INFLATION

History and Measurement

Robert O'Neill,
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palgrave
macmillan

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ISBN 978-3-319-64124-9 ISBN 978-3-319-64125-6 (eBook)
DOI 10.1007/978-3-319-64125-6

Library of Congress Control Number: 2017948705

Credit line: photo division/Getty

Printed on acid-free paper

This Palgrave Macmillan imprint is published by Springer Nature
The registered company is Springer International Publishing AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Preface

Consumer price inflation is one of a small number of leading economic indicators that have become essential in the management of economies over the course of the past hundred years. The monthly statistical bulletin from the Office for National Statistics, which gives the latest information on consumer price inflation for the UK, is arguably the most important of all Official Statistics.[1] As well as their influence at the national level, the various measures of consumer price inflation affect the lives of citizens of the UK on a personal level through their use in adjusting many benefits, prices and tax thresholds in accordance with Government policy and contractual agreements. The total amount of money affected by the values of these inflation measures is enormous, which is why seemingly small changes in the rates of inflation have such significance and are reported widely in the media.

The construction of the official measures of inflation is a significant undertaking by the Office for National Statistics in the UK, requiring a substantial data collection operation every month and the application of statistical methods which have been developed over a long period

[1] For an example of the statistical bulletin published by the ONS, see ONS (2017).

of time, in response to theoretical and practical considerations. Where did the knowledge and expertise to do this come from and when was it developed? The earliest known discussions of how to summarise the price change of a collection of goods and services in a single figure arose in the eighteenth century. Classical economists started to consider what would be required to implement a systematic approach to measuring overall price change in the mid-nineteenth century. In the UK, the government started producing a regular measure at the start of the First World War, though it wasn't until the early 1950s that the extent of data collection and the methodology applied became what we would recognise as "modern practice" in estimating inflation. In the six decades since, inflation measures have been subject to a series of changes aimed at continual refinement and improvement; developments have taken the measures closer to those imagined by the economists and statisticians who have grappled with the subject of price measurement. This book tells the story of the development of UK inflation measures and provides a guide to what goes into producing the monthly estimates.

Producing a "complete" history of the development of consumer price inflation measures would be a mammoth task, especially as the subject sits at the intersection of economics, statistics, politics and sociology. Such a history would require the inclusion of both political and technical considerations (and their interactions) and would look across the whole world, as the development of UK measures was influenced by international activities. For practical reasons, this book takes a subset of this potentially panoramic scope within the domain of Index Numbers and Price Statistics as its subject. We have chosen to write the story of only the economic and statistical development of the measures and have consciously shied away from writing a political history.[2] Our focus is on development in the UK; of course, developments elsewhere have had a major impact on UK practice (and thinking), and we have described the most important of them where they are required in order to tell the story. The development of best practice methodology in recent decades has been an international, collaborative effort and its implementation in the UK is in line with international best practice.

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[2] Thomas Stapleford (2009) provides a political history for the USA.

The target audience is an important consideration for any book. A history of consumer price statistics could be written for only the specialists who work in the field or in closely related fields, though what those specialists would have us include might be an interesting study in itself. Our aim, however, is to make the story of UK inflation measurement accessible to a wider audience and to promote a better understanding of what these statistics are, where they have come from and where they might go in the future. To achieve our goals, we have included material that explains the basic concepts involved in measuring inflation, which readers who are more familiar with Index Numbers will recognise. The details of calculations aren't specified here; our previous book (Ralph et al. 2015) describes the basic mathematical practice; readers requiring a little more guidance on their introduction to Index Numbers may be well served by starting with that volume or having it available alongside this one.

There is a considerable body of literature associated with measuring consumer price inflation. The details of the developments are contained in a large number of technical research papers, manuals and committee papers which record the changes in methodology over time. The nature of the changes in methods has been controversial and subject to much vigorous debate; in many cases, the debates are still going on in professional circles. With such a rich source of material to draw on, we have had to be selective over which aspects to include in this book—our aim has been to highlight the most important and influential elements. For those readers who would like to know more, we have included many references. Readers may feel we have neglected important sources and favoured others; however, in selecting material, we are not making any judgements regarding the validity of particular arguments, but instead seeking to represent the views which we believe have been most influential in the development of the UK measures. An example of a topic which is largely omitted is the family of Divisia indices[3]; while they are important in the development of Index Number theory, especially chain-linking, they have featured less in the practical construction of price measures in the UK.

[3] See Hulten (2008) for more information on these indices.

When writing any book, it is helpful to have hands-on experience. The authors of this volume all worked for the Office for National Statistics in the field of Index Numbers and Price Statistics and have contributed to the research and discussions behind the changes in the methodology of consumer price indices over a number of years. While we have direct experience of the developments over the past decade or so, we also have colleagues whose experience extends back far longer to cover the past thirty years. Access to this personal experience has been very useful to supplement the documentary record, and such contributions from colleagues, past and present, are gratefully acknowledged.

Organisation of the Book

This book comprises fifteen chapters. The first two chapters provide an overview of inflation as a concept and its influence in the UK. The remaining chapters are broadly split into two types—those which relate to a history of inflation measurement for a period of time and those that explain how the measures are produced in the UK. We have mixed these types to create what we think is the best exposition of the overall material—practical considerations of current practice help to inform the development of the historical material.

Chapters 1 and 2 provide an introduction to inflation and its uses. Chapter 1 takes an informal approach to introducing inflation and presents examples taken from media coverage to demonstrate the influence that measures of inflation have exerted on the general public in the recent past. In contrast, Chap. 2 gives a more technical definition of inflation and then provides examples of situations where Governments have lost control of inflation, known as hyperinflation. This chapter also looks at the experiences of inflation and the perception of inflation as felt by individuals and groups of citizens. It considers how well personal experience relates to the official measures of inflation. It also considers where price change is experienced differently for different income groups and what this might mean for inflation measurement.

The origins of a systematic approach to measuring inflation are the subject of Chap. 3; it covers the period up to the year 1879. Chapter 4 introduces the concept of a price index and price index numbers; it explains how inflation is derived from a price index. The history of inflation measurement continues in Chap. 5 which covers the period from 1880 until just after the end of the Second World War. Chapter 6 takes up the story where Chap. 5 leaves off and follows the development of the index until 1989. The subsequent three chapters are concerned with elements of how inflation is measured. Chapter 7 looks at the representative basket of goods, its important role and how the basket has changed over time. How prices are collected is the subject of Chap. 8, and how the relative expenditure of households on goods in the basket is measured is described in Chap. 9.

Chapter 10 returns to the historical development and describes a period of rapid change in the way inflation was measured in the UK—it covers the period 1990–2011. This period includes the introduction of the Consumer Prices Index and the switch from the Retail Prices Index to the Consumer Prices Index as the UK's inflation target. Chapter 11 describes an important and highly controversial aspect of the construction of inflation statistics—how price change is measured at the lowest level of a price index where weighting information is not available for most goods and services.

Chapter 12 looks at the arguments over the target for measuring price change—should we aim to measure a cost of goods index or a cost of living index? Chapter 13 brings the story of the historical development of inflation measurement up to date by covering the period from 2012 to the end of 2016. This was a very busy period with a number of major developments, including the change in the status of the long-running Retail Prices Index, two UK Statistical Authority assessment reviews, a major external review and a large-scale quality assessment of the source of weighting information. The period also saw a clear recommendation for changing the headline inflation measure and strong calls for the retirement of the long-running Retail Prices Index.

Chapter 14 provides a brief view of other inflation measures available for the UK, including the Producer Price Index, the Services Producer Price Index, Purchasing Power Parity and the Implied Price Deflator.

The final chapter, Chap. 15, considers the future of inflation measurement; by its very nature, this is somewhat speculative, but makes it clear that this book is attempting to tell readers a story which is far from complete.

Suggested Routes Through the Book

The composition and sequence of chapters have been considered carefully and designed to provide an effective exposition of the subject by combining chapters on the history of inflation measurement with supporting chapters on how the measurement is carried out in current practice. The main purpose of this structure is to provide an effective journey for readers who proceed through all the chapters in the order in which they are presented. However, this isn't the only route.

For those readers who have a basic understanding of how inflation is measured already, a number of the chapters on aspects of construction can be omitted leaving the history chapters and chapters on more specialist aspects of the methodology: 1, 2, 3, 5, 6, 10, 12, 13, 14 and 15.

The two introductory chapters and the history chapters only may be a more acceptable route for those who are less interested in the details of how inflation measures are actually constructed: 1, 2, 3, 5, 6, 13 and 15.

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Acknowledgements

We would like to thank our many colleagues in the Index Number and Price Statistics community, both within the UK and further afield—we have benefited greatly from the many helpful and interesting discussions over the years we have worked in the subject area. Thanks also go to our colleagues at the University of Huddersfield, the Office for National Statistics and the University of Southampton for their support and encouragement over the year and a half it has taken us to write this book.

A number of colleagues at the Office for National Statistics kindly read chapters of the book and provided helpful comments: Richard Campbell, Jim O'Donoghue, Jo Bulman and Duncan Elliott. Outside of ONS, we would also like to thank Joe Winton at Statistics New Zealand. Any remaining errors in the book are, of course, the responsibility of the authors.

In our writing, we have consulted many books and papers, some old and obscure. We have been fortunate to have the expert assistance of the library staff from our respective institutions.

We would also like to thank our partners Sarah, Bryony and Mila for their comments and advice as well as their extraordinary patience.

Thanks also go to Palgrave MacMillan for their expert handling of the manuscript.

Finally, we would like to note that the views expressed in this book are those of the authors and not necessarily those of the organisations for which they work.

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1
Introduction

We are all consumers; we buy and use a wide range of goods and services, and the prices we pay change over time. While we sometimes see prices fall, the general perception of most people is that, overall, prices tend to go up. We might question whether this is in fact true. As each of us consumes different items in different quantities and different combinations from anyone else, and we are endowed with our own tastes and resources, we each have a very individual experience of how prices change. However much we spend, none of us as individuals can provide a complete picture of price changes across a complex economy like that of the UK. To go beyond individual experiences and subjective perceptions and gain an objective, comprehensive picture, we have to turn to Official Statistics.

Official measures of the price level for consumer goods and services and estimates of how it has changed over time are produced each month in the UK by the Office for National Statistics, a part of the Government Statistical Service which operates across the public sector.[1] In simple

[1]Officially, the ONS is the executive arm of the UK Statistical Authority (UKSA), a non-ministerial Governmental department, meaning that no minister is responsible for the functioning of the UKSA, which reports directly to parliament.

R. O'Neill et al., *Inflation*, DOI 10.1007/978-3-319-64125-6_1

terms, these measures of price change are produced by collecting the prices of a representative sample of goods and services, then using surveys and administrative data to estimate the amount that households spend on different types of goods and services. These two sets of data are combined by adding together the price change ratios for each item, with the weight assigned to each item being proportional to the percentage of household spending taken up by the item and others it represents.

The "general level of prices" is the generic name given to an average of prices of consumer goods and services relative to a reference period, and the main statistic constructed as a measure of this is the Consumer Prices Index (CPI).[2] The (twelve-month) inflation rate is the percentage change in the CPI for a given month relative to the same month a year ago; this is the headline inflation figure that appears each month on news programmes and is reported formally in the Consumer Prices statistical bulletin by the ONS (e.g. ONS 2017).

Looking at the official figures shows that the common public perception of increasing overall prices is largely correct. The inflation rate for the period January 1996–September 2016 was negative for only three months out of 249 and then by only 0.1% on each occasion.[3] Although prices have shown a consistent upward trend over this time period, the rate of change has been relatively modest, especially when compared to historical values of the same measure. For the time period specified above, the average inflation rate was around 2%. More recently, from January 2015 to September 2016, the average has been much smaller, at a little over 0.2%.

Relatively low levels of inflation haven't always been the case in the UK; prices rose much more quickly in the 1970s, with the inflation rate

[2]The general level of prices is reported in the CPI as a number which has been artificially set to 100 in some year and month. Thus, though we discuss the general level of prices, we are not referring to an amount which is stated in pounds and pence. The CPI including a measure of owner occupied housing, CPIH, became the main measure in July 2017.

[3]April, September and October 2015; calculated as the percentage change between a month and the same month a year ago using the Consumer Prices Index. Office for National Statistics, Consumer Price Inflation Dataset MM23, https://www.ons.gov.uk/economy/inflationandpriceindices/timeseries/d7g7 (accessed 28 May 2017).

reaching a peak of 26.9% in August 1975[4]; this is roughly equivalent to a rate of price change which would see prices double every three years. A level of price change of the size experienced in the 1970s creates significant issues for Governments, businesses and members of the public; Governments in the 1970s struggled to contain price changes in the recession that occurred between 1973 and 1976 (Nelson and Nikolov 2004), a period commonly referred to as stagflation—a stagnant or shrinking economy coupled with high levels of inflation. Damaging rates of inflation are not just a historical phenomenon; in December 2016, Venezuela was experiencing an annual inflation rate estimated to be more than 100% (BBC 2016). Chapter 2 gives further examples from around the world where prices have risen at very high levels with drastic consequences, though these episodes remain the exception rather than the norm.

1.1 Price Levels and the Value of Money

One way of thinking about the increasing trend in the general level of prices is that the value of money has declined at the same time. Official Statistics tell us that the general level of prices almost doubled between January 1996 and January 2016; we could also say that the value of money almost halved over this period. The expressions "inflation" and the "fall in the value of money" are often used synonymously by economists; this is described further in Chap. 2.

A wide range of factors influence the price of an individual good or service, including basic supply and demand conditions affecting both the production and the consumption decisions of households. For example, the cost of many family holidays increases outside of school terms as demand increases dramatically in such periods. At the time of writing, there is a wider pressure that is expected to increase the prices

[4]This is the percentage change between August 1974 and August 1975, using the Retail Prices Inflation measure, which was the main measure at the time. Office for National Statistics, https://www.ons.gov.uk/economy/inflationandpriceindices/timeseries/czbh/mm23 (accessed 28 May 2017).

of some goods in the UK—the value of the pound against dollar has fallen by a fifth following the result of the referendum on whether the UK should leave the EU (see, e.g., the issues raised in FT 2016). This will make imported goods, whether they are final goods for consumption or as inputs to goods and services produced in the UK, more expensive. This is expected to lead to increases in the prices of goods and services which require imported inputs. Changes in the general level of prices are a concern for Governments, businesses and individuals as there is a widespread desire to avoid a high-inflation rate in the UK as was experienced in the 1970s.

1.1.1 Inflation as an Economic Indicator

For countries which have adopted monetary policy regimes, inflation is an important economic variable which needs to be managed. Central banks are often tasked with maintaining stable prices; that is, keeping inflation low, defined as an annual rate of around 2%, as well as acting to support Government objectives on employment and growth (Bank of England Monetary Policy Framework, no date). The main tool used by Central Banks is the appropriate setting of interest rates—in its simplest form, it is thought that raising interest rates limits the availability of money which reduces inflation.

With the broad objectives of stable prices, high employment and growth, set by the UK Government, inflation is one of the most important economic indicators of the state of an economy. While a modest rate of inflation, such as an annual rate of 2%, is seen as a sign of a healthy economy, higher rates are damaging—raising costs and risking making a country's exports uncompetitive.

1.1.2 Inflation as Affecting Businesses

In a competitive marketplace, businesses need to keep a keen eye on their costs. Price increases of inputs, labour and other production costs have to be either absorbed, through more efficient operations, or passed on to customers. Where certain commodities are vital to a business, rises in the prices are sometimes "hedged", where a business pays insurance and gains some relief from price changes (see, e.g., Carey 2016, which deals with the practice of firms hedging against changes in the cost of fuel); however, this is often contingent on businesses having access to option markets as well as the financial and intellectual capital to make appropriate use of such markets.

Long-term contracts, for example large aerospace projects, often have adjustments for inflation written into the terms to allow for changes in the price of labour and/or materials; this is to protect both sides of a deal against the potential effects of unforeseeable price changes. In general, volatile prices are challenging for businesses and can lead to companies holding back on investment decisions, and some firms operating on slim margins of profit may find their existence threatened by the resulting economic conditions.

1.1.3 Inflation as Affecting Individuals

From the view of the public, inflation is a concern as people are anxious about being able to service their household debt and maintain, or improve, their standard of living. People in employment would like their incomes to at least keep pace with inflation and ideally show an increase which outpaces the increase in the general level of prices. Those whose incomes don't keep pace with rising prices become worse off as they may no longer be able to maintain their standard of living with their wage.[5] Like our individual experiences of buying goods and services, our employment experiences will be different, so whether we have become better or worse off over time will vary from person to person. However, we can ask the more general question—how have average wages compared to the general level of prices over time? A simple way to do this is to take a wage measure and divide it by a

[5]The real impact is more complex as it depends on what a person/household buys. An employee may receive a less than inflation pay increase but see their own standard of living increase as the collection of goods and services they spend their money on has increased at a lower rate. Such considerations are rarely taken into account when individuals discuss the fair rate of change in their income.

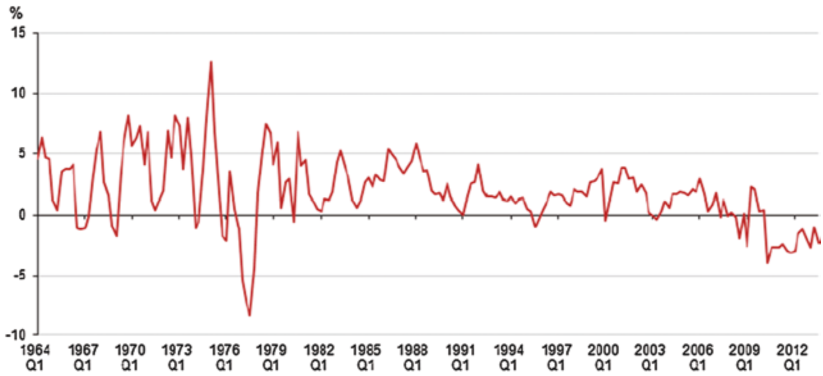

Fig. 1.1 Real Wage Growth, percentage change on the same quarter a year ago (Average Weekly Earnings total pay deflated by the RPI). *Source* Office for National Statistics

price measure to give a measure of "real wages". A study by the Office for National Statistics looked at wages over the past forty years. This showed a growth of wages in real terms from 1975 until the mid-2000s when falls were experienced coinciding with a recession (ONS 2014). Figure 1.1 shows a graph of change in Average Weekly Earnings (total pay) divided by the Retail Prices Index, the latter being a long-term measure of consumer price change. Apart from extreme volatility in the mid-1970s, there has been positive wage growth for almost the whole period. The graph shows a sharp fall in real wages following the 2008–2009 recession and only occasional improvement since then, with real wages continuing to fall. Recent figures show that positive growth was only achieved in 2015. Other studies have shown that the recent period of falling wages is the longest since the Second World War (CIPD 2014).

People in retirement are particularly concerned about the effects of increases in prices on their situation. While those in employment have the potential to work more, or seek better-paid jobs to improve their standard of living, retirees rely on their pensions and any savings they might have. If the value of their pension isn't maintained in line with changes in inflation, then over time, they will become increasingly less well off as the purchasing power of the money they have at their disposal declines. The compounding effect of successive, small deficits becomes significant over long periods.

For retirees with private pensions, some will have automatic increases included in their pension agreements, so each year, the value of the pension will increase in line with a measure of consumer price inflation. The UK state pension has been subject to a triple lock guarantee since 2010, which guarantees to increase the state pension by the greater of inflation, the average wage or 2.5%.[6] Clearly, these adjustments to pensions are an important aspect of maintaining the standard of living of retirees. For those who rely on benefits for some or all of their income, the same considerations apply, as similar deliberations are made regarding the changes of the levels of payments.

Today, we are used to adjustments to wages, benefits and thresholds to account for inflation. For benefits, adjustments are made most years. For some benefits, annual adjustment is on a statutory footing, and for others, the relevant Secretary of State has to consider whether to provide an adjustment, but may decide against doing so given the wider economic position. Most employers evaluate staff performance annually and will provide an increase in pay provided business objectives are met or exceeded; this will include an increase to account for inflation and sometimes an additional amount to reflect staff performance.

A number of important ingredients have come together to lead to the current position described above in the uses of official inflation measures in the UK. An internationally defined methodology for producing measures of the general level of prices has been applied, and a public body is responsible for the collection of data and production of statistics on consumer prices. The practice of applying adjustments to account for price changes is a widely accepted practice in both the private and public sectors. Although a great deal of progress has been made to get to the current position in the way inflation is measured, questions are raised regularly by the people and organisations affected. There are long-standing disagreements about how measures are put together and which ones are used in making adjustments and how much adjustments should vary according to a range of incidental factors.

[6]Whether the triple lock will continue is unclear at the time of writing.

How did we get to the current, highly developed position? Who were the pioneers who devised the basic elements of the methodology? When were the prices of goods and services first collected in a systematic way? When did household expenditure surveys start? When was modern good practice first achieved? What changes have been made to the measures in recent times and how will they differ in future? These questions are the subject of this book, and by attempting to answer them, we hope to leave the reader better informed about the ways in which measures of inflation can, and should, be used.

1.1.4 The Development of Inflation Adjustment

The change in the value of money over time was recognised as causing difficulties long before anyone proposed a way to account for it. The economist Joseph Lowe, in his 1823 book, The Present State of England, proposed that a general measure of prices be determined and explained why it would be useful:

> … and what would be the practical application of this knowledge? The correction of a long list of anomalies in regard to rent, salaries, wages etc. (Lowe 1823, p. 278)

Although the benefits of having such a measure were identified in the early nineteenth century, it wasn't until almost ninety years later that an official measure of the general level of prices was produced and used for adjustment purposes in the UK.

Following the advent of the First World War, and the economic turmoil that accompanied it, UK prices rose very steeply. Food prices increased by 14% between 1900 and 1913 (Board of Trade 1914, p. 6, food prices for London), but between July 1913 and July 1914, they increased by 32% (Board of Trade 1920, p. 65, food prices for the UK). Such increases caused widespread unrest, and in order to minimise disruption to essential war work, the Government instigated adjustment of wages in line with an early "cost of living measure". The measure was based on the expenditure of working-class families.

Similar developments took place in the USA, where prices also rose in 1915 and 1916 as a consequence of the war in Europe. Some employers provided special Christmas bonuses to their staff in the form of fixed percentages of wages as compensation for the rises in the cost of living for the previous year. Other organisations used prices for a range of goods to estimate overall price rises in order to determine a suitable wage adjustment.

In the UK, wage adjustment was extended to other workers in the post-war period which established the indexation concept for wages. The Labour Gazette for December 1920 lists a range of industries where Employers' Associations had reached agreements with Trades Unions, "… providing for regular and automatic adjustment of wage rates in accordance with variations in the cost of living". At this time, a fall in the cost of living would lead to a reduction in wages; it is difficult to imagine this practice would be accepted today.

When the concept of indexation was established and had been applied widely, the quality of the measure came under scrutiny; for example, in the 1920s, the Civil Service Association questioned the use of a working-class measure of inflation for adjusting civil servants' payments. By 1947, 3 million workers had their wages linked to a measure of inflation (Crafts et al. 2007), with the basis for measurement incorporating information obtained at the turn of the century when the global economy was very different.

The use of indexing was gradually extended to include other financial instruments. Index-linked Government bonds were introduced in 1981; £1 billion of index linked gilts were issued in March 1981 with ownership restricted to pension funds and similar institutions. The all-items Retail Prices Index was identified as the measure used to adjust for changes in the value of money (UK Debt Management Office, no date).

By the later years of the twentieth century, many thresholds and benefits were adjusted for a change in the value of money. The Social Security Administration Act 1992 required the Secretary of State to review the level of benefits annually to see whether they had maintained their value relative to the general level of prices. Some benefits had statutory requirements for uprating—for example, the state pension and incapacity benefits had such guarantees built in. Others such as child benefit and job seekers' allowance didn't have this statutory uprating requirement, though the Secretary of State was required to examine the value of these benefits in the light of changes in prices, also taking into account the wider economic situation of the country (DWP 2015). This situation arose in 2010, where the government announced that child benefit would be frozen for three years. Inflation, as measured by the Consumer Prices Index, was above 2% for this period, meaning that the value of the benefit was cut in real terms (BBC 2010).

The use of indexation is now an extremely widespread practice and is seen as essential part of the modern financial world, where a degree of fairness is achieved through making adjustments to reflect the change in the level of prices or the purchasing power of money. The effectiveness of these adjustments is, of course, entirely dependent on having accurate and effective measures of inflation. The total financial consequences of a change of just 0.1% in the inflation figure are enormous.[7] Such considerations place great importance on the way the measures are constructed and have no doubt driven some of the more passionate debates regarding the methodology employed as different groups can benefit or lose out depending on the rate of inflation.

1.2 Measuring Inflation

The importance of measures of inflation can be seen from the "methodological infrastructure" that goes with them. Almost all the countries in the world produce a range of inflation measures to internationally agreed specifications with an official statistical organisation given the responsibility for collecting data and carrying out the necessary calculations. The detailed methodology behind the specification of the data needed and the statistical procedures is subject to regular review and development by statistical and economic specialists, and changes are subject to careful scrutiny and governance. The current position is

[7] The total impact is not known as it would require estimation of the number of contracts linked to an individual measure and their terms.

one which has taken a long time to reach, and the governance arrangements serve to make the construction of the statistics open and as fair as possible.

1.2.1 The Early Development of Inflation Measures

A number of practical problems of converting the value of money from one time period to another were behind the earliest attempts to measure a general price level; these took place in the eighteenth century. They involved collecting prices at two time periods for very simple baskets of goods; a representative basket is a key concept that is still in use today. The device for converting prices from one time period to another is a price index—the concept of a price index and its corresponding quantity or volume index is described in Chap. 4.

In the nineteenth century, a number of important developments followed, including: the need to broaden the range of goods and to introduce services into the basket, the use of expenditure weights and a more systematic approach to price collection. Investigation of different formulas for combining price changes and expenditure information was also carried out. By the end of the century, all of the foundations of the modern approach to inflation had been established. What remained was to understand the scale of implementation and to refine the methodology.

A UK Government statistical department had been first set up in the 1830s; annual summaries of Official Statistics were started in the 1850s and are still published today. The last decades of the century saw the expansion of Official Statistics to include better understanding of the labour market and movements in retail prices. The early history of inflation measurement is described in Chap. 3.

1.2.2 The First Half of the Twentieth Century

The need for Governments to achieve a better understanding of the living conditions and wages of the working classes drove the development of household income and expenditure surveys. The earliest were carried out in 1903 and 1904, initially just covering food[8]; they were then extended to include rent and fuel. Systematic collection of wholesale prices of a range of commodities had been started in the 1850s with retail prices collected from the 1890s. The retail price data were combined with expenditure information to produce a measure of the cost of maintaining a basic standard of living for working-class households; it was first published in 1914 and titled the "cost of living index", the name being more a reflection of its use than its conceptual basis, as is discussed in Chap. 13.

While prices were captured every month by staff working in local labour exchanges, the 1904 data for the expenditure shares for different types of goods was not updated through the 1910s, 1920s and into the 1930s; indeed, a new household expenditure survey wasn't carried out until 1937/1938. The cost of living index was widely criticised for its use of out-of-date weighting information. As a result of the outbreak of World War II, the new weighting information wasn't implemented until after the war was over. The developments that occurred in the first half of the twentieth century are described in Chap. 5.

1.2.3 Towards a Modern Measure of Inflation

After the end of the war, it was clear that a new measure of overall price change was needed. At first, the old cost of living index was replaced by an interim index of retail prices. An important development as part of this process was the recognition that updating the expenditure shares on a regular basis was important; it was agreed that this would be carried out every four to five years. A new index, the Retail Prices Index, was initiated in 1956, and from this point, household expenditure was measured every year. The methodology of the Retail Prices Index was revised over the following decades under the guidance of an expert panel. Chapter 6 covers the major changes up to 1989.

[8]Food made up a much greater proportion of household spending than it would today, which motivates the focus on this area of consumption.

The Retail Prices Index was used as the indexing measure for a wide variety of purposes, including adjusting pensions and tax thresholds. As well as the main Retail Prices Index, there were also sub-indices, produced for specific purposes. For example, the RPIX was the RPI minus mortgage interest payments—it became the Government's inflation target when the Chancellor of the Exchequer announced that inflation would be targeted by the UK in 1992 (for more information, see Haldane 2000).

International developments played an important part in the development of UK inflation measures in the 1990s. A new measure was introduced by the European Union in the 1990s—the Harmonised Index of Consumer Prices (HICP). Its purpose was to provide comparable inflation figures across the Eurozone and to act as a measure for the assessment of economic convergence in preparation for the establishment of the Eurozone, thus preventing countries from using differing methodologies to help meet the requirements of membership. Each country in the EU introduced its own version which conformed to the agreed specification. The Consumer Prices Index (CPI) is the UK version of the European Harmonised Index of Consumer Prices and was introduced in the UK in1996. It differs from the Retail Prices Index in a number of ways; this is described in Chaps. 10, 11 and 13. The methodology of the HICP influenced development in the domestic measures of each EU country. From this decade, the overall development of inflation measures became more of an international, collaborative process with changes often being very similar across the world.

The 1990s also saw a significant challenge to the way inflation was measured. It came from an influential commission in the USA in 1996, led by the Stanford Professor of Economics, Michael Boskin (Boskin 1996; Gordon 2006). He assembled a panel of experts who examined the construction of the US consumer prices index and concluded that it was upwardly biased, overestimating inflation by as much as 1.1%. The committee also recommended a different conceptual framework—an economic cost of living index rather than a cost of goods index. Although the analysis and recommendations were aimed at the US CPI, they had implications across the world and were studied in the UK. The Bureau of Labour Statistics in the USA adopted the economic cost of living index as the conceptual target for its consumer price index; this was not the case in the UK or in Europe which still follow the cost of goods approach. However, the work of the Boskin Commission was influential beyond the USA; it prompted ONS to examine its implication for UK measures. The issues are explored in Chaps. 11 and 12.

After 2000, the CPI gradually replaced the RPI as the main measure of inflation in the UK. In 2003, the Government changed the measure used for inflation targeting from the RPI to the CPI. The RPI had been used for uprating of many benefits and the state pension; in 2010, the Government announced that the CPI would become the index for uprating benefits, state pensions and public sector workers' pensions. The CPI is usually lower than the RPI, and the Government estimated that the change would save £1.2 billion in 2011/2012 rising to £5.4 billion by 2014/2015.[9]

Savings on Government expenditure result from implementing smaller increases than are needed to adjust for changing prices. Depending on your perspective, this may be a sensible fiscal strategy or a stealthy way to enact a budget cut. Making such changes is not popular and is frequently met with much opposition. Civil servants, affected by the change in the measure used to adjust their pensions, voted to take the Government to court, the case being brought by Civil Service unions; they lost, but not before they had staged industrial action. Chapter 10 describes the developments in the period 1990–2011.

1.2.4 Changes in the Methodology

As well as the Government changing the consumer price index used for a particular purpose, the measures themselves change over time. Such changes are of two types—firstly, there are regular, usually annual, changes to keep aspects of the measure up to date and secondly, changes in the methodology which are less frequent and are usually aimed at moving the measure closer to a theoretical ideal.

The update of the basket is an annual activity; its intention is to keep the 700 or so representative products and services covered by the price collection mechanism both current and a good representation of the wider market of consumer goods and services. Similarly, the proportions

[9]See Thurley (2017), for example, guidance issued by the House of Commons library around the switch for pensions.

of household expenditure on the items in the basket (and the range of items they represent) are adjusted each year to take account of changes in consumer preferences. These are routine updates and help to keep the measures relevant. Chapter 7 looks at the contents of the basket and how it is updated; Chap. 8 describes the collection of prices, and Chap. 9 looks at the measurement of expenditure shares on types of goods and services.

Methodological changes are also required for a variety of other reasons. Usually, these changes result from improved methods being developed or made more practical in the light of new technologies. For example, in 2011, the treatment of car prices was reviewed, and recommendations made for an improved methodology. A public consultation on the proposals ran between October and December 2011, and the changes were implemented in both the RPI and the CPI in March 2012. This is discussed along with other changes in methodology in Chaps. 10 and 13.

The choice between the RPI and CPI for threshold and benefit adjustment came under great scrutiny after 2010. The rate of inflation measured using the CPI is generally lower than the RPI, and its use results in lower increases in pensions, benefits and thresholds. An important difference between the two indices is the way price changes at the lowest level, called the elementary aggregate level, are combined. The CPI uses a combination of geometric and arithmetic means, while the RPI uses arithmetic means only. The most appropriate type of mean has been studied extensively, and expert opinion differs with regard to the correct approach to use. The public consultation on the future of the RPI in 2012 saw the highest number of responses of all price statistics consultations, mainly related to this issue, although many of the responses were concerned more with the effect of changes on household finances than on the statistical basis for the difference in approach. The choice of method remains a controversial issue; Chap. 11 covers the arguments in some depth.

1.2.5 Reviews and Housing

The years from 2010 to 2016 saw a great deal of activity for consumer price statistics. There were two major reviews, the formation of new governance arrangements, the downgrading of the RPI and the introduction of a new inflation measure.

The HICP (and its UK implementation—the CPI) had omitted a major commodity from its introduction in 1996—owner occupied housing. The measurement of this commodity was acknowledged to be difficult and had been studied for many years, with the hesitancy to include it in the HICP related to significant uncertainty around the methodology to adopt, particularly for consistency within Europe. Pressure to include housing costs led to work to decide between the methods in which contributions from owner occupied housing can be measured. Equivalent rents (that is, using an estimate of the cost of renting an equivalent property as the measure of the price of the housing services to an owner occupier) was chosen for the UK; this recommendation was subject to a public consultation in 2012. Following this, a new measure was created—CPI including housing costs, known as CPIH. ONS started to produce this new index alongside the CPI in 2012.

In 2013, Paul Johnson, the head of the Institute for Fiscal Studies, was asked to carry out a review of Consumer Price Indices. The review (Johnson 2015) reported in 2015 and made twenty-four recommendations, including curtailing the use of the RPI for any new purpose and endorsing the choice of equivalent rents to measure owner occupiers' housing costs. The Living Costs and Food Survey, which is a major source of weighting information for the RPI and CPI, was the subject of a National Statistics Quality Review in 2016 (Ralph and Manclossi 2016). The review report contained thirty recommendations for improvements. Both reviews led to development programmes which are in progress at the time of writing. Most of the recommendations are being implemented and will lead to changes in the data and methods used in the construction of inflation measures in the UK in the coming years.

A review of the Governance arrangements for inflation measures was also instigated in 2013 which recommended the formation of two panels—a stakeholder and a technical panel to advise the National Statistician. The first meetings of the Advisory Panels on Consumer Prices were held in January 2015. The panels meet three times a year; minutes and papers are published shortly after the meetings.

The UK Statistics Authority carries out a programme of assessments of statistical outputs against the UK Code of Practice. Official Statistics which are compliant against the Code are awarded "National Statistics" status. Their review of consumer price statistics in 2013 resulted in the removal of the National Statistics status from the RPI. The RPI is still used for a variety of adjustment purposes despite it being considered not to meet methodological best practice. In 2016, the National Statistician endorsed the CPIH as the main measure of inflation.

Chapter 13 describes the developments over the period 2012 to 2016.

1.3 The Future of Inflation Measurement

The way that inflation is measured does not stand still. The rapid growth in the creation of digital data and its increasing availability has led statisticians to consider whether there are different ways of producing Official Statistics. For price statistics, the availability of prices from websites has made it possible to explore producing more frequent inflation estimates. These data require different mathematical methods to be used to produce price indices, and there remains a debate about which of these methods are most appropriate.

The future for inflation measurement will be based around international collaboration. National Statistical Institutes are in regular contact, and research carried out in one country is communicated widely and studied by the corresponding organisations in other countries. For example, in some countries, statisticians have acquired retail transaction datasets and have used them to enhance the conventional measures for certain hard to measure price changes. This is particularly useful for complex commodities such as electronic goods which change in specification on a regular basis.

Requirements from users of Official Statistics also drive developments; there is much interest in inflation measures for regions and for income groups. These topics are part of the current research agenda. Chapter 15 considers what might happen next in the development of inflation measurement.

1.4 The Long Road to the Current State

The route to the current position has taken centuries of development and incorporated the thoughts and skills of a large range of groups and individuals, from eighteenth-century bishops to professional statisticians and economists. It is helpful to consider the different ingredients that have been needed to reach the current position.

Firstly, an overall conceptual target, or theoretical framework, is required to guide price statisticians when decisions need to be made on how best to measure price change for each of the many goods and services in scope of a consumer price index. The two options here are the "cost of goods" and the "cost of living" frameworks; the UK (and Europe) has chosen the former and the USA the latter. There is still much debate as to which framework should be followed.

Secondly, a detailed methodology is needed to specify how measures of inflation are to be constructed. This is a combination of mathematics, statistics and economics and has grown up over the centuries. Although great strides have been made, the methodology continues to evolve.

Thirdly, high-quality data are needed to ensure accurate measures of inflation. The practical collection and processing of data is a constant challenge, and the increasing availability of digital data from commercial sources will impact on the way the data collection is carried out and the volume of data available for use in the calculations.

Finally, an organisation is required to accept responsibility for the above ingredients. It has to have the necessary specialist expertise to carry out these functions, to maintain the basket and to lead research that will result in better measures in the future. It also has to communicate with the wide range of users of inflation measures to explain how the calculations are carried out and to collect emerging requirements.

Each of these elements has its own history which intertwines with the other elements; this book attempts to summarise the developments into one overall story.

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2

What Is Inflation?

This book is largely concerned with the use of a statistical tool, Index Numbers, to measure a particular economic phenomenon which is typically referred to as inflation. This chapter will focus on what inflation is, why it matters and why it might be important that we have a good measure of the phenomenon in the form of an Official Statistic, and in turn, why it might be important to read the rest of this book! Economists will likely be familiar with much of the content in this chapter; however, it is worth making sure that we begin our discussion of the measurement of inflation on a common footing with those readers who may have less training in this area.

Typically in this book, we will be concerning ourselves with a specific measure of inflation: the percentage change in an index of prices encountered by consumers for the same set of goods and services across two differing time periods. Measures of inflation need not be restricted to the context of the prices faced by consumers; for example, the Office for National Statistics (ONS) produces several measures of inflation, for example, for imports and exports and producer prices as well as multiple measures of inflation in prices faced by consumers, such as the Retail Prices Index (RPI) and Consumer Prices Index (CPI). In this chapter, we will use the term inflation synonymously with a percentage change in an index of consumer prices.

R. O'Neill et al., *Inflation*, DOI 10.1007/978-3-319-64125-6_2

2.1 Why Does Inflation Matter?

Imagine trying to negotiate a pay rise with your boss without knowing what the recent level of inflation has been. You might tell your boss that the cost of the things you buy has increased over the course of the past year, while they might argue that their experience has been that prices are falling. If we then abstract this argument to a broader level and consider the bargaining positions of unions and management teams, it may help to make it clear what might be a sensible wage increase to maintain the purchasing power of workers' wages.[1] Such concerns do not only affect those working but also affect those in receipt of benefits. A pensioner who is given a pension on retirement will see their ability to purchase consumer goods fall if price levels rise, and so they are likely to be keen to make sure that benefit payments keep pace with changes in the level of prices in a given area during a given passage of time.

2.2 The Language of Inflation

Before moving on it is useful to consider the common definition of inflation and the definitions of related terms as they are commonly understood by economists, who are likely to make the most frequent use of such terms. The OED definition of inflation (relating to economics) is that it defines a general increase in prices and a fall in the purchasing value of money, see OED (2017). Similar definitions of inflation are offered by some of the leading textbooks aimed at students of economics[2] although their focus is much more on the first part of this definition—that inflation is defined as a general increase in price levels.

For many people, a definition of inflation as the increase in the price levels experienced in an economy may be enough for them to be happy that they understand it. However, for those of a statistical mindset, the

[1]We note here that we are deliberately keeping away from the contentious phrase 'maintaining a fixed standard of living', which will be discussed more fully in later chapters.

[2]See, for example, Mankiw and Taylor (2017), p. 583 or Sloman et al., p. 262.

definition of inflation we have offered is likely to call to mind questions regarding what the price level experienced by people in an economy is and how we go about measuring it when we are in a situation in which we do not have complete information regarding prices and quantities involved in economic transactions. It is, however, worth noting that the rest of this book is focused on how changes in price levels are measured by statisticians and how they relate to the original concept of inflation which we often see defined at a fairly high level. If these questions did not come to mind when you read or heard the definition of inflation mentioned above then it is hoped that this book will help you see that they are important for understanding the phenomenon of inflation and its measurement. If you immediately questioned how the price level might be measured, we hope this book will provide at least a partial solution to the questions you are asking.

Alongside the definition of inflation, we will also often hear economists make use of the term *deflation* which the OED defines as a reduction in the level of prices in an economy.[3] This refers to periods of time in which the level of prices, however measured, is declining, rather than increasing as is the more common situation in modern economies. This definition of deflation can cause some confusion for students of Index Numbers as deflation can also be used to refer to the practice of dividing a series of values measured in nominal[4] money at different periods of time by one plus the percentage change in a price index measured as a decimal so that the effect of changes in the price level between the periods is removed and the amounts are measured at a constant price level. Where there is any ambiguity in the course of this book, we will attempt to clarify our meaning in the context of the situation being discussed.

Economists will often also make reference to a period of disinflation which represents a period in which inflation is falling from a previous level to a new lower level (for an example of this being used in context see

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[3]Surprisingly, the definition seems incomplete compared the earlier statement referring to inflation. However, deflation might also be defined as an increase in the purchasing power of money.

[4]By this we mean the amounts measured in money in the time period they occur, so for example, company accounts are stated in nominal amounts, and the value of the pounds values are measured in changes across the years due to inflation.

Roger 2009). For example, in the past three decades, the UK has experienced a period of disinflation as inflation has fallen to a relatively very small, but generally positive, level. Hence, where we talk about a period of disinflation, we should be careful not to confuse this term with deflation as prices are still rising across the economy, however, at a slower rate than in some comparator period.

It is worth considering how these terms are typically used when talking about the phenomenon of inflation as it is measured and reported by National Statistical Institutions (NSIs) such as the Office for National Statistics. Typically, the headline measure of inflation, the annual change in the Consumer Prices Index, will be released to the press, and their reports will talk about inflation rising, falling or staying constant. It is worth noting that in all three of these cases, the price level is still increasing, although at a different rate. If inflation falls from 3% to 2%, then it does not mean that prices have fallen, only that the rate of change in the price level has slowed down. The case in which prices are falling would occur only if the inflation rate itself was reported as a negative number. Hence, we should be careful when referring to a falling inflation rate that we do not assume that this is synonymous with falling prices and subsequent increases in the purchasing power of money.

2.3 The Role of Inflation in Monetary Economics

Monetary Economics is the branch of economics which is concerned with the role played by money in economies. Its influence in recent decades has been significant in the development of economic policies by governments and central banks (for more on the history of Monetary Economics see: Dimand 2008). As a result of the focus this area of study has on the role of money, it has been the main area of economics which has made use of and developed the thinking around inflation. In this section, we will attempt to highlight the main principles developed in this area so that the measurement of inflation can be better understood and related to discussions of macroeconomic theory. However, given restrictions of space, it will, by necessity, be a high-level summary of some key statements related to the area.

One of the key theories related to the study of inflation in Economics is the quantity theory of money,[5] which, broadly stated, posits that an increase in the quantity of money in an economy, or money supply, will lead to an increase in the level of prices. From our definition of inflation, we can see that this price level increase will also result in a fall in the purchasing power of money, hence defining a reciprocal relationship between the price level and the purchasing power of a unit of currency or its value.

As individuals will tend to want to hold more units of a currency as the purchasing power of that currency falls, it is fair for us to expect the demand for money to exhibit a negative correlation with the purchasing power of money. This is the same as saying there will be a positive relationship between the price level and the amount of money which people would like to hold. Given this, if we assume that the supply of money is set for the economy by some central bank, then we can see that the equilibrium point, where quantity of money demanded is equal to the amount supplied, will be related to a lower level of purchasing power as we increase the supply of money and will be related to a higher level of purchasing power as the supply of money is decreased.

The above demonstration of the effect of an increase in the money supply is somewhat artificial, and in the real world, the mechanisms which governments and central banks have for managing the supply of money in a given economy are much more varied. The money supply can be increased by central banks, such as the Bank of England, buying assets from financial institutions, offering issues of debt to be repaid in future, adjusting the rate of interest at which the bank is willing to lend to other financial institutions and various other means. The effect of changes will also take some time to filter through the markets until the full effect of any policies is felt. However, we will not examine the mechanisms by which this takes place in this book.

[5]First discussed by economists in the seventeenth and eighteenth centuries.

2.4 Is Inflation Bad?

Most people will naturally assume that an increase in the price level in the country they are living in is a bad thing. This might well be true in some circumstances; however, there are others in which this need not be the case. Imagine the case in which your monthly salary is paid to you on the morning following the announcement of the official measure of inflation and that each month your salary is increased by the rate of inflation. In this case, you have little reason to fear an increase in the price level as you will find that you are able to buy (approximately) the same amount of things as last month. Where wages and prices are both automatically linked to inflation, and a significant period of time does not pass between the inflation being measured and spending being undertaken, then there should be little impact on people's consumption.

The above idea is taken to its logical conclusion in the idea of monetary neutrality in that the prices of things don't really play much of a factor in real economic decisions. This would imply that the nominal prices that people might pay for things will change, however, the level of real economic activity underlying these prices need not change in conjunction with the change in the purchasing power of money. In this view of the world, there is little to fear from inflation as it does not affect the real economic interactions underpinning the world we live in and is not a practical problem.

Unfortunately, we do not live in a world which is as neat as this and as a result, there are several costs which are thought to result from inflation, impacting an economy and the people affected by its workings. For example, if inflation was regularly large, and prices change significantly on a regular basis, then businesses would be forced to regularly revise their prices and publish them accordingly. Advertising such changes comes at a cost to businesses, and as a result of these *menu costs*, price lists will not necessarily adjust to reflect changes in the purchasing power of money immediately.

In addition to menu costs, economists will also talk about the experience of *shoe leather costs* being related to periods of inflation. This reflects the fact that as prices change investors will have to shop around for the best deals and that the time used is a cost to economic agents as they have to allocate some of their valuable economic resources, particularly time, to disentangle the effects of inflation.

It is possible for inflation to bring about some redistribution of the wealth across the economy, whether these redistributions are good or bad may be a matter of personal judgement regarding the position of the parties involved. Imagine an individual obtains a mortgage from a bank which has a fixed rate of interest of 5% per annum. If the house is purchased for £200,000 and (for the sake of simplicity) we assume no repayments are made over the 5 years for which the interest is fixed, then the value of the debt at the end of the 5 year period is £255,263. Now, assume that the person's salary is £50,000 at the start of the period and their salary increases in line with inflation. If inflation soars, due to an unexpected event, and inflation is 20% per annum[6] then the final salary will be £124,416. At the beginning of the period, the person owed 4 times their annual income, while at the end of the period they owe only 2.05 times their annual income, while the value of the debt to the bank has increased in terms of the amount owed but has decreased in real terms. This is an example of a wealth transfer from the bank to the individual, although no money has changed hands in the five-year period. This is an artificial example, however if inflation shifts suddenly, smaller changes in relative wealth will occur due to fixed price contracts across the economy. Other people may lose out. Consider, for example, a person who had their savings in a 5-year bond issued by the bank with an annual interest rate of 5%. In this case, there will be a transfer of wealth from the individual to the bank.

In the UK, the Bank of England is set an inflation target of 2%, based on the annual change in the CPI, and will consider monetary policy tools to achieve the target in line with its wider remit regarding the UK economy. It is therefore not uncommon for non-economists to ask the question that if inflation can be harmful why is there a target of positive inflation rather than price stability? The economist's response to

[6]This now seems like a very high rate of inflation in the UK. However, in living memory inflation was at this level for several years.

this question would be along the lines that a small amount of inflation associated with growth in the economy, which is desirable. One possible argument to support this is that inflation allows some flexibility in the pricing of labour in less productive industries. As wages are increased by less than inflation in some jobs and more than inflation in others, the relative value of labour in these occupations is allowed to change and there can be a reallocation of labour to more productive endeavours. If inflation was around zero, this would be harder (though not impossible) to achieve as it might mean wage decreases for some roles which are more difficult for employers to enact.

Having considered the harmful effects of inflation, it might be worth considering the alternative situation brought about by a period of deflation. Deflation can have several effects but consider you are running a business with a significant bank loan and that you had based your repayments on the price level you charge your customers. If the price level decreases and the price of your own goods is pushed down, then you will need to sell more units in order to be able to pay off your debt. You would also have to negotiate price decreases for the inputs to your business, which may be a fraught process. As your debt rises in real terms (the number of units you have to sell to cover the debt), then it will become more and more difficult for you to pay off what you owe, especially, if consumers expect the prices of consumer goods and services to carry on falling and in anticipation of this decide to start putting off purchases. It is therefore possible that businesses that were operating on the margins of efficiency before the period of deflation go under very quickly, increasing unemployment and decreasing demand at the same time and further pushing the economy along a deflationary path. Before long more businesses would be in significant trouble. Hence, although the idea of falling prices may initially sound like a good thing, deflation can be at least as harmful as inflation. Note that many of the costs of inflation described above may also be applied to deflation, such as shoe leather costs and menu costs.

