts. This is particularly the case for the price index of materials used in house building (HB). The HB price index (as further described in Chapter 13) is an input price index concerned with measuring changes in the prices builders pay for materials used in building houses (as opposed to townhouses, apartments and non-residential buildings). The HB index is weighted using a *bill of quantities* approach.

6.40 The HB price index uses a basket of goods that is constructed in the following manner:

a. A selection of a range of typical or representative house designs is undertaken (for example, brick veneer house 100m2, double brick house 180m2 etc.);

b. The frequency of construction of each selected house design is determined;

c. Each selected house is decomposed into types and quantities of specific materials (for example, the number and type of bricks is determined, as with the type and amount of paint used, the specific type and quantity of roofing, etc.);

d. The price of the quantity of each specific material is determined, resulting in the value, in purchasers' prices, of the total materials used in the construction of each house type (this means for each house type there is effectively a bill for the quantity of each material, and hence for the total materials used – this is where the term "bill of quantity approach" is derived);

e. The values for each house type are weighted together using the frequency data, but then decomposed by broad product type;

f. The fixed price basket (and hence the upper level weights) is then determined using the values of the broad product types.

6.41 The bill of quantities approach is refined further in practice by allowing the frequency of construction to vary by capital city. In effect, this results in a separate price index for each capital city based on the same set of house designs with the same material composition, with differences in the price index design between each city arising due to different frequencies of construction of the different house designs.

6.42 The ABS employs quantity surveyors in designing the HB price index using the bill of quantities approach. Quantity surveyors provide the ABS with data regarding house designs, frequency of construction of selected designs, types of materials and quantities used in designs, as well as the price of materials used in designs.

SOURCES OF DATA FOR LOWER LEVEL WEIGHTS

6.43 Lower level weights are the weights that apply to the components of a price index structure below the regimen item level down to the elementary aggregate. The weights, including the weight of the elementary aggregate (but not the price sample within the elementary aggregate) may be adjusted to reflect changes in either producer or purchaser behaviour in the market and hence changes in the relative importance of goods and services in the basket. Furthermore, the effects of discontinued and new types of products and services can also be accommodated. The process of updating lower level weights is known as a *sample review* and is detailed further in Chapter 11.

National accounts data

6.44 In addition to broad data from input-output tables, other data sources used to construct national accounts aggregates are frequently used in the estimation of lower level weights for producer price indexes. Whilst these data typically come from other ABS economic surveys (see below), the national accounts component data are generally more complete in terms of consistent coverage and valuation basis. The data used for lower level weighting are at a more detailed level than published national accounts data.

ABS economic surveys

6.45 ABS economic surveys are also used in the production of lower level weights for the output producer price indexes. These data typically provide information on type and characteristics of producers, as well as some detailed information on revenue. In addition, these ABS surveys frequently provide information regarding industry outputs in terms of quantity measures. Deriving lower level weights from these quantity data requires combination with measures of average prices.

6.46 Examples of the use of ABS survey data for lower level weights include:

- A range of revenue estimates from the Service Industries Statistics program are adopted to weight lower level components of the service industry PPIs;

- A range of quantity, expenditure and revenue estimates from the Building and Construction Statistics program are adopted to weight the lower level components of a number of different PPIs, including the price index for the output of the general construction industry;

- Revenue estimates from the Survey of International Trade in Services are used in weighting the service industry PPIs, particularly regarding transport (freight) activities;

- Quantity estimates (kilometre-tonnes) from the Survey of Motor Vehicle Usage are used together with measures of average prices in weighting the lower levels of the road freight service industry PPI.

ATO taxation data

6.47 The Business Activity Statement (BAS) is a tax return lodged with the Australian Taxation Office (ATO) in respect of:

- GST

- PAYG withholding and instalments

- FBT instalments.

The BAS must be lodged by all registered businesses, including government entities for each tax period. Since GST is levied on revenue from sales, the BAS data provide information on output (revenue) by size and type of business. These aggregate data can be incorporated into lower level weights for a range of output PPIs.

Other uses of the bill of quantities approach

6.48 In addition to the use for regimen items in the price index of materials used in house building, the bill of quantities approach is used as part of the process of determining lower level weights for other construction producer price indexes.

6.49 As described above, the use of the bill of quantities approach provides aggregate "broad product type" estimates of expenditure for use as upper level weights in the HB price index. The disaggregated measures by detailed product type are in turn used as lower level weights.

6.50 A similar approach is undertaken for components of the price index of the output of the general construction industry. Here the "representative designs" are not of houses but of other building types. Rather than restrict the "bill of quantities" to just building materials, the approach adopted in parts of the general construction price index includes work in place, which covers labour, plant and materials, plus margins. Again, this approach requires data from quantity surveyors.

International merchandise trade

6.51 The use of international merchandise trade data for upper level weighting is described above. Data provided by the ACS is coded to very detailed levels of the Harmonised System (HS) trade classification. This fine level of detail allows use of these data in constructing lower level weights for the international trade price indexes.

Other sources of weights

6.52 *Administrative data:* A wide variety of administrative data on production values are available from public agencies charged with regulating or monitoring certain economic activities. For example, the Australian Bureau of Agricultural and Resource Economics (ABARE) has data on both agricultural and mining activities. The Department of Industry, Tourism and Resources (DITR) has similar data regarding the production and consumption of energy. The Department of Transport and Regional Services (DOTARS) has information regarding outputs and consumption of transport services. These types of data are used in developing weights below the regimen item for a range of producer price indexes.

6.53 *Industry associations:* Another source for weighting data is industry associations. Many associations conduct surveys of their membership that include detailed information on value of sales by product. Alternatively, where production of a type of good or service is dominated by one or two large firms, the market shares for these firms can be a source of weighting data. Both types of data are adopted for use in PPIs, particularly for the service industry output PPIs.

SOURCES OF DATA FOR MICRO-INDEX WEIGHTS

6.54 The calculation of the broad price indexes starts with the measurement of the relative price change for an elementary aggregate, which represents the first level at which price observations are combined to calculate an index. At this level, weights are needed to combine individual price observations in order to calculate higher-level indexes. The elementary aggregate index covers all prices collected for one detailed product type. Each elementary aggregate is composed of price observations for products that are similar in terms of material composition, end use, and price behaviour.

6.55 It is important that the weight for each price observation covers the value of all products that the individual transaction represents. That is, most price observations will have a weight that represents other products and transactions in addition to the value of the sampled product alone. Micro-index weights are frequently adjusted to account for the introduction of new product varieties within a product type (such as a unit of sale or new flavour). Similarly, they are adjusted to account for the removal of discontinued individual product lines.

6.56 For example, consider an elementary aggregate for "bottled beer" for an output price index. The specifications within the elementary aggregate typically incorporate information on brewery, brand, bottle size and units of sale (such as 12 ×750 ml bottles or 24 ×375 ml bottles etc.). Through the process of sample selection (see Chapter 7), sampled products are selected to represent other products. A particular sampled product may be a best selling brand of beer in a 24 ×375 ml bottle carton; but the weight of the specification would include not only the value of sales of such a product but also the value of sales of other brand varieties sold by the particular brewery. The weight may also include the value of sales from other breweries.

6.57 In calculating such a weight, it is necessary to know several critical pieces of information regarding the values of transactions. Continuing the "bottled beer" example from above, the following data are required:

- the value of sales of the selected beer product (brewery, brand, size, units of sale);
- the value of sales of other brands of the same size from the selected brewery;

- the value of sales of 24 ×375 ml cartons of beer from other (non-sampled) breweries.

6.58 In general, value data (either sales or purchases) are required for the sampled product and also for any other products that are within scope of the elementary aggregate. Determining such information requires the co-operation of sampled respondents. The ABS generally collects this information via a personal visit during the activity known as a *sample review* (see Chapter 11).

6.59 The use of international merchandise trade data for both upper and lower level weighting is described above. Data provided by the ACS is coded to very detailed levels of the Harmonised System (HS) trade classification. This fine level of detail allows use of these data in constructing lower level weights for the international trade price indexes, particularly the import price index.

6.60 The other key source of detailed product information used in micro-index weighting is industry associations, as described above for lower level weights.

Difficulties with specification specific weighting

6.61 Determining value data at the product specification level is a difficult process that sometimes proves to be burdensome for sample respondents. In addition, it frequently becomes an increasingly complex task to ensure that the micro-index weights are correctly maintained over time. Continuing the "bottled beer" example from above, the introduction of an immediately popular new brand (such as a boutique beer) requires collection of not only the sales revenue of the new product but also a measure of how the sales values of existing products have changed in response to the new competition. Collecting such information in a timely manner frequently proves impossible.

Equal weighted index formulae

6.62 In the case where specification weighting is intractable, an alternative is to adopt a micro-index formula where the sampled specifications have the same weight within an elementary aggregate. This process is currently applied to the accommodation price index within the stage of production producer price indexes. The ABS is looking to extend this practice to the majority of its producer and international trade price indexes in the near future.

CHAPTER 7 SAMPLING

INTRODUCTION

7.1 The ABS producer and international trade price indexes measure price changes, over time, in broad sectors of the Australian economy and international trade. Transactions for each of these sectors may cover purchases and sales of thousands of different products at a wide variety of prices. The sheer volume and complexity of these transactions mean that it is impossible to collect prices from every establishment and for every product or to take into account every price at which products are sold. Consequently, it is necessary to adopt a sampling approach; that is, to price a sample of products from a sample of respondents, and for each of these products price a sample of transactions.

SAMPLING METHODS

7.2 Choice of sampling methods requires a trade-off between two types of error. *Sampling error* arises because price measurement is only undertaken for a sample of transactions. If the entire population of transactions was measured, a different result may be determined. The variability of the price index from the sample survey and that measured from the entire population is known as sampling error. The term *non-sampling error* in this case covers all the other sorts of error that can arise during the construction of the price index. Non-sampling error exists even in the case where all transactions in the population are observed. Many sources of error contribute to non-sampling error, including non-response and errors made by respondents during transcription of prices.

7.3 The selection of a sampling method will be based on the availability of resources and the likelihood and magnitude of the different types of survey error.

Probability sampling

7.4 In the context of the producer and international trade price indexes, a system of probability sampling involves the selection of a sample of products from all producers in the economy. Under this system, all producers and products have a known probability (chance) of inclusion in the sample. The key benefits of probability sampling are that it allows control of sampling error through the design of the sample, and allows measurement of sampling error based on the prices observed. A probability sample, with an appropriate estimation scheme, also provides a robust mechanism for making inference from the sample back to all products and transactions.

7.5 Although probability sampling arguably represents a theoretical ideal, there are disadvantages associated with this approach. The use of probability sampling requires identification of all units (e.g. producers, and products) in all sectors of the economy that are relevant to the intended price index (known as the sampling universe). This requirement translates into the need for a sampling frame of products – in price indexes, the unit of interest is the product not the producer. In addition, the list of individual products needs to be kept up to date. Developing and maintaining such a list is an expensive exercise, both in terms of administrative costs for the ABS and cost in terms of respondent burden for businesses. The practical difficulties in satisfying this requirement mean that there are high costs in the design, implementation and ongoing administration of probability samples for price index purposes.

7.6 Another disadvantage with probability sampling for price indexes is that the products selected must be available in the market place for repeated quarters in the future. Probability sampling selection mechanisms can occasionally select a product that disappears immediately after its inclusion in the sample. The problem of replacement of this product immediately introduces a bias of its own.

7.7 More generally, a probability sampling scheme can only be used to select products for initial inclusion in the price sample; that is, probability sampling is used to put products into the "basket of goods and services". As products come and go, the need to replace products results in a price sample that can no longer be considered a true probability sample. As discussed in Chapter 11, the need to maintain a contemporary basket of goods is paramount in the construction of price indexes, and the issue of dealing with product change and product replacement is one that requires substantial investment on the part of the ABS. The benefits of a probability sample in the base period are frequently outweighed by changes to the basket in subsequent periods.

Purposive sampling

7.8 Purposive or judgment sampling involves the choice of producers and products by index compilers in conjunction with industry representatives. Samples are selected using information on market shares and the relationships between price movements within the various categories of products.

7.9 A key benefit of purposive sampling is that it can be used where the sampling universe is not known. Further, the use of judgment sampling for price indexes ensures that both producers and products that are significant are included in the index, with particular emphasis on continued existence in future periods.

7.10 However, indexes compiled based on purposive sampling do not lend themselves to assessments of error brought about by the sampling process – it is not possible to produce a measure of sampling error for a purposive sample. It is generally accepted that price indexes are an area of statistics where the risks in not using a probability sample are relatively low, as the diversity of price change charged by various producers over time is not usually large[35].

Choice of sampling method

7.11 Purposive sampling is used in the producer and international trade price indexes[36] in preference to probability sampling for a number of reasons. In a system of purposive sampling the price index compilers can take account much more effectively of issues that are important to the production of reliable and accurate price indexes, such as availability of data on an ongoing basis, location of respondents, management of the reporting load placed on respondents, and representativeness of items selected for pricing.

7.12 To maintain index quality and relevance, price indexes are subject to frequent replacement of respondents and products (for a full discussion see Chapter 11, Maintaining Samples of Products). In these circumstances, purposive sampling is more practical and less costly than probability sampling.

THE SAMPLING PROCESS

7.13 The sampling process for the producer and international trade price indexes comprises the selection of goods and services appropriate to each of the indexes, identification of businesses which produce (or consume) such products, and the selection of individual items produced or used by those businesses to be priced on an ongoing basis.

---

[35] See, for example,

- Dalén, J (1998) ''Studies on the Comparability of Consumer Price Indices'', in *International Statistical Review*, Vol. 66, No. 1, pp. 83–113
- de Haan, J and E. Opperdoes, and C. Schut (1999) ''Item Selection in the Consumer Price Index: Cut-off Versus Probability Sampling'', in *Survey Methodology*, Vol. 25, No. 1, pp. 31–41.

[36] Purposive sampling is also used in the Consumer Price Index (CPI)

7.14 In essence the purposive process involves using whatever data are available to build up a picture of the overall "market" for a particular index. That is, determining who the potential respondents are, their relative importance, what particular products they sell, who they sell to, and what their pricing policies are. A range of sources is used in selecting the industries and the business respondents in the industries. These sources include market reports, industry associations, ABS industry census data, other ABS surveys, and discussions with potential respondents. This information is used in developing a comprehensive understanding of the market and making appropriate judgments in the sample selection process. The specific methods used will vary depending on the nature and purpose of each index within the set of producer and international trade price indexes. For example, extensive use is made of international trade data in the selection of categories of goods for pricing in the export and import price indexes.

7.15 The effectiveness of the purposive sample approach depends on the representativeness at each level of an index. A "chain of representativeness" approach is adopted in which:

- key products are selected to adequately represent the price movements for all the products which come within the scope of the particular price index;
- respondents are selected to adequately represent all the suppliers/users of the selected products. In general, the aim is to cover businesses which account for a high proportion of sales or purchases of the goods and services in the index;
- specifications are selected from each respondent to adequately represent the whole product range within the selected product description; and
- prices are obtained for each selected specification which best represent the price movements of all transactions in the selected product range.

Selecting specifications to be priced

7.16 Once the items to be included in an index are determined, and potential data suppliers are identified, the actual transactions to be priced are determined in consultation with the respondents. Each item to be priced is specified in detail to ensure that exactly the same item is priced each quarter (this process is described further in Chapter 8, Price Collection).

7.17 As noted in paragraph 7.15, only a selection of products is chosen for ongoing pricing. It is therefore important to ensure that they are representative of the wider class of goods and services to which they belong in the index classification. A major consideration in this process is the likelihood that price changes in the items selected for pricing will also reflect price changes in other items within their class of goods or services – the selected items should generally exhibit the same sorts of price behaviour as all the items that they represent. The other key consideration is the continuing availability of the selected product for future pricing purposes. Whilst products eventually disappear from the market place (as discussed in further detail in Chapter 11), it is important to avoid initial selection of one-off promotional products or discontinued items.

7.18 The choice of individual items to be priced is finally made in consultation with business respondents to the *Survey of Producer Prices*. This process ensures that the selected items are clearly identified and described, that they are representative of the price behaviour of the items they represent, at least from the perspective of the selected producer, and confirms that the items selected will be available for pricing in future periods. The representativity of the items in the "price basket" is regularly reassessed, a process described further in Chapter 11, Maintaining Samples of Products.

7.19 It is not always the case that an actual product is chosen for pricing purposes. On occasion, model pricing is used. For example, while many construction projects differ markedly in their design, there may be common elements in them, such as ceiling construction materials etc. In these circumstances, the respondent may provide regular re-pricing of a model ceiling, whose price will be expected to vary in line with that of actual ceilings in certain types of buildings. See Chapter 8 for more information on pricing specifications.

CHAPTER 8 PRICE COLLECTION

8.1 This chapter gives an overview of the general price collection issues that are encountered in compiling producer and international trade price indexes. It provides an overview of price collection philosophy, and its relationship to both sample selection (Chapter 7) and sample maintenance (Chapter 11). It also describes the common issues encountered in measuring prices for a wide range of goods and services. More detailed descriptions of product-specific pricing issues are provided separately in Chapter 13.

PRICE COLLECTION PHILOSOPHY

8.2 Much of price index theory concerns the suitability of price indexes for measuring price change occurring within different sectors of the economy. The issues described in this chapter detail how the ABS confronts the real world aspects of collecting prices for an ongoing quarterly survey. Underlying the ABS approach to price collection is a philosophy that tries to balance a set of opposing constraints.

8.3 The first constraint that confronts the ABS is a requirement to work within a fixed set of resources. The resources of most importance are time, labour costs and the physical costs of collecting forms (such as postal costs, and both information and communication technologies). Time is a particularly constrained resource since the ABS guarantees to publish the producer and international trade price indexes within 4 weeks of the end of the reference period.

8.4 The second and perhaps most important constraint is the total burden that the *Survey of Producer Prices* places on responding businesses. The ABS has an obligation and commitment to minimising total provider burden across all ABS surveys. For the *Survey of Producer Prices* (the collection vehicle for the producer and international trade price indexes), this burden consists of:

(i) Respondent time (staff hours) spent during enrolment into the survey;

(ii) Respondent time spent in completing the quarterly forms;

(iii) Respondent time spent in resolving pricing queries; and

(iv) Respondent time spent in maintaining and updating price samples.

Note that the ABS attempts to minimise the total burden across all providers, as well as the burden on individual providers.

8.5 In satisfying these constraints, the ABS has developed a price collection philosophy that aims to:

- yield the largest benefit from provider interactions;
- maximise the utility of data collected; and
- where possible, reuse price index components.

Benefit of provider interactions

8.6 Obtaining and securing the cooperation of selected respondents is an expensive exercise for both the ABS and its data providers. The *Survey of Producer Prices* requires collection of pricing data, reasons for price movements, and details regarding changes in product characteristics. Explaining the rationale for and importance of these requirements needs an investment of time for both the ABS and the data providers. In addition, enrolment into the survey will require the capture of additional information regarding sales data and purchasing information. This also requires time and effort on part of the respondent to the survey.

8.7 Additional administrative information is also required during survey enrolment, particularly concerning contact details for persons responsible for pricing information, and for persons responsible for providing information regarding changes in product characteristics.

8.8 Due to these reasons of cost and effort on the part of both the ABS and its providers, the ABS has adopted a strategy to yield the most benefit from these interactions with providers. This strategy is based on the principle that most providers purchase a range of commodities that are consumed in production activities, and also sell a range of products. This being the case, a provider sampled to provide information regarding the sale of one type of product may be asked to provide information on sales of other significant product types, and to provide information on significant material purchases.

8.9 Example: consider a manufacturer who is selected in the *Survey of Producer Prices* to provide information on the sales of wooden doors to builders for use in house building (as per the price index of materials used in house building, an input price index). The provider supplies the price of a particular type of door, delivered on-site to a house builder. Depending upon the value of sales made by this provider, they may be additionally asked to provide information on the sale of other wooden products, regardless of where they are consumed, to increase coverage of the articles produced by manufacturing industries price index. In addition, depending upon the value of purchases made by this provider, they may be further asked to provide information regarding purchases of timber to increase coverage of the materials used in manufacturing price index. Such additional questions are asked where sample coverage could be improved and where sales (or purchasing) data are considered significant for the particular products concerned. Note that these questions introduce a small increase in the burden placed on this particular provider, but considering the time taken to enrol and maintain new providers this practice results in a lower provider burden when considered over all businesses.

Maximising the utility of collected price data

8.10 Information regarding a transaction is collected to ensure that the price captured is on the correct pricing basis for the index concerned. Collection of a small piece of additional information, or collecting information in a slightly different way, frequently allows the pricing data to be used in multiple ways. This re-use of price data is considered a mechanism whereby the ABS maximises the utility of collected pricing data.

8.11 As discussed in Chapter 5, the producer and international trade price indexes cover a range of pricing bases, measuring price changes for both sales and purchases. This requires measuring prices on different valuation bases (for example, measuring the price received by the producer and the price paid by the purchaser). In some circumstances, this requirement necessitates sampling both buyers and sellers of different types of products. In other circumstances, one provider may be able to provide prices on more than one pricing basis. This is particularly convenient in the case where the difference in pricing basis is due to a margin such as delivery costs (compare the discussion of basic and purchasers' prices in Chapter 5). In such a case collecting the delivery fee as a separate data item not only allows calculation of prices on more than one pricing basis but also allows decomposition of individual price movements into different components. Decompositions of this type enhance the capability for data confrontation and validation, improving the overall quality of the price indexes.

8.12 Continuing the example of the door manufacturer above, the provider is reporting the price paid by builders when purchasing wooden doors, including delivery to building site. This price is a purchaser's price and is used in an input price index. If the provider can additionally provide the price of the door alone, this price is effectively the basic price of the door. It can then be utilised in the price index of articles produced by manufacturing industries, which is an output price index.

8.13 Furthermore, there are some transactions where there are no delivery costs, product subsidies nor distributive trade margins, in which case the basic price and the purchaser's price are identical. Under these circumstances, a price collected as a purchaser's price for use in one price index may be reused as a basic price in another price index.

8.14 This practice of capturing sufficient information to value the transaction on more than one pricing basis occurs frequently for manufacturing and building products, but also occurs frequently for imports of products that are consumed within Australia's manufacturing industry. The pricing basis of the import price index is "free on board" (f.o.b.), meaning that the price of the good is a price that includes all production and other costs incurred up until the goods are placed on board the international carrier (at a foreign port). The pricing basis for materials used in manufacturing industries is purchasers' prices. A variety of products used in manufacturing processes are imported from other countries and so, in line with the philosophy of maximising utility of data, sufficient information is collected to price an import on both an f.o.b. basis and a purchaser's price basis. For an imported product, the purchasers' price is termed "cost, insurance and freight" (c.i.f.), and differs from the f.o.b. price by the inclusion of transport, and insurance costs both for international carriage (from a foreign port to an Australian port), and domestic transport from the Australian port of arrival to the manufacturer concerned. For this type of product, providers frequently report prices on both a c.i.f. and an f.o.b. basis. Note that this information is readily available from most purchasers since the f.o.b. price is used in paying customs duty.

Re-use of equivalent components

8.15 In addition to valuation of transactions on multiple pricing bases, the compilation of ABS producer and international trade price indexes adopts a mechanism whereby equivalent components in price indexes with similar pricing bases are reused. This frequently occurs for the articles produced by manufacturing price index, valued at basic prices, and the export price index, valued f.o.b. Both price indexes are output price indexes, measuring the price Australian producers receive for sale of their goods. However, f.o.b. is not strictly the same as the basic price, in that it includes transport from the producer to the Australian port, where basic price excludes such costs where they are separately invoiced.

8.16 By way of illustration, consider the output index for the manufacturing industries. Rather than use a counterpart price for each transaction of an exported manufactured product (as discussed in Chapter 5), the articles produced by manufacturing industries price index re-uses entire components (price baskets) from the export price index. For example, the entire beef component of the export price index is used to move the exported beef component of the price index of articles produced by manufacturing price index.

8.17 Like counterpart pricing, this practice has an implicit assumption that transport costs from producer to ship move proportionally with the export f.o.b. price.

TIMING AND FREQUENCY OF PRICE COLLECTION

8.18 A key use of the producer and international trade price indexes is in the production of the quarterly Australian national accounts. As described in Chapter 2, price indexes are used as deflators in the preparation of the national accounts, particularly in the production of chain volume measures. The key requirement for these price indexes is that they measure price change between quarters. To meet this key requirement ABS producer and international trade price indexes are compiled on quarterly basis, with the purpose of measuring average quarterly price change.

8.19 Most individual items priced in the producer and international trade price indexes are priced once per quarter, using a *point-in-time* pricing mechanism. There are some exceptions in this regard, particularly for products that exhibit volatile price behaviour. In such cases, collections are carried out monthly or even more frequently (for example, a series of crude oil prices is collected daily).

8.20 The usual practice is to collect prices from all respondents in each pricing quarter. However, there may be some cases where prices are generally stable, products take a long time to produce, or price changes happen at predetermined times. In these cases it is not necessary to collect prices in every quarter.

Point-in-time prices

8.21 Point-in-time prices relate to the price of a product on a particular date of the quarter e.g. the first day of the month, the nearest trading day to the fifteenth day of the month, middle day of the quarter etc. This approach makes the collection date straightforward for both the ABS and for data providers.

8.22 The main advantage of point-in-time pricing is that comparisons from quarter to quarter will be consistent, which is particularly important when there are changes in prices taking place during the quarter such as a general price increase.

8.23 Several potential problems in the application of point-in-time pricing require special attention. One of the disadvantages of a set point in time for PPIs is that a transaction may not have taken place on the specified date. If this happens, respondents can be asked to provide details of a transaction that occurred as near as possible to the specified date; for example, "last shipment within the previous 30 days".

8.24 Another problem is that point-in-time estimates are more susceptible to short-term external influences (for example, extreme weather, labour stoppages, seasonality) that could affect the price on the particular day of the price collection. They may also miss short-term price changes (for example, rises and falls) that occur between pricing dates. To mitigate this issue, the ABS maintains the same pricing point for particular respondents each quarter but spreads the pricing points for all respondents to different positions over the 13 weeks. In this manner, the price of a particular product type is generally observed at more than one point in time during the quarter.

THE PRICE OBSERVATION

8.25 Prices that are collected for the producer and international trade price indexes are referred to as *price observations*. A price observation is the price of a specific product at the point in time. To ensure consistency in the final index, a price observation should compare "like with like" in each different collection period. With this aim, *product specifications* are defined as tightly as possible so that prices collected for particular goods or services can be compared from period to period and so that any changes in product characteristics (quality) can be identified. As prices are meant to reflect actual transactions that take place in the market, the price observations need

to include all available discounts and special offers (see paragraphs below for further discussion on price discounting).

Product specifications

8.26 The purpose of a product specification is to ensure that a product (including conditions of sale) is uniquely defined, so that it may be comparably priced from period to period. It is essential that a product is priced to constant quality; that is, the product priced in each period must maintain those characteristics that affect the utility to the purchaser. The main criteria that could affect the utility of a product and could form part of a specification are listed below:

TABLE 8.1 FACTORS THAT AFFECT A PRODUCT'S UTILITY

ITEM	REASON
Product name & serial number	Company's name for the product within the specified product group. This should contain information about the model/variety of product.
Description	In addition to the product name, this gives an opportunity for the company to specify what (if any) enhancements or add-ons are included in the product. For example, with cars, a number of options are usually available (metallic paint, air conditioning, sun-roof), all of which affect the utility of the product.
Size of transaction (quantity data)	The amount (quantity) of product sold, and whether volume discounts apply.
Class of customer	Some companies may have different pricing structures for different customers (for example, trade discounts). A unique customer identifier can be used for customer confidentiality.
Units of sale	Units used in describing the product (for example, kilograms or litres).
Discounts	Many companies offer trade, volume, competitive, or preferred customer discounts. All applicable discounts should be described.
Transport terms	Whether transport costs are included and a description of how the goods will be collected or delivered.
Currency	Currency the transaction will be traded in.

8.27 The details in the table above combine to give a tighter specification for the product than just the description alone. Specifying a product in this way also supports the adjustment of the price associated with any changes in the product quality or the terms and condition of sale (see Chapter 9, Quality Change and New Goods).

Other forms of description

8.28 For some industries, a specification for a particular product may not be appropriate. For example, some industries produce goods or services on a made-to-order basis or a one-off basis, and the same product is not produced in successive periods. Examples of such products include ships, buildings, and many business services. In these instances, a model specification may be more appropriate. This would be a specification, as described previously, but for a non-standard product, rather than for a specific product. See further discussion below under Unique Products.

DISCOUNTS

8.29 Producer and international trade price indexes aim to measure changes in actual prices (transaction prices) paid to or received from producers for goods or services.

8.30 The prices of goods or services as quoted in a catalogue or a brochure are often list prices; however, these may not necessarily be the actual transaction prices, which are often determined with the inclusion of discounts or surcharges.

8.31 The key issue of ensuring that the collection of transaction prices includes discounts is the actual identification of the discounts. Discounts are frequently commercially sensitive information. For example, where knowledge of competitors' discounts with major customers (or major suppliers) is of enormous commercial value; in other cases such information may have significant public relations or political impact.

8.32 The identification of discounts is complicated in practice by a number of factors. First, the pricing structure used by the company may be complex and the conditions under which discounts apply may be described in non-standard terms. Second, differences in pricing and discounting procedures between companies require data collection to be tailored to each company. Third, the full level of discounts offered to major customers may only be known to senior company officials.

8.33 In clearly identifying discounts, it is convenient to classify the discounts into two major categories: recurring discounts, and non-recurring discounts.

8.34 Recurring discounts generally reflect cost savings to the seller and are generally on-going, recurring every time a sale is made that meets specified conditions. The most common forms of discounts fall into this category (e.g. discounts based on type of customer, volume discounts, settlement discounts). Recurring discounts can be documented and included in price collection materials (e.g. the form for the *Survey of Producer Prices*), if the problems involved in identifying and describing the terms and conditions applicable and in determining the respective market share of each discount class can be resolved. The disadvantage of such an approach is that providers often change the type or level of discounts, either because they perceive cost advantages in doing so or, commonly, in conjunction with an overhaul of their pricing structures. Under such circumstances, it is essential that quarterly price collection also captures changes in the types and levels of discounts applied.

8.35 Non-recurring discounts are discounts that reflect the bargaining power of the buyer vis-a-vis the seller and/or current market conditions. This category includes various forms of competitive discounts (including those that appear in the guise of short-term changes to specific classes of customer and other recurring discounts). Non-recurring discounts depend on variable circumstances, and as such are frequently volatile and non-predictable. Questionnaire design and the ongoing cooperation of providers are essential in detecting this type of discounting practice.