As prices in the past few decades have been relatively stable, it is interesting to consider the confusion that a sustained period of price changes might wreak on people's everyday life. Imagine if the price of food items could change by 30% every month while your mortgage payment increased by 7% and the price of petrol increased by 19% while your income increased by 15% and that you didn't know about any of this before the start of the month, but knew prices were liable to change. It would be very difficult to plan consumption and making decisions would be much more difficult. It would be very stressful for some people who had restricted incomes or no savings to absorb potentially harmful price rises. If you were planning consumption on larger items, you might want to put these off as long as possible and save some of your income to help stave off the effect of future price changes. In order to do this, you would need to find an investment product which compensated you for changes in the price level. None of this effort and stress will increase the real value of GDP and in some cases may mean less is consumed than otherwise. As a result, the confusion and worry which pervades as prices are changing rapidly represent another cost to the economy as a whole. Many such problems would also occur in the case of deflation.

2.4.1 The Rise of Monetarism

When discussing the effects of changes in the money supply, economists will often make reference to the Fisher[7] Equation of Exchange, derived from the work of other late nineteenth and early twentieth-century economists. This equation specifies the long run relationship between four economic variables: the velocity of money (V), the level of output (Y), the money supply (M) and the price level (P). The relationship between these variables is then commonly stated to be:

$$MV = PY$$

Hence, the two sides of this identity must be balanced in order to maintain the stated relationship. Economists believe that, in the short term at least, the velocity of money is relatively stable and hence an increase in the supply of money (via any of the mechanisms we

[7] This is named for Irving Fisher who was the first to specify the relationship algebraically.

discussed above) will lead to an increase in the product of price and output. This will relate to the amount of output in current prices in an economy. In the short run it is expected that both prices and output will increase, with the increase in output stimulated by the falling interest rates as the money supply increases. As this happens, demand will increase and in the long-run output will shrink back towards its original level. As this occurs, and in order to maintain the identity, it is again the price level which will increase.

Having considered the above we note that nothing has really changed regarding the real economic activity we are seeing, in the short term at least. This leads us back towards the idea of monetary neutrality and the idea, espoused by the Nobel Prize-winning economist Milton Friedman in his famous quote that "inflation is everywhere and always a monetary phenomenon" (Friedman 1970). Friedman was an avowed advocate of a method for approaching the management of national economies by a collection of concepts, ideas and tools which together have been labelled as monetarism, and its advocates are usually identified as monetarists. Friedman espoused his ideas on monetarism over much of his career[8] and most importantly in Friedman and Schwartz (1963) on the monetary history of the USA in which much of the groundwork for his later ideas was laid.

At his most forceful Friedman would hold that it was government's inability to properly manage the money supply which could lead to severe problems in the economy. Most notably, when Friedman analysed the financial crisis of 1929, which gave rise to the great depression of the 1930s, he claimed that it was instances in which the money supply was not adequately managed which brought about contractions in economic output, and that the crisis could have been ameliorated had a more active monetarist stance been taken.[9]

[8]For a brief biography of Friedman's impact on economics see the address on his 90th birthday made by Bernanke (2002).

[9]For a readable account of this argument, which is not written with only academics in mind see Chap. 7 in Friedman and Friedman (1980).

In the practice of macroeconomic theory in the second half of the twentieth-century, monetarism became the dominant way of thinking about managing the economy, particularly in the USA and UK, where the policies have become attached to the legacy of leaders such as Margaret Thatcher and Ronald Reagan. This growing prominence was due to the inability of traditional Keynesian economic theory to explain the stagflation (stagnation in growth coupled with high inflation) which was experienced by some countries in the 1970s. The ideas of monetarism became ever more influential in this context, and as Roger (2009) describes, this growing prominence was emphasised when New Zealand adopted a formal inflation targeting regime, in which monetary policies were set in relation to the rate of inflation experienced. Several other countries followed, such as the UK and USA and the growing acceptance of the theory of monetarists saw it exported to other countries via the work of multinational organisations such as the International Monetary Fund (IMF) and World Bank. As Roger (2009) notes, the acceptance of such policies was questioned in the light of 2008 financial crisis. However, inflation targeting remains a valid part of the macroeconomic environment for several countries. In the UK the Bank of England still has an inflation target of 2% and the Governor of the Bank of England must report to the Chancellor of the Exchequer if annual CPI inflation falls more than 1% away from the target in either direction.[10]

The rise of monetarism means that management of the money supply has become a critical issue to economists over the past 50 years and as a result, it is clear that a measure of inflation which allows for effective inflation rate targeting is of critical importance to such a system of management. The Governor's August 2016 letter to the Chancellor of the Exchequer begins by quoting official measures of inflation and includes results from sub-indices prepared by the ONS. This demonstrates the important and explicit role that inflation statistics plays in the management of the economy using an inflation targeting regime, such as that

[10]The letters are published, along with the Chancellor's responses, see http://www.bankofengland.co.uk/monetarypolicy/Pages/letters.aspx.

adopted by the UK government. Hence an understanding of both what inflation is, and how it is measured should be of interest to economists who use this measure for important decisions, although often the detail of such arguments is overlooked even by those who regularly make use of them. Of course, inflation measurement is also of interest to those monitoring the economy in countries which have not adopted an inflation targeting regime.

2.4.2 Hyperinflation

In recent years, as some countries have adopted inflation targeting regimes, the rate of price changes in these countries has been relatively modest; however, several countries have historically experienced instances of extreme inflation, called hyperinflation. The word hyperinflation often calls to mind a number of historical episodes, such as the rampant inflation in 1920s Germany which saw banknotes have such a low value that some people were willing to use them to paper their walls or use blocks of money as toys,[11] according to famous photographs from the time. It therefore seems useful to have a definition to distinguish between periods of high inflation and these periods, when inflation reaches to another level.

Cagan (1956) was the first to propose a formal definition for the conditions under which a country (or any identifiable region) could be considered to be experiencing hyperinflation. Cagan (1956) claimed that a hyperinflation commences in a month when the price increases by 50% or more in a month and lasts until the monthly index falls below this level and subsequently stays below the cut-off of 50% for 12 months. Hence, it is not possible to say an economy has exited hyperinflation until price increases have reduced considerably for a period. Cagan (1956) admits that these rules are arrived at arbitrarily in a footnote to his work, however, it would be difficult to argue that any economy seeing such a high level of price changes is not experiencing some form

[11] See for example http://rarehistoricalphotos.com/children-playing-stacks-hyperinflated-currency-weimar-republic-1922/.

of inflationary crisis. Having identified seven periods of hyperinflation, Cagan (1956) considers the monetary dynamics of such periods which are beyond the scope of this brief review.

Hanke and Krus (2013) adopt Cagan's definition of hyperinflation and attempt to collect a complete and reproducible list of hyperinflations which have occurred and can be documented based on published economic statistics. They note the difficulty of finding documentable cases and emphasise that as periods of hyperinflation can often be linked to periods of geopolitical instability, the existence of an uninterrupted stream of economic statistics cannot always be guaranteed. Despite problems with identifying data, Hanke and Krus (2013) identify 56 separate instances of hyperinflation, with the first taking place in France in 1795 and the most recent in Zimbabwe, which had the dubious honour of hosting the first hyperinflation of the twenty-first century. Bernholz (2015) and Cagan's (1956) definitions identify twenty-nine instances up to 2001. Bernholz (2015) notes that other episodes could be included in this class of events if the criteria were expanded by defining a range of qualifications commonly associated with very high rates of inflation.

According to the calculations of Hanke and Krus (2013), Hungary had the ever documented inflation with a monthly inflation rate of $4.19 \times 10^{16}\%$ in July 1946, which means that prices were doubling around once every 15 hours, if we make the assumption that the pattern of price changes was smooth over the month. What is clear is that hyperinflation represents a very different price regime than most of us are used to and therefore is worth considering for anyone setting out to think about inflation measurement. Hanke and Kwok (2009) demonstrate the problems of measuring even contemporary hyperinflation rates in the case of Zimbabwe, where in 2008 standard data was not available, as they rely on measuring inflation rates via exchange rate changes, underpinned by the concept of purchasing power parity. It is worth bearing in mind that many of the tools and arguments we will consider surrounding inflation in this book were developed in times less dramatic than those considered in this section; however, when considering how inflation is measured, it is worth considering how the techniques and arguments might be applied in an economy exhibiting hyperinflation.

2.5 Some Questions About Inflation

Inflation, as we have defined it so far, has largely been a single macroeconomic variable, and we have treated it as though in many cases we can apply our description of the variable in a very general sense. However, we might be left with a number of questions about inflation to consider as we look at how inflation is currently measured and has been measured in the past.

One question is whether an aggregate measure of inflation is useful for reflecting the inflation experience of several groups of individuals across several parts of the UK, which itself is made up of several nations. Is the measure of inflation, as reported by the ONS and considered by politicians and the Bank of England's Monetary Policy Committee detailed and reliable enough for decisions to be made which are fair and just? One important example of this is the inflation experience of pensioners in the UK. It is likely that their expenditure patterns will be significantly different to those of other groups who are well represented in the expenditure weights used in the CPI; this is discussed in some detail for UK consumers in Flower and Wales (2014a, b). Is it therefore fair to use a general measure of inflation in deciding changes to pensions when there is no corresponding measure for only pensioner households? We might then go on to note that the population of pensioners in the UK is also heterogeneous, with some heavily reliant on state pensions and others having alternative sources of income. Similar arguments might be made for a number of other groups. For example, is the inflation experience of a 50-year-old nurse with two children likely to be significantly different to that of a 22-year-old investment banker living alone? How do geographical considerations factor into such questions—will the difference in inflation vary if these two people live next door to each other or are separated by several hundred miles? All of these questions will naturally arise as we begin to consider the way in which inflation is used and constructed. It seems that they require further consideration in defining what inflation is, and this is reflected, as has been seen in recent recommendations to develop a family of price indices to better represent the inflation experience of groups within the UK as we shall see in Chap. 8.

We might also want to question what an inflation measure represents and how well it summarises information about the complex economy we live in. When a chocolate bar is made smaller, and the price remains the same, many people rightly consider this to be inflation and we will see how such a situation would be reflected in inflation measurement. We also consider some more difficult questions about what represents a price and what represents a change in that price. We might struggle to identify a change in price as goods change significantly in quality. For example, many electrical products are released each year with new functionality so how do we compare the price of these items to prices of the old items? When a new mobile phone is released with extra features, yet the price is similar to an existing model would this represent a price drop in terms of the existing functionality? If so, how much would an equivalent model be priced at? Such issues become even more complex when there are features of products aside from their technical specifications. Consider a new smartphone, which has been effectively marketed for some months; at least part of the initial price is likely to be related to how fashionable it is. As the smartphone becomes older and less fashionable, the price may drop. The phone might well then be considered to have two elements, the technical features which remain unchanged, and one which is based on how fashionable the phone is, which is time varying. Disentangling such effects is difficult which might be why inflation estimation tends to use baskets containing goods whose prices are more easily handled.

These examples show behind the estimation of inflation lies a very complex economy, with interactions between a great many groups of people with a range of wants and needs. It is therefore important for the user to consider whether the inflation statistic we have discussed so far is able to reflect the underlying economic reality of the UK. If not, do we need more detail in order to make the use of the statistic more appropriate? Are we likely to be misled if we use the statistics for evaluating our own economic position? These are important questions, and before we can answer them fully, we will need to make sure we have an understanding of what inflation is as we refer to it in our own lives and how it is calculated in the measures produced by organisations such as the ONS.

2.6 The Common Uses of Inflation

Having considered the theoretical basis for inflation and how it might be thought about by economists, it is also useful to think about the common uses of the statistics which come out of the measurement of inflation. In this section, we will more generally consider how price indices measure the change in the price of consumer goods and services are used. In doing this, we will expand our scope beyond the annual change in the CPI to changes in some related indices, which regardless of their status are still used as measures of price change in some way. The intention of this list is to indicate the breadth of the uses of statistics which measure price change, and further examples can be found in Evans and Restieaux (2013).

- Companies use price indices in their setting of contracts. In some cases, we can see this as explicit[12] while in others expectations about the future changes in a price index may impact price setting behaviour. Consider, for example, large aerospace projects which may take many years, and so the company undertaking the work wants to make sure that during the period of construction the amount they are being paid makes the work worthwhile. In this case, the contract might include a clause to increase payments in line with inflation.
- We have seen that the MPC explicitly considers the level of inflation, as measured by the CPI. It would be simplistic to suggest that this is all the members look at, as they consider a range of information and will often consider their expectations about the future alongside information about the current state of the world.
- The Government often explicitly uses inflation statistics, although they may seem inconsistent in their application. CPI is used as part of the triple lock for pension payments,[13] and uprating of other benefits. In addition, Government oversees the annual increase in some

[12]See for example, Vodafone's use of RPI in updating the price of contracts, see https://www.vodafone.co.uk/explore/costs/rpi/.

[13]This states that pensions will increase by the lower of the annual increase in the CPI, average wages and 2.5%.

prices such as rail fares. Recently as part of the Teaching Excellence Framework,[14] there is a proposal that tuition fees for students will increase for some students in line with the RPI. As the RPI usually reports a higher rate of inflation than the CPI, the judicious choice of inflation statistics allows the Government to manage the public purse by utilising the difference which exists between the CPI and RPI, which will be discussed in subsequent chapters.

- Unions and individuals often use inflation statistics as a point of reference when negotiating pay increases. On the opposite side of the table, employers are also likely to use inflation statistics in constructing their own negotiating position. The complication in the UK is that we have two measures of consumer price inflation which are well known and have been used in a variety of contexts, the RPI and CPI. As the RPI inflation is often greater than the CPI inflation, it is natural to expect that employees will base their requested pay increase on the RPI while employers are more likely to argue for a price rise in line with the CPI. This no doubt leads to some tense negotiations, and it is unlikely either side is particularly concerned with the technical differences in these two indices. However, in the rest of this volume, we hope to help make them clear.
- Economists make a lot of use of economic data, in their analysis of the economy and in their academic research which helps them in understanding the economic world around them. This can take many forms, from the forecasting of inflation rates to the determination of the interplay between other factors and the rate of inflation. Without this data from a central source, it would be difficult for such research to be conducted and be of a high quality, which itself would have an impact on the quality of decisions made by a range of economic agents. The impact of research using inflation goes far beyond the world of academia.
- Media sources report on inflation statistics as part of their coverage of the economy. These regular reports are part of the way in which the general public stay aware of the economic conditions in their country and provides a foundation for their expectations regarding future levels of inflation.

[14]For more information on the Teaching Excellence Framework, see http://www.hefce.ac.uk/lt/tef/.

2.7 Why Is an Accurate Measure of Inflation Important?

As we have begun to understand what inflation is, the costs of decisions based on it and the role that it plays in the world around us, it should hopefully be clear that measuring the change in the price level in an accurate manner is an important task. As with other economic statistics, it is important for inflation to accurately reflect the reality of the world around us. If this is not the case, then either the statistic will become disregarded, possibly to be replaced by an alternative measure, see, for example, The Economist (2016) or alternatively bad decisions will be made which can be costly for organisations or individuals, or even for society as a whole.

While many people will never be fascinated by the construction of inflation statistics, it is very likely that their life has been affected by them, whether it be in their mortgage interest rate reflecting changes in the interest rates set by the Monetary Policy Committee, or their union negotiating their wage on the basis of recent inflation measures. Indeed, many economists never go beyond considering inflation or Index Numbers at a very high level. While every student of economics need not consider where the statistics come from, and how the decisions about measurement have led to the current form of the statistics, we hope that through this book the users of inflation statistics are better able to understand them by considering some of the detail of the methods used for measuring inflation, and how these measures have developed in the UK as this will reveal interesting aspects of the history and practice of measurement.

2.8 Perceptions of Inflation

Producers of Official Statistics strive to ensure that the statistics they produce meet user needs and the methods employed adhere to best practice. There is another aspect that is important for producers public confidence in official measures. Some important Official Statistics, by their nature, are detached from personal experience; for example, it is not possible to relate Gross Domestic Product to an individual's experience. The situation for inflation is different as we do all experience paying for the products and services we buy. In Chap. 1, the point was made that as individuals we all buy different items in different quantities to others, and it is impossible for any one of us to have a comprehensive picture of price change. While this is recognised by many members of the public, it is only natural to take account of our own experiences and form a personal view. The construction of the official measures is oriented towards their use as indicators at the aggregate level, for example, for deflating expenditure aggregates. The weighting is plutocratic, which means that households with greater expenditure have a greater influence on the index than a lower spending household. An approach oriented to an individual would adopt democratic weighting where each household is given an equal influence.

2.8.1 Investigating Perceptions of Inflation

How does the public's perception relate to the official figures? In a study from 2007, O'Donoghue (2007) notes that people tend to believe inflation is higher than the official figures and attributes this to a number of factors. Firstly, individual household spending patterns differ from official figures which are based on averages across households. Secondly, the frequency at which households purchase certain goods and services leads to a different perception of the rate of inflation, with more frequently bought items having a greater influence on perceptions than items bought infrequently.

O'Donoghue (2007) divided goods and services into four categories according to the cumulative frequency of purchase: at least monthly, at least quarterly, at least annually and all purchases. Using the Retail Prices Index, the study calculated the 12-month percentage change in prices for these categories over the ten-year period 1996–2007. The results showed that the most frequently purchased items had the highest rate of inflation for almost the whole of the time period. While this doesn't prove a link between perception and the frequency of purchase, it offers a possible explanation.

2.8.2 Personal Inflation Calculators

To help people understand how the prices of their own pattern of purchasing are changing, the ONS launched a personal inflation calculator in January 2007. The calculator allowed people to enter their household spending on different categories of goods and services; from these inputs, households weights were calculated and used to combine the price indices for each category. The calculator was also hosted by the BBC. A later version on the BBC website was developed in conjunction with Warwick University; this used household characteristics to estimate a rate of inflation for the household. O'Donoghue (2007) describes a methodology for doing this. Other organisations provide inflation calculators; however, they simply allow the user to enter a sum of money at one date and use a consumer price index to calculate the value at a different date.

2.8.3 German Index of Perceived Inflation

The Federal Statistics Office in Germany used an approach developed by Brachinger (2005). This was based on the insights of perception psychology using three principles: individuals compare prices to the last time they bought a product and not a specific reference period used in the official measure. Individuals put more weight on price increases than price falls. Inflation is perceived more strongly for price increases in frequently bought goods than goods bought infrequently. These hypotheses are used to adjust weights which are then used in conjunction with data from the German CPI to calculate an index of perceived inflation. Looking at the year just before and after the introduction of the Euro, that is January 2000 and December 2001, it showed a perceived rate of inflation four times higher than the official measure (for details see sDestatis 2007).

2.8.4 Official vs. Perceived

The analysis of the frequency of price changes described above and the German Index of Perceived Inflation provide insight into possible reasons for individuals believing that their experience of price change is different to the official measures. The use of personal inflation calculators provides insight for individuals to investigate how their own profiles of household expenditure might differ from the official, average measure.

While these three initiatives won't resolve the difference between individual perceptions and the official measures, they do help to explain why their might be differences. Perhaps this work has contributed to the public confidence in the official measures.

2.8.5 Variations of Inflation Across Households

An insight into how different types of households experience inflation was provided by work carried by Flower and Wales (2014a, b). They used household expenditure data to identify how different types of household spend their money; this provided different sets of weights across households which could be combined with price data to estimate the variation of price indices and inflation rates between 2003 and 2014 (Flower et al. 2014).

The work showed found that the inflation experience of UK households differed widely over this period with low-spending households experiencing faster rates of price increase than high-spending households. For the lowest income decile, prices rose by 39.3% between 2003 and 2013 compared with a rise of 31.4% for the seventh decile. The work also found higher average rates of inflation for retired households at 2.8% against 2.5% for non-retired households.

This analysis also provides insight into how individual household experiences might differ from the official, average inflation rates.

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3

The Origins of Inflation Measurement: 1700–1879

The identification of the time period that constitutes the "early history" of inflation measurement is, of course, an arbitrary one. In this book, we have taken the period 1700–1879 as a useful division of time to cover for this early history. From 1880 onwards, the collection of data was increasingly formalised and managed by official organisations and the conclusions drawn from it were used in political decision making, which approaches modern practice.

A number of prominent authors in the field of Index Numbers, both current and past, provide overviews of the early developments in inflation measurement; these include Fisher (1922, Appendix IV), Mitchell (1938), Kendall (1969), Diewert (1993), Persky (1998) and Balk (2008). There are also helpful summaries in the book by Walsh (1901, see the bibliography) and the introduction written by Allen, to the first edition of the extremely comprehensive bibliography of Index Numbers edited by Maunder (1970). The original books and pamphlets of the key people in the early development of the subject are, in most cases, available from Internet sources and provide a fascinating and detailed description of the development of the subject. Both original and summary sources have been used for this chapter.

R. O'Neill et al., *Inflation*, DOI 10.1007/978-3-319-64125-6_3

3.1 Overview

The modern approach to measuring the change in the level of prices combines a number of key ingredients, each of which has been the subject of considerable development over a long period of time:

- The concept of what is being measured—are we aiming for a cost of goods index or a cost of living index?
- The choice of the mathematical formula used to combine together changes in price of items and their respective expenditure shares to produce an estimate of inflation which is represented by a single number
- The selection of a "representative" basket of goods and services, relevant to a target population of consumers that can account for their consumption habits
- The collection of prices for the selected range of goods and services across locations and outlets that sell them for at least two different time periods, so that the change in prices for individual items can be measured
- The relative expenditure shares relating to types of goods and services for a defined set of households in scope, called "index households"; this enables an appropriate weight to be applied to price changes to reflect the relative spending on them by consumers
- An organisation to carry out the data collection, processing and calculation of results together with the development of the methodology in collaboration with international partners.

As well as these essential ingredients, there are many important decisions that must be made in the construction of a modern inflation measure and they have all had to be worked out both in concept and in practice and then refined over significant periods of time.

The balancing of a conceptually preferred approach to detailed aspects of inflation measurement with the practicality of implementation is a perpetual exercise. Whatever method is adopted for each aspect of the measurement has to fit within a monthly production timescale.

A close reading of developments reveals how compromises are made to balance statistical purity with practicality. Seen in this light, modern measures are both highly developed and pragmatic.

This chapter begins the story of how the elements of modern inflation measurement developed. It attempts to answer the questions: when did it all start, what were the drivers for developing the measures and who was responsible for their development?

3.2 Measuring Price Changes

The problems caused by variations in prices were recognised many centuries ago. Historical records contain prices of goods and services and the wages of workers right back to the time of Hammurabi (around 2150 BCE) who specified the wage rates of workers in terms of goods and the price of hiring animals in the Wage and Price Control Statutes from his famous Code (Schuettinger and Butler 1979, pp. 153–154). This specification of rates of pay and the price of goods demonstrate an early attempt to counter the variation of prices.

From the earliest times, fluctuations in the prices of goods and services arose from natural and man-made events such as bad weather and war. These events affected the interacting forces of supply and demand, which economists would later recognise as being central to the determination of market prices. Price rises affecting essential items were of particular concern; discontent could arise quickly when these prices rose rapidly and prevented families from procuring adequate provisions. Rulers and governments typically responded by imposing price and wage controls, attempting to manage their economies from above.

Another well-known attempt to manage price changes is Roman Emperor Diocletian's Edict of 301 CE. Instead of fixing the price of a variety of goods, he specified maximum prices for a long list of items. The intention was to allow for lower prices to occur for goods which were abundant in certain areas. Although the punishment for violating the regulations was death, the Edict was widely ignored and failed to stabilise prices (Schuettinger and Butler 1979, pp. 20–26). The use of controls on prices is not just an ancient phenomenon. In the 2015 General Election, the Labour Party pledged to help with household bills by freezing energy prices until 2017 (The Labour Party 2015, p. 10), and in the intervening years, governments of many compositions have attempted to directly influence prices of key items to relieve specific problems.

The variations in price of the multitude of goods and services consumed in the UK over many centuries have been the subject of a number of studies (Deane and Cole 1962; Burnett 1969). The historic price data available for this work is fragmentary and there is great difficulty in drawing general conclusions from any resulting estimates of inflation. However, economic historians have analysed this economic data and produced estimates of overall price levels and changes (Phelps Brown and Hopkins 1956). Of course, these studies are retrospective analyses, with the advantage of knowledge of modern methods and the benefit of additional resources which provide evidence on the economic situation of the times. While the effects of changes in prices were well recognised before the eighteenth century, it is thought that no attempt was made to measure the overall change in a systematic way before then. It was a specific, highly practical type of problem that drove innovative thinkers to consider the problem of measuring general price change.

3.3 The Origins of the Basket

Within the Index Numbers literature, the problem presented to Bishop William Fleetwood in the early eighteenth century is commonly identified as the first-recorded consideration of the change in the general level of prices and how to go about measuring it (Kendall 1969). The issue he considered was documented in his book, Chronicon Precosium (Fleetwood 1707).

An Oxford college, founded between 1440 and 1460, required fellows to vacate their fellowship if their annual income exceeded £5 with no provision or mechanism for increasing this amount over subsequent periods. Over the years, between the founding of the college in the mid-fifteenth century and the early eighteenth century, prices had risen significantly. The question posed to the Bishop was whether it could be considered acceptable to take the oath to become a fellow, even if the applicant's income exceeded £5.

Bishop Fleetwood reviewed prices for a variety of goods over 600 years together with wages of workmen and servants. For example, he documented wages for various workmen—in 1446, the rate for mowing an acre of meadow was between 4d and 6d and reaping corn in the first week of August was 2d. For goods, the Bishop listed prices of common goods including corn, bacon, mutton and ale and their variation over time. He wrote that Parliament had tried to regulate prices of goods and services across time, but without much success. In the conclusion to the book, the Bishop explained that he had a long-held interest in the variation of prices over time, which may mark Bishop Fleetwood out as the first identifiable scholar of the phenomenon known as inflation.

The last chapter of his book, Chap. 6, presented his conclusions, in which he addressed the specific question about the change in the value of money. He informed the reader that in order to find the equivalent sum of money in 1700 to 5 pounds in 1440–1460, one should compare the prices of "Corn, Meat, Drink and Cloth" at the two time periods. In another very interesting aspect of his investigation, he pointed out that it is not acceptable to take prices from a particularly cheap or expensive year and a year must not be selected that would be to the advantage of the scholar (an early recognition that statistics should be objective and independent). Instead, he explained that prices should be taken over a number of years and the average calculated; Bishop Fleetwood identified twenty years as a suitable period for the averaging of prices, matching the original period covered by the statute—the twenty years from 1440 to 1460.

For wheat, he noted that in 1440–1460, a quarter cost 6s 8d and in the period 1686–1706, the average cost was 40s, giving a six fold increase in the price of a single item over the period (Fleetwood 1707, p. 167). A simple estimate of the average rate of annual inflation implied by these figures is around 0.5%. For meat, he looked at the prices of beef, mutton and bacon estimating a fivefold growth in prices. The same factor applied to drink. He concluded that 5 pounds in 1440–1460 was equivalent to 25–30 pounds in 1686–1706.

Before reaching a final conclusion, the Bishop addressed a different aspect of the problem; this was a legal consideration rather than a point of statistical methodology, again foreshadowing arguments which would affect the use of inflation measures in the centuries to come. Should the scholar interpret the founder's intentions as fixing the threshold for being a fellow regardless of the change in the value of money or should it be interpreted as a measure of the standard of living that should include the change in the value of money? In more modern terms, was the threshold an absolute or relative measure? The Bishop thought it was the latter that the founder's intention was most likely that the scholar should be able to live in a manner comparable with fellows at other universities without restrictions, which would imply that there was latitude for accounting for price change.

The Bishop mentioned another and rather more serious aspect of maintaining a threshold without adjusting it with the change in the value of money. He related the views of a Judge Spelman who complained that "laws do not have sufficient regard to the price of things" (Fleetwood 1707, p. 169). He was particularly concerned about the law that a thief stealing goods to the value of twelve pence or more would be condemned to death. The judge had said that when the law was made, the amount of goods 12d would buy would now cost 20s and that "many die for thefts of value less than 20s", which may be the only reference to the application of Index Numbers in saving lives.

The approach of the *Chronicon Precosium* contains early versions of some of the key elements identified at the start of this chapter as being essential to the measurement of overall price change. The representative basket is rather modest at four items, but they are relevant to the target population (academic fellows). A variety of prices were collected and compared across the period of interest. One aspect which had been avoided was the challenge of how to combine different degrees of price change, as all four changes were found to be very similar. However, this could be viewed as an early application of the rule that if all price changes are similar, the change in the overall level should be close to this number. This is a property of index numbers which would later be enshrined in one of the axioms of the axiomatic approach to choosing between index number formulae (a summary of index number axioms can be found in Appendix B of Ralph et al. (2015)).

Bishop Fleetwood included a comment on how his considerations would be viewed by his readers:

> … as the World now goes, the greatest (though I will think not the best) Part of Readers will be rather apt to despise than commend the Pains that are taken in making collections of so mean Things as the price of Wheat and Oats, of Poultry, and such like Provisions ….

This rather disparaging view was not restricted to the Bishop and was only slowly overcome, as the following sections will show.

3.4 Early Price Index Formulae—Dutot and Carli

A similar type of question to that presented to Bishop Fleetwood was asked of the French economist Nicholas Dutot in 1738; he has been credited with producing the first genuine price index (Balk 2008, p. 5). Dutot was asked whether Louis XV, with revenue of 100 million livres in 1735, was wealthier than Louis XII with an income of 7.65 million livres in 1515. To decide, he found prices for a wide range of goods and services, including a goat, a chicken, a rabbit, a pigeon, a rick of hay and a day's labour for a man and a woman. He added the prices of each together for both time periods and divided one by the other; expressed mathematically, this gives the ratio of average prices, which has become commonly known in the study of Index Numbers as the Dutot index:

$$I_D = \frac{\sum_i p_{t_2,i}}{\sum_i p_{t_1,i}} = \frac{\frac{1}{N}\sum_i p_{t_2 i}}{\frac{1}{N}\sum_i p_{t_1 i}}$$

The ratio indicated that the value of money had declined by a factor of 22 leading Dutot to conclude that Louis XV was considerably worse off than Louis XII, despite having a much higher level of absolute wealth.

A further step had been taken in Dutot's approach to his problem. The "basket of goods" appears rather arbitrary, but it did include services as well as goods. Unlike Bishop Fleetwood, Dutot combined the price changes explicitly, using a stated mathematical formula for different items to produce an overall measure of change in a single number. In this case, the total, or average, price of the collection of goods and services at one time period was divided by the total at the other time period. Note that there was no explicit weighting applied to the prices of the items, however by rearranging the formula as below:

$$\frac{\sum_{i=1}^{n} p_{t_2,i}}{\sum_{i=1}^{n} p_{t_1,i}} = \sum_{i=1}^{n} \frac{p_{t_2,i}}{\sum_{j=1}^{n} p_{t_1,j}} = \sum_{i=1}^{n} \frac{p_{t_1,i}}{\sum_{j=1}^{n} p_{t_1,j}} \frac{p_{t_2,i}}{p_{t_1,i}}$$

we can see that there is an implicit weighting scheme to the Dutot index which places the greatest weight on the items which were relatively more expensive in the first period covered by the price index.

An alternative way of combining prices was suggested by Count Rinaldi Carli, a professor of astronomy in Milan, in a study of 1764 of the decline in the value of money since the discovery of America. His selection of items included grain, wine and oil, and he studied price changes of these three items over the period 1500–1750 (Kendall 1969). The formula he used to combine the individual price observations was:

$$I_C = \frac{1}{N} \sum_{i=1} \frac{p_{t_2 i}}{p_{t_1 i}}$$

This is the average of the ratio of prices, or the average of price relatives. Note that this is the first formula to make explicit use of the ratios of prices for individual products—i.e. price relatives—in an index number formula.

3.5 Indexation in 1780—The American War of Independence

A further historical episode shows the early application of a measure of the general price level: indexation; that is, the adjustment of a financial quantity in response to overall price changes as measured by a price index. During the American War of Independence, the value of paper bills in Massachusetts declined rapidly, despite attempts to fix prices. By 1780, soldiers were almost destitute, with resultant impacts on their ability to carry on fighting. An Act was passed requiring the value of money to be calculated from the prices of "Beef, Indian Corn, Sheep's Wool and Sole Leather". This showed that prices had increased by a factor of more than 32 in just three years, or an increase of 317% per calendar year on average. As a result of these findings, it was then specified that, for the rest of the war, soldiers would be paid by means of credits to match the price of the collection of items (Kendall 1969, p. 3).

3.6 An Early Attempt at Measuring Price Levels Over Time

Kendall comments that the various elements of the basic approach to calculating and using measures of the general level of prices, and its change, were put together by Fleetwood, Dutot and Carli during isolated episodes. They were concerned with answering specific questions about the value of money over well-defined periods and were not part of an overall coordinated approach. He credits Sir George Shuckburgh Evelyn (1751–1804) with the first presentation of the overall problem in a form that is recognisably how we understand it today (Kendall 1969, p. 4).

Shuckburgh Evelyn was a politician and astronomer; he was Member of Parliament for Warwickshire and a fellow of the Royal Society. He possessed an observatory and published a twelve-volume ephemeris of observations; he also carried out scientific research in metrology. Shuckburgh Evelyn's contribution to Index Numbers comes in the form of a short note and an influential table at the end of his late eighteenth-century treatise on weights and measures—"An account of some endeavours to ascertain a standard of weight and measure" (Shuckburgh Evelyn 1798, pp. 175–176).

He includes a single paragraph on the prices of provisions and necessities of life at different periods in history and the depreciation of money, which we might interpret as depreciating in terms of value. Shuckburgh Evelyn says that while other people have written on prices and how they change over time, they haven't drawn general conclusions.

Shuckburgh Evelyn collected prices; his basket of goods was somewhat broader than that of Bishop Fleetwood; it included horse, cow, ox, sheep, hog, goose, hen, wheat, butter, cheese, ale, beer, beef and mutton; he also included labour in husbandry. Shuckburgh Evelyn then averaged the prices and presented a table of these arithmetic mean prices for different periods of time; he called it a "table of appreciation". He went further than this, aggregating the different prices into a single value and then using interpolation to give averages prices at regular time intervals from the Norman Conquest to the period when he lived. When the results were presented, they were scaled, so that the value was set to be 100 for the year 1550—a representation we can recognise as a time series of index numbers. His findings are summarised in Table 3.1 using his column labels. Between 1700 and 1800, Shuckburgh Evelyn gives values every 10 years (not shown here).

Like William Fleetwood before him, Shuckburgh Evelyn wrote that the consideration of prices and changes had taken him into uncomfortable territory:

> … However, I may appear to descend below the dignity of philosophy in such economical researches, I trust I will find favour with the historian and the antiquary.

Table 3.1 Index of a combination of the prices of articles at different times

A.D.	Mean appreciation by interpolation
1050	26
1100	34
1150	43
1200	51
1250	60
1300	68
1350	77
1400	83
1450	88
1500	94
1550	100
1600	144
1650	188
1700	238
1750	314
1800	562

Shuckburgh Evelyn's work showed a number of steps towards modern day index number practice—a more expansive basket of goods and services, the combining of prices into an explicit summary measure, identification of a reference period and the scaling of prices into an index numbers series. The representation as a "table of appreciation", with a time series of index numbers is a format we recognise today from modern statistical releases. However, on the downside, prices for different commodities were combined without any explicit consideration of their relative importance—no weights are applied.

The table of appreciation presented by Shuckburgh Evelyn was influential; perhaps this was partly as a result of an effective representation of the data. His work would influence the developments which followed.

3.7 The Quality of Price Information and the Use of Weights

The next step in the development of inflation measurement was provided by the agriculturalist, Arthur Young (1741–1820). Young criticised Shuckburgh Evelyn's work by saying that he had left important items out and hadn't defined the items he had included carefully enough (Young 1812). Young also criticised Shuckburgh Evelyn's data and the equal weighting of each item. He gives Shuckburgh Evelyn no credit for the progress he had made in identifying an overall price measure and representing its variation over time as an index number series. Young was particularly concerned that the application of an incorrect measure of price change might create disadvantages for agricultural producers; an early example of users of index numbers series becoming involved in the debate regarding the construction of those numbers.

Young travelled and collected his own extensive price information and derived a table of price levels over time which differed from the work of Shuckburgh Evelyn. In creating his own combined measure, Young counted items according to their importance by relative value; wheat five times, barley and oats twice, provisions four times, day labour five times, wool, coal and iron once each. It is not entirely clear how he arrived at these factors but he treated them as weights, using them to combine price changes and dividing by the sum of the weights.

Young's use of weighting information gave price rises for some categories of goods that were ten times smaller than Shuckburgh Evelyn's, which represented a very significant difference. Although this weighted combination was clearly an important step towards modern measures, Young didn't appreciate its importance; that credit is given to Joseph Lowe.

3.8 Towards a Solid Foundation

Although the work described in the sections above showed gradual but important developments, it is the Scottish economist, Joseph Lowe (died in 1831) who is usually recognised as putting the subject on a firm footing and is often described as being the "father of Index Numbers". Lowe is credited with developing the concept of a formula for the relative price change of a constant basket and the index formula associated with it—this is the formula used around the world today (Kendall 1969, p. 7).

In his book, Lowe (1823) discussed the effect of the Napoleonic Wars and Chap. 10 titled "Value of Money" discussed fluctuations in the value of commodities and their impact, with further information given in an appendix to the chapter. Lowe addressed three important topics: the tendency of prices to fluctuate, the impossibility of foreseeing or preventing such fluctuation and a plan for lessening its "injurious operation". In discussing the first two topics, he noted factors which lead to increases and decreases in prices; in the former category comes "the contingency of war" and in the latter "increases in productive industry", though there are many other causes of both rises and falls. He recognised that, given such causes, it is impossible to predict changes in prices and that "fluctuation in the value of money cannot be prevented".

With the inevitability of the variation in the value of money, Lowe went on to identify the need for what he calls a measure of the "power of purchase", or "the power of procuring articles for consumption" which would "put an end to uncertainty in time contracts, would relieve us from a great national evil". Explaining his concerns further, he noted that a money value in a short-term contract is, in general, a safe measure; however, in a contract of long duration, it was far from being so. This had undesirable effects for both national and individual purposes.

Through his research, Lowe provided examples of the problems that workers had faced:

> How important would such a standard of reference have been throughout the last thirty years, a period of such frequent contention between the employer and the employed? During the war, workmen in towns were repeatedly obliged to combine for the purposes of raising their wage to level of provisions. Lowe (1823, pp. 336–337)

Lowe went on to ask what would be the benefit of having a measure of "the power of purchase":

> In what, it may be asked, would the benefits of it consist? In ascertaining on grounds that would admit of no doubt or dispute, the power in purchase of any given sum in one year, compared to its power of purchase in another. And what would be the practical application of this knowledge? It would correct a long list of anomalies in regard to rents, salaries, wages, etc. arising out of unforeseen fluctuations in our currency. Lowe (1823, p. 335)

Having identified the central issue to be considered, Lowe then described a previous, simple attempt to adjust for the change in the value of money which had linked living costs with the price of corn. Lowe rejected this approach and showed that there was a wide variation in how much different households spent on corn. Instead, Lowe recognised that: "… in an age of such varied and refined expenditure, a standard of more comprehensive character, ought, if possible to be adopted"—that is a measure based on a wider range of items was needed to reflect the consumption habits of households.

Lowe went on to propose a table of articles of general consumption, grouped into "produce of the soil—wheat, barley, oats and butcher meat and general animal food", "manufactures—woollens, cottons, linen, silk, leather and hardware", "foreign articles—sugar, tea and others" and finally, "a multiplicity of articles of less importance".

This presented, perhaps, the first attempt at a subdivision of a measure of price change into categories, similar to the approach used to classify items into different product strata in modern indices. For each item, the quantity consumed and an average price was needed. Lowe presented examples of these tables, adapted and presented here as Table 3.2:

As Table 3.2 shows, almost 50% of expenditure could not be measured. Lowe noted that a complete table was preferable … "but as the heads of our public offices, like our individual enquiries, are as yet only at an early stage of statistical research, a considerable time must elapse ere their materials acquire a finished form". Despite this incompleteness, he believed that the table would provide a "very fair scale" for comparing years. It is interesting to note that Lowe's comments seem prescient in looking to the future of more comprehensive expenditure investigations which would be carried out to assist the construction of measures of inflation.

While Young had criticised Shuckburgh Evelyn for treating each item equally and suggested that some items should be counted multiple times, the concept of explicit weighting in the construction of a price index has been attributed to Lowe for his detailed description of its importance and use. Lowe also considered the question of whether different weights would be required for different types of households.

Table 3.2 Apportionment of expenditure by respective articles

Articles consumed	Expenditure on each article (£m)	Proportion of the expenditure on each article to the total expenditure of the public, calculated in parts per 100
Wheat	30	8.6
Barley	9	2.6
Oats	10	2.9
Butcher meat and all animal food	35	10.0
Woollens	20	5.7
Linen	15	4.3
Leather	15	4.3
Cottons	12	3.4
Silk	8	2.3
Hardware	9	2.6
Sugar	9	2.6
Tea	8	2.3
All other heads of national consumption	170	48.6
Total	350	100.0

Also attributed to Lowe is the price index formula:

$$P_{Lowe}^{0,t} = \frac{\sum_i p_{ti} q_{bi}}{\sum_i p_{0i} q_{bi}}$$

The time period b can be different to the time periods associated with the two sets of prices and can be of different length; the set of quantities q is sometimes called a Tabular Standard.

While an explicit formula of the type presented above doesn't appear in his book, it is implicit from his writing. He discussed the degree to which the expenditures would change over time and he considered that any changes would be gradual, while prices may change each year. Lowe, therefore, suggested that the expenditures only need to be updated every five years, while the prices should be updated every year. This is a notable suggestion as current international guidance recommends updating baskets and weights at least every five years; annual updating of the basket was introduced in 1962 in the UK. Statistics New Zealand updates their basket every three years and Statistics South Africa every four years.

3.9 A Geometric Approach

Kendall notes that apart from a few re-statements of the work of Joseph Lowe, the subject seemed not to progress further until a book by the English economist, William Stanley Jevons (1835–1882), published in 1863. In a notable aspect of his work, Jevons (1863) departed from the use of arithmetic formulae by proposing geometric averaging of price relatives as he was interested in proportional rather than absolute increases. This approach was not made in the context of Index Numbers, but on the problem of measuring changes in the value of gold. Indeed, the discussion of the index method is very brief relative to the rest of the book.

Despite the briefness of his contribution, it has been acknowledged as significant, as made clear in the following quote from John Maynard Keynes in discussing Jevons' contribution to the area of Index Numbers:

> Jevons had to solve the problem of price index-numbers practically from the beginning; and it is scarcely an exaggeration to say that he made as much progress in this brief pamphlet as has been made by all succeeding authors put together. He examines the logical and dialectical problem, the question of weighting, the choice between an arithmetic and geometric mean, whether articles which have moved abnormally should be excluded, and, generally speaking, what classes of commodities can best be taken as representative. …… For unceasing fertility and originality of mind applied, with a sure touch and unfailing control of the material, to a mass of statistics, involving immense labours for an unaided individual ploughing his way through with no precedents and labour-saving devices to relieve his task, this pamphlet stands unrivalled in the history of our subject. (Keynes 1936, p. 525)

There is, of course, a complication in using the geometric mean—it is harder to calculate and is less accessible to the uninitiated. However, the question of how to calculate the average of price relatives is very much alive today. It is still part of modern debates through the "formula effect" and both geometric and arithmetic averaging is used in modern price indices, as Chap. 11 describes.

While price data was becoming increasingly available and was improving in quality, the same wasn't the case for quantity information. Jevons suggested that while the tabular standard was appealing, it wasn't practical, and having quantity weights could be expected to yield the same results as using an un-weighted index of main commodities (Persky 1998, p. 199).

3.10 Laspeyres, Paasche and Drobisch

The next decades saw consideration of different index formulae by two German economists and a mathematician: Laspeyres (1864), Paasche (1874) and Drobisch (1871) all included terms for quantities as well as prices in their conceptualisation of a price index.

Etienne Laspeyres (1834–1913) began his investigations into Index Numbers by using the un-weighted, Carli formula on price data for 48 articles from Hamburg and argued with Jevons about whether the arithmetic mean was better than the geometric mean, thus beginning a debate which would outlive both men by more than a century. The mathematician Moritz Wilhelm Drobisch (1802–1896) was called in to assist in the discussion. He rejected both formulas and instead suggested a formula of his own which compared the expenditure per unit on each product between two time periods (Vogt and Barta 1997, p. 13):

$$P^{0,t}_{Drobisch\ II} = \frac{\sum_i p_{ti} q_{ti} \Big/ \sum_i q_{ti}}{\sum_i p_{0i} q_{0i} \Big/ \sum_i q_{0i}}$$

Laspeyres rejected this formula as it could exhibit a change when prices remained the same across two time periods—through changes in the quantities (Persky 1998, p. 200). However, Laspeyres did accept the need for including quantities and came up with his now well-known formula:

$$P^{0,t}_{Laspeyres} = \frac{\sum_i p_{ti} q_{0i}}{\sum_i p_{0i} q_{0i}}$$

It is interesting to note that Laspeyres didn't use the formula himself as he lacked quantity data and did not deduce that there was an "expenditure weighted average of price relatives" version of the index. The Laspeyres formula can be considered a special case of Lowe's general, "basket" formula, with the quantities taken from the specific time period "0". The Lowe index is sometimes called a "Laspeyres-type" index when it should really be the other way round.

The alternative and also well-known formula of Hermann Paasche (1851–1925) takes quantities from a single time period; however, in contrast to the Laspeyres index, they come from the current, or second, period; so, the Paasche formula is also a version of the Lowe formula with quantities taken from the time period "t" and is defined as:

$$P^{0,t}_{Paasche} = \frac{\sum_i p_{ti} q_{ti}}{\sum_i p_{0i} q_{ti}}$$

Drobisch had experimented with both the formulas now associated with Laspeyres and Paasche, but had rejected them; he did propose the following formula which bears his name, which is the arithmetic mean of the Laspeyres and the Paasche:

$$P^{0,t}_{Drobisch\,I} = \frac{1}{2}\left(P^{0,t}_{Laspeyres} + P^{0,t}_{Paasche}\right)$$

Balk (2008, pp. 7–8) notes that neither Laspeyres nor Paasche realised that their formulas could be written in terms of price relatives and expenditure weights, which would have great significance when applying the formulas in practice. The Laspeyres formula can be written as a base weighted arithmetic sum of price relatives and the Paasche formula as a current period weighted harmonic mean of price relatives (for a discussion of this see, for example, Ralph et al. (2015), Chap. 5):

$$P^{0,t}_{Laspeyres} = \sum_i \left(\frac{p_{ti}}{p_{0i}}\right) . \, w_{0i}$$

$$P^{0,t}_{Paasche} = \left[\sum_i \left(\frac{p_{ti}}{p_{0i}}\right)^{-1} . \, w_{ti}\right]^{-1}$$

where

$$w_{si} = \frac{q_{si}}{\sum_j q_{sj}} \quad s = 0 \, and \, t.$$

The economist Irving Fisher noted this important fact many years later in his own research relating to Index Numbers (Fisher 1922, p. 60).

3.11 Early Price Data

The collection of price data is a key ingredient for producing an estimate of the general level of prices. The early pioneers of price indices had to collect their own data from whatever sources they could find—this was the approach taken by Fleetwood, Shuckburgh Evelyn and Young and it was a time-consuming activity. From the middle of the nineteenth century, a more systematic approach began to emerge, though it was still largely dependent on enlightened individuals and private organisations. The modern approach, with a specialist, statistical public body taking responsibility for extensive, careful collection of relevant data wouldn't begin until the late nineteenth century and it would take a few more decades before it covered sufficient items and locations to produce a useful national level estimate of inflation.

The earlier data used in the study of Index Numbers came from sources associated with trade. The Economist magazine first published a commodity price index in 1864 with data going back to 1845; it was based on 22 commodities. It is a very long-running series as it is still published today. In Hamburg, the economists Laspeyres and Paasche could draw on price and quantity data for more than 300 commodities collected and published by the Chamber of Commerce (Balk 2008, p. 9).

3.12 The Development of Official Bodies for Price Statistics

Beyond the data and methodology ingredients in the development of inflation measures listed at the start of this chapter, the responsibility for producing them needs to be assigned to a suitable organisation. While a history will rightly focus on developments in the data collected and the statistical methodology, the organisational developments are important as well.

In the UK, the statistical department of the Board of Trade had been set up in 1832 in response to criticism over the lack of reliable information to support policy making in a period of great reform (Cullen 1975, p. 19). Part of the new department's remit was to bring together statistical information from parliamentary reports and papers, removing extraneous information in the process; this resulted in the publication of a statistical yearbook (Ward and Doggett 1991, p. 12). Statistical publication developed further and from 1854, an annual publication summarised a variety of official statistics including imports and exports, excise and shipping (Board of Trade 1854). The difficult economic conditions of the 1880s led to public and political concern about unemployment, wages and industrial disputes. Trades Unions and the Royal Statistical Society lobbied the government to improve the provision of data for these topics and a Labour Department within the Board of Trade was established in 1886 and further developed into the labour department in 1893 (Searle 2015). These steps established the initial elements of the framework which would later come together to form a modern National Statistics Institute, that is, the Office for National Statistics in the UK.

Balk (2008) notes that trust is a key attribute of a National Statistics Institute. The Office for National Statistics is the National Statistics Institute of the UK and together with the wider Government Statistical Service has the responsibility for producing official statistics. Together, these producers of Official Statistics must be trusted by the users of the statistics; in particular, that statistical outputs have been produced in-line with international best practice.

3.13 The Pace of Development

A final topic to consider in this brief summary of the early history of Index Numbers is why more effort wasn't made earlier to establish formal price statistics. Mitchell (1938, p. 10) noted:

> It is a curious fact that men did not attempt to measure changes in the level of prices until after they had learned to measure such subtle things as the weight of the atmosphere, the velocity of sound, fluctuations of temperature, and the precession of the equinoxes.

Mitchell went on to consider possible for reasons for this. He discounted mathematical difficulties, noting that such challenges were modest compared to other fields, and giving two other reasons. Firstly—as the comments of William Fleetwood and George Shuckburgh Evelyn indicate—despite the practical value of a measure of the general price level, it was not seen as a noble enterprise. Secondly, and probably, the main cause was the sheer diversity of price change across the range of items that consumers buy and the difficulty in capturing sufficient data to produce a reliable average. The scale of the collection and processing required meant that the enterprise was beyond the reach of individuals operating alone.

The scale of data collection and processing required to produce "a reliable measure" only became apparent in the early twentieth century as is described in Chap. 5. It remains a significant undertaking to the present day.

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4
What Is a Price Index?

Having seen how some of the early price indices were constructed in response to a specific need, in this chapter we discuss what a price index is and how it can be put together, using a relatively simple data set to highlight many of the issues. In order to help clarify the issues we are talking about in determining an appropriate measurement of price change, we first attempt to clarify the language that we will use to talk about measuring a change in the price level. Then we consider the potential inputs to such a process and discuss how such inputs might be used to produce meaningful estimates of the change in the price level, some of the methods for which we have already met in Chap. 3.

4.1 Defining a Price Index, Inflation and Index Numbers

In the course of this book and the practice of measuring changes in the general price level, we use a precise terminology. Before we define the mechanisms for producing numerical estimates of inflation, it is worth

R. O'Neill et al., *Inflation*, DOI 10.1007/978-3-319-64125-6_4

clarifying the way in which we talk about this process so that we start from a common platform of understanding.

We will often refer to **Index Numbers** as the subject, hence the capitalisation of the term. This covers the entire area of study of the design, properties, applications and potential uses of statistical tools which are designed to produce a single number to summarise the movement in one variable, constructed from many observations of other variables, between two or more different states of the world. These states could be spatially or temporally defined, as most price indices are. In this book we have focused explicitly on the use of Index Numbers in the pursuit of measuring changes in the general price level in the UK between different time periods, with each time period representing a distinct state of the world. We might otherwise have chosen to focus on using Index Numbers tools to measure the differences in contemporaneous price levels across a set of different countries (see Chap. 14), or we might have employed the techniques to indicate changes in industrial production across time periods in the UK. These represent just a few uses of the broad set of statistical tools which we have labelled as the domain of Index Numbers, and emphasises that this book focuses on a small subset of this broader subject area. We aim to help to make the study of Index Numbers in the context of UK inflation measurement more accessible.

Having defined the area of study in which our attention is focused on as **Index Numbers**, we will focus specifically on the different estimators which have been designed to measure the change in the price level through time. We collectively call this class of estimators **index number formulae** and they represent the way in which inputs can be combined in order to produce single, summary estimates of the price level, and percentage changes in these estimates across time then form our measure of inflation.

As we will see, the **index number formulae** which we employ will produce a different number to summarise our variable of interest (the price level) in each state of the world (time period). We will refer to the set of numbers which results from the computations from a single estimator as a set of **index numbers**. Note that this set of numbers is indicated by the use of lower case letters in "index numbers". This is in contrast to the use of capitalisation in the naming of the subject Index

Numbers. This is similar to the definition of the study of Statistics (the subject) and a set of statistics (e.g. average scores of students on a test). Although this may seem confusing at this point, hopefully our use of the two different terms will become clear as we make further headway in our consideration of inflation measurement in the UK context.

A set of index numbers is scale free, so it is usually scaled to be set equal to some value in a given state of the world, so for example in a set of index numbers to measure inflation one period is usually defined as having the value of 100. In this case, we will refer to this state of the world as the **reference period** for the index, as our states of the world will be exclusively time-based in this book. At the same time, we will label the arbitrary (and relatively unimportant) value to which the index is set in the **reference period** as the **reference value** of the index. The reference period is the one with which it will be most common for us to make direct comparisons and this can be facilitated by the setting of a sensible reference value, which is why a value of 100 is often used.

When constructing index numbers it is necessary to compare some states of the world with an initial or **base period**. This base period is the one which we compare our observations of price or quantity to. In many cases, this will be the earliest period for which an index is constructed, but need not be so. In more complex, long-running series, the **base period** is often updated on a regular basis. It is possible for an index to have different periods for base and reference periods, and the distinction between them will become more clear as we describe the uses of Index Numbers. In Chap. 2 we considered the nature and definition of **inflation**, which we concluded was an increase in the general level of prices. We will further abstract from this idea and in this chapter, the various index number formulae will produce a series of index numbers summarising the price levels, and the percentage change in these will define inflation as measured with that formula. Alternatively, we will consider **deflation** as the percentage decrease in our price level through time, as represented by a decrease in the value of an index number in the series when compared with some period in the past. It should be noted that elsewhere we will consider a further use of the term deflation, however it should be clear from the usage when we are using the term to describe a fall in the price level.

4.2 The Potential Inputs to Index Numbers Calculation

There are two main inputs to the set of index numbers formulae we will consider in this chapter: prices and quantities. While we might, in practice, make use of a further set of information relating to expenditure shares, much of the thinking around Index Numbers begins with a consideration of how prices and quantities might be used to measure a change in the general level of prices.

Consider an economy in which there are n products[1] and that each of these n products is available at a single price, p_{it}, in a given time period t, p_{it} where $i = 1, 2, \ldots, n$. This in itself is not as simple an assumption as it might seem, as a number of goods have prices which differ according to the people buying them, for example many cinemas charge different prices to children, adults, students and pensioners. We will therefore use the simplifying assumption that each good is sold at a single price in a single time period. The $n \times 1$ column vector of prices is therefore represented by $\mathbf{P}_t = (p_{1t}, p_{2t}, \ldots, p_{nt})'$ in the rest of this discussion.

The other main input in our estimation of index numbers is the amount of a given product which is consumed at the price we defined above. We represent the quantity of a product consumed in a given time period, t, as q_{it} where again $i = 1, 2, \ldots, n$. We can also represent this as a column vector $\mathbf{Q}_t = (q_{1t}, q_{2t}, \ldots, q_{nt})'$.

It is often difficult for those compiling inflation statistics to directly observe the quantities of products being purchased, however it is much more practical to be able to observe the amount of money which is spent on a given good in a period of time. For that reason, in our discussion of index numbers formulae, we will typically show the equation in two forms, one which specifies the estimator in terms of prices and quantities and another in terms of **expenditure shares**. The expenditure

[1]The terminology for individual items tends to vary across disciplines. Statisticians will be more likely to refer to products, while economists will more commonly refer to goods. We use the two terms interchangeably henceforth.

share of product i in period t represents the proportion of total expenditure which is related to purchases of the i^{th} product. Hence, if we can denote total expenditure as the sum of the products of prices and quantities across the n goods, $\mathbf{P_t'Q_t}$ then the expenditure share of the i^{th} good can be represented as:

$$w_{it} = \frac{p_{it}q_{it}}{\mathbf{P}_t'\mathbf{Q}_t}$$

and again we can create a column vector of these for the n goods, $\mathbf{w}_t = (w_{1t}, w_{2t}, \ldots, w_{nt})'$.

As we will see, there are some specialised index numbers which require additional inputs, usually parameters governing economic behaviour, and we will discuss these for individual formulae as we come across them. However, we are now well equipped with the building blocks of our index numbers and can begin to consider how they might be combined in order to tell us something about the general level of prices and how it changes over time.

4.3 Some Popular Index Numbers Formulae

This section introduces a small selection of the index number formulae which have been suggested for the construction of an index number series to measure the change in the general level of prices. We begin by considering a slightly different question, the Index Number problem, which motivated many of the first attempts at identifying an appropriate estimator for the general level of prices.

4.3.1 The Index Number problem

The Index Number problem begins by looking at the change in the overall level of consumption between two time periods. We will label the first of these periods as time 0 and the later one as t. In this case, we can create a **value index** which measures the change in the amount spent (the sum of price multiplied by quantity for each individual good) on a set of n goods in period t compared to the base period. We will denote this value index as $V^{0,t}$ where

$$V^{0,t} = \frac{\mathbf{P}_t^{'}\mathbf{Q}_t}{\mathbf{P}_0^{'}\mathbf{Q}_0}$$

and note that in this case the base value of the index is 1, as $V^{0,0} = 1$ by definition. In this case, if $V^{0,t} > 1$ then the amount of total spending has increased in period t compared to period 0, while if $V^{0,t} < 1$ then total spending is less in period t than it was in period 0.

The Index Number problem was introduced by many early academics working in the area, summarised in Frisch (1936), and has driven much discussion in Index Numbers since. The crux of the problem is that there are only two things which can have changed between the two time periods. Either quantities can change or prices can change and it is thought that the change in total spending should therefore lend itself to being decomposed into a measure of changes in the level of prices and a measure of change in the level of consumption. That is, if we label the index of changing prices as $I_P^{0,t}$ and the index of changes in the quantity consumed as $I_Q^{0,t}$, then it should be possible to specify a price index which, alongside an appropriate quantity index, satisfies the property:

$$V^{0,t} = I_P^{0,t} \times I_Q^{0,t}$$

where the quantity index corresponding to a given price index can be inferred from the above identity.

We mention the Index Number problem here as it motivated much of the early development of weighted indices and we wish to highlight how such indices fit into the framework of this overarching problem below. Indeed, the Index Number problem remains relevant as price indices are used to deflate output measures so that changes in real economic activity can be measured in a currency with a consistent purchasing power. We will return to this application of index number series in the final section of this chapter.

4.3.2 Unweighted Index Numbers

Index number formulae can generally be split into two categories[2]: those that are weighted using quantity information and those that are not. In splitting the formulae in this way, we are stepping outside of the historical flow, which presents the main formulae in the order they were suggested.

We begin by considering the category of formulae for which we do not need quantities in order to be able to calculate the index numbers. It is rare for a measure of inflation to be constructed as a purely unweighted index, however it is common for such formulae to be used at the lowest level of a more complex index structure as we will see in Chap. 10 when we discuss elementary aggregates.

The first equation we will consider is the Carli index, which is the arithmetic mean of the **price relatives** for the n goods under consideration. Denoting this index numbers formula as $I^{0,t}_{Carli(P)}$ where:

$$I^{0,t}_{Carli(P)} = \frac{1}{n}(\mathbf{R}_{\mathbf{t}}^{'}\mathbf{1}_n)$$

where $\mathbf{R}_t = \left(\frac{p_{1t}}{p_{10}}, \frac{p_{2t}}{p_{20}}, \ldots, \frac{p_{nt}}{p_{n0}}\right) = (R_{1t}, R_{2t}, \ldots, R_{nt})$ and $\mathbf{1}_n$ denotes an $n \times 1$ column vector in which every element is equal to 1.

An alternative to the Carli index is the Dutot index, which rather than taking the averages of the ratios of prices takes the ratio of the averages of prices. Hence,

$$I^{0,t}_{Dutot(P)} = \frac{\frac{1}{n}(\mathbf{P}_t^{'}\mathbf{1}_n)}{\frac{1}{n}(\mathbf{P}_0^{'}\mathbf{1}_n)} = \frac{\mathbf{P}_t^{'}\mathbf{1}_n}{\mathbf{P}_0^{'}\mathbf{1}_n}$$

the final statement is valid only where n, the number of goods, is constant between the two time periods.

[2]There are many other ways we might choose to classify index number formulae, this approach is chosen only for presentational purposes.

Hereafter, the unweighted indices become increasingly less obvious. The most important such index was proposed by W.S. Jevons in Jevons (1863), in his pamphlet on the changes in the value of gold. Jevons proposed that the change in the price level should be measured by the geometric mean of price relatives in the sample.

$$I^{0,t}_{Jevons(P)} = \left(\Pi^{n}_{i=1} R_{it}\right)^{(1/n)}$$

Our list of potential unweighted indices does not end here, and we might consider using the harmonic mean of price relatives as an alternative measure. In this case, the index formula is defined as:

$$I^{0,t}_{Harmonic(P)} = \frac{1}{\frac{1}{n}((1/\mathbf{R}_t)'\mathbf{1}_n)} = \frac{n}{(1/\mathbf{R}_t)'\mathbf{1}_n}$$

The Carruthers-Sellwood-Ward-Dalen (CSWD) index, is named after the combination of authors who have supported its use over the years. It produces index numbers which are the geometric mean of the corresponding Carli and Harmonic indices:

$$I^{0,t}_{CSWD(P)} = \sqrt{I^{0,t}_{Carli(P)} \times I^{0,t}_{Harmonic(P)}}$$

As far as we can discover the formula itself was first proposed in Coggeshall (1886). It is thought that the CSWD is an unweighted approximation to the Fisher index, which we will meet when we consider weighted index numbers formulae below. The properties of the Fisher index will be discussed in later chapters, however for the minute it is sufficient to note that this formula is one which many Index Numbers experts would be likely to include among their preferred formulae for inflation measurement, if sufficient data were available, hence the importance of the CSWD index, as a potentially unweighted version of the Fisher index. The CSWD formula seems like a much less natural estimator of an unweighted change in the price level, however as we will see several times in this book, as relates to Index Numbers, it is rarely the most obvious solution to a problem which turns out to be best in the eyes of the Index Numbers community.

Mehrhoff (2010) considers which unweighted index numbers formulae are equivalent to weighted indices, and doing this makes use of the concept of a generalised mean of price relatives. For a parameter value r, we can define the generalised mean of price relatives as:

$$I^{0,t}_{Gen.Mean(r)(P)} = \sqrt[r]{\frac{1}{n}(\mathbf{R}^r_t)'\mathbf{1}_n}$$

where $\mathbf{R}^r_t = (R^r_{1t}, R^r_{2t}, \ldots, R^r_{nt})'$. As Mehrhoff (2010) shows, this index number formula includes several of the unweighted formulae we have already seen as special cases. As the value of r is changed, so does the nature of the average of price relatives we are taking. If we set $r = 1$, then the generalised mean reduces to the Carli index as described above. Similarly, as $r \rightarrow 0$ then $I^{0,t}_{Gen.Mean(r)(P)} \rightarrow I^{0,t}_{Jevons(P)}$ and if $r = -1$ then $I^{0,t}_{Gen.Mean(r)(P)} = I^{0,t}_{Harmonic(P)}$.[3] We then technically have an infinite number of ways to combine the price relatives to produce a series of index numbers as r can take on any real value. In practice, however this will not have much practical appeal, particularly as it can be shown that the upper and lower limits of the generalised mean are the maximum and minimum values from the column vector of price relatives, hence $min(\mathbf{R}_t) \leq I^{0,t}_{Gen.Mean(r)(P)} \leq max(\mathbf{R}_t)$. Mehrhoff (2010) goes on to ask an interesting question: What value of r allows an unweighted index to replicate the results of a given form of weighted index?

4.3.3 Weighted Index Numbers

We now turn our attention to the second collection of methods for producing estimates of the price level at a given point in time. All of these formulae use information other than prices to estimate the price level.

As we saw in Chap. 3, Etienne Laspeyres (1864) proposed that the quantities from the base period of the comparison could be used in

[3]Mehrhoff (2010) also considers $r = 2$ which produces a quadratic mean and $r = -2$ which produces a reciprocal quadratic, however we have never seen either of these formulae applied as price indices so do not include them in our discussion.

order to provide some useful weighting information. In essence, his famous index numbers formula measured the factor by which we would need to multiply income to ensure that a consumer could buy exactly the same goods at time t in exactly the same numbers as was observed at time 0. His formula can be written as:

$$I^{0,t}_{Laspeyres(P)} = \frac{\mathbf{P}_t^{'}\mathbf{Q}_0}{\mathbf{P}_0^{'}\mathbf{Q}_0}$$

Laspeyres despaired that this might not be the most practical of index numbers formulae as it called for the dual collection of prices and quantities. It was soon shown by Irving Fisher, in his 1922 study of Index Numbers, that there is an alternative way of writing the Laspeyres formula which does not require the explicit use of quantities and uses expenditure weights instead:

$$\begin{aligned} I^{0,t}_{Laspeyres(P)} &= \frac{\mathbf{P}_t^{'}\mathbf{Q}_0}{\mathbf{P}_0^{'}\mathbf{Q}_0} = \frac{\sum_{i=1}^{n} p_{it}q_{i0}}{\sum_{i=1}^{n} p_{i0}q_{i0}} = \sum_{i=1}^{n} \frac{p_{it}q_{i0}}{\sum_{i=1}^{n} p_{i0}q_{i0}} \frac{p_{i0}}{p_{i0}} \\ &= \sum_{i=1}^{n} \frac{p_{i0}q_{i0}}{\sum_{i=1}^{n} p_{i0}q_{i0}} \frac{p_{it}}{p_{i0}} = \mathbf{W}_0^{'}\mathbf{R}_t \end{aligned}$$

where $\mathbf{W}_t = \left(\frac{p_{1t}q_{1t}}{\sum_{i=1}^{n} p_{it}q_{it}}, \frac{p_{2t}q_{2t}}{\sum_{i=1}^{n} p_{it}q_{it}}, \ldots, \frac{p_{nt}q_{nt}}{\sum_{i=1}^{n} p_{it}q_{it}} \right) = (w_{1t}, w_{2t}, \ldots, w_{nt})$ is the column vector of period t expenditure shares. This allows for the estimation of a Laspeyres price index series if all we have access to price quotes from a given time period and the expenditure weights from the base period of the index.

In some cases, it is not possible to obtain expenditure weights without a significant delay, relative to the time scale demanded for release of inflation estimates. As a result, it may be necessary to use quantities from some time period $s < 0$ before the base period for prices. In this case, we are comparing the cost of the basket of goods from period s, obtained at period 0 prices with the cost of obtaining the same basket of goods and services at time period t.[4] This is the Lowe index, which we saw in Chap. 3, preceded the Laspeyres index, and can be written as:

$$I^{0,t}_{Lowe(P)} = \frac{\mathbf{P}_t^{'}\mathbf{Q}_s}{\mathbf{P}_0^{'}\mathbf{Q}_s}$$

We will deal with how this formula can be operationalised to produce index numbers at length, as it is the form which is most commonly adopted by NSIs in their production of official price statistics for a number of reasons. We could also write it as a weighted combination of price relatives:

$$I^{0,t}_{Lowe(P)} = \frac{\mathbf{P}_t^{'}\mathbf{Q}_s}{\mathbf{P}_0^{'}\mathbf{Q}_s} = \mathbf{W}_{s,0}^{'}\mathbf{R}_t$$

where $\mathbf{W}_{s,0} = \left(\frac{p_{10}q_{1s}}{\sum_{i=1}^{n} p_{i0}q_{is}}, \frac{p_{20}q_{2s}}{\sum_{i=1}^{n} p_{i0}q_{is}}, \ldots, \frac{p_{n0}q_{ns}}{\sum_{i=1}^{n} p_{i0}q_{is}}\right)$.

The Lowe index assumes that we are able to identify the quantities from period s, however we might also consider what happens if we are only able to obtain expenditures in period s. In this case, we could use the formula proposed in Young (1812) which is:

$$I^{0,t}_{Young(P)} = \mathbf{W}_s^{'}\mathbf{R}_t$$

which Arthur Young used in his consideration of the changing value of money in England for agricultural products.

Although it is often thought that the Laspeyres index is a fairly intuitive way of presenting a price index, there are some clear alternatives to this way of doing things which have been suggested and have stood the test of time in the Index Numbers literature. The most famous alternative to the Laspeyres formula is the Paasche index formula, as presented by Herman Paasche (1874). In this formula, we take the quantities not

[4] In many practical applications of this formula, it is normal for those producing price indices to attempt to minimise the distance in time between period s and period 0 so that the basket of goods is as relevant as possible.

from period 0, but from period t, as there is no reason why the quantities purchased in this period should not be treated with as much emphasis as those from period 0. Hence the Paasche formula is:

$$I^{0,t}_{Paasche(P)} = \frac{\mathbf{P}'_t\mathbf{Q}_t}{\mathbf{P}'_0\mathbf{Q}_t}$$

which is very similar in structure to the Laspeyres formula. It is possible to write the Paasche index as a weighted combination of price relatives in a style similar to that of the Laspeyres index above:

$$\begin{aligned} I^{0,t}_{Paasche(P)} &= \frac{\mathbf{P}'_t\mathbf{Q}_t}{\mathbf{P}'_0\mathbf{Q}_t} = \frac{\sum_{i=1}^n p_{it}q_{it}}{\sum\limits_{i=1}^n p_{i0}q_{it}} = \sum_{i=1}^n \frac{\sum_{i=1}^n p_{it}q_{it}}{p_{i0}q_{it}} \frac{p_{it}}{p_{it}} \\ &= \sum_{i=1}^n \frac{\sum_{i=1}^n p_{it}q_{it}}{p_{it}q_{it}} \frac{p_{it}}{p_{i0}} = (\mathbf{W}'_t(1/\mathbf{R}_t))^{-1} \end{aligned}$$

which means that the Paasche index is a current period weighted harmonic mean of the price relatives between the two time periods.

We have seen a few index numbers formulae which use weighting information and it is possible to alter these formulae to produce new formulae. For example, starting with the expenditure weighted version of the Lasperyes formula, there is no reason that the arithmetic weights need to come from the base period. We can replace these weights with those from period t, which leads us to the Palgrave price index:

$$I^{0,t}_{Palgrave(P)} = \mathbf{W}'_t\mathbf{R}_t$$

which is a period t expenditure share weighted arithmetic mean of price relatives between period 0 and period t.

In a similar fashion, we can ask why the weights in the harmonic version of the Paasche formula, must come from period t. It is a straightforward exercise to replace these weights with those from period 0 in order to obtain a further weighted price index, which we call the harmonic-Laspyeres index:

$$I^{0,t}_{Harmonic-Laspeyres(P)} = (\mathbf{W}_0'(\mathbf{1}_n/\mathbf{R}_t))^{-1}$$

which will produce another alternative set of index numbers.

As we have seen already, the differences between the geometric and arithmetic mean have given rise to a large number of different index number formulae, and it is also possible to identify geometric versions of the Laspeyres and Paasche indices, in which the price relatives are first raised to the power of their expenditure share in a given period and then multiplied together to give either a geometric Laspeyres, when we use period 0 expenditure shares, or a geometric Paasche, when we use the period t expenditure shares. This further expands the number of formulae available for combining prices and quantities to measure changes in the price level.

We could follow this path further along several other dimensions, for example we could take a generalised mean of the various combinations of weights and price relatives, which would then produce a huge number of new indices, many of which would be difficult to interpret in an economic sense. We therefore restrict the rest of our discussion to alternative formulae which have made an appearance in the existing Index Numbers literature in order to ease the potential burden we have in considering which formula to employ when considering the estimation of inflation.

4.3.4 Symmetrically Weighted Index Number Formulae

Having looked at index number formulae which try to isolate which set of quantities, or expenditure weights we should be using, we can now consider a class of indices which do not require such a choice but in some sense try to treat the weightings from the two periods as symmetric. Later on, we will say a lot more about the properties of the index number formulae which we present under this heading, however it is worth noting that they are of particular interest in the field of Index Numbers.

By far, the most famous index number formula using both sets of weights is the Fisher index, discussed at length in Fisher (1922) by the famous economist Irving Fisher. The formula for this index takes the geometric mean of the Laspeyres and Paasche indices, hence:

$$I^{0,t}_{Fisher(P)} = \sqrt{I^{0,t}_{Laspeyres(P)} \times I^{0,t}_{Paasche(P)}}$$

where we can see that the value of this index number series at time period must be somewhere between the values of the Lasperyes and Paasche indices. It is notable that this is the geometric mean of a weighted arithmetic mean and a weighted harmonic mean of price relatives, hence we can see the relationship between this formula and an unweighted version of it that we have seen above in the CSWD index, introduced in the unweighted collection of index numbers.

Unsurprisingly given the breadth of choice of index number formulae that we have already encountered in this chapter, there are further symmetrically weighted price index formulae options available. Törnqvist (1936) introduced an index number formula which takes a weighted geometric mean of the price indices, where the weights on individual price relatives are the arithmetic mean of the expenditure shares in the two periods.

$$I^{0,t}_{Tornqvist(P)} = \Pi^{n}_{i=1} R_{it}^{\frac{w_{i0}+w_{it}}{2}}$$

Alternatively, the Marshall-Edgeworth formula takes a weighted arithmetic mean of the price relatives; however, in this case, the weights chosen are the arithmetic means of the expenditure share for each of the goods across the two periods considered by the index:

$$I^{0,t}_{Marshall-Edgeworth(P)} = (\frac{1}{2}(\mathbf{W}_0 + \mathbf{W}_t))' \mathbf{R}_t.$$

Having considered the Marshall-Edgeworth formula, it was not clear to Walsh (1901, 1921) that the weights used should be estimated using an arithmetic mean. Instead, he suggested the weights be produced by the geometric mean of the expenditure shares in the two periods:

$$I^{0,t}_{Walsh(P)} = (\mathbf{W}_{0\times t})' \mathbf{R}_t$$

where $\mathbf{W}_{0\times t} = \left((w_{10}w_{1t})^{(1/2)}, (w_{20}w_{2t})^{(1/2)}, \ldots, (w_{n0}w_{nt})^{(1/2)})\right)$. Drobisch[5] (1871) had earlier suggested what now seems an obvious alternative to the Fisher formula; the arithmetic mean of the Laspeyres and Paasche indices:

$$I^{0,t}_{Drobisch(P)} = \frac{I^{0,t}_{Laspeyres(P)} + I^{0,t}_{Paasche(P)}}{2}$$

which is guaranteed to have higher numbers in its index numbers series than the Fisher index when $t \neq 0$ except in the special case in which $I^{0,t}_{Laspeyres(P)} = I^{0,t}_{Paasche(P)}$.

As we progress further into our study of Index Numbers, we will see that the subject is closely tied to the area of utility optimisation in microeconomics. It is no surprise then that this area of study should also have provided its own version of a price index for consideration alongside other measures. The index proposed in Lloyd (1975) uses as its basis a constant elasticity of substitution (CES) utility function, which contains the parameter σ, which represents the elasticity of substitution, which determines the rate at which consumers are willing to substitute goods with differential rates of marginal utility. The formula proposed in Lloyd (1975) was:

$$I^{(0,t)}_{Lloyd-Moulton(P)} = \left(\mathbf{W}_0'(\mathbf{R}_t^{1-\sigma})\right)^{\frac{1}{1-\sigma}}$$

which was rediscovered by Moulton and Moses (1997) and has since become known as the Lloyd-Moulton formula. The new formula, which allows us to estimate an index which would ensure consumers have a fixed level of utility, requires the estimation of σ, which in itself is a complex task and therefore complicates the problem of operationalising

[5]As von Auer (2010) the contribution of Drobisch to the field of Index Numbers goes far beyond the suggestion of this formula, including first proposing the forms of the indices which carry the names of Laspeyres and Paasche and the suggestion of a unit value index.

such an index.[6] We might consider such a formula as a single-weighted index; however, as it attempts to fix utility across multiple periods, we have included it in this section of our introduction to Index Number formulae.

The differences between the various indices are subtle at first glance and the breadth of choice may appear overwhelming. The first question we might ask is whether it really makes a difference which formula we use to measure inflation? The short answer is yes, which we will try to demonstrate with the use of a small numerical example. However, it is possible to see that all of these formulae will produce slightly different sets of index numbers, and therefore slightly different estimates of inflation. In some cases, the difference will be relatively small, for example when the Laspeyres and Paasche formulae produce similar index number series then the Fisher and Drobisch indices will, by definition, produce similar sets of index numbers as well. In many cases, the weighted indices will produce similar sets of index numbers, which in some sense should be considered reassuring—if they were wildly different when using the same inputs, then the debate about which index number formula to use in measuring inflation would be even more lively.

4.3.5 Returning to the Index Number Problem

Having been introduced to a multitude of Index Number formulae, we can now return to the original question with which we began this section: do the above index number formulae, and the index numbers they produce, allow us to answer the Index Number problem?

The answer is perhaps less clear than we might have hoped. If we had a value index, then we could indeed divide this by any of the price indices we have considered, and this would give us a value which would theoretically represent the change in the quantity level implied by our price index. In some cases we are able to answer the question more forcefully; for example, if we divide our value index by a Laspeyres price index,

[6]For an example of attempts to estimate σ for alcohol products in the UK, see Elliott and O'Neill (2012).

then the resulting quantity index will be a Paasche quantity index[7] as we can show:

$$\frac{V^{0,t}}{I^{0,t}_{Laspeyres(P)}} = \frac{\mathbf{P}_t^{'}\mathbf{Q}_t}{\mathbf{P}_0^{'}\mathbf{Q}_0}\frac{\mathbf{P}_0^{'}\mathbf{Q}_0}{\mathbf{P}_t^{'}\mathbf{Q}_0} = \frac{\mathbf{P}_t^{'}\mathbf{Q}_t}{\mathbf{P}_t^{'}\mathbf{Q}_0} = I^{0,t}_{Paasche(Q)}$$

Hence, by deflating a value index by a Laspeyres price index, we know exactly what we will get. When doing things the other way around, deflating a value index series by a Paasche price index series we obtain a Laspeyres quantity index series as seen below.

$$\frac{V^{0,t}}{I^{0,t}_{Paasche(P)}} = \frac{\mathbf{P}_t^{'}\mathbf{Q}_t}{\mathbf{P}_0^{'}\mathbf{Q}_0}\frac{\mathbf{P}_0^{'}\mathbf{Q}_t}{\mathbf{P}_t^{'}\mathbf{Q}_t} = \frac{\mathbf{P}_0^{'}\mathbf{Q}_t}{\mathbf{P}_0^{'}\mathbf{Q}_0} = I^{0,t}_{Laspeyres(Q)}$$

In a similar fashion, when dividing through our value index by a Fisher index then by definition the resulting quantity index must be a Fisher quantity index, that is

$$\frac{V^{0,t}}{I^{0,t}_{Fisher(P)}} = \sqrt{\frac{V^{0,t}}{I^{0,t}_{Laspeyres(P)}}}\sqrt{\frac{V^{0,t}}{I^{0,t}_{Paasche(P)}}} = \sqrt{I^{0,t}_{Laspeyres(Q)} \times I^{0,t}_{Paasche(Q)}}$$

As we progress to deflation of the value index with more complicated formulae, the resulting quantity indices are less easy to interpret. This may cause problems, as if we cannot clearly state the corresponding quantity index, and make it understandable, we will only be defining the quantity index via the form of the price index we have chosen. Although the form of the quantity index is not always a central consideration when choosing from the many price indices above, it is worth consideration as deflating series from current to constant values will be one of the key uses of the index numbers produced using the various estimators discussed in this chapter.

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[7]Due to space restrictions, we do not spend more time discussing the quantity index versions of the above indices.

4.4 Differences in the Estimation of Inflation

Having seen so many estimators of index number series, it may be useful to see how these formulae might produce estimates of inflation using a small data series in which we can have most of the data we require. In this section we will therefore use an artificial data set to create series of index numbers using all of the formulae discussed above, with the exception of the Lloyd-Moulton index as this would require us to specify the utility function of consumers.

In Table 4.1 we provide the detail on the prices and quantities of 20 goods, as consumed by a group of people over a given time period. We observe quantities and prices over 10 time periods (labelled 0 to 9 so that when we use the first as the base period it is consistent with our notation). We therefore have the data required to estimate many of the index numbers series for each of the formulae we have considered in this chapter.

In Table 4.2 for each of the considered Index Number formulae we report the estimates of inflation (the percentage change in the index number series) compared to the base period. We choose the earliest period 0 as the base period, although we could easily re-base our estimations to another period, say period 5, which would change our estimated measures of price and quantity change. In order to see what this implies regarding quantity changes in the period, we also report the percentage change in the quantity index implied by the calculated price index. This means we have a number of estimates of inflation and of changes in the quantity index and below we will discuss some of the significant differences.

There are considerable differences in the results for different indices, although it is notable that all of the symmetrically weighted indices are similar. The differences between the final estimates of inflation are much larger for the unweighted indices, which therefore affects the corresponding quantity indices. Neither of these results is unexpected as we will see as we delve further into considerations of the nature of the indices we have considered. It is also clear that unweighted versions of indices do not do a very good job of approximating weighted indices, for example the CSWD is a poor approximation of the Fisher index, the harmonic mean is a poor approximation of the Paaasche and the Carli performs badly in replicating the results of the Laspeyres index.

Table 4.1 Prices and quantities for the 20 items in our basket over ten periods

Time	0		1		2		3		4		5		6		7		8		9	
Good	P	Q	P	Q	P	Q	P	Q	P	Q	P	Q	P	Q	P	Q	P	Q	P	Q
1	2.5	27	2.81	28	2.9	28	3.04	30	3.09	28	3.46	28	3.66	29	3.48	31	3.61	34	3.59	31
2	6.2	6	6.38	6	6.25	6	6.81	6	6.52	6	6.62	7	6.85	7	6.63	7	7.39	7	7.94	7
3	7.4	8	8	8	7.77	7	8.59	7	8.55	6	8.74	5	9.84	5	10.85	5	10.45	5	10.81	5
4	2.5	29	2.56	27	2.79	25	3.18	23	3.51	25	3.69	27	4.14	28	4.46	26	4.77	27	5.39	29
5	11.3	28	12.76	30	13.37	28	13.83	28	14.81	29	14.85	29	15	28	17.12	27	16.91	26	17.75	27
6	11.5	12	11.3	11	11.89	11	12.35	12	13.68	11	13.11	10	13.84	9	14.13	9	13.43	9	15.38	9
7	9.7	12	9.45	12	9.51	12	10.69	12	10.84	12	12.34	12	11.9	12	12.06	13	11.62	13	12.52	13
8	10.9	12	11.04	12	11.15	13	11.25	12	12.61	13	12.73	13	13.05	12	14.6	13	13.97	12	15.74	12
9	7.1	11	7.2	10	6.93	10	6.84	10	7.47	10	7.73	9	8.38	10	8.99	11	10.06	12	10.35	13
10	9.1	12	8.89	11	8.68	10	8.75	10	9.04	9	8.95	10	10.16	9	11.14	8	11.79	8	13.47	8
11	11.4	28	12.62	30	12.54	32	13.52	33	12.87	32	13.42	29	13.86	28	13.4	30	14.41	33	14.46	32
12	5	9	5.1	8	5.53	7	5.34	7	5.81	7	6.61	7	6.44	8	6.9	8	7.9	8	7.62	8
13	3.2	30	3.37	32	3.33	35	3.41	35	3.68	35	4.04	38	3.93	41	4.43	43	4.55	47	4.84	51
14	7.5	26	7.8	28	8.12	27	8.48	28	9.17	29	9.99	28	11.09	26	12.7	28	14.41	27	15.93	29
15	7.8	14	7.51	13	8.15	13	7.93	12	8.57	12	8.39	12	8.69	11	8.69	11	8.8	11	8.71	12
16	8.8	28	10.03	30	9.93	27	10.46	26	11.04	28	12.01	27	13.58	28	14.1	29	14.42	28	14.35	28
17	8	29	8.58	28	8.78	28	9.65	27	9.8	25	10.75	25	10.7	23	11.99	23	12.08	21	11.97	21
18	3	7	3.3	7	3.75	8	4.19	7	4.77	6	5.14	6	5.42	6	6.11	6	5.87	6	6.72	7
19	2.2	19	2.53	20	2.87	20	3.2	22	3.18	24	3.51	25	3.95	24	4.35	22	4.24	21	4.21	22
20	2.3	11	2.31	11	2.4	12	2.59	12	2.74	11	2.76	11	2.79	11	3.12	12	3.59	11	3.98	11

Table 4.2 Price and quantity indices between period 0 and period *t*

	Time	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Carli	P	4.99	8.41	14.72	20.68	27.31	34.13	43.74	48.61	57.35
	Q	3.01	0.46	0.04	−1.02	−3.03	−5.68	−3.65	−3.86	−2.65
Dutot	P	4.47	6.72	12.15	17.72	22.88	29.02	37.74	41.39	49.73
	Q	3.52	2.05	2.33	1.47	0.47	−1.94	0.55	1.05	2.31
Jevons	P	4.83	8.07	14.06	19.93	26.14	32.62	41.53	46.41	54.67
	Q	3.17	0.78	0.61	−0.4	−2.13	−4.6	−2.14	−2.41	−0.96
Harmonic	P	4.67	7.74	13.44	19.22	25.01	31.24	39.48	44.32	52.22
	Q	3.32	1.09	1.16	0.2	−1.24	−3.6	−0.7	−1	0.63
CSWD	P	4.83	8.08	14.08	19.95	26.16	32.68	41.59	46.45	54.76
	Q	3.17	0.77	0.6	−0.41	−2.14	−4.65	−2.18	−2.44	−1.02
Lasperyes	P	6.33	8.71	14.59	19.79	25.85	32.17	41.5	45.83	53
	Q	1.71	0.18	0.15	−0.28	−1.9	−4.28	−2.12	−2.02	0.12
Paasche	P	6.6	8.86	14.88	20.02	26.33	32.76	41.81	45.99	53.62
	Q	1.45	0.05	−0.1	−0.47	−2.28	−4.71	−2.33	−2.13	−0.28
Palgrave	P	6.93	9.31	15.65	20.82	27.63	34.77	44.93	49.74	58.52
	Q	1.14	−0.37	−0.77	−1.13	−3.27	−6.13	−4.44	−4.58	−3.37
Harmonic	P	5.99	8.25	13.79	18.97	24.5	30.4	38.54	42.34	48.94
Lasperyes	Q	2.04	0.61	0.85	0.41	−0.84	−2.98	−0.03	0.38	2.85
Geometric	P	6.16	8.48	14.19	19.38	25.18	31.26	40	44.04	50.88
Lasperyes	Q	1.87	0.4	0.5	0.06	−1.38	−3.62	−1.07	−0.81	1.53
Geometric	P	6.77	9.08	15.26	20.42	26.98	33.74	43.36	47.83	55.97
Paasche	Q	1.29	−0.16	−0.43	−0.8	−2.78	−5.4	−3.39	−3.35	−1.79
Fisher	P	6.46	8.78	14.73	19.9	26.09	32.47	41.66	45.91	53.31
	Q	1.59	0.12	0.03	−0.37	−2.09	−4.5	−2.23	−2.08	−0.08
Tornqvist	P	6.46	8.78	14.73	19.89	26.08	32.49	41.67	45.92	53.4
	Q	1.59	0.12	0.03	−0.36	−2.08	−4.51	−2.24	−2.08	−0.14
Marshall-Edgeworth	P	6.63	9.01	15.12	20.31	26.74	33.47	43.22	47.78	55.76
	Q	1.43	−0.09	−0.31	−0.71	−2.59	−5.21	−3.3	−3.32	−1.65
Walsh	P	6.47	8.8	14.78	19.92	26.19	32.68	42.21	46.54	54.09
	Q	1.58	0.1	−0.02	−0.39	−2.17	−4.65	−2.61	−2.5	−0.59
Drobsich	P	6.47	8.78	14.73	19.9	26.09	32.47	41.66	45.91	53.31
	Q	1.58	0.12	0.03	−0.37	−2.09	−4.5	−2.23	−2.08	−0.08

4.5 Conclusions

We began this chapter by asking what a price index is and we have seen in the discussion that followed that an individual price index series represents estimates of a number which aggregates lots of information, usually regarding prices and quantities, the changes which then tell us about the rate of inflation. Identical data can be used to produce a wide range of index numbers, which means we potentially have a wide range of estimates of inflation. As we look more specifically at an individual inflation measure, the change in consumer price levels in the UK, we should be careful to remember that the index numbers produced are just one among many possibilities and that there are many ways to think about the measurement of price changes. As a result, there is no single answer to the question of what the value of the price index is in a given period and any price index we produce remains a single realisation using one among many potential methodologies.

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5

The Development of the Cost of Living Index: 1880 to 1946

The need for a "standard of value" or "general level of prices" as a means of adjusting contracts and wages had been proposed by a number of commentators in the nineteenth century, as Chap. 3 described. However, it wasn't until 1914 that this was achieved in the UK, and then, only in an imperfect form. This chapter describes the developments that took place to establish the data needed for an index of retail prices—household budget shares and the prices of goods and services.

Social and political imperatives drove the need for better understanding of both household spending and the course of prices in the latter years of the nineteenth and early years of the twentieth centuries. The dramatic effects of the onset of the First World War provided added motivation in the form of an increased need for stability of prices of essential goods such as staple food items. As noted in Chap. 3, it was not possible to control prices completely, and where price rises did occur, the need for industrial stability saw the introduction of compensation for essential workers in the form of wage increases to ensure that disputes were avoided in vital industries. This set of circumstances led to conditions that established both a measure of the cost of living and the practice of linking wages to it.

R. O'Neill et al., *Inflation*, DOI 10.1007/978-3-319-64125-6_5

Prior to 1903, only limited information on household budgets and retail prices were available. Between 1903 and 1914, the Labour Department of the Board of Trade carried out a substantial volume of work to address this lack of data. As a result, the Board gradually established household budget data for working-class families and the means to collect retail prices for a range of commodities on a monthly basis; a number of large Board of Trade reports described this work (see for example Board of Trade 1905). By the onset of war, the Board was able to produce a measure of the level of prices in the form of monthly cost of living index numbers. By the end of the war, the index numbers showed that prices had almost doubled.

During the First World War, wage boards for different groups of workers provided compensation for the increases in prices of essential goods. This approach established the new long-standing principle of adjusting pay to maintain purchasing power by reference to the changes in a specified price index.

In the period between the wars, wages for many types of workers tracked the cost of living index; however, the willingness of groups and individuals to question the accuracy of the measures of changes in the price level grew, especially as the expenditure weights used in the measure were based on a basic standard of living for working-class families determined before the start of the First World War. It wasn't until the late 1930s that a new household expenditure survey was carried out. It was the first to be based on a representative sample of households where random stratified samples were drawn from the National Insurance register (Gazeley and Newell 2009, p. 8).

The onset of the Second World War halted the implementation of the new expenditure shares and the weights which had been used since 1914 were left unchanged until after the war was over. The limited range of products covered in the index, together with the use out of date weights, meant that it was common for people to believe the index underestimated overall price increases during the Second World War when prices of everyday items rose sharply; this undermined confidence in the index as a reliable measure of price change.

5.1 Price and Expenditure Series Before 1880

Before describing the developments that took place to help establish the first measure of the general level of prices, it is important to set out the starting position. What retail price data were available and what was known about household budgets at the beginning of the time period we are considering?

5.1.1 Price Information

Prices paid for goods and services have been recorded for many centuries; a few examples were given in Chap. 3. Burnett (1969) provided a range of historical material on such data which covered the period from the Middle Ages to the turn of the twentieth century. He listed a range of prices of both goods and services obtained from a variety of sources including the accounts of grand houses and monasteries. While these prices were of historical importance, they related to different locations, times and circumstances, and provided a poor basis for a measure of the general level of prices because of their lack of representativeness of the general situation at the time.

An early attempt to construct a measure of the changing course of prices was made by Sir George Shuckburgh Evelyn; Chap. 3 describes his ambitious efforts to calculate a mixture of the “prices of various necessities of life together with rates of day labour” over the period 1050–1800 CE (Shuckburgh Evelyn 1798). To support his work, Shuckburgh Evelyn notes that the information was derived from “respectable authorities”, though there is no formal definition of what this term meant.

Wholesale prices were better recorded than retail prices as a result of the need for conducting business. A more systematic approach to price collection was developed in the nineteenth century, with prices for a variety of commodities being collated by individuals and organisations from the middle of the century onwards. This led to several series of price index numbers being produced independently, including those of Jevons, Sauerbeck and the Economist. These index series are described briefly in Chaps. 3 and 14.

5.1.2 Early Official and Private Inquiries into Household Expenditure

A small number of records of household expenditure exist as far back as the twelfth century, with increasing numbers of records available from the fifteenth century. Specific study of household expenditure is considered to have originated in the seventeenth century with Sir William Petty, with a further step taken at the end of the eighteenth century with Davies and Eden collecting information by direct contact with families (Deeming 2010); Davies and his collaborators collected 127 family budgets and Eden collected data for 60 agricultural and 26 urban families. In the mid-nineteenth century, Dr Edward Smith carried out the first national household survey into food standards by analysing 370 family budgets to compare average food consumption against a proposed minimum standard (Deeming 2010, p. 770). Historical household budgets have been recognised as important sources of information and efforts are underway to collect them from a wide range of countries into a database for research (A'Hearn et al. 2016).

Official efforts to collect data on household income and expenditure began very modestly. The first enquiry carried out by the Board of Trade on household expenditure of working-class families and retail prices consisted of questioning just 36 working men in 1889 (Board of Trade 1889). A larger US survey was carried out by the commissioner of Labour of the USA in 1891; this was a budget survey of working-class households in a number of countries to obtain data to compare with the USA. Data was collected from 455 families in the UK (Ward and Doggett 1991, p. 132); it showed that on average, families had an income of £1 13s 10½d, with 15s 7d spent on food, 5s 7d on clothing and 3s 9½p on rent.

The late nineteenth century also saw two highly influential, privately funded investigations. They were not specifically designed to capture the detailed income and expenditure of working-class households for wider statistical purposes, though this information was collected as part of the investigations. The intention of the studies was to discover the extent of poverty among the working classes.

The industrialist and social reformer Charles Booth captured household income and expenditure data, firstly in the East End of London, and then in other parts of the city; he found that 35% of families were living in "abject poverty". His work was published in 1889 and 1891 (Booth 1889–1891). Similar investigations were carried out in York by another industrialist—Seebohm Rowntree. Rowntree's work found that 28% of the population were living in serious poverty without the means to acquire sufficient quantities of the basic necessities of life—food, fuel and clothing; his results were published in Poverty, A study in Town Life in 1901 (Deeming 2010). The work of Booth and Rowntree was significant, both in indicating the extent of extreme poverty in the UK and in establishing the foundations of social research using data collected from households. The conclusions, indicating that about 30% of families were in poverty, were in contrast to the official data on "paupers", which reported poverty levels of just a few per cent (Pugh 2012, p. 49).

The statistician Arthur Bowley made an important contribution to the development of the statistical approach to social investigation. While Rowntree aimed to collect data for every household in York, Bowley realised that a carefully selected sample could be as effective. To illustrate the point, he carried out a 1 in 20 survey of working-class households in Reading in 1913 (Deeming 2010, p. 773). Bowley played an important role in establishing the sample survey, an important tool which has been used ever since in the production of official and other statistics (Bethlehem 2009, p. 12).

Further steps in the development of official expenditure surveys were gradual following the investigations in the latter half of the nineteenth century. In 1902, the Board of Trade carried out an investigation into the income and food expenditure of 114 agricultural workers in different regions of England (Board of Trade 1903b, Chap. 18, p. 210). The agents collecting data were landowners, farmers, Local Government Board inspectors, the clergy, tradesman and agricultural labourers. This work provided estimates of average income of 18s 6d compared to average food expenditure of 13s 6½d—expenditure on food therefore accounted for about three quarters of total income. The report noted that the estimates of income did not include a number of sources of income which were relevant at the time, such as home grown produce, a category of economic activity which remains difficult to measure to this day.

5.2 The Political Imperative

The need to better understand the wages and the cost of living of the working classes in the period around the start of the twentieth century came from two sources. Firstly, reliable information was required for general political debate, as reflected in a resolution passed in the House of Commons in March 1886 for "the full and accurate Collection and Publication of Labour Statistics" (Hansard 1886, p. 73). Secondly, the extent of poverty was poorly understood and social reformers were seeking to understand its extent in working-class families in different parts of the country; as noted above, many suspected that poverty was much more widespread than was officially recognised and this appeared to be supported by independent statistical investigation.