Types of discounts

8.36 Examples of factors which influence discounting are:

ii. *Competitive discounts* reflecting unique supply or demand conditions, generally in specific markets for the product. These discounts are generally of short duration in any specific market area, but may be applicable in at least one market area on a frequent basis.

iii. *Surcharges* are additions to the listed price. These are generally of short duration and reflect unusual cost pressures affecting the manufacturer. Examples include fuel surcharges for trucking companies.

iv. *Prompt payment discount* for remitting payment within a fixed period such as ten days. These discounts are generally of small magnitude, remain unchanged for long periods, and are available to all customers.

v. *Volume discounts* are generally tied to specific order sizes and increase the larger the order. These discounts are generally available to all customers.

vi. *Class of customer discounts* are specific to certain classes of buyer. Trade discounts are available to wholesalers to help cover their selling expenses. Advertising discounts are available to retailers to help cover their promotional expenses. These tend to be expressed as percentages and remain unchanged for long periods.

vii. *Financing discounts* relate to providing assistance to customers to pay for the good they are purchasing. They may serve as a buy-down on the bank loan interest rate for those customers borrowing to pay for the good.

viii. *Cumulative volume discounts* are offered to customers who purchase a certain amount of an item in units or sales in several shipments over a specific period.

Identifying discounts

8.37 The challenges in correctly identifying and measuring discounts are best addressed using personal interviews at sample enrolment. As discussed in more detail in Chapter 11, the use of a personal interview allows the ABS to determine the current and likely future use of the discount practices described above, and to emphasise the importance of notifying the ABS of any future use of discounts (including non-recurrent discounting).

8.38 The subsequent design of the questions in the *Survey of Producer Prices* (tailored to each individual provider) is the key mechanism through which the ABS captures information on price discounting.

8.39 Operational procedures for processing the *Survey of Producer Prices*, especially editing and querying of respondents, also focus on identifying changes in discounts and pricing procedures.

8.40 There are also a number of additional sources of information that are useful in revealing the existence of (or changes to) discounts:

i. Media reports - discounting of major products or product types are often subject to media commentary. Further, media coverage of annual reports and meetings often reveal the existence of competitive price discounting (e.g. a “price war”);

ii. Market intelligence, gathered from other ABS subject matter experts, industry associations and other Australian government departments;

iii. Confrontation of price data across other providers. It is a rare situation for a provider to set prices (and discounts) independent of competing providers. Differences in price levels (or in price movements) may indicate non-reported discounts. Care must be used here to identify price leaders in these circumstances, as discounts from competitors may occur in earlier or later periods.

8.41 In the case of volume discounts, the same customer may face varying prices for the same product purchased in consecutive periods, because different volumes are purchased in the two periods. In circumstances such as this, the unit price will vary simply because the volume of sales has changed rather than because of a change in the underlying price of the

product. If it is determined that this is a 'typical' occurrence for a particular product or service, the specification of the item will usually identify a certain volume for pricing purposes. That volume is then priced in each pricing period.

8.42 Also related to volume discounting is the common occurrence of providing a larger quantity of the product for the same price, sometimes for a limited period. Again, to ensure that price changes are correctly included in the price index, quantity details are also collected.

8.43 The overarching principle in the ongoing identification of discounts, so that they may be correctly included in the final transaction price, is to record list price and discount as separate data items. In this manner, it is far more likely that a change in discount is correctly observed in calculating the final transaction price.

Discounts and constant quality

8.44 The producer and international trade price indexes use transaction prices to measure real price change. These products being exchanged in different periods must be *priced to constant quality* (a concept that is discussed in more detail in Chapter 9).

8.45 *Pricing to constant quality* applies to discounts as it does to other aspects of price index construction. Most importantly, a discount for a damaged good (such as new cars damaged by hail), or for a good that has reached the end of its effective lifespan should not be included (indeed, some other quality adjustment activities should be employed, as detailed in Chapter 9).

8.46 Discounts should also relate to unchanged conditions of sale. As noted above, particular attention needs to be paid to volumes. A common practice observed in several industries is to vary the discount as the volume purchased varies. For example, the discount per thousand bricks for a purchase of fifty thousand bricks may be substantially different to that observed for the purchase of one million bricks. The ABS addresses this issue by indicating the price of a specific size category of product. For example "price per 1,000 bricks for buyer purchasing 200,000 bricks".

Specific issues involved in measuring discounts

8.47 *Discounts based on per dollar amounts,* where a discount is specified in terms of the dollar amount of purchases (e.g. a 25% discount to all buyers with an order of $1,000 or more). The problem with such discounts is that the product being considered changes over time. For example, $1,000 of petrol in 1998 is a substantially different volume to that purchased in 2006. In such cases, the ABS must work with providers to obtain typical or representative quantities purchased, and to price the quantities over time. For the petrol example above, the ABS may ask the price of several representative quantities over time (500 litres, 750 litres, 1000 litres, 2000 litres). In obtaining such information it would be also necessary to determine the value (or share) that each type of purchase represents (e.g. 80% of sales are to purchasers of 750 litres).

8.48 *Discounts to cover promotional costs*, where a discount is provided in the form of a separate cash payment to the buyer to cover part of the cost in promoting the product via reduced prices, special advertising, and other promotions. This type of promotional activity is common in respect of consumer goods, especially those sold through supermarkets where manufacturers commonly pay supermarket chains to promote their products. It is difficult in these cases to determine where to draw the boundary between regarding such payments as being types of discounts (and therefore to be taken into account in the indexes) or regarding them as advertising or marketing expenditure (and therefore out of scope of the

price index). The key to making this decision should be the extent to which the payments directly or indirectly reduce the price to the buyer. Where the payment is directly related to the product and reduces its net price it should be taken into account. In those situations where it is related more to advertising the product (such as paying for in-store promotional activity) it should be ignored.

REBATES

8.49 A rebate is a form of discount where the discount is paid after the purchase and is normally based on the cumulative value of purchases over a specified time.

8.50 Rebates in price indexes pose major practical problems in that they are often determined by future events – for example, the buyer receives a rebate at the end of the financial year based on how much he purchased in the year. Thus, at the start of the year, while it is known that the buyer will receive a rebate, the precise amount is unknown. The particular problem posed by rebates of this sort is that the final price to be paid will not be known until after the end of the period concerned. This type of rebate is often referred to as a *retrospective price fall*.

8.51 The situation is often further complicated by the rebate being paid to the buyer in the form of a reduction in the cost of his purchase in a particular quarter. That is, the total rebate for all purchases in a previous year is applied to the price of purchases in a particular quarter. This practice results in a large price fall in the quarter in which it is applied.

Treatment of rebates

8.52 The question arises as to how such rebates should be treated. Should the price paid each quarter be shown in the index as the price for the item? If so, how should the rebate be treated - as a retrospective price reduction? And if so, should the previous prices be revised?

8.53 On balance, it is considered that where the rebate is already in existence the rebate should be treated as a discount and deducted from the quarterly price, and not treated as retrospective price reductions. The basis for calculating the rebate should be the buyer's normal volume of purchases (if the buyer is a new customer than the basis for calculating the rebate should be the average quantity purchased by that category of buyer).

8.54 Changes in the level of rebates should only be reflected where the actual rebate for the same quantity purchased/sold changes. Changes in the rebates paid to a particular customer due to the customer changing his volume of purchases should not be reflected as price changes.

8.55 As price indexes are designed to measure price changes for a constant quantity of purchases, the rebate collected should be the rebate applicable to that constant quantity and clearly set out in the pricing specification.

8.56 Where rebates are specified in terms of the monetary value of purchases it is important to realise that, due to inflation, a monetary value does not represent a constant real quantum. As per the discussion above for discounts, any monetary values should be converted to quantity data.

8.57 If the quantity of a respondent's purchases changes significantly, the pricing specification should be changed to reflect this. The change in rebate associated with a change in volume should not be allowed to affect the index.

8.58 Where a number of levels of rebates are offered it is necessary to ascertain the importance of each level of rebate and to price those that are significant.

8.59 On occasions rebates will be introduced retrospectively, that is a supplier introduces rebates based on a previous financial year's purchases. Note that this is not the situation of a "class of customer discount", as described earlier, where the price for future periods is determined by customer loyalty in earlier periods. It is instead a change to prices for products previously purchased, or a retrospective price fall. Two types of practices arise here. The first practice is where prices for previous periods are amended prior to settlement. The second practice is where prices for a particular subsequent period are themselves amended to reflect price changes for earlier periods.

8.60 Example: consider a manufacturer of steel shelving who purchases sheets of stainless steel as a material input. This particular producer is offered a rebate of 5% if he buys more than 2000 tonnes in a calendar year. His purchasing data appear as follows:

EXAMPLE: PURCHASES OF STAINLESS STEEL

Period (Quarter)	Price ($ per tonne)	Quantity (Tonnes)	Value ($'000)	% change in price from previous quarter
2004				
March	380	570	216.6	
June	420	590	247.8	10.5%
September	460	560	257.6	9.5%
December	510	590	300.9	10.9%
Total		**2,310**	**1,022.9**	

The producer exceeds 2000 tonnes purchased within the calendar year, and his supplier provides a 5% rebate for the year's purchases. This amounts to 5% of $1.0229 million dollars, or $51,145. The supplier provides this rebate by deducting this value from the March 05 total value.

Period (Quarter)	Price ($ per tonne)	Quantity (tonnes)	Value ($'000)	% change in price from previous quarter
2005				
March	560	660	369.6	
March with rebate	318.455 / 660 = 482.5	660	369.6 – 51.145 = 318.455	-5.4%
June	610	660	402.6	26.4%

How should this rebate be accounted? In the ABS producer and international trade price indexes the rebate is shown in the quarter in which it is applied, resulting in a substantial price fall in March 2005 and substantial offsetting price rise in June 2005.

8.61 There are three reasons for this practice, stemming from the concept that the indexes measure the prices applying in a particular quarter:

i. With regards to inflation and decision making, the prices applying in the quarter of March 2005 were those used in the index; that is, businesses were making decisions based on those prices and charging their buyers prices based on these prices (or equivalently improving margins for this quarter);

ii. With regards to use in the production of quarterly national accounts, both the revenue data and expenditure data used in compiling the national accounts use the value data represented above. As the aim of the national accounts is to show changes in volumes (quantities), the price data for March 2005 must show a price fall commensurate with the payment of the rebate; failure to do so would result in a (false) fall in volumes in the national accounts. The correcting price rice in June 2005 must similarly occur so as not to cause a false rise in volumes.

iii. There are strong practical reasons for not revising prices given the use of price indexes in contracts' escalation - revisions create major problems for users.

UNIQUE PRODUCTS

8.62 A unique product is one that is only manufactured once to the specification of a customer. Within a group of products, each product will be different from the others, for example, industrial furnaces, ships and architectural services. In these cases, the price cannot be observed over future reporting periods.

8.63 The solution to this problem is based on the concept that products are a collection or bundle of different characteristics. For example, a ship can be considered as consisting of steel, engine components, navigational equipment, and so forth; an architectural service may consist of different numbers of hours of senior and junior architects' time together with associated information technology and other materials. The challenge is to define a product in terms of its characteristics, and then determine a real price for that product in future periods even if such a product is not actually sold. This approach is called *model pricing*.

Defining a product for model pricing

8.64 The model pricing approach begins with the definition of a notional product (the "model") that is to be priced over time. The difficulty with such an exercise is that the circumstances that dictate the use of model pricing mean that the products are themselves unique, and frequently the goods or services provided are complex in nature.

8.65 There are several techniques that may be used in identifying and describing a notional product. All such approaches require a high degree of interaction and cooperation with data providers, and these approaches must usually be individually tailored to respondents.

i. *Repeat recent sale*: an actual product sold in a recent period is used as the notional product. The product should be representative of the provider's output. The advantage of this approach is that a product recently sold will certainly represent at least one type of activity that the provider undertakes, and that the provider will have had experience in pricing such a product. It may also be less burdensome on the provider. The disadvantage of such an approach is in ensuring that the recent activity selected is representative of future business.

ii. *Base product*: a "base level" or "standard product" is chosen as the product. For example, a standard house design is quoted for an architectural service, or a standard model yacht for a shipbuilder. The advantage of this approach is that the provider will frequently have a range of base products from which all other products are designed (and also frequently how they are priced). The disadvantage of this approach is that the base level design will almost certainly not reflect the actual types of products being produced in future periods.

iii. *Hypothetical single product:* working with the provider it may be possible to describe a hypothetical product that is representative of the types of products produced by the respondent. While this model may never have been (or never will be) produced, it must represent an item which could be readily produced. This approach has the advantage that the provider identifies a model that could be produced through the current production process, and should correctly incorporate margins. A disadvantage is that the product is hypothetical and may prove difficult to price accurately in practice.

iv. *Hypothetical component model*: in those cases where no single model can represent the output of the respondent, a notional model incorporating the key components from the various items produced can be established; that is, incorporating the different types of materials used and different production techniques. This differs from the hypothetical single product above since the hypothetical component model would be purely hypothetical, in that it would never be built. The advantage of this approach is that the model covers all the sorts of activities undertaken by the provider. The disadvantage is that the model is purely hypothetical, and furthermore cannot actually be produced, and so its definition must take extra care to include explicitly overheads and margins.

8.66 When defining products to be priced over time, a key limitation of the model pricing approach is that the specified product must continue to be representative of the types of products being produced. The consequence of this limitation is that the notional model must be frequently checked for representativity, and updated and re-specified over time.

Collecting prices for model pricing

8.67 Working cooperatively with data providers to specify notional models is the first stage of model pricing. The remaining effort required is to devise mechanisms to collect prices for these models over time. The models have not been produced in the reference period, and have been designed instead to represent the types of activities undertaken by providers.

8.68 From a data provider's point of view, the burden faced when pricing a model not actually produced and sold during a reference period may range from an inconvenience through to the effort required when tendering.

8.69 For these reasons the ABS works with producers of unique products to apply price collection procedures that yield the correct price movement with the least burden placed on providers.

8.70 There are several techniques to repeatedly price these notional models:

a. *Single price approach:* whereby the provider determines the price for the completed model and reports this back to the ABS. This approach is attractive in that it is operationally identical to other price collection techniques (in terms of forms, systems,

editing, respondent queries etc.). The disadvantage of this approach is that this technique is frequently difficult to apply correctly in practice; it may prove difficult to ensure that such a price represents the actual transaction price such a product would receive in the marketplace. Further, the correct pricing of the single product may prove to be a high burden to the provider.

b. *Component pricing:* in those cases where it is not possible to simply repeat price a notional product, it is frequently expedient to collect prices of components from a data provider and aggregate them in some pre-determined manner. This approach is readily applicable to the hypothetical component model, but is also applicable to other models where sufficient information regarding their composition is available. In practice, component pricing is achieved in several ways:

   (i) *Respondent algorithm*: in this case the respondent agrees to collect prices for individual components and combines the price to one final price. This differs from the single price approach because the provider and the ABS agree from the outset what components are to be priced. The respondent provides the ABS with both the component prices and the final price, and informs the ABS if the algorithm requires updating.

   (ii) *ABS algorithm*: in this case the respondent agrees to collect prices for individual components only, and the prices are combined to a final price by the ABS. This approach places less burden on the provider, and requires the ABS to develop and maintain the aggregation algorithm.

Component pricing is often attractive to data providers, yet may prove to be problematic unless representative prices are obtained for components such as profit margins.

Developing and maintaining model prices

8.71 These approaches are much more burdensome on respondents, since they cannot simply look at recent sales data to provide price quotes. To accurately supply price quotes using these approaches may lead to the respondent incurring substantial costs, so in practice there is an element of estimation in this process.

8.72 In all of the above unique product cases, the main difficulty is persuading respondents of the value of this approach because they do not produce this specific product as described. To resolve these issues, the ABS employs a personal interview with representatives of the data provider.

8.73 The ABS also regularly re-visits providers who supply data using a model price. These visits re-emphasise the importance of model pricing (as well as thanks for continued cooperation with the ABS), and are an opportunity to update price models.

TRANSFER PRICES

8.74 Transfer prices are defined in the 1993 SNA (3.79) as

> "affiliated enterprises may set the prices of transactions among themselves artificially high or low in order to effect an unspecified income payment or capital transfer".

Transfer prices and the PPI

8.75 Transfer prices should be used with caution because they often do not fully reflect the true value of the goods or services being transacted. The ABS has the aim of collecting real transaction prices, which generally require a transaction with a third party. Transactions to another part of the same business (or to an affiliated business) may not reflect the true price (or true price movements) observed in the marketplace. The ABS only includes a transfer price in the producer price indexes when the price behaviour is confirmed to represent true market transactions.

Transfer prices and the customs frontier

8.76 Merchandise that either enters or leaves Australia presents a particular challenge for the international trade price indexes where the parties to the transactions are between affiliated enterprises in different countries.

8.77 In such cases, the prices adopted in their books for recording transactions in goods and services may not correspond to prices that would be charged to independent parties. To the extent that these transfer prices are different from those charged to third party establishments, the prices recorded represent a departure from real transaction prices. However, transfer pricing to avoid tax is illegal in Australia, and consequently the distortions in economic statistics caused by transfer pricing through the customs frontier are not considered widespread. For these reasons, transfer prices are sometimes included in the import price index and export price index. This practice is consistent with the practical treatment of these value data (for merchandise crossing the customs frontier) in both the ABS national accounts and international accounting frameworks.

COLLECTION PROCEDURES

8.78 The ABS aims to facilitate the collection of price data from respondents in a secure and cost-effective manner, while minimising the administrative burden on the respondent. The producer and international trade price indexes use a range of collection methods to collect prices data each quarter, including personal interview at enrolment, a quarterly survey form (*Survey of Producer Prices*), collection of price data from company websites, use of media reports, use of administrative by-products such as exchange rates, and data from other ABS collections (particularly international merchandise trade).

Tailored forms

8.79 The forms for the *Survey of Producer Prices* are tailored specifically for each data provider. Each selected provider is asked to provide the price for one or more products, and the description of these products is tailored to individual providers. Further, the type of information requested is tailored to specific products for each provider. For example, as discussed above, although all products require collection of price data, for some products it is also necessary to collect a discount, for others it is necessary to collect the quantity purchased, and so forth. In this manner, the survey forms are tailored separately for each individual product specification (and each data item), to each selected data provider.

8.80 The *Survey of Producer Prices* uses a mail-out mail-back methodology, where respondents are sent the tailored questionnaire together with a reply-paid envelope. To facilitate ease of reply, survey questionnaires are frequently faxed back to a dedicated fax number.

8.81 In the event of a late reply, the ABS contacts providers to remind them of the due date for the survey return. One step in this intensive follow-up process involves phone contact with providers. During this contact, some respondents choose to provide pricing data over the phone to ABS price collectors.

Use of email

8.82 The ABS is aware that some respondents use email as their preferred communication medium. The ABS policy in this regard is focussed on the security of respondent information. Within the ABS information technology environment, such electronic information is secure with access restricted to those officers compiling the price index. The ABS cannot guarantee the security of electronic communication outside the ABS, and so does not attempt to collect pricing data via email. However, acknowledging that electronic communication may reduce provider burden for some respondents, the ABS has developed a secure and confidential collection facility which is known as a *secure deposit box*.

8.83 Whilst not as flexible as internet email, the secure deposit box provides internet-based facilities for some providers to lodge survey data with the ABS.

Collection during sample maintenance

8.84 A price index must measure the price change of a representative basket of goods and services. This basket must not only be representative during the initial or base period of the price index, but must maintain its representativity (and hence relevance) over time. The ABS ensures that its price baskets remain representative through the facilitation of a dedicated program to maintain and review the sample of products.

8.85 Part of this program involves infrequent contact with a sample of providers outside of the quarterly cycle of the *Survey of Producer Prices*. Pricing data are frequently collected during these provider interactions, and are often used in place of (or to supplement) the quarterly price collection.

8.86 Maintenance of the samples of products is discussed in detail in Chapter 11.

Other sources

8.87 Compilation of the producer and international trade price indexes uses data from other sources in addition to that collected in quarterly survey forms. Much data collected for the production of international and merchandise trade are used, particularly in those cases where the products are homogeneous (having near identical characteristics).

8.88 The ABS also uses data that are readily available in the public domain, such as exchange rates, and some commodity data. In addition, the ABS sources data from other Australian government agencies (particularly for mineral fuels and some agricultural commodities).

8.89 In the cases where internet prices reflect actual transaction prices the ABS will use this data to supplement its price samples.

8.90 In some cases the ABS purchases data from third parties, particularly when measurement of prices for groups of commodities requires additional specialist skills. For example, the ABS purchases data from quantity surveyors as one input into price measures for the outputs of the construction industry.

8.91 In addition to their use in compiling price indexes, data sources such as those described above provide a valuable tool in editing and confronting prices data.

CHAPTER 9 QUALITY CHANGE AND NEW GOODS

CHANGES TO THE FIXED BASKET

9.1 The producer and international trade price indexes are designed to measure the average change in the price of goods and services as they leave the place of production (output prices at basic values) or as they enter the production process (input prices at purchasers' values). The price indexes are constructed to measure the changing cost of a fixed basket of goods and services. In this context, the basket is 'fixed' in terms of both the types and quantities of products.

9.2 Over time specific types of goods and services in the price basket appear and disappear. New goods and services can appear because technical progress makes production of new products possible. Existing products often decrease in importance or disappear from the market altogether as new products appear. Moreover, the basket of products priced from period to period is a sample of products available in the marketplace. Products in the sample may appear and disappear, not because they are truly new to, or no longer produced or used by, all establishments, but because they may be only new to, or no longer produced by, the respondents selected in the sample.

9.3 This chapter covers how to deal with the problem of continuous change in the assortment of transactions whose prices make up a price index.

QUALITY

9.4 Most types of products are available in the marketplace in many different qualities; that is, they have physical characteristics which differ from each other. For example, potatoes may be old or new, red or white, washed or unwashed, loose or prepacked. Loose unwashed Russet Burbank potatoes (used for French fries) are different qualities of potatoes from washed, prepacked Atlantic potatoes (used for crisps).

9.5 When sets of products are sufficiently similar to be considered the same generic type of product (such as a potato), but have sufficiently different characteristics that make them distinguishable from each other from an economic viewpoint, the products are said to possess *different qualities*.

9.6 Not all differences in quality are attributable to differences in physical characteristics of products. Products with identical physical characteristics delivered to different locations, or at different times, are considered to have quality differences. Purchasers situated in one location frequently have different marginal utility from that of purchasers in other locations; hence, different locations may result in different qualities.

9.7 Similarly, identical products provided at different times of the day (or year) must be treated as different qualities. An example of such a quality difference occurs with the supply of electricity – electricity provided at peak times is considered to be of a higher quality than that provided at off peak; the very fact of a "peak time" shows that purchasers of electricity attach greater utility to the provision of electricity at these times.

9.8 Quality differences may also be determined by a range of other non-physical attributes. Quality may be determined by conditions of sale, presence of free after sales service, guarantees for durable goods, inclusion of delivery, methods for payment, and so forth.

PRICING TO CONSTANT QUALITY

9.9 The objective of price indexes is to measure pure price change over time; that is, to measure the extent to which the cost of an identical basket of goods changes over time, not affected by changes in quality or quantity or the terms of sale. This is often referred to as *pricing to constant quality* and is not a simple objective to achieve because the characteristics of goods being sold in the market place, and their terms of sale, change over time. Frequently the precise product priced in one period is no longer available in the next period because either there has been some change in the characteristics of the product or else something new has taken its place. For price index purposes it is necessary to devise techniques to identify quality differences and eliminate their effect on prices from the calculations of price change for inclusion in the index.

9.10 The concept of quality is based on the notion of *utility to the purchaser*. Quality change is measured by reference to the expected value of the changes to the purchaser. While it is not always possible to achieve this in practice, it is the principal guideline in making decisions concerning quality change.

Does a product's price give information about its quality?

9.11 In economic theory it is generally assumed that whenever a difference in price is found between two goods or services which appear to be physically identical, there must be some other factor, such as location, timing, conditions of sale etc., which is introducing a difference in quality. Otherwise it can be argued that the difference could not persist, as rational purchasers would always buy the lower priced items and no sales would take place at the higher price.

9.12 However, underlying the economic theory are some strong assumptions which rarely hold true in the marketplace. The key assumption behind "different price means different quality" is that purchasers are well informed and that they are free to choose between goods and services offered at different prices.

9.13 In most markets, purchasers are not universally informed about existing price differences and may therefore inadvertently buy at higher prices. While it is true that most purchasers will search out lower prices, costs are incurred in the process. The lack of information about price differences may result in search costs being greater than price differences, in which case rational purchasers may be prepared to accept the risk that they are not in fact buying at the lowest price. That such imperfect information exists in the marketplace is evident from the number of situations where buyers or sellers negotiate over prices. On the other hand, the differences in prices of products from different types of outlet frequently reflect differences in quality attributable to the differing conditions under which the products are sold.

9.14 Even when purchasers are well informed, in practice they are not always free to choose the price at which they purchase. This situation arises because of *price discrimination*, whereby the seller is in a position to charge different prices to different categories of purchasers (for products that are otherwise identical). Price discrimination is a common practice in the marketplace as it enables sellers to increase revenues and profits.

9.15 Complicating this observation is the difficulty that arises when purchasers can retrade amongst themselves (that is, purchasers that buy at the lowest price can resell products to other purchasers). Under such circumstances price discrimination is less likely to occur. Yet whilst such a circumstance can occur for the sale of most goods, this situation rarely arises for services, since it is usually impossible to retrade services. Price discrimination is frequently practised in many of the transportation and business service industries for this very reason. Thus, when different prices are charged to different purchasers it is essential to establish whether there are in fact any quality differences associated with the lower prices.

9.16 A further point concerning the applicability of the underlying economic theory is with regard to supply. Differences in price may arise because there is insufficient supply at the lower price. Such a situation typically occurs when there are two parallel markets. For example, there may be a primary domestic market and a secondary market for imports. If the quantities available in the domestic market are limited, there may be excess demand so that supplies may be imported. As a result, the price on the secondary market will tend to be higher. It is also possible that products from the second market are not only more expensive but of different quality.

9.17 Therefore prices statisticians are faced with a contrast between theory and practice: theory indicates that a difference in price means a difference in quality, but a difference in price may also arise due to lack of information, price discrimination by customer type, supply constraints and/or the existence of parallel markets. Thus, the existence of different prices does not always reflect corresponding differences in the qualities of the goods or services.

9.18 The term 'quality' embraces all those characteristics in a good or a service that the purchaser values or from which it derives utility. Thus the problem is to identify those characteristics that purchasers value, to make an estimate of the value of those characteristics and to measure the change in those characteristics embodied in the good or service so that their effect can be removed when calculating price movements. When used in this context, 'quality' encompasses all attributes of a product, including quantity.

Why quality change is an issue

9.19 It is essential that, in the compilation of a price index, each item included within the price basket be priced to the same quality that it was in the previous period. Failure to price to constant quality would result in a price index that measured a price change and a quality change; that is, in addition to a price change the index would also (incorrectly) measure the impact of a change in the quality of the product being delivered.

9.20 Since different qualities are economically different from each other, quality differences must be treated as volume differences and not as differences in price. The overarching principle for designing methods to deal with variety is that, at the most detailed level, the prices of items between any two periods may be directly compared only if the items are essentially the same. Violating this principle would mean that a given quarterly price ratio measures not only the change in price, but also the value of the qualitative difference between two items. This contaminates the estimate of relative price change with an element, quality, that measures relative volume rather than price. It degrades the accuracy of the price index formed with the price ratios or relatives for the specific transactions.

DEALING WITH QUALITY CHANGE

9.21 The real world of economic transactions is ever changing and dynamic. Frequently the product priced in one period is no longer available in the next period because either there has been some change in the characteristics or something new has taken its place. Specific varieties of goods and services regularly appear then disappear. New goods and services can appear because of advances in technology, making the production of these new items possible.

9.22 Failure to account for quality changes would introduce a bias into the price index. Thus, if the qualities of goods or services being compared are not identical, there are effectively two options:

- to adjust the observed price of the old quality for the change in quality which has taken place (referred to as a quality adjustment); or
- to treat the two qualities as if they were two separate goods and to estimate their prices in the periods in which they are not sold.

9.23 The problem facing price statisticians is isolating and quantifying the direct effects of changes in the quality on goods and services they are pricing in the fixed basket, to achieve an index of pure price change.

QUALITY ADJUSTMENT

9.24 *Quality adjustment* is defined as making a change in the price or price movement that accounts for the change in quality that effects the utility of the good or service.

9.25 In compiling of the producer and international trade price indexes, five methods are adopted to quality adjust prices when a product changes:

- *Overlapping sales* - where there is at least one period when both qualities are on sale in the market at the same time;
- *Non-overlapping sales* - where one quality is replaced by another of different quality, but the two qualities have not been available in the market at the same time;
- *Component approach* - where there are some changes in the composition of a particular quality;
- *Hedonics* – where the different qualities are assumed to be functions of certain measurable characteristics; or
- *Not directly comparable* – where qualities are different but no information exists to allow an explicit quality adjustment to be made.

Overlapping sales

9.26 Overlapping sales arise where a particular product being priced is no longer available in the market place from one period to the next, but there is another similar item that has been, and continues to be, available in the same market as the initial product and is expected to be a substitute once it is discontinued.

9.27 In this situation, provided the two items have sold side by side for some time in the same market and both have sold in reasonable quantities, the approach is to collect prices for both items at the one date and to assume that the difference in prices represents the difference in quality between the two. The implicit assumption is that the market has adequate knowledge of the qualities and prices of each product and that the difference in price is regarded by them as a reasonable measure of the difference in quality. The second item is then substituted for the first using the technique of splicing price series, as illustrated below:

Example: consider two harvesters for sale. Harvester A is for sale in period 0 and period 1. Harvester B is for sale in period 1 and period 2. The two harvesters are both for sale during period 1, in which case there is overlap of the two products. The products are considered to be of different qualities.

Price of Harvester	Period 0	Period 1	Period 2
Harvester A	$80,000	$85,000	
Harvester B		$95,000	$98,000
Price relative for harvesters	100.0	100 × 85,000 / 80,000 = 106.3	106.3 × 98,000 / 95,000 = 109.7

The price movement reflected in the index from period 0 to period 1 is the movement in the price of Harvester A (6.3%). The price movement from period 1 to period 2 is based on Harvester B (3.2%), which will be priced in subsequent periods to replace Harvester A. The difference in price between Harvester A and Harvester B has been eliminated through the process of splicing the new price series to the old price series.

An equally applicable interpretation of this process is to consider the comparison of prices between period 1 and period 2. In period 1, Harvester A is priced at $85,000. In period 2, Harvester B is priced at $98,000, and this is interpreted as:

- a *quality change* of $10,000, from $85,000 to $95,000, and
- a *price change* of $95,000 to $98,000.

9.28 In some cases, even with overlapping sales, simple splicing of the price of the new specification to the existing price series is not a satisfactory way of eliminating changes in quality. This situation occurs, for example, when the price of a new model reflects not only the extent of modifications but also a degree of price change, upwards or downwards, for reasons quite distinct from these modifications. In these circumstances, a simple splicing of the old and new prices would eliminate the elements of pure price change as well as the elements of change in quality. In such cases, it is necessary to assess the degree of pure price change involved and to ensure that this is reflected in the price series after splicing.

Non-overlapping sales

9.29 In the instance where two qualities are not sold in the marketplace at the same time, it is necessary to implement indirect methods of quantifying the change in quality. This circumstance arises frequently for durable goods, such as motor vehicles, white goods, home entertainment

products and so forth, where producers cease all production of the superseded model when a new model is introduced. In these cases, it is necessary to estimate the relative prices of the old and new models, had they been sold in the market at the same time. The estimated relative prices then give an indication of the measure of the relative qualities.

9.30 In many circumstances the difference between the old and new products is a matter of size or dimensions. For example, an 80g jar of instant coffee is replaced with a 100g jar. In such cases[37] the difference in price is readily determined by considering the per unit price; in the case of instant coffee, the change in price per gram would yield the quality adjusted price change.

Price of Coffee	Period 0	Period 1
80g jar	$4.20	
100g jar		$5.00
Price per gram	$0.0525	$0.05
Price relative for coffee	100.0	100 × $0.05 / $0.0525
		= 95.2

9.31 This process is equivalent to considering the difference in size as a difference in quality, and then explicitly pricing this difference. In the case of the coffee jar, the process would be to determine the price of the "extra 20g". This value would then indicate the quality change between the smaller and the larger jar. In practice, this value of the quality difference is used to quality adjust the previous period price, such that the products in both the current period and the previous period are of the same quality.

Price of Coffee	Period 0	Period 1
80g jar	$4.20	
100g jar		$5.00
Price per gram	$0.0525	$0.05
Change in quality		20g
Value of quality change in previous period prices	20g × $0.0525/g = $1.05	
Quality adjusted price (i.e., 100g jar of coffee)	$4.20 + $1.05 = $5.25	$5.00
Price relative for coffee	100.0	100 × $5.00 / $5.25
		= 95.2

These data may be interpreted as

- a *quality change* of $1.05, from $4.20 to $5.25, representing the addition of an extra 20g of coffee; and
- a *price change* of $-0.25, being the fall from $5.25 to $5.00.

[37] In such cases the change in size is assumed to be the only change, and that the resulting new product has the same end use as its predecessor. This approach cannot be adopted when the change in size suggests a different end use (eg, 80g jar of coffee with 45kg container of coffee). In such circumstances it is necessary to adopt other quality adjustment mechanisms.

Component approach

9.32 The method used to adjust for changes in the composition of a quality is to identify the quality difference and place a value on that difference. Frequently the composition of a particular product changes because of the use of different materials or the addition or deletion of particular features.

9.33 An example would be a change in the wool/synthetic mix of a yarn. In such cases, the technique used to estimate the value to the user of the quality change involves ascertaining the additional cost (or saving) to the manufacturer and examining the prices of broadly comparable items (e.g. yarns containing various proportions of pure wool and synthetic fibres).

9.34 Sometimes the modified product differs markedly from the previously priced product. An example of such changes occurs with the change in model for a particular make of motor vehicle. This type of quality change requires the collection of a considerable amount of information and, in some cases, subjective judgement is required to estimate a monetary value by which to adjust the price. The first step is to obtain a full picture of the differences between the old and new models. This is done by:

- obtaining detailed information from the manufacturer or industry associations, such as design and engineering reports;
- examining published tests and other comments on the new model in trade publications, magazines, etc.; and
- physically examining the new model and questioning producers about the nature of the changes.

9.35 Having identified the precise differences between the models, the next step is to determine which of these differences represents changes in quality and to estimate the monetary value of each change. Some changes are relatively simple to quantify. Continuing the car example, changing the type of tyres on the new model when both types of tyres are sold separately in the market is readily assessable since the value of the quality change can be assessed as the difference in the selling prices of the tyres.

9.36 Other changes require more detailed examination. If we consider motor vehicles again, a new model car may have cloth covered seats while the old model has vinyl covered seats, in which case the factors that would be considered are:

- the unit cost to the manufacturer of the change;
- whether the cloth covered seats have been previously available as an option and, if so, what was the price and did a significant number of buyers purchase the option at that time; and
- the change in comfort and durability of the seats.

Hedonics and personal computers[38]

9.37 Personal computers are an area of rapid technological change. Products available in the marketplace change frequently as new features are added and existing features improve. For example, the rapid change in hard disk size, random access memory, and clock speed of desktop personal computers is well documented. A further issue is that older models quickly

[38] For a more detailed description of hedonic price indexes and the ABS methodology, see the ABS Information Paper *The Introduction of Hedonic price Indexes for Personal Computers, 2005* (Cat. 6458.0) This paper is available on the ABS website: www.abs.gov.au

become redundant. The net result of these changes is that over any two periods there are both new products and discontinued products, with the result that comparing "like with like" becomes difficult. This is of particular concern when it is observed that improved features on later models do not always result in a price increase, or a commensurate price increase that would be observed if the components were bought separately (again, a bigger hard disk drive is an example). The quality adjustment problem is applicable to all price indexes, not just those for personal computers. However, traditional approaches to solving this problem (for example, matched model approaches, explicit quality adjustments, or component level pricing, amongst others) are inadequate for these sorts of products.

9.38 When faced with measuring prices for products which undergo rapid quality change, international best practice is to develop hedonic price indexes when suitable source data are available. This is the approach being advocated by international agencies such as the OECD[39], the ILO and the IMF.

9.39 A hedonic price index is any price index that utilises, in some manner, a hedonic function. In broad terms, a hedonic function identifies the relation between the prices of different varieties of a product, such as differing models of personal computers, and the characteristics within them. By comparing prices and features of various computers, a hedonic regression model assigns values to each of the particular features that are identified as “price determining” (for example, processor speed, memory, disk capacity etc).

9.40 The producer price indexes use a form of hedonic index known as the 'consecutive two period chained time dummy double imputation hedonic price index' for use in price indexes for personal computers. This process sees a matched model price index applied for personal computers sold between consecutive periods, combined with a consecutive-period time dummy price index (this is produced by using regression techniques) to measure price changes for both discontinued and newly introduced goods.

9.41 The double imputation method can best be thought of as a traditional matched model index with an explicit adjustment applied because of both the departure of superseded models and the introduction of new models. A key deficiency of the basic matched model approach is that it makes no provision for systematically including the effects of price and quality changes in models available in the marketplace, and determines price change by only considering those models which appear in the market in both periods of interest. In other words, any improvement in quality associated with the introduction of a new model will not be measured if only matched models are priced.

9.42 The double imputation price index counters this deficiency by implicitly imputing price movements for both superseded models and newly introduced models. This is where the term 'double imputation' arises. The index is then considered representative of all transactions, since recently superseded models and new models are included in the determination of price change, in addition to products common to both periods.

[39] See for example, Triplett, J, 2004, *Handbook on hedonic price indexes and quality adjustments in price indexes: special application to information technology products*. OECD STI working paper 2004/9

9.43 Further, the implicit imputation process at the core of this technique uses a hedonic function to adjust for changes in the characteristics of both the new and superseded models; that is, the prices imputed are adjusted for quality change, and hence the resulting index measures pure price change.

9.44 The current process utilises price data from Australian vendors of personal computers, and so is not only representative of the Australian marketplace but also avoids issues with both exchange rate fluctuations and arbitrarily lagging prices to take account of shipping times etc. The double imputation index uses a hedonic function based on characteristics of personal computers sold in the Australian marketplace, using prices in Australian dollars, and so furthermore does not rely on the restrictive assumptions underlying a universal hedonic function.

9.45 Any movements in the double imputation index can be decomposed into the movement due to changes in prices of the matched sample, and the movement due to changes in products in the marketplace. Movements in the index can be explained in terms of changes in list prices of existing products and changes in quality of new products, and so the resulting measures are easily explainable to users.

9.46 In September quarter 2003 the ABS introduced the double imputation hedonic index for personal computers into the PPI in the Price Index of Articles Produced by Manufacturing Industries (APMI), and as a consequence into the Stage of Production Producer Price Indexes (SOP).

Not directly comparable

9.47 Despite the efforts to quantify explicitly differences in quality, circumstances occasionally arise where insufficient information exists to value the differences between two models of a product. In such cases it is still necessary to make a quality adjustment to allow comparison of prices. In the absence of any other information, the strategy employed in the producer and international trade price indexes is to consider the problem in two parts.

- If the old model had existed in the current period, how much would the price have changed between the current and previous period?
- What would the price have been in the current period?

9.48 If no other information is available, the quarterly movement in the price of the old model needs to be estimated from the price movements of similar products. In this manner the price movement problem is directly analogous to the "imputation and temporarily missing price observations" problem described in Chapter 10.

9.49 Once the price movement has been determined, an estimate of the current period price for the old model can be made by working forwards from the observed previous period price. The new model is then introduced in the *subsequent* period (with a back price), and any difference at that time between the estimated price for the old model and the (observed) previous period price for the new model is due to the difference in qualities between the two models.

9.50 This approach is only used in circumstances where other efforts at quality adjustment have been exhausted, since excessive use would introduce bias into the price indexes. Such biases arise because of the assumptions underlying the application of this technique.

1. Prices for new models move the same as prices for other models – the use of the "not directly comparable technique" has an implicit assumption that the new model has the same price movement as other models. It is known across some industries that prices are increased when new models are introduced (as a means of increasing revenues and profits), in which case use of this mechanism would result in a downward bias for these types of products.

2. Prices change for reasons other than the introduction of new models – a more severe consequence of the "prices move the same" assumption occurs for those products where the *only* price movement occurs when models are changed. In this case, prices for continuing models remain static from quarter to quarter. The introduction of a new model would always result in an imputed (estimated) price change of zero – meaning that the index would never change. This may also be interpreted as *all* differences in observed price being solely attributable to quality change.

NEW PRODUCTS

9.51 The production or importation of a "new product" causes particular difficulties in compiling the producer and international trade price indexes. These difficulties arise because:

- new products are difficult to identify when using a fixed basket; in particular, difficulties arise when differentiating new products from improvements to existing products;
- measuring price changes for new products has its own range of issues; and;
- incorporating a new product into a "fixed basket" index requires index restructuring, measurement of value data for the new product and reweighting of the existing index structure.

Why are new products important?

9.52 New products are significant in an index context because these products tend to exhibit quite marked price behaviour after entering the market characterised by a high entry price, followed by a period of rapidly declining price (if not in absolute terms then at least in relative terms) before assuming the status of an 'established product'. During the period between when a new product enters the market and becomes an accepted, established product, its marked downward price behaviour is unlikely to be reflected by the price behaviour of existing products. To the extent that the price falls of new products are not captured by the price index, the index is upwardly biased.

9.53 An important issue in assessing the potential impact of the omission of new products from a price index during this initial phase of their life cycle is that the initial quantities (sold or purchased) are usually very low, growing as the price falls. Therefore, the bias which arises because of the delay in introducing a new product new goods bias increases with the delay in which new products are introduced to the index — particularly if the delay is such that the new goods are not introduced until such time as they can be said to have become established products.

Identifying new products

9.54 The key question in identifying new products is differentiating new products from existing products whose quality has changed. A practical definition of a new product (as opposed to a changed product) is that the new product cannot be effectively linked to an existing product as a continuation of an existing resource base and service flow. Such new products are known as *revolutionary* products, whereas *evolutionary* products are produced in the same manner to better satisfy the same end

use. For example, the VCR was a completely new product when it was introduced in the 1970s because nothing like it had existed before. On the other hand, the DVD recorder replaced the VCR when it was introduced.

9.55 Identifying new products requires regular assessment of the marketplace, involving ongoing liaison with producers, regulatory authorities and industry associations.

9.56 The ABS approaches this problem using several different methods. For the international trade price indexes, new goods are identified through annual analysis of data from the Australian Customs Service, and international merchandise trade statistics. These data are particularly useful since they not only highlight the emergence of new products but also the value of sales and purchases, indicating the importance of any new good.

9.57 The producer price indexes use a variety of different instruments to detect the emergence of new products. First, questions regarding new products are asked each quarter in the *Survey of Producer Prices*. Second, regular contact is made with respondents outside the quarterly cycle to assess specifically potential changes in production. Finally, a program of personal visits is made to respondents and industry associations. This program, and its other purposes, is discussed in further detail in Chapter 11, Maintaining Samples of Products.

Measuring price change for new products

9.58 After a new product is identified, its price for two consecutive quarters needs to be determined before it is included in the price index. This requirement ensures that a quarterly price movement can be associated with the new product. Such a requirement means that "back prices" are sometimes used, where the price in a previous period is supplied in a later period. In all circumstances, it is necessary for the product to have existed in the marketplace sufficiently long for a price movement to be determined. Of further concern is that an individual new product will almost certainly represent other such products sold in the marketplace, in which case it is necessary that any such initial price movement is representative of the entire market (for the new product).

Incorporating the new product into the basket

9.59 A new product, by its very nature, does not belong to the fixed basket of a price index and must be introduced at some point after its arrival in the marketplace. As described above, the bias associated with new products is exacerbated through delays in introducing it to the price index. Yet a new product can only be introduced when both sufficient value data for the product exists and when the price index is reviewed.

9.60 Value data (either revenue or expenditure depending upon the nature of the price index) are essential for incorporating any product into a price index. Introducing a new product will also have an impact on the revenue (or expenditure) of other products in the marketplace. Consequently, value data are required for not only the new product but also for other products in the price basket. The introduction of a new product results in a value aggregate (and therefore a weight) being attached to the new product, and a change in the value aggregates of other items in the basket.

9.61 Chapter 11 of this manual discusses reviewing price indexes, and reweighting of price indexes is discussed in Chapter 12.

CHAPTER 10 PPI CALCULATION IN PRACTICE

10.1 The purpose of this chapter is to describe the way in which producer and international trade price indexes are calculated in practice.

10.2 The calculation of price indexes proceeds in two stages. First, price indexes are estimated for the *elementary aggregates*. These elementary price indexes are then averaged to obtain *higher level indexes* using the relative values of the value aggregates for elementary aggregates as weights. This chapter starts by explaining how the elementary aggregates are constructed and what economic and statistical criteria need to be taken into consideration in defining the aggregates. The different ways of imputing for missing prices are also explained.

THE COMPOSITION OF THE ELEMENTARY AGGREGATES

10.3 Elementary aggregates are constructed by grouping individual goods and individual services into homogenous products and transactions. They may be formed for products in various regions of the country or for the country as a whole. Likewise, elementary aggregates may be formed for different types of establishments or for various sub-groups of products. The key points in constructing an elementary aggregate are:

- Elementary aggregates consist of groups of goods or services that are as similar as possible in terms of material composition and end use (such that the group of products is homogeneous).
- They consist of products that may be expected to have similar price movements. The objective should be to try to minimise the dispersion of price movements within the aggregate.

10.4 Each elementary aggregate, whether relating to the whole country, a region, or a group of establishments, will typically contain a large number of individual goods or services[40]. In practice, only a small number of products can be selected for pricing. When selecting the products for pricing from period to period, the following considerations are taken into account:

- The transactions selected are ones whose price movements are believed to be representative of all the products within the elementary aggregate.
- The number of transactions within each elementary aggregate for which prices are collected should be large enough for the estimated price index to be statistically reliable. The minimum number required will vary between elementary aggregates depending on the nature of the products and their price behaviour.
- The object is to try to track the price of the same product over time for as long as possible, or as long as the product continues to be representative. Therefore the products selected are ones that are expected to remain on the market for some time so that like can be compared with like.

THE AGGREGATION STRUCTURE

10.5 The aggregation structures for producer and international trade price indexes were discussed in Chapter 6, with an example provided in figure 6.1. Using different classifications of products and industries, the goods and services covered by the producer and international trade price indexes can be divided into broad divisions, sub-divisions and groups, and

[40] In the compilation of the producer and international trade price indexes, the ABS refers to "goods and services" collectively as *products*.

then further refined into smaller classes. At the bottom of the standard classification structure, further disaggregations are made to reflect different end uses and different price behaviours.

10.6 Each component in the price index, from the top "all products" level (or *root*) of the aggregation structure down to each individual elementary aggregate, is associated with two distinct characteristics that allow future compilation of aggregate price index measures. These defining characteristics are:

1. The *link period value aggregate* – the value aggregate defined at the period when the index is designed; this measure effectively determines the underlying quantity weights of the price index.

2. The *link period P-index* – measures the price change for the component that occurred between the design or link period and the price index reference period; in the case where the link period and the reference period are the same the link period P-index takes a value of 100.0.

10.7 Linking price indexes is discussed in more detail in Chapter 12.

10.8 In addition to these characteristics, the elementary aggregates have one additional feature. Elementary aggregates are the only components within the index structure to have price samples. From these price samples, it is possible to directly construct price indexes. A price index for an elementary aggregate should measure price change and correctly account for changes in quality and both new and disappearing goods. This index is called an *elementary aggregate C-index* (this term comes from the reference to index compilation, and is also an indicator that the index correctly accounts for compositional changes to the price basket).

10.9 Beginning with these two defining characteristics and the aggregation structure, price indexes are created by working upwards from the elementary aggregate C-indexes. All indexes above the elementary aggregate level are higher level indexes that can be calculated from the elementary price indexes using the elementary value aggregates as weights. The aggregation structure is consistent so that the weight (link period value aggregate) at each level above the elementary aggregate is always equal to the sum of its components. The price index at each higher level of aggregation can be calculated on the basis of the weights and price indexes for its components, i.e. the lower level or elementary indexes. The individual elementary price indexes are not necessarily sufficiently reliable to be published individually, but they remain the basic building blocks of all higher level indexes.

THE COMPILATION OF ELEMENTARY PRICE INDEXES

10.10 Within the ABS producer and international trade price indexes, the elementary aggregate C-indexes are calculated using either the Laspeyres price index formula or the Jevons (equal weighted geometric mean) price index formula. The Laspeyres price index is illustrated by means of a numerical example in Table 10.1. In the example, we have assumed that the following conditions apply:

- prices are collected for four representative products within an elementary aggregate;

- the quality of each product remains unchanged over time so that the month-to-month changes compare like with like;

- a set of micro-index weights is available for use in the Laspeyres index formula;

- prices are collected for all four products in every quarter covered so that there is a complete set of prices;
- there are no disappearing products, no missing prices and no replacement products.

10.11 This example has quite strong assumptions, because many of the problems encountered in practice are attributable to breaks in the continuity of the price series for the individual transactions for one reason or another[41].

10.12 The calculation of the C- index for each elementary aggregate begins through calculation of a weight for each price observation. For elementary aggregates that use the Jevons index formula, the weights are equal. The majority of elementary aggregates in the producer and international trade price indexes use the Laspeyres index formula, which is applied through the price relative form. In this form, as discussed in Chapter 4, *price relatives* are combined using weights that represent the value share in the base period. Note that these weights represent not only the value of the particular transactions included for pricing in the elementary aggregates each quarter but also the other transactions which these observations represent. The base period value share is determined once for each observation and is only modified if the products in the elementary aggregate are changed; in which case the elementary aggregate undergoes sample maintenance, which is described in more detail in chapter 11.

TABLE 10.1 EXAMPLE OF ELEMENTARY AGGREGATE PRICE INDEX USING THE LASPEYRES PRICE RELATIVE APPROACH

	Base period				Period 1			Period 2		
	Base period value share	Price ($)	Price Relative	Weight x relative	Price ($)	Price Relative	Weight x relative	Price ($)	Price Relative	Weight x relative
Product A	30	5	1.000	30.000	6	1.200	36.000	7	1.400	42.000
Product B	20	7	1.000	20.000	7	1.000	20.000	6	0.857	17.143
Product C	10	2	1.000	10.000	3	1.500	15.000	4	2.000	20.000
Product D	40	5	1.000	40.000	5	1.000	40.000	5	1.000	40.000
Laspeyres price index				**100.0**			**111.0**			**119.1**
Percentage change from previous period							11.0%			7.3%

10.13 This example shows a price index of 111.0 in period 1, and 119.1 in period 2. The prices in the elementary aggregate have moved 11.0% in the first period, 7.3% in the second period and 19.1% since the base period.

[41] Departures from these assumptions are discussed separately:
- Introduction of new respondents is discussed in Chapter 4 (Price Index Theory)
- The treatment of new products is described in Chapter 9 (Quality Change and New Goods)
- Imputation for missing prices is discussed subsequently in this chapter
- Changes to the types of products in the marketplace are discussed in Chapter 11 (Maintaining Samples of Products)

IMPUTATION AND TEMPORARILY MISSING PRICE OBSERVATIONS WITHIN AN ELEMENTARY AGGREGATE

10.14 In any period an event may occur that makes it impossible to obtain a price measure for a particular item. For example, an item could be temporarily out of stock or the quality is not up to standard (as may occur with fresh fruit and vegetables because of climatic conditions).

10.15 There are various options the ABS employs to handle temporarily missing observations within price indexes. These include:

i. repeat the previous period's price of the item (also called "carry forward" or "show no change")

ii. impute a movement for the item based on the price movement for all other items in the sample

iii. use the price movement from another price sample.

10.16 These options are known as *imputation* algorithms. Their purpose is to impute a price for the temporarily missing product. The aim of imputation is to provide prices such that the resulting movement in the price index is the same as would have been calculated had all prices been observed. In achieving such a result, it is necessary to make an assumption regarding the price behaviour of the temporarily missing product.

Carry forward imputation

10.17 The rationale for adopting a carry forward imputation mechanism is that failure to observe a price for a product reflects no transactions for the product, and hence there can be no price change. However, each product in the price sample represents similar products purchased and sold elsewhere in the marketplace, and such an assumption does not hold in most cases. Application of this method of imputation when transactions are actually occurring in a marketplace (but not observed by the sample) consistently biases the index towards zero (that is, biased downward when prices are rising and biased upward when prices are falling). It is for these reasons that the ABS applies this imputation mechanism only under specific conditions where it is known that failure to observe a transaction means that no transactions are occurring (such as where there is only one sale per year of a type of agricultural crop, for example, or where the price changes only once per year during annual price setting).

Imputation from other products in the price sample

10.18 The rationale for imputing a price movement from other products in the sample is that products are bought and sold in a competitive marketplace and in those cases where an individual product has not been observed it is assumed that the behaviour is reflected by similar products in the sample. The design of elementary aggregates to contain products that are homogeneous in terms of price behaviour (as noted above) ensures that the assumption underlying this imputation mechanism is generally robust.

10.19 Imputing from other products in the sample is also mathematically equivalent to excluding the item, for which a price is unavailable in one period, from both periods involved in the index calculation. It strictly maintains the 'matched sample' concept.

10.20 In order to impute a movement resulting from excluding the item it is necessary to construct a measure of price change from the previous period to the current period for those items common to both periods. This calculation is dependent upon the price index formula used for the elementary aggregate. When the elementary aggregate is compiled using a Laspeyres formula, it is first necessary to derive the implicit quantities shares underlying the weights of the matched items. This can be achieved by dividing the weight for each item by its base period price.

10.21 The resulting quantity shares for the matched items are then used to calculate the price change from the previous period to the current period.

$$s_{q,i} = \frac{\frac{w_i}{p_i^0}}{\sum_{MATCHED} \frac{w_i}{p_i^0}}$$

$$M_{t-1}^{t} = \frac{\sum_{MATCHED} s_{q,i} p_i^t}{\sum_{MATCHED} s_{q,i} p_i^{t-1}}$$

$$\hat{p}_j^t = M_{t-1}^{t} \times p_j^{t-1}$$

where $s_{q,i}$ is the implicit quantity share in the base period for matched item *i*, w_i is the weight for matched item *i*, p_i^0, p_i^{t-1}, p_i^t are respectively the base period price, previous period price, and current period price for matched item *i* (at time *t*), M_{t-1}^{t} is the price movement between the previous and current period for the matched items, and $\hat{p}_j^{t-1}$ is the imputed price for missing item *j* at time *t*.

10.22 An example of this calculation is shown in Table 10.2.

TABLE 10.2 EXAMPLE OF IMPUTATION FROM OTHER ITEMS IN THE PRICE SAMPLE

	Base period value share	Base Period Price ($)	Previous Period Price	Current Period Price
Product A	30	5	8	12
Product B	60	10	16	20
Product C	10	2	4	n.a.
	Implicit quantities	Implicit quantity share	Share x Current Period Price	Share x Previous Period Price
Product A	6	0.5	6.0	4.0
Product B	6	0.5	10.0	8.0
Total			16.0	12.0
Movement				1.333
	Current period Price after impute	Price relative after impute	Weight x relative	
Product A	12	2.4	72	
Product B	20	2	120	
Product C	5.333	2.666667	26.66667	
Laspeyres price index			**218.6667**	

Imputation from another price sample

10.23 The third approach to imputation used in the producer and international trade price indexes is to use the price movement from another related sample. This approach is adopted in the rare cases where all observations from a particular elementary aggregate are not available (such as might result from localised storm damage, for example). In such cases prices may be imputed to move from similar items produced or purchased in different markets. This approach is usually only adopted when circumstances adversely affect price collection, rather than affecting market conditions themselves.

PRICE INDEXES FOR HIGHER LEVEL COMPONENTS

10.24 Once a price movement for the elementary aggregate is determined, the resulting C-index price movement is used to *price update the value aggregate* associated with the elementary aggregate. The resulting measure is known as the price updated value aggregate (or more commonly the *current period value aggregate*). For a given elementary aggregate (EA):

$$VA_{EA}^{t} = \frac{I_C^t}{I_C^{t-1}} \times VA_{EA}^{t-1}$$

where VA_{EA}^{t} is the current period value aggregate for the elementary aggregate in period *t*, VA_{EA}^{t-1} is the previous period value aggregate, and I_C^t and I_C^{t-1} are respectively the current and previous period C-indexes for the elementary aggregate.

10.25 The price updated value aggregate is then used to determine the current period P-index for the elementary aggregate.

$$I_{P,EA}^{t} = \frac{VA_{EA}^{t}}{VA_{EA}^{LINK}} \times I_{P,EA}^{LINK}$$

where $I_{P,EA}^{t}$ is the current period P-index for the elementary aggregate in period *t*, VA_{EA}^{LINK} is the link period value aggregate for the elementary aggregate and $I_{P,EA}^{LINK}$ is the link period P-index for the elementary aggregate

10.26 Once the current period value aggregates for all elementary aggregates are determined, the current period value aggregates for all higher level components of the index structure are calculated by summing the price updated value aggregates of their components.

10.27 Current period price indexes for any component in the aggregation structure are then calculated by price updating the link period P-index for the component. That is, for any component, the current period P-index is given by:

$$I_P^t = \frac{VA^t}{VA^{LINK}} \times I_P^{LINK}$$

where I_P^t is the current period P-index in period *t*, VA^t is the current period value aggregate for the component, VA^{LINK} is the link period value aggregate for the component and I_P^{LINK} is the link period P-index for the component of the index (or aggregation) structure.

Points contribution and points change

10.28 Points contributions are also calculated using the value aggregates. In any period, the points contribution of a component to the top level (or 'root' of the index) is calculated by multiplying the root index number for the period by the value aggregate for the component in that period and dividing by the root value aggregate for that period. This can be stated algebraically as:

$$PC_i^t = I_{P,ROOT}^t \times \frac{VA_i^t}{VA_{ROOT}^t}$$

where PC_i^t is the points contribution for component *i* in period *t*, $I_{P,ROOT}^t$ is the P-index for root in period *t*, VA_i^t is the value aggregate for component *i* in period *t* and VA_{ROOT}^t is the value aggregate for the root of the index in period *t*.

10.29 Changes in points contribution for a component of a price index give an assessment of the component's contribution to net price change. However, such a comparison is limited to periods between linking of price indexes. Comparisons of a component's contribution to the index that cross a link period are comparing contributions on different weighting bases and therefore do not measure the contribution to net price change; any attempt at such comparison will confound change of weight with change of price.

10.30 Calculation of upper level price indexes is illustrated in Table 10.3. This table shows an input price index where products are classified by source (domestic and imported) and then by type of product.

TABLE 10.3 EXAMPLE OF AGGREGATION OF A PRICE INDEX

	Value aggregates		P-Index	
	Link Period	Period 1	Link Period	Period 1
Materials used	**105,479**	**133,610**	**105.6**	**133.7**
Imports	**41,198**	**44,909**	**110.0**	**119.9**
Textile, clothing, footwear	5,682	5,750	109.3	110.6
Wood and paper products	4,654	4,753	100.3	102.4
Chemicals, plastic, rubber	11,127	10,742	97.1	93.7
Fabricated products	16,099	17,885	107.8	119.7
Agricultural products	562	548	119.9	116.9
Mining products	3,074	5,230	103.2	175.6
Domestic	**64,281**	**88,701**	**104.7**	**144.5**
Agricultural products	28,036	38,530	107.9	148.3
Electricity and gas	11,169	12,289	110.0	121.0
Forestry and logging	1,472	1,738	113.0	133.4
Mining products	23,604	36,144	102.6	157.0

	Elementary Aggregate C-Index		% movement
	Period 1	Period 2	
Materials used			
Imports			
Textile, clothing, footwear	110.6	109.7	-0.8%
Wood and paper products	102.4	106.3	3.8%
Chemicals, plastic, rubber	93.7	96.2	2.7%
Fabricated products	119.7	120.7	0.8%
Agricultural products	116.9	121.8	4.2%
Mining products	175.6	259.1	47.6%
Domestic			
Agricultural products	148.3	148.1	-0.1%
Electricity and gas	121.0	125.6	3.8%
Forestry and logging	133.4	142.4	6.7%
Mining products	157.0	223.9	42.6%

	Price Updated Value aggregate (Period 2)	*P-Index (Period 2)*
Materials used	***152,625***	***152.7***
Imports	***47,989***	***128.1***
Textile, clothing, footwear	5,704	***109.7***
Wood and paper products	4,934	***106.3***
Chemicals, plastic, rubber	11,029	***96.2***
Fabricated products	18,035	***120.7***
Agricultural products	571	***121.8***
Mining products	7,717	***259.1***
Domestic	***104,635***	***170.5***
Agricultural products	38,478	***148.1***
Electricity and gas	12,756	***125.6***
Forestry and logging	1,856	***142.4***
Mining products	51,546	***224.0***

SECONDARY INDEXES

10.31 A key philosophy of price index design for the producer and international trade price indexes is to re-use components to maximise the utility of collected data (this philosophy is discussed in more detail in Chapter 8). One mechanism that helps achieve this aim is through construction of *secondary indexes*. The preceding sections have described how elementary aggregate price indexes can be combined to produce higher level indexes. The particular combination of elementary aggregates is determined by the underlying classification of the price index (as noted in Chapter 5).