In response to the demand for more information, the Board of Trade made a commitment in 1886 to extend its statistics to collect information on "prices, production and the cost of living" (Wright 1984, p. 166). However, this commitment was not seen as a priority for the Board of Trade as the economic circumstances of working families were generally felt to be improving in the last quarter of the century as wages rose and food prices fell. A retrospective analysis estimates that there was an average annual increase in real wages of 2% in the last two decades of the century and a general improvement in living standards for working people (Burnett 1969, pp. 256–257; Gazeley 2003, pp. 14–15).

A further driver for more comprehensive information on household budgets, together with both retail and wholesale prices, came from political considerations relating to UK trade with the countries that were the principal commercial partners of the UK at the turn of the twentieth century (Searle 2004, p. 334). In 1903, the Prime Minister, Arthur Balfour, asked the Board of Trade for a range of data to inform the debate on trade, including information on wages, the cost of living and comparisons with other leading nations (Searle 2015, p. 147). In response, the Board produced two substantial reports in August 1903.

5.3 The Board of Trade Enquiries of 1903

The first document, titled—a "Report on Wholesale and Retail Prices in 1902 with Comparable Statistical Tables for a Series of Years" (Board of Trade 1903a), dated August 6th, brought together "the course of prices" for over 80 commodities including coal, wool and food items, in most cases covering the years 1870–1900. The majority of the data series were for wholesale prices with a smaller number of retail prices, mainly for food.

The second report produced by the Board of Trade, dated 12th August (Board of Trade 1903b), brought together a larger survey of household expenditure and summarised the previous work of the Board and the other sources described above; it included material written by the Board in response to Ministers' requests (Board of Trade 1903b).

The data from these two reports were combined to provide tentative cost of living index numbers for a range of years, with caveats made on the range and quality of the data used.

5.3.1 Report 1: Wholesale and Retail Prices

The first substantial document was a very useful summary which indicated the range of goods for which price data were available at the time, including the sources, the geographical coverage and the time periods in which the data were collected. The work had taken several years to complete. The report stated that "so far as it is known this is the first attempt to compile continuous records of the retail prices of commodities in the UK in an official report" (Board of Trade 1903a, p. xiii).

Given the extent of the wholesale prices collected, the Board was able to put together an index series. Wholesale prices for 45 commodities were combined to produce a wholesale price index covering the years 1871–1902 which was disaggregated firstly into four groups: "coal and metals", "textiles", "food and drink" and "miscellaneous"; the food and drink group broken down further into three sub-categories: "corn etc.", "meat, fish and diary" and "sugar, tea, wine and tobacco". In order to extend the series back to the start of the nineteenth century, the index series of Jevons (1865) was used from 1800 to 1845 and the series of Sauerbeck (1886) was used from 1846 to 1870 (Board of Trade 1903a, p. xxxiv).

Appendix 1 in the report described the various sources of price information and noted that the Board of Trade had published some prices in its various publications from 1853 onwards. However, to create the tables and graphs for the current report for a broad range of commodities, unofficial sources had been needed for certain commodities including trade associations and farmers' clubs. In other cases, contract prices paid by hospitals and asylums were used to fill in some of the gaps in the data.

By modern standards, the data used in the report were very restricted. The data provided limited geographic coverage, came from a wide variety of disparate sources with variable quality, and covered different time periods. However, the report did show that the Board of Trade was taking the need for both wholesale and retail price indices seriously and was considering the data and the methods to use.

The second Board of Trade report was also noteworthy for Appendix 2, which discussed the methods of index number construction and detailed a range of consultations that had taken place to gain advice on the best approach to take in compiling the statistics. Two key questions covered by the discussion were the nature of the "selection of a mean", that is the index number formula to be used, and whether weighting was needed when combining index series for a variety of commodities.

5.3.2 Report 2: British and Foreign Trade and Industrial Conditions (Cd 1761)

The scope of the second report (Board of Trade 1903b) included the value of exports and imports of goods to and from major trading partners and details of any tariffs, the course of money wages over time, the consumption of food by the working classes and the cost of living.

The introductory material to the report acknowledged that, previously, data on important topics such as the levels and rates of growth of wages and changes in the cost of living had been inadequate; it included new work on these topics to attempt to address the lack of knowledge. The report also stated that it was completed under great time pressure—the Board was given only three and a half months to complete the work. The report accepted that the new statistical information presented within it was incomplete, and therefore could only be thought of as being provisional. The preparatory note to the paper also explained that extensive use of index numbers had been made as a means of summarising complex data and illustrating change over time. While index numbers had been used for measuring the course of prices for a long time, they were also used extensively in the report for other economic variables—a practice that continues today in statistical outputs from the Office for National Statistics. The report praised the use of index numbers as a helpful statistical tool, saying that "this method, if judiciously and prudently used, is an exceedingly powerful one, enabling many classes of comparisons to be approximately made which otherwise would be altogether impossible" (Board of Trade 1903b, p. vii).

5.3.2.1 Expenditure on Food

An additional survey required for the report was carried out by the Labour Department of the Board of Trade; it collected information from 400 households composed of urban workers' families in 1903 of which 286 returns were considered to be usable. Although the size of the sample had increased from the previous work, the geographical distribution was far from adequate. One hundred and one of the returns were for families living in London, 35 from around London; this left only 105 for the rest of Great Britain. Of the 286 usable returns, a smaller number, 88 returns, contained sufficient information to be used for compiling index numbers for an extended range of items including butter, milk, potatoes, sugar and tea. Of these 88 returns, 68 were for families in London.

In previous studies, a wide variety of "investigators" were used, including tradesmen, landowners and the clergy, which inevitably contributed unwanted variation in the information collected. Gradually, the Board of Trade moved to using their own staff, thereby enabling a more standardised approach. The study resulted in an estimate of average income for the sample households of 29s 10d, more than double the average for agricultural workers. Information on non-food expenditure such as rent, fuel and lighting was not collected as resources were not available to make this practical.

Chapter 18 of the report is titled: "Consumption of Food and Cost of Living of Working Classes in the United Kingdom and Certain Foreign Countries" and it brought together the existing information on income and expenditure on food for working-class families from all of the sources mentioned above, together with retail and wholesale price data and data for Germany, Belgium, France and the USA.

This chapter of the Board of Trade report began with a short explanation of the difficulties of carrying out household budgets surveys. It identified that the most trustworthy approach to such an investigation was by "special inquiry from a sufficient number of working class families", but recognised that obtaining the total income and expenditure of such households is very difficult. The difficulties came from factors such as the lack of household record keeping of expenditure and the seasonal nature of some expenditure. The report also noted that income from paid work carried out by young children was often omitted. Further, difficulty arose from trying to ensure a comparable specification for the products being priced in the consumption of the different families. Some of these challenges are ones we still face today, and overcoming such concerns is a substantial challenge to obtaining high quality statistics about life in a complex economy such as that of the UK.

The report contrasted the figures from the investigation of agricultural labourers, the US survey and the urban workers' families study. It also noted household income and expenditure data from the studies conducted by Booth and Rowntree. While the studies showed broad agreement in their results, they differed in their methodology and combining them with new data in a meaningful way was made difficult. For example, the US study had the largest sample size but this was related to expenditure covering just a couple of weeks of the year and was over twelve years old. The 1903 Board of Trade inquiry had data extending to a full range of food items but only for a small proportion of the total sample.

5.3.2.2 Clothing and Rent

When considering clothing, the parliamentary paper noted that very little data was available and it had to use three sources which covered a whole year. The first two sources comprised just seven families, together giving an average percentage of expenditure on clothing of 17%. The third source was the US survey; while this collected data from a larger numbers of households, the collection period was limited to a few weeks of the year and had taken place twelve years previously. It gave the percentage of expenditure on clothing as 15%, which is close to the result from the smaller sample, though neither can be considered reliable. The paper noted that the two figures "agree closely"; however, the first two "samples" are tiny.

For consideration of rent, no specific data had been collected, but there were organisations with rental information that the Board of Trade had approached. In London, rents for county council tenements and other trusts were available; outside of London municipal tenements and housing schemes from working cooperatives provided rental information for working-class properties. The US survey also included rental information. The average rents varied by location and type of property and also by the source; this led to the paper giving only a broad figure of 4s–5s a week for rental expenditure.

5.3.3 An Early Cost of Living Index Series

The first of the 1903 reports (Board of Trade 1903a) presented series for retail prices. While the retail prices for bread covered the whole of the UK, for other items (flour, potatoes, beef, mutton, bacon, tea, butter and sugar) prices were taken from London only. Prices were collected from firms, clubs and hotels; quantities were sometimes not specified in the collection of prices. Despite the patchy geographical nature of the data, index numbers for the price of food for a workman's family covering the years 1877–1901 were produced for the report. In order to be able to compare the resulting statistics to Germany, the weights were taken from the US survey produced in 1889 which included both the UK and Germany.

The Board of Trade noted that the statistics in the reports were "the first attempt to compile continuous records of the retail prices of commodities in the UK in an official report" (Board of Trade 1903a, p. xiii). The index series showed a 30% fall in the cost of food over the period with the decrease being most rapid in the first ten years of the period. The index series is presented in Fig. 5.1.

The index numbers series showed that average food prices fell from an index value of 143 in 1877 to 100 in 1901. The historical context can be used to explain this variation in prices. Over the period from 1877, imports from commonwealth countries increased rapidly,

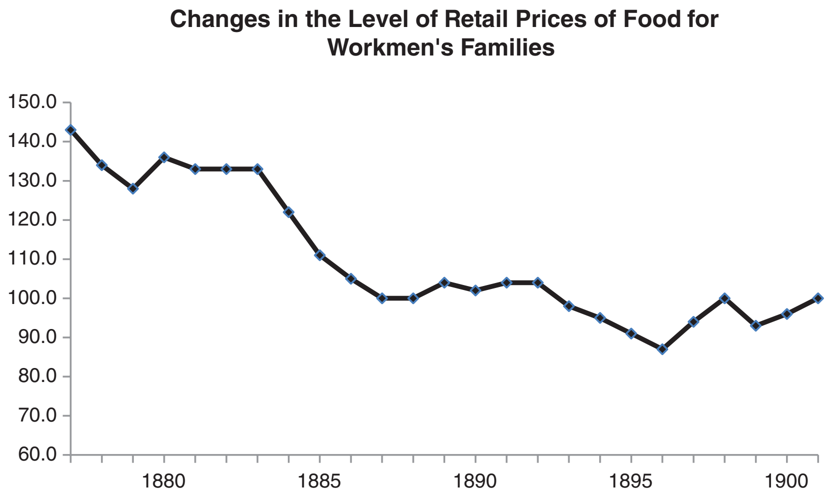

Fig. 5.1 Board of Trade (1903b) level of retail prices for workmen's families for London (1900=100)

pushing down prices as supply increased; for example, wheat from Canada and meat from Australia and South America meant that these items were now much cheaper.

Clearly, the data used in construction of the 1903 index were far from ideal for the purpose of measuring inflation and were a long way from modern practice. However, the publication of the series demonstrated both the urgent need for information for political debate, and the direction of travel that the Board was taking in producing official statistics on price levels.

5.4 The 1904 Household Expenditure Survey

The limitations on household budget data were clear to the statisticians working in the Labour Department of the Board of Trade when compiling their reports. For clothing, data was almost non-existent, and even for food, it was limited to a number of important categories only. The usable returns were heavily concentrated in London, leaving few to cover the rest of Great Britain. A subsequent Board of Trade report noted that the time allowed for the investigation was inadequate given such a "difficult and complicated subject" (Board of Trade 1905, p. 19). Up to this date, resources in the statistical department at the Board of Trade had been directed to collecting data on other topics such as industrial unrest, unemployment and hours and earnings (Searle 2015, p. 147). The new work represented a significant shift in the balance of work of the department.

For an expenditure survey to be suitable to form the basis for compilation of weights for a consumer price index, a sample had to be of sufficient size to produce estimates covering all of the major items of household expenditure; it had to cover the whole of the geographic domain, while not being unduly affected by issues such as sampling error. The intention of the next step in official expenditure surveys was to extend the sample size to improve on the limitations of previous work.

In retrospect, the 1904 survey of household expenditure was extremely important in the development of official statistics and the investigation of household expenditures in the UK. The relative expenditures derived from the new survey would go on to form the weights for the new cost of living index and would continue to do so right up to the late 1940s, even though it was clear as early as the end of the First World War, that expenditure patterns had changed significantly since the 1904 survey.

5.4.1 The Sample and the Data Collection

The 1904 survey was designed to address many of the specific weaknesses from 1903. Firstly, the sample size was increased in order to capture data from 2283 households, of which 1808 returns were considered to have provided data that were usable. The 136 usable returns from the 1903 survey were also included, making 1944 in total. The survey was designed to collect information on food and rent only. It covered Great Britain and Ireland and the regional division was much less concentrated in London, as shown in Table 5.1.

The sample size was still small to cover the whole of the UK and Ireland; however, it represented a step forward from the 1903 survey. This is an example of the gradual way in which developments affecting price indices were introduced; new work built on previous efforts.

Care was also taken in the 1904 survey to include families with a range of incomes; the distribution of income for the usable returns over household income is shown in Table 5.2.

The collection period was one week in the summer, though not all responses were collected from the same week; questionnaires were sent out in July, August and September 1904. The recipients were members of workmen's organisations, co-operative societies and individuals who were asked to provide the required information themselves or from fellow workmen.

Table 5.1 Regional distribution of 1904 expenditure survey returns

Region	Returns
North of England	439
Midlands	262
London and Suburbs	347
Rest of England and Wales	318
Scotland	455
Ireland	123
Total	1944

Table 5.2 Income distribution of expenditure survey returns in 1904

Weekly income	Returns
Under 25s	261
25s and under 30s	289
30s and under 35s	416
35s and under 40s	352
40s and over	596

Clearly, this was far from a random sample of working-class households; however, it would have been difficult to improve on this approach without delaying the construction of the new statistics significantly.

Five categories of goods were included: food, rent, clothing, fuel and light, and "other". Intoxicating drinks and tobacco were not included.

5.4.2 Items of Food

For food, there were fourteen types of item which covered three quarters of all food expenditure; they were: beef, mutton, bacon, fish, flour, bread, potatoes, tea, sugar, milk, butter, margarine, cheese and eggs. It was suggested that omitting other items of lesser expenditure wouldn't affect the overall change in prices. The main omissions from the survey were fruit and vegetables which were considered impractical to include as the highly seasonal nature of the items—much more seasonal than in today's world of long-distance food transport—wouldn't allow for continuous and reliable prices to be captured.

Tables 5.3, 5.4 and 5.5 show some of the main results of the 1904 survey. Table 5.3 shows household income and number of children by income category. Tables 5.4 and 5.5 contain average weekly quantities consumed for certain categories and the costs of those quantities. The 1904 report lists fewer categories for the quantities than the costs. The figures are listed for income groups in the tables, though the report also presents this information further broken down by region.

Table 5.3 Weekly income and number of children at home, urban workers, 1904

Limits of weekly income	Under 25s	25s and under 30s	30s and under 35s	35s and under 40s	40s and above	All incomes
Number of returns	261	289	416	382	596	1944
Average weekly family income (*s. d.*)	21 4½	26 11¾	31 11¼	36 6¼	52 0½	36 10
Average number of children living at home	3.1	3.3	3.2	3.4	4.4	3.6

In the discussion of the results, the report examined the variation in the percentage of income spent on food across the categories of household income; as shown in Table 5.6, this decreased with increasing household income.

The report also compared the percentage of household income spent on food per person. The highest spend was in London at 12.2% and the lowest in the North of England at 10.1%.

5.4.3 Rent, Clothing, Fuel and Light

The previous report (Board of Trade 1903b) contained index numbers for the cost of food over the course of a number of years; this was based on household budget data almost exclusively from the London area. As well as this geographic limitation, the 1903 report didn't include any data on other important items of household expenditure such as rent and clothing. To obtain these data, the Board carried out "special investigations". The results were reported in the second part of the 1904 report and included data on rent, clothing, fuel and light.

The data on rents were obtained from town hall clerks and Charity Organisation Societies and covered London and twenty provincial towns, for streets in working-class neighbourhoods covering the period 1880–1903. Rents were produced as five-year period averages. This showed that, unlike food, which was decreasing in price, rents rose by

Table 5.4 Average weekly quantities of certain articles of food consumed by urban workmen's families in 1904; all articles are measured in lbs except for fresh milk, which is in pints

Limits of weekly income	Under 25s	25s and under 30s	30s and under 35s	35s and under 40s	40s and above	All incomes
Bread and flour	28.44	29.97	20.44	29.99	37.76	32.04
Meat (bought by weight)	4.44	5.33	6.26	6.43	8.19	6.50
Bacon	0.94	1.11	1.19	1.38	1.82	1.38
Fresh milk	5.54	7.72	9.85	10.34	12.63	9.91
Cheese	0.67	0.70	0.79	0.77	1.02	0.83
Butter	1.10	1.50	1.69	1.80	2.78	1.96
Potatoes	14.05	15.84	16.11	15.87	19.93	16.92
Currants and raisins	0.42	0.50	0.62	0.80	0.91	0.70
Rice, tapioca and oatmeal	2.54	2.64	2.93	2.55	3.38	2.95
Tea	0.48	0.55	0.57	0.59	0.72	0.60
Coffee and cocoa	0.15	0.18	0.20	0.23	0.29	0.22
Sugar	3.87	4.62	4.79	5.21	6.70	5.31

about a quarter between 1880 and 1900. The report gives two reasons for this increase—firstly, a rise in the standard of accommodation available and secondly, the increase in the urban population over the rural population; previous analysis had shown that rent was higher in urban areas.

For clothing, the Board looked at the price of similar articles over the course of the 1880–1903 period, including the costs of twenty-five garments using manufacturers' prices and price lists of large stores. The report concluded that the overall price of clothing had fallen by about 5% over the period considered.

Turning their attention to fuel and lighting, representative items were required; coal was used to represent fuel, while petroleum, gas and

Table 5.5 Average weekly cost of certain articles of food consumed by urban workmen's families in 1904

Limits of weekly income	Under 25s		25s and under 30s		30s and under 35s		35s and under 40s		40s and above		All incomes	
	s.	d.	s.	d.	s.	d.	s.	d.	s.	d.	s.	d.
Bread and flour	3	0½	3	3¾	3	3½	3	4¼	4	3¾	3	7
Meat (bought by weight)	2	8	3	4¾	4	3½	4	5½	5	10½	4	3½
Other meat (including fish)	0	7½	0	8¾	0	10	1	0	1	4	0	11¾
Bacon	0	6¾	0	9	0	10¼	0	11½	1	3¾	0	11½
Eggs	0	5¾	0	8 ½	0	11	1	0	1	4¾	1	0
Fresh milk	0	8	0	11¾	1	3¼	1	4¼	1	7¾	1	3¼
Cheese	0	4¾	0	5 ½	0	6	0	6	0	8	0	6½
Butter	1	2	1	7	1	10¼	2	0	3	0½	2	1½
Potatoes	0	8¾	0	9 ¾	0	10½	0	10¾	1	1¾	0	11
Vegetables and fruit	0	4¾	0	7	0	10	0	11¾	1	3¾	0	11
Currants and raisins	0	1½	0	1¾	0	2¼	0	3	0	3¾	0	2¾
Rice, tapioca and oatmeal	0	4½	0	5	0	6	0	5¾	0	7	0	6
Tea	0	9¼	0	11¼	1	0¾	1	1¼	1	5	1	1½
Coffee and cocoa	0	2	0	3	0	3½	0	4¼	0	5½	0	3¾
Sugar	0	8	0	10	0	10¾	0	11¼	1	3	0	11
Jam, marmalade, treacle and syrup	0	4½	0	5¼	0	6	0	6½	0	8¾	0	6½
Pickles and condiments	0	2	0	2¼	0	3¼	0	3½	0	4¼	0	3¼
Other items	1	0½	1	3¾	1	6½	1	10½	2	6¼	1	9½
Total expenditure on food	14	4¾	17	10¼	20	9¼	22	3½	29	8	22	6

Table 5.6 Percentage of income spent on food for income categories

Limits of weekly income	% income spent on food
Under 25s	67
25s and under 30s	66
30s and under 35s	65
35s and under 40s	61
40s and above	57

candles were the items selected for lighting. Retail prices were obtained for London and nine other towns. Weights were difficult to determine, so the simple average of prices for the three sources of lighting was used to measure the price level in this category. When combining fuel and lighting, a ratio of ten for fuel and three for lighting was used, based on expenditure information from the 1891 US survey. The results showed greater fluctuation in prices for fuel and lighting than for food or rent. The combined prices of fuel and lighting showed an increase of about 20% for the years 1900–1903 over the period 1880–1900.

5.4.4 Cost of Living Index Numbers

With index numbers for food, rent, clothing and combined fuel and light, a total cost of living index number could be created. The remaining question was how to weight together with the respective index series. The Board's 1904 report explains that it had considered "available statistics of working class expenditure" (Board of Trade 1903b, p. 32) and had produced estimated weights relating to the four categories; they are shown in Table 5.7.

With rents only available as averages over five year periods, interpolation was used to provide index numbers of rental prices for each year; these were combined with the index numbers for other categories of goods and services to give the overall cost of living index numbers.

With this additional information on weighting, index numbers could be compiled for inclusion in the 1904 report for the period 1880–1904 which showed the changes in the key component series representing working class families in London and large towns in Great Britain. Figure 5.2 shows the results.

Table 5.7 Weights for categories of items

Category	Weights
Food	7
Rent	2
Clothing	2
Fuel and light	1
Total	12

Figure 5.2 shows that while the price of food fell dramatically between the years 1880 and 1895, rents gradually rose. The combination of items is dominated by food because of its relatively high-expenditure weight, as seen in Table 5.7. The overall cost of living index numbers show a fall of about 20% between 1880 and 1903, with most of the fall occurring in the period 1880–1887. This is equivalent to an annual fall in the level of prices of –0.8%, which might seem modest, but over long periods had a significant impact on what could be bought with a fixed amount of money.

The work detailed in the 1904 report was a significant improvement over what came before. The data presented formed the basis of the weights for cost of living index numbers that were applied for almost fifty years following the report. Although a major step forward had been achieved, there were aspects of the investigation that the Board of Trade wanted to improve on and these are described in the next sections.

5.5 The 1908 Report—Report of an Enquiry into Working-Class Rents, Housing and Retail Prices

The Labour Department of the Board of Trade extended the work from the 1903 and 1904 studies in a report published in 1908—the result of two years of further work (Board of Trade 1908). The data relates to one month—October 1905. The work described in this report established the means by which regular price collection would be carried out in the future.

The areas where the previous enquiries were considered incomplete were the extent of regional information on rents of workmen's dwellings

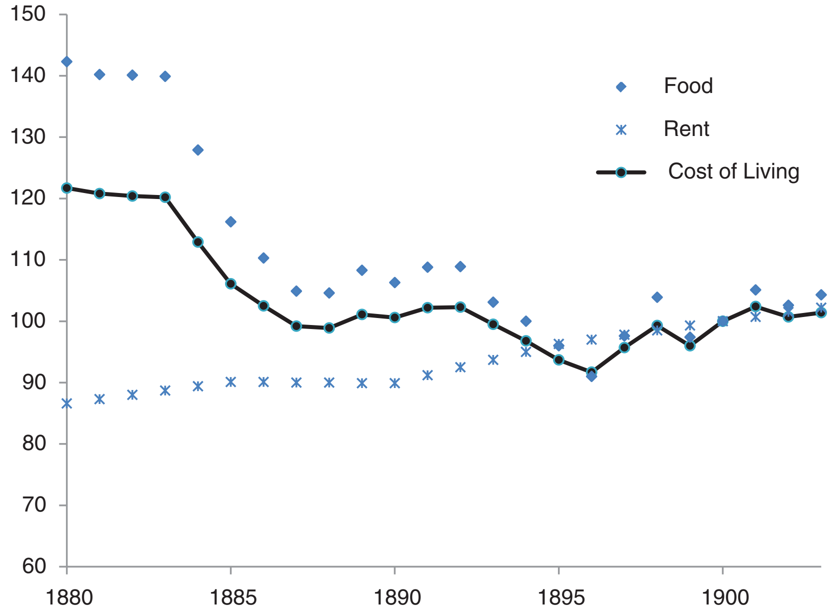

Fig. 5.2 Cost of main items of workmen's expenditure for London and large towns in GB (1900=100)

and the prices of food and fuel. New data were collected from 97 industrial towns. A further aim was to establish a standard for districts of the UK and for foreign countries that would service as a base to which data for later years could be compared. The report also contained information on wages, though the Board of Trade noted that further enquiries would take place to provide more comprehensive information on wages in the future.

The data were collected by Board of Trade officials who visited all of the 97 industrial towns covered by the report (often more than once) and were helped by a wide range of public and private officials, including town clerks, borough treasurers, sanitary inspectors and surveyors of taxes. Information on rents was provided by estate agents and owners of properties. For groceries, meat and coal, prices were supplied by tradesmen, co-operative societies and large firms with multiple outlets.

Table 5.8 Regional index numbers for working class rents (London = 100)

Geographical group	Number of towns	Rent index numbers
London		100
Northern counties and Cleveland	9	62
Yorkshire (except Cleveland)	10	56
Lancashire and Cheshire	17	54
Midlands	15	51
Eastern counties	7	50
Southern counties	10	61
Wales and Monmouth	4	60

5.5.1 Rents

The results of the enquiry on working-class rents, summarised by geographical areas, are shown in Table 5.8, which also shows the number of towns covered in each area by the investigation.

It is interesting to note that London rents were already significantly higher at this time than elsewhere, where rents showed limited variation across the regions. The 1908 report contained an extensive discussion of the variation in the types of properties in different areas; the rents captured were for all types of properties found, though the dominant types of property differed between industrial towns and regions.

5.5.2 Prices for Food and Fuel

Prices for important food and fuel categories were also collected as part of the enquiry from the range of industrial towns. What was captured was the "price most usually paid" or "predominant price" by the working classes. The prices were supplied by "representative tradesmen in possession of a working class custom". Shopkeepers were asked to state prices as they were in October 1905.

5.5.3 Creation of Index Numbers

Regional index numbers were created for a combination of food and fuel and separate index numbers were calculated for rent; when the two

Table 5.9 Regional index numbers for working class rents together with food and fuel (London = 100)

Geographical Group	Rent	Food and fuel	Rent, food and fuel combined
London	100	100	100
Northern counties and Cleveland	62	97	90
Yorkshire (except Cleveland)	56	94	87
Lancashire and Cheshire	54	92	84
Midlands	51	93	85
Eastern counties	50	98	88
Southern counties	61	102	93
Wales and Monmouth	60	96	89
Scotland	69	102	95
Ireland	50	97	87

were combined into overall index numbers, an approximate relative weighting of 0.2 for rent and 0.8 for food and fuel was used. Table 5.9 shows the rent and prices index numbers combined for regions with London = 100.

The results showed that food and fuel prices varied across regions far less than rent. As the food and fuel component of the index had a significantly larger weight than rent, the overall price index numbers displayed less geographical variation than the rents index, though London still had the highest living costs.

5.6 The 1913 Report—Report of an Enquiry into Working-Class Rents and Retail Prices

The 1903, 1904 and 1908 reports can be seen as a sequence, with the latter two reports building on the work of the first. The 1904 report established the household budgets on which weights could be derived for a cost of living measure. The 1908 report extended the work in a number of ways, but in particular, it improved the extent of regional prices for rents, food and fuel.

While retail prices had been stable in the first few years of the twentieth century, they began to rise from 1905, with steeper rises after 1909. This affected those industrial workers who weren't being compensated for rises in prices, and industrial action followed as workers became increasingly dissatisfied (Searle 2015, p. 147). This raised the political profile of the measurement of the cost of living as a means for addressing what could become a significant problem facing the Government.

The 1913 report, which has an identical title to the 1908 report, was carried out to investigate the rents of working-class dwellings and the prices paid by the working classes for principal items of food and for coal; there was also a collection of wage information for the building, engineering and printing trades as part of the data collection exercise (Board of Trade 1913). The aim was to repeat the 1905 enquiry (reported in Board of Trade 1908) in 1912, so that the extent of changes in the seven years that had elapsed could be determined. The towns from which information was collected were the same and as far as possible, the same retailers were used when seeking price quotes as in the previous report. The same month, October, was chosen for comparison to minimise seasonal effects.

There were two extensions to the scope of the 1913 report compared to 1908; firstly, information on historic retail and wholesale price variation were published to give context to the changes found between 1905 and 1912. Secondly, information from foreign countries was also used to compare UK inflation with that experienced overseas though it was acknowledged that the methodologies used in measurement differed across countries.

The 1913 report noted the recent events that may have affected prices, including: a national coal strike, the serious drought of 1911 and an outbreak of foot and mouth disease.

5.6.1 Changes in Prices Across Regions

The results of the 1913 report showed a small increase in rents of 1.8%, but a larger increase in the retail prices of food and coal of 13.7%. The combined figure for the overall change in the price level was an increase of 11.3%. The regional changes in combined rent, food and fuel over the period are given in Table 5.10.

Table 5.10 Percentage change in retail prices by geographical group of industrial towns between October 1905 and October 1912

Geographical group	Mean percentage increases
London	11.3
Northern counties and Cleveland	13.2
Yorkshire (except Cleveland)	14.0
Lancashire and Cheshire	15.8
Midlands	14.4
Eastern counties	12.4
Southern counties	9.8
Wales and Monmouth	15.0
Scotland	13.1
Ireland	15.0

5.6.2 Extended Price Index Numbers

The 1913 Board of Trade paper noted that the 1905 enquiry was the first of its kind undertaken by the Board and that the 1912 enquiry, being only the second, meant that there was only one comparison made. The report noted that prices could have been influenced by temporary fluctuations and that the differences would not represent a permanent change.

To put the degree of change in prices in a wider context, the Board of Trade looked at data from other sources to cover a wider period of time, finding the following information:

- Retail prices of food in London, nine articles 1892–1903
- Retail prices of food in London, 23 articles 1892–1912

A comparable source of prices for provincial towns wasn't available to the Board of Trade, so it had to use these data to produce its historical comparisons. Table 5.11 gives index numbers for food items in London over the period 1892–1912.

The index numbers show that the overall cost of food in London rose gradually from 1900, rising more steeply in the years from 1910 than in the years at the end of the nineteenth century.

Table 5.11 Price index numbers for food items for London from 1892 to 1912 (1900=100)

Year	Groups of food items					
	I Bread, flour, cereals and potatoes	II Meat	III Dairy produce	IV Tea, coffee and cacao	V Sugar jam, currants and raisins	Index number for all articles
1892	103.9	111.0	99.4	98.5	98.0	117.8
1893	99.3	97.2	98.9	99.0	97.1	109.2
1894	94.9	92.3	96.5	94.7	93.8	98.7
1895	92.1	89.4	93.8	92.4	93.8	91.7
1896	91.7	89.9	90.2	93.8	93.8	94.1
1897	95.5	101.3	93.4	94.8	93.8	88.4
1898	99.5	114.3	94.6	94.8	93.7	90.1
1899	95.4	94.3	96.1	97.2	94.4	92.6
1900	100.0	100.0	100.0	100.0	100.0	100.0
1901	100.4	96.0	103.6	99.1	102.8	104.3
1902	101.0	97.9	106.4	98.6	102.8	97.9
1903	102.8	106.4	104.3	97.4	102.8	102.8
1904	102.4	107.3	100.4	96.8	108.2	106.1
1905	102.8	102.4	101.1	98.5	106.8	117.5
1906	102.0	99.7	102.9	101.2	101.0	108.7
1907	105.0	105.4	104.2	101.4	103.8	116.7
1908	107.5	112.5	105.6	103.1	105.5	112.9
1909	107.6	114.5	107.2	102.9	103.4	105.9
1910	109.4	109.6	113.1	104.1	102.9	117.7
1911	109.4	109.4	113.1	107.4	103.1	121.2
1912	114.5	115.1	115.1	111.1	103.4	129.2

The series discussed in Sect. 5.3.3, covering the years 1877–1901, overlaps the above series and it can be seen that the index numbers aren't the same. The older series were based on prices for nine items and price changes were combined using weights from the US survey of 1893; the later set of index numbers was based on 23 items and used the 1904 weights. Both were using prices taken from London. These differences were an early warning of the potential differences resulting from using different methodologies to produce index numbers.

The Board of Trade commented that the average difference between the price of food as measured by the 1905 and 1912 enquiries, which

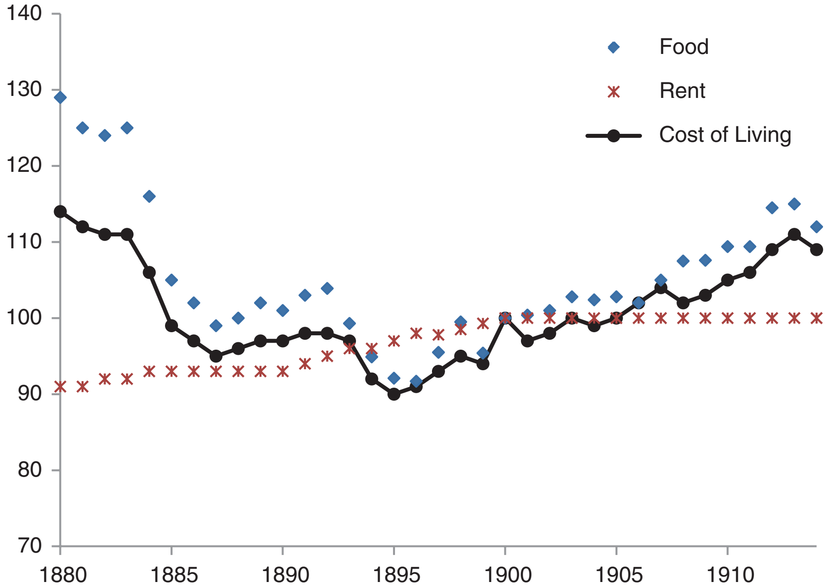

Fig. 5.3 Cost of living index 1880–1914

include prices from 88 towns, was 12.8%, while using London prices only the difference was 11.4%. The report suggests therefore that the index numbers for London wouldn't be far from the real picture for the rest of the country. The statistician Arthur Bowley created one series for the whole of the period 1880–1912 by re-weighting the older series to use 1904 weights (Bowley 1937, p. 121); this was considered to be the best that could be achieved with the data available at the time. The re-weighting lowers the food index numbers for earlier years. Figure 5.3 shows Bowley's price index numbers for food, rent and for the cost of living, which is a combination of food, rent, clothing, fuel and sundries.

Bowley's version of the cost of living index showed a fall of about 20% between 1880 and the last years of the 1890s; from there, the index rose by 10% by 1914.

5.7 First World War

With the onset of the Great War, prices of many goods rose rapidly and the need for frequent reporting of prices was required. Previously, limited information on retail prices was published occasionally in the Board of Trade Gazette. From September 1914, the Board of Trade began reporting monthly prices for a range of food items and specified the price change from July 1914. The September report of the Board of Trade reported that, in the first eight days of August 1914, food prices rose by almost 15%; this initial high rate of inflation wasn't sustained, but prices continued to rise. In July 1915, the regular reporting of retail prices was extended to include a limited range of non-food items.

5.7.1 Cost of Living During the War

With the regular collection of prices, and using the 1904 household budget survey for the weighting information, a cost of living index was created by the Board of Trade; Table 5.12 shows the index values from 1914 to 1919. The all items cost of living index shows that prices more than doubled throughout the course of the war (Mitchell 1988, p. 475).

The significant increase in prices had the potential to create industrial unrest at a time when all economic energies were needed to maintain the war effort. To reduce the risk of stoppages, wages were increased for some workers. The degree to which wages were adjusted varied between industries. For miners, wages largely kept up with prices, while builders, printers and textile workers saw their real wages fall (Searle 2015, p. 150). There were complaints of profiteering and frustration with temporary food shortages from some parts of the population. In 1917, the government set up a committee of inquiry into industrial unrest; this reported that anger at high food prices and an unfair distribution of food was a contributory factor. There was also a concern that there could be military consequences; letters home from troops expressed anger at the perception of high prices of food at home. While there was a need for a reliable inflation measure in relatively stable times there was an even greater need in times of turbulence.

Table 5.12 Cost of living index numbers for 1914–1919

Year	Index numbers (1914 = 100)	
	Food	All items
1914	100	100
1915	131	123
1916	160	146
1917	198	176
1918	215	203
1919	219	215

The Government responded to the potential threat of unrest by using the powers of the Munitions Act 1915 to adjust wages using the cost of living index. The Government wrote to Trade Boards urging them to adjust minimum rates of pay in line with the index (Searle 2015, p. 150). In this way, the pressure to maintain order and industrial production throughout the First World War had established the mechanism of using a measure of the change in consumer prices to adjust wage rates, something which has continued for many years and has become an established part of wage-setting negotiations.

The actions of the Government didn't completely alleviate public concern about prices. Rationing had been introduced in 1918, but this still frequently required queueing to obtain rationed goods (Winter, p. 216). The government was concerned that despite the changes of 1917, real wages had fallen and this had had a significant negative impact on working-class households. An official investigation was needed to find out the position and in 1918, the Prime Minister, David Lloyd George asked Lord Sumner to chair a committee to investigate whether living standards had declined during the war.

5.7.2 The Sumner Committee

The Sumner committee consulted a variety of sources including the 1904 and 1912 surveys and Ministry of Food data on rations (Working Classes Cost of Living Committee 1918). It also carried out a survey of household budgets, mostly in the first week of June 1918, with the remainder in later weeks in June and July; it sent out 10,000 questionnaires of which 1400 were returned (Gazeley and Newell 2013, p. 74). The comparison of data between 1914 and 1918 was not simple. Firstly, working-class consumption for 1914 had to be estimated from the 1904 survey. There were also differences between the 1914 and 1918 data—the 1918 families were older and had fewer young children. The committee accounted for this by comparing household expenditure on a standard family basis (Gazeley and Newell 2013, p. 75). The committee found that although the cost of food had increased by about 75% there hadn't been a decline in food consumption, but what was eaten had changed between 1914 and 1918. For example, meat was replaced by bacon and white bread by brown.

A modern reanalysis of the work of the Sumner Committee was made possible by the discovery that many of the original returns to the Board of Trade's 1904 household budget survey still exist (Gazeley and Newell 2013, p. 76). This reanalysis largely concurs with the Sumner Committee conclusions. The amount spent on food nearly doubled between 1914 and 1918, but prices had doubled over this period as well. The broad conclusion of the Sumner Committee was that working-class families had maintained their standard of living during the war. Another finding was that the difference in expenditure between the skilled and un-skilled narrowed from 29 to 17%. Analysis suggests that where food items were subject to rationing and price controls, consumption was maintained; in contrast, where no controls where applied, for example, with fruit and vegetables, consumption declined. Another important control was that applied to rent; Winter (2003) writes that the act of controlling rents was probably the most important factor in making working-class living affordable (Winter 2003, p. 229).

A key comparison from the Sumner Committee report was between the price of food and wages. Estimating real wages is challenging as Winter (2003) notes; although the Board of Trade published data on wages it was not complete. It covered only about 40% of workers and didn't account for overtime rates, bonuses and other adjustments (Winter 2003, p. 231). Using the data that was available, Winter (2003) showed that wages for all workers increased by 95% between 1914 and 1918, matching the rise in the cost of food. This summary includes workers for whom the increases were above and below the average; for example, the rise for bricklayers was 57% and for engineering labourers 113%.

The Sumner Committee made an interesting recommendation that was outside of its terms of reference. The difficulty of acquiring the data it needed from multiple sources led it to suggest the need for a central body for statistics which would ensure that the statistics produced by various Government departments were produced to a uniform standard using interrelated methods. The Ministry of Labour disagreed; a Central Statistics Office was formed, but not until many years later—in 1941 on the instructions of Winston Churchill (Ward and Doggett 1991, p. 30).

5.8 The Methodology of the Cost of Living Index Numbers

The regular collection of prices for calculating cost of living index numbers was an important step in inflation measurement. The following sections examine the methodology used by the Board of Trade to carry out this task. The methodology wasn't published in any detail at the time of the survey; the Board of Trade recorded that in the years following the publication of the first cost of living index in 1914, it had attracted much interest, and a note on the method of compilation was published in the Gazette for March 1920 and again in extended form in February 1921 (Board of Trade Labour Gazette, February 1921, pp. 69–72). As a description of the methodology, the 1921 Board of Trade publication, at four pages, is very brief. In comparison, the description of the methodology for just the expenditure shares in the most recent technical manual for the Living Costs and Food Survey (ONS 2017), runs to 95 pages.

5.8.1 The Purpose of the Index

The description of the methodology begins with a statement of the purpose of the index titled—"the general significance of the statistics". The definition is given as: "a measure of the average increase in the cost of maintaining unchanged the pre-war standard of living of the working classes". It notes that it pertains to the period just before the start of the war and is not concerned with the question of whether the standard is adequate or not.

The nature of the index, being an average, is explained further. It notes that pre-war expenditure varied according to the family income and the cost of maintaining this standard would also vary. Further variation would result from different sizes of families as they could buy different commodities in different quantities. These different commodities would have different changes in price resulting in a different overall cost depending on what was bought.

5.8.2 The Expenditure Weights

The final part of the general description of the index is concerned with the possible changes in the standard of living; that is, the expenditures on the different types of commodity. The specification explains that the expenditure shares were based on data from 1904 and that these hadn't been updated to the current date, that is, to 1921. The explanation for this was that a regular exercise to measure changes in the expenditure would be impractical due to the effort it would take.

5.8.3 Price Collection

"Predominant prices" were collected by clerks from local employment exchanges at the start of each month from both large and small stores that conducted "working-class trade". This was carried out for all towns with a population exceeding 50,000 as identified by the 1911 Population Census and a selection of 530 smaller towns and villages; in total, 620 locations were reported on, containing 5500 retailers. The local officers of the Ministry of Labour collated the data, producing the predominant price for their area and the change in that price from the last period. The percentage change for each item, for the whole of the UK, for larger towns and smaller locations, was obtained by taking an unweighted arithmetic average of the percentage changes from the current period to July 1914. The two overall figures for larger towns and smaller locations were combined by taking the arithmetic mean of the two summary calculations.

Combining the changes for different food items used weighting to take into account the different expenditures on various items, though weights were taken from pre-war household budgets. The budget analysis was taken from 1904 data based on 1944 urban working-class households (see Sect. 5.4.1). The question of the appropriateness of using budget shares from a considerable period in the past was discussed. The justification given for not revising the budget shares was that the "real basis of monthly variation" is the change in prices not budget shares. To modern eyes, we would accept that for monthly indices, variation of prices is greater than variation in budget shares; however, the modern view is that an annual update of the budget shares is needed, and that budget shares could change significantly over a decade and could have a significant impact on the index. The Board calculated that the average increase between 1921 and July 1904 was 163%.

For rent, controls had been applied during the First World War as a temporary measure; the intention was that they would expire six months after the end of the war. However, they were extended and expanded in 1919 and 1920 through the Increases of Rent and Mortgage (Restrictions) Act 1920 (Wilson 2017, p. 4). Rent prices were collected from associations of property owners, for furnished and unfurnished dwelling houses applicable to working-class families.

The description of clothes that were priced included: a selection of men's and women's outer and inner garments together with hosiery and boots most "frequently purchased by the working class, i.e. relatively low-priced grades". Enquiry forms were sent to over 500 representative outfitters, drapers and boot retailers in 97 towns. To assist the retailer in selecting appropriate items of a similar quality, the price quoted by the retailer at the previous period was identified and the retailer was invited to supply the current price. Clothing was recognised as a difficult item to price accurately—a concern that still applies today. It was noted that for foodstuffs, it was possible to identify "predominant prices", but this was not possible for clothing which has a much wider spread of prices.

5.9 Indexing Arrangements After the War

The adjustment of wages as the cost of living varied was put onto a more formal footing after the war with the introduction of sliding scales. Unions and Trade Boards came to agreements where wages would be adjusted by defined amounts as the cost of living varied. The first such agreement was struck in 1919 and applied to wool workers and rapidly spread to other groups of workers including those in the public sector; by 1922, the Ministry of Labour estimated that three million workers had variations in their wages covered by sliding scales (Searle 2015, p. 150). These agreements meant that if the measure of the cost of living fell, so would wages too. Clearly, this aspect was not popular with those who had their wages dictated by this mechanism. As the general level of prices was mostly falling from 1918 until 1934, such agreements were gradually abandoned with the numbers down to 2.5 million by 1925 and 1.5 million by 1933.

Although formal index adjustment to wages was declining, wages were still broadly kept in-line with changes in the cost of living, and as prices rose after 1934, unions pressed for wage increases. In the 1930s, the cost of living measure had become an important factor in Government decisions. The impact of changes of the level of duty on goods on the cost of living was debated and the degree to which price controls should be applied was at least partially influenced by the potential effects on the cost of living measure (Searle 2015, p. 151).

With the importance of the measure of price change firmly established, attention focussed on the way the measure was constructed. One clear criticism was the continued use of the expenditure weights from the period before the First World War. Consideration was given to carrying out a new household expenditure survey in 1926 and plans were drawn up for a survey of 5000 households. Trades Unions and employers' bodies were consulted and both raised objections; one being that there were still distorting influences on expenditure and budgets from the war, so the survey didn't go ahead.

Criticism of the index continued and in 1936, Ernest Brown, the Minister of Labour, announced an expenditure survey to establish the current distribution of working-class family expenditure; this would then be used as the basis of the cost of living index. A committee was established to advise on the inquiry under the chairmanship of Frederick Leggett, a senior Civil Servant from the Ministry of Labour; its members included government departments, the Trades Unions, the Women's Co-operative Guild and Professor Bowley from the University of London. The survey was carried out in 1937–1938 covering manual workers and non-manual workers earning up to £250 a year. The samples were drawn from National Insurance records supplemented by households headed by workers who were exempt from insurance including civil servants and railwaymen (Ward and Doggett 1991, p. 139).

This 1937–1938 expenditure survey presented a major methodological advance over any previous surveys in this area. Care was taken to establish a random sample which was representative of the population. Participating households were asked to supply expenditure information for four separate weeks in October 1937, then January, April and July 1938; 10,762 households supplied expenditure records for all four weeks. This sample was five times the size of that achieved in 1904 and its random sample basis improved the quality of the information significantly.

With the onset of the Second World War, the publication of the results of the expenditure survey was delayed; the description of the methodology was published in the Ministry of Labour Gazette in December 1940 with the results following in the January and February editions. The results showed significant changes in the pattern of household expenditure between 1914 and 1937/1938; in particular, the percentage spent on food fell from 60% in 1914 to 39% in 1937/1938 with expenditure on non-food goods increasing (Ministry of Labour & National Service 1947, Appendix III, p. 9).

The price of food fell more sharply than the price of non-food items in the 1920s. If the cost of living index had been calculated using a greater weight for non-food items and less to food, the overall index would not have fallen so much. This would have had implications for employers and employees; a higher index would have resulted in higher wages for both public and private employees (Searle 2015, p. 155).

5.10 The Second World War

The cost of living index was continued during the Second World War using the 1914 weights. As during the First World War, prices rose sharply at the start of the war, with the index rising six points in the month of September 1939. The result of these price changes was a round of demands for wage increases from employees and unions. In the case of mine workers, the mine owners were willing to agree to a small increase in wages as long as they could pass this on as higher coal prices. This presented a problem for the government as this would lead to a higher cost of living index and further demands for higher wages. The Government considered a number of possible actions including severing the link between the index and pay; however, the link was by now established and there were worries that such a move might end in more, rather than less, industrial action. There were voices who called for controlling wages and others for the direct control of prices; the latter would require subsidies. Faced with this choice, the Government decided to enact a policy to control prices, committing to keeping the cost of living index between 125 and 130% of pre-war prices. The emphasis was on controlling the price of food, which dominated the index based on the 1914 expenditure weights. The result was a stable cost of living index through the years of the war. The number of items in the index was limited and the experience of the consumer who bought a wider range of goods was that prices weren't really stable overall. The aim became to make the index stable, rather than reflect the economic reality of wartime Britain (Searle 2015, p. 158).

Alternative calculations, based on the 1937/1938 weights, compiled by Allen (Allen 1947), presented a different picture to the official cost of living index, as Table 5.13 shows.

Table 5.13 Comparison of cost of living index numbers using 1904 weights, from the Ministry of Labour (Mitchell 1988, p. 191), and using 1937/1938 weights, from Allen (1947) 1938 = 100

Year	Official ministry of labour	Allen (1947)
1938	100	100
1939	102	103
1940	119	120
1941	128	132
1942	129	142
1943	128	146
1944	130	149
1945	131	150
1946	131	152

5.11 Conclusions

This chapter has described the gradual development of the first official index of consumer prices—the cost of living index—and its impact up to the end of the Second World War. The period 1903–1914 saw elements we would recognise today come together, from the measurement of household expenditures to the regular collection of prices from outlets across the country. A surprising feature to current eyes is the maintenance of the 1904 expenditure shares for such a long time after they were first collected. This was, perhaps, partly a consequence of the magnitude of the task of collecting and processing the information and partly the belief that this aspect of a price index was much less important than the change in prices.