10.32 However, a given elementary aggregate may be classified in multiple ways. Reclassifying elementary aggregates according to a different aggregation structure results in a secondary index. The relationship between the original primary source index and the secondary index is marked by two important features. First, the elementary aggregates for the secondary index are the same as those in the source index, having the same P-indexes and value aggregate data. Second, the source index and the secondary index are identical at the root or top level of the index. The indexes only differ at the intermediate levels (between the root and the elementary aggregates), since a secondary index is defined through the different aggregation structure.

10.33 Frequent use of secondary indexes occurs within the international trade price indexes, with classification by both SITC and BEC (further details of these classifications are provided in Chapter 5).

10.34 An example of a secondary index is provided in Table 10.4. This example uses a reclassification of the elementary aggregates presented in Table 10.3, with emphasis on type of product rather than the domestic or imported split.

TABLE 10.4 EXAMPLE OF A SECONDARY PRICE INDEX

	Value aggregates		P-Index	
	Link Period	Period 2	Link Period	Period 2
Materials used	105,479	152,625	105.6	**152.7**
Agricultural products	**28,597**	**39,048**	**108.1**	**147.6**
Domestic	28,036	38,478	107.9	**148.1**
Imported	562	571	119.9	**121.8**
Chemicals, plastic, rubber	**11,127**	**11,029**	**97.1**	**96.2**
Imported	11,127	11,029	97.1	**96.2**
Electricity and gas	**11,169**	**12,756**	**110.0**	**125.6**
Domestic	11,169	12,756	110.0	**125.6**
Fabricated products	**16,099**	**18,035**	**107.8**	**120.7**
Imported	16,099	18,035	107.8	**120.7**
Forestry and logging	**1,472**	**1,856**	**113.0**	**142.4**
Domestic	1,472	1,856	113.0	**142.4**
Mining Products	**26,679**	**59,263**	**102.6**	**228.0**
Domestic	23,604	51,546	102.6	**224.0**
Imported	3,074	7,717	103.2	**259.1**
Textile, clothing, footwear	**5,682**	**5,704**	**109.3**	**109.7**
Imported	5,682	5,704	109.3	**109.7**
Wood and paper products	**4,654**	**4,934**	**100.3**	**106.3**
Imported	4,654	4,934	100.3	**106.3**

TERTIARY INDEXES

10.35 The key feature of secondary indexes is that they rearrange the existing basic building blocks of the price index along a different compilation structure, and in doing so retain both the price movements and underlying value aggregates of the elementary aggregates.

10.36 It is also possible to construct *tertiary indexes*, where price movements are retained but an entirely new weighting pattern is applied. In this case the resulting tertiary index has consistent price movements at the elementary aggregate level, but results in a different price movement at the top or root of the index. This device is a powerful analytic tool that allows further re-use of price samples. The Stage of Production (SOP) producer price indexes are examples of tertiary price indexes, where price samples from other indexes (including the import price index, the service industry price indexes, and both the input and output price indexes for the manufacturing industries) are reused to provide a broader measure of price change.

CHAPTER 11 MAINTAINING SAMPLES OF PRODUCTS

BIASES IN PRICE INDEXES

11.1 A price index may be described as biased if it produces estimates that depart from the 'true' or 'correct' measure. Price indexes are generally susceptible to the following types of bias:

1. elementary index bias (or "within EA bias"), which results from the use of inappropriate formulae for compiling index numbers at the elementary aggregate level
2. substitution bias (or "between component bias"), arising from using formulas at levels above the elementary aggregates which do not allow for substitution in response to changes in relative prices
3. biases that arise because the transactions in the elementary aggregates are generally fixed to specific suppliers and/or specific customers:
    - for input price indexes, outlet or supplier substitution bias arises when purchasers shift from higher cost suppliers to lower cost suppliers for the same product
    - for output price indexes, customer substitution bias arises when producers practise price discrimination and shift the sales from customers with lower prices to customers who pay higher prices for the same product
4. quality adjustment bias, which arises from inadequate adjustment for quality changes
5. new goods bias, which arises largely from the failure to include new goods when first introduced into the market.

11.2 While it is almost impossible to eliminate these sources of bias, the ABS producer and international trade indexes adopt a program of sample review and maintenance to minimise each of the sources of bias. The current program is known as the *Bias Avoidance and Reduction program* (BAR). This chapter describes how the BAR program and other mechanisms help protect the price indexes from these known sources of bias.

LIMITATIONS OF FIXED BASKET PRICE INDEXES

11.3 The development of a price index by considering a fixed basket has several advantages. First, the concept is relatively easy to understand: price the exact same basket of goods and services at two different periods, and compare the total cost of the basket. Second, and perhaps more importantly, by fixing both the items within the basket and their respective quantities, the resulting values provide a measure of pure price change that is free from issues such as compositional changes.

11.4 In application this process is more complex than the basket analogy would immediately suggest. First, the ABS needs to undertake a sample survey rather than view every transaction of every item and so the issue of combining items according to their value share is more involved. Value shares must be calculated not only from the perspective of the items in question but also in terms of the other items and transactions the sample now represents.

11.5 Second, producers in the real world frequently:

- change the items they produce, such as introducing new models and discontinuing old lines;
- change the quantities of the items they produce, producing more of some items and less of others; and
- change the types of customer they deal with.

11.6 Similar observations can be made regarding the materials that producers consume as part of the production process.

11.7 Third, producers themselves also appear and disappear from the marketplace.

11.8 Fourth, even when we observe all producers and all transactions we find that they frequently make changes to the characteristics of the items they produce, offering new features, new options or new conditions of sale.

11.9 These issues are ones of ensuring that price samples and resulting indexes are representative. The "chain of representivity" as discussed in Chapter 7 can only work when sufficient value data are obtained which will allow us to weight the sample back to the population. Value data are revenue data for an output index and expenditure data for an input index. It is therefore necessary to obtain value data for providers at both a broad level and at the detailed specification level.

11.10 Consequently, although the ABS uses a fixed basket to construct price indexes, in practice it finds the actual transactions occurring in the market place are frequently changing. This observation results in a dilemma, namely how can a price index use a fixed basket to measure pure price change and at the same time remain both contemporary and representative of the market as a whole?

ABS STRATEGY FOR REVIEWING AND MAINTAINING PRICE INDEXES

11.11 The aggregation structure for a price index was discussed in Chapter 6, with an illustrative example provided in Figure 6.1. In describing the aggregation structure, and respective weighting sources, it was useful to consider the different levels of the price index in turn. Summarising the discussion in Chapter 6, we saw that the index could be thought of as

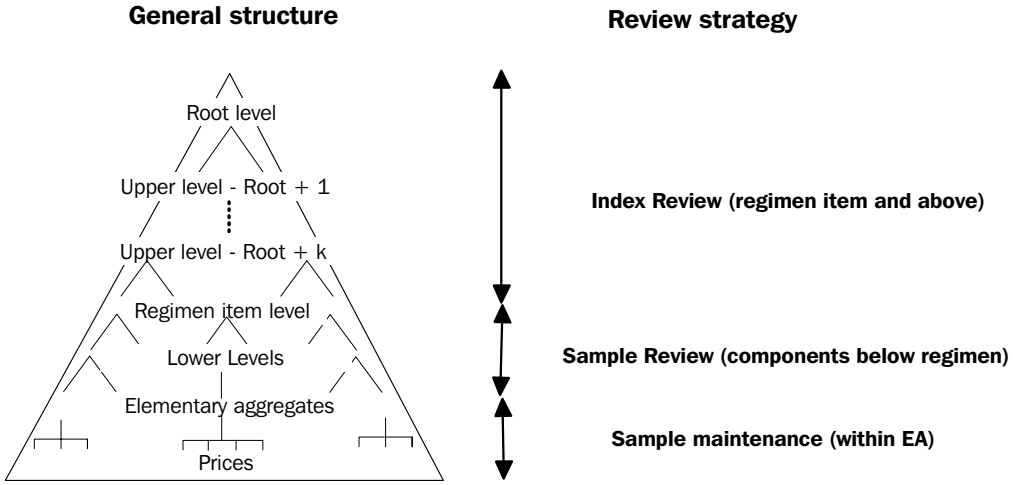
- an index root
- upper level price indexes, between the regimen item and the index root
- regimen level price indexes
- lower level price indexes, below the regimen item level and the elementary aggregates
- elementary aggregate price indexes.

This concept is illustrated again in Figure 11.1.

Index reviews

11.12 This division of the price index according to the regimen item level is at the centre of the ABS strategy for reviewing and maintaining price samples. The structure and weighting data remain fixed for the price index at the regimen item and above. This includes components at the regimen item level, all the upper level price indexes, and the root or top of the price index. The application of the term "fixed basket" here means that all levels at or above the regimen item level remain fixed, until such time as the entire index structure is reviewed in a process known as an *index review*.

FIGURE 11.1 AGGREGATION STRUCTURE AND REVIEW STRATEGIES



11.13 An index review is a periodic reassessment of the "fixed basket", resulting in a change to the items represented by the basket, their relative importance as reflected by their value aggregates, and the way the products relate to each other through classifications and the aggregation structure. Such a review is usually undertaken regularly although infrequently, since it can be a costly and complex exercise. Index reviews are typically undertaken when new weighting data become available, and when such data indicate significant shifts in patterns of revenue or expenditure. Changes to standard classifications can also trigger the need for a review, although such a review still depends upon the availability of value data categorised under the new classification.

11.14 In addition to reviewing and reweighting the entire index structure, the other use of index reviews is to allow the introduction of new products. As discussed in Chapter 9, new products present challenges regarding identification and price measurement, but the other obstacle they pose is that they are not defined anywhere in the "fixed basket". An index review is a mechanism whereby new products can be introduced into the price basket, since this is the process by which new classifications are introduced and where all components of the price index are reweighted.

11.15 An index review is also the only mechanism whereby a price index can expand its scope to include additional sectors of the economy.

11.16 Although index reviews are the only activity that changes the weight or structure of an index down to regimen item, they are frequently undertaken simultaneously with *sample reviews*.

Sample reviews

11.17 Most of the producer and international trade price indexes have detailed aggregation structures below the fixed level of the regimen item, down to the elementary aggregate (but not including the specifications within an EA). These structures often represent different end uses of a generic product type. For example, the 4-digit ANZSIC class is the regimen item level in the Transport (Freight) and Storage Services Producer Price Index. One such class is 6110 Road Freight. The structure below this regimen item includes components that represent transportation of different types of products (such as live animals or refrigerated goods). Other structures represent more detailed disaggregation of a product type according to physical characteristics. An example here would be the class 2812 Beer and Malt Manufacturing in the Price Index of Articles

Produced by the Manufacturing Industries. Below this level, the structure includes components for canned beer, bottled beer and beer sold in bulk.

11.18 A sample review is a review of any single index structure below the regimen item level. Such a review can introduce new components, change index structures, split or combine price samples, and incorporate new weights for lower level components. Any new value aggregate data introduced must still sum to the value aggregate at the regimen item level. Note that whilst a sample review can change the value aggregate associated with an elementary aggregate, the sample review activity itself does not change specifications within an elementary aggregate (see sample maintenance below).

11.19 The key benefit of the sample review strategy is that since the review is done below the regimen item level, it can be done in isolation from other parts of the price indexes. Classification, value data and market behaviour need to be determined for only the "branch of the index" being reviewed. Continuing the examples from above, a review of Road Freight could be undertaken without reviewing Sea Freight, Air Freight nor any of the other components of the Transport and Storage price index. Beer and Malt Manufacturing can be reviewed without simultaneously reviewing Bread Manufacturing, nor any other component of the Articles Produced by Manufacturing price index. This means that sample reviews can be done more often, for more products across more price indexes, when compared to the scale and frequency of an index review.

11.20 The sample review strategy allows reviewing resources to be targeted to those sectors of the economy that are undergoing rapid transformation, in terms of what is being produced, how it is being produced, and how it is being sold. This allows indexes to be updated to adequately represent shifts in market share, changes in production function, and changes in both customer types and suppliers.

11.21 Sample reviews also allow periodic reassessment of industry *pricing mechanisms* – the manner in which producers charge for their goods and services – so that the pricing methods detailed in product specifications adequately capture the behaviour in the marketplace. Sample reviews also allow reassessment of different pricing methods to reflect emerging international best practice, or to adopt consistently new techniques to price to constant quality.

11.22 Like index reviews, sample reviews can be used to incorporate new products. However such activity may be limited within a sample review depending upon how revolutionary is the new product. A new product can be introduced as part of a sample review if it is different enough that it is not considered an evolution of an existing product, but can be still considered a product of a broad general type covered by an existing regimen item. Otherwise, such a product would be incorporated into a price index via an index review.

11.23 Sample reviews are sometimes undertaken as part of an index review, although they are frequently undertaken independently. Furthermore, sample reviews are often undertaken simultaneously with *sample maintenance*.

Sample maintenance

11.24 Sample reviews as described above can update the value aggregate associated with an elementary aggregate, but such activity does not change the specifications being priced from quarter to quarter. Updating specifications, adding different items, removing transactions that are no longer representative, or changing the micro-index weights are all part of the within-elementary aggregate activity known as sample maintenance.

11.25 Sample maintenance is an activity that is undertaken on a continuous basis, most often as data are received from respondents selected in the *Survey of Producer Prices*. Such activity changes the contents of the smallest "price baskets" that contribute to the producer and international trade price indexes. Although sample maintenance can change the within-EA micro-index weights, it does not change the value aggregate associated with an elementary aggregate. Another way of considering this is that sample maintenance is an activity that gives a better measure of the price changes for an elementary aggregate, whilst sample reviews (and index reviews) are changes to the way the elementary aggregates are combined to form upper level price indexes.

11.26 Sample maintenance is also the mechanism whereby new respondents are introduced to the price sample, or existing respondents leave.

Reviews versus maintenance

11.27 Sample (and index) reviews differ from sample maintenance in that they are both "above EA" type activities, whereas maintenance is concerned with specifications within an elementary aggregate. However the two types of activities differ in another important aspect, namely that sample and index reviews are a proactive step, initiated by the ABS to update the price basket to reflect new or emerging issues across broad sectors of the economy. On the other hand sample maintenance is a reactive activity, whereby the ABS reacts to changes identified through interactions with selected respondents.

A PROGRAM FOR AVOIDING AND REDUCING PRICE INDEX BIASES

11.28 The aims of the Bias Avoidance and Reduction program are:

1. To respond, through sample maintenance, to changes to product specifications identified through the quarterly *Survey of Producer Prices;*
2. To detect, through the annual *Producer Price Indexes Review Form,* sectors of the economy that have experienced significant changes in:
    - relative values (expenditure or revenue) of selected products;
    - types of products purchased and sold;
    - conditions of sale, including discounting practices;
    - types of customers (or suppliers);
    - pricing mechanisms employed by businesses;
    - operations of providers as business expands, contracts or diversifies; or
    - their product lives through the emergence of new products;
3. To prioritise the targeting of resources, by considering the impact and importance of changes identified through the *Producer Price Indexes Review Form;*

4. To undertake sample reviews and, where appropriate, index reviews so that the price indexes are representative of price change activity occurring within the economy.

Producer Price Indexes Review Form

11.29 The aim of the annual *Producer Price Indexes Review Form* is to identify changes in production activity, purchasing activity or marketing practices. Rather than provide detailed specification level information for each respondent, the purpose of this questionnaire is to provide an aggregate measure of changes by product type across all respondents. In this manner, the questionnaire highlights areas where the "fixed basket" is becoming non-contemporary, or areas where substantial changes are occurring in the marketplace. Identifying such areas allows targeting of individual product groups for sample review.

Review outcome

11.30 A sample review (or index review) begins with an assessment of known or likely issues affecting the construction of a price index for the selected product. Such issues may be associated with inherent difficulties associated with pricing the particular product, or may be issues identified from the review questionnaire. Such issues typically include the need to update value data, potential changes to index structures to represent contemporary end use and price behaviour, and incorporation of pricing methods to best capture prices from the current pricing mechanisms of the industry. Pricing to constant quality is an issue that is present in each review. Identifying the relevant issues allows a clear articulation of the intended outcome of the review.

Information gathering

11.31 Following identification of the review outcome, most reviews proceed along an intensive information-gathering phase. It includes an assessment of current ABS methods, review of international literature regarding price indexes for the products concerned, as well as consultation with a range of users of the price index data. A key aspect to this phase is identifying and manipulating the data to be used as value aggregates for index components. This information-gathering phase is important as it identifies areas with potential problems with respect to the intended review outcomes.

Personal visits

11.32 Most sample reviews are sufficiently complex that they require first-hand knowledge regarding both the production and use of the products targeted for review. This knowledge is obtained through a series of personal visits to businesses engaged in either the production or use of the products in question. Visits are also made to key regulatory authorities and industry associations. The purpose of these visits is to gather more information regarding pricing mechanisms, to get more detailed data to use in weighting, particularly micro-index weighting, and to identify any difficulties that current and potentially new respondents may have in pricing the particular products. This activity can identify the emergence of new trends or issues, as well as opportunities arising in, or competition from, international markets. One other key aspect of this phase is that it allows identification of issues that are likely to affect current and future price movements, so that reported prices can be more readily validated in the quarterly compilation of producer and international trade price indexes.

11.33 The personal visit phase can also involve aspects of sample maintenance as specifications for existing respondents are verified and updated where necessary.

Data confrontation and analysis: decision making

11.34 Following the personal visits phase it is necessary to confront all the information gathered to date, from respondents, industry experts and from the initial research activities. This activity results in a decision regarding the specific form the new index structure will take, as well as deciding upon appropriate pricing methods. These decisions reflect not only the information gathered to date but also the intended outcome of the review.

11.35 In some cases this crucial phase involves several iterations, resulting in further contact with respondents and other stakeholders. Careful judgement is required here regarding balancing provider burden against the outcomes of the review.

New price indexes and other enrolments

11.36 When a new component of a price index is developed (or when existing samples are in need of replenishing as part of maintenance), it is necessary for the ABS to enrol new respondents into the *Survey of Producer Prices*. Given the range of concepts that need to be discussed, the number of different stakeholders within a provider's organisational structure that might be involved, and the importance of collecting value data (revenue or expenditure), the option preferred by the ABS is to meet with new respondents for a personal interview. The aim of the enrolment interview is

1. To ensure the cooperation of new respondents;
2. To ensure that all respondents understand the importance of
    - providing prices on the correct pricing basis;
    - pricing like with like from period to period;
    - reporting any changes in characteristics of products selected in the sample;
    - reporting the emergence of new products
3. To ensure selected specifications, and hence price baskets, are contemporary, and reflect the activities actually undertaken in the economy;
4. To ensure that the items selected in the sample are representative and that sufficient value data (that is, revenue data or expenditure data) are collected to allow compilation of price indexes.

11.37 In other cases, interviews are undertaken to clarify complex issues with existing respondents.

Implementation and systems issues

11.38 Once a new structure has been determined, together with weights and appropriate pricing methods, the final stage is implementation. This involves incorporating the new index structure into the existing structure within the ABS system for producer and international trade price indexes. Such activity is undertaken through a process of *linking*, which is described in detail in Chapter 12 (Reweighting and linking indexes).

MITIGATION OF BIAS

11.39 The introduction to this chapter outlined the types of bias to which price indexes are susceptible. In the paragraphs above, a program of sample review and maintenance was outlined. This section shows how such a program, together with other activities, protects the producer and international trade price indexes from bias.

Choice of index formula and elementary index bias

11.40 The *International Producer Price Index Manual* indicates that price indexes that use quantity or value data for specification weights are preferable to equi-weighted indexes[42]. The majority of elementary aggregates within the producer and international trade price index use the price relative form of the Laspeyres price index, with differentially weighted specifications. As discussed in Chapter 6, the value data to create such weights are generally obtained through the cooperation of respondents. This practice provides some protection against elementary index bias, but weighting alone is generally not sufficient to entirely mitigate against the impact of substitution.

11.41 Substitution is the behaviour exhibited by producers, both in the sale and in the purchase of goods. To illustrate these phenomena we will consider two economic models, one for an output price index and one for an input price index.

11.42 For the **output price index**, we will consider an illustrative model where producers have fixed inputs. Under this model, it is assumed producers aim to sell more higher-priced items as opposed to lower-priced items. This behaviour is revenue maximising (and for fixed inputs revenue maximising is profit maximising, an expected behaviour of producers). A fixed basket price index measuring price changes for this economic model would exhibit bias. This bias arises because the quantities in the basket are fixed, but the behaviour exhibited in the marketplace has producers selling more of the expensive products – that is, quantities change. The failure of the price index to account for this shift is the extent to which the index is biased.

11.43 For the **input price index**, we will consider an illustrative model where producers have fixed outputs. Under this model, it is assumed producers aim to purchase more lower-priced intermediate inputs as opposed to higher-priced products. This behaviour is cost minimising (and for fixed outputs, cost minimising is profit maximising, an expected behaviour of producers). A fixed basket price index measuring price changes for this economic model would exhibit bias. This bias arises because the quantities in the basket are fixed, but the behaviour exhibited in the marketplace has producers purchasing more of the cheaper products – that is, quantities change. The failure of the price index to account for this shift is the extent to which the index is biased.

11.44 Elementary index bias arises from substitution within the elementary aggregate price indexes. Since the elementary aggregates themselves are tightly defined in terms of physical characteristics and end use, such substitution is towards a very similar product being sold at a different price.

11.45 There are two strategies that can be adopted to further protect these price indexes from elementary aggregate bias. The first of these strategies is to frequently update the weights in the basket. This can be achieved through a regular program of sample reviews, as described in the previous section.

11.46 The second strategy that can be employed is to adopt a different price index formula that better reflects such behaviour. The Jevons, or geometric mean, price index is a formula that is unbiased if the price

[42] Paragraph 9.11 from the *PPI Manual*: In many cases, the explicit revenue weights are not available to calculate the price indices for elementary aggregates. Whenever possible, however, weights should be used that reflect the relative importance of the sampled products, even if the weights are only approximate

behaviour is unit elastic[43]. This approach is used in the producer and international trade price indexes when markets are evolving very quickly, or detailed level value data is unavailable in a timely manner. Such a strategy is often adopted only in those cases where the price behaviour is reasonably matched by the properties of the index formula[44], a condition which is not universally applicable for every product.

"Between Component" substitution bias and Sample Reviews

11.47 The preceding section described the phenomenon of substitution, as producers change what they produce (or what they purchase) in response to price changes.

11.48 Elementary index bias arises from substitution between similar products within an elementary aggregate. In the marketplace, however, producers make other types of substitution. For example, producers may substitute between natural and synthetic fibres, between steel and ceramic parts for machinery, between wooden and aluminium window frames and so forth. This sort of substitution can occur in response to price changes or from changes in taste. In terms of a price index, such substitution would occur outside elementary aggregates. This substitution again results in a quantity shift, and the failure of a fixed basket price index to account for this shift is again the extent to which the index is biased.

11.49 The sample and index review processes described above result in an updated "price basket" and are the key mechanism by which the ABS mitigates "between component" substitution bias. The *Producer Price Index Review Form* provides an annual picture of change across all products in the producer and international trade price indexes, and assessment of this change allows resources to be targeted to those areas that are most susceptible to this type of bias.

Outlet/Customer biases and personal visits

11.50 Outlet or supplier substitution bias arises in input price indexes that use a fixed sample basket of outlets or suppliers. Purchasers often change suppliers for some or all of their purchases, particularly if the suppliers enter the market offering substantially discounted prices. If the price index does not detect the shift to new lower priced suppliers (and these are not included in the price index), the resulting price index is upwardly biased. A similar analogy exists for output price indexes regarding change in customers.

11.51 The bias that arises due to change in supplier or customer is mitigated in several ways in the producer and international trade price indexes. For the price index of materials used in manufacturing industries (an input price index), prices are generally observed by surveying the purchaser. If the purchaser changes supplier (and pays a lower price) then this is detected in the quarterly *Survey of Producer Prices* and, after being adjusted for any appropriate quality changes, appears as a movement in the price index. Similarly, for the output price indexes, prices are generally observed by surveying the producer, and any price rises resulting from changes to new customers will similarly appear in the price indexes. Much but not all of the risk of bias is mitigated by this approach to sample selection.

---

[43] "Unit elasticity" means that quantities respond proportionally to changes in prices, such that value remains constant. For example, if 5 units of a product are sold at \$4.00 each, the value is $5 \times \$4 = \$20$. If a price rise of 25% to \$5.00 sees a commensurate price fall of 20% in the units sold, or 1 unit, so that 4 units are exchanged, the total value is then $4 \times \$5 = \$20$. In these circumstances, the total value is constant and the product is exhibiting *unit elasticity*.

[44] As per the "Choosing an index number formula" section in chapter 4, other factors aside from elasticity are also useful in determining suitability of index formulae.

11.52 There are two situations where potential biases can arise. The first is in the price index of materials used in house building. This input price index measures prices paid by builders by surveying the businesses supplying the products rather than the builders themselves. This practice is far more practical and efficient than attempting to survey a sample of individual builders. However, one drawback to this approach is that this price index becomes susceptible to outlet (supplier) substitution bias. For example, if builders begin purchasing from a chain wholesaler outside the sample that offers materials at substantial discount, the price index would exhibit an upward bias.

11.53 The second case where biases arise is where counterpart pricing is utilised. As described in Chapter 5, 'counterpart pricing' is a term to reflect using a transaction price observed on a pricing basis that differs from the conceptual base of the price index. Examples of such pricing occur in some instances within the manufacturing price indexes, where in some instances suppliers provide the prices they receive to be incorporated into the input price index. Aside from the appropriateness of the underlying assumptions regarding distributive trade margins, this practice also has the potential to introduce outlet substitution bias, since it does not always detect when purchasers change their point of supply (at lower prices). A similar issue arises when purchasers provide prices for incorporation into an output index (although in this case the bias is more suitably termed 'customer substitution').

11.54 Regardless of where such practices occur, the potential for bias is mitigated through the *PPI Review Form* and subsequent index and sample reviews. As detailed above, such reviews measure expenditure and revenue for different products and involve consultation, both with industry bodies and producers themselves. Regular activity of this kind detects changes in sales or purchasing markets and allows price indexes to be updated to reflect the shift in the quantities and revenue/expenditure.

Quality adjustment bias

11.55 Failure to adequately adjust prices to account for changes to quality results in volume changes being inappropriately measured as price changes, with a resulting bias in the price index. Pricing to constant quality, and the mechanisms by which quality adjustments are made, are described in detail in Chapter 9.

11.56 With a set of tools to enable quality adjustments to be made, the remaining risk for quality adjustment bias occurs through failing to detect changes in products or conditions of sale. This risk is mitigated through forms design of the *Survey of Producer Prices*, and through the initial enrolment process for selected respondents. As described above, a key feature of the enrolment process is to convince selected businesses of the importance of pricing to constant quality. The detailed specification of products together with their condition of sale is also protection against quality change, since it allows respondents to inform directly the ABS of variations in characteristics.

New products

11.57 The issues surrounding new products were discussed in Chapter 9, which noted that the bias arising from the introduction of new goods is exacerbated through delays in introducing such products to the price basket. In the preceding sections both sample reviews and index reviews were described as opportunities to incorporate new products into the price baskets. If such reviews are done regularly, the risk from the emergence of new products is substantially mitigated. Index and sample reviews provide further protection against new product bias in that they allow an assessment of market trends and conditions.

SUMMARY

11.58 This chapter began with a description of biases in price indexes, and then followed with a detailed description of a program for reviewing and maintaining price samples. A description of how such reviews are undertaken, and the techniques and tools used, was also provided. Finally, this chapter showed how such a review program, together with other mechanisms, protects the producer and international trade price indexes against the aforementioned biases.

CHAPTER 11 APPENDIX PROVIDER LOAD

A11.1 The principal objective of the ABS in respect of business provider load is to impose the lowest load possible while meeting its obligations to provide Government and the community with a high quality official statistical service.

A11.2 Effective management of business provider load:

- lowers the real costs to businesses in providing statistical information;
- minimises the need to resort to compulsory powers;
- improves the perception businesses and governments have of the ABS and its functions;
- lowers the costs to the ABS involved in obtaining statistical information; and
- improves the quality and timeliness of the statistical information provided to the ABS.

A11.3 A primary responsibility of the Australian Statistician, as set out in the *ABS Act (1975)*, is to ensure that particular regard is given to "the avoidance of duplication in the collection by official bodies of information for statistical purposes … [and] … the maximum possible utilization, for statistical purposes, of information … available to official bodies" in order to minimise reporting load.

Provider load as it arises in the PPI

A11.4 In compiling the producer and international trade price indexes, provider load occurs in the following circumstances:

- during enrolment (or initialisation) in the survey through the sample review and maintenance program;
- through filling out a quarterly *Survey of Producer Prices* form;
- in answering queries triggered during input editing of the survey form;
- in answering queries triggered during output editing of the survey form;
- during the program of annual contact via the PPI Review Form to ensure the basket is both contemporary and representative;
- during a personal visit triggered by sample review activity;
- during follow-up activities that may arise as a result of sample reviews.

A11.5 Whilst output editing queries are a result of confronting several sources of data and cannot be controlled, the other types of burden can be considered as a function of two factors:

- the number of Survey of Producer Prices forms that a provider gets determines the number of times the provider is contacted in the annual program, as well as the number of times the provider can be contacted regarding input edit queries each quarter; and

- the number of specifications collected will determine how complex the quarterly survey form is to complete, and also give some indication as to the length of any interviews undertaken as part of review contact.

A11.6 Given the extra burden placed on providers through multiple visits (each of which necessitates explaining the function of the ABS, the purpose of the survey, the authority under which the data are collected and how the data are to be used), and the extra burden triggered during input editing, it is desirable, as far as is practically possible, to have one form per respondent.

A11.7 This is an intentional trade-off: reducing the instance of multiple contacts with all providers (and hence, avoiding duplicating effort) in exchange for slightly longer annual contact with some respondents.

CHAPTER 12 RE-REFERENCING AND LINKING PRICE INDEXES

12.1 The producer and international trade price indexes have been described as fixed baskets of goods and services. These baskets are periodically reviewed, as discussed in Chapter 11, to account for substitution in the marketplace, the evolution of pricing mechanisms practiced by different businesses and the emergence of new products. The discussion of sample review and maintenance in Chapter 11 indicated the rationale for such reviews, the ABS approach to keeping a basket simultaneously both fixed and contemporary, and the sorts of activities and research undertaken during reviews. This chapter describes how the new weights and index structures are incorporated into an existing price index via the process known as *chain linking*, which is also described as *rebasing* or *reweighting*. This chapter will also discuss *re-referencing*.

REFERENCE PERIOD

12.2 In describing re-referencing it is necessary to begin with the concept of a reference period. Within the context of price indexes, three kinds of reference period may be distinguished for PPI purposes:

1. *Weight reference period*. The period covered by the revenue or expenditure data used to calculate the underlying value aggregates (or weights). Usually, the weight reference period is a financial year, although in some instances such as for house building or exports the reference period spans more than one year. Multi-year weight reference periods are used in those instances where a single year's data may not be adequate, either because of unusual economic conditions (such as introduction of a new tax system), volatility observed in the marketplace or insufficient sample sizes from survey data.

2. *Price reference period*. The period whose prices are used as denominators in the elementary index calculation. This period will vary from component to component and may be updated when sample maintenance is undertaken.

3. *Index reference period*. The period for which the index is set to 100.0. In ABS publications this is referred to as the "reference base of the index".

12.3 The three periods are generally different. For example, the price index of property and business services has 1996-97 as the weight reference year, 1998-99 as the index reference period where the index is equal to 100.0, and has price reference periods in different elementary aggregates ranging from 1999-2000 through to 2003-04. The expression 'base period' is sometimes used to mean any of the three reference periods and in this application can be quite ambiguous.

12.4 Re-referencing is the process of changing the index reference year, and so is also described as "updating the 100.0 year".

INCORPORATING A REVIEW INTO AN INDEX

12.5 The process of sample and index reviews was described in chapter 11, which showed that reviews result in a new aggregation structure, with new weights for components. Weights, and their sources, were discussed in detail in Chapter 6, which showed that value data from sources such as national accounts input-output tables were used to construct value aggregates. To incorporate the newly weighted structure into an existing price index, three steps must be undertaken: a link period must be chosen, value data must be price updated to the link period, and the new structure chained onto the existing price index.

The link period

12.6 The link period for the producer and international trade price indexes is a quarter in which the index is calculated on both the old and new weighting structures. The choice of which period to link through is based on availability and timing of data, internal resource constraints, and economic behaviour. Since the process of linking limits some analyses, it is highly desirable that the link period is one that is expected to exhibit "normal" behaviour, and as such will be chosen not to coincide with changes to tax legislation or other significant regulatory amendments.

12.7 The June quarter is frequently chosen as the link period for these reasons as this choice allows detailed comparisons of complete financial years without having to account for the link. In particular the international trade price indexes are chain linked every year through the June quarter.

Price updating value data

12.8 The derivation of weights was discussed in detail in Chapter 6, which noted that weights are *price updated* to account for price changes between the weighting reference period and the link period. Weighting data usually comes from an annual data source, and in some cases can span more than one year. The link period, however, is always chosen to be a single quarter, and is always a period subsequent to the weighting reference period. Although only observed in aggregate, the value data can be considered as being composed of the product of prices and quantities from the weighting reference period. To be included as weights in a price index, these data must be converted to prices from the link period and quantities from the weighting period – it is the quantities after all which are fixed in the basket of goods and services.

12.9 Price updating value data is achieved by multiplying the weighting data by a measure of price change between the weighting period and the link period. This updating occurs at the elementary aggregate level, with the resulting upper level value aggregates determined through aggregating the price updated components along the new index structure.

12.10 The measure of price change between the weighting period and the link period is determined by the ratio of the price indexes for the two periods; here the price indexes are on the existing index structure. In the usual case where the weighting reference period is longer than a quarter, the price index for the weighting period is determined as the average of the quarterly price indexes that the weighting period spans. The ratio takes the form of link period index divided by weighting period index.

12.11 The resulting link period value aggregate is then expressed in terms of prices from the link period and quantities from the weight reference period.

Chain linking through a link period

12.12 Chain linking can best be illustrated by means of an example. In this example we will consider a price index at period k, with the index constructed from weights introduced in the base period 0. Using the terminology from Chapter 10 (Compilation), we would express the price index at period k as

$$I^k = \frac{VA^k_{OLD}}{VA^0_{OLD}} \times I^0$$

If we choose period *k* as the link period, any future period price indexes will make comparisons back to the link period, and be scaled by the link period index I^k. Note that any such comparisons will use the same price index I^k but use a value aggregate calculated on the new weighting basis. If we consider *t*, some period after *k*, a price index measuring the average price change from period 0 to period *t* is given by

$$I^t = \frac{VA^t_{NEW}}{VA^k_{NEW}} \times I^k$$

New components

12.13 The introduction of new elementary aggregates (or any other component) into a price index during a sample review follows the same general principles, with one key exception. Any new elementary aggregate will not have a price index for the link period under the old structure. This poses two problems. First, what should the elementary aggregate price index be for the link period under the new structure, and second, how should the value data underlying the weights be price updated from the weighting reference period to the link period?

12.14 In determining the link period price index, there are two options available.

1. The first is to assume no information regarding the historic behaviour of the new elementary aggregate, and set the price index to 100.0. This means that the index reference period for that component is now set to the link period, which may differ from other components in the price index. This does not cause a problem for upper level index compilation but can be an issue when comparing price indexes of other components.

2. The second approach is to estimate the historic behaviour of the new component. This may be done using data from other sources. If these data are not available then an assumption needs to be made regarding price behaviour. One common although explicit assumption is the that new component has exhibited similar price behaviour to another component, in which case it is appropriate to set the link period price index to that of another component within the structure.

12.15 When considering price updating of the new component between the weighting reference period and the link period, it is also necessary to make an assumption regarding the price behaviour of the new component, at least over the short term. If an assumption has been made regarding setting the link period price index from another component, then the movement of this component between the weighting reference period and the link period can be used to price update the value data for the newly introduced component. On the other hand, if the new component has a link period price index of 100.0, the standard approach is to use the price movement of the component immediately higher in the index structure. This practice is sometimes called "inheriting the movement from the parent", a term which arises because the tree-like structure of a price index can be thought of as a series of parent-child relationships.

Example of chain linking

12.16 The concepts described in the preceding paragraphs are illustrated in Table 12.1.

TABLE 12.1 EXAMPLE OF CHAIN LINKING

	Price Index					Price Updating Value Data					New Link period Data		
	Period 1	Period 2	Period 3	Period 4	Average	Value data (Total over Period 1-4)	Period 4 Index	Average of Price Index Period 1-4	Price change between Period 1-4	Price updated Value Data (Period 4 prices and Average quantities over Period 1-4)	New Link Period Value Aggregate	Weight share (%)	New Link period Price Index
Materials used	133.7	152.7	154.7	161.9	150.75	194025	161.9	150.75	1.07		***211432***	100.0	161.9
Imports	119.9	128.1	135.8	145.2	132.25	66766	145.2	132.25	1.10		***72151***	34.1	145.2
Textile, clothing, footwear	110.6	109.7	112.4	113.7	111.60	6559	113.7	111.60	1.02	6690	6690	3.2	113.7
Wood and paper products	102.4	106.3	112.1	120.3	110.28	5181	120.3	110.28	1.09	5647	5647	2.7	120.3
Chemicals, plastic, rubber	93.7	96.2	104.5	112.1	101.63	9374	112.1	101.63	1.10	10311	10331	4.9	112.1
Fabricated products	119.7	120.7	120.7	132.6	123.43	28855	132.6	123.43	1.07	30875	30875	14.6	132.6
Agricultural products	116.9	121.8	124.0	130.4	123.28	457	130.4	123.28	1.06	484	484	0.2	130.4
Mining products	175.6	259.1	269.5	272.3	244.13	8489	272.3	244.13	1.12	9508	9508	4.5	272.3
Metals (a)						7851	***145.2***	***132.25***	***1.10***	***8636***	8636	4.1	145.2
Domestic	144.5	170.5	173.2	183.6	167.95	127259	183.6	167.95	1.09		***139281***	65.9	183.6
Agricultural products	148.3	148.1	151.3	156.3	151.00	50021	156.3	151.00	1.04	52022	52022	24.6	156.3
Electricity and gas	121.0	125.6	127.7	134.3	127.15	8929	134.3	127.15	1.06	9465	9465	4.5	134.3
Forestry and logging	133.4	142.4	144.4	154.4	143.68	1299	154.5	143.68	1.08	1403	1403	0.7	154.5
Mining products	157.0	224.0	240.7	248.2	217.48	67010	248.2	217.5	1.14	76.391	76391	36.1	248.2

(a) Imported metals introduced as new elementary aggregate during index review

12.17 In this example we see an index structure being updated through a link period. Value data are available for the total transactions over Period 1 through Period 4. The link period in this example is "Period 4". The link period value aggregates are formed by price updating the value data by the price change between Period 4 and the Period 1 to Period 4 average. This is achieved by multiplying the value data by the ratio of the Period 4 price index to the average of the Period 1 through Period 4 price indexes.

12.18 This example also illustrates the introduction of a new elementary aggregate into the index structure. The new structure sees the introduction of "imported metals". The inclusion of this new component requires a decision regarding the link period price index for the new component. In this example, the assumption has been made that imported metals have behaved similarly to other imported items, and in this case receive the same link period price index as all imports (145.2). A second decision is required regarding the price behaviour of the new component over Period 1 to Period 4. Again, the assumption has been made that the behaviour of "imported metals" has followed the behaviour of other imported goods. The outcome is that the price index of the new component is assumed to have increased by a factor of 145.2 / 132.25 = 1.10 between the Period 1 to Period 4 average and the link period (Period 4).

RE-REFERENCING PRICE INDEXES

12.19 The reference base, or index reference period, for each of the producer and international trade price indexes is published along with each index series. Ideally, all price indexes would be on the same reference base. If all indexes are on the same reference base then comparative movements may be undertaken by direct comparison of index numbers. However, price indexes are frequently developed at different times, with the result that more recently developed price indexes have more recent reference bases. This could be avoided by re-referencing all price indexes when a new companion series is introduced, yet frequent change of reference base introduces a degree of inconvenience to users, particularly those users who utilise price indexes in contract escalation. Re-referencing may also result in loss of detail in historic data, especially for long series.

12.20 Changing a reference base means assigning a new period (usually financial year) to take the value 100.0. Price index numbers for periods both before and after the new reference period are scaled so that the price movements are invariant to the change in reference base. This is achieved through applying a factor. For periods following a change in reference base, index numbers on the former basis can still be derived from index numbers on the new basis using arithmetic conversion factors derived from the relationships between the old and new series at the time of the change. For example, from the December quarter 1995 issue onwards, the Materials Used in House Building index was converted to a reference base of 1989-90 = 100.0 from the previous reference base of 1985-86 = 100.0. The factor for Sydney to be used to convert from the new basis to the old was derived as:

- All groups index number (on 1985-86 = 100.0), for Sydney, for 1989-90 = 139.1

- Factor to be used to convert All groups index numbers for Sydney on old reference base of 1985-86 = 100.0, to the new reference base of 1989-90 = 100.0

  = 100.0/139.1

  = 0.71891

12.21 This factor of 0.71891 may be applied to any Sydney Materials Used in House Building index number on the present (1989-90 = 100.0) reference base to give a corresponding index number on the previous (1985-86 = 100.0) reference base. The reverse conversion, i.e. from the previous basis to the present basis, can also be made - in this example using the conversion factor: 139.1/100.0 = 1.39100.

12.22 Loss of precision in long-term historic series may arise as a result of this process because price index data are stored to one decimal place.

CHAPTER 13 SPECIFIC EXAMPLES

13.1 This chapter provides details of the key price producer and international trade price indexes published by the ABS. It describes the scope of each index, provides details about weights[45], and highlights practical difficulties particular to each of the indexes.

13.2 This chapter also provides a detailed appendix covering the Stage of Production producer price indexes, describing the concepts of transaction flows and division of the economy into successive stages. Information regarding derivation of the weights for the different stages of production from the national accounting input-output tables is also included.

A. MANUFACTURING INDUSTRIES PRODUCER PRICE INDEXES

Articles produced by manufacturing industries

Type of index	Output price index (net sector)
Purpose	Measures changes in the prices in articles produced by manufacturing industry as a whole, and by fifteen sub-sectors within the manufacturing sector.
Major uses	General economic analysis; chain volume measures in the Australian national accounts; contract adjustment. The components of these indexes are also inputs to the ABS Stage of Production producer price indexes.
Pricing basis	Manufacturers' selling prices, exclusive of excise taxes and GST. This equates to basic prices. As far as possible, actual transaction prices are collected from businesses, representative of discounts offered or other differences from list prices. The index aims to measure prices ex-factory, although costs such as transport and handling are included if they are an indistinguishable part of the price.
Classification system	Products are classified according to the Input-Output Product Classification (IOPC). Published indexes describe products classified by industry of origin, with industries classified according to ANZSIC 1993.
Composition and weighting	Indexes are published for total manufacturing (ANZSIC93 Division C), and for selected industry groupings within the sector (ANZSIC93 two digit and combinations of selected three digit levels). The total division index is compiled on a net sector basis, i.e. prices relate only to manufactures that are sold to buyers outside of the ANZSIC93 manufacturing division (including materials that are sold overseas). Similarly, independent net sector indexes are also compiled at the subdivision and group (two and three digit) levels. Upper level weights are derived from input-output tables. Table 13.1 contains the detailed weighting pattern for the index.
Weighting reference period	1993-94
Link period (regimen item)	June quarter 2000
Index reference period	1989-90 = 100.0

[45] Weights presented in the tables in this chapter may not sum to 100 due to rounding.

Table 13.1 - Articles produced by manufacturing industries

ANZSIC, 1993	% contribution	
Manufacturing Division	**100.00**	
Food, beverages and tobacco	**25.61**	
Meat and meat product manufacturing		6.36
Dairy product manufacturing		3.86
Fruit and vegetable processing		1.65
Oil and fat manufacturing		0.36
Flour mill and cereal food manufacturing		1.26
Bakery product manufacturing		2.09
Other food manufacturing		5.03
Beverage and malt manufacturing		4.18
Tobacco product manufacturing		0.82
Textile and textile products	**2.13**	
Textile fibre, yarn and woven fabric manufacturing		1.11
Textile product manufacturing		1.02
Knitting mills, clothing, footwear and leather	**3.44**	
Knitting mills		0.41
Clothing manufacturing		2.37
Footwear manufacturing		0.37
Leather and leather product manufacturing		0.29
Log sawmilling and other wood products	**2.63**	
Log sawmilling and timber dressing		0.80
Other wood product manufacturing		1.83
Paper and paper products	**1.13**	
Printing, publishing and recorded media	**5.20**	
Printing and services printing		0.75
Publishing		4.15
Recorded media manufacturing and publishing		0.30
Petroleum and coal products	**9.30**	
Petroleum refining		9.28
Petroleum and coal product manufacturing		0.02
Chemicals	**6.18**	
Basic chemical manufacturing		1.90
Other chemical manufacturing		4.28
Rubber and plastics	**2.36**	
Rubber product manufacturing		0.66
Plastic product manufacturing		1.70
Non-metallic mineral products	**4.22**	
Glass and glass product manufacturing		0.31
Ceramic product manufacturing		0.85
Cement and concrete product manufacturing		2.69
Other non-metallic mineral products manufacturing		0.37
Basic metal products	**8.03**	
iron and steel manufacturing		1.74
Basic non-ferrous metal manufacturing		5.27
Non-ferrous basic metals manufacturing		1.02
Fabricated metal products	**5.12**	
Structural metal products manufacturing		2.24
Sheet metal product manufacturing		0.93
Fabricated metal product manufacturing n.e.c.		1.95

Table 13.1 - Articles produced by manufacturing industries (continued)

Transport equipment and parts	**10.61**	
Motor vehicle and part manufacturing		7.59
Other transport equipment manufacturing		3.02
Electronic equipment and other machinery	**10.02**	
Photographic and scientific equipment manufacturing		0.91
Electronic equipment manufacturing		1.61
Electrical equipment and appliance manufacturing		3.40
Industrial machinery and equipment manufacturing		4.10
Other manufacturing	**4.02**	
Prefabricated building manufacturing		0.31
Furniture manufacturing		2.72
Other manufacturing		0.99

Materials used in manufacturing industries

Type of index Input price index (net sector)

Purpose Measures changes in the prices of materials used by manufacturing industry as a whole, and by seventeen sub-sectors within the manufacturing sector. Series are also provided for materials classified according to whether they are domestically produced or imported.

Major uses General economic analysis; chain volume measures in the Australian national accounts; contract adjustment. The indexes are also inputs to the ABS Stage of Production producer price indexes.

Pricing basis Manufacturers' purchase prices, generally on a delivered into store basis. This equates to purchasers' prices. As far as possible, actual prices are collected from manufacturers, with some exceptions when it is more efficient to collect from suppliers (e.g. electricity prices).

Classification system Products are classified according to IOPC. Published indexes describe industry of use, with industries classified in accordance with the ANZSIC 1993.

Composition and weighting Indexes are published for total manufacturing (ANZSIC93 Division C), and for selected industry groupings within the sector (ANZSIC93 two digit and combinations of selected three digit levels). The total division index is compiled on a net sector basis, i.e. prices relate only to materials that are purchased from outside the ANZSIC93 manufacturing division. Similarly, independent net sector indexes are also compiled at the subdivision and group (two and three digit) levels. Upper level weights are derived from input-output tables. Table 13.2 contains the detailed weighting pattern for the index.

Weighting reference period 1989-90

Link period (regimen item) June quarter 1996

Index reference period 1989-90 = 100.0

Table 13.2 - Materials used in manufacturing industries

ANZSIC, 1993	% contribution	
Manufacturing Division	**100.00**	
Agriculture	**26.47**	
Horticulture and Fruit Growing		1.42
Grain, Sheep and Beef Cattle Farming		14.85
Dairy Cattle Farming		4.22
Poultry Farming		1.52
Other Livestock Farming		1.55
Other Crop Growing		2.91
Forestry and Logging	**1.30**	
Coal Mining	**0.84**	
Oil and Gas Extraction	**11.59**	
Metal Ore Mining	**9.27**	
Other Mining	**4.14**	
Construction Material Mining		2.46
Other Mining		1.68
Textile, Clothing, Footwear and Leather Manufacturing	**5.20**	
Textile Fibre, Yarn and Woven Fabric Manufacturing		4.54
Knitting Mills		0.27
Leather and Leather Product Manufacturing		0.39
Wood and Paper Product Manufacturing	**4.64**	
Log Sawmilling and Timber Dressing		0.84
Other Wood Product Manufacturing		0.37
Paper and Paper Product Manufacturing		3.43
Petroleum, Coal, Chemical and Associated Product Manufacturing	**10.81**	
Basic Chemical Manufacturing		6.05
Other Chemical Product Manufacturing		2.07
Rubber Product Manufacturing		0.96
Plastic Product Manufacturing		1.73
Non-Metallic Mineral Product Manufacturing	**0.66**	
Glass and Glass Product Manufacturing		0.66
Metal Product Manufacturing	**5.22**	
Iron and Steel Manufacturing		3.36
Non-Ferrous Basic Metal Product Manufacturing		0.57
Fabricated Metal Product Manufacturing		1.29
Machinery and Equipment Manufacturing	**9.71**	
Motor Vehicle and Part Manufacturing		3.91
Other Transport Equipment Manufacturing		0.20
Photographic and Scientific Equipment Manufacturing		0.81
Electronic Equipment Manufacturing		2.21
Electrical Equipment and Appliance Manufacturing		1.31
Industrial Machinery and Equipment Manufacturing		1.27
Electricity and Gas Supply	**10.15**	
Electricity Supply		4.21
Gas Supply		5.94

Copper materials used in the manufacture of electrical equipment

Type of index	Input price index
Purpose	Measures changes in the prices of copper materials used in the manufacture of electrical distribution and power transformers.
Major uses	Chain volume measures in the Australian national accounts; contract adjustment.
Pricing basis	The types of each material reflect their use in the manufacture of both types of electrical equipment. Prices are those charged by major manufacturers or distributors of copper materials to electrical equipment manufacturers for materials delivered into store. This equates to purchasers' prices. Prices relate to materials of fixed specification.
Classification system	Products are classified according to material composition and end use within the electrical equipment manufacturing industry. Separate indexes are published for copper materials used in power transformers, in distribution transformers and in electrical motors.
Composition and weighting	Weighting data were determined from an expenditure survey of electrical equipment manufacturers conducted in April 2002. The items for pricing were selected and allocated weights in accordance with the estimated average values of copper materials used in the manufacture of types of equipment in 1998-99. Table 13.3 contains the detailed weighting pattern for the index.
Weighting reference period	1998-99
Link period (regimen item)	June quarter 2002
Index reference period	1989-90 = 100.0

Table 13.3 - Copper materials used in the manufacture of electrical equipment

	% contribution
Distribution transformers index	**100.0**
Enamelled winding wire	81.4
Strip	18.6
Power transformers index	**100.0**
Strip	97.6
Busbar	2.4

B. CONSTRUCTION INDUSTRIES PRODUCER PRICE INDEXES

Output of the general construction industry

Type of index	Output price index
Purpose	Measures changes in the prices of the output of four components of the construction industry: houses, other residential buildings, non-residential building, and roads and bridges.
Major uses	General economic analysis; chain volume measures in the Australian national accounts contract adjustment. The indexes are also inputs to the ABS Stage of Production producer price indexes.
Pricing basis	Basic price. The general approach is model pricing, where the components of a 'typical' construction project are repriced over time to provide measures of price change.
Classification system	Industry of production as defined in ANZSIC93 subdivision 41. Within subdivision 41, indexes are produced for the following ANZSIC93 classes: 4111 - house construction; 4112 - residential building construction i.e. 4113 - non-residential building construction; and 4121 - road and bridge construction.
Composition and weighting	The price index for house construction is the Consumer Price Index (CPI) for house purchase, but excluding taxes and subsidies. This CPI component covers the purchase of newly constructed owner-occupied houses, and further information on it can be found in the *CPI Concepts, Sources and Methods* (cat. no. 6461.0). Upper level weights are determined from input-output tables, with lower level weights determined via a bill of quantities approach. Two types of projects are priced for residential construction other than houses (multi-storey apartment), and seven types of projects are priced for non-residential building (small and large offices, small and large shopping centres, industrial building, health building and hotel). Representative projects within each state and territory are selected for road and bridge construction. The indexes relate solely to new capital work. Repair and maintenance, site works (such as land clearance), external services (such as drainage), design and other professional services and land cost are all excluded. A total building construction price index is compiled by combining the residential building and non-residential building model price indexes in accordance with the value of work done for the years 1994-95 to 1998-99, obtained from ABS construction activity statistics. Road construction and bridge construction indexes are combined on the basis of ABS construction activity statistics over the period 1994-95 to 1998-99. Table 13.4 contains the detailed weighting pattern for the index.
Weighting reference period	1994-95 to 1998-99 (5 year average)
Link period (regimen item)	June 2002
Index reference period	1998-99 = 100.0

Table 13.4 - Output of the general construction industry

ANZSIC, 1993	% contribution
General Construction	**100.00**
4111 House Construction	41.71
4112 Residential Building Construction n.e.c.	15.55
4113 Non-Residential Building Construction	33.38
4121 Road and Bridge Construction	9.35

Materials used in house building

Type of index Input price index

Purpose Measures changes in the prices of selected materials used in the construction of detached houses in each of the six state capital cities.

Major uses General economic analysis; chain volume measures in the Australian national accounts contract adjustment. The indexes are also inputs to the ABS Stage of Production producer price indexes.

Pricing basis Actual prices (including any discounts etc) paid by building contractors or subcontractors for materials delivered to the building sites. Deductible indirect taxes such as GST are excluded from prices. Prices are collected directly from manufacturers and wholesalers of building materials, rather than from builders themselves, although such prices include delivery to building site where appropriate. This equates to purchasers' prices.

Classification system Products are classified according to the Australian Standard Method of Measurement of Building Works (Fifth Edition) (ASM). Indexes are published for six capital cities, as well as detailed product series, with building products classified by a historical material composition classification. The indexes have been available on the ASM classification since December quarter 2005.

Composition and weighting The weighting pattern was calculated using bill of quantities data for 2002-03 obtained from a quantity surveyor. The bills of quantity were determined using data for the three years ending 2002-03, but were valued using 2002-03 prices. These quantities were valued at 2003-04 prices and then benchmarked to ABS Building Activity Survey value data for 2003-04, including value data by capital city. Table 13.5 contains the detailed weighting pattern for the index.

Weighting reference period 2002-03 for product details, 2003-04 for state expenditure pattern.

Link period (regimen item) September quarter 2005

Index reference period 1989-90=100.0

Table 13.5 - Materials used in house building

Product group	% contribution to All Groups
All groups	**100.00**
Timber, board and joinery	**27.37**
Structural timber	11.18
Timber windows	2.79
Plywood and board	2.18
Timber doors	4.33
Cupboards and fittings	6.89
Ceramic products	**12.66**
Clay bricks	10.25
Terracotta tiles	1.24
Ceramic tiles	1.17
Concrete, cement and sand	**6.30**
Cement	0.52
Pre mixed concrete	5.46
Sand	0.32
Cement products	**2.55**
Concrete bricks	0.00
Concrete tiles	1.50
Fibrous cement products	1.05
Plumbing products	**6.55**
Plastic sanitary ware	0.93
Sheet metal sanitary ware	0.85
Plastic pipes and fittings	0.94
Ceramic sanitary ware	1.47
Shower screens	2.36
Installed gas and electric appliances	**1.84**
Stoves	0.91
Heaters	0.19
Hot water services	0.74
Other materials	**17.60**
Mirrors and other glass	3.49
Termite barriers	0.39
Carpet and other floor coverings	3.09
Waterproofing materials	0.22
Paint and other coatings	3.55
Plaster products	3.79
Insulation	3.07
Steel products	**5.78**
Steel beams and sections	3.70
Steel door frames	0.00
Steel house frames	0.00
Reinforcing steel	2.08
Other metal products	**16.46**
Metal garage doors	0.94
Aluminium windows and doors	6.51

Materials used in house building (continued)

Taps and valves	1.25
Metal roofing and guttering	3.47
Builders hardware	3.59
Copper pipes and fittings	0.70
Electrical equipment	**2.89**
Switchboards and distribution boards	1.76
Electrical cable and conduit	0.46
Other electrical equipment	0.67

C. MINING INDUSTRIES PRODUCER PRICE INDEXES

Materials used in coal mining

Type of index Input price index

Purpose Measures changes in the prices of materials used in open cut black coal mining and in underground black coal mining.

Major uses The components of these indexes are inputs to the ABS Stage of Production producer price indexes; contract adjustment

Pricing basis Prices relate to specified standards of each material. As far as possible, actual transaction prices are used (i.e. the prices actually paid by coalmines to suppliers for materials delivered to mine sites). The prices used include all relevant charges and freight costs, and are net of any discounts and rebates. The goods and services tax (GST) is excluded from the prices because, in the main, it is deductible on business-to-business transactions. Prices include delivery to a mine site, or to the primary storage site for a group of mines. This pricing basis equates to purchasers' prices.

Classification system Items for pricing are selected in consultation with the mining industry. Data are published as a single numbers for two series: open cut mining and underground mining.

Composition and weighting The items included in the indexes were selected and allocated weights on the basis of the estimated average usage of materials in coal mining during 1999-2000. The estimated values used to determine the item weights were derived from data reported from a sample of coal mines. The sample was selected to give appropriate representation to open cut and underground mines located in New South Wales and Queensland. Since the weights are based on average materials usage from a range of coalmines with particular characteristics, the index is not necessarily representative of price movements for materials used in any particular mine and the price changes may differ from those experienced by any individual mine. Table 13.6 contains the detailed weighting pattern for the index for Open Cut mining, and Table 13.7 contains the weighting pattern for Underground mining.