The considerable impact on prices of the First World War and the start of the use of the index to adjust wages set a pattern that led to the statistical techniques of Index Numbers establishing a prominence in economic statistics. The importance of a measure of the general level of prices to the population, through the increasing use of indexation, focussed attention on the methodology which continues to this day.

Chapter 6 takes the story of UK inflation measures forward to the period after the Second World War, where further important developments took place and the index reached the form that is familiar to modern eyes.

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6

The Development of the Retail Prices Index: 1947–1989

6.1 Overview

The period from the end of the Second World War to the close of the 1980s saw the official measure of inflation undergo very significant change. It went from a limited measure, with index households restricted to working-class families, a limited range of goods and services in the basket and utilising weights which were decades out of date, to a modern measure that we would recognise today.

With growing wealth and the development of the consumer marketplace in the second half of the twentieth century, consumption patterns changed significantly, with spending on food reducing from about 35% of consumer spending on average in the mid-1940s to about 16% in 1989. Tobacco expenditure went from about 12% to 4% over the same period, as health concerns and taxation policies influenced consumption, while clothing and footwear fell from 11% to 4% of total spending. Increases were seen in the proportion spent on housing, transport and leisure (O'Donoghue et al. 2006).

R. O'Neill et al., *Inflation*, DOI 10.1007/978-3-319-64125-6_6

The methodology used to construct the index changed too. The weights were updated annually from 1962, and the number of representative items was increased from about 200 in 1947 to over 600 in 1989. The structure of the index also changed over time with new groups added; for example, "meals bought and eaten outside the home" became a separate category to reflect this growing area of expenditure. There were particular challenges from measuring price changes relating to owner occupier housing, which was originally measured by the method of equivalent rents and then changed so that it was based on mortgage interest and other payments.

This chapter looks at the considerable developments that took place over these years as the measurement of inflation gained in maturity.

6.2 After the War

In the immediate aftermath of the Second World War, the official measure of inflation was still based on 1904 household expenditure information, with small adjustments made to update to 1914 levels. As Chap. 5 describes, a new budget enquiry had been held in 1937/1938, but its results hadn't been implemented due to the onset of the Second World War. Clearly, there was a pressing need to address the use of a household budget that was now over forty years out of date; however, there was a choice to be made between adopting the 1937/1938 budget survey and carrying out a new one.

The options were discussed by the statistician R. G. D. Allen, a professor at London University, in an article written for the Spectator Magazine in October 1946 (Allen 1946). He noted that nearly three million workers had wages which were on a cost of living "sliding scale", where changes to wages were linked to the official, cost of living index. The official measure was widely recognised as being out of date, and Trades Unions were pressing for a new calculation.

Professor Allen's article reminded readers of the official definition of the cost of living index—"the cost of maintaining unchanged the standard of living prevailing in working-class families prior to 1914". He went on to explain that households were spending more in 1946 than in 1914 for two reasons; firstly, prices had risen and secondly, the average standard of living had improved. The cost of living index attempted to measure the first effect, but not the second. He noted that naming the first measure as a "cost of living index" was misleading and that in the USA, the name had been changed to a consumers' prices measure to better reflect what was accomplished in the measurement of the index.

The article examined three options for the way forwards:

- Undertake a new budget survey to ensure that changes in the consumption pattern since before the war were captured and reflected in a revised measure; this would take up to two years to complete
- Don't wait for a new budget survey, adopt the results of the 1937/1938 survey immediately
- Continue with the index using the 1904/1914 household budget.

Rationing continued for some items, others were in short supply and a few were subsidised—these were all weaknesses of the first approach. A new survey would reflect distorted conditions which would become out of date rapidly as restrictions were lifted, and the investigation would involve a significant cost, at a time when there were many competing priorities for public funds. For the second option, it was expected that consumption had changed in the intervening eight years, given the forced changes in the nature of the economy, so the 1937/1938 consumption pattern would be inaccurate. The third option looked a poor choice, given how much consumption patterns had changed in the intervening years since the 1904 data had been collected.

In order to decide on the best course of action, the Minister of Labour and National Service appointed a Cost of Living Advisory Committee to advise him on "the basis of the official cost-of-living index figure and on matters connected therewith".[1]

[1] The "basis" of the index is the household budget information used; that is, the set of expenditure weights applied to the corresponding set of price changes for each type of good and service.

6.3 The Cost of Living Advisory Committee

The Cost of Living Advisory Committee was appointed on 8th August 1946 with the most pressing topic requiring its scrutiny being whether: "revision to the basis was desirable and practicable in current conditions and, if so, the revision that might be made". The committee produced an interim report with recommendations in March 1947, following five meetings (Ministry of Labour and National Service 1947). The committee was chaired by Mr R. M. Gould, from the Ministry of Labour and National Service and included representatives of other Government Departments, the Trades Unions and Retail Employers, Professor Allen and Mr J Stafford from the recently formed Central Statistical Office. Rather than meet regularly, the committee was convened when requested by the Department to which it reported.

The need for a revised basis for measurement of price changes was readily apparent from a comparison of the proportions of expenditure on types of goods between the 1914 and the 1937/1938 budget enquiries. This showed a significant shift in household spending away from food and onto household goods. Table 6.1 shows the relative proportions for the two time periods (Ministry of Labour and National Service 1947, p. 7).

This shift was indicative of both growing wealth and the availability of a wider range of goods. In fact, the transition was part of a long-term trend which has continued to this day. The modern proportion of spending attributed to food and non-alcoholic beverages is significantly lower, accounting for about 11% of household spending in 2015 (DEFRA 2017).

Table 6.1 Expenditure comparison between 1914 and 1937–1938

Group of Items	Weights based on 1904/1914 expenditure	Weights based on 1937–1938 expenditure
Food	60	40.1
Housing	16	12.7
Clothing	12	9.5
Fuel and light	8	7.6
Other items		
In index	4	8.1
Not in index	–	22
Total	100	100

Table 6.2 Changes in sales for groups of articles between 1945 and 1946 (1942 = 100)

Group	Index value in 1945	Index value in 1946	% change
Food	112	124	11
Non-food merchandise	113	143	27
Household goods	115	188	63
Apparel	111	133	20

The evidence of the two budget enquiries, together with other information, led the committee to conclude that the use of the 1904 basis in the current index should be ended, and a new basis used. But what basis should this be? The committee had to consider whether post-war conditions meant that an expenditure survey carried out in 1947/48 would result in expenditure shares that would change significantly in the following years as rationing and subsidies were reduced.

To investigate the volatility of expenditure, the committee looked at retail sales data from the Board of Trade; Table 6.2 shows the changes in average daily sales for four groups of articles between 1945 and 1946, with sales values set to be 100 for 1942. The difference in the index numbers showed that it would not be possible to obtain stable expenditure weights in the circumstances of the time.

As well as considering the immediate problem of determining what basis should be used in the index, the committee considered the long-term approach to ensuring that changes in expenditure patterns could be taken into account promptly. The committee proposed that regular updates to the expenditure information be made and incorporated into the index, and that they would consider how relevant international practice was evolving to inform their approach. Achieving firm proposals for a longer term strategy would need further consideration, which the committee felt would take time to achieve; this therefore required an "interim" position. The committee decided that the 1937/1938 budget enquiry should be used as an interim arrangement and that a technical group be appointed to consider the best way to use this pre-war basis. There was also a clear expectation that the technical group would consider which items should be included in the index and how prices should be collected—therefore taking a fresh look at essential aspects of the inflation measure. As a final comment, the committee recommended that the technical group would need to work quickly to enable a new, interim index to be produced "in a few months".

6.4 The Interim Index of Retail Prices

The new index—called the "interim index of retail prices", using the 1937/1938 budget enquiry data to provide expenditure shares, was first constructed in June 1947. Although it used out-of-date consumer expenditure patterns, in other ways changes to the methodology moved the measure significantly towards modern practice. The food group was expanded to 80 items, up from fourteen items in the previous incarnation of the index; alcohol was included for the first time, as were some services.

Other improvements to the index were introduced at this time, including to the quality of clothing prices. The postal survey used to collect this information was sent to a panel of retailers; the size of the panel was quadrupled and more attention was given to accounting for quality changes in garments (Ward and Doggett 1991, p. 143).

Although it was recognised that the interim index was a considerable improvement over the old cost of living index, it was criticised for being based on pre-war spending patterns which didn't take into account recent changes in consumption. There was a widely held view that it wasn't adequately capturing recent price rises. With this growing concern in mind, the Minister of Labour and National Service decided to call together the Cost of Living Advisory Committee to consider "… whether conditions of spending were sufficiently stable to justify the holding of a full-scale budget enquiry" (Ministry of Labour and National Service 1951).

The committee held its first meeting on 7th February 1951 and held six further meetings before publishing its conclusions. They noted that it was mainly the weighting basis of the index that had been criticised and so it was this issue that the group had focussed on. There were two main questions to answer:

- Was it the right time to hold a new budget enquiry to update the weighting basis of the index and if so, what should be the scope and nature of the enquiry?
- Was the range of items being priced sufficiently representative of current spending and the means of collecting prices satisfactory?

On the first question, the committee noted that four years had passed since the start of the interim index, which had been introduced because spending patterns were not considered sufficiently stable to justify the expense of a new budget enquiry. It was hoped that over this period of time spending patterns would have stabilised; however, the committee judged that such stability in spending had not yet been achieved. A number of factors were taken into account by the committee in reaching their conclusion. They included changes in the distribution of income, the introduction of social security schemes and the removal of clothing rationing.

The committee acknowledged that these changes would have affected the pattern of spending and considered it likely that further change would follow. However, doubts continued to be expressed by the public about the accuracy of the current index, particularly by those whose wages were adjusted in line with the index. In response to public concern, the committee recommended that a new budget enquiry should be held as soon as possible. To address the potential problem of expenditure patterns continuing to change, the committee suggested smaller scale, follow-up enquiries at annual intervals.

The committee considered other matters too; firstly, whether additional indices for different social and economic groups were needed, an issue which is still discussed today. For example, it had been suggested that there should be a separate index for professional, clerical, technical, administrative and supervisory workers. This was not thought necessary by the committee, as the scope of the households included in a new budget enquiry was to be widened to many salaried workers. Other suggestions for extensions of the index included regional indices; these were also rejected, as the committee was concerned about possible confusion arising from multiple indices being published on a monthly basis.

6.5 Wider Uses of Budget Enquiries

Capturing household spending for use in weighting price changes for categories of goods and services to produce an overall measure of the change in the general level of prices would only require data to be collected from households within the defined scope of the index, which was a specified household income range. Other Government Departments were also interested in household spending, and their interest extended to all income groups; for example, the Ministry of Food had been running special enquiries for its National Food Survey. With an adjustment to the proposed scope, this requirement could be addressed by an extended budget enquiry.

The committee estimated that the new budget enquiry for inflation measurement would cover 85% of households, so the additional cost of covering all households would be modest. The recommendations of the committee were accepted by the Minister, and preparations for a new budget survey were made.

6.6 Report of the Technical Committee

The Cost of Living Advisory Committee was aware of a number of questions about the performance of the index and about details of the methodology behind the index. At a meeting of the Advisory Committee in February 1951, a recommendation was made that a technical group be set up to consider specific, methodological issues and to provide advice to the main committee. There were five specific questions posed to the technical group:

- Whether the use in the present index of weights based on a pre-war level of consumption had resulted in a false impression of the rise in the level of prices since 1947
- Whether the kinds of items and the range of prices included in the present index were sufficient to produce a satisfactory representation of overall price change

- Whether the treatment of rental prices was adequate
- Whether the treatment of quality change was satisfactory
- Whether the treatment of seasonal items was acceptable.

The technical group report, with recommendations, was included in the Cost of Living Advisory Committee report published in March 1952 (Ministry of Labour and National Service 1952).[2]

The technical group concluded that the use of pre-war weights hadn't given a false impression of the change in prices. While components of the overall index had moved differently, these movements were found to have largely cancelled each other out. This was treated as "fortuitous", and the Group didn't expect this state of affairs to continue. The technical group proposed an update to the pre-war weights using values relating to 1950, derived from National Income and Expenditure data, until the results of a new budget were available.

In examining the scope of the index, the technical group summarised the number of items for which prices were collected. 250 items were priced regularly which included 84 items of food with several varieties included for each item; prices were collected from 200 locations with usually five retailers per area, so 1000 prices were collected for each food item. The total number of prices collected came to about 100,000. The technical group had previously recommended a broadening of the number of retailers from whom prices were collected, and they noted that this had been achieved. The group believed that the current arrangements were satisfactory for the scope of the index.

On the issue of rents, the technical group recommended a wider class of rental prices should be collected which included newly erected buildings (built after June 1947). The question of whether the costs facing families who owned their own houses should be included in the index was considered. The technical group noted that this was a difficult question and recommended that for the time being, only housing costs associated with rental properties should be included. This particular

[2] Note that the technical report was received earlier than this, possibly in January of 1952.

question is one which has been debated for many years and is still controversial, as later chapters will describe.

Regarding quality change, the technical group considered the existing practice of making adjustments where a quality change was apparent and considered this satisfactory. On seasonal movements, they stated that removing all seasonal effects would not be possible, so these should be accepted as a feature of the index.

The group did make a further recommendation on the structure of the index. They recommended splitting "Drink and Tobacco" into separate groups. This would enable households with no expenditure on one or both to be able to calculate an index that fitted their expenditure pattern on these goods.

The technical recommendations were almost all accepted by the Cost of Living Advisory Committee and were included in the index from February 1952.

6.7 The 1953–54 Budget Enquiry

The recommendation of the committee that a new budget survey should be carried out was accepted by the Minister. The data collection for the survey started towards the end of January 1953. The drawn random sample comprised 20,000 addresses taken from local rating records, and collection was carried out over the year. Responses were collected by local officers from the Ministry of Labour and National Service and from the Social Survey unit from the Central Office of Information. 12,911 households cooperated fully by supplying data over a three-week period. Processing of the data was carried out throughout 1954 and the early months of 1955 (Ministry of Labour and National Service 1956). Low- and high-income households were excluded from the estimation of expenditure weights—this meant that 11,638 households or about 90% of the total were included.

Analysis of the data showed that expenditure was under-reported for alcohol and tobacco—as it didn't match Customs and Excise figures. For this category of expenditure, adjustments were made to match the tax data. There was also evidence that expenditure on meals out was being under-reported.

The inclusion of alcohol and tobacco was a departure from the first cost of living index. Originally, only items considered necessities or "appropriate" spending were included; alcohol and tobacco were excluded. The Advisory Committee's view was that, by design, the scope should include "the whole field of goods and services over which households distribute their expenditure". However, there were some types of expenditure which, on principle, were excluded, examples being: income tax, national insurance, insurance premiums and capital sums. In most cases, the nature of the services supplied from these payments was difficult to define, or a unit of purchase was difficult to specify, so that the price of a unit couldn't be tracked over time.

The structure of the index was also reviewed as part of the work surrounding the new enquiry. There were nine main groups in the index as previously defined; the Committee recommended that transport, which was part of "services", should be separated out to form its own group. This reflected the growth of expenditure on transport, particularly resulting from the rise of private motoring. Also, the group "rent and rates" was to be renamed "housing" as it would include payments for repairs and maintenance of dwellings. Sub-divisions of the groups were identified as "sections"; the existing index comprising 50 sections. The committee recommended that this number should increase substantially to 91 as a result of the more detailed information available from the new expenditure survey—this was expected to lead to a more accurate index.

6.8 The Introduction of the New Index

The new index—the Index of Retail Prices, which became known as the Retail Prices Index, was initiated in January 1956 with the index reference value set to be 100 in this period. It is interesting to note that the committee thought that January was an appropriate month to start the index as January is a month where "few prices are at abnormally low or high level on account of seasonal movements and January may therefore be regarded as a representative month suitable for a base" (Ministry of

Table 6.3 Changes in expenditure proportions for groups of articles between 1950 and 1953/54

Group	Existing weights (1950 consumption)		New weights 1953–1954 consumption at 1956 prices
	At January 1952 prices	At January 1956 prices	
Food	389	432	350
Alcoholic drink	78	69	71
Tobacco	90	80	80
Housing	72	73	87
Fuel and Light	66	73	55
Durable household goods	62	55	66
Clothing and Footwear	98	84	106
Transport and Vehicles services	91	94	68 58
Miscellaneous goods	44	40	59
All items	1000	1000	1000

Labour and National Service 1952, p. 14), which suggests that the phenomenon of January sales had yet to take root in the economy of the post-war years. The choice of January as a reference month would cause problems at a later date with the onset of significant sales in January.

The effect of the new expenditure survey information on the weights for groups is shown in Table 6.3.

The committee noted that the differences between the weights for January 1956, using the consumption pattern for 1950, and the 1953–1954 consumption pattern derived from the recent expenditure survey, came from three sources. Firstly, they reflected changes in consumption patterns between 1950 and 1953–1954. Secondly, the latest weights were based on a new expenditure enquiry whereas the 1950 weights were based on a pre-war expenditure survey updated to 1950 using "rough" estimates of changes between 1937–1938 and 1950. Lastly, there had been an extension of the definition of index households and some other methodological changes such as changes of structure, which would have contributed to the change in weights.

6.9 Updating the Expenditure Weights

In the Interim Report of 1951 (Ministry of Labour and National Service 1951), the Cost of Living Advisory Committee had recommended further surveys of household expenditure following the 1953 enquiry, but on a smaller scale. These would act as a means to identify whether significant changes in consumption had occurred which would justify a further full-scale enquiry. The new Index of Retail Prices began in 1956 and following this, a continuous expenditure survey was started in January 1957—the Family Expenditure Survey. The first report of the survey, covering the years 1957–1959, was published in 1961 (Ministry of Labour 1961).

The Family Expenditure Survey consisted of a random sample of 5000 households spread evenly throughout the year. Households were asked to maintain detailed expenditure records for a period of 14 consecutive days and to provide interviewers with information on regular payments and income (Ministry of Labour 1962). This was similar to the 1953 survey, except with a smaller sample size and a reduced recording period (21 down to 14 days). Each participating member of a household was paid £1 as a reward for their contribution; the response rate was around 60%.

In the larger-scale 1953 survey, decisions were made as to which households should be included as "index households", that is, those contributing to the Index of Retail Prices. At the upper end of the income scale, if the head of the household's recorded gross income exceeded £20 a week, then the household would be excluded. At the other end, a household whose income was mainly based on the state pension: "… income derived from National Insurance retirement or similar pensions …" was also excluded. The same principles were applied to the Family Expenditure Survey, but with suitable updates. The upper limit was adjusted to account for the change in price levels, so the threshold was extended to £25 for 1957 and 1958 and £30 for 1960. The adjustment for the under-reporting of consumption of alcohol and tobacco applied in the larger-scale 1953 survey was also applied to the Family Expenditure Survey.

The committee considered the best use of the Family Expenditure Survey (FES). The original idea was to use it as an indicator of change in the consumption pattern; if a significant change was found, a new full-scale expenditure survey would be required with all its associated costs. An obvious alternative was considered—using the FES itself as a source of the expenditure shares. The small usable sample size of about 3000 participating households was considered too small to be effective; for example, items which were bought on an irregular basis would not be adequately captured with such a sample. Combining three consecutive years of the survey data would provide a sufficient achieved sample size and would have the advantage of reducing fluctuations in irregular purchases, so this option was chosen.

Using the FES was attractive but led to a further question. Should the weights be changed only when a "significant change" was detected, or should the weights be updated every year? The former option would require defined criteria for what represented a significant change. The committee decided instead on an annual update of weighting information which would ensure that the consumption pattern was always up-to-date. The committee's words in the 1962 report gave a clear statement of this important decision:

> … we recommend that the Retail Prices Index should be re-weighted annually in January on information obtained through the Family Expenditure Survey in respect of "index" households over a period of three consecutive three years ended the previous June.

The report of 1962 contained two other significant recommendations—one indicating wider changes in society and the other a statement on an item that would continue to be challenging for decades: meals out and owner occupiers' housing. Expenditure on meals bought and consumed outside the home was split between the food group and other groups in the index. With the rise in expenditure on this item, it was recommended that it should be included as a group in its own right. It was recognised that collecting sufficient, consistent price data would be challenging and the committee recommended that the Ministry of Labour collect data on an experimental basis. For owner occupiers' housing, the committee recognised that its treatment was necessarily complex and required further study, though the existing use of rental information should continue.

6.10 Meals Out, Housing and Further Indices

In 1967, the Ministry of Labour asked the Advisory Committee to provide advice on both of the topics mentioned above—a specific indicator for meals out, and how the housing costs of owner occupiers might be included. Advice was also requested on whether price indices were needed for regions, and then income and social groups. Apart from the first item, all these topics are still studied and discussed today.

Between the questions being posed and the report on the considerations of the Advisory Committee being delivered in 1968, the functions of the Ministry of Labour had been taken over by the newly created Department for Employment and Productivity (Department of Employment & Productivity 1968).

Before describing the issues raised above, it is worth summarising the methodology of the index at this time; this is the approach that the 1968 report takes. It starts by reminding the reader of the basic object of the index and provides a summary of the methodology:

> …. to reflect price changes throughout the whole field of consumer goods and services, but excluding certain items of expenditure such as National Insurance contributions, life insurance premiums, investments and charitable subscriptions, regarded as being outside the index.

The index comprised 350 items at this time with prices collected for varieties within these items. About 120,000 price quotations were captured to allow regular estimation of the index. Index households covered all households with the exception of a few per cent at the top and bottom of the income scale. Weights were obtained from the Family Expenditure Survey, with expenditure information taken from index households with data from three consecutive years combined. The indices from each year were chained[3] together to form a continuous series set at 100 in 1962. The revised weighting took effect in February of each year.

1. Meals Bought and Consumed Outside of the House

As described above, the committee's report from 1962 recognised that meals bought and consumed outside of the house were becoming an important item of expenditure and should become a separate group within the index. However, to ensure it was possible to collect reliable, comparable prices each month, the committee had recommended the collection of prices on an experimental basis. The Ministry of Labour collected prices for lunches, cups of tea and sandwiches across the UK from 200 works and staff canteens in 1963 and 1964; this led the Ministry to decide that a larger number of price quotations was required, extending to 500. Previous analysis by the Advisory Committee decided this scale of collection was satisfactory, and meals bought and consumed outside the home was adopted as a separate major group in the index from February 1968 with statistics published from March of that year. The new group had a weight of 41 parts per thousand in 1968.

2. Housing Costs of Owner Occupiers

The appropriate treatment of owner occupiers' housing is one of the longest running debates in consumer price statistics; it is still controversial today. The committee recognised that it was possibly the most difficult topic to address in the construction of a price index. Consumers buying a house face a variety of costs including rates, water charges and repairs & maintenance. There may be interest payments to financial organisations such as building societies for mortgages, where the payments depend on the size of the loan, the number of years outstanding and the interest rate. Other owners may have bought their properties outright or have paid off any loans. With the appreciation of value of

[3] For a discussion of index chaining, see Chap. 7 of Ralph et al. (2015).

a property, some of the money paid could be viewed as representing an investment.

The committee looked at a number of options and concluded that the existing method of rental equivalence was still the best approach; while they recognised that it was not ideal, they couldn't suggest a better alternative.

3. Retail Price Indices for Regions

The possible uses of inflation measures on a regional basis had been raised many times since a measure of inflation was first constructed at the start of the First World War. It was discussed by the Advisory Committee in 1951 (Ministry of Labour and National Service 1951) but wasn't pursued. This time the committee suggested two types of regional index. The first would resemble the overall index and would show the change in prices in each region and would enable comparisons to be made for each region over time, but would not provide comparisons between regions; this was called an "inter-temporal" index. The second type would allow comparison between regions at a point in time—an "inter-regional" comparison.

The committee identified a number of challenges that would need to be overcome to enable an effective inter-regional comparison to me made; for example, whether regional baskets would be required and how they should be constructed. The committee recommended a technical group be set up to examine these issues in greater detail.

Towards the end of the Advisory Committee report in 1968, the committee suggested that it be renamed the Retail Prices Index Advisory Committee (Depart for Employment and Productivity 1968, p. 28). This was to avoid continuing criticism of the index arising from confusion over its purpose. This recommendation was accepted, and the name was changed for the next report issued in 1971.

The technical group reported in 1971 (Department for Employment 1971). It examined the feasibility of producing inter-regional and inter-temporal indices. For the former, indices could be calculated on an annual basis for the eleven planning regions of the UK and the Greater London Council area. For the latter, indices could be created for the counties of the UK and the Greater London Council area on a quarterly basis. The Advisory Committee accepted the advice of the technical group that it was feasible to produce these indices; however, the committee was split on whether it would be beneficial to introduce them, and so the Department of Employment[4] decided to go no further.

4. Retail Price Indices for Social and Income Groups

The original cost of living index was a measure for working-class households; that is, budget enquiries were limited to manual workers and small salary earners. This led to calls for additional indices suitable for other income groups. From 1956, the reference population had been expanded to include most wage earners except very high and low earning households which had reduced the need for alternative measures. However, the situation with pensioners needed a closer look in the opinion of the committee.

The Family Expenditure Survey contained household budget data for the low-income households excluded from the reference population of the Index of Retail Prices. Comparison of the consumption patterns of pensioner and index households are given in Table 6.4.

Although the consumption patterns show differences, the committee noted that this didn't necessarily result in differences in the movement of prices. Further work was needed to investigate price movements using the pensioner patterns. This analysis showed that between the periods January 1962 to January 1965 and January 1965 to January 1968, the average level of prices for pensioner households rose more than for index households. For the whole period, the rise for pensioner households was 26.0% while it was 21.9% for index households (Department of Employment & Productivity 1968, p. 17).

Although the committee accepted that there was a significant difference between index and pensioner households, there was a reluctance

[4]The Advisory Committee started out reporting to the Ministry of Labour and National Service in 1947. The Ministry was renamed the Ministry of Labour in 1959, then the Department of Employment and Productivity in 1968 and then the Department of Employment in 1970.

Table 6.4 Comparison of expenditure shares for pensioner and index households, 1958–1961(Department of Employment and Productivity 1968, p. 16)

Group	Expenditure shares for pensioner households	Expenditure shares for index households
Housing	18.8	11.4
Fuel, light and power	14.1	6.3
Food	35.3	28.4
Alcoholic drink	1.7	4.2
Tobacco	3.8	5.9
Clothing and footwear	5.1	8.8
Durable household goods	3.4	6.2
Other goods	7.2	6.7
Transport and vehicles	3.0	12.9
Services	7.7	8.8
Miscellaneous	–	0.4

to increase the number of indices. In this case, the committee decided there was a justification for separate measures for pensioners. The two reasons being that: firstly, they were excluded from the main index and secondly, their expenditures differed substantially from the index households. The committee considered the case for further measures for social and income groups but came to the conclusion that they were not justified.

6.11 Mortgage Interest and Owner Occupiers

The treatment of owner occupiers' housing costs had always been recognised as challenging. The issue had been discussed by the Advisory Committee in 1952, 1962 and 1968 and was re-examined in 1974 by a technical working party put together to consider housing together with other technical matters. The method used up to this enquiry was "equivalent, or imputed rents" which treats housing as providing shelter services which are consumed by the owner occupier. This was an internationally accepted approach. Concern with the method arose from doubts about whether the recent experience of movements of equivalent, or imputed rents was in line with observed rents. There was a view that recent rises in interest rates were not being reflected in the rents being charged and that growth of owner occupation meant that more than half of households fell into this category. A note was presented to the Advisory Committee from the Trades Union Congress on this matter (Department of Employment 1975). The technical working party felt that the currently available rental information didn't provide an acceptable measure of imputed rent.

An alternative method could be based on mortgage interest payments. This approach would present a more direct measure of the costs faced by owner occupier households which would be more easily understood. This approach had been studied before, and difficulties were identified. For example, owner occupiers, who borrow in the traditional way, pay a capital element as well as interest on the borrowing. The capital repayment is considered "savings and investment" and not consumption, so is excluded from the index.

The technical working party considered the problems and attempted to find a practical approach that would prove satisfactory. Having considered the position, it recommended a move to use mortgage interest payments both for the determination of weights and for the indicator of price change. The weight would be compiled from average expenditure on mortgage interest, after deduction of tax relief, and the price indicator would be taken from the movements in mortgage interest (after tax relief) derived from two components. The first was the current rate of mortgage interest recommended by the Building Societies' Association and the second was a weighted combination of current and past house prices representing the outstanding debt from individual years.

Table 6.5 shows the impact of changing from the rental equivalence method to the one based on mortgage interest payments (Department of Employment 1975, p. 31):

The new indicator was higher than the previous, rental equivalence indicator and closer to the movement in house prices. The weights for the respective methods also changed, from 37 parts per thousand for the rental equivalence to 20 parts per thousand for the mortgage interest method.

Table 6.5 Comparison of rental equivalence and mortgage measures of owner occupiers' housing costs

Year	Mortgage interest method	Rental equivalence method	House prices	Approximate average mortgage interest payment index
1970	100	100	100	100
1971	111	108	113	110
1972	116	118	149	120
1973	162	133	200	159

6.12 Three-Year Weights to One-Year Weights

Since the introduction of the Family Expenditure Survey (FES) in 1957 to provide the weighting basis for the index, the weights had been produced from a rolling three-year average of household expenditures. The Advisory Committee asked the technical group to consider the move to using just one year of the FES, since the sample size had been doubled in 1967 (Dunn 2008, p. 2). The Committee felt that using data from just the previous year, representing an improvement in timeliness, would improve the acceptability of the index. The original reasons for using three years of expenditure data were to reduce the sampling errors in the weights and to smooth out non-random fluctuations from a small number of durable items (Department of Employment 1975, p. 32).

The technical group considered the standard errors published with the FES; it found that in most cases where standard errors were large, the weights were small. There were exceptions where some items had both large standard errors and weights; for example, "furniture", "floor coverings" and "repairs & maintenance". For these cases, the recommendation was to retain the method of using three years' data to reduce the sampling error.

6.13 Major Structural Changes in 1986

The Advisory Committee was reconvened in 1984 to re-examine the treatment of housing costs and to look at the construction of the index. The committee noted that its new terms of reference were very similar to those from 1973, and the current remit was to consider the decisions made then to see whether they still held. As before, the Advisory Committee appointed a technical working group to assist them. The technical group reported their recommendations in June 1986, after 10 meetings had been held (Department of Employment 1986). The Committee reviewed a number of important parts of the index including the coverage, the definition of index households, the choice of reference base, the reference date and the level of publication and whether the treatment of complex items was still effective.

The report began by stating some guiding principles which were used when evaluating the effectiveness of the index and in considering whether change was required. The first principle stressed the value of the Retail Prices Index arising from its consistency and continuity, this meant that the committee would only suggest change where they felt it was necessary. The second principle re-affirmed the view taken by previous committees that the RPI is an index of price changes and not a cost of living index. The third principle was that maintaining public confidence in the index was important; the report expressed this by stating that the methods used should be understandable and reasonable to the "the man in the street". Finally, the index should be appropriate for its uses; the committee identified seven major uses (Department of Employment 1986, p. 32):

- assessing changes in the standard of living of consumers
- monitoring the effectiveness of counter-inflation policies
- calculating the purchasing power of after-tax incomes, interest payments, etc.
- deflating statistics, such as the value of retail sales
- uprating social security benefits, state pensions, the capital value of some National Savings gilt-edged securities and the level of tax thresholds
- providing proxy-measures to stand for more specific price indicators; for example amounts covered by insurance
- pay bargaining.

The Advisory Committee made eighteen recommendations. Most were relatively minor; six of the more important recommendations were:

- for housing costs faced by owner occupiers, the recommendation was to continue with mortgage interest payments with some small changes to the methodology
- the special indices for low-income pensioners should be continued, but regular indices should not be produced for other groups. However, there was a recommendation to carry out historical analyses of the impact of price changes on other household types
- a technical manual should be produced detailing the sources of data and the methods used; it should also contain instructions to allow users to construct their own tailored measures based on published sub-indices
- indices for all categories of expenditure with weights of five or more parts per thousand should be published, and the Department of Employment should be willing to supply others when requested
- the definition of index households should be changed to identify the wealthiest households by the household income and not the income of the head of the household
- the range of price indicators for fruit and vegetables should be extended, including some which are not available throughout the year.

One of the issues still discussed today is the choice of reference month; the 1986 report discussed this and the options for different choices. The Advisory Committee report noted that the choice of January as a reference month goes back to 1952, and the committee didn't see a need to change this. They considered the option of using an annual average, which was used for other statistics, but rejected it—one reason for this being that they believed that non-technical users would find it easier to visualise price changes from a specific date rather than over an extended period of time.

6.14 Alternative Inflation Measures

6.14.1 Pensioner Indices

The broad range of uses to which an inflation measure was applied grew considerably over time and this made it increasingly difficult to ensure that all user needs were met by a single measure. While it had long been recognised that there was a benefit from having as few measures as possible to avoid confusion, the Advisory Committee recognised that there were cases where a variant of the main Retail Prices Index was needed.

Indices for low-income pensioners were introduced in 1969 for one- and two-pensioner households. The weights for the RPI specifically excluded Family Expenditure Survey data on pensioner households, at least three-quarters of whose income came from state benefits. While the same price data were used as in the main index, the weights were based on expenditure information from pensioner-index households, and they excluded certain items such as canteen meals, housing, charges for health services (from which pensioners were exempt); concessionary travel was substituted in place of normal fares. The pensioner indices were published quarterly.

6.14.2 RPIX and RPIY

The two variants RPIX and RPIY were introduced for specific purposes. RPIX was the RPI without mortgage interest payments—the other items were then re-weighted to account for its exclusion; it was introduced in 1975. When the UK Government introduced inflation targeting, the initial target was the RPIX; this target applied from October 1992 until its replacement by the CPI in 2003, as Chap. 10 explains. This variant was needed because the RPI included mortgage interest rates and it would have been unacceptable to use the RPI as a basis for setting interest rates, when it could be directly influenced by the level of those rates.

RPIY was sometimes referred to as "core inflation"; it removed items which were influenced by indirect taxation and interest rates; it was introduced in 1995. Exclusions included mortgage interest payments, local authority taxation, excise duties, VAT, insurance taxes and air passenger duty.

6.14.3 Tax and Price Index

This variant measured how much the average person's gross income needed to change to purchase the basket allowing for the average amount of income tax and national insurance paid on earnings—it was introduced in 1979 (Baxter 1998, p. 77). It provided an inflation measure that was not affected by any movement between direct and indirect taxation, that is, a measure of how much gross income would need to change to maintain real income which takes into account both price changes and changes to taxes and benefits. It was introduced following the Conservative victory in the general election that year, when the new Government increased in VAT (which increased the RPI) but reduced income tax (which did not affect RPI).

6.14.4 The Rossi Index

The Rossi index variant was introduced by the Minister of State for Social Security between 1981 and 1983; it was used to uprate income related benefits. It excluded most of the housing sections as recipients were not expected to be paying significant housing costs (Baxter 1998, p. 83).

6.15 Responsibility for Producing the Index

The Department of Employment had been responsible for producing the Retail Prices Index since 1968. The last Advisory Committee report under the Department of Employment considered the transition from domestic rates to the Community Charge, which was introduced in 1989/90. The committee considered arguments for and against its inclusion and recommended that it should be included and estimated the possible effects of the transition (Department of Employment 1989).

The committee then passed to the newly organised Central Statistical Office in 1989; most of the two statistics divisions at the Department of Trade and Industry and the divisions working on the Retail Prices Index and the Family Expenditure Survey in the Department of Employment merged with the existing Central Statistical Office (Ward and Doggett 1991, p. 4).

6.16 The Retail Prices Index Over the Period 1945–1989

Figure 6.1 shows the 12-month annual change in the Retail Prices Index, which is commonly called the "rate of inflation" between 1945 and 1989. For the initial period, from 1945 to 1960, inflation was relatively low—under 5% a year, with the exception of the years 1951–1952 when global prices of raw materials increased, and some consumer goods markets were restricted as a result of the Korean War (O'Donoghue et al. 2006). By today's experience, 5% seems a high value, but given the overall experience of the period, it was relatively low.

The rate of change in the index fell in the last few years of the 1950s, briefly becoming negative in 1959; this was mainly due to lower prices for alcohol, food and household goods. The 1960s were a period of mostly stable and low inflation with rises occurring as the decade ended; over the period the largest increases were in the costs of housing and services with the smallest increases coming from clothing and footwear.

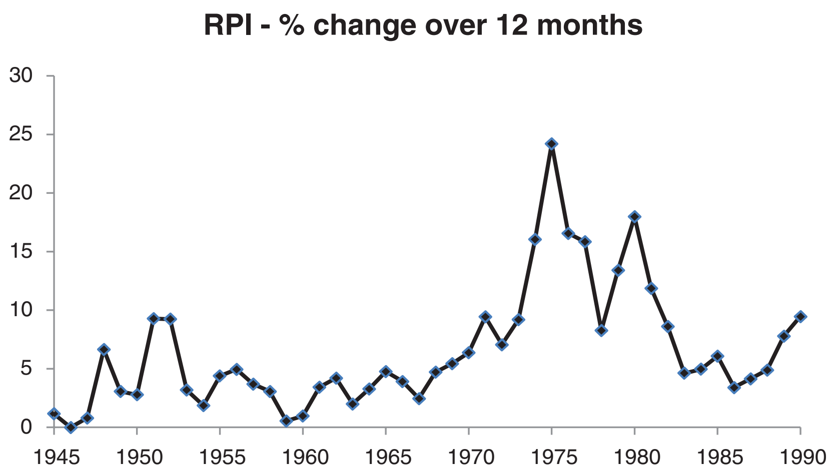

Fig. 6.1 All items RPI annual average percentage change over 12 months 1945–1990

As Fig. 6.1 shows, the 1970s was a period of high inflation with most prices doubling during the decade. Inflation was more than 10% a year for each year from 1974 to 1979 with the exception of 1978. Global supply shocks including large increases in the price of oil were major factors in the price increases. 1975 saw the highest inflation rate at over 24%. The 1980s started with inflation at about 20% before falling back to 2.4% in 1986 and rising again to about 11% at the end of the decade.

6.17 Final Remarks

The period from the end of the Second World War up to the end of the 1980s saw a very considerable change in the way inflation measurement was carried out. By the end of the period, the methodology of the measure bore a close resemblance to how we measure inflation today. This doesn't mean that there weren't further changes during the 1990s and beyond—there was a major new measure that would take centre stage and a range of issues attracted much attention, some encountered before and some that were new. These issues are the subject of Chaps. 10 and 13.

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7

What's in the Basket?

Although the methodology behind the measurement of the general level of prices contains many technical and complex elements, there is one aspect that is easier to understand and is of particular interest to the general public—the basket of goods and services. When we refer to the "basket" we really mean the selection of goods and services for which prices are collected every month. This collection is traditionally visualised as a large shopping basket containing a representative set of goods and services taken from all consumption items available to the general public. The construction of a representative basket was identified in Chap. 3 as one of the five key elements required for producing a measure of the general level of prices.

The current basket contains about 700 goods and services including everyday food products like milk and bread, but also items less frequently bought such as airfares and haircuts. The basket is updated each year to reflect changes in the products available and consumer tastes, though the number of changes is small—only 5% of items changed in 2017 (Gooding 2017). What is appealing about the basket to the general public is that it highlights changes in the products that they buy—items that have gained or lost expenditure share over recent years.

R. O'Neill et al., *Inflation*, DOI 10.1007/978-3-319-64125-6_7

For example, in 2010, lip gloss replaced lipstick and hair straighteners replaced hair dryers (Gooding 2010), reflecting changes in the markets for such items. The update to the basket, produced by the Office for National Statistics in March of each year, has always appeared prominently in news bulletins.[1]

This chapter explains the role and importance of the basket and the reasons why items are added to or removed from the basket and the process followed for identifying items for inclusion or exclusion.

7.1 Why Do We Need the Basket?

Before looking at the basket in detail, it is instructive to consider what data we would like to have in the ideal situation. We can imagine the price statistician wishing for data on prices paid in every transaction for every item purchased by consumers every month.[2] Of course, this is not practical, and we have to take a sample of goods and services and a sample of the transactions. Clearly, an appropriate selection of items for the basket is a vital aspect of inflation measurement.

From a statistical viewpoint, we could consider selecting a sample of goods and services from the overall "population" like any other sampling procedure. The standard approach would be to build a sampling frame that included all the sampling units within scope and coverage for the reference population, and relevant to the desired geographical domain of the inflation measure.

It is useful at this point to be clear about these four aspects of the definition of a measure of prices, as to some extent they will determine the way in which the items in the basket of goods and services are selected, and significant changes in any of these factors could affect the sample selection process.

[1] See, for example, http://www.bbc.co.uk/news/business-35810466 (accessed 3 June 2017).

[2] In fact, this would present considerable problems for the statistician as will be explored in Chap. 15.

- scope: the transactions which we would ideally like to measure; this covers the outlets from which the prices are obtained as well as the items themselves
- coverage: those transactions within scope which it is practical to measure
- reference population: the consumers whose transactions we would like to include in our inflation measure
- geographical domain: this is the whole of the UK for all inflation measures (but not including offshore islands such as the Channel Isles and the Isle of Man).

On the last bullet point, we could, of course, decide we would like inflation measures for just England, Wales, Scotland or Northern Ireland, or for regions of each country.

The construction of a suitable sampling frame of individual transactions is not feasible for an economy as large and complex as the UK. Instead, a multistage design is used, starting with high-level samples and then selecting subsamples within these. Price collection is divided into central and local collection. Central collection is used for items where prices are the same across the UK, or where regional prices can be collected via the Internet, phone or email. Local prices are obtained by price collectors who visit cities, towns and the shops within them.

Locations and retail outlets are chosen by random sampling as are the prices for central collection; however, locally collected prices are not selected randomly as price collectors choose items which are "most sold". The danger of non-probability sampling is that it might lead to biased estimates. To keep selection bias to a minimum, the specification of the items to be collected is guided by well-established principles and is carried out by a team of qualified and experienced professionals. Further description of the sampling is given in Chap. 8.

Ways of improving sampling methodologies is a topic of current study and the Office for National Statistics is both investigating and monitoring international work on the use of scanner data to help determine which items should be included in the sample selection exercise for the measurement of inflation (e.g. van der Grient and de Haan 2010). This topic is discussed in Chap. 15.

The current basket of goods and services comprises over 700 goods and services which represent the totality of items within the scope for the reference population. There are some types of expenditure which are excluded from the scope of the index: savings and investments, charges for credit and betting; however, they are relatively few. It is clear that the proportion of available items which are included in the basket is very small; however, for many varieties and brands of product, price movements will be similar; for example, it would be unnecessary to capture prices every month for every variety of shampoo. We would expect a small number of shampoo prices to provide a good representation of what is happening to prices for the rest of shampoo products, as well as other hair care or cosmetic items.

Clearly, what consumers in the UK buy changes over time. New products and varieties appear and others disappear; consumer tastes change and what was once popular loses ground to new items. New technologies make previously popular items obsolete. If the contents of the basket were fixed over a long period of time, the basket would become out of date and not provide an accurate representation of consumer purchases. This was indeed the case when the consumption pattern from 1904 was used to help determine inflation measures in the 1930s and 1940s, leading to widespread dissatisfaction with the index. As Chaps. 3 and 5 explained, household expenditure on food has reduced over time and spending on a broader range of household goods has increased as more products became available. While the basket is updated annually, over the course of a year it is fixed, as Chap. 4 explained, and measures of the change in general level of consumer prices are found by combining price changes for each item, weighted by the proportion of expenditure on each item (in fact, the range of items it represents).

The Office for National Statistics is the public body in the UK with the responsibility for producing consumer price indices. Each year, it publishes an article explaining the changes in the basket of goods and services and this always gains wide coverage in the national press. It describes the reasons for each change and provides an insight into areas where consumer choices and the marketplace have changed.

7.2 The Expansion of the Basket

Earlier chapters described how the measurement of inflation has developed from the origins in the early eighteenth Century. Chapter 3, which looked at the early history of the subject, described how the pioneers of Index Numbers used baskets of just a handful of items, with Joseph Lowe (1823) recognising that a much wider range of goods and services would be needed to produce a reliable measure.

The first official index, produced in 1914, used 23 items in the categories: food, clothing, rent, fuel and lighting, as described in Chap. 5. By 1947, the number of items had increased to around 200; in 1993, there were over 600; today, there are more than 700.

Will the number of items in the basket increase further? There is no immediate likelihood of the number increasing significantly—current practice tries to maintain the size of the basket by removing items when new ones are added. It is important to recognise that there is a cost associated with capturing prices every month for all of these items. Despite this, there is no immediate reason to suppose that the number of items in the price index has reached a limit in the medium to long term. The availability of more data sources and data collection techniques such as web scraping, there may be further increases in the number of items in the future.

7.3 The Role of Items in the Basket of Goods and Services

While the basic principle is to place items in the basket to cover the whole range of consumer goods and services, there are a variety of reasons why specific products are chosen for inclusion. Some individual goods and services are included because household spending on them is large; examples include petrol, electricity and gas supply (Gooding

2017, p. 4). Other items are included to represent a broader range of products; for example, garden spades represent all other garden tools; in this way, a whole category of items can be represented by a small subset of products, and these are called representative items. Another example is provided by the "furniture and fittings" category—there are twenty items in this category which cover wardrobes, tables, chairs, kitchen units, patio sets, curtains, duvets and bed sheets. While this category covers a broad range of items, the number of items needed to represent it in the basket is relatively small.

For those items which are used to represent many others, the weights allocated to them are the weights of the categories of goods that the items represent—so, price changes for garden spades are weighted by the expenditure of the broader category covering garden tools. Chapter 9 describes how the weights themselves are estimated from modern expenditure surveys and other data.

For categories of items which represent a large proportion of household expenditure, more items are usually chosen to provide representative price changes for that category; however, relative expenditure isn't the only consideration in determining how many items are needed to cover each category. Where price movements in a category are considered to be volatile, more items will be chosen to enable a reliable overall estimate of price change; however, this relies on being able to make an accurate assessment of the variability of price changes in a given category. To make an efficient allocation of items to categories requires consideration of both the size of expenditure and the spread of prices. The allocation of representative items across the high-level categories, commonly referred to as divisions, is shown in Table 7.1 (Gooding 2017, p. 5).

There is a further important consideration in the determination of what to include in the basket of goods and services—the practicality of collecting prices for the items in the basket. Local prices are collected every month by price collectors who visit retail outlets of different types around the UK. Items in the basket must be found easily by price collectors when they visit shops, and prices must be straightforward to obtain—this ensures that a sufficient number of price quotes are found in a range of retail outlets across the UK. Ideally, the items should be

Table 7.1 Allocation of items to CPIH Divisions—2017

	CPIH Weight, Jan 2017 (%)	Observed variation in price changes	Representative items (% of total)
Food and non-alcoholic beverages	8.3	Medium	24
Alcohol and tobacco	3.3	Medium	4
Clothing and footwear	6.2	Medium	11
Housing and household services	27.6	Low	5
Furniture and household goods	5.1	Medium	10
Health	2.2	Low	3
Transport	13	Medium	6
Communication	2.1	Medium	1
Recreation and culture	12.3	High	17
Education	1.7	High	1
Restaurants and hotels	10.4	Low	7
Miscellaneous goods and services	7.8	Medium	11

available throughout the year, as the aim is to collect prices for identical items. In some cases, items are seasonal and are treated differently in the compilation of the index (ONS 2014). Not all prices are collected manually in retail outlets; some are collected online or from catalogues; however, similar considerations about the availability of items and prices need to be taken into consideration.

7.4 More Than One Basket?

Across the different measures of price change for the UK, there are a few differences in the composition of the baskets. The Retail Prices Index, which is the long-running measure produced since 1956, has a basket which includes some items that are not found in other measures; for example, estate agent fees. The CPI and CPIH have almost identical baskets, though the CPIH, which is the measure which adds owner occupiers' housing (OOH) costs, includes OOH and council tax which aren't in the CPI. Where the baskets are slightly different for the different measures, the weights allocated to the categories will differ too.

7.5 Updating the Basket

While the number of items considered to represent a sufficient sample has stabilised at around 700 over the last two decades, exactly which items are present in this collection changes each year. While the number of items that are added to the basket and the number dropping out are small, just a few per year, this annual updating is an essential activity. For the CPIH basket in 2017, 16 items were added, 11 were removed and 8 items have been modified out of a total of 713 items.

Changes to the basket are introduced each February with updated weights, but prices are collected for both new and old items in January. Price changes between December and January are based on the old basket and between January and February on the new basket. This allows the change to be introduced and the before and after series to be chained together to ensure there is no discontinuity in the time series of index numbers (for an explanation of chain-linking, see Ralph et al. 2015, Chap. 7).

7.6 Identifying Potential New Items and Reviewing Existing Items

Information about items comes from a variety of sources. Firstly, market research data provides information on expenditure; this identifies products that are gaining or declining in popularity. Secondly, price collection field workers provide important information from their experiences in collecting prices; for example, they can identify shelf space allocated to products and report significant changes. Thirdly, the Living Costs and Food Survey (the latest incarnation of the Family Expenditure Survey that we met in Chap. 6) can provide information on categories of items, and items themselves, that are purchased more or less frequently. A set of possible inclusions is identified and is subject to detailed investigation by a team of specialists within the Prices Division of the Office for National Statistics to decide on whether they should be added.