Weighting reference period 1999-2000

Link period (regimen item) March quarter 2001

Index reference period 1989-90 = 100.0

Table 13.6 - Materials used in coal mining (open cut)

Group / Material	% contribution	
Open cut black coal mining	**100.0**	
Distillate and lubricants		**20.5**
Distillate		18.0
Lubricants		2.5
Explosives		**20.0**
Wet explosives		8.9
Dry explosives		9.1
Accessories		2.0
Mechanical spare parts		**28.2**
Rubber tyred earth-moving equipment		14.1
Dragline and electric shovel parts		12.5
Impact Tips		1.6
Washplant compounds		**3.2**
Magnetite		1.2
Flocculents and washplant reagents		0.9
Washplant screens		1.1
Electricity - open cut		**13.2**
Electricity		13.2
Other materials - open cut		**14.9**
Electrical parts		3.6
Tyres		6.3
Miscellaneous materials - open cut		5.0

Table 13.7 - Materials used in coal mining (underground)

Group / Material	% contribution	
Underground black coal mining	**100.0**	
Mine roof supports		**18.5**
Roof bolts and resins		12.8
Roof timber and props		1.2
Steel roof supports		4.5
Mechanical spare parts		**23.1**
Continuous miners		8.6
Longwall spares		14.5
Electrical materials		**7.8**
Electrical cables		2.1
Other electrical parts		5.7
Washplant materials		**5.4**
Magnetite		3.0
Flocculents and washplant reagents		1.2
Washplant screens		1.2
Electricity - underground		**15.8**
Electricity		15.8
Other materials - underground		**29.4**
Hydraulic oils, lubricants and distillate		10.0
Miscellaneous materials - underground		19.4

D. SERVICE INDUSTRIES PRODUCER PRICE INDEXES

Output of transport (freight) and storage industries and output of property and business services industries

Type of index	Output price index
Purpose	Measure changes in the prices of services provided by producers of the transport (freight only) and storage, and the property and business services divisions of the ANZSIC93. Passenger transport services are excluded from the transport price indexes.
Major uses	General economic analysis; chain volume measures in the Australian national accounts; contract adjustment. The indexes are also inputs to the ABS Stage of Production producer price indexes.
Pricing basis	Prices relate to amounts received by service providers, exclusive of any taxes on products and transport and trade margins. Where possible, actual prices, including the effects of any discounts offered are used in the indexes. Samples are regularly updated and pricing methodologies are reviewed over time. The complexities involved in measuring services output prices mean that there is no single method of pricing. The most appropriate pricing strategy for any particular business respondent is determined by way of extensive industry consultation. Prices are not restricted to business-to-business transactions but rather include all outputs from the industry.
Classification system	Services are classified according to their ANZSIC93 industry of origin (4-digit class level). Indexes are available at the 4 digit ANZSIC93 level for most services, with aggregate indexes published for significant groups, subdivisions. Total division level indexes are also published for ANZSIC93 division I - transport (freight) and storage, and division L - property and business Services.
Composition and weighting	ANZSIC93 class indexes are aggregated to the relevant group, subdivision and division using weights derived from the ABS 1996-97 input-output domestic production values, in combination with data from other ABS surveys, and industry sources. Table 13.8 contains the weighting pattern for transport (freight) and storage, while Table 13.9 contains the weights for the property and business services industries.
Weighting reference period	1996-97
Link period (regimen item)	March quarter 2002
Index reference period	1998-99=100.0

Table 13.8 - Transport (freight) and storage industries

ANZSIC, 1993	% contribution
Division I - Transport and storage	**100.00**
61 Road Transport	**49.08**
611 Road Freight Transport	49.08
6110 Road Freight Transport	49.08
62 Rail Transport	**10.19**
620 Rail Transport	10.19
6200 Rail Transport	10.36
63 Water Transport	**10.13**
630 Water Transport	10.13
6301 International Sea Transport	6.93
6302 Coastal Water Transport	3.20
64 Air & Space Transport	**9.42**
640 Air & Space Transport	9.42
6401 Scheduled International Air Transport	7.66
6402 Domestic Air Transport	1.77
65 Other Transport	**2.28**
650 Other Transport	2.28
6501 Pipeline transport	2.28
66 Services to Transport	**12.30**
661 Services to Road Transport	1.54
6611 Parking Services	1.54
662 Services to Water Transport	4.49
6621 Stevedoring	1.06
6622 Water Transport Terminals	0.99
6623 Port Operators	0.64
6629 Services to Water Transport	1.81
663 Services to Air Transport	2.96
6630 Services to Air Transport	2.96
664 Other Services to Transport	3.30
6644 Customs Agents	3.30
67 Storage	**6.58**
670 Storage	6.58
6701 Grain Storage	2.43
6709 Storage n.e.c.	4.27

Table 13.9 - Property and business services

ANZSIC, 1993	% contribution
Division J Property and business services	**100.00**
77 Property Services	**38.86**
771 Property Operators	27.91
7712 Commercial Prop Operators	27.91
772 Real Estate Agents	6.74
7720 Real Estate Agents	6.74
774 Machinery, Equipment Hire	4.21
7741 Motor Vehicle Hiring	0.87
7742 Other Trans Equip Lease	0.13
7743 Plant Hiring or Lease	3.22
78 Business Services	**61.14**
781 Scientific Research (a)	1.32
7810 Scientific Research	1.41
782 Technical Services	5.20
7821 Architectural Services	1.11
7822 Surveying Services	0.58
7823 Consultant Engineering	3.51
783 Computer Services (a)	13.10
7831 Data Process Services	0.99
7832 Info Store & Retrieval	0.35
7833 Computer Maintenance	0.45
7834 Computer Consultancy	11.30
784 Legal & Accounting (a)	13.23
7841 Legal Services	7.55
7842 Accounting Services	5.88
785 Marketing, Business Mgt (a)	12.08
7851 Advertising Services	3.29
7852 Commercial Art, Disp	1.12
7853 Market Research Services	0.75
7855 Business Mgt Services	7.03
786 Other Business Services(a)	16.21
7861 Employment Placement	0.60
7862 Contract Staff Services	4.38
7863 Secretarial Services	2.26
7864 Security, Investigation	1.99
7865 Pest Control Service	0.26
7866 Cleaning Services	3.57
7869 Business Services NEC	3.14

E. INTERNATIONAL TRADE PRICE INDEXES

Export price index

Type of index	Output price index
Purpose	The export index measures changes in the prices of all exports of merchandise from Australia, including re-exports (goods which are imported into Australia then exported without alteration). The index numbers for each quarter relate to prices of exports actually shipped during that quarter.
Major uses	The main uses of the export price index are for the production of chain volume estimates in the Australian national accounts; general economic analysis; and the indexation of business contracts. The indexes are also inputs to the ABS Stage of Production producer price indexes.
Pricing basis	In general, prices are obtained from major exporters of the selected commodities included in the index. The prices used in the index are the prices at which the goods physically leave Australia, i.e. the prices are free on board (f.o.b.) at main Australian ports of export. Prices used in the index are expressed in Australian currency. As a result, changes in the relative value of the Australian dollar against overseas currencies (in particular the major trading currencies such as the US dollar, Japanese yen, Pound sterling and Euro) can have a direct and significant impact on the price movements of the many commodities that are sold in terms of prices expressed in overseas currencies. Forward exchange cover is excluded from the prices used in the index.
Classification system	Products in the export price index are classified according to the Australian Harmonised Export Commodity Classification (AHECC). Index numbers are produced in accordance with four classifications: (i) AHECC; (ii) The Standard International Trade Classification (SITC), Revision 3; (iii) ANZSIC (industry of origin basis); and (iv) the Balance of Payments Broad Economic Category Classification (BOPBEC).
Composition and weighting	The export price index is an annually reweighted chained Laspeyres index. The index items were selected based on the significance of their average export value in the two years preceding each index year (e.g. 2004-05 and 2005-06 for the index for each quarter in 2006-07) and the weights for each year are based on the average weights of those two preceding years as well. The weighting pattern being used during 2005-06 is set out in Table 13.10.
Weighting reference period	The export price index is reweighted each year, linked through the June quarter, based on the average values of exported merchandise trade for the immediately preceding two financial years.
Link period (regimen item)	June quarter each year
Index reference period	1989-90=100.0

Table 13.10 - Export price index

SITC		% contribution to All Groups
	All Groups	**100.00**
0	**Food and Live animals**	**18.50**
00	Live animals	1.02
01	Meat and meat preparations	5.06
02	Dairy products and birds' eggs	2.29
03	Fish, crustaceans and molluscs, and preparations thereof	1.14
04	Cereals and cereal preparations	5.25
05	Vegetables and fruit	1.43
06	Sugars, sugar preparations and honey	1.46
07	Coffee, tea, cocoa, spices and manufactures thereof	0.22
08	Feeding stuff for animals (not including unmilled cereals)	0.55
09	Miscellaneous edible products and preparations	0.08
1	**Beverages and tobacco**	**2.44**
11	Beverages	2.44
2	**Crude materials**	**17.57**
21	Hides, skins and fur skins, raw	0.62
22	Oil seeds and oleaginous fruits	0.92
24	Cork and wood	1.10
26	Textiles	5.30
27	Crude fertilizers and minerals	0.41
28	Metalliferous ores and metal scrap	9.22
3	**Mineral fuels, etc.**	**20.57**
32	Coal, coke and briquettes	10.17
33	Petroleum, petroleum products and related materials	7.09
34	Gas, natural and manufactured	3.31
4	**Animal and vegetable oils, etc.**	**0.28**
41	Animal oils and fats	0.28
5	**Chemicals and related products**	**8.14**
51	Organic chemicals	0.01
52	Inorganic chemicals	3.76
53	Dyeing, tanning and colouring materials	0.66
54	Medical and pharmaceutical products	2.35
57	Plastics in primary form	0.42
58	Plastics in non-primary form	0.33
59	Chemical materials and products n.e.s.	0.61
6	**Manufactured goods by material**	**12.12**
61	Leather, leather manufactures, n.e.s.	0.47
62	Rubber manufactures	0.16
64	Paper, paperboard and articles made of paper	0.80
66	Non-metallic mineral manufactures n.e.s.	1.09
67	Iron and steel	2.04
68	Non-ferrous metals	7.56
7	**Machinery and transport equipment**	**12.32**
71	Power generating machinery and equipment	4.38
76-77	Telecommunications and electrical machinery n.e.s.	2.39
78	Road vehicles	3.89
79	Other transport equipment	1.66
8	**Miscellaneous manufactured articles**	**2.77**
81-82	Prefabricated buildings and furniture and parts thereof	0.28
87	Professional, scientific and controlling instruments and apparatus n.e.s.	1.04

Table 13.10 - Export price index (continued)

88	Photographic & optical goods		0.86
89	Miscellaneous manufactured articles n.e.s.		0.59
9	**Commodities and transactions n.e.s.**	**5.29**	
97	Gold, non-monetary (excluding gold ores and concentrates)		5.29

Import price index

Type of index

Input price index

Purpose

The import price index measures changes in prices of imports of merchandise into Australia. The index numbers for each quarter relate to prices of imports landed in Australia during the quarter.

Major uses

The main uses of the import price index are for the production of chain volume estimates in the Australian national accounts; general economic analysis, particularly as a guide to future inflationary trends; and the indexation of business contracts. The indexes are also inputs to the ABS Stage of Production producer price indexes.

Pricing basis

Prices of individual shipments are obtained from major importers of the selected items. Imports are priced on a free on board (f.o.b.) country of origin basis. Freight and insurance charges involved in shipping the goods from foreign countries to Australian ports are excluded from the prices used in the index, as are Australian import duties. All prices used in the Import Price Index are expressed in Australian currency. As a result, changes in the relative values of the Australian dollar and overseas currencies can have a direct impact on price movements of imports that are purchased in foreign currencies. Prices reported in a foreign currency are converted to Australian dollars using the relevant exchange rates at the date of change of ownership. Where foreign currency purchase prices use forward exchange cover, the prices used in the index exclude the forward exchange cover.

Classification system

The Standard International Trade Classification (SITC), Revision 3 is the primary classification system for the Import Price Index. Indexes are also published according to the Balance of Payments Broad Economic Category classification. To comply with international statistical agreements, indexes are also published, and available on request, according to the Combined Australian Customs Tariff and Statistical Nomenclature (Customs Harmonised Tariff), based on the international Harmonised System (HS).

Composition and weighting

The import price index is an annually reweighted chained Laspeyres index. The index items were selected based on the significance of their import value in the year preceding the index year (e.g. 2005–06 for the 2006-07 indexes) and the weights each year are based on the imports from the preceding year. The weighting pattern being used during 2005-06 is set out in Table 13.11.

Weighting reference period

The import price index is reweighted each year, linked through the June quarter, based on the average values of imported merchandise trade for the immediately preceding financial year.

Link period (regimen item)

June quarter each year.

Index reference period

1989-90=100.0

Table 13.11 - Import price index

SITC		% contribution to All Groups
	All Groups	**100.00**
0	**Food and live animals**	**4.07**
02	Dairy products and eggs	0.35
03	Fish, crustaceans, molluscs, and preparations thereof	0.98
05	Vegetables and fruit	0.97
07	Coffee, tea, cocoa, spices and manufactures thereof	0.73
09	Miscellaneous edible products and preparations	1.04
1	**Beverages and tobacco**	**0.86**
11	Beverages	0.60
12	Tobacco	0.26
2	**Crude materials**	**1.58**
23	Crude rubber	0.17
24	Cork and wood	0.68
25	Pulp and paper waste	0.29
26	Textile	0.21
27	Crude fertilisers, minerals	0.23
3	**Mineral fuels, etc.**	**8.37**
33	Petroleum, petroleum products and related materials	8.37
4	**Animal & vegetable oils, etc.**	**0.30**
42	Fixed vegetable fats and oils	0.30
5	**Chemicals and related products**	**12.02**
51	Organic chemicals	1.85
52	Inorganic chemicals	0.57
53	Dyeing, tanning and colouring materials	0.44
54	Medical and pharmaceutical products	4.28
55	Essential oils etc.	1.06
56	Fertilizers (excl. crude)	0.64
57	Plastics in primary forms	1.15
58	Plastics in non-primary forms	0.81
59	Chemical materials and products n.e.s.	1.22
6	**Manufactured goods by materials**	**12.47**
61	Leather, leather manufactures, n.e.s.	0.12
62	Rubber manufactures	1.39
63	Cork and wood manufactures	0.59
64	Paper, paperboard and articles made of paper pulp	1.95
65	Textile yarn, fabrics and related products	2.00
66	Non-metallic mineral manufactures	1.62
67	Iron and steel	1.58
68	Non-ferrous metals	0.77
69	Manufactures of metal n.e.s.	2.45
7	**Machinery & transport equipment**	**46.25**
71	Power generating machinery and equipment	2.39
72	Machinery specialised for particular industries	3.67
74	General industrial machinery, equipment and parts	5.56
75	Office machines and A.D.P. machines	5.67
76	Telecommunications and sound recording equipment	5.26
77	Electrical machinery, etc. and parts thereof	5.51
78	Road vehicles	13.51
79	Other transport equipment	4.68
8	**Miscellaneous manufactured articles**	**13.68**

Table 13.11 - Import price index (continued)

81	Prefabricated buildings & fixtures n.e.s.		0.34
82	Furniture & parts thereof		1.18
83	Travel goods & handbags		0.36
84	Articles of apparel and clothing accessories		2.65
85	Footwear		0.76
87	Professional, scientific and controlling instruments and apparatus n.e.s.		2.39
88	Photographic and optical goods		1.13
89	Miscellaneous manufactured articles n.e.s.		4.87
9	**Commodities and transactions n.e.s.**	**0.40**	
97	Gold, non-monetary (excluding gold ores and concentrates)		0.40

F. STAGE OF PRODUCTION PRODUCER PRICE INDEXES

Type of index	Output price indexes (transaction flow). **Note**: For a more detailed description of SOP see the appendix to this chapter.
Purpose	Stage of Production Price (SOP) indexes are economy-wide price measures. According to the SOP concept, all commodities are categorised into three stages, i.e. Stage 1 (preliminary stage), Stage 2 (intermediate stage) and Stage 3 (final stage). These stages are not aggregated. The basis for the categorisation is the Australian Input-Output tables. The indexes of each stage cover both domestically produced and imported commodities, individually and in aggregate. The SOP indexes are compiled from data used in the industry sector indexes, the international trade indexes and some additional data collections.
Major uses	The SOP framework allows for analyses of price change as commodities flow through the production process. Price changes for earlier stages of production may be indicators of possible future price changes for other stages.
Pricing basis	In concept, the valuation basis of the SOP indexes is basic prices i.e. the prices received by producers for sale of their goods. The SOP indexes include both domestic and imported goods. SOP indexes are compiled using other producer price indexes. However, the use of component series from existing ABS price collections results in some cases in the pricing basis diverging from the ideal (i.e. basic prices). For example, some components are sourced from prices collected for the materials used in manufacturing industries, which are valued at purchasers' prices.
Classification system	Products are classified according to their industry of origin (or competing industry of origin for imports) according to ANZSIC 1993. Imported goods are classified to their equivalent Australian industry of origin. Products are also classified according to their "stage of production" destination. The destination classification is further disaggregated for the final stage, with products classified by destination to consumer, capital or export.
Composition and weighting	Items included in the Stage of Production indexes reflect the values of commodity and service flows from the 1996-97 input-output tables. Tables 13.12 and 13.13 set out the weighting patterns for the Stage of Production PPIs.
Weighting reference period	1996-97
Link period (regimen item)	September quarter 2002
Index reference period	1998-99=100.0

Table 13.12 - Stage of Production PPIs, Preliminary and Intermediate Stages

ANZSIC, 1993	PRELIMINARY (STAGE 1) COMMODITIES			INTERMEDIATE (STAGE 2) COMMODITIES		
	% contribution to Total Industries			% contribution to Total Industries		
	Domestic	Imports	Total	Domestic	Imports	Total
Total Industries	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
01 Agriculture	5.4		4.7	7.7		6.6
02 Services to Agriculture; Hunting and Trapping	0.3		0.3	0.2		0.1
03 Forestry and Logging	0.3		0.3			
04 Commercial Fishing				0.3		0.2
11 Coal Mining	1.4		1.2	0.7		0.6
12 Oil and Gas extraction	1.8	9.5	2.8	0.9	4.6	1.4
13 Metal Ore Mining	1.1	0.8	1.1	1.2	1.0	1.1
14 Other Mining	1.1	0.5	1.0	0.7	0.4	0.7
21 Food, Beverage and Tobacco Manufacturing	2.7	1.5	2.5	4.8	2.5	4.5
22 Textile, Clothing, Footwear and Leather Manufacturing	0.8	5.5	1.4	1.4	8.0	2.4
23 Wood and Paper Product Manufacturing	3.3	9.7	4.2	3.8	5.5	4.1
24 Printing, Publishing and Recorded Media	3.9		3.4	4.8		4.1
25 Petroleum, Coal, Chemical and Associated Product	7.8	27.7	10.5	6.8	19.8	8.6
26 Non-metallic Mineral Product Manufacturing	1.7		1.5	3.8	3.2	3.8
27 Metal Product Manufacturing	8.6	9.9	8.8	8.5	8.7	8.5
28 Machinery and Equipment Manufacturing	4.7	34.9	8.7	6.5	43.8	11.8
29 Other Manufacturing					2.5	0.4
36 Electricity and Gas Supply	3.8		3.3	3.4		2.9
37 Water Supply, Sewerage and Drainage Services	1.4		1.2	0.8		0.7
57 Accommodation, Cafes and Restaurants	0.6		0.5	0.5		0.5
61 Road Transport	7.3		6.3	6.0		5.1
62 Rail Transport	0.9		0.8	0.7		0.6
63 Water Transport	0.6		0.5	0.6		0.5
64 Air and Space Transport	1.5		1.3	1.3		1.2
65 Other Transport	0.3		0.3	0.2		0.2
66 Services to Transport	1.9		1.6	1.6		1.4
67 Storage	1.2		1.0	1.0		0.8
77 Property Services	15.8		13.7	11.4		9.7
78 Business Services	19.8		17.1	20.4		17.5

Table 13.13 - Stage of Production PPIs, Final Stage

ANZSIC, 1993	FINAL (STAGE 3) COMMODITIES							
	Domestic			Imports			All production	
	Consumer	*Capital*	*Total*	*Consumer*	*Capital*	*Total*	*Total (excluding exports)*	*Exports*
	% contribution to Total Industries			% contribution to Total Industries			% contribution to Total Industries	
Total Industries	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
01 Agriculture	4.9		2.2				1.7	7.4
02 Services to Agriculture; Hunting and Trapping								1.5
04 Commercial Fishing	1.9		0.9				0.7	0.6
11 Coal Mining								11.4
12 Oil and Gas Extraction								4.1
13 Metal Ore Mining								15.6
14 Other Mining								0.9
21 Food, Beverage and Tobacco	36.5		16.1	20.6		10.8	15.1	13.9
22 Textile, Clothing, Footwear and Leather Manufacturing	7.1		3.1	17.8		9.3	4.4	3.0
23 Wood and Paper Product Manufacturing	1.6		0.7				0.6	1.0
24 Printing, Publishing and Recorded Media	4.1		1.8	4.6		2.4	1.9	
25 Petroleum, Coal, Chemical and Associated Product	9.3		4.1	15.1		8.0	4.9	5.4
27 Metal Product Manufacturing		0.7	0.4	2.7		1.4	0.6	11.8
28 Machinery and Equipment Manufacturing	8.2	10.9	9.7	30.2	97.5	62.1	20.0	9.8
29 Other Manufacturing	2.1	3.5	2.9	9.0	2.5	6.0	3.5	
36 Electricity and Gas Supply	7.9		3.5				2.8	
37 Water Supply, Sewerage and Drainage Services	4.7		2.1				1.7	
41 General Construction		73.9	41.2				33.1	
57 Accommodation, Cafes and Restaurants	3.0		1.3				1.1	2.1
61 Road Transport	3.2		1.4				1.1	1.8
62 Rail Transport	1.0		0.4				0.3	1.1
63 Water Transport	0.6		0.2				0.2	2.0
64 Air and Space Transport	0.1		0.1				0.1	0.2
66 Services to Transport	3.8		1.7				1.3	3.0
77 Property Services		2.8	1.6				1.2	0.5
78 Business Services		8.2	4.6				3.7	2.9

CHAPTER 13 APPENDIX STAGE OF PRODUCTION PRODUCER PRICE INDEXES

Introduction

A13.1 The stage of production producer price indexes relate to the *supply of products* to the Australian economy in a stage of production (SOP) framework. As such, the indexes cover both domestically produced and imported commodities, individually and in aggregate. The SOP indexes are compiled from data used in the industry sector indexes, the international trade indexes and some additional data collections. The indexes are calculated on the reference base 1998-99=100.0.

A13.2 These indexes are compiled within the statistical framework outlined in the *1997 ABS Information Paper: An Analytical Framework for Price Indexes in Australia* (cat. no. 6421.0) and are designed to support the study of price inflation.

A13.3 A more detailed explanation of the SOP concept is contained in the ABS *Information Paper: Producer Price Index Developments* (cat. no. 6422.0), released on 25 March 1999. The index numbers in the current Producer Price Indexes publication (cat. no. 6427.0) cannot be directly compared with the experimental index numbers in the information paper because:

- the coverage of the series has been expanded to include selected service and construction industries; and
- the weighting patterns of the indexes have been updated to 1996-97 and the reference base of the indexes has been updated to 1998-99=100.0.

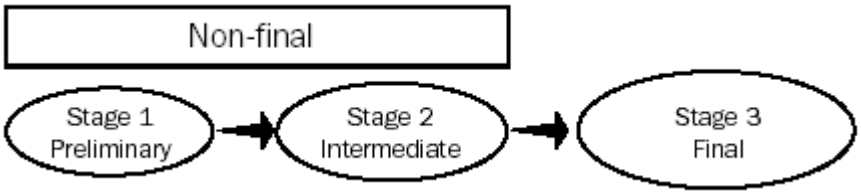
Pricing basis

A13.4 In concept the valuation basis of the SOP indexes is basic prices. However, the use of component series from existing ABS price collections in some cases results in the pricing basis diverging from this ideal. For example, imports are priced on a 'free-on-board' (f.o.b.) basis, not 'cost, insurance, freight' (c.i.f.), which approximates basic prices.

The SOP concept

A13.5 The indexes are compiled using the SOP concept. Under this concept flows of commodities are categorised according to their economic destination on a sequential basis along the production chain. The basis for the categorisation is the Australian input-output tables (1996-97). The primary categorisation is between final commodities (i.e. commodities destined for final consumption, capital formation or export) and non-final commodities (i.e. commodities that flow into intermediate consumption for further processing).

A13.6 This initial breakdown of the commodity flows into final and non-final represents a useful economic dissection of producers' transactions. However, the non-final commodities can flow into the production of both final and other non-final commodities. Therefore, to aid analysis, the non-final commodity flows have been divided on a sequential basis between Stage 1 (or preliminary) commodities and Stage 2 (or intermediate) commodities as illustrated below. This approach results in three separate stages of production.



A11.8

A13.7 The three stages are not aggregated in order to avoid the potential distorting effects that may result from multiple counting of changes in transaction prices as commodities flow through different production processes.

A13.8 Under this framework, preliminary (Stage 1) commodities are used in the production of intermediate (Stage 2) commodities; in turn intermediate (Stage 2) commodities flow into the production of final (Stage 3) commodities.

A13.9 The framework allows for analyses of price change as commodities flow through production processes. Price changes for earlier stages of production may be indicators of possible future price changes for later stages.

Transaction flow approach

A13.10 The ABS has adopted a transaction flow approach in disaggregating commodity supply into the various production stages. This approach means that the assignment of a commodity to a stage is based on the proximity of its use in final demand.

A13.11 Alternative degree of fabrication or principal destination approaches are employed by statistical agencies in some other countries. These approaches result in the allocation of particular commodities to one, and only one, stage. This would present particular problems for Australia due to the openness of the economy, with exports (and imports) equivalent to about 20% of gross domestic product. Commodities such as wheat, wool, and iron ore are exported in large volumes as well as being further processed locally. The allocation of such commodities to a single stage would be very arbitrary by necessity.

A13.12 Adopting the transaction flow approach means, for example, that exported wheat and domestically used wheat are treated as different commodities for index construction purposes. Under this approach commodities transactions can be allocated to more than one stage. Exported wheat is treated as a final (Stage 3) commodity while wheat used domestically to make the flour used in bread production is considered to be a preliminary (Stage 1) commodity. Similarly, commodities such as energy and containers appear under all three categories.

Scope and coverage

A13.13 Producer price indexes conventionally relate to the output of domestic industries, at basic prices, either inclusive or exclusive of exports. As the main focus is on domestic inflation, exports are excluded from the headline SOP series 'Final (Stage 3) commodities'. Index series for Final (Stage 3) commodities including exports are available in tables 26 & 27 on the ABS web site <www.abs.gov.au>.

A13.14 Imports have also been incorporated within the framework, recognising that they represent an important potential source of inflationary pressure.

A13.15 In concept, the SOP indexes incorporate all flows of goods and services. However, currently there is limited coverage of service industries and the construction industry by the producer price indexes (see sections on construction industry and service industries producer price indexes below).

A13.16 Price indexes for most transport and storage services (division I of ANZSIC) and property and business services (division L of ANZSIC) industries have been included in the SOP framework. However, price series for most Final (Stage 3) consumer services are not currently available on a sufficiently timely basis to allow their inclusion in the indexes. This has the effect of decreasing the relative weight of consumer items versus capital items in the final stage. It is intended to introduce additional services price series as they become available, along with the consequential weight changes.

A13.17 Index coverage for the construction industry (division E of ANZSIC) is currently limited to the output of the following ANZSIC classes:

- 4111 House construction;
- 4112 Residential building construction n.e.c.;
- 4113 Non-residential building construction; and
- 4121 Road and bridge construction.

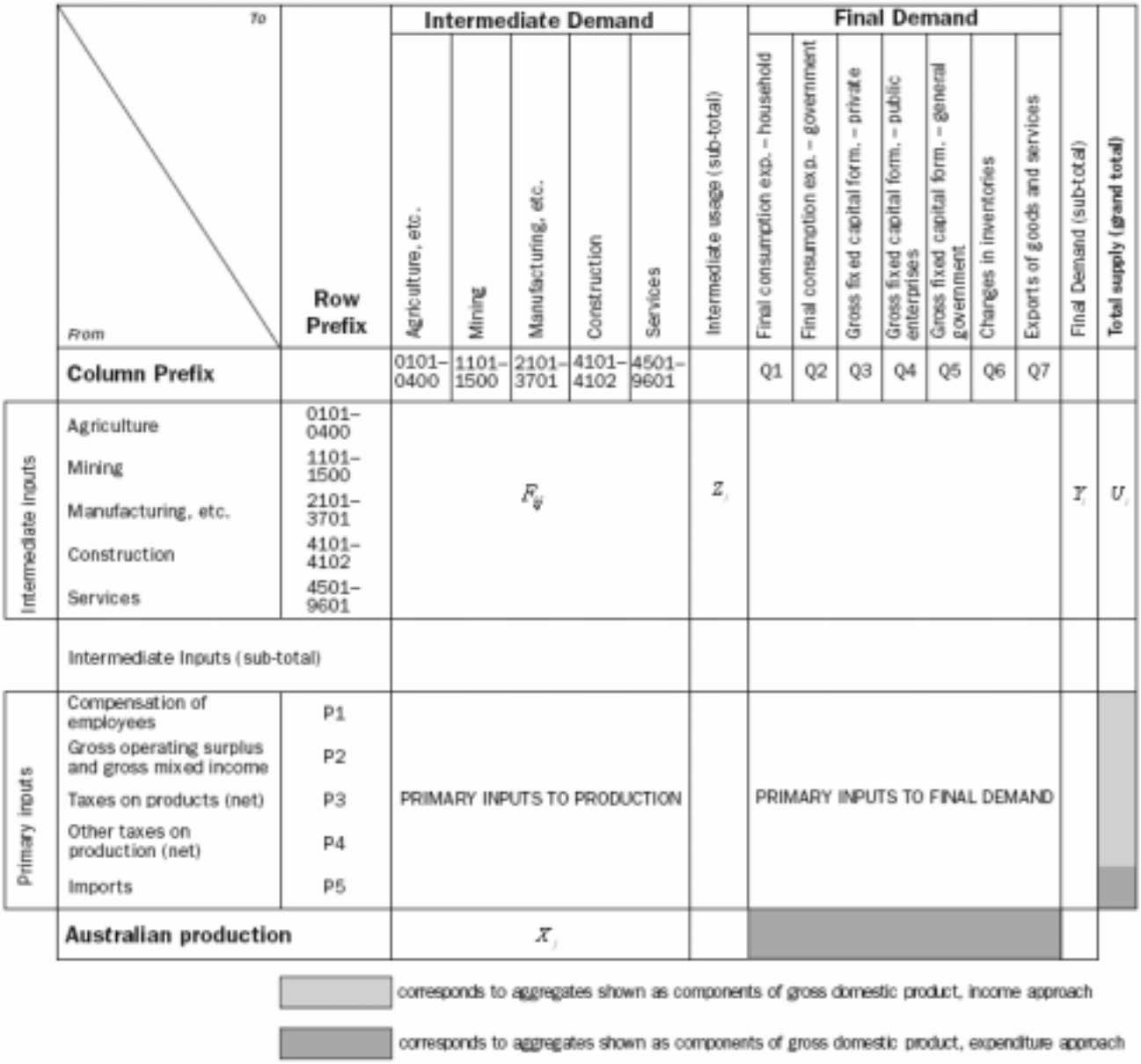
A13.18 As with services, it is intended to introduce further construction price series as they become available.

Items and weights: transaction flows and the national accounts input - output table

A13.19 The basis of the weights for SOP is the *use table* from the input-output framework. For the 2002 design, the 1996-97 IO tables were used, with particular emphasis on the 107 products x 107 industry use table (Table 2 from *Australian National Accounts: Input-Output Tables* (cat. no. 5209.0)). In describing the use of the input-output tables it is convenient to introduce some terminology.