There are guidelines for whether an item is included in the basket or not. At the time of writing, items that represent more than one part per thousand of consumers' expenditure (roughly £700 m) are required by EU regulation to be included in the basket (EU regulations only apply to the CPI). Examples are air fares, electricity and laptops. In practice, the threshold for inclusion is frequently less than that: if consumers collectively spend more than £400m on a particular item during the course of a year it is highly likely to be included in the basket. On the flip side, an annual spend below £100m means an item will either drop out of the basket, or not be introduced. There are other criteria; for example, it is preferable that items are available all year round, though some commodities are seasonal.

Price variations are also examined. For categories of goods with large variability in price, a larger number of items are included or prices are collected from more than one shop in a location for a given item. If, in an expenditure class, there are products with similar price movements, then one is likely to be dropped.

The same procedures operate at the next levels of aggregation. For product groups with high expenditure, a relatively large number of items are usually selected, though if the price movements of items in such a category are similar, then the number can be reduced. In contrast, where price movements within a category are very different then a larger number of items will be chosen.

It is also important that price collectors in retail outlets can find items that match the items chosen to be in the basket fairly easily. In some cases, there is a trial period where pricing of new items is piloted to ensure that price collectors can capture appropriate prices in a reasonable time. The selection is purposive. In each outlet, price collectors select an item that matches the specification so that it is typical of what people buy in the area.

7.7 Examples of Changes Over Time

Looking over the composition of the basket from 1947 to the present day reveals a large number of changes, which demonstrate how items fall from favour and the widening range of products available to consumers (O'Donoghue et al. 2006):

- for bread, the 1947 basket contained large and small white loaves and rolls. The small brown loaf was added in 1952/1956[3] and large wholemeal loaves in 1987; today, the basket includes pitta bread as well as white and brown loaves
- poultry wasn't included in the 1947 basket, while beef, mutton and lamb were strongly represented. Chicken was introduced in 1952/1956; turkey in 1987; fresh chilled chicken and frozen chicken pieces in 1987
- butter was part of the 1947 basked and has been there ever since. Lard was included in 1962 and disappeared in 1987; today, the basket includes margarine, low-fat spread and cooking oil
- potatoes were part of the 1947 basket and have been included ever since. Crisps were included in 1952/1956; dried mashed potato appeared in 1974 and went out again in 1987 when frozen chips were included
- representing electrical appliances, the 1947 basket included vacuum cleaners and electric irons. Washing machines were included from 1952/1956; refrigerators and cookers from 1962; toasters, microwaves and hair dryers from 1987; tumble dryers and dishwashers from 1995
- audio visual equipment and media have seen very dramatic changes. The 1947 basket included a radio set and a gramophone record; in 1987, the personal cassette player, colour TV and VHS player were added and radio sets were out. 1995 saw CDs included.

Other changes include:

[3] The basket was unchanged between 1952 and 1956.

Hairdryers and lipstick left the basket and hair straighteners and lip gloss appeared in 2010; digital TVs, set-top boxes and blu-ray discs were added in 2008; frozen prawns were added and canned salmon was taken out in 2002 and personal cassette players were replaced by personal CD players in 1998.

Taken together, the changes to the basket of goods and services reveal much about the preferences and behaviours of consumers in the UK. The story of the basket and how its contents have changed is a part of the history of post war consumption in the UK.

7.8 Specific Changes for 2017

As Sect. 7.3 notes, changes in the basket arise for a number of reasons and the specific changes for the 2017 basket (Gooding 2017) provide a good illustration of this.

There are several examples of new items added to the basket in 2017 in order to represent growing parts of the consumer marketplace. Non-dairy milk products were added to reflect the increasing expenditure on "free from" products. Similarly, flavoured water was added as this is a growing part of the mineral waters, soft drinks and juices category. Men's base layer tops were not previously covered by the sample but expenditure is increasing, as is the case for cycle helmets which were added to the basket, reflecting the increasing popularity of cycling.

In other cases, products were added to broaden existing coverage as expenditure changes. In 2017, gin was put back into the basket having been removed in 1996; this resulted from the rise of small, craft distilleries offering new varieties and improved the coverage of the spirit section. Off licence sales of spirit-based alcoholic drinks have been removed from the basket to allow gin to be added.

Council tax in Great Britain and rates in Northern Ireland were excluded from the CPI as they were considered direct taxes and are therefore excluded by European Regulations. However, this has been controversial as they are important costs associated with a dwelling and many people believe they should be included. ONS carried out a consultation on the issue and as a result they are being included in the

CPIH measure and so represent a new part of the basket for an important new measure of UK price changes.

In other situations, the difficulty of price collection can influence which specific products are included for a category. In the toys, photographic and sports goods category, fewer price quotes have been collected for the child's swing, reflecting its decreasing presence in shops, so it has been replaced by a child's scooter, which will represent children's outdoor play equipment.

To keep the size of the basket manageable, products are removed to roughly maintain the total number of goods and services. Products with a low expenditure weight, taken to be 0.5 parts per thousand in 2016, or in areas where there is considered to be good coverage are removed. Examples include: mobile phones, which are being increasingly replaced by smartphones; and the fee for stopping a cheque, which has been removed from the basket in 2017.

7.9 The Commodity Review Process

The importance of keeping the basket up to date was explained in Sect. 7.5; this section looks at how this is achieved. Clearly, it would be a mammoth exercise to review every category of good and service every year; instead, a rolling programme of reviews is carried out by the Office for National Statistics. Most products are reviewed every few years but technological goods and services, where products tend to evolve more frequently than other areas, are reviewed more often.

The purpose of commodity reviews is to maintain a good understanding of a section of the consumer marketplace, identifying the products available, the types of retail outlets selling them and the proportions of expenditure on a more detailed classification of the products in the category.

7.10 Concluding Remarks

The basket of goods and services is a crucial part of the measurement of inflation. The updating of the basket is also vital to ensure that the measurement remains relevant as consumer preferences and the consumer marketplace change. For price statisticians, the popularity of the annual publication on how the content of the basket has changed provides an opportunity to communicate the work to produce inflation measures to a wide public audience. For social and economic historians, the changing content of the basket provides a picture of how consumer tastes and the availability of products in the marketplace have changed.

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8

Collecting Prices

8.1 Introduction

All of the price indices we discuss in this book require observations of prices at different periods of time in order to allow for construction of even the most elementary of price indices. As it is currently impossible for anyone, or any organisation, to produce a complete list of prices of items available at any given point in time (or a complete list of transaction prices), it is required that only a sample of prices is collected each period. This chapter considers how ONS goes about collecting the large number of price quotes needed in order to provide the raw material required in producing a price index such as the CPI.

Inevitably, much of the material in this chapter relies on source material from ONS, who are responsible for overseeing the collection and processing of price observations for inclusion in the final price indices. Where possible this material is related to more general material and discussed in the light of statistical considerations. A key source is Chap. 3 of the ONS technical manual (see ONS 2014b). As the methods used in the UK collection are somewhat particular to the UK market, it should

R. O'Neill et al., *Inflation*, DOI 10.1007/978-3-319-64125-6_8

not be assumed that all of the methods described in this chapter can be considered standard across countries.

One of the challenges of inflation measurement is that everyone buys a different set of products, and therefore experiences different fluctuations in prices. The task facing a statistician is to produce an aggregate measure which reflects some average of the inflation experiences of different people, and the options for a range of such averages have been explored in Chap. 4. These statistics require observations of prices as inputs, and alongside the definition of price it becomes important also to record precisely what good or service the price relates to, so that changes in prices can be separated from changes in the specification of the goods.

8.2 ONS Technical Manual

COICOP[1] (Classification of Individual Consumption by Purpose) categories are used in order to select the consumer products. Only certain items will be chosen for each category, for example loin chops with bone and shoulder with bone are taken to be indicative of the price movements for the rest of the items in the category "home-killed lamb". This is, as far as we know, an untested assertion that items within a category will tend to move together and therefore that a representative item can be chosen in order to represent the prices movements of all other items in this area. It is likely that Big Data in the form of scanner data sets, or from Web-scraped data will allow for either the validation of such claims in the near future by NSIs or that the amount of data more cheaply available may reduce the need to place such weight on a small number of representative items within a category.

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[1]See the nomenclature part of the EU Website for the COICOP classification as adapted for the HICP and for an example based on food categories. http://ec.europa.eu/eurostat/ramon/nomenclatures/index.cfm?TargetUrl=LST_NOM_DTL&StrNom=HICP_2000&StrLanguageCode=EN&IntPcKey=37592057&StrLayoutCode=EN.

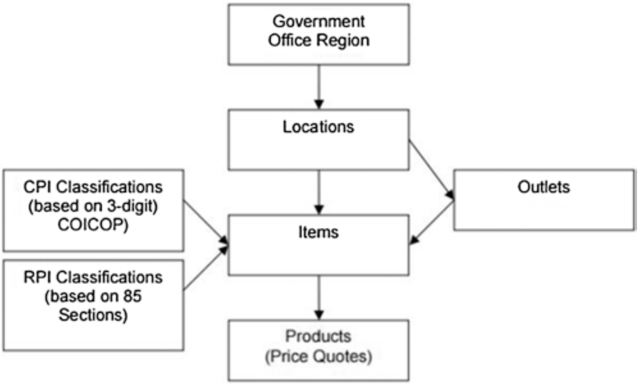

Fig. 8.1 Outline sampling scheme for CPI/RPIU local price collection. *Source* ONS CPI Technical Manual (2014b)

Usually, the descriptions of items given to price collectors are more detailed, for example according to the CPI Technical Manual (2014b) they will commonly include information on pack sizes where multiple sizes are known to be available. Despite this level of detail, it will still be incumbent on the price collectors to be able to exercise judgement in defining what is and isn't a representative item.

Prices are sampled in each stratum of the price index. For locally collected items, an individual stratum will relate to a given shop type, in a given location in a given region. Indices are then first constructed using elementary aggregate formula (see Chap. 11), and the individual indices are then weighted together using the weights discussed in Chap. 9 (Fig. 8.1).

8.3 Historical Methods of Price Collection

Prior to 1995 price collection for the purposes of producing UK price indices was carried out by the staff of the Unemployment Benefit Offices, (CPI Technical manual 2014b, p. 21). As The Independent (1994) reported, vast numbers of prices were still collected via this method with 150,000 price quotes from 180 areas of the country. This system was not as formal as might be thought required for such an important statistic and so collections were made separately by Government Office Region. Spreading the collection in such a fashion allowed greater confidence that price quotes would be collected from across the country.

8.4 Current Price Sampling Procedures

The current sample design for local price collection in the CPI has four stages (see Box 8.1). The first stage consists of selecting *locations*, which are shopping centres of sufficient size to contain many outlets (for a description of how locations are defined and aligned with boundaries see ONS 2014b). The number of locations depends on the number of centres from which they are grown—1200 in Great Britain. The outlets in a location need to cover the range of representative items in the basket so that the full range of quotes can be collected in a single location. So any locations with fewer than 250 outlets are excluded (since it is not generally possible to collect all the required prices in such a small location). In some cases, a city centre and an out-of-town shopping area are paired to form a location to ensure that the full range of products can be covered, since out-of-town shopping centres frequently do not include food outlets from which the full range of items can be priced. The locations are constructed from information on retail outlets and number of employees from the Inter-Departmental Business Register (IDBR), which ultimately derives much of its local unit (outlet) detail from the Business Register & Employment Survey. If you imagine a landscape where the height of the land is proportional to a combination of the number of outlets and employment for a geographic location, then by flooding the whole area and then controlling the draining of the water, the emergent high ground will form the locations.

Box 8.1 Summary of the UK sample design for local price collection

The local price collection follows a complex sample design with five phases.

Stage I: Select clusters (locations)

Locations are areas of retail activity, derived from seed points which represent centres of high activity, and 'grown' at a rate proportional to retail activity until they meet the boundary of a neighbouring region (with some additional constraints to stop them becoming too large). Locations are stratified by region to ensure that price information is obtained from all regions. Some of the locations are selected randomly with probability proportional to retail activity (as measured by number of employees in the retail sector). The largest locations are included with certainty.

Stage II: Select outlets

Within the selected locations, outlets are *listed*—a process where each retail outlet is visited; its activity and whether it is a single outlet or part of a chain (a *multiple*) noted and its floorspace estimated (floorspace is categorised by product if it is a department store selling many products). Listing starts at the centre of the area and excludes outlets which belong to stores from which prices are collected centrally. Only the first 1500 outlets are listed. Once the list has been produced, outlets are selected from it within commodity groups (though an outlet may be in more than one group—so stratification is by outlet $\times$ commodity group), with probability proportional to size where there is large variation, or by simple random sampling otherwise.

Stage III: Select representative items

A limited range of items can be priced, so it is necessary to select a sample of the types of products available. This is a purposive procedure, excluding the commodities with the lowest overall purchases by value, and influenced by the more commonly purchased items (both elements as derived from the Living Costs and Food Survey). This procedure defines the basket for the price indices, which is described in more detail in Chap. 7.

Stage IV: Select products to price

When a price collector visits an outlet they must choose a product to price, and this process is generally purposive; the collector making a choice after consulting with the store manager about which products which fall within the representative item description sell most.

Stage V: Select times to gather price information

Once the products to be priced are defined, the final step is in choosing on which days to obtain prices. For most products, this reflects the practice for the Retail Prices Index where there is a defined collection day, usually the second Tuesday of a calendar month, but adjusted if this falls near a public holiday. For some prices (particularly food), this is supplemented by further collections on a different day to give a wider temporal coverage.

The ONS Technical Manual (ONS 2014b) provides more detail on the methods used in order to construct the definition of regions; however, it is notable that this was a significant piece of statistical work in itself, requiring the purchase of a commercial database of shopping locations as well as the use of geographical information software in order to fully refine the map of locations until all were contiguous. It was also then important to make sure that the boundaries of these locations were usable, for example being bounded by roads.

The ONS approach is not the only method of detailing where locations are for the purposes of sampling. The office of the Deputy Prime Minister (2005)[2] proposed to use Valuation Office Agency data in conjunction with employment data in order to define town centres, along with buffer zones. Though this approach seems to have been more focused on the needs of planning, ONS (2014b) notes that this did change some of the centres of some of the locations. Although the major retailing centres of the country have a probability to be sampled in proportion to the importance of their retailing activity, it is necessary to consider how such locations might change over time as shopping habits change and as new retail centres become available, particularly as out of town retail locations are developed around supermarkets. Such developments require those responsible for collecting item prices to update the locations periodically, and to ensure that the sample of locations remains representative of the shopping habits of the population at large.

The number of locations to be sampled in each region is proportional to the number of employees in retail activity in each region. Locations are selected using probability proportional to size (pps) sampling. The largest locations are always included, because they exceed the threshold at which pps sampling means that they are always selected. Locations with fewer than 250 shops are assigned a probability of zero. Some locations are also merged to make locations large enough to cover the full basket of goods. This might require the pairing of out of town locations with other locations to ensure food is available or combining locations based on previous price collection experiences (ONS 2014b).

[2]Office of the Deputy Prime Minister Technical Report; using town centre statistics to indicate the broad location of retail development—initial analysis, London: ODPM, 2005, p. 11.

8.5 Collecting from Multiple Shop Types

The collection of prices can be carried out via a number of methods. The majority of this chapter is concerned with the local collection, which occurs when price collectors visit retail locations and collect prices directly. This is not the only method of price collection as some prices are collected via telephone, for example prices of services such as child minding. Others are collected via returns sent to the ONS by companies involved in the provision of certain goods and services; this is known as central collection and is typically used for large retailers. This allows time to be saved in obtaining multiple prices quotes from large retailers with multiple locations around the country. Other prices, for example those of television licences are collected from other sources. Still, other prices are collected from the Internet as prices become available from more locations. The diverse range of collection methods reflects the diversity of the goods and services included in the basket and it is important for those collecting the prices that they can get price observations in a timely and cost-effective manner.

8.6 Recording Discounts

Some items are easily priced, for example the price charged for a bag of sugar or loaf of bread in a supermarket will generally be the same regardless of the customer. However, it is possible to think of pricing strategies employed by retailers which make the collection of prices more difficult. In some cases, such problems can be overcome by better specification of items. For example cinema tickets are priced according to the time of performance and age and educational status of the person buying the ticket, so an adult full-price ticket for an evening show is a better specification of the item to be priced and removes some of the ambiguity.

The general rule for recording prices on which discounts are offered is established in ILO et al. (2004, paragraph 6.81), which says that the discounted price should only be recorded if it is generally available.

Hence prices which are dependent on loyalty to a particular store, or discount coupons, should be disregarded.

Prices recorded by the ONS are generally taken to be that for a cash transaction, and all prices are based on transactions that could actually take place, so that they do not rely on list prices which may not actually be charged to consumers. Discounts are not normally included in these prices; there are several specific criteria for pricing with discounts:

- discounts for cash sales are included (since the cash basis is the standard).
- discounts which are available indiscriminately to all customers are included (for example if there is 10% off for sales over £100, and the item costs more than £100, the discount is included in the price).
- discounts available selectively are excluded. So discounts for pensioners on certain days of the week are excluded, and discounts for multiple purchases are excluded (as they are not available to consumers making single purchases).
- the quality of discounted goods should not be different. So ex-display models, goods near their sell-by date and so on are not included in price collection. There is no guarantee that goods of comparable quality would be available each period for pricing, and indeed, the volumes of such discounted goods are likely to be quite low in many circumstances.
- in some specific cases, discounted and non-discounted prices are collected. For example, for gas and electricity, dual fuel discounts and discounts for direct debit payment are collected and factored into the calculation of the relevant indices.

ILO et al. (2004) have much more detailed guidance about what should and should not be included in a price, for example whether or not service charges should be included in a reported price.

The ONS price collectors use a number of codes as part of their collection of prices to record information about individual price quotes which may be relevant to subsequent analysis of the data. This includes codes which record when items are on sale or have recently been taken off sale. The use of hand-held devices helps collectors in tracking the status of such prices on a month to month basis.

8.7 Hedonic Regression

In some cases item specifications can change quickly, for example a PC or laptop. This makes it difficult to price a consistent item each month. In cases such as these, it is possible to use price and characteristics information about the products that are available to estimate the price adjusted for the quality change. The regression model estimated is

$$log(price_i) = \beta_0 + \beta_1 X_1 + \cdots + \beta_p X_p + \in_i$$

where the p independent variables which the log price is regressed on are characteristics of the item being priced (for example processor speed, or presence of a built-in camera). The slope parameters, therefore, represent percentage changes in the price of the item for that specific characteristic, with all other parameters being held constant. The regression model is fitted anew each month using the price and attribute information, and to estimate the changing effect on different characteristics on the price. The percentage change in the price estimated from the model between the replacement item and the original item is then used to adjust the base price, and using the adjusted base price in the index calculation adjusts the price index for the change in quality.

The above is an interesting use of regression techniques for improving the imputation of prices in the index, and it has been extended to items which have a significant number of technical characteristics, including digital cameras and mobile phones (and it is also used in house prices, see Chap. 14). However, such a regression model might not be useful for items such as clothing where unobservable variables such as fashionability will have a significant impact on pricing and so the fitted values from a linear regression may not be of as much use. Despite this, there has been some significant work on the use of these “hedonic” regressions in the sphere of pricing and further examples, including an example data set can be found in ILO et al. (2004).

8.8 Index Day—When to Collect Prices

As well as the questions of what prices to collect and where to collect them from, there is a need for those constructing a price index to decide when the price observations will be collected. There are a number of options. If only one price for an item is to be collected in a given month, then it seems logical that collections are equally spaced. This gave rise to the practice of the ONS selecting an "index day" during a given month—usually the second Tuesday of the month, but in some cases adjusted to the third Tuesday where it would fall close to a bank holiday, which might lead to some unusual changes in prices (ONS 2014b). This might be more accurately labelled as "price collection day" as this is the day on which the local collection of prices takes place and the majority of the work done by price collectors is conducted; the index is then calculated subsequently. Although the choice of index day is important, ONS (2014b) acknowledges that some of the price collection takes place on the days either side of the index day as well on the day itself due to practical considerations. Fresh fruit and vegetable prices are always collected on index day itself.

The international guidance on the collection of prices (ILO et al. 2004, paragraph 6.15) recommends that for a point to point estimate of inflation, which is what the CPI measure constructs, it is important to try to keep the gap between the points at which prices are collected constant. As a result, they note that keeping a fixed number of weeks between collections is often optimal, especially as the number of days in given months is not constant. By adopting the current cycle of price collections, the ONS conforms with this guidance for its price collections.

One could question whether the collection of prices on a single day within a given month is an optimal practice. If the price of an item is fairly volatile, changing several times within a month, in both an upward and downward direction, then a single-time point observation of the price may not be reasonable. In the ILO guidance on the issue in (see ILO et al. 2004, paragraphs 6.7–6.8), it is noted that the need for an index based on a period rather than a point approach may depend on both the nature of the economy under consideration and the use of the index. At the moment in the UK it is not anticipated that there are many goods which have prices which move so fluidly and so there seems no pressing reason to increase the number of price collection times which contribute to the construction of the CPI. The only exception to this historically has been petrol prices which are observed on more than one occasion across a month and then averaged for inclusion in the index.

The HICP (which is the CPI in the UK) is, however, intended to use price information that covers a period (and conceptually should be an average of prices over the month to which it relates)—with, according to the EU regulation on temporal coverage (Council Regulation EC 701/2006), prices representative of at least a week in the middle of the month. The RPI, however, has always used prices collected on index day, usually the second Tuesday in the month. Since in the UK the same price quotes are used for both index calculations, this creates a tension.

An additional collection of prices for fresh fruits and vegetables on Friday in the same week as index day has been introduced to the price collections from 2016 and is expected to be introduced into the CPI from 2018 to bring it in line with the EU regulation on temporal coverage. A few items are collected more frequently (particularly petrol and oil, which have particularly variable prices), and some items which change infrequently are designated as 'periodical items' and only collected three or four times per year (but always in January to enable the annual chain-linking to take place with real data).

In the future, it is likely that the cost of price collection will fall as the advent of technologies such as Web scraping make the process more affordable and make it possible to collect prices from different days in the month, as trialled by the ONS as part of its Big Data project (Breton et al. 2016). This new technology brings with it new challenges, for example on websites, it is often more difficult to tell whether an item is in stock or whether there have been any quality changes to the product since the last collection. In addition, such an approach will also need to take advantage of machine learning tools to deal with issues such as the matching of prices across periods and the identification of alternative products. In essence it is important to understand that although technologies such as Web scraping are likely to be useful there is still a need to ensure that their use maintains the same level of detail and flexibility in the collection currently achieved by price collectors.

The provision of data from more than one day calls into question how a monthly index is constructed; should we be taking a price index using average prices?[3] Which sort of average is appropriate (noting the array of options discussed in Chap. 4)? Should we take an average growth rate for the price level on the days in the month? Should we retain the method of taking averages between a fixed point in the month? Such questions might seem trivial in the push to move Official Statistics towards the use of more Big Data sources, however, if the integrity of the resulting statistics is to be maintained then such issues will require methodological consideration, as well as consultation across countries in order to ensure a consistent approach is applied.

ILO et al. (2004, paragraph 6.12) indicate that some items do not require a price collection during each month under which the price index is being constructed. This is because it is expected that some items will not change in price very frequently. Such items include government tariffs, travel charges and entry to football matches. ONS (2014b) reflects this by saying that the frequency of centrally collected prices is lower than the local collection, for example with football admission prices being collected only annually.

8.9 Sampling Error in Price Measurement

We have seen in Chap. 6 that one source of sampling error in the construction of price indices is the inclusion of weights based on a survey of household expenditures. The second source of sampling error can be found in the methodology used to collect prices for inclusion within the index itself, or alternatively the sampling of price relatives from the much broader population. A large number of price quotes (around 180,000 per month) is collected for construction of CPI and RPI, but

[3] And given the issues raised elsewhere in this book we might ask which sort of average is appropriate.

this still represents a tiny fraction of the prices available to consumers among the many consumer goods and services. As a result, two questions about the sampled measure of inflation remain: does the sampling of prices introduce a bias? And how efficient is the estimate—or what is its standard error?

To a large extent, the answers to the question of whether there is a bias in the collection of prices is unknown. One might think that collected prices are only of established goods—ones that have been around long enough to come to the attention of ONS and be included within an updated basket.[4] The inclusion of only somewhat established goods might therefore bias the collection of prices in some way, for example if more established goods might be expected to have slower moving prices. Part of the problem is that the movement of prices not in the basket of goods and services is much less well known than those collected. The availability of scanner data and Big Data sets of prices means that in the future it may be possible to consider the distribution of prices, and price relatives, from which a sample is selected and then assess whether the sampled items produce a biased measure of the population mean, whether that be weighted or not.

The second issue, of the sampling error, is a technically very difficult one—the standard error of a measure inflation is a standard error of a ratio of weighted combinations of random variables, with both weights and random variables with their own variances. The application of numerical methods such as bootstrapping may help in the estimation of such an error, although the development of a standardised methodology for such a calculation is some way off from being well established.

8.10 Representativeness of the Sample

The sampling of representative items is described by ONS (2014b) as purposive, as the sample of representative items is selected with the purpose of constructing the basket for the measurement of the CPI.

[4]According to http://www.unclebens.com.au/about/, Uncle Ben's released its first UK microwavable rice produced in 1999 (accessed Friday, 10th March 2016).

ONS (2014b) also describes the criteria which contribute to the selection of individual products; for example the selection of brands and goods which are expected to be widely available both geographically and through the calendar year so that a largely unbroken sequence of prices might be expected. The number of representative items in a given area of the basket is a function of the expenditure weight and the variability in the prices of items in these areas (see Chaps. 7 and 9).

Selection of individual products to price within a given location outlet is left to the judgement of the price collector[5] who is asked to choose one variety of the item which is "representative of what people buy in your area" (ONS 2014b, p. 37). This instruction leaves some room for interpretation by the price collector, though they may get help from the retailer in determining which products are representative items in the given shop.[6] In a few cases, it is possible to use a random sampling approach, and this is applied. The only alternative to this is to use the probability proportional to size approach described in ONS (2014a, b) for some goods which have technical specifications—currently washing machines, fridge freezers, audio systems and digital camcorders. This uses hedonic regression to identify characteristics which are important in determining prices. Past sales data for the individual outlet are classified by these characteristics, and a combination of characteristics is selected with probability proportional to sales. The price collector then looks for a product with these characteristics to price, in fact six selections are made in case there is no product with the chosen combination of characteristics, and the collector works down the list until they find a corresponding product to price.

In some cases the price collectors are given more guidance about which items they should be looking for. In the case of DVDs, computer games, books, CDs and music downloads, best-selling items are selected

[5]For some more information regarding the work of the price collectors, see The Guardian (2017), which includes comments on the process from one of the price collectors contributing to the ONS data collection.

[6]This may be one reason why Index Day is sometimes moved, and to avoid disrupting retailers at times at which they may be particularly busy. Illustration: Source ONS CPI Technical Manual (2014b).

from lists of popular items, for example the list of best-selling books according to the Sunday Times (ONS 2014b). The item is then priced consistently until it falls out of the list of best-selling items, at which point it is replaced with a comparable item.

Price collectors use hand-held electronic devices for collecting prices. This technology issues warnings to the collector for prices which have changed dramatically over a short period of time. The specific limits vary by item category (ONS (2014a, b, p. 34). This helps to prevent measurement error in the price quotes and helps to ensure that the data obtained from the CPI collection is of a high quality. In addition ONS carry out an audit in which some of the collected prices are checked to ensure that they are being recorded in an accurate manner.

Price collection can be challenging. It is quite straightforward to view the process of price collection in terms of going into a given shop throughout a year and looking up the pricing for the same item on each of your visits. Imagine going into a shop and checking on the price of a fairly standard product, say a chocolate bar, in January and then going back each month to check the price of the same bar of chocolate in each subsequent month. What if the weight of the bar of chocolate is increased in March, then the recipe of the chocolate is changed in April to remove nuts, and in two of the summer months the price label is on the shelf but the chocolate bar itself is not in stock. The chocolate bar is then re-released in October under a new name and with new packaging—but with the original weight and recipe and a new price. How many of the changes noted here would have to occur before you stopped being able to compare the price of the most recently observed chocolate bar with that of the original? These are some of the challenges facing price collectors, and each of these requires a detailed resolution—for example in the case of the CPI the price of the newly weighted bar of chocolate would be prorated so that a comparable size of item was being compared across the two periods.

When items are not available in a given month, a choice needs to be made regarding their use in the index. For a single month the item will be kept in the index, with the last price rolled forward, while for an item which has been missing for three months or more the guidance given to the price collector is to select a replacement item so that the index can be updated. Where the price is recorded only intermittently then there is the problem of how to allocate the change in the price of the goods over the months involved, although as such prices rarely represent large individual price movements they will not normally have a material impact on the index.

The problem of collecting prices for goods and services becomes even more difficult when we do not directly observe the price of something. The classic example of this is the cost of housing services, which are a key component of the goods and services consumed by households. It is very difficult to accurately determine the market value of such services in a way that makes sense. The RPI has used rental equivalence measures and mortgage interest payments at different periods (see Chap. 7) to approximate the price that would be paid for the housing services consumed by a household. Rental equivalence is used in CPIH, a version of CPI including costs for owner-occupied housing. This approach itself raises a number of subsequent issues, for example finding an appropriate rental price has been problematic in the UK, where the rental market is much smaller than in other countries.

8.11 Evaluation of the Sampling Design

There are several ways to interpret the sampling process for CPI. In the following, we will consider a finite population sampling approach, where the population of interest is that of all retail transactions in a particular period. There is no clear estimator to optimise (see Chap. 2 and the Index Number Problem) which complicates both design and an evaluation of it. We therefore, consider the general principles.

The selection of representative items from the available items and the selection of days from the available days in a month are both purposive sampling procedures, and both are orthogonal to the multistage sampling procedure for locations–outlets–items, in that they are sampled once and applied in each appropriate location-outlet-item combination. They could be treated as coming before, between or after the steps of the location–outlet–item sampling; here we treat representative items sampling as stage III and temporal sampling as stage V (see Box 8.1).

At the first stage of the design proper, only the defined locations are available for price sampling. In this sense, the first phase follows a cut-off design with some parts of the population of transactions never available for sampling. It is quite likely that *prices* are different in the uncovered outlets, but not so clear whether there is any effect on price *changes*, which are typically the main target of interest. The effect of this is to rely on the assumption that price change in the smaller part of retail activity which is never sampled is well approximated by the price quotes obtained from the areas which do have a chance to appear in the sample. For the purposes of comparing price levels, a similar assumption is needed, but much less likely to hold. The cost of a study on price variation would be large and there has been little formal work on the issue to date.

The locations selected at the first stage represent the prices for a region. These locations are retained for five years, and then replaced in a sample rotation. Some locations are so large (and therefore have such a large proportion of transactions) that they are always included in the sample. The rotation ensures the long-term representativity of the sample since it is gradually updated, but introduces an additional element of variability.

Only locations which have been sampled have their outlets listed. In other words, this is a type of area sampling, as there is an outlet sampling frame only for those locations which are selected in the first stage of sampling. There is an element of cut-off sampling in the selection of outlets, since the listing stops at 1500 outlets, so any further outlets will never be included in the sample. The choice of simple random sampling for outlets, unless there is large variation in selling areas by outlet, keeps the variation in sampling weights small.

The choice of representative items is purposive, and the strategy for choosing items means that they will generally be the types of items which are most frequently purchased, among the range of similar items. This will also act like a cut-off sample, with the cut-off defined by the frequency of purchases. This seems intuitively reasonable, and indeed, there is general support for cut-off approaches in de Haan et al. (1999) and Dorfman et al. (2006); however, Heravi and Morgan (2014) investigate different cut-off and pps sampling procedures using a particular dataset and suggest that the pps methods are better at recovering a population price index. Clearly more work is needed to assess the quality implications of different sampling approaches in price indices.

The selection of an item to price also has an element of cut-off sampling, since collectors are encouraged to use items with modal sales. It is likely that minority and luxury products in the same COICOP categories as more commonly bought products will never be selected. The probability sampling procedure used for washing machines etc. gives better coverage of the range of models available and therefore, gives a price index which better reflects the range of prices. The procedure is, however, costly and therefore only used for this minority of products where it makes the most difference. In principle, it could be used everywhere, but then would need a product listing (in some cases with appropriate price-determining characteristics) to work from.

The preponderance of cut-off type techniques at more detailed levels of sampling is likely to act to reduce the variance of the final index, although there is limited work on how to calculate sampling variances in price indices (which remains an open research topic). The sampling at more aggregate levels is aligned with standard probability sampling techniques and therefore more amenable to analysis. The use of probability sampling methods to define the data collection for price indices in the UK has slowly been extended since 1994 when it was introduced for locations and outlets, and it seems likely that further extensions will continue as more information becomes electronically available (see Chap. 15). In the USA, the process has already extended further to the random selection of items (BLS 2015).

The choice of a single day (or a small number of days) from the month constitutes a clustered design with each day forming a cluster and one (or a few) cluster(s) selected. In this case, we expect that transactions on days within a month are generally rather similar, so that cluster sampling here works well (between cluster variance is low, within cluster variance is high)—probably much better than in the more classical examples of clustered sampling in social surveys. The same assumption is made for prices collected less frequently than monthly—that changes based on the collected prices, based on time clustering, are a good estimator of the overall price change.

The allocation of the number of price quotes to collect in each product type is a challenging question in the Consumer Prices Index, not least because the variance calculation in a statistic which contains several layers of purposive sampling is far from straightforward. Fenwick et al. (2006) suggest that some rebalancing of the distribution of price quotes might be appropriate according to some initial analyses with quite strong assumptions.

8.12 Hyperinflation

Here, we return to the idea of hyperinflation first mentioned in Chap. 2, which refers to situations in which prices are changing very quickly, with daily price increases not being unknown in historical examples. In these cases the rate of inflation is of fundamental importance to people's lives, as well as government policy. It might be useful for us to consider how price collection would work in such an extreme set of circumstances. Such scenarios are also considered in ILO et al. (2004, paragraphs 6.24–6.25), although at a very high level.

In a country experiencing hyperinflation prices of common items would be changing rapidly and the need for reliable data would be acute. In this case, it might be advisable to recruit civil servants into the role of price collectors to get a more frequent sample of prices. As price variability is likely to increase, and with it the sampling error, it may well be that a massive increase in the volume price quotes collected is required in order for the resulting inflation statistics to maintain the same accuracy.

As the value of the currency changes rapidly it is likely that people will bulk buy non-perishable essential items whenever possible, and making it more common for price collectors to encounter empty shelves when they try to repeatedly measure the price of a single item. If the situation continues black markets in some items will also develop which will be very difficult to obtain prices from in a reliable fashion.

8.13 International Issues

The price collection in the UK is tailored to the way consumers purchase goods and services. Such methods will not always be usable elsewhere, for example in some countries, it will be standard for people to negotiate with sellers, rather than accepting a price as stated by the seller. In these cases alternative price collection methodologies are needed. For example ILO et al. (2004) describe that it may be necessary to authorise price collectors to engage in such negotiations in order to reveal the price which might be achieved by a typical consumer. In many cases this will also require that collectors actually make a purchase in order to ensure that the negotiation process is not biased by the introduction of a non-legitimate negotiation process. In other cases the day on which the price is collected may affect the price recorded, for example ILO et al. (2004, paragraph 6.14) gives the example of the occurrence of market days in Middle East countries, which can affect the prices recorded, and the possible effect of the time of day on the price (paragraph 6.33).

Economies other than the UK may also have much more seasonally variable markets and as a result the pricing of consistent items of comparable quality may not be possible. This leads to a requirement to consider a much more thorough approach to seasonal items, which are a very small factor in the UK CPI. Methods for dealing with such items are discussed in ILO (2004) Chap. 6.

8.14 Summary

The collection of prices is an important part of the construction of a price index and if it is not handled with appropriate care, it can cause the resulting statistics to be of a lower quality than is needed for making good economic decisions. The UK currently has a sophisticated system for collecting prices which has evolved over many years. However, it is clear that in the coming years, new technology will become more and more prominent in the gathering of quotes and/or transaction prices for constructing price indices. Although it is not necessary to know the details of this process in order to use index number series effectively, an appreciation of the work which goes into collecting the 180,000 price quotes needed to construct the CPI helps us to understand its properties and gives additional confidence in its reliability.

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9
Estimating Household Expenditure Shares

9.1 Introduction

Previous chapters have identified the two essential sets of data that are combined to produce a consumer price index—they are the change in prices of individual goods and services between two time periods and a measure of the proportion of household expenditure on those goods and services.

To obtain the price change component, a selection of goods and services is identified that represents the huge number of consumer goods and services that are available for consumers to buy. These are called representative items and can be visualised collectively as comprising a basket of goods and services. Locations and retail outlets are selected and prices collected for the representative goods and items from the retail outlets in the selected locations, with prices for some items collected centrally. For each item in the basket, a number of prices are collected and the change in price between the current month and the reference month (which is the January of a year) is calculated. The ratios of the current price to the reference price are called price relatives.

R. O'Neill et al., *Inflation*, DOI 10.1007/978-3-319-64125-6_9

A price index, such as the CPI, is calculated as the weighted sum of price relatives, where the weights are derived from the proportions of expenditure on the various goods and services (see Chap. 4). This ensures that in the overall measure of price change, each good or service contributes to the overall measure according to its proportion of household expenditure. An item with a large price change may contribute little if relatively little money is spent on it, while price changes for items which are associated with large proportions of household expenditure are much more influential. (For a more thorough introduction to index calculation, including the equations used, see Ralph et al. (2015, Chaps. 4 and 5)).

Chapter 7 looked at the composition of the representative basket, and Chap. 8 explored how prices are collected. This chapter looks at the remaining piece of the puzzle in terms of constructing price index numbers—the measurement of how much of overall household expenditure is associated with consumer items for each category.

Before describing the current arrangements for establishing household expenditure shares, Sect. 9.2 provides a short history of the collection of data related to household budgets. While the use of budget information for calculating changes in the general level of prices is relatively recent, starting in 1904, investigations into household budgets have taken place for many centuries. It is also notable that research into household budgets can be considered an important part of the early development of social science and in the use of random sampling for surveys.

9.2 Private and Early Official Inquiries into Household Expenditure

An important driver to understand household budgets came from the investigation into the extent of poverty among the general population. The traditional approach to this was to estimate household income and expenditure, using whatever data could be found including prices, wages and early National Accounts data (Deeming 2010, p. 768).

A small number of records of family income and expenditure exist as far back as the twelfth century, with increasing numbers available from the fifteenth century, although the extent to which such data might be considered as representative of general trends is understandably difficult to ascertain. In the medieval world, the economy was more a natural one of exchange rather than a monetary one of buying and selling, though large estates and manors kept detailed accounts of goods bought and sold and certain payments—for rent, for example (Burnett 1969, pp. 15–18).

Research into household budgets is divided into distinct phases by Deeming (2010). The earliest phase took place in the seventeenth century with the origins of social research, or "political arithmetick" as it was then known. In 1670, William Petty, an English polymath and politician, proposed that society could be studied numerically; his fascination with the importance of quantifiable phenomena was present throughout his work. In this period, hypothetical household budgets were constructed for "typical" workers. This approach led to the view that the majority of the population lived at subsistence level, if not all of the time, then for periods of time (Deeming 2010, p. 767).

In the 1690s, Gregory King used "scattered information on prices wages and patterns of consumption" to create hypothetical budgets for classes categorised by "rank and title" (Deeming 2010, p. 768). This found that about a third of the population were "paupers and cottagers"; for workmen, it was found that about half of their income would be spent on food. While these early attempts at measuring household budgets were more anecdotal than scientific, they established a direction of travel that leads to our modern, large scale enquiries into economic statistics.

The next phase of the exploration of household spending patterns took the important step of researchers contacting families and capturing income and expenditure data from them directly, based on their actual experiences. Davis and Eden both conducted such surveys at the end of the eighteenth century, their motivation being to investigate the effect of rising bread prices on rural labourers. They collected 127 and 86 household budgets respectively; Eden's study comprised 60 families of agricultural labourers and 26 urban families (Deeming 2010, p. 769). For agricultural families, he found that nearly three-quarters of income was spent on bread. Both Davis and Eden proposed that wages should be adjusted by the cost of living, although this phrase was being used very differently to the context in which it would be understood by modern economists.

Medical motivations drove further research into household budgets in the early part of the nineteenth century. These took a scientific approach with minimum dietary standards being proposed so that measured food consumption could be assessed against them. The question being investigated was whether famine conditions applied in areas of industrial England. To investigate this question, Dr Edward Smith carried out the first national household survey in the 1860s (Smith 1864). He analysed 370 family budgets and found that average food consumption was below the dietary standard of the time. This investigation of the dietary requirements of households is still carried out today as can be seen in Bernstein et al. (2010) and in the discussion of whether this makes sense to economists, as explained in Frazão et al. (2011).

At this time, other researchers were suggesting that survival required more than a subsistence diet and that adequate shelter and clothing were also needed (Deeming 2010, p. 770); this was an early insight that anticipated the modern multidimensional measures of household circumstances (Oxford Poverty and Human Development Initiative, no date). It is also interesting to note that early household budgets have been recognised as important sources of historical information and efforts are underway to collect them from a wide range of countries into a database for research (A'Hearn et al. 2016).

Towards the end of the nineteenth century, the alleviation of poverty was based on the three Victorian approaches—self-help, charity and Poor Law, though by this time, they were seen as being inadequate. Official figures for paupers suggested 2%–3% of the population was living in poverty (Pugh 2012, p. 46). The work of the social reformers Charles Booth and Seebohm Rowntree advanced the understanding of household budgets and developed the field of social science research. In two of their key works, Booth (Life and Labour of the People of London) and Rowntree (Poverty, A Study of Town Life), estimated the proportion of the population living in poverty to be closer to 30%. In the 1890s, Booth attempted to survey the entire population of London with this enquiry being described (arguably) as the first social survey. He described a "poverty line" and found 30% of households with barely adequate provision—an order of magnitude greater than the figures on pauperism. In a similar way, Rowntree's survey of poverty in York in 1901 attempted to collect data from every household. His work concluded that around 30% of families in York were living in poverty. To improve the reliability of his conclusions Rowntree included a Board of Trade national survey of wages and earnings in 1907 in his analysis.

The use of the statistical technique of random sampling was introduced into household budget surveys by Arthur Bowley.[1] Bowley was a statistician at the London School of Economics who pioneered the use of sampling in social statistics as well as being a pioneer in the production of Economic Statistics and a contributor to the debate on the economic approach to Index Numbers. He carried out a 1 in 20 sample of working-class households in 1913 in Reading. This is claimed to be the first use of probability sampling in the UK (Deeming 2010, p. 773).

At this point, the development of household budget surveys moved to the public sector with the development of official surveys carried out by the Board of Trade; these are described in detail in Chap. 5. Poverty researchers turned away from their own surveys of households and used official data, as the resources that could be directed towards studies by official organisations far exceeded those available to individuals. This was an important step in the development of modern Official Statistics. Highly motivated and insightful individuals established the value of social and economic investigation, which was then taken over by Government agencies who could apply the necessary resources to achieve the scale of work required to deliver reliable statistics. The challenge then was to understand the scale of investigation required and the best methods for achieving it; this was only gradually understood through extensive research carried out over a long period of time.

[1]For further biographical information see https://www.york.ac.uk/depts/maths/histstat/bowley_biog.htm (accessed 4 June 2017).

The modern approach to analysing poverty is to consider factors beyond income and expenditure; that is, to include a wider range of indicators or multi-dimensional measures which recognise various deprivations such as overcrowding and access to education. The indices of multiple deprivations produce relative measures on a small scale of geography and are produced separately for the countries of the UK. For example, the English version divides England into 32,844 small areas, with administrative data used to construct a composite indicator for each area. The index is used by both Government and private foundations in allocating funds (DCLG 2015).

9.3 The Development of Official Expenditure Surveys

Chapter 5 describes the development of the first official measure of the general level of prices—the cost of living index. It considers the work of the Board of Trade from the first, limited, attempts to estimate household expenditure via small-scale surveys through to the work in 1904 which established the consumption pattern which was applied in the estimation of inflation right up to the end of the Second World War. The continued use of this "standard of living", or consumption pattern, despite the change in both the availability of goods and services and consumer preferences over an extended period of time was the subject of much debate as described in Chap. 5. Eventually, a new expenditure survey was carried out in 1937/1938 but the Second World War intervened and it wasn't implemented in the calculation of the cost of living index. After the war, the need for regular updates to information regarding household expenditures across the different segments of the population was recognised and an annual household survey has been carried out since 1957.

Between 1957 and 2001, the Family Expenditure Survey and the National Food Survey provided information on household expenditure shares and food consumption. In April 2001, these surveys were combined to create the Expenditure and Food Survey (EFS) (Bulman et al. 2017). A further change was made in 2008 where selected household surveys were brought together into an Integrated Household Survey. The EFS became a module of the Integrated Household Survey and was renamed the Living Costs and Food (LCF) module. A further change was made in 2014, when the LCF left the Integrated Household Survey.

The Living Costs and Food Survey currently provides ONS with much of the data it needs in order to estimate measures of consumer price inflation and is a long way from the first scattered attempts at establishing expenditure patterns seen at the beginning of the last century.

9.4 The Uses of Household Expenditure Data

Traditionally, the main driver for running a household expenditure survey was the need to provide information on spending patterns for use in the construction of inflation measures. Today there are many uses and users for household expenditure data. The Department for Environment, Food and Rural Affairs (DEFRA) uses the LCF data on food expenditure to estimate food consumption and nutrition. The Department for Transport uses the data to monitor and forecast levels of car ownership and use and to investigate the effects of motoring taxes. Academic researchers use the data for a wide range of research studies (Bulman et al. 2017, Chap. 1).

The Office for National Statistics makes use of the data in the production a number of statistics other than inflation measures; for example, it is used in estimating the effects of government taxes and benefits on household income (ONS 2017) and in compiling estimates of household final consumption expenditure (ONS 2016). The data are also used by Eurostat, the EU's statistics agency, to make comparisons of aspects of household spending across EU countries (Eurostat no date a).

9.4.1 Family Food—From DEFRA

DEFRA publishes an annual report analysing food and drink purchases—Family Food (DEFRA 2017). It takes the food and drink data component from the LCF and produces analysis and commentary on food and drink purchases, expenditure and derived nutrient content. This analysis is used to inform Government policy and academic research.

The latest publication at the time of writing is the report for the year 2015; the high-level findings include:

- the average percentage household spend on food was 10.7%; the spend is highest for lowest income households—for the bottom quintile it was 16.0%
- on average, UK households spent 3.7% less on food in 2015 compared with 2012 in real terms
- the average calorie intake has fallen 2.9% between 2015 and 2012

The output examines dietary trends over time; in particular, for types of food that have significance for health, such as purchases of fruit and vegetables. Analysis of the data shows that fruit and vegetable purchases were 1.6% higher in 2015 than 2012.

9.4.2 Family Spending

While the DEFRA report describes trends in food spending, the Family Spending report from ONS looks at a broader range of household expenditure, including transport, clothing and footwear, education and health (Bulman 2017a). For the UK, for 2015, transport represented the area accounting for the highest percentage of expenditure at 14%, with spending on restaurants and hotels at 9% and clothing and footwear at 4%. Looking at expenditure by region, the highest expenditure was found in London and the lowest in the North East. It is notable that overall, the percentage of spending represented by food was only 11%, which is much lower than the estimates from some of the historical sources cited above. This analysis of household spending shows that consumption patterns are continuing to change in the UK.

As well as expenditure, the report considers expenditure by income category as well. The lowest decile is found to spend 16% of their income on food and non-alcoholic drink; the comparable figure for the highest decile is 8%. The Family Spending report also looks at trends in spending over time. Examples of trends include a gentle increase in spending on recreation and culture and a decline in expenditure on alcoholic drinks and tobacco.

9.4.3 Energy Expenditure

The former Department for Energy and Climate Change, now part of the Department for Business, Energy and Industrial Strategy, uses household expenditure data from the LCF to examine spending on energy across household income deciles and to compare this spending against spending on other items (DECC 2016).

9.5 The Living Costs and Food Survey

This section describes the way the LCF survey is carried out, including a brief description of the sample design, the fieldwork, the questionnaires and the statistical processing (for a more detailed description of the survey, see Bulman et al. 2017).

9.5.1 Overview

Estimates of household income and expenditure are established via a survey of households. A random sample of households is selected and approached to take part in the survey. Those that agree to participate are visited by a field worker who captures information on regular expenditure and income. The household is left with a set of diaries, in which each member of the family is asked to record their purchases for two weeks. The information captured is checked and recorded against a classification of expenditure types. The responses are then weighted so that they represent the household population of the UK, and used as the basis of estimates for a range of income and expenditure categories.

The following sections consider the stages of the survey in more detail.

9.5.2 Sampling

The LCF is a voluntary sample survey of private households. The statistical definition of a household is based on the concept of one or more people sharing accommodation which is their main residence; they do not need to be related by blood or marriage. Where an address contains more than one household, a process is applied to select one household from that address.

For Great Britain, a version of the Postcode Address File is used as the sampling frame—it contains "small user" postcodes only, excluding most institutions and commercial premises. "Small users" are defined as premises which receive fewer than fifty mail items a day. ONS maintains its own version of this file which it updates twice a year and which excludes business premises.

The LCF has a two-stage sample design within which postcode sectors are taken as the primary sampling units (PSUs). The postcode sector comprises the postcode district; that is, the portion before the "space" and the first character following the "space". In advance of a reporting year, 638 PSUs are selected using probability proportional to size sampling, stratified by Government office region, the National Statistics socio-economic classification and car ownership. Eighteen addresses are selected from each PSU to give an annual sample of 11,484 households. For 2015/2016, the response rate was 46%.

In Northern Ireland, the arrangements are different, and the sampling is carried out by the Northern Ireland Statistics and Research Agency (NISRA). A systematic random sample of one thousand addresses is drawn from the Land and Property Services Agency's property database.

9.5.3 Collection instruments

There are two parts to the collection of data for the LCF. Firstly, all members of households complete an interview in which they are asked to provide information on items of household expenditure and income. Secondly, adults (those aged 16 and over) in the household are asked to keep a diary to record all items of expenditure for two weeks; a simplified version is provided to children between the ages of seven and fifteen.

The interviewer led part of the collection procedure captures socio-demographic information about the members of household such as age, gender and marital status. Regular outgoings are captured, including mortgage or rent payments, insurance payments and utility bills together with less frequent expenditures, such as on cars and holidays. As well as capturing information on expenditure, respondents are also asked about employment and income details, receipt of benefits and allowances and other financial assets. The interviewer records the information on a laptop which runs an electronic collection instrument.

The diary is a paper booklet designed to assist the respondent to remember and record expenditure over the two-week period. It is divided into ten sections to cover different types of expenditure; the first six cover daily expenditure, repeated for each day of the 14 day collection period. The remaining four sections are for recording expenditures for the entire period. Example sections for daily recording are: "food and drink brought home" and "clothing and footwear". An example section from the four sections covering the whole period includes "holiday expenditure abroad". For some categories of goods, it is known that consumption is under-reported; this happens where consumption is perceived as negative by society; for example, for alcohol consumption or smoking. In these cases, tax data are used to adjust the reported expenditures.

9.5.4 Fieldwork

The LCF interviews are conducted face-to-face by ONS interviewers. To minimise travel costs and time, interviewers are usually assigned complete quotas of eighteen addresses. Prior to the first call at an address, the selected household is sent a letter with an explanation of the survey. In order to give a good chance of making contact with the household, interviewers are asked to make at least four calls, two of which should be in an evening.

Once a household has agreed to take part, an appointment is made with the aim of interviewing all members of the household in one visit. The diaries are left with the household and need to be commenced within two days of the visit. Over the two-week diary period, the interviewer will make at least one call to check that respondents are correctly completing the diary and to answer questions from the respondents relating to the data collection process; this usually happens within the first five days after the start of keeping the diary.

Once the two-week diary period is complete, the interviewer will make a final visit where the diary or diaries are collected. During this visit, the interviewer will check that the diary information is complete and that sufficient detail is added where it is needed. Where the information provided is complete, ONS provides a gift of money to each member of the household and each child who completes a diary successfully.

The interview length depends on the size of the household; the overall mean duration for interviews for 2015/2016 was 74 minutes. Consistency checks are applied within the electronic collection instrument; hard checks will not allow the collection to proceed until the inconsistency is resolved. Soft checks warn the interviewer that a data item is suspect, but can be overridden if the interviewer has checked with the respondent that the information is correct. The interviewer also runs checks away from the household and aims to resolve any issues during a checking call or when the diaries are collected; if they cannot be resolved, a note is added to the record.

9.5.5 Data processing

9.5.5.1 Coding

Once interviews are completed, the information from the questionnaire is transferred electronically to the coding and editing team at ONS. The paper diaries are posted back to ONS where the information is keyed into specialist software which assigns each item of expenditure to an expenditure classification code.

The use of a classification system is important and is used in several stages of the construction of modern price index numbers in order to ensure a consistency of approach. The LCF uses the Classification of Individual Consumption by Purpose, or COICOP system. This system is used internationally and allows comparison across Europe in Consumer Price Indices and National Accounts (United Nations Statistics Division, no date). The classification system has a tree like structure with twelve major categories which are successively sub-divided into more specific sub-categories. For food, the COICOP categories don't sub-divide sufficiently to meet the requirements of all of the customers of the LCF. In these cases, a further level of classification is added. The coder allocates each item captured in the diary to a specific category.

When coding expenditure items, the coder will ensure that all the necessary information is included. Households are allowed to staple supermarket receipts to the diary rather than recording each purchase individually. The descriptions of items on these receipts may not be sufficiently comprehensive to ensure they are correctly coded. In these cases, the coders will use retailers' websites to capture missing information.

9.5.5.2 Checking

Checks are made to ensure that data are consistent and modifications may be made at this point based on the available information. Similarly, missing information may be imputed from look-up information or by using average amounts from previous years. The coding process is labour intensive but highly accurate; staff ensure that the data are complete and accurate. Automatic coding systems are being studied at the time of writing though manual intervention is likely to still be needed to ensure a high level of accuracy is maintained.

9.5.5.3 Weighting

Two stages of weighting are used to reduce the effect of non-response from the original sample. Firstly, sample-based weighting is applied based on information from the Census. The Census is compulsory, so provides an almost complete record of household information. It is possible to match LCF sampled households to Census households of the same type and so establish information about non-responders in the LCF. Using Census information and statistical modelling techniques, weights can be derived to adjust for households which are under-represented in the LCF sample compared to their occurrence in the Census. Secondly, non-response weights are adjusted so that weighted totals match population totals, thus ensuring that the LCF estimates better represent the structure of the population.

9.5.6 Response

The rate of response to a survey is a key indicator or the quality of estimates produced from survey data. Social surveys are not compulsory (unlike business surveys), and there has been a long-term decline in response rates which is reflected across many countries. The response rate for the LCF in 2000/2001 was 60% but by 2015/2016 it had fallen to 46%. The non-response component includes refusals (42%) and non-contacts (7%).

Low response rates are associated with a lack of precision in the statistics produced from a given sample. There is also a possibility of bias resulting from the characteristics of non-responders differing in a systematic manner from those of responders. Adjustments to account for non-responders are made in the survey processing by means of weighting. The effect of sample size on precision is reflected in the coefficient of variation of estimates from the survey; the smaller the achieved sample size the greater the coefficient of variation.

ONS takes steps to encourage participation; these include training for interviewers to "achieve co-operation" and providing incentives for sampled households to participate. Reasons given for non-participation are recorded and analysed in order to identify more effectively any potential sources of bias. The profiles of these households are analysed and help ONS to develop strategies to improve the chances of achieving successful responses in the future.

9.5.7 Precision

The estimates derived from the LCF are based on a sample and therefore differ from values that would be calculated from a census of households. The size of the sampling error depends on the sampling design and the size of the sample. Given the relative complexity of the sample design and the weighing applied, the calculation of standard errors is complex (Bulman et al. 2017, Chap. 7).

The main LCF report contains information on components of expenditure and their precision. Table A1 of the publication lists over eight hundred expenditure components with average and total expenditure, the number of reporting households and the percentage standard error (Horsfield 2015, Table A1). An extract is given below, in Table 9.1. Note that those expenditure categories with few reporting households tend to have higher standard errors.

The reporting of standard errors is an important part of the statistical output. It provides an indication of the quality of each expenditure component, so users of expenditure data can assess their impact. An important example of this is the use of expenditure information to derive the weights used in consumer price indices. The standard errors of the expenditures result in standard errors for expenditure weights which, in turn, will result in standard errors of the consumer price index numbers over and above that relating to the fact that the prices fed into the index are also subject to a similar sampling error. It is not an easy matter to calculate the effect of sampling errors of expenditures on price index numbers; an initial study has suggested that the effects are relatively small at the aggregate level (O'Donoghue 2017).

9.6 Challenges of Capturing Expenditure and Income

Experience in running household expenditure and income surveys has identified categories where under-reporting is found consistently (Leicester 2012). For example, alcohol and tobacco expenditures are under-reported; this is apparent when survey expenditures are weighted up to the population level and the aggregates are then compared with tax and retail sales data. The potential for respondent embarrassment is believed to be one of the reasons for under-reporting for these categories. There are further difficulties in splitting out elements of combined

Table 9.1 Components of household expenditure, UK, 2014 (extract). From Horsfield (2015, Table A1)

				Average weekly expenditure all households (£)	Total weekly expenditure (£ million)	Recording house-holds in sample	Percentage standard error (full method)
Total number of households						**5130**	
Commodity or service							
1	**Food and non-alcoholic drinks**			**58.80**	**1563**	**5100**	***0.9***
1.1	Food			54.00	1436	5100	*0.9*
	1.1.1	Bread, rice and cereals		5.40	145	5000	*1.1*
		1.1.1.1	Rice	0.40	12	1380	*4.3*
		1.1.1.2	Bread	2.60	69	4810	*1.3*
		1.1.1.3	Other breads and cereals	2.40	64	4200	*1.5*
	1.1.2	Pasta products		0.40	11	2030	*2.6*
	1.1.3	Buns, cakes, biscuits etc		3.70	98	4570	*1.4*
		1.1.3.1	Buns, crispbread and biscuits	2.20	59	4240	*1.6*
		1.1.3.2	Cakes and puddings	1.50	39	3320	*2.1*
	1.1.4	Pastry (savoury)		0.80	21	1950	*2.6*
							0.0
	1.1.5	Beef (fresh, chilled or frozen)		2.00	53	2230	*2.9*

expenditure; for example, where electricity and gas are paid under a combined tariff or where television, telephone and internet access are combined into a single payment. The separation of expenditure on each component is needed, particularly when components are attributed to different COICOP categories. There are other concerns about the survey process, including diary fatigue towards the end of the two-week diary period, where households become less inclined to record every item of expenditure.

On the income part of the survey, there are concerns about under-reporting for means tested benefits, including income support, pensions and tax credits. For pension credits, comparison with administrative data from the Department of Work and Pensions shows consistently lower estimates in the survey; the reasons for this aren't clear and it is the subject of continuing research.

Comparisons can also be made between the LCF estimates and National Accounts aggregates, the latter balanced with other sources to give a consistent picture of the economy. LCF estimates are lower than those from the National Accounts though care has to be taken as the scope of the two sources isn't exactly the same—the National Accounts include expenditure from tourists and so should be different to the LCF.

9.6.1 Comparison with Other Sources

An important quality check for statistical outputs is to compare the data and the resulting statistics with other sources; this is known as coherence (Eurostat no date b). There are two types of coherence check that can be made for the information captured from the LCF, detailed data comparisons and aggregated data comparisons.

Detailed data comparison is difficult as there isn't a directly comparable source. The LCF is carried out to provide data that isn't available elsewhere; however, there is a partial means of comparison for detailed LCF data. Market research companies also capture expenditure information from households; they do this to provide information for retail businesses who are their customers. For example, they provide information on a variety of topics including market shares of supermarkets and brand performance. Kantar Worldpanel is one such organisation.[2] They maintain consumer panels that record household expenditure. The sample size they use is much larger than that used in the LCF, currently 30,000 households, though expenditures are captured for a more restricted range of goods and services, with data collection mainly focussed on food and drink items.

The households in the Kantar sample are not chosen by random sampling as in the LCF; however, Kantar captures socio-demographic data and adjusts the non-random sample to improve its representativeness. There is another important difference between the data sources, which is the technology used in the collection of data from the panels—Kantar's respondents record their purchases using handheld barcode scanners with look-up data provided by retailers to link the scanned EAN code to corresponding products. This approach is not the same as the process used in the LCF, which uses diaries maintained by respondents. Research studies have compared the estimates of expenditure from the LCF and market research sources (Leicester 2012, p. 17). These comparisons show a lower level of expenditure captured in the market research data; again the reasons for this are not clear and it is the subject of research. It would be ideal if weighting information derived from different sources gave very similar results but this is not the case. Further research may identify the sources of difference. Market research data is used in a few categories to supplement LCF and National Accounts data and may be used further in future.

9.6.2 The Johnson Review of Consumer Price Statistics

A variety of concerns about consumer price indices led to an independent review being carried out by Paul Johnson, the head of the Institute of Fiscal Studies, in 2015 (Johnson 2015). This review is described in more detail in Chap. 13. Part of the review considered the source of the weights for consumer price indices and concern was expressed that the declining sample size of the LCF was resulting in lower precision

[2] http://www.kantarworldpanel.com/en.

of expenditure weights which was being propagated into consumer prices index numbers and therefore estimates of inflation. The Johnson Review recommended that ONS investigate this question. As noted in Sect. 9.5.7, an initial study has been carried out which found that the effects were small (O'Donoghue 2017).

9.6.3 Summary of Quality Concerns

Concerns about the quality of the expenditure and income estimates provided by the LCF included the sample size and the resulting precision of the estimates, the underestimation of some elements of income and expenditure and the differences between the LCF and other sources of data. Given the importance and wide usage of the data provided by the LCF, the ONS decided that a major quality review of such statistics was required, starting in 2015.

9.7 Quality Assessment of the LCF

The importance of Official Statistics for informing policy and Government decision-making means that statistical outputs need to be of high quality. In order to achieve this, they are subject to quality reviews which assess them against defined quality criteria and produce recommendations for improvement.

9.7.1 Quality Reviews of Official Statistics

The UK Statistics Authority's Office for Statistics Regulation runs a programme[3] which assesses statistical outputs across government against the National Statistics Code of Practice (UK Statistics Authority 2009). The Code requires Official Statistics to meet the needs of users and be of sound quality. Statistics that adhere closely to the Code of Practice

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[3]UK Statistics Authority Assessment Programme, UKSA, https://www.statisticsauthority.gov.uk/monitoring-and-assessment/assessment/.

are awarded National Statistics status. The LCF was assessed against the Code in 2011 and was awarded National Statistics status (UK Statistics Authority 2011). There were a number of recommendations for improvement, including to publish more information on the limitations of the data and to provide more commentary within the Family Spending publication.

The Office for National Statistics runs its own quality reviews and they are of two types—Regular Quality Reviews and National Statistics Quality Reviews.[4] Both types of review assess statistical outputs against the European dimensions of statistical output quality (Eurostat no date b), but their approach is very different. Regular Quality Reviews (RQRs) are short, focused reviews; recommendations are made and recorded and form part of the future work plan for the output (Sanderson and Bremner 2015).

The National Statistics Quality Review process involves a much more in-depth examination of the methodology used in an output and takes about a year to complete and report. A review team is assembled which includes at least one external expert—usually an academic with an interest in a related subject field.

9.7.2 Summary of Concerns

A number of concerns led to the LCF being chosen as an output in need of a detailed methodological review in 2015. With the downward trend in response rates, commentators and users expressed concern that the quality of the data from the survey would continue to decline and the statistics derived from the LCF data would no longer be fit for purpose. A typical manifestation of the effects of declining sample sizes would be the increase in volatility of outputs, making it very difficult to distinguish between a movement resulting from a real, underlying effect and a movement due to sampling variation that is a statistical artefact of the sampling process.

[4] Quality Reviews overview, ONS, https://www.ons.gov.uk/methodology/methodologytopicsandstatistical concepts/qualityinofficialstatistics/qualityreviews.

The Johnson Review into price indices (Johnson 2015) expressed concern that consumer price index numbers derived from the LCF were becoming less reliable as a result of the falling response rate; the report therefore recommended a review of the LCF and subsequent action to be taken to halt this decline in confidence in the expenditure shares. Another of the recommendations of the Johnson Review was for ONS to continue to investigate the inflation experience of different types of household. Fulfilling this recommendation would need expenditure shares for sub-samples of the households sampled for the LCF, which would significantly increase the effect of sampling error, or would require a significant change in the sampling process used in the LCF survey.

9.7.3 A Major Review of the LCF

ONS responded to these concerns by commencing a National Statistics Quality Review of the LCF in 2015. The objectives of the review were to assess the current methods against four of the standard quality dimensions: relevance, accuracy, comparability and timeliness—identifying areas that have not kept up with international best practice and require improvement. In addition, the review looked at the potential for using alternative ways of collecting data (Ralph and Manclossi 2016).

The review examined the sample design and the precision of estimates, the collection of data and the processing stages of the survey. There was also a comparison of the methodology against international best practice and consideration of how the survey might change in future.

The review concluded that the survey required improvement to make it entirely fit for purpose. For most expenditure categories, it was still the best source of expenditure information available to the ONS. For income data, calibration controls were needed to manage volatility. There were also aspects of the collection instruments that needed improvement, particularly the diary which needed major work.

A subset of the data needed supplementing with other data sources where the expenditure and income estimates have high coefficients of variation. Market research companies are possible sources of more detailed information through their consumer panel studies as has been seen from research work with datasets from Kantar (Ralph and Manclossi 2016, pp. 80–81). For certain categories, there is known under-reporting which needed further study and the development of tools to mitigate the effects of such problems.

In all, the review report made thirty recommendations and a work plan has been published (Bulman 2017b); at the time of writing, a number of projects are in progress to address the recommendations. The process of carrying out an extensive review, supported by external experts, resulting in a number of recommendations which are then implemented will improve the quality of the survey and consequently the statistics which are derived from it.

9.8 The Future of Expenditure Measurement

The National Statistics Quality Review of the LCF also considered how production of expenditure estimates could change in future. One possibility is to use point of sale scanner datasets from large retailers such as supermarkets. These datasets are created from the scanning of product barodes at the tills—they are used by the retailer for recording the purchase and for stock control. These datasets could potentially supply highly accurate expenditure estimates for detailed expenditure categories.

At the time of writing, such data is not available from retailers in the UK, but this may change in future. Scanner data is available elsewhere; for example, Statistics New Zealand has used scanner data to measure price change for consumer electronics products for their CPI (Krsinich 2015).

9.9 Conclusions

This chapter has looked at the way household expenditure data is obtained. The long-established approach of capturing data directly from households is still the best way, though increasingly other data sources are being used to supplement the survey source. This trend is likely to continue in future as more non-survey data becomes available. Chapter 15 describes research work looking at the potential to use alternative data sources.

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10

From the RPI to the CPI: 1990–2011

This chapter continues the story of measures of inflation in the UK and covers a period of two decades which saw significant change in the use and measurement of inflation statistics. A number of these developments have had long-lasting consequences for the statistics considered in this volume. This period also includes the development of a formal inflation targeting regime in the UK, with the target specified in terms of annual changes in the Retail Prices Index. This is followed by the development of the Harmonised Index of Consumer Prices by the European Union, the UK implementation of which is the Consumer Prices Index. As our discussion moves into a new century, we will see the UK Government change its chosen target of inflation for monetary policy, as well as the index used in the uprating of certain benefits and pension arrangements. As the period covered by this chapter draws to a close we will see how differences in indices used to construct measures of inflation in the area of clothing prices led to a renewal of some arguments regarding the choice of elementary aggregates in a price index. Taken together, we will see that the developments of the twenty-year period covered by this chapter had significant impacts on the way inflation is both measured and used in the UK, and that, the issues raised in this period have continued to have ramifications for the development of price indices in the UK, as we will see when the story is continued in Chap. 13.

R. O'Neill et al., *Inflation*, DOI 10.1007/978-3-319-64125-6_10

10.1 Early 1990s–Refinement of the RPI

In the first few years of the 1990s the work on inflation measurement in the UK was aimed at the improvement of the RPI, the existing and established basis of measuring the change in the general level of prices. These refinements were discussed by the Retail Prices Index Advisory Committee.

One of the central issues discussed in the committee's report (CSO 1990) was the inclusion of holiday expenditure in the index. The committee recommended that the RPI should cover not only expenditures relating to holidays taken in the UK, but expenditure by UK citizens when on holiday abroad. This decision would create a difference in the future with the CPI, which would exclude expenditures by citizens when out of the country. The committee also considered in some detail how to record the price changes relating to holidays, noting that the price change of a beach holiday between April and June is likely to reflect significant quality differences, as well as any genuine change in prices. The solution proposed was to experiment with an index which included all of the change for a holiday in a specific month, say August, in that month, and the price of an August holiday would then be rolled forward in the index. The committee reviewed the treatment of holidays in their 1993 report (CSO 1993a), and again recommended their inclusion in line with these ideas, which were implemented in the RPI in 1993. The committee also considered how to classify and record the different elements of credit and financial services for credit cards, bank accounts and insurance, though some issues remained unresolved, such as disentangling the prices of different services.

The committee also considered longer-term issues, for example, the desirability of compiling inflation measures for different types of households was revisited, and it was felt that such analyses should be attempted on an occasional basis and in arrears. The committee felt that such information would represent "an illuminating extra dimension to the longer-term measurement of price change" (CSO (1990), para 61). The committee would no doubt be glad to see that work on producing such indices has been pushed to the fore again in recent years, as will be discussed in Chap. 15.

The final section of the committee's 1990 report is devoted to the discussion on some findings of the National Audit Office (NAO 1990) in a report on the RPI, which included discussions on the role of the committee. The RPI Advisory Committee noted that the focus of the report was the reliability of the RPI statistics and the effectiveness of the money spent on them, which was reported as being £3 million. The discussion raised several points, however the most affecting seems to have been the discussion of how prices are collected. The committee responded to criticism from the NAO regarding the continued reliance on the workforce of the Employment Service. The NAO had investigated the practices of those collecting prices and found "significant variations in local price collection practices" (NAO 1990, p. 3) which might affect the data collected. The concerns related by the NAO mentioned the high turnover of staff, lack of training, absence of checking by management and in some areas, the failure to meet the targets for price collection. One of the extensions considered by the NAO was the collection of price quotes on multiple days. The committee accepted some of the NAO criticisms, and that some outdated practices in this area had been allowed to continue for too long. They noted that the CSO had initiated its own review aimed at improving this aspect of the index and that in the future the burden for price collection might be removed from the Employment Service and be placed in the hands of a more specialist data collection body. This discussion was therefore the catalyst for the introduction of a more dedicated price collection force and the development of the modern methods of price collection described in Chap. 8. The NAO raised other issues which would be significant in the future development of the RPI, noting that there was a chance out of town retail outlets would not be included as areas covered by price collection had not been updated since the 1940s, and that there was the potential for bias in the expenditure weights used in the RPI as there was no adjustment for differential response rates between different income groups in the Family Expenditure Service.

The 1990 report of the committee is representative of the type of issues that were facing those compiling inflation measures at the beginning of the period considered by this chapter. The material discussed is of a technical nature and focuses on ways in which the existing RPI could be improved. Significantly, there is no mention of the coming changes in use for the index, or of the introduction of the CPI, which was still a few years away. The committee notes that in some areas, for example holiday prices, it was breaking new ground without an international consensus. This approach led to some developments which would mean that the RPI would not conform to international standards on price measurement in future years, but saw the development of the RPI furthered in several significant areas.

10.2 The Adoption of the RPIX as an Inflation Target

The second half of the twentieth century saw a significant rise in the prominence of monetary economics for the management of economic problems, as we discussed in Chap. 2. As part of this process, the UK adopted an inflation targeting regime as part of the government's official monetary policy in 1992, following the UK's departure from the Exchange Rate Mechanism in September 1992, which might have been viewed as an alternative form of monetary policy. As Allen (1999) notes, there are several issues which might impact on the choice of inflation target including: What price index should be targeted? What should the target rate of inflation be? And should there be a target band?

The government's choice of the target for inflation was the RPIX, rather than the RPI itself. RPIX excludes mortgage interest payments from the measure of inflation. The justification for the exclusion of this important element was that there was a link between interest rates and mortgage interest rates, and so including mortgage interest rates in the index would allow a direct effect on the target via the setting of interest rates. The inflation rate target was set at 2.5%, and no band was adopted. Haldane (2000) discusses the benefits of adopting a point target, rather than a range, one important consideration being that a definite target prevents monetary policy from being too slow to react to changes in inflation. Technically, the target was, and still is, set every year by the Chancellor of the Exchequer in the annual budget; however it has changed very rarely in the years since inflation targeting was adopted in the UK. Alongside the definition of the initial targets it was agreed that the Governor of the Bank of England would be responsible for writing to the Chancellor of the Exchequer should the measure of inflation fall outside of the range of 1.5–3.5%, with the letter containing details of the causes and potential policy responses being taken.

The UK was not the first country to adopt an inflation targeting regime to underpin monetary policy (Allen 1999; Haldane 2000). Such an approach has not been adopted by all countries either, though stabilisation of inflation has become a more common feature of monetary policy. The period of disinflation which followed the introduction of a formal inflation rate target has led some to conclude that the move was successful. However, Allen (1999) noted that the approach had yet to be tested by a prolonged period of inflationary pressures. The Bank of England Act of 1998 further formalised the role of inflation measurement in the official oversight of the economy when the Bank of England was made independent, rather than reporting directly to the Government. This did not affect the requirement for the Bank of England to manage an inflation target, but further underlined the success of the first years of inflation targeting. The terms of reference for this incarnation of the RPI Advisory Committee, which advised on the construction of inflation statistics, asked it to consider the treatment of Council Tax, which had replaced the unpopular community charge (better known as the Poll Tax), and also the treatment of owner occupiers' housing costs and motor vehicles. The committees considerations were published in a series of reports in the early 1990s.

10.3 Further Developments to the RPI

10.3.1 Council Tax

The committee recommended that Council Tax should be included in the RPI from its introduction in April 1993 (CSO 1993a, b), replacing the community charge. Council Tax was conceptually more similar to domestic rates, which had been included in the RPI along with housing costs from its earliest days, than to the community charge. But the committee was also tasked with taking account of practices elsewhere in (what was) the European Community, where there was a range of approaches in different countries. The committee found it hard to draw any general conclusions from these comparisons. The committee eventually concluded that Council Tax should be treated as an indirect tax on the occupation of property and included in the RPI, thereby maintaining both the continuity of the coverage of the index and its public acceptability.

10.3.2 Owner-occupied Housing

The Retail Prices Index Advisory Committee's deliberations on owner occupiers' housing costs (OOH) were reported in December 1994 (see CSO 1994b). Their central conclusion was that OOH should continue to be included in the RPI, though the investment portion of such dwellings should be excluded. This meeting also saw the decision to include a measure of housing depreciation, based on a house price index, introduced into the RPI. This is another example of the work of the advisory committee leading to a development which would later cause the RPI to be noticeably different to the CPI. The work of the committee was quite detailed, with the majority of members accepting that a payments approach to the issue of OOH was appropriate, and so mortgage interest payments should be included. However two minority reports are included alongside the main findings of the committee, reflecting the split of views across the committee. Despite this difference of opinion, the committee felt they could not delay or defer the inclusion of OOH costs in the RPI as the public would refuse to accept that such costs should be excluded from the all-items RPI for most of the purposes for which it was being used (see CSO 1994a, b, para 60). This is noteworthy as it is only in recent years that there have been moves to include OOH in the CPI on a consistent basis, whereas there has been little refusal of the public, and other bodies, to make use of the CPI in favour of the RPI on this basis. Another adjustment was made to the RPI methodology in December 1994. The committee considered whether it was possible for an index of car prices to be based on new car prices rather than used car prices. The results of work in conjunction with the University of Cardiff were considered, with the introduction of hedonic methods being discussed. The conclusion of the committee was that insufficient data was available for a reliable index to be constructed from new car prices for inclusion in the RPI. New car prices were soon to be included in an index utilised in the construction of the CPI however, so perhaps, the committee's recommendation was not borne out in this case.

10.4 The Initiation of the Harmonised Index of Consumer Prices

The European Union had from the beginning espoused "the process of creating an ever closer union among the peoples of Europe", and as it became more influential there was a need for increased harmonisation and comparability between the statistics reported by the countries taking part in the institution. One important area in which there was a need for harmonised statistics was in measuring the economy, and inflation was one such statistic which required a harmonised approach. One of the main drivers was the development towards European Monetary Union, which progressed in three phases. The central phase, from 1 January 1994 to 1 January 1999, aimed at gradual converge of economies, including a targeted reduction of inflation. In order to measure this consistently, a harmonised measure was needed. A common approach to inflation measurement would allow for improved comparisons of price changes, otherwise the methodological choices made by member states could affect the inflation numbers they reported to the European Union; at the same time, a composite measure across the EU would make little sense if the estimates of inflation for the constituent countries were not compiled on a common basis.

In order to ensure a common approach to the measurement of price changes, a shared approach to inflation measurement was agreed upon, with the resulting index being named the Harmonised Index of Consumer Prices (HICP). The specification of measurement of the HICP was originally formalised in a European Council Regulation (European Council 1995). In this regulation, it was stated that the overall aim of the regulation was "to establish the statistical basis for arriving at the calculation of comparable indices of consumer prices at Community level". As a result of the regulation member states were required to compile the HICP on a monthly basis from January 1997, with an experimental series pre-dating this, based on common approaches to price collection and the methodology of the index. The Regulation formally excluded owner-occupied housing as well as health and educational services from the new index, which immediately made it clear that the new index would differ from the RPI. Importantly, the HICP would be compiled under a common approach, including the choice of elementary aggregate formula—the approach to be used at the lowest level of the index when no weighting information is available (elementary aggregates options are discussed in more detail in Chap. 11). Around this time, the Boskin commission (see Chap. 11) was preparing a report which would make the Jevons the clear choice of elementary aggregate for the index of consumer prices in the USA. This may have helped finalise the decision of the EU, which required the use of the Jevons or Dutot formulae at the lowest level of the HICP. The specification of the formulae to be used is made in European Commission (1996) and is worded as follows (information in brackets added by authors): "*HICPs shall be compiled using either of the two formulae (Dutot or Jevons) given in paragraph 1 of Annex II to this Regulation or an alternative comparable formula which does not result in an index which differs systematically from an index compiled by either of the given formulae by more than one tenth of one percentage point on average over one year against the previous year*".

This regulation therefore meant that a member state could not use another formula, for example the Carli as used in many areas of the RPI, unless it could be shown to have made only an immaterial difference. In addition Annex II of European Commission (1996) stated explicitly that the Carli should not normally be used and should not be used when the index is chained more frequently than annually.

The reasoning for the choice of the Jevons over the Carli is unclear, however it became the EU's agreed approach. Most countries calculated the new HICP in addition to their national measure. In some cases the national measure already used the approved formulae, in other cases countries changed their price indices (over time) in order to bring their national measures in line with the new regulation. The UK decided to continue to produce the RPI using the Carli index as before and to produce the HICP for the purposes of fulfilling the requirements of reporting to the EU. On the face of it, the changes made to fulfil the requirements of the HICP would seem to have little impact on the inflation statistics of the UK; however, over the next few years, the new approach would have a significant impact as the HICP became used more widely in the UK.

The differences between the HICP/CPI and the RPI were not limited to the elementary aggregate formulae. The main differences can be summarised as falling into three categories: population, coverage and construction.

We have seen in previous chapters that the RPI excludes the income of people at the top and bottom ends of the income distribution for the purposes of expenditure weighting, and as we saw in Sect. 9.2, following the decision taken by the advisory committee also included expenditure by these households outside of the UK. In contrast, the CPI takes as its population coverage all expenditure by private households occurring within the UK (but not abroad), which includes the highest and lowest earning households, as well as the spending of foreign nationals on visits to the UK. These population differences are reflected in differences in weights for the various categories of expenditure, and the population target for the two indices is never fully aligned.

One of the differences between the RPI and CPI which can produce significant disparities in the rate of inflation calculated from them is the inclusion of mortgage interest payments in the RPI, but not in the CPI. This was obvious during 2009 as the rate of change in the RPI became negative, while CPI inflation remained above 1%. A major part of this change was due to changes in mortgage interest payments caused by rapid decreases in interest rates as a response to the growing global financial crisis. There are other differences in the items covered by the two indices, with some items being in scope for the CPI but not the RPI (stockbroker fees, foreign students tuition fees and university accommodation fees) and some which are in the RPI and not in the CPI (road fund licences, trade union subscriptions, house purchase fees and housing depreciation). In addition, some items, such as insurance, may be included within different sections of the indices, as the classification of spending does not entirely align, for example insurance is included in its own section of the CPI but is included in the associated area of consumption in the RPI, for example car insurance is included with other spending on automobiles.

The differences in the construction of the RPI and CPI, resulting from their differing circumstances of inception, meant that after 1996, the UK had two measures which, to those not fully engaged in the study of Index Numbers, apparently sought to measure the same thing and produced different estimates. While one of these measures was kept in the background, this was unlikely to be an issue, however, as the CPI became more prominent, more people became interested in the difference between the two indices.

10.5 Changing the Target for Inflation from the RPI to CPI

In December 2003, the National Statistician (Len Cook) made the announcement that the Harmonised Index of Consumer Prices would be renamed as the Consumer Prices Index (CPI) ONS (2003). This rebranding of an index which had originally only been compiled in order to satisfy an EU regulation was in response to the news that in his pre-budget report of December 2003 HM Treasury (2003b) (paragraph 1.9), then Chancellor of the Exchequer Gordon Brown had confirmed (following an initial announcement on 9 June 2003) that the UK inflation target would switch to the HICP, with the new target rate of inflation being set at an annual rate of 2%. The report explained that the differences in the inflation rate targets for the RPIX and CPI of 0.5% was due to the differences in the way the two indices were calculated at the time (see paragraph 1.9 of HM Treasury (2003a)), although unsurprisingly no further technical information was given directly in the pre-budget report regarding such differences, which would at least have partly been the result of the use of different elementary aggregate formulae in the two indices.

The pre-budget report did make a further comment on the differences between the two inflation targets which would cause significant confusion in the following years. The introduction to Chap. 2 of HM Treasury (2003b) states the following: *The advantages of CPI as a measure of inflation for monetary policy purposes are set out in a paper published by the ONS today. The CPI is a better measure of inflation for the purposes of setting monetary policy, as it has a more realistic characterisation of consumer behaviour, a wider population coverage, is the most comparable measure of inflation internationally and represents international best practice.* From the purposes of public interpretation of the decision, the appeal to the idea that the CPI was based on a more realistic characterisation of consumer behaviour was particularly problematic. This was based on an article produced by the ONS; however, much of the evidence can be traced back to the limited textbook example that a Jevons index could be a precise cost of living index measure for a certain version of the Cobb-Douglas utility function used to train students of economics.

In making the argument for the change of target, HM Treasury (2003b) makes reference to ONS (2003), which provides more detailed background to the decision on the part of the statistical institute regarding the decision to change the name of the CPI and the focus of the official inflation target. It is clear from ONS (2003) that there is little desire to develop the CPI as a distinct entity from the HICP, and the change of name is intended only to underline the new importance of the measure in the framework of UK economic statistics. On consumer behaviour, ONS (2003) seems somewhat confused with a statement that a cost of living index would be lower than a fixed basket index and implies that the reduced rate of inflation often associated with the CPI approach to measurement might seem better as it would be closer to a cost of living index. ONS (2003) does confidently claim that the Jevons allows for the effects of substitution behaviour to be incorporated in the CPI, while not being included in the RPIX, or the RPI. The basis for such a statement would seem to be a numerical example based on the example using the Cobb-Douglas preferences in the example mentioned above; however, when moving outside of this very specific example, there is no guarantee that the Jevons index will be a more accurate measure of a cost of living index than some other common elementary aggregates.

ONS (2003) is confusing for those following the arguments around price indices for a number of reasons. Firstly, it seems unsure regarding the target for the index, and throughout, much of the discussion of the change of target seems to implicitly prefer a cost of living index target, rather than a cost of goods target, something which was never the official target of either the RPI or CPI. Secondly, economic evidence regarding substitution is very limited and is not challenged in a particularly rigorous manner. While some of the issues surrounding substitution are relevant to the economic approach to index numbers (see Chap. 12), they do not seem to have been placed in the wider context of the development of the CPI or the RPI in the UK. Such conclusions were also expressed in an annex to the remit letter sent from HM Treasury to the Bank of England's Monetary Policy Committee (HM Treasury 2003c), and from this point on it seems to have become accepted wisdom that the Jevons elementary aggregate was superior to the Carli at least in part due to the supposed ability of the formula to account for substitution behaviour. This claim regarding substitution behaviour would not be categorically rejected until the consultation surrounding the improvement of the RPI in 2012, when ONS would perform further research in this area (see Chap. 13).

There were other good reasons to adopt the HICP approach for the inflation target. It would bring the UK measure in line with international best practice, and issues surrounding the concern of chain drift in the index would be alleviated (HM Treasury 2003b; ONS 2003), and one might question whether the appeal to the argument surrounding substitution was even needed. There is no doubt that such arguments had become popular in the wake of Boskin et al. (1996a, b); however, it was not necessarily needed for the Chancellor of the Exchequer to make a reasoned argument for changing the inflation target.

At the time of the transition, it might have seemed that the changing of the inflation target was a relatively minor technical point which was mainly the concern of professional macroeconomists, many of whom were not particularly concerned about the decision to use the CPI rather than the RPIX. Indeed, there was no obvious appetite to curtail the use of the RPI, and it was still used to index UK Gilts, and so, there was little direct practical implication for many citizens. The importance of this change was, however, to bring the CPI into greater use as the official measure of inflation for the UK. Once this was established it was logical that other areas which used indices for uprating would begin to make use of the CPI rather than the RPI. However, the existence of two officially produced measures of inflation sowed the seed of potential disagreement, especially as one commonly produced a higher rate of inflation than the other. Anyone collecting money with payments indexed by inflation would be sure to prefer the use of the RPI to reflect changes in the purchasing power of money, while those on the other side of the transaction would prefer the CPI as their payments would increase at a slower rate. The conflict this caused meant that each method would have its own advocates and created an issue which it would be difficult for the ONS to disentangle.

10.6 Increased Use of the CPI

The change in the inflation target from the RPIX to the CPI did not in itself cause much controversy. The change affected only the working of the monetary policy system, and the overall aims of the system had not been altered in any significant way by the adoption of the new target. The change would have little direct impact on the lives of most citizens.

The change in the target was important though as it was the first time that the CPI was used ahead of the RPI, or its derivative indices. This was part of a growing suggestion that the new index might be in some way preferable, or superior, to the measure which had been in use in the UK as a measure of inflation for over 50 years. Following the adoption of the CPI as the official rate of inflation for the operation of monetary policy, it made sense for the government and associated bodies to make wider use of the CPI in place of the RPI.

The most controversial adoption of the CPI for a practical purpose was the announcement in the 2010 budget (HM Treasury 2010) that from 2011 state pensions, housing benefits and tax allowances would be uprated using the CPI, where previously, the RPI or its derivatives had been used. HM Treasury (2010, para 1.106) makes two arguments for the adoption of this new measure; firstly that as CPI excludes the costs of home ownership, it is more relevant to low-income families, who are less likely to own their home, and pensioners who are more likely to own their home outright. Secondly, the assertion that CPI better represents consumer behaviour than alternative measures is invoked, which relies on the arguments made in Sect. 10.5. The same paragraph of the budget states that the use of the same index for use in the uprating of taxes and duties is being considered, while protecting revenues.

The new uses of the CPI were immediately controversial as they would directly impact the future financial positions of most households in the UK. The most obvious criticism came from pensioners, who saw that their future incomes would be reduced by smaller increases to offset inflation; however most taxpayers were affected as the amount they could earn before paying tax would subsequently increase at a slower rate than under the RPI. In some quarters, the government's change to using CPI for these measures may be interpreted as opportunistic. By switching to the use of CPI for uprating the categories of items mentioned above, while maintaining RPI in the uprating of money being collected, the government was able to effectively use the difference between the CPI and RPI to help reduce the shortfall between revenues and spending in the UK which had led to the government inheriting a large fiscal deficit. The UK economy was also in the early stages of recovering from a financial crisis and faced external pressure to manage its finances. In the light of these considerations, the use of the CPI in the way proposed in HMT (2010) seems driven in some part by a desire to better manage the UK's fiscal policy using differentials in inflation rates produced by two different indices. In this way, the CPI became more than just a guide to monetary policy in the UK by becoming an active part of the fiscal policy of government.

If one believes that the CPI is a better measure of inflation than the RPI, then there is nothing controversial in the wider use of the statistic to represent inflation, whether in fiscal or monetary policy. Indeed, if one holds this view the concern might be that the use of the CPI has not yet become wide enough to supplant the RPI. Others may have genuinely believed the RPI was a better basis on which to measure inflation, and we will return to these arguments below.

10.7 Consultations: 2009–2011

Consulting users regarding changes that would affect the statistics that they use is an important part of the Code of Practice for Official Statistics, introduced in 2009, which built on a previous code; it is described in Protocol 1: User Engagement (UK Statistics Authority 2009, p. 13).

The first four consultations in this period were set up to consider important issues, but were not on the scale of the two that would follow in 2012 as described in Chap. 13.

10.7.1 Mortgage Interest in the RPI

In 2009, ONS proposed a revision to the way in which mortgage interest was calculated for inclusion in the RPI. Previously, the mortgage interest rate was calculated from the standard variable rate (SVR); however, more mortgages were being taken up as fixed rate, discounted or tracker mortgages, and the proposal from ONS was to include these products into an overall, weighted mortgage rate—the average effective rate (AER). The new methodology was developed jointly by ONS and the Bank of England. The effect of the change in methodology was calculated for the time period 2005–2009 inclusive; this showed that using the AER led to the RPI 12-month growth being an average of 0.1% higher than when estimated using the standard variable rate. The index using the AER wasn't always higher than the using the SVR—it was higher up to December 2007 but lower after that date, which may have resulted from the conditions in mortgage markets around the financial crisis. The proposal was discussed at the September 2009 meeting of the Consumer Prices Advisory Committee (CPAC) and was agreed—this went forward as a recommendation to the UK Statistics Authority (Berger 2009a).

The proposed change was subject to a public consultation; it opened on 30 November 2009 and closed on 22 January 2010. The consultation document asked whether the proposed change in methodology provided a better measure of the expenditure on mortgage interest by households and whether the change should be made alongside the next basket update in March 2010. As with other changes to the RPI, the change would not be made retrospective; the data series with the new method would be linked onto the existing data series, which illustrates the fact that although it provides a long time series, the RPI has accommodated changes in methodology.

The response to the consultation was published in February 2010 (ONS 2009a). There were sixteen responses to the consultation and seven requests for further information which the ONS responded to. The responses to the consultation were mostly positive and agreed that the proposed changes would lead to a better overall measure of interest payments. However, there were concerns about the timing of the change given the economic situation and the resulting unusually low interest rates. ONS replied that the general approach was to implement methodological improvements as quickly as possible. This was the shared opinion of ONS, CPAC and the Bank of England.

The response document also explained that ONS had also consulted the Bank of England about the proposed change, as it was obliged to do under section 21 of the Statistics and Registration Service Act. Changes to the RPI have the potential to impact on holders of index-linked gilts, and if they are considered "material", they would require the consent of the Chancellor of the Exchequer. A change which was considered detrimental to gilt holders could result in triggering the redemption clause in index-linked gilts. In this case, the Bank of England judged that the proposed change wasn't "material" under the terms of the Act. The UK Statistics Authority decided to proceed with the change which was implemented in the February index which appeared on 23 March 2010.

10.7.2 Redesign of the Consumer Prices Statistical Bulletin (2010)

In the first of two further public consultations carried out in 2010, ONS consulted on the redesign of the Consumer Price Indices Statistical Bulletin (ONS 2010c). It was proposed that the bulletin should concentrate on one main measure of inflation—the CPI—with the RPI presented later. Additional briefing was added on the one-month change and how it related to the 12-month change. There was also a clearer reconciliation between the CPI and the RPI. Consultation feedback from users was generally positive and the new design, introduced in July 2010, was retained. Users proposed further changes and most were accepted and incorporated in the October bulletin.

10.7.3 Seasonal Prices (2010)

The second consultation in 2010 was driven by new European regulation which required changes to the method used to measure seasonal items in the CPI (ONS 2010g).

The method would move from the "carrying the index forward" approach to an improved imputation-based method. In the old method, used for both the RPI and CPI, the price index calculated carried forward the old prices for goods which were not available due to their seasonal nature until they were next available. The new method interpolated the change between these points and avoided the sudden one-off impact on the index caused by seasonal goods.

While adhering to the European Regulation was only compulsory for the CPI, it was proposed that the improved method for seasonal items should be carried over to the RPI. A public consultation was carried out between October and December 2010. The Bank of England carried out an assessment of the effect of the change. It was decided that the change didn't represent a fundamental change to the RPI, and it could therefore go ahead without reference to the Chancellor of the Exchequer.

The change was implemented in the construction of the January 2011 CPI and RPI, which appeared in the February 2011 bulletin.

10.7.4 Improving the Measurement of Car Prices

During 2011, the Consumer Prices Advisory Committee considered the approaches taken in the RPI and CPI to measure new car prices and made recommendations for improvements (ONS 2011b). The existing methodology differed between the RPI and the CPI. In the RPI, price movements for used cars were taken as a proxy for new cars; this approach had been recommended by the RPI Advisory Committee in their 1994 report and arose because new cars were considered to be of less importance to index households than used cars. In the CPI, list prices of new cars without discounts were used.

Neither of these methods was considered to be appropriate to the current circumstances. Analysis to examine the movements in prices of new and used cars found that they were significantly different over a number of years. Also, the use of list prices didn't include discounts and therefore didn't reflect the prices consumers actually paid; this had the potential to introduce bias into the index. ONS investigated a range of options for resolution of the issue, and the best approach was found to be collection from car dealer Websites—the prices were stable and included discounts and so better reflected the actual prices paid by consumers.

10.8 Conclusions

The period 1990–2011 saw some significant changes in the way in which inflation was measured and used in the UK. The seeds of these changes were sown with the introduction of a new measure, the CPI, which would eventually compete with and then surpass the RPI as the official measure of inflation in the UK. A number of important decisions were made regarding inflation measurement in this period. The adoption of an inflation targeting regime raised the profile of inflation measures in economic policy. At the same time, the RPI was developed in a number of important ways, which would turn out to be different from the EU's standard HICP approach, including incorporating better measures of OOH. Taken together, this twenty-year period contains the most drastic changes to UK inflation measurement since the inception of such indices, and, as we will see in Chap. 13, it has created issues which are still under consideration today. The new system also caused the UK to become more concerned with an issue resulting from the new regime, the formula effect, which does not occur in other countries as they do not have measures of inflation based on different elementary aggregates.

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11
Measuring Inflation at a Detailed Level

11.1 The Absence of Weights

As we have seen in other chapters in this book, the construction of a price index for measuring inflation is a complex business, however, at the lowest level of most price indices, it is reduced to a more simple problem: how to measure the average price change when we are faced with only price information? In this chapter, the main methods for doing this are re-introduced and the relationships between them are considered before we discuss the various ways in which people choose between the available methods.

11.2 Elementary Aggregate Formulae

We refer to elementary aggregates in this chapter as a description of a level of a price index for which no quantity information is available. We introduced many of the formulae we will use here in Chap. 4, but place much more focus on their role in the construction of inflation measures here. In the CPI, the lowest level of a price index could see

R. O'Neill et al., *Inflation*, DOI 10.1007/978-3-319-64125-6_11

a product stratified by item, region and shop type, so the elementary aggregate strata may be something such as: "Own brand white envelopes: Watford, multiple store" (ONS 2014). Within this category, we would have a range of price observations for goods which, hopefully, should be interchangeable, or more formally which consumers are indifferent to when forced to choose between them. It is arguable whether even such a tight definition of products as this gives a homogeneous category of products, however in the absence of weighting information it is difficult to go further.

It is possible to conceive of data which would allow us to break down our index further; in our envelope example this might include further defining categories by size of envelope. In order for these sub strata to be useful we would need information on their relative importance, i.e. expenditure information for the different sizes of envelope. While this may be obtainable, the cost and inconvenience of compiling this information at regular intervals is likely to be burdensome to those collecting the data as well as those reporting it. As a result, elementary aggregates are used at a level of an index at which everyone is relatively happy about the homogeneity of the goods. An elementary aggregate which included motor cars, paperback books and envelopes would be too diverse—we would want to take account of the relative size of expenditure on items as varied as these.

At the elementary aggregate stage of compiling a price index, statisticians are faced with the task of compiling an index of the level of prices without quantity or expenditure information. The Laspeyres, Paasche, Fisher, Törnqvist, etc. indices are now beyond the reach of the index compiler as they do not have the required weighting data. This might seem like an easier job, however, as these elementary aggregate formulae are the building blocks of the higher level index, we need to make sure that the choice made at the lowest level of the index does not negatively affect the measure when aggregated to a higher level.