$i = 1,\ldots,107$	subscript referring to *products* (rows in the IO table)
$j = 1,\ldots,107$	subscript referring to *industries* (columns in the IO table)
Y_i	final demand for product *i*
X_j	total production of industry *j*
F_{ij}	the flow of product *i* consumed in industry *j* as part of intermediate input into industry *j*
a_{ij}	$a_{ij} = \frac{F_{ij}}{X_j}$ the amount of product *i* directly required to produce one unit of output from industry *j*. Known as the *technology coefficient* or the *direct requirements coefficient*
U_i	total use of product *i*
$\hat{Y}_i$	"adjusted" final demand for product *i*, that is final demand less change in inventories
Z_i	$Z_i = \sum_{j=1}^{107}$ intermediate consumption of product *i* across all industries

A simple input output framework



A13.20 An input-output table focuses on the interrelationships between industries in an economy with respect to the production and uses of their products. Using the terminology described above, the input-output table is based upon the assumption of fixed coefficient linear production functions relating inputs used by an industry (down a column) to its output flow - that is, for every unit of production of a given product, a fixed amount of input is required. The fixed input is known as a technology coefficient or a direct requirements coefficient, and is determined by considering the ratio of intermediate consumption of a product for a given industry to the total input of the consuming industry. That is if we have the relationships described by the following equations

$$a_{11}X_1 + a_{12}X_2 + \ldots + a_{1n}X_n + Y_1 = X_1$$
$$a_{21}X_1 + a_{22}X_2 + \ldots + a_{2n}X_n + Y_1 = X_2$$
$$\ldots$$
$$a_{n1}X_1 + a_{n2}X_2 + \ldots + a_{nn}X_n + Y_n = X_n$$

then the coefficients (the a*ij*'s) are equal to the intermediate consumption of product *i* by industry *j*, divided by total production (column total) of industry *j*.

$$a_{ij} = \frac{F_{ij}}{X_j}$$

A13.21 We interpret the direct requirement coefficient as the amount of product *i* directly required to produce one unit of output from industry *j* .

A13.22 If we construct a matrix A of all the technology coefficients, and vectors for final demand *y* and total production *x*, then the system of equations relating intermediate consumption, final demand and total production can be written as:

$$A = \begin{bmatrix} a_{11} & \ldots & a_{1n} \\ \vdots & \ddots & \vdots \\ a_{n1} & \ldots & a_{nn} \end{bmatrix}, \quad \underset{\sim}{x} = \begin{pmatrix} X_1 \\ \vdots \\ X_n \end{pmatrix}, \quad \underset{\sim}{y} = \begin{pmatrix} Y_1 \\ \vdots \\ Y_n \end{pmatrix}$$

$$A\underset{\sim}{x} + \underset{\sim}{y} = \underset{\sim}{x}$$

A13.23 If the values of the coefficients and of final demand are known, then it is possible to solve this system of equations to find the total production required from each industry (*x*) to satisfy a specific level of demand (*y*)

$$A\underset{\sim}{x} + \underset{\sim}{y} = \underset{\sim}{x}$$
$$\underset{\sim}{y} = \underset{\sim}{x} - A\underset{\sim}{x}$$
$$= (I - A)\underset{\sim}{x}$$
$$\underset{\sim}{x} = (I - A)^{-1}\underset{\sim}{y}$$

A13.24 The matrix $(I\text{-}A)^{-1}$ is known as the *Leontief inverse matrix*.

Economic interpretation

A13.25 The input structures represented by the A-matrix and discussed in previous sections of this chapter show the type and amount of various inputs each industry requires in order to produce one unit of its output but tell nothing about indirect effects. For example, the effect of the production of a motor vehicle does not end with the steel, tyres and other components required. It generates a long chain of interaction in the production processes since each of the products used as inputs needs to be produced and will, in turn, require various inputs. The production of tyres, for instance, requires rubber, steel and cloths, etc. which, in turn, require various products as inputs including the transport service provided by motor vehicles that necessitates the production of motor vehicles in the first place. One cycle of input requirement requires another cycle of inputs which in turn requires again another cycle. This chain of interactions goes into infinity. However, the *sum* of all these chained reactions is determined from the value of the Leontief inverse.

A13.26 In chain reactions in input-output analysis, the first exogenous shock ("originating outside") is assumed to be initiated by an exogenous increase in net final demand, like an increase in export demand, or an increase in fixed capital formation. This assumption is made mainly for the sake of simplicity of exposition. Actually, the first shock can happen anywhere. It can be an increase in domestic production of intermediate consumption to replace imports, an increase in indirect taxes, a change in technology represented by changes in input structures, etc.

A13.27 Consider now an increase in demand for one product (say product i). The initial requirement for an extra dollar's worth of product i is called the *initial output effect*. This is equal to one in total for all products since an additional dollar's worth of product will require an additional dollar's worth of output from the producing industry plus any induced extra output. The *first round effect* is the amount required from all industries of the economy to produce the initial output effect. This is measured by the direct requirements matrix A as described above. Similarly, the first round effect in turn requires input from all industries. This will be measured by the product of the direct requirements matrix with itself (A x A). In turn this will require more input (A x A x A), and so forth.

A13.28 This concept can be best illustrated by introducing a measure d (vector of Di's) of change in demand for each product i, resulting from an exogenous shock:

	Direct input	**Additional output required**	**Cumulative total**
Initial shock		d	d
1st round	d	Ad	$d + Ad$
2nd round	Ad	$A\ (Ad)$	$d + Ad + AAd$
3rd round	AAd	$A\ (AAd)$	$d + Ad + AAd + AAAd$
...			
k th round	$A^{(k-1)}d$	$A^k d$	$d + Ad + AAd + \ ... \ + A^k d$
Total after k rounds			$(I + A + ... + A^k)\ d$

A13.29 Further, we know that from the properties of the matrix A that

$$\lim_{k\to\infty} I + A + \ldots + A^k = \left(I - A\right)^{-1}$$

A13.30 The resulting matrix is (known as the Leontief Inverse matrix as noted above), has elements called *total requirement coefficients*.

A13.31 If we now apply this approach to the vector of final demand (y), we can determine:

- Final demand itself, which forms the final stage weights in SOP
- The direct requirements to produce final demand, given by the product of the technology matrix and the demand vector (Ay), which forms the intermediate stage weights
- The direct requirements to produce the intermediate inputs, given by the product of the technology matrix with the direct requirements to produce final demand (AAy).

STAGE OF PRODUCTION PRODUCER PRICE INDEXES

Stage	**Description**	**Value used for weighting**
Stage 3 Final	Final demand	$\underset{\sim}{y}$
Stage 2 Intermediate	Inputs used in meeting final demand, and only those inputs, equivalent to 1st round of impacts following shock	$A\underset{\sim}{y}$
Stage 1 Preliminary	Inputs used in meeting 1st round demand, and only those inputs, equivalent to 2nd round of impacts following shock	$A^2\underset{\sim}{y}$

A13.32 It is important to note from the weighting pattern that the three SOP indexes do not represent all production undertaken in the economy. Aside from the scope and coverage limitations discussed earlier, the aggregate of the SOP weights is less than total production. From above we see

$$\begin{aligned}\underset{\sim}{x} &= \left(I - A\right)^{-1}\underset{\sim}{y} \\ &= (1 + A + A^2 + A^3 + A^4 + \ldots)\underset{\sim}{y} \\ &> (1 + A + A^2)\underset{\sim}{y}\end{aligned}$$

A13.33 Total production x is greater than the values used for SOP weights when aggregated across all three stages. This observation can also be made when considering that the "Preliminary" stage of production itself must require some inputs, which in turn require other inputs, and so forth. However, from the 1996-97 input-output tables, the 3-stage design of SOP still covers over 90% of in-scope production.

A13.34 The items included in the indexes reflect the values of commodity flows, for both domestic supply and imports, allocated to stages based on an analysis of detailed 1996-97 input-output tables. The index structures and weighting patterns for the SOP indexes are shown in the Appendix of the December 2002 issue of *Producer Price Indexes, Australia* (cat. no. 6427.0).

Comparisons with the Consumer Price Index

A13.35 Final (Stage 3) indexes are presented for consumer commodities. It should be noted that this index is not directly comparable with the Consumer Price Index (CPI). The two indexes differ significantly in concept and coverage. The major differences are:

- The pricing basis for the Final (Stage 3) SOP consumer index is basic prices. The CPI, however, measures changes in purchasers' prices, i.e. the actual retail prices paid by households for products, inclusive of non-deductible taxes on products, such as the GST, and any transport and trade margins;

- The coverage of the two indexes differs. Currently the Final (Stage 3) SOP consumer index mainly measures changes in the prices of goods, i.e. most household services are currently excluded from the index. The CPI covers both goods and services.

- The indexes have different weighting bases. The weighting pattern for the Final (Stage 3) SOP consumer index is based on the 1996-97 input-output tables, while the CPI weighting pattern is based on the 2003-04 Household Expenditure Survey.

CHAPTER 14 OUTPUTS AND DISSEMINATION

INTRODUCTION

14.1 This chapter outlines the kinds of producer and international trade price index data available from the ABS and gives some guidance to users who wish to interpret or further manipulate the data.

PUBLICATION OF STATISTICS

14.2 The producer and international trade price indexes are compiled and published quarterly in *Producer Price Indexes, Australia* (cat. no. 6427.0) and *International Trade Price Indexes, Australia* (cat. no. 6457.0), respectively. Both publications are released approximately 15 working days after the end of the reference quarter. Each quarterly issue of these publications announces the precise release dates for the subsequent two quarterly issues; that is, the publication dates for these statistics are finalised and announced six months in advance.

Equity of access

14.3 The statistics are made available simultaneously to all interested parties through these releases. To ensure equitable access to the data all statistics are subject to an embargo until 11.30 a.m. (Canberra time) on the day of release. Prior to the end of the embargo time, no information about the price indexes is publicly available.

14.4 The 11.30 a.m. embargo and simultaneous access applies to the statistical releases in all forms of media; specifically, electronic data and hard copy publications are made available simultaneously.

Materials released

14.5 The statistics released through *Producer Price Indexes, Australia* (cat. no. 6427.0) and *International Trade Price Indexes, Australia* (cat. no. 6457.0) are disseminated via several different mechanisms. The publications themselves are available in hard copy (printed product), however the key mechanism for dissemination of data is via the ABS web site www.abs.gov.au. The web site provides free of charge:

- the main findings from the statistical releases
- a downloadable version of the publications in PDF format
- all publication tables in the publications, downloadable in Microsoft Excel format; and
- a range of additional tables containing all available producer and international trade price indexes downloadable in Microsoft Excel format.

Quarterly and annual data

14.6 Price index figures are published on both a quarterly and a financial year basis. The index number for a financial year is the simple arithmetic average (mean) of the index numbers for the 4 quarters of that year. Index numbers for calendar years are not calculated by the ABS but can be derived by calculating the simple arithmetic average of the quarterly index numbers for the year concerned.

Revisions

14.7 Producer and international trade price index figures may be subject to revision. However, revisions are rare and are only made if the effect of the revision is significant. In the event of a revision the affected figures are highlighted in the publication, with a reason for revision provided in the commentary.

INTEPRETING INDEX NUMBERS

Index numbers and percentage change

14.8 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 Final (Stage 3) Stage of Production PPI between the December quarter 2002 and the December quarter 2005. The same procedure is applicable for any two periods.

	Index numbers:
December quarter 2005	119.7
less December quarter 2002	110.3
equals change in index points	9.4

Percentage change = 9.4 / 110.3 x 100 = 8.5%

14.9 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 change of 1.7 per cent, but if the index number were 80 a change of 2 index points would be equivalent to a change of 2.5 per cent — a significantly different rate of price change. Only when measuring change from the reference base period of the index will the points change be numerically identical to the percentage change.

14.10 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 will not necessarily 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 per cent (multiplying by 1.1) each period. After four periods, the index will equal 146.4 delivering an annual percentage change of 46.4 per cent, not the 40 per cent obtained by adding the four quarterly changes of 10 per cent.

14.11 Although the producer and international trade price indexes are compiled and published as a series of quarterly index numbers, their use is not restricted to the measurement of price change between particular quarters. A quarterly index number can be interpreted as representing the average price during the quarter (relative to the base period), and 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 1998 would be calculated as the arithmetic average of the index numbers for the March, June, September and December quarters of 1998.

14.12 This characteristic of index numbers is particularly useful. It allows the average prices in one year (calendar or financial) to be compared 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.

Index numbers and points contribution

14.13 The quarterly change in a price index represents the weighted average price change of all the product groups included in that index. Publication of index numbers and percentage changes for components of the broad price indexes are useful in their own right. However, 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 a product group's price change and its relative importance in the index.

14.14 If a broad level index number is thought of as being derived as the weighted average of the indexes for all its component product groups, then the index number for a component multiplied by its weight to the broad level 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 broad level price index resulting from the change in that component's price. This relationship only applies if all components have the same reference base and the same link period. Calculation of "points contribution" is covered in more detail in Chapter 10, whilst reference base and link periods are discussed in Chapter 12.

14.15 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 from the December quarter 2005 Export Price Index (EPI):

SELECTED VALUES FROM THE INTERNATIONAL TRADE PRICE INDEX PUBLICATION, DECEMBER QUARTER 2005

	Index numbers		Percent change	Points contribution		Points change
Product	Sep qtr	Dec qtr		Sep qtr	Dec qtr	
Total exports	129.3	132.1	2.2	129.3	132.1	2.8
Mineral fuels	248.4	250.9	1.0	34.26	34.61	0.35

14.16 Using only the index numbers themselves, the most that can be said is that between the September and December quarters 2005, the price of mineral fuels exports increased by less than the overall EPI (by 1.0 per cent compared with an increase in total exports of 2.2 per cent). The additional information on points contribution and points change can be used to:

- ***Calculate the effective weight for mineral fuels in the September and December quarters*** (given by the points contribution for mineral fuels divided by the total exports index). For September, the weight is calculated as $34.26/129.3 \times 100 = 26.50$ per cent and for December as $34.61/132.1 \times 100 = 26.20$ per cent. Although the underlying quantities are held fixed, the effective weight in export revenue terms has decreased due to the prices of mineral fuels increasing by less than the prices of all other products in the EPI basket (on average).

- ***Calculate the percentage increase that would have been observed in the EPI if all prices other than those for mineral fuels had remained unchanged*** (given by the points change for mineral fuels divided by the total exports index number in the previous period). For December quarter 2005 this is calculated as $0.35/129.3 \times 100 = 0.27$ per cent. In other words, a 1.0 per cent increase in mineral fuels export prices in December quarter 2005 would have resulted in an increase in the overall EPI of 0.27 per cent.

- ***Calculate the average percentage change in all other items excluding mineral fuels*** (given by subtracting the points contribution for mineral fuels from the total exports index in both quarters and then calculating the percentage change between the resulting numbers — which represents the points contribution of the 'other' products). For the above example, the numbers for total exports excluding mineral fuels are: September, 129.3 – 34.26 = 95.0; December, 132.1 – 34.61 = 97.5; and the percentage change, (97.5 – 95.0)/ 95.0×100 = 2.6 per cent. In other words, prices of all exports other than mineral fuels increased by 2.6 per cent on average between the September and December quarters 2005.

- ***Estimate the effect on the Total Exports of a forecast change in the prices of one of the products*** (given by applying the forecast percentage change to the products points contribution and expressing the result as a percentage of the total exports index number). For example, if prices of mineral fuels were forecast to increase by 25 per cent in March quarter 2006, then the points change for mineral fuels would be 34.61×0.25 = 8.7, which would deliver an increase in the total exports index of 8.7/132.1×100 = 6.6 per cent. In other words, a 25 per cent increase in mineral fuels prices in March quarter 2006 would have the effect of increasing the EPI by 6.6 per cent. Another way commonly used to express this impact is "a 25% rise in the price of mineral fuels would contribute 6.6 percentage points to the change in the total exports EPI".

Points contribution, reweighting and link periods

14.17 As noted in Chapter 10, the use of points contribution as an analytical tool is limited to comparison of those index numbers on the same weighting base. If a price index is rebased (and its weighting basis changed), it will not be possible to compare points contribution data on the old weighting basis with data from the new weighting basis. This means it is not possible to undertake points contribution analyses across a "link period". Linking of price indexes is discussed in detail in Chapter 12.

14.18 This limitation has particular impact on the international trade price indexes, since these price indexes are reweighted every year (with June quarter as the link period). This means that points contribution analyses cannot be undertaken, for example, in comparing price indexes from September quarter with price indexes from March quarter of the same calendar year. Such an analysis would bridge the June quarter link period and is therefore not possible.

Precision and rounding

14.19 To ensure consistency in the application of data produced from the price indexes, 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 price index data for analytical or other special purposes.

14.20 Index numbers are always published to a 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. Percentage changes between these periods are calculated from the rounded average index numbers.

CHAPTER 15 THE SYSTEM OF PRICE STATISTICS

INTRODUCTION

15.1 The objective of this final chapter is to help to improve users' knowledge and understanding of the array of Australian price statistics and facilitate the selection of the most appropriate measure(s) for particular applications, whether it be analysis of inflation, indexation, business contract adjustment or other purposes.

15.2 The producer and international trade price indexes are part of a broader system of price statistics. There exists a range of other price indexes that apply to different sectors of the economy. This chapter describes other direct price measures of price change produced by the ABS. It also describes where each of these measures, together with the producer and international trade price indexes, are used in compiling the Australian national accounts. In doing so, the interrelationships between the different price indexes are illustrated by reference to the input-output (IO) framework. Finally, a range of other derived measures of price change is described.

PRINCIPAL PRICE INDEXES

15.3 The principal price indexes in the system of economic statistics — the producer price indexes (PPI), the consumer price index (CPI), the house price index (HPI), the export price index (EPI), the import price index (IPI), and the labour price index (LPI) — are well–known and closely watched indicators of macroeconomic performance and the purchasing power of money, and are used as deflators in providing summary measures of the volume of goods and services produced and consumed. Consequently, these indexes are not only important tools in the design and conduct of the monetary and fiscal policy of the government, but also of great utility in economic decisions throughout the private sector. These price indexes provide an integrated and consistent view of price developments pertaining to production, consumption, and international transactions in goods and services.

Direct measures of price change

15.4 The principal price indexes described above are *direct measures of price change*, in that they are derived through collecting and directly using price data. All the producer and international trade price indexes described in this manual are direct measures of price change. The CPI, HPI and LPI are detailed in the following paragraphs.

Consumer Price Index (CPI)

15.5 The Consumer Price Index (CPI) relates to goods and services bought by resident household consumers. The population group for the CPI is employee households in metropolitan areas. Indexes are produced for each of the eight capital cities, for eleven broad groups of goods and services and for 90 expenditure classes. The CPI is published quarterly in *Consumer Price Index, Australia* (cat. no. 6401.0).

15.6 The CPI is an input index, and it relates to the prices of goods and services bought by householders. The valuation basis is purchasers' prices and the prices are obtained by direct collection from retail outlets and other businesses, authorities, etc. from which the CPI population group buys.

15.7 The CPI has fixed weights that are updated approximately every five years.

House Price Index (HPI)

15.8 The House Price Index (HPI) relates to the selling prices of houses in each of the eight capital cities. The information is presented in the form of price indexes constructed separately for Established Houses and for Project Homes. The index for project homes is compiled for use in calculating the "house purchase" expenditure class of the Consumer Price Index (CPI). The index for established houses, while not contributing to the CPI, is compiled and published along with the project homes index in recognition of the widespread interest in information specifically relating to housing prices.

15.9 The valuation basis of the HPI is purchasers' prices. The HPI is published quarterly in *House Price Index, Eight Capital Cities* (cat. no. 6416.0).

Labour Price Index (LPI)

15.10 The Labour Price Index (LPI) measures changes in the price of labour services resulting from market pressures, and is unaffected by changes in the quality and quantity of work performed. Wages and salaries account for the majority of expenditure on labour costs and an index of wage prices is published quarterly. Non-wage costs (such as superannuation, workers' compensation and paid holiday leave) cover the remaining part of labour costs. A non-wage price index is published annually. When combined with the wage price index, the overall labour price index is the outcome.

15.11 As the LPI relates to labour costs incurred by employers in both the public and public sector, the valuation basis for the LPI is purchasers' prices. Employers primarily engaged in agriculture, forestry and fishing are outside the scope of the LPI.

15.12 The LPI is published quarterly in *Labour Price Index, Australia* (cat. no. 6345.0).

PRICE INDEXES AND THE VALUE AGGREGATE

15.13 This manual has described price indexes in terms of a fixed basket of goods and services, with the resultant measure of price change being measured by changes in the value of the basket over time. The basket is "fixed" in terms of both the types of products in the basket and the quantities of those products. In this context, a price index is only meaningful in relation to the "basket" to which it refers. The *value aggregate* is a measure that expresses base period quantities in terms of current period prices. For an input index, a value aggregate is a measure of expenditure, and for an output index it is a measure of revenue. A value aggregate, with prices from period *t* and quantities from period *0* is defined as:

$$V^{0,t} = \sum_{i=1}^{n} p_i^t q_i^0$$

15.14 Included in this definition of a value aggregate is the specification of the group of included products (which items to include) and of the economic agents engaging in transactions involving those products (which transactions to include), as well as the valuation and time of recording principles motivating the behaviour of the economic agents undertaking the transactions (determination of prices). The included elementary items, their valuation (the p_i^t), the eligibility of the transactions and the item weights (the q_i^0) are all within the domain of definition of the value aggregate.

15.15 The meaningfulness of all of the indexes such as the PPI, the CPI and so forth derives in no small measure from the meaningfulness of the value aggregates to which each refers. Therefore, it is important to understand the macroeconomic framework in which these price indexes are the key components for measuring changes in real output.

PRICE INDEXES AND THE AUSTRALIAN NATIONAL ACCOUNTS

15.16 The system of national accounts can be considered a core system of value aggregates for transactions in goods and services that is of broad economic interest. The major price indexes should cover, in principle, those value aggregates in the national accounts system representing major flows of goods and services and levels of tangible and intangible stocks. If the coverage of the major indexes is not complete, relative to the national accounts aggregates, then it should be compatible with and clearly related to the components of these aggregates. This section describes how the producer and international trade price indexes, as well as the CPI and LPI, are related to components of the Australian system of national accounts (ASNA).

15.17 The Australian system of national accounts is designed to provide a systematic summary of economic activity and has been developed to facilitate the practical application of economic theory. At their summary level, the accounts reflect key economic flows: production, income, consumption, investment and saving. At their more detailed level, they are designed to present a statistical picture of the structure of the economy and the detailed processes that make up domestic production and its distribution.

15.18 A top-level view of the major national accounts aggregates allows an overview of the principal price indexes described above. Highlighting the use of price indexes in the compilation of the national accounts allows precise relationships to emerge between the well-known headline price indicators—the PPIs, CPI, HPI, EPI, IPI, and LPI—and the closely-watched national accounts aggregates.

Supply and use of goods and services in aggregate

15.19 At the most aggregate level, the supply and use of goods and services in the national accounts is the macroeconomic identity equating total supply with total uses. "Total supply" is the sum of output, imports, and net taxes (taxes less subsidies on products). "Total uses" is the sum of intermediate consumption, the final consumption of households and government, capital formation, changes in inventories, and exports.

15.20 There are three approaches which can be used to measure GDP:

- the *income approach* (I), which involves summing net factor incomes, consumption of fixed capital (depreciation) and taxes less subsidies on production and imports;
- the *expenditure approach* (E), which involves summing all final expenditures, changes in inventories and exports less imports of goods and services; and
- the *production approach* (P), which involves taking the value of goods and services produced by an industry (i.e. output) and deducting the cost of goods and services used up by the industry in the production process (i.e. intermediate consumption) and adding the result across all domestic industries. To this is added taxes less subsidies on products if output is valued at basic prices, as recommended in the national accounts framework *System of National Accounts, 1993* (or "SNA93").

15.21 GDP is internationally recognised as the central national accounts aggregate for measuring national economic performance. It is essentially a measure of production, as distinct from final demand: more precisely, it measures the value added by the productive activity carried out by all the units resident in an economy. As imports are not included in GDP, a price index for GDP is tracking internally generated inflation. Compiling indexes for tracking the parts of relative change in GDP and its components that can be attributed to price and volume change is one of the primary objectives for ABS price indexes.

15.22 Before turning to further elaboration on the components of these goods and services accounts, it is important to specify how each entry in the value aggregates comprising them is to be recorded. The individual items in the value aggregate equation represent detailed goods and services flows that are classified into categories of transactions. There are two defining aspects of recording transactions: *timing* and *valuation*.

Timing of transactions covered

15.23 To associate each transaction with a date, the national accounts consider a transaction to have occurred, and therefore required to be recorded, when the event takes place that creates the liability to pay. In the case of flows of goods and services, the time of recording the transaction should be when the ownership of the good is exchanged or when the service is delivered. In general, this time will be when the payment actually takes place but it is not always the case (e.g. when goods are sold on credit).

Valuation

15.24 There are two valuation principles in the national accounts, one for suppliers and one for users. For suppliers, transactions in goods and services are to be valued at *basic prices*. The basic price is the price per unit of good or service receivable by the producer. As the producer does not receive taxes (if any) on products, but does receive subsidies (if any) on products, taxes on products are excluded from the basic price, while subsidies on products are included. The producer also does not receive invoiced transportation and insurance charges provided by other suppliers, or any distribution margins added by other, retail/wholesale service producers, and these are also excluded from the basic price. On the other hand, the user, as purchaser, pays all of these charges, and users' purchases are therefore valued at purchasers' prices, which add taxes net of subsidies on products and margins for included transportation, insurance, and distribution services to the basic price.

15.25 Accordingly, output and imports are valued at *basic prices*, to which are added taxes less subsidies on products (net taxes) to arrive at total supply. The components of total uses (including both final expenditure and intermediate consumption) are valued at *purchasers' prices*. This is straightforwardly interpreted for the final consumption of households and government. For capital formation expenditures, the notion of purchasers' prices also includes the costs of "setting up" fixed capital equipment. For exports, purchasers' prices include export taxes net of subsidies, according to the "free on board" (f.o.b.) value at the Australian customs frontier.

Use of price indexes in national account component aggregates

15.26 The producer and international trade price indexes are used in the expenditure approach to measuring GDP as well as the production approach. GDP using the income approach is compiled only in current prices and does not directly utilise price indexes; proxy volume estimates are produced for this approach using the implicit price deflator (IPD) from the expenditure account (the IPD is detailed below under the discussion on Derived Measures of Price Change).

15.27 It is important to highlight that the ABS price indexes used in compiling the national accounts are not the only mechanisms used to derive volume measures. Other techniques are also used, including direct volume measurement where applicable. Of particular importance is the use of quantity revaluation (i.e. multiplying current period quantities by a base period unit value) in calculating volumes of exports. This approach is used, for example, with homogeneous export products such as wheat and coal. Further, in some circumstances price indexes are combined to produce aggregate deflators (for example, combining a labour price index component with a PPI component). These composite measures are required when the value aggregate from the national accounts has a broader scope than the contributing price indexes.

THE INPUT OUTPUT FRAMEWORK

15.28 The ASNA also contains a comprehensive input-output framework. Input-output tables are essentially a disaggregation of the goods and services account. The framework represents a fully consolidated measure of economic production for the economy where only transactions representing final production are shown and intermediate production is netted out. On the other hand input-output tables bring back into focus inter-industry flows of goods and services, thereby providing a more complete description of the process of economic production. They provide detailed information about the supply and disposition of commodities in the economy and the structure and interrelationships of industries. This particular aspect of input-output tables suggests an ideal framework for showing the interrelationships between price indexes. Not only are the interrelationships between consumer, producer, import, export and labour prices themselves established within such a table, but also their linkages with price index for major macroeconomic aggregates such as gross domestic product (GDP).

15.29 The interrelationships between each of the above price measures can be illustrated by reference to the framework used to produce the Australian input-output tables. An input-output absorption (or use) table has commodities and primary inputs in its rows, and using industries and final demand categories in its columns. It shows the flow of goods and services and the link from production to final demand.

15.30 Input-output tables (or matrices) can be presented in either basic prices or purchasers' prices. Looking across the rows of a table at purchasers' prices, the margin elements are included in the values of the flows of all the commodities which attract the margin; on the other hand, in a table at basic prices, the margin commodity flows (e.g. retail trade, road freight, etc.) are shown separately in their own right against the appropriate sector (e.g. transport). Note that as per the SNA93 definition of basic prices, transport costs are included in basic prices of other products in those cases where the transport service is not separately invoiced.

15.31 Further, there are two alternative treatments of imported commodities in the tables: direct allocation and indirect allocation.

15.32 Direct allocation of imports involves allocating all imports directly to the sectors that use them (in which case they are reflected in row P6 in the lower part of the table, and the top half of the table thus refers only to the use of local products). On the other hand, indirect allocation means that imports are added to the supply of the equivalent commodities produced in Australia and then allocated across the corresponding row to the using sectors; the top half of the table thus contains imported and locally produced commodities aggregated together.

15.33 For a more detailed explanation of these concepts, see *Australian National Accounts: Concepts, Sources and Methods* (cat. no. 5216.0).

15.34 The two tables below are respectively valued at purchasers' prices with indirect allocation of imports (Table 15.1), and basic prices with direct allocation of imports (Table 15.2). A more detailed discussion of these relationships, together with an outline of future projects for ABS prices statistics, is provided in *An Analytical Framework for Price Statistics* (cat. no. 6421.0).

DERIVED MEASURES OF PRICE CHANGE

National accounts chain price indexes

15.35 Chain price indexes published in the national accounts are annually reweighted chain Laspeyres price indexes. An annually chained price index weights price changes together using the previous year's weights for each quarter of the current year. The chain price indexes are calculated from the deflators used to derive the volume estimates, weighted together in the same way and at the same level of detail as the chain volume estimates. In those cases where quantity revaluation is used to derive volume estimates the implicit price deflator at a detailed level of disaggregation is used in constructing the chain price indexes to minimise the impact of any compositional change.

15.36 Chain price indexes are published in *Australian National Accounts: National Income, Expenditure and Product* (cat. no. 5206.0).

Implicit price deflators

15.37 In addition to the chain price indexes published for the major national accounts aggregates, the ABS publishes a range of implicit price deflators (IPDs). IPDs are obtained by dividing a current-price value by the chain volume measure expressed in dollar terms. Thus IPDs are derived measures (hence the term *implicit*) and are not normally the direct measures of price change by which current price estimates are converted to volume measures. They reflect both changes in the prices between the two periods and changes in the composition of the aggregate between those periods.

15.38 Because the composition of an aggregate often changes from period to period, IPDs do not compare the price of a constant basket of goods and services between any two periods (except in comparing the base period with any other period). IPDs calculated from quarterly aggregates may be particularly affected by changes in the physical composition of those aggregates. As much of the quarter-to-quarter change in the physical composition is of a seasonal nature, IPDs derived from seasonally adjusted data are normally more reliable measures of price change than those calculated from unadjusted data. Even so, seasonally adjusting the series may not completely eliminate the impact of seasonal changes on the derived IPDs.

15.39 IDPs are available for GDP, exports of goods and services, imports of goods and services, and of domestic final demand and its four major components.

15.40 Implicit price deflators are published quarterly as part of *Australian National Accounts: National Income, Expenditure and Product* (cat. no. 5206.0), and *Balance of Payments and International Investment Position, Australia* (cat. no. 5302.0).

Which price series should I use?

15.41 Quarter to quarter movements in fixed-weight price indexes are generally consistent with those for chain price indexes for indexes with similar coverage. In general, for short-term analysis of price change, the choice of index formula (fixed-weighted or current-weighted) has limited effect although they can differ significantly in some quarters. Overall, the chain price indexes are considered the most suitable indexes for measuring actual price change, as the effects of compositional change are excluded from these indexes whereas IPDs are affected by compositional change.

INPUT OUTPUT TABLE, PURCHASES' PRICES (PP), INDIRECT ALLOCATION OF IMPORTS

	To / From	Row Prefix	Intermediate Demand: *Agriculture, etc*	*Mining*	*Manufacturing, etc*	*Construction*	*Services*	*Intermediate Usage (sub total)*	Final Demand: *Final Consumption Expenditure - Private*	*Final Consumption Expenditure Government*	*Gross Fixed Capita Expenditure - Private*	*Gross Fixed Capita Expenditure - Public enterprises*	*Gross Fixed Capita Expenditure - general governemnt*	*Increase in stocks*	*Exports of Goods and servcies*	*Final Demand (sub-total)*	*Total Supply (grand total)*
	Column prefix		0101-0400	1100-1500	2101-3701	4101-4102	4501-9601		Q1	Q2	Q3	Q4	Q5	Q6	Q7		
Intermediate (a) inputs	Agriculture	0101-0400			**MUMI**	**HB**			**C P I**		**HPI**						
	Mining	1100-1500															
	Manufacturing etc.	2101-3701															
	Construction	4101-4102															
	Services - Market	4501-															
	-Non Market	9601															
	Intermediate inputs (sub-total)																
Primary Inputs	Wages salaries and supplements	P1	**LPI**														
	Gross operating surplus	P2															
	Commodity taxes (net)	P3															
	Indirect taxes n.e.c. (net)	P4															
	Sales by final buyers	P5															
	Australian production																

(a) Including imports

National Accounts IPDs and chain price index
chain price indexes

INPUT OUTPUT TABLE, BASIC PRICES (BP), INDIRECT ALLOCATION OF IMPORTS

	To / From	Row Prefix	Intermediate Demand: *Agriculture, etc*	*Mining*	*Manufacturing, etc*	*Construction*	*Services*	*Intermediate Usage (sub total)*	Final Demand: *Final Consumption Expenditure - Private*	*Final Consumption Expenditure Government*	*Gross Fixed Capita Expenditure - Private*	*Gross Fixed Capita Expenditure - Public enterprises*	*Gross Fixed Capita Expenditure - general governemnt*	*Increase in stocks*	*Exports of Goods and servcies*	*Final Demand (sub-total)*	*Total Supply (grand total)*
	Column prefix		0101-0400	1100-1500	2101-3701	4101-4102	4501-9601		Q1	Q2	Q3	Q4	Q5	Q6	Q7		
Intermediate (a) inputs	Agriculture	0101-0400													**EPI**		
	Mining	1100-1500															
	Manufacturing etc.	2101-3701	**APMI**						**APMI**								
	Construction	4101-4102	**Construction**						**Construction**								
	Services - Market	45011	**PPI Services**						**PPI Services**								
	-Non Market	9601															
	Intermediate inputs (sub-total)																
Primary Inputs	Wages salaries and supplements	P1															
	Gross operating surplus	P2															
	Commodity taxes (net)	P3															
	Indirect taxes n.e.c. (net)	P4															
	Sales by final buyers	P5															
	Imports	P6	**SOP - Imports/IPI**						**SOP - Imports/IPI**								
	Australian production																

(a) Including imports

SOP - Domestic (including exports)

APPENDIX 1 PRICE INDEXES AND CONTRACT PRICE INDEXATION

INTRODUCTION

Price indexes published by the **Australian Bureau of Statistics (ABS)** provide summary measures of the movements in various categories of prices over time. They are published primarily for use in Government economic analysis.

Price indexes are also often used in contracts by businesses and government to adjust payments and/or charges to take account of changes in categories of prices (**Indexation Clauses**).

This paper sets out a range of issues that should be taken into account by parties considering including an Indexation Clause in a contract using an ABS published price index.

THE ROLE OF THE ABS IN RESPECT OF INDEXATION CLAUSES

Although the ABS acknowledges that the various price indexes it publishes are used by businesses and government to adjust payments and/or charges, it neither endorses nor discourages such use.

The role of the ABS as the central statistical authority for the Australian government includes publishing price index data, and to broadly explain the underlying methodology and general limitations on such data. The ABS may provide information about what price indexes are published by it, but will not recommend or comment on the use (or otherwise) of the price indexes. In addition, the ABS does not advise, comment or assist in preparing or writing contracts and nor does it provide advice on disputes arising from contract interpretation.

IMPORTANT DISCLAIMER

This paper is intended to summarise information about the various price indexes currently published by the ABS and some of the issues which should be considered by persons in deciding to use such price indexes in Indexation Clauses. It is a brief description only and is not a comprehensive or exhaustive description of price indexes or of the issues which should be considered by persons in deciding to use price indexes or Indexation Clauses.

Neither the ABS, the Commonwealth of Australia, nor their employees, advisers or agents will in any way be liable to any person or body for any cost, expense, loss, claim or damage of any nature arising in any way out of or in connection with the statements, opinions or other representations, actual or implied, contained in or omitted from this paper or by reason of any reliance thereon by any person or body. This paper is not business, investment, legal or tax advice and persons should seek their own independent professional advice in respect of all matters in connection with the use of price indexes published by the ABS and their use in Indexation Clauses.

No representation or assurance is given that any ABS published price indexes are accurate, without error or appropriate for use by persons or that the ABS will continue to publish any of the price indexes, publish them at a particular time or that the methodologies for their determination will not be changed or that they will be suitable for use in any Indexation Clauses.

WHAT PRICE INDEXES ARE PUBLISHED BY THE ABS?

The **Consumer Price Index (CPI)** is regarded as Australia's key measure of inflation. It is designed to provide a general measure of price inflation for the Australian household sector as a whole. The CPI measures changes over time in the prices of a wide range of consumer goods and services acquired by Australian metropolitan households and it is published quarterly, 3 to 4 weeks after the end of the reference quarter. It is revised only in exceptional circumstances, such as to correct a significant error. As is the case with all price indexes, the reference base (i.e. the period in which the index is set equal to 100.0) will be changed periodically. The index number levels for all periods will be changed by this process and it may also result in differences, due to rounding, between the percentage changes published on the old base and those on the new base.

Several **Producer Price Indexes (PPIs)** are produced and published. Economy-wide indexes are presented within a stage of production framework together with a set of indexes relating to specific industries (selected manufacturing, construction, mining and service industries). PPIs can be constructed as either output measures or input measures. Output indexes measure changes in the prices of goods and/or services sold by a defined sector of the economy while input indexes measure changes in the prices of goods and/or services purchased by a particular economic sector. PPIs are published quarterly, 3 to 4 weeks after the end of the reference quarter. Once published the PPIs are revised infrequently, sometimes to incorporate improved methods in one or more of the components and occasionally to correct an error. As is the case with all price indexes, the reference base (i.e. the period in which the index is set equal to 100.0) will be changed periodically. The index number levels for all periods will be changed by this process and it may also result in differences, due to rounding, between the percentage changes published on the old base and those on the new base.

The **International Trade Price Indexes** are intended to broadly measure changes in the prices of goods imported into Australia (the **Import Price Index (IPI)**) and goods exported from Australia (the **Export Price Index (EPI)**). The prices measured in the indexes exclude import duties, and exclude freight and insurance charges incurred in shipping goods between foreign and Australian ports. As the prices used in the indexes are expressed in Australian currency, changes in the relative value of the Australian dollar and overseas currencies can have a direct impact on price movements for the many commodities that are bought and sold in currencies other than Australian dollars. Both the IPI and EPI are published quarterly, 3 to 4 weeks after the end of the reference quarter. The IPI and EPI are not often revised. As is the case with all price indexes, the reference base (i.e. the period in which the index is set equal to 100.0) will be changed periodically. The index number levels for all periods will be changed by this process and it may also result in differences, due to rounding, between the percentage changes published on the old base and those on the new base.

The **Labour Price Index (LPI)** broadly measures annual changes in the price of labour in the Australian labour market. The **Wage Price Index (WPI)** broadly measures changes in the wages paid by Australian businesses to employees and it is compiled and published quarterly, about 6 to 7 weeks after the end of the reference quarter. The non-wage price indexes and the aggregate labour price index are only produced annually in respect of financial years ending 30 June. Individual indexes are compiled for various combinations of State/Territory, sector (private/public), and broad industry groups, with wage price indexes also being produced for broad occupation groups. The 'headline' wage price index is that for the total hourly rates of pay excluding bonuses for Australia and it is published in original, seasonally adjusted and trend terms. The seasonally adjusted and trend series for some

quarters are revised as extra quarters are included in the series analysed for seasonal influences, but the non-seasonally adjusted (i.e. original) series is not revised in normal circumstances. As is the case with all price indexes, the reference base (i.e. the period in which the index is set equal to 100.0) will be changed periodically. The index number levels for all periods will be changed by this process and it may also result in differences, due to rounding, between the percentage changes published on the old base and those on the new base.

Price indexes covering a wide range of economic transactions are produced as part of the **National Accounts**. Two types of national accounts based price index are published. The first type is referred to as **chain price indexes** which are calculated for all expenditure components and sub-components of **Gross Domestic Product (GDP)**. The components are: government consumption, household consumption, private capital formation, public capital formation, and imports and exports of goods and services. Chain price indexes are also calculated for GDP and other macro-economic aggregates such as Domestic Final Demand and Gross National Expenditure. Chain price indexes use as their weights the volumes of expenditure in the previous financial year (ending 30 June). The second type of price index is referred to as **implicit price deflators (IPDs)** which are compiled at the same levels as for the chain price indexes but which use for their weights the volumes of expenditure in the current period. IPDs have long been used to provide macro-economic measures of price change and are usually used in seasonally adjusted form. Both chain price indexes and IPDs are compiled quarterly and are published roughly two months after the reference period. Unlike the other price indexes listed above, the National Accounts price indexes are often revised, sometimes to a significant extent. Also, they are re-referenced to a new base year every year so the level of the index changes regularly, although the percentage changes for earlier periods are not normally affected by this process, other than for rounding differences. These two characteristics are important considerations if National Accounts price indexes are to be used in contracts.

GENERAL MATTERS TO CONSIDER WHEN DEVELOPING INDEXATION CLAUSES USING A PRICE INDEX

Considerable care should be taken when considering and using Indexation Clauses. Appropriate professional advice should be obtained when considering the use of an Indexation Clause or any ABS published price indexes.

The following are some general matters to consider when considering an ABS published price index in an Indexation Clause. It is not an exhaustive list. These matters are provided subject to the disclaimer outlined above.

- **Establish the base payment, selling or purchase price subject to indexation.** Specify the item subject to indexation as precisely as possible (e.g. rent, wage rate, commodity, etc.). Provide the effective date (e.g. quarter or year) of this base price, because it is the period from which the base payment, etc. will be indexed. Indicate the relationship between the effective date of the base payment, etc. and the price index being used in the indexation (e.g. a contract coming into effect on 5 January 2005 could have a price indexed using the most recent available quarterly data (in this case, September quarter 2004) as its starting point or by using the 2003-04 financial year as the starting point, depending on the intent of the parties).

- **Select an appropriate index or indexes.** The index or indexes selected will affect the price change recorded and should be chosen carefully to best represent the item subject to indexation and the intention of the parties.

- **Clearly identify the selected index and cite an appropriate source.** The Indexation Clause of a contract should identify the selected index by its complete title and any identifying code. For example, in the case of the CPI, it should be specified whether the index to be used is the All groups CPI, or a selected sub-component index of the CPI and also whether it is the weighted average of the eight capital cities or for a particular city. In the case of PPIs, the broad alternatives that could be specified are stage-of-production, or commodity, or industry-based indexes. The specific component index being used should be explicitly identified. For LPIs, the broad characteristics that could be specified are national, state, industry group or occupation group indexes. Contracting parties should cite specific index series rather than table numbers and/or table titles in their indexation contracts because table numbers and the contents of tables are subject to change.

- **State the frequency of price adjustment.** The Indexation Clause should specify the frequency at which price adjustments are to be made, such as quarterly, half-yearly, annually etc. It may be useful to set out the method to be used in calculating the indexation factor, particularly if the indexation is half-yearly or annually. For example, different results are generally obtained for annual estimates calculated as the change in the latest quarter over the same quarter of the preceding year (e.g. June quarter 2004 over June quarter 2003) compared with those calculated as the average of the latest four quarters over the average of the preceding four quarters (e.g. the average of the four quarters from September quarter 2003 to June quarter 2004 over the average of the four quarters from September quarter 2002 to June quarter 2003). Similar issues apply to half-yearly changes.

- **Provide for renamed, varied or discontinued price indexes.** Occasionally price indexes can be reviewed or restructured which may result in some component index series being renamed, discontinued or the timing of the publication of the index changed. Sometimes an index is permanently discontinued (for example, when a commodity declines in market importance). Indexation Clauses should contain a default mechanism for determining an equivalent appropriate index or price adjustment mechanism should this occur.

- **Provide for potential revisions to the price index data.** The quarterly and annual movements recorded by the ABS price indexes are not often revised (apart from the seasonally adjusted wage price index and trend wage price index, which can be revised as extra terms are added to the end of the series). Generally, the situations in which revisions do occur include to correct an error that has arisen in the data first published. It could be useful for parties to set out agreed procedures to deal with the possibility of revisions occurring. For example, an Indexation Clause could state that a price is to be indexed by the percentage change first published in the relevant (indexation) series for each period covered by the contract, or it could be indexed by the latest available data at the point at which the indexation clause takes effect.

- **Avoid locking indexes used for Indexation Clauses into any particular reference base period.** Occasionally the reference base period of a price index (i.e. the period in which the index is set equal to 100.0) can be changed. This will result in a change in the index level from that which was previously available. Relative movements of any series over time, however, are not generally affected by a reference base change (except for rounding differences). Indexation Clauses should be drafted by the parties to them to not be adversely affected by a change to the reference base period of a price index.

- **Define the formula for the price adjustment calculation.** Often the change in payments or price is directly proportional to the percentage change in the selected index between two specified time periods. The following CPI example, which has a reference base year of 1989-90 = 100.0, illustrates the computation of percentage change:

Index number for the All Groups CPI for Sydney in 2003-04	144.1
less index number for the corresponding series in 2002-03	141.1
Change in index points	3.0
Percentage change	3.0/141.1 x 100 = 2.1%

- **Allow for negative price movements.** Any potential variations from the recorded price movements should be explicitly set out. For example, in some Indexation Clauses there is no change in the contract price in a period in which there is a fall in the price index being used for indexation. In some cases, there will be a catch-up once the index rises again.

FURTHER DETAILS

For more information about ABS price indexes, contact:

Lee Taylor
Assistant Director
Dissemination
Prices Branch
Australian Bureau of Statistics
PO Box 10
Belconnen, ACT, 2616

phone (02) 6252 6251

email <lee.taylor@abs.gov.au>

GLOSSARY OF TERMS

This glossary provides brief definitions or explanations of the main technical terms and abbreviations used in this publication.

ABS	Australian Bureau of Statistics.
Aggregation	The process of combining lower level price indexes to produce higher level indexes.
AHECC	Australian Harmonised Export Commodity Classification.
ANZSIC, 1993	The Australian and New Zealand Standard Industry Classification, 1993 edition.
APR	The "arithmetic mean of price relatives" - a formula used in compiling price indexes.
Basket	A commonly used term for the goods and services priced for the purpose of compiling a price index.
BOPBEC	The Balance of Payments Broad Economic Category Classification.
Component	A level of aggregation of like items in a price index. It can be either a series of specifications linked to a component or a series of components linked to higher level components.
CPI	Consumer Price Index - a general indicator of the rate of change in prices paid by households for consumer goods and services.
Elementary aggregate	The lowest level of commodity classification in ABS price indexes and the only level for which index numbers are constructed by direct reference to price data.
GM	The "geometric mean" - a formula used in compiling price indexes.
Fixed-weight index	A price index in which the weighting pattern is fixed for the life of each index series.
Goods and services tax (GST)	An ad valorem tax applied to supplies (goods and services produced or delivered) by registered suppliers engaged in taxable activity. The GST is effectively paid only by final consumers. The legislated rate of GST is 10%.
HS	The international Harmonised System for classifying exports and imports. In Australia, it is embodied in the Combined Australian Customs Tariff and Statistical Nomenclature (Customs Harmonised Tariff).
Indexation	The periodic adjustment of a money value according to changes in a price index.
Index points change	The change in an index number series from one period to another expressed in terms of the difference in the number of index points in each of the index numbers.
Index points contribution	A quantitative expression of how much each component contributes to the magnitude of the All Groups index number.
Index number series	A series of numbers measuring the change over time from a reference base period value, which is normally presented as an index value of 100.0.

Inflation (deflation)	A term commonly used to refer to changes in price levels. A rise in prices is called inflation, while a fall is called deflation.
Input-output table	An input-output table is a national accounting presentation that proovides a means of presenting a detailed analysis of the process of production and the use of goods and services and the income generated in the production process.
IOPC	The Input-output Product Classification.
ITPI	International Trade Price Indexes - the Export Price Index and the Import Price Index are the two ITPIs.
Linking	The technique used to join a new index series (e.g. one having a changed composition and/or weighting pattern) to an old index series to form a continuous series. The technique ensures that the resultant linked index reflects only price variations and that introducing the new items and/or weights does not affect the level of the index.
Link factor	A ratio used to join a new index series to an old index series to form a continuous series.
Matched sample	In a matched sample, items that are priced from period to period are identical in all respects.
Percentage change	The change in an index series from one period to another expressed as a percentage of its value in the first of the two periods.
PPI	Producer price index.
Price index	A composite measure of the prices of items expressed relative to a defined base period.
Price levels	Actual money values in a particular period of time.
Price movements (or price changes)	Changes in price levels between two or more periods. Movements can be expressed in money values, as price relatives or as percentage changes.
Price relative	The ratio of the price level in one period to the price level in an earlier period.
Quality adjustment	The elimination of the effect that changes in the quality or composition of an item have on the price of that item in order to isolate the pure price change.
RAP	The "relative of average prices" - a formula used in compiling price indexes.
RBA	Reserve Bank of Australia.
Reference base	The period in which an index series is given a value of 100.0. The reference base should not be confused with the weighting base period - see "Weighting base" below.
Regimen item	The selected goods and services priced for the purpose of compiling a price index.
Respondents	Businesses, government agencies etc from which prices data and associated information are collected for use in compiling the PPIs and the ITPIs.
Sample	A representative selection of items to be priced.

Seasonal items	Products that are only available, or available in very much greater supply, at certain times of the year.
SITC	The Standard International Trade Classification.
Spatial price indexes	Indexes that measure the difference in prices between localities at a particular point in time.
Specification	Detailed description of the characteristics of an item to be priced.
Splicing	A technique used to introduce new items or respondents into the index calculations so that the level of the index is not affected.
Superlative index	A superlative index is one of a small group of indexes that makes equal use of prices and quantities and treats them in a symmetric manner in each pair of periods under observation. Examples are the Fisher Index and the Tornqvist Index. Superlative indexes require both price and expenditure values for all periods.
Temporal price indexes	Indexes that measure differences in prices over time in a particular locality (or group of localities).
The New Tax System	Package of changes to the taxation and social welfare system including the introduction of GST and the changes to business taxation introduced in 2000 in response to the review of business taxation.
Transaction price	The price actually paid by a purchaser of a good or service – as opposed to a "list" or "quoted" price.
Utility	Often defined as the satisfaction derived from consumption of a good or service.
Value aggregate	The current cost in dollars per year of purchasing (or revenue received from selling) the same quantity of goods or services as was purchased/sold in the weighting base period.
Weight	The measure of the relative importance of an item in the index regimen. Weights can be expressed in either quantity or value terms. Value weights are used by the ABS in compiling all official price indexes
Weighted average	An average that is obtained by combining prices or price indexes according to the relative importance of each component.
Weighting base	The period to which the fixed quantity weights relate. (See also "Reference base".)

BIBLIOGRAPHY

Australian Bureau of Statistics, *Information Paper: The Introduction of Hedonic Price Indexes for Personal Computers,* cat. no. 6458.0, Canberra, February 2005.

Allen, R.G D. 1975, *Index Numbers in Theory and Practice,* The Macmillan Press Ltd, London.

Aizcorbe, Ana, Corrado, Carol and Mark Doms 2000 'Constructing Price and Quantity Indexes for High Technology Goods', *Paper presented at the National Bureau of Economic Research Summer Institute 2000 session on Price, Output and Productivity Measurement*, Cambridge, July 31.

Becker, Gary S. 1965, 'A Theory of the Allocation of Time,' *Economic Journal*, vol. 75, pp.493-517.

Bresnahan, Timothy F. and Robert J. Gordon eds 1998, *The Economics of New Goods, Studies in Income and Wealth Volume 58*, National Bureau of Economic Research Conference on Research in Income and Wealth, The University of Chicago Press.

Boskin, Michael J., Ellen R. Dulberger, Robert J. Gordon, Zvi Griliches and Dale Jorgensen 1996, 'Towards a More Accurate measure of the Cost of Living,' *Final Report to the U.S. Senate Finance Committee from the Advisory Committee To Study The Consumer price Index.*

Department of Labour, *Wage Indexation for Australia?* Discussion Paper, Melbourne 1974.

Department of Social Security, *Better incomes for older Australians?* Policy Research Paper no. 65, Canberra, August 1993.

Department of Social Security, *Developments in Social Security: A Compendium of Legislative Change Since 1908*, Canberra, June 1983.

Diewert, W. Erwin 1976, 'Exact and Superlative Index Numbers', *Journal of Econometrics* vol. 4, pp. 115-145.

Diewert, W. Erwin 1978, 'Superlative Index Numbers and Consistency in Aggregation', *Econometrica*, vol. 46, no. 4, pp. 883-890.

Diewert, W. Erwin 1987, 'Index Numbers' in Eatwell, J., M. Milgate, and P. Newman, eds *The New Palgrave: A Dictionary of Economics*, London: The Macmillan Press, 1987, pp. 767-80.

Diewert, W. Erwin 1988, 'The Early History of Price Index Research,' *Discussion Paper no. 88-26*, Department of Economics, The University of British Columbia, Vancouver, Canada, September.

Diewert, W. Erwin 1995, 'Axiomatic and Economic Approaches to Elementary Price Indexes,' *Discussion Paper no. 95-01*, The University of British Columbia, Department of Economics.

Diewert, W. E. 1992, 'Fisher Ideal Output, Input, and Productivity Indexes Revisited', *The Journal of Productivity Analysis*, vol. 3, pp. 211-248.

Diewert, W. E. 1996, 'Sources of Bias in Consumer Price Indexes,' *Discussion Paper 96/4*, School of Economics, University of New South Wales.

Diewert, W. E. 2000, 'The Quadratic Approximation Lemma and Decompositiosn of Superlative Indexes,' *Discussion Paper no. 00-15*, The University of British Columbia, Department of Economics.

Fisher, I. 1922, *The Making of Index Numbers,* Boston: Houghton Mifflin. (Edition 2, 1923).

Fisher, Franklin M. and Karl Shell 1972, 'Taste and Quality Change in the Pure theory of the True cost-of-Living Index,' *The Economic Theory of price Indices: Two Essays on the Effects of Taste, Quality, and Technological Change,* Academic Press, New York and London.

Hausman, Jerry A. 1994, 'Valuation of New Goods Under Perfect aand Imperfect Competition', NBER Working Paper no. 4970, reprinted in Bresnahan, T. and R.J. Gordon, eds., *The Economics of New Goods*.

Henderson, James M. and Richard E. Quandt 1958, *Microeconomic Theory A Mathematical Approach*, McGraw-Hill.

Hicks, John 1940, 'The valuation of the Social income,' *Econometrica*, vol. 7, August pp.108-24.

Hofsten, E. v. (1952) *Price Indexes and Quality Changes*, Stockholm.

Houthakker, H. S. 1950, 'Revealed preference and the Utility Function,' *Economica*, vol. 17, pp. 159-174.

INDECS, *State of Play 8: The Australian Economic Policy Debate*, Allen & Unwin, Sydney, 1995.

International Monetary Fund, et al (2004), *Producer Price Index Manual: Theory and Practice*, IMF

Konüs, A. A. 1924, 'The Problem of the True Index of the Cost of Living,' translated version in *Econometrica*, vol. 7, no. 1, 1939, pp. 10-29.

Lancaster, Kelvin J., 1966 'A New Approach to Consumer Theory,' *Journal of Political Economy*, vol. 74, pp. 132-157.

Moulton, Brent R. 1996 'Bias in the Consumer Price Index: What Is the Evidence,' *Journal of Economic Perspectives*, vol. 10, no. 4 pp. 159-177.

Muellbauer, John 1974, 'Household Production Theory, Quality and the "Hedonic Technique",' *The American Economic Review*, vol. 64, no. 6, pp. 977-994.

Muth, R. F. 1966, 'Household Production and Consumer Demand Functions,' *Econometrica*, vol. 34, pp. 699-708.

Nicholson, J. L. 1975, 'Whose Cost of Living,' *Journal of the Royal Statistical Society*, Series a, vol. 138, pp. 540-542.

Ohta, Makoto and Zvi Griliches 1975, 'Automobile Prices Revisited: Extensions of the Hedonic Hypothesis,' in Nestor E. Terleckyj, ed., *Household production and Consumption, Studies in Income and Wealth*, no. 40 National Bureau of Economic Research, Conference on Research in Income and Wealth, New York: Columbia University Press (1975), pp. 325-390.

Prais, S. J. 1959, 'Whose Cost of Living,' *Review of Economic Studies*, vol. 26, pp.126-134.

Pollak, Robert A. 1971, 'The Theory of the Cost-of-Living Index,' *Research Discussion Paper #11*, Bureau of labor Statistics, Washington DC. Published in *Price Level Measurement* ed W.E. Diewert and C. Montmarquette, Ottawa: Statistics Canada 1983, and in Robert A. Pollack, *The Theory of the Cost-of-Living Index*, Oxford University Press 1989.

Pollak, Robert A. 1980, 'Group Cost-of-Living Indexes,' The American Economic Review, vol. 70, no. 2 (May 1980), pp. 273-278, reprinted in Robert A. Pollack, *The Theory of the Cost-of-Living Index*, Oxford University Press 1989.

Pollak, Robert A. 1981, 'The Social Cost-of-Living Index,' Journal of Public Economics, vol. 15, no. 3 (June 1981), pp. 311-336, reprinted in Robert A. Pollack, *The Theory of the Cost-of-Living Index*, Oxford University press 1989.

Pollak, Robert A. 1998, 'The Consumer Price Index: A Research Agenda and Three Proposals,' *Journal of Economic Perspectives*, vol. 12, no. 1, Winter 1998, pp. 69-78.

Richter, Marcel K. 1987, 'Revealed Preference Theory,' in Eatwell, J., M. Milgate, and P. Newman, eds. *The New Palgrave: A Dictionary of Economics*, London: The Macmillan Press, pp. 166-170.

Samuelson, P. A. 1938, 'A Note on the Pure Theory of Consumer's Behaviour: and an Addendum,' *Economica*, vol. V, pp. 61-71 and 353-354.

Samuelson, P.A. 1947, *Foundations of Economic Analysis*, Harvard Economic Studies vol. LXXX, Cambridge: Harvard University Press.

Samuelson, P.A. 1948, 'Consumption Theory in Terms of Revealed Preference,' *Economica,* vol. 15, pp. 243-253.

Shapiro, Mathew D. and David W. Wilcox 1997, 'Alternative Strategies for Aggregating Prices in the CPI,' *Federal Reserve Bank of St. Louis Review*, May/June.

Szulc, Bohdan J. 1983, 'Linking Price Index Numbers', in in *Price Level Measurement* ed W.E. Diewert and C. Montmarquette, Ottawa: Statistics Canada.

Triplett, Jack E. 1983, 'Concepts of Quality in Input and Output Price measures: A Resolution of the User-Value Resource-Cost Debate,' in Foss, Murray F. ed *The US National Income and Produuct Accounts: Selected Topics*, Chicago: University of Chicago press.

Triplett, J.E. 1988, *Price Index Research and its Influence on Data: A Historical Review*, paper presented at the 50th Anniversary Conference of the Conference on Income and Wealth, Washington, D.C., May 12.

Triplett, Jack E. 1999, 'Should the Cost-of-Living Index Provide the Conceptual Framework for a Consumer Price Index?' in *Proceedings of the Measurement of Inflation Conference*, Mick Silver and David Fenwick (eds), Cardiff University, Cardiff.

Woolford, Keith 1994, '*A Pragmatic Approach to the Selection of Appropriate Index Formulas*,' paper presented at the International Conference on Price Indices (October 31- November 2), Ottawa, Statistics Canada.

FOR MORE INFORMATION . . .

INTERNET	**www.abs.gov.au** the ABS web site is the best place for data from our publications and information about the ABS.
LIBRARY	A range of ABS publications are available from public and tertiary libraries Australia wide. Contact your nearest library to determine whether it has the ABS statistics you require, or visit our web site for a list of libraries.

INFORMATION AND REFERRAL SERVICE

Our consultants can help you access the full range of information published by the ABS that is available free of charge from our web site, or purchase a hard copy publication. Information tailored to your needs can also be requested as a 'user pays' service. Specialists are on hand to help you with analytical or methodological advice.

PHONE	1300 135 070
EMAIL	client.services@abs.gov.au
FAX	1300 135 211
POST	Client Services, ABS, GPO Box 796, Sydney NSW 2001

FREE ACCESS TO STATISTICS

All ABS statistics can be downloaded free of charge from the ABS web site.

WEB ADDRESS	www.abs.gov.au

2642900001046
ISBN 0 642 47972 0

RRP $11.00