11.2.1 The Carli Index

Count Giovanni Rinaldo Carli (sometimes Carli-Rubbi) (1720–1795) was a respected economist, serving Leopold of Tuscany in several roles, being appointed as head of the council of public economy and of the board of public instruction in 1765, see Chisholm (1911) for further detail. The year prior to this appointment he had published a paper which included a proposition for a price index (Carli 1764)[1] which is the arithmetic mean of relative prices between two-time periods. This simple measure has since become known as the Carli index and formally is:

$$I_{Carli}^{0t} = \frac{1}{N}\sum_{i=1}^{N}\frac{P_{it}}{P_{i0}}$$

This index is a clear and easily understood average of the individual price relatives; however, it is far from the only option available and has some troubling properties. The Carli index does not fulfil the time (or base) reversal test, first considered in Fisher (1922). This requires that an index number of the price change between times 0 and t should be the reciprocal of that between t and 0, i.e.

$$I_{Carli}^{0t} \neq \frac{1}{I_{Carli}^{t0}}$$

Fisher (1922) argues that there are two reasons that indices should have this property: (1) because there is no reason to construct the index in a single direction, for which the index should not be applied in the opposite direction and (2) because this rule must work for individual items. He concludes that for an index to make sense, if prices double between 2010 and 2015 then they must halve if we reverse time and look from 2015 to 2010. In a geographical setting removing the natural inclination to think of time moving in one direction, Fisher (1922) notes that if bread is twice as expensive in New York as it is in Philadelphia, and the opposite is true for butter, then a bread and butter index which compares Philadelphia with New York as the

[1]We are indebted to the work of Diewert and Nakamura (1993) in providing historical references for the discussion of the early pioneers of index numbers.

base using a Carli formula will give us a value of $\frac{1}{2}(2 + 0.5) = 1.25$. If we then switch the base to Philadelphia the index number is $\frac{1}{2}(0.5 + 2) = 1.25$ using the Carli index. This leads us to the odd conclusion that Philadelphia is 25% more expensive than New York, but New York can be shown by the same formula to be 25% more expensive than Philadelphia! This property of the Carli index has been important in recent discussions on choice of elementary aggregates.

11.2.2 The Jevons Index

John Maynard Keynes (1936) remarked that economist William Stanley Jevons (1835–1882) had made as much progress in the topic of Index Numbers in his 1863 pamphlet on the fall in the value of gold as all succeeding authors had jointly. Jevons (1863) was expressly concerned with determining whether, and by how much, the value of gold had fallen in response to the discovery of relatively large deposits in America and Australia. His discussion begins with an explanation of how we might deduce that the value of gold had fallen if what could be bought with that gold bought today was less than it had bought in the past. Substituting gold with money makes this section of the pamphlet a direct discussion on the potential for currencies to see their purchasing power diminished. In his consideration of how to use prices to ascertain the fall in the value of gold, Jevons states that the average of price ratios used must be geometric rather than arithmetic, giving:

$$I_{Jevons}^{0t} = \left(\prod_{i=1}^{N} \frac{P_{it}}{P_{i0}} \right)^{(1/N)}$$

Jevons (1863) motivates his choice using an example similar to Fisher's—if the price of cocoa has doubled and the price of cloves has halved the arithmetic mean, or Carli index,gives a value of 1.25. Jevons rejects this as logically inconsistent with the evidence in the prices—if one has been doubled and the other halved then there has been "no alteration of price whatever".

11.2.3 The Dutot Index

Nicolas Dutot was a French economist concerned with several issues including monetary neutrality, who Velde (2009) credits with the first unweighted price index in Dutot (1738), building on the work of Bishop Fleetwood, whose work Dutot had purchased. Velde notes that Bishop Fleetwood had not gone so far as to combine various measures of price change into an aggregate measure, while Dutot did. Balk (2008) agrees that Dutot had constructed the first price index by taking the ratio of the averages of the prices as;

$$I_{Dutot}^{0t} \frac{\frac{1}{n}\sum_{i=1}^{n} P_{it}}{\frac{1}{n}\sum_{i=1}^{n} P_{i0}}$$

11.2.4 Which Elementary Aggregates are Used in the UK?

Price indices in the UK make use of all three of the elementary aggregate indices discussed above. In the CPI, 63% of lowest level indices use the Jevons and 5% using the Dutot, the remainder is compiled using weights and are so not elementary aggregates (ONS 2012). The RPI makes use of the Carli for 27% of items and the Dutot for 29%. Hence the main difference between the two indices comes from the differential use of the Carli and Jevons indices, which creates a difference which has come to be known as the formula effect.

The elementary aggregates in the CPI and RPI are constructed at a level where there is no weighting information and goods are relatively homogeneous. Elementary aggregates may also be compiled for separate shop types and separate regions; weighting information is available when aggregating these lower level indices.

11.3 Relationship Between Elementary Aggregate Formulae

Knowing something about the relationships between the indices will be important for deciding which of the indices we prefer. We begin by considering some well-known properties of the indices and then test them using some real-world data.

First, note that the Jevons index must be less than or equal to the Carli index. The Jevons index is given by

$$I^{0t}_{Jevons} = \left(\prod_{i=1}^{N} \frac{P_{it}}{P_{i0}} \right)^{1/N}$$

so in taking the natural logarithm

$$log(I^{0t}_{Jevons}) = \frac{1}{N} \left(\sum_{i=1}^{N} log\left(\frac{P_{it}}{P_{i0}} \right) \right).$$

and that the logarithm of the Carli index is

$$log(I^{0t}_{Carli}) = log\left(\frac{1}{N} \sum_{i=1}^{N} \frac{P_{it}}{P_{i0}} \right)$$

Noting that the natural logarithm is a strictly concave function, the finite form of Jensen's inequality[2] implies that

$$\log\left(\frac{1}{N} \sum_{i=1}^{N} \frac{P_{it}}{P_{i0}} \right) \geq \frac{1}{N} \left(\sum_{i=1}^{N} \log\left(\frac{P_{it}}{P_{i0}} \right) \right)$$

[2]For a strictly concave function $f(\cdot)$ then $f\left(\frac{\sum_i w_i x_i}{\sum_i w_i}\right) \geq \frac{\sum_{i=1} w_i f(x_i)}{\sum_i w_i}$ and the inequality is reversed where $f(\cdot)$ is a convex function.

with the equality holding only when all price relatives are the same number, the one case in which an index number is unnecessary to summarise the change in the price level.

11.3.1 Taylor Series Approximation

The work of Dalén (1992) and Diewert (1995) shows how Taylor series approximations can be used to formalise the relationships between elementary price indices. In this section we review some of the key results from this area of the literature, while in the next section we will test their validity for a small applied data set. Almost all of the theory in this section comes directly from Diewert (1995) and Dalén (1992).

11.3.1.1 Jevons compared with the Carli

We can rewrite any price relative $R_{it} = \frac{P_{it}}{P_{i0}}$ as the product of the arithmetic mean of price relatives (or the Carli index) and a factor which scales the mean to a given price relative so that $R_{it} = \bar{R}_t(1 + e_{it})$ where $\bar{R}_t = \frac{1}{n}\sum_{i=1}^{n} R_{it}$ and by definition $\sum_{i=1}^{n} e_{it} = 0$. We can then rewrite the Jevons index so that:

$$I_{Jevons}^{0t} = \left(\prod_{i=1}^{n} R_{it}\right)^{\frac{1}{n}}$$

We can then take a second order multivariate Taylor series expansion of this equation around the vector point with all price relatives set equal to some real number A, that is, $A\mathbf{1}_n = \mathbf{A}$ where $\mathbf{1}_n$ is an n dimensional column vector in which every element is set equal to 1. The distance between the price relatives and the value around which we expand the Jevons formula is $\mathbf{R} - \mathbf{A}$.

The second order Taylor series expansion of the Jevons formula is:

$$I^{0t}_{Jevons} \simeq A + (\mathbf{R}-\mathbf{A})^T \begin{bmatrix} \frac{1}{n}A^{-1}A \\ \vdots \\ \frac{1}{n}A^{-1}A \end{bmatrix} +$$

$$(\mathbf{R}-\mathbf{A})^T \begin{bmatrix} \frac{1}{n}\left(\frac{1}{n}-1\right)A^{-2}A & \frac{1}{n^2}A^{-2}A & \dots & \frac{1}{n^2}A^{-2}A \\ \frac{1}{n^2}A^{-2}A & \frac{1}{n}\left(\frac{1}{n}-1\right)A^{-2}A & \dots & \frac{1}{n^2}A^{-2}A \\ \vdots & & \ddots & \vdots \\ \frac{1}{n^2}A^{-2}A & \frac{1}{n^2}A^{-2}A & \dots & \frac{1}{n}\left(\frac{1}{n}-1\right)A^{-2}A \end{bmatrix} (\mathbf{R}-\mathbf{A})$$

as when we evaluate a Jevons index in which every price relative is equal to A, the overall index must also take on the value A, regardless of whether or not we are using the Carli of Jevons index. The additional vector and matrix in this first stage of the expansion are the values of first and second derivatives around the vector we use for expansion.

The above expression can be manipulated as follows:

$$I^{0t}_{Jevons} \simeq A + \frac{1}{n}\sum_{i=1}^{n}(R_{it}-A) + \frac{1}{2An}\left[\frac{1}{n}\sum_{i=1}^{n}\sum_{j=1}^{n}(R_{it}-a)(R_{jt}-A) - \sum_{i=1}^{n}(R_{it}-A)^2\right]$$

$$= A + \frac{1}{n}\sum_{i=1}^{n}R_{it} - \frac{nA}{n} + \frac{1}{2An}\left[\left(\sum_{i=1}^{n}R_{it} - nA\right)^2 - \sum_{i=1}^{n}(R_{it}-A)^2\right]$$

$$= I^{0t}_{Carli} + \frac{1}{2An}\left[\frac{1}{n}\left(\sum_{i=1}^{n}R_{it}\right)^2 + nA^2 - 2A\sum_{i=1}^{n}R_{it} - \sum_{i=1}^{n}R_{it}^2 - nA^2 + 2A\sum_{i=1}^{n}R_{it}\right]$$

$$= I^{0t}_{Carli} + \frac{1}{2An}\left[\frac{1}{n}\left(\sum_{i=1}^{n}R_{it}\right)^2 - \sum_{i=1}^{n}R_{it}^2\right]$$

$$= I_{Carli}^{0t} + \frac{1}{2A}\left[\frac{1}{n^2}\left(\sum_{i=1}^{n} R_{it}\right)^2 - \frac{1}{n}\sum_{i=1}^{n} R_{it}^2\right]$$

$$= I_{Carli}^{0t} - \frac{1}{2A}\sigma_R^2$$

where $\sigma_R^2 = \frac{1}{n}\sum_{i=1}^{n} R_{it}^2 - \frac{1}{n^2}\left(\sum_{i=1}^{n} R_{it}\right)^2$ is the variance of the price relatives. Dalén (1992) presents a special case of this in which $\bar{R} = 1$ is chosen as the point for the expansion, although this may not be an optimal value for any particular data. We can rewrite this statement and replace the A with the Carli index, or the arithmetic mean of the price relatives at time t, so that:

$$I_{Jevons}^{0t} \approx I_{Carli}^{0t} - \frac{\sigma_R^2}{2\bar{I}_{Carli}^{0t}}$$

Diewert (1995) shows that we can make an equivalent argument in terms of the errors. Firstly, the Jevons index is further reorganised so that

$$I_{Jevons}^{0t} = \left(\prod_{i=1}^{n} \bar{R}_t(1 + e_{it})\right)^{\frac{1}{n}} = \bar{R}_t\left(\prod_{i=1}^{n}(1 + e_{it})\right)^{\frac{1}{n}}$$

Diewert then takes a Taylor Series Expansion of $\left(\prod_{i=1}^{n}(1 + e_{it})\right)^{\frac{1}{n}}$ around the point at which $e_{it} = 0 \ \forall i, t$, which is shown to be

$$\left(\prod_{i=1}^{n}(1 + e_{it})\right)^{\frac{1}{n}} \approx 1 - \frac{1}{n}\sum_{i=1}^{n} e_{it} = 1 - \frac{1}{2}\sigma_{e_t}$$

where $\sigma_{e_t} = \frac{1}{n}\sum_{i=1}^{n} e_{it}$ leading to an alternative statement of the Jevons index

$$I_{Jevons}^{0t} \approx \bar{R}\left(1 - \frac{\sigma_{e_t}}{2}\right)$$

It can be shown by simple rearrangement that $\bar{R}(1 - \frac{\sigma_{e_t}}{2}) = I_{Carli}^{0t} - \frac{1}{2\bar{I}_{Carli}^{0t}}\sigma_R^2$ so that the result of Dalén (1992) is equivalent to the result of Diewert (1995). The interesting thing about the approximations above is that they imply that the difference between the Jevons and the Carli indices is driven entirely by the variance of the price relatives. If we have two sets of price relatives with the same mean the difference between the Jevons and Carli indices should be greatest for the set of price relatives with the largest variance. Further, we expect this difference to be a linear function of the variance. Therefore one possible interpretation of an increased formula effect is an increase in the variance of the price relatives.

11.3.1.2 Jevons Compared with the Dutot

We next turn our attention to a comparison of the Jevons formula with the Dutot formula. We begin by noting that it is possible to write a Jevons index as a function of the Dutot index for a set of prices recorded over two periods.

$$I_{Jevons}^{0t} = \left(\prod_{i=1}^{n} R_{it}\right)^{\frac{1}{n}} = \left(\prod_{i=1}^{n} \frac{P_{it}}{P_{i0}}\right)^{\frac{1}{n}} \tag{11.1}$$

$$= \left(\prod_{i=1}^{n} \frac{\bar{P}_t(1+e_{it})}{\bar{P}_0(1+e_{i0})}\right)^{\frac{1}{n}} = \frac{\bar{P}_t}{\bar{P}_0}\left(\prod_{i=1}^{n} \frac{1+e_{it}}{1+e_{i0}}\right)^{\frac{1}{n}} \tag{11.2}$$

$$= I_{Dutot}^{it}\left(\prod_{i=1}^{n} \frac{1+e_{it}}{1+e_{i0}}\right)^{\frac{1}{n}} \tag{11.3}$$

We can then focus on approximating the function of the mean deviations which we can rewrite for the ease of exposition as:

$$f(\mathbf{e}_0, \mathbf{e}_t) = \left(\prod_{i=1}^{n} 1 + e_{it}\right)^{\frac{1}{n}} \left(\prod_{i=1}^{n} 1 + e_{i0}\right)^{-\frac{1}{n}}$$

where $\mathbf{e}_t = [e_{1t}, \ldots, e_{nt}]^T$ is a vector of the disturbances in period t. We can now take a second order Taylor series expansion around the point $\mathbf{e}_t = \mathbf{e}_0 = A\mathbf{1}_n$, i.e. we expand around two vectors of constants A. Note that $f(A\mathbf{1}_n, A\mathbf{1}_n) = 1$.

The first derivatives of the function to be expanded with respect to the deviation terms are:

$$\frac{\delta f}{\delta e_{i0}} = -\frac{1}{n}(1 + e_{io})^{-1} f(\mathbf{e}_0, \mathbf{e}_t) \tag{11.4}$$

$$\frac{\delta f}{\delta e_{it}} = \frac{1}{n}(1 + e_{it})^{-1} f(\mathbf{e}_0, \mathbf{e}_t) \tag{11.5}$$

Hence if we set $e_{it} = A \forall i, t$ then

$$\frac{\delta f(A\mathbf{1}_n, A\mathbf{1}_n)}{\delta e_{i0}} = \frac{-1}{n}(1 + A)^{-1} \tag{11.6}$$

$$\frac{\delta f(A\mathbf{1}_n, A\mathbf{1}_n)}{\delta e_{it}} = \frac{1}{n}(1 + A)^{-1} \tag{11.7}$$

The Taylor series expansion around A then includes the terms

$$\sum_{i=1}^{n}(e_{i0} - A)\frac{\delta f(A\mathbf{1}_n, A\mathbf{1}_n)}{\delta e_{i0}} + \sum_{j=1}^{n}(e_{jt} - A)\frac{\delta f(A\mathbf{1}_n, A\mathbf{1}_n)}{\delta e_{jt}}$$

which we can show to be equal to:

$$\frac{1}{n(1+A)}\sum_{i=1}^{n}(e_{it}-A+A-e_{i0}) = \frac{1}{n(1+A)}\left(\sum_{i=1}^{n}e_{it}-\sum_{j=1}^{n}e_{i0}\right)=0$$

Where the last part of the above makes use of the fact that by definition $\sum_{i=1}^{n} e_{it} = 0\forall t$ so that the sum of the two terms in brackets equals 0.

For the final part of the second order expansion, we need a matrix of second derivatives, Σ, where the ij^{th} element is the derivative with respect to first the j^{th} element, and secondly the j^{th} element of the vector $(\mathbf{e}_0, \mathbf{e}_t)'$. Such a matrix where $n = 3$ is:

$$\Sigma = \frac{1}{n^2(1+A)^2}\begin{bmatrix} 1+n & 1 & 1 & -1 & -1 & -1 \\ 1 & 1+n & 1 & -1 & -1 & -1 \\ 1 & 1 & 1+n & -1 & -1 & -1 \\ -1 & -1 & -1 & 1-n & 1 & 1 \\ -1 & -1 & -1 & 1 & 1-n & 1 \\ -1 & -1 & -1 & 1 & 1 & 1-n \end{bmatrix}$$

From this we can see that:

$$(\mathbf{e}_0,\mathbf{e}_t)'\Sigma(\mathbf{e}_0,\mathbf{e}_t) = \frac{1}{n^2(1+A)^2}\sum_{i=1}^{n}(ne_{io}-nA)(e_{io}-A)+\sum_{j=1}^{n}(nA-ne_{it})(e_{it}-A)$$

$$= \frac{1}{n^2(1+A)^2}(n^2A^2-n^2A^2+n\sum_{i=1}^{n}e_{io}^2-n\sum_{i=1}^{n}e_{it}^2)$$

Hence by combining these elements of the expansion we see that

$$f(\mathbf{e}_0,\mathbf{e}_t) \cong 1+\frac{1}{(1+A)^2}\left(\frac{1}{n}\sum_{i=1}^{n}e_{io}^2-\frac{1}{n}\sum_{i=1}^{n}e_{it}^2\right) = 1+\frac{1}{(1+A)^2}(\sigma_{\mathbf{e}_0}^2-\sigma_{\mathbf{e}_t}^2)$$

Where $\sigma_{\mathbf{e}_t}^2$ is the variance of the deviations contained in the vector $\mathbf{e}_t$. As a result of this and returning to the original definition then:

$$I_{Jevons}^{0t} \cong I_{Dutot}^{0t}(1 + \frac{1}{(1+A)^2}(\sigma_{\mathbf{e}_0}^2 - \sigma_{\mathbf{e}_t}^2))$$

When $A = 0$ then this reduces to

$$I_{Jevons}^{0t} \cong I_{Dutot}^{0t}(1 + (\sigma_{\mathbf{e}_0}^2 - \sigma_{\mathbf{e}_t}^2))$$

Which is the result as stated in ILO et al. (2004). This shows that these two indices are related and will only differ to the extent that the variances of the error terms from the arithmetic mean are different between periods 0 and t. This would only be important if the distribution of prices around the mean had changed significantly between the two time periods.

11.3.1.3 Carli Compared with the Dutot

We can use the same approach to compare the differences between the Dutot and Carli indices and begin by noting that:

$$I_{Carli}^{0t} = \frac{1}{n}\sum_{i=1}^{n}\frac{\bar{P}_t(1+e_{it})}{\bar{P}_0(1+e_{i0})} = \frac{1}{n}\frac{\bar{P}_t}{\bar{P}_0}\sum_{i=1}^{n}\frac{(1+e_{it})}{(1+e_{i0})}$$

$$= I_{Dutot}^{0t}\frac{1}{n}\sum_{i=1}^{n}\frac{(1+e_{it})}{(1+e_{i0})}$$

and by definition $\sum_{i=1}^{n} e_{it} = 0$ for any t. We can therefore expand the function $\sum_{i=1}^{n}\frac{(1+e_{it})}{(1+e_{i0})}$ around the point where $e_{it} = A\forall t$ to give us an approximate relationship between the Carli and Dutot indices.

We begin by noting that if we define:

$$f(\mathbf{e}_0, \mathbf{e}_t) = \sum_{i=1}^{n}\frac{(1+e_{it})}{(1+e_{i0})}$$

at the point of expansion, we obtain:

$$f(A\mathbf{1}_n, A\mathbf{1}_n) = \sum_{i=1}^{N} \frac{(1+A)}{(1+A)} = \sum_{i=1}^{n} 1 = n$$

We then need the derivatives of the function with respect to each e_{it} and therefore note the following general results for the two time periods:

$$\frac{\delta f}{\delta e_{io}} = -\frac{(1+e_{it})}{(1+e_{i0})^2}$$

$$\frac{\delta f}{\delta e_{it}} = \frac{1}{(1+e_{i0})}$$

Hence at the expansion point

$$\frac{\delta f(A\mathbf{1}_n, A\mathbf{1}_n)}{\delta e_{io}} = -\frac{(1+A)}{(1+A)^2} = -\frac{1}{(1+A)}$$

$$\frac{\delta f(A\mathbf{1}_n, A\mathbf{1}_n)}{\delta e_{it}} = \frac{1}{(1+A)}$$

Hence we can see that using the vectors $\mathbf{e}_0 - A\mathbf{1}_n$ and $\mathbf{e}_t - A\mathbf{1}_n$ cross multiplied with the vectors of first derivatives we obtain the following:

$$\frac{-1}{(1+A)}(\mathbf{e}_0 - A\mathbf{1}_n)'\mathbf{1}_n + \frac{1}{(1+A)}(\mathbf{e}_t - A\mathbf{1}_n)'\mathbf{1}_n$$

$$= \sum_{i=1}^{n}\left(\frac{A}{1+A} - \frac{e_{i0}}{1+A}\right) + \sum_{i=1}^{n}\left(\frac{e_{it}}{1+A} - \frac{A}{1+A}\right)$$

$$= \sum_{i=1}^{n} \frac{A}{1+A} - \sum_{i=1}^{n} \frac{A}{1+A} + \frac{A}{1+A} \sum_{i=1}^{n} e_{it} - \frac{A}{1+A} \sum_{i=1}^{n} e_{i0} = 0$$

The next stage is to take the second derivatives with respect to each of the error terms which give the following:

$$\frac{\delta^2 f}{\delta e_{io}^2} = \frac{2(1+e_{it})}{(1+e_{i0})^3} \tag{11.8}$$

$$\frac{\delta^2 f}{\delta e_{it} \delta e_{i0}} = \frac{\delta^2 f}{\delta e_{i0} \delta e_{it}} = -\frac{1}{(1+e_{i0})^2} \tag{11.9}$$

With all of other second derivatives being zero. Around the expansion point, we therefore have:

$$\frac{\delta^2 f(A\mathbf{1}_n, A\mathbf{1}_n)}{\delta e_{io}^2} = \frac{2}{(1+A)^2} \tag{11.10}$$

$$\frac{\delta^2 f(A\mathbf{1}_n, A\mathbf{1}_n)}{\delta e_{it} \delta e_{i0}} = \frac{\delta^2 f(A\mathbf{1}_n, A\mathbf{1}_n)}{\delta e_{i0} \delta e_{it}} = \frac{-1}{(1+A)^2} \tag{11.11}$$

This then means that the matrix of second derivatives can be summarised as follows for the case with three products:

$$\Sigma = \frac{1}{(1+A)^2} \begin{bmatrix} 2 & 0 & 0 & -1 & 0 & 0 \\ 0 & 2 & 0 & 0 & -1 & 0 \\ 0 & 0 & 2 & 0 & 0 & -1 \\ -1 & 0 & 0 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 & 0 & 0 \\ 0 & 0 & -1 & 0 & 0 & 0 \end{bmatrix}$$

Therefore we can define the final part of our expansion as:

$$\frac{1}{2}(\mathbf{e}_0 - A\mathbf{1}_n, \mathbf{e}_t - A\mathbf{1}_n)'\Sigma(\mathbf{e}_0 - A\mathbf{1}_n, \mathbf{e}_t - A\mathbf{1}_n)$$

Which can be rearranged to give:

$$\frac{1}{1+A^2}\left(\sum_{i=1}^{n} e_{i0}^2 - \sum_{i=1}^{n} e_{it}e_{i0} - \frac{A^2}{2}\right)$$

Taking all this information together then we can see that:

$$f(\mathbf{e}_0, \mathbf{e}_t) \cong n + \frac{1}{1+A^2}\left(\sum_{i=1}^{n} e_{i0}^2 - \sum_{i=1}^{n} e_{it}e_{i0} - \frac{A^2}{2}\right)$$

Which means that:

$$I_{Carli}^{0t} = I_{Dutot}^{0t}\frac{1}{n}\sum_{i=1}^{n}\frac{(1+e_{it})}{(1+e_{i0})} \cong I_{Dutot}^{0t}\frac{1}{n}\left(n + \frac{1}{1+A^2}\left(\sum_{i=1}^{n} e_{i0}^2 - \sum_{i=1}^{n} e_{it}e_{i0} - \frac{A^2}{2}\right)\right)$$

which can be simplified to be a function of $\sigma_{\mathbf{e}_0}^2$, the variance of the period 0 deviations and $\sigma_{\mathbf{e}_0,\mathbf{e}_t}$, the covariance of the two vectors of deviations as follows:

$$I_{Carli}^{0t} \cong I_{Dutot}^{0t}\left(1 + \frac{1}{1+A^2}\left(\sigma_{\mathbf{e}_0}^2 - \sigma_{\mathbf{e}_0,\mathbf{e}_t} - \frac{A^2}{2n}\right)\right)$$

If we further assume that $A = 0$ then this reduces to:

$$I_{Carli}^{0t} \cong I_{Dutot}^{0t}(1 + \sigma_{\mathbf{e}_0}^2 - \sigma_{\mathbf{e}_0,\mathbf{e}_t})$$

And we can see that the relationship between the Carli and Dutot varies based on the variance of the price relatives in the base period and the strength of the relationship between the relatives in the two time periods. In summary in this section, we have seen that the difference between the Jevons and Carli indices is driven by the variance of price relatives across the two time periods under construction. The difference between the Jevons and Dutot is driven by the variances of the prices in the two time periods while the difference between the Carli and Dutot is driven by the relationship between the variance of prices in the base period and the covariance between price relatives between the two periods. These results tell us something about the nature of differences we observe between elementary aggregates using a single set of data.

11.4 Which is the Best Elementary Aggregate Formula?

The question of which is the best elementary aggregate formula to be used in a given price index is an important one. These low-level indices form the building blocks of all higher level measures of price change, and an error at this level is likely to propagate through the index. The choice of a given unweighted index formula to use at the lowest level of the index is has a bearing on a range of other questions in the construction of a price index. In this section, we discuss how choices between such indices have been made historically, and how they can help us with the choice between the unweighted formulae.

11.4.1 The Test Approach

The test approach is most commonly used in comparing Index Number formulae with each other and is commonly credited with having been introduced by Walsh (1901), but probably reached its apex in Fisher (1922), in which the approach was applied to a larger set of formulae than just the unweighted subset considered here. The test approach essentially works by defining a set of axioms, which it is fair to, or in Fisher's words sensible, to expect Index Number formulae to obey. Some properties are uncontroversial, for example a requirement that if all prices increase then the level of the resulting index should also increase. The approach becomes less clear the more the set of properties is allowed to expand and Reinsdorf and Triplett (2009) explicitly make the point that the choice of formula changes depending on the set of required properties, which is subject to personal choice rather than any scientific scheme. Reinsdorff & Triplett (2009) also note that it is common for the tests to be weighted equally, and so a winning formula is selected on the number of tests it passes from a set arbitrarily identified by the investigator.

Despite these perceived weaknesses, the test approach has endured in the study and discussion of index numbers. For example, Diewert (2012) in his recommendations to the ONS made it clear that the failure of the Carli index to fulfil the time reversal test was a critical part of the reasoning in rejecting its use for computing elementary aggregates. Such reasoning can govern the choice of elementary aggregate, and thus the final measures of inflation, although it may initially seem a small detail. There is an opportunity for further research on the relationships of the tests to other ways of constructing index numbers, for example how the economic view of index numbers (described in Chap. 12) relates to the various properties.

11.4.2 The Economic Approach

Distinct from the test approach is the economic approach, which is presented in Chap. 12. This approach uses the economic concept of utility and chooses the index number formula which will most accurately reflect the change in income needed to maintain a constant standard of living. This "cost of living" approach produces index numbers which are different to those compiled on the cost of goods approach.

The economic approach is supported by mathematical economics and provides what may feel like a more rigorous conceptual basis for a price index than the test approach. Unfortunately, it is very difficult to reliably use much of this theory in the practical construction of index numbers.

The economic approach has been used at times to justify changes in elementary aggregate preferences. We saw in Chap. 10 that in 2003 it was proposed that the Jevons index better represented substitution behaviour, which meant the Jevons was better at representing economic behaviour. While this was true in an artificial setting it was difficult to extend these findings to the real world, which means there is not much that the economic approach can reliably tell us about the choice of elementary aggregate formula.

11.4.3 The Statistical Approach

The ONS measures inflation using a sampling approach, as with many other statistics they produce. More generally in producing statistics it is typical to attempt to estimate a population value from an appropriately chosen sample. The same approach could be applied to inflation measurement. If we knew how we would combine all price and quantity information to measure inflation, if such information were available to us, we then might be able to construct a sampling and estimation methodology which would provide the best unbiased estimate of the change in price levels for the population.

This approach is most likely to appeal to those with a statistical background; however, the most important part of such a process is missing, as nobody has officially defined the population target for measurement in the case of inflation, indeed the lack of such a target is the basis of the whole "index numbers problem" (see Chap. 4). Without this, we can note that the three main elementary aggregate indices considered in this chapter may well be the best sample estimators of some population targets (see the investigation in Elliott et al. 2012), but until we decide between the various targets this is unlikely to be very useful.

11.5 Conclusion

As we will see in the chapters covering the recent history of the CPI and RPI the choice of elementary aggregate is not without controversy. It is therefore important that we understand the differences between these formulae, as well as the different ways in which people may choose between them. And in making a choice, it is important to document the approaches which have been used and their importance.

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12

What Should We Be Measuring?

We have already met much of the history of Index Numbers as it has been utilised in measuring inflation, along with a review of techniques currently used in the production of inflation figures by the ONS. In this chapter we stand back from the stream of these issues to consider what we measure when we estimate inflation and how it relates to the economic theory of what inflation is. We will firstly consider the main choice between the type of index we might ideally want to produce using the tools at our disposal, before dipping into the theoretical literature on the economic approach to inflation to see what it can tell us about constructing an index. We will then consider how these different approaches have affected the practice of compiling index numbers and consider what index numbers currently tell us about the changing cost of living and whether it is likely to change at any point in the near future.

R. O'Neill et al., *Inflation*, DOI 10.1007/978-3-319-64125-6_12

12.1 Cost of Living Vs. Cost of Goods

In Frisch's (1936) survey of the development of the theory of Index Numbers a distinction between "atomistic" and "functional" Index Numbers is made. Frisch's atomistic Index Numbers literature is concerned with price and quantity, and determining the change in the general level of prices, but importantly views prices and quantities as independently determined random variables, to be combined in some way via the technology of Index Numbers. The same paper alternatively defines a functional approach to measuring price levels, viewing price and quantity as jointly determined. In this case Index Numbers should be developed by taking account of the relations between price and quantity.

Such distinctions are common in Index Numbers and the different ways of framing the debate around how to interpret the set of Index Numbers produced by National Statistical Institutes continues to this day. In the Johnson Review, Johnson (2015) was explicitly asked in its terms of reference to consider the arguments for using a cost of goods and cost of living framework in compiling Index Numbers. It recommended that ONS should continue its work in developing a superlative index as an approximation to a cost of living index while noting that the existing indices are cost of goods measures.

Before moving forward in discussing what we should be measuring when we compile index numbers it is worthwhile to compare the two main ways of thinking about index numbers as they are used in price measurement, which correspond closely, but not exactly, to the definitions offered by Frisch (1936). It will be seen that the established indices produced by NSIs are producing cost of goods indices. Then we will investigate how the more formal concept of a cost of living index relates to this idea.

Readers with a training in Economics will be familiar with the concept of utility, which is the benefit derived by consumers from consumption of a bundle of goods and services. In this theoretical setting, it is usual to define a change in the price level as referring to the proportional change in income which is required for our consumer to experience exactly the same level of utility after the price change as before it. In more widely used language we will thus be effectively maintaining their "standard of living" at a fixed level to remove the impact of price changes. This is typically what Economists mean when they refer to a cost of living index, and they might alternatively use the term a fixed utility index.

The cost of goods index approach sets aside notions of utility in favour of asking what the change in the cost of purchasing a fixed basket of goods and services between two periods has been, an approach which should be familiar from the preceding chapters. The cost of goods idea lends itself most readily to the idea of pricing a fixed basket of goods and services, which is intuitive for many people, including many non-economists. The difference between the cost of goods and cost of living approaches to Index Numbers can be subtle at times, however they are critical in framing the way we think about measurements of inflation produced around the world.

The cost of goods index maintains the amounts of each good or service in the basket constant between the two periods under consideration when we know some of the prices of these items have changed. The cost of living index is more flexible as it allows people to alter what is in the basket, so long as their resulting standard of living remains the same, and then prices the before and after baskets under their respective price regimes. The main difference between the two approaches is then the substitution behaviour of consumers, which is allowed in the cost of living index but not in the cost of goods index framework. Substitution behaviour refers to the fact that as relative prices change so might the relative proportions in which goods are consumed. Problems can occur when people interpret a cost of goods index as a cost of living index or vice versa as the two things are rarely equivalent and our understanding of the practical differences between them is far from complete.

In the rest of this chapter, we will focus on the method of measuring inflation which is known as the cost of living index. If we were able to reliably measure the change in income needed to maintain a fixed level of utility this would have significant implications for government policy regarding welfare concerns. We progress with a discussion of how this measure might be defined, how the concept has been developed and how it has impacted on practical approaches to inflation measurement.

12.2 What Is a Cost of Living Index?

In some news reports which summarise movements in the CPI in the UK it is not unusual to see inflation referred to as the change in the cost of living.[1] This is despite the fact that the ONS has stated previously that the CPI is a cost of goods index and the CPI technical manual states that current measures of consumer price inflation are "not intended to measure what people often refer to as the 'cost of living'", (ONS 2014, p. 106). Similarly, the Cost of Living Advisory Committee recommended the removal of the term "cost of living index" in 1946. to avoid any such confusion. Clearly, the phrase "cost of living index" has had a long-term association with inflation and at times this association has been controversial, mainly as a result of the fact that an index which measures the true cost of living has been formally defined by Economists for quite a long time.

Staehle (1935) neatly summarises the main problem addressed by cost of living indices as the process of "determining money incomes which yield equivalent satisfaction in one or more situations". This remains a concise statement of the problem faced by economists today, although they are far more likely to use the word utility in place of satisfaction. For those who have never studied microeconomics before some of the terminology around the cost of living index, or constant utility index may be confusing. However it is important to note that where we talk about a cost of living index in this book we are strictly referring to an index which measures the price change of obtaining a fixed level of utility.

We begin by considering an individual for whom we can observe prices, quantities and their overall utility level, which we assume conforms to the usual assumptions made by economists and is represented by an indifference surface, connecting all bundles of goods which yield

[1] See for example http://www.bbc.co.uk/news/10612209 and http://www.theguardian.com/business/2015/aug/18/uk-inflation-increase-interest-rates-bank-of-england, accessed 19/10/2015. These examples are by no means more egregious than others and it is always a good idea to keep an eye out for allusions to the cost of living when reading news stories about inflation measures.

equivalent utility, which is convex to the origin.[2] We begin by considering a simplified world in which we have only two goods consumed by a single consumer (this aids some graphical representations below, but all of the arguments extend to systems of n goods). In some base period the person consumes quantities of two goods which we represent by a vector $\mathbf{q}_0 = (q_{01}, q_{02})$, these are purchased at prices $\mathbf{p}_0 = (p_{01}, p_{02})$. The consumer's utility function takes as an input the quantity vector and produces a utility level, $U(\mathbf{q}_0) = u_0$, which is associated with the cost function, $C(\mathbf{p}_0, u_0) = m_0$ where m_0 is the minimum budget needed to achieve utility level u_0 at prices $\mathbf{p}_0$. We will also make use of the indirect utility function $V(\mathbf{p}_0, m)$ which maps prices and budget to the maximum attainable utility level.

We assume that our consumer is rational and so their selected quantities, $\mathbf{q}_0$ maximise utility and minimise the cost of achieving maximum utility. The product of the prices and quantities therefore represent the minimum price of achieving the utility level u_0 under the initial set of prices. This situation is represented in Fig. 12.1[3] in which the point A is the point of tangency between the budget line (the downward sloping straight line) with total value m_0 at prices $\mathbf{p}_0$ and the indifference curve (the curved line) for the utility level u_0.

The convex indifference curve in the two-dimensional space connects all bundles of goods which yield identical levels of utility; hence, the consumer is indifferent regarding which of these combinations is consumed. There are many indifference curves and as we get further from the origin the utility levels are increasing. The choice of which bundle to consume is determined by the negatively sloped budget line which connects all points which cost the same amount. The consumer will choose the combination of goods for which the budget line is tangential (just touching) to the highest indifference curve possible.

We then allow there to be some change in prices so that in our second period our rational consumer faces prices $\mathbf{p}_1$. If we assume that one

[2]In order to avoid a significant digression here we refer the reader to an economics textbook such as Varian (2014).

[3]It should be noted that the graphical representation of the ideas in this section owes much to the use of similar diagrams in Schultz (1939).

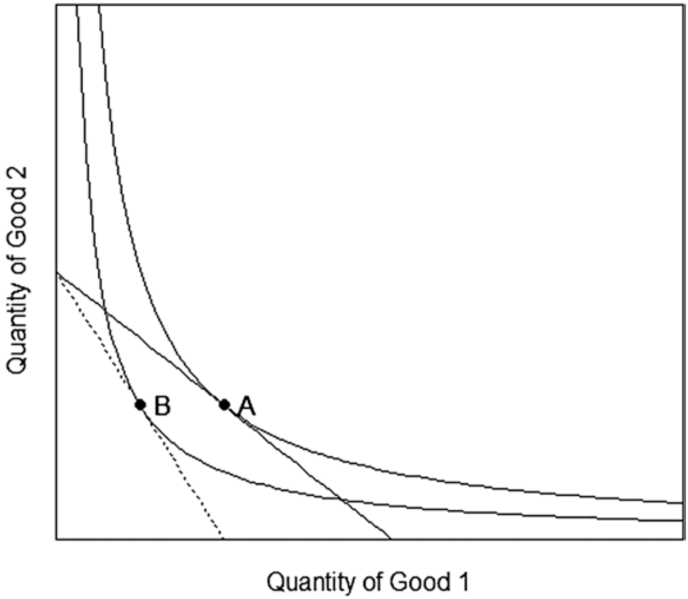

Fig. 12.1 This figure shows the position of a consumer under the original budget condition (point A) and the resulting reduction in utility caused by an increase in the price of good 1

of our prices, the price of good 1 in the case of Fig. 12.1, increases, we can see the impact on our budget line and utility level in Fig. 12.1. The budget line pivots inward and the new highest indifference curve we can achieve a point of tangency with is below the original indifference curve, representing a lower utility level. We see that the price increase has forced the consumer onto an indifference curve closer to the origin, or a lower standard of living. We might therefore ask ourselves how we can we calculate the increase in income needed for the consumer to return to the original standard of living. This proportional increase is the Laspeyres-Könus cost of living index and is the ratio of the cost function which measures the cost of achieving u_0 at the new prices to the cost of achieving u_0 at the old prices:

$$I^{01}_{Laspeyres-Konus} = \frac{C(\mathbf{p}_1, u_0)}{C(\mathbf{p}_1, u_0)} = \frac{C(\mathbf{p}_1, u_0)}{\mathbf{p}_0'\mathbf{q}_0} \quad (1)$$

where the final identity follows from the assumptions we have already made about the consumer's behaviour earlier in this section. The Laspeyres part of this name has found it's way into the definition of the index as it uses the period 0 utility in a similar way to which the Laspeyres price index uses base period quantities as a reference.

It is possible to develop an argument that the traditional Laspeyres index will return an index which is greater than the change in the cost of living index for this specific base period level of utility. Papers mentioned in this chapter do so in more or less formal ways but all rely on the same arguments. Following a change in the vector of prices from $\mathbf{p}_0$ to $\mathbf{p}_1$ our numerator requires us to find a bundle of goods which still yields the original utility level u_0 while minimising the cost. As the utility function, preferences, etc. of our consumer are constant across the time periods then we see that the bundle of goods $\mathbf{q}_0$ will still yield the required level of utility. We therefore know that we can achieve u_0 at a cost of $\mathbf{p}_1'\mathbf{q}_0$ The problem is that if any of the relative prices have changed in our price vector then it will be possible for a consumer to substitute some of the goods for others and obtain some utility level higher than u_0 as in effect $\mathbf{p}_1'\mathbf{q}_0$ is more money than is strictly needed to achieve u_0 as their standard of living. We can therefore infer that $\mathbf{p}_1'\mathbf{q}_0 \geq C(\mathbf{p}_1, u_0)$ and therefore that:

$$I^{01}_{Laspeyres-Konus} = \frac{C(\mathbf{p_1}, u_0)}{\mathbf{p}_0'\mathbf{q}_0} \leq \frac{\mathbf{p}_1'\mathbf{q}_0}{\mathbf{p}_0'\mathbf{q}_0} = I^{01}_{Laspeyres} \tag{2}$$

We can see what is meant in the above statement by plotting some indifference curves and budget lines in our two good system. We make the second good a numeraire good so that $p_{2t} = 1 \forall t$. If instead the budget line bisects an indifference curve then the consumer will be able to increase their standard of living at no additional cost.

Figure 12.1 uses indifference curves to illustrate the argument regarding the Laspeyres-Konüs index. We see in this case that we start with the solid, downward sloping budget line and an indifference curve. The consumer then chooses the combination labelled A. The price of the first good then increases causing the budget line to pivot inwards. Lines parallel to this new budget line then show that the Laspeyres

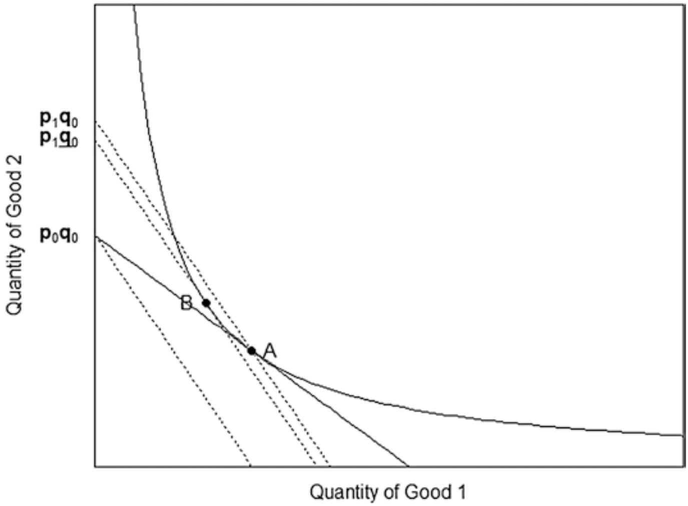

Fig. 12.2 This figure shows that the Laspeyres index will be higher than a cost of living index which maintains utility at the level of the base period. The figure shows a single indifference curve (utility equal to u_0 and shows that after a price increase in good 1 a Laspeyeres index will overcompensate the consumer)

compensated income (represented by the highest dashed line) would allow consumers to reach points above the original indifference curve. The point B shows the minimum expenditure needed to return to the original indifference curve under the new price regime. Given the definition of Good 2 given earlier the vertical intercept is equal to the total expenditure on a given budget line, thus allowing us to graphically confirm the conclusion that the Laspeyeres index will be greater than the cost of living index. Note we have used $\underline{\mathbf{q}_0}$ to represent the bundle which minimises the cost of achieving u_0 under the new set of prices here (Fig. 12.2).

Just as we have the Paasche price index as an alternative to the Laspeyres index when switching between base and current period quantities for weighting we can also switch which of the two periods we take the utility level from in a cost-of-living framework. We can construct an index which compares the cost of achieving u_1, the utility achieved under prices $\mathbf{p}_1$ with the amount which would have been needed to achieve u_1 when faced with the prices $\mathbf{p}_0$. Thus, we have a second cost-of-living index which is referred to as a Paasche-Konüs index defined as:

$$I^{01}_{Paasche-Konüs} = \frac{C(\mathbf{p}_1, u_1)}{C(\mathbf{p}_0, u_1)} = \frac{\mathbf{p}_1'\mathbf{q}_1}{C(\mathbf{p}_0, u_1)} \tag{3}$$

Using a similar reasoning to that applied to the Laspeyres type indices we can argue that the Paasche index undercompensates consumers compared to the true Paasche-Konüs index. Under $\mathbf{p}_0$ we know that $\mathbf{q}_1$ remains a possible way of achieving u_1, hence we know that given $\mathbf{p}_0'\mathbf{q}_1$ the consumer could achieve the required level of utility. Given that we allow relative prices to change though there will be a lower cost way of achieving this, that is $\mathbf{p}_0'\mathbf{q}_1 \geq C(\mathbf{p}_0, u_1)$ hence as the numerators of the Paasche and Paasche-Konüs are identical then:

$$I^{01}_{Paasche-Konüs} = \frac{\mathbf{p}_1'\mathbf{q}_1}{C(\mathbf{p_0}, u_1)} \geq \frac{\mathbf{p}_1'\mathbf{q}_1}{\mathbf{p}_0'\mathbf{q}_1} = I^{01}_{Paasche} \tag{4}$$

We now have two inequalities, for two different cost of living indices, both of which were described in Konüs (1939); however, we should be careful to note that this does not mean that the true cost of living index falls between the bounds of the Laspeyres and Paasche indices. Special conditions are needed for this to be true, for example, if $u_1 = u_0$ then this is true; however, this represents a most uninteresting case. Konüs (1939) acknowledges that the two bounds he determines for the cost-of-living index do not mean that *the* cost-of-living index can be bounded by the Paasche and Laspeyres formulae, as we are talking about two different cost of living indices, rather than a single true index which measures the cost of living. Konüs (1939) does note that there must be some standard of living u^*, where $u^* \in \{u_0, u_1\}$ for which the true cost-of-living index must be between the Laspeyres and Paasche indices, i.e. that $I^{01}_{Paasche} \gtrless \frac{C(\mathbf{p}_1, u^*)}{C(\mathbf{p}_0, u^*)} \gtrless I^{01}_{Laspeyres}$. This is not the same as the conclusion sometimes ascribed to Konüs(1939) that the true cost of living index must be between the Paasche and Laspeyres index, only that there is some intermediate level of utility for which this is true. Konüs (1939) then showed that if $\frac{\mathbf{p}_1'\mathbf{q}_1}{\mathbf{p}_0'\mathbf{q}_0} = \frac{\mathbf{p}_1'\mathbf{q}_0}{\mathbf{p}_0'\mathbf{q}_1}$ we can make the statement that

$I^{01}_{Paasche} < \frac{C(\mathbf{p}_1,u^*)}{C(\mathbf{p}_0,u^*)} < I^{01}_{Laspeyres}$ and unless we make some restrictive assumptions about the utility function, the utility in periods 1 and 0 can still vary significantly.

12.3 The History of Arguments Around the Cost of Living Index

Most Index Numbers specialists consider that the literature on what we now think of as a cost-of-living index began with Konüs (1939), which was a translation of a paper presented in Russian in 1924.[4] The key results of this paper were made known to non-Russian speakers via Bortkiewicz. Konüs (1924) was subsequently translated into English and published at the suggestion of Henry Schultz as Konüs (1939), thus ensuring a wider audience for this important work in the development of the economic approach to index numbers. In Konüs (1939), it is made clear that compiling a cost-of-living index is near impossible given the need to be able to identify the consumption bundles which yield an identical level of utility, which requires a more fundamental understanding of the relationship between consumption and prices; such issues remain relevant today despite the vast increase in the range and depth of data available to economists and statisticians.

Having had Konus (1924) translated and recommended reprinting of the article, Schultz (1939) then commented on problems in the way in which index numbers scholars had been summarising the main findings of the papers. He notes that the main conclusion from Bortkiewicz (1928), which itself was a review of a book written in German by Gottfreid Haberler, had been a poor summary of Könus (1924). Schultz (1939) said that the main conclusion mentioned in Bortkiewicz (1928) had never been stated explicitly in Könus (1924) and was only one step in a longer argument, the conclusion which is not mentioned by Bortkiewicz.

[4]Credit for organising the translation and subsequent publication of this important paper rests with Henry Schultz, a founding member of the econometric society.

Against this landscape of confusion, Bowley (1928) considered the general background of Index Numbers before moving on to the specific problem of determining an appropriate measure for a cost of living index. He determined that the formula:

$$I^{01}_{Bowley} = \frac{\mathbf{p}_1'(\mathbf{q}_0 + \mathbf{q}_1)}{\mathbf{p}_0'(\mathbf{q}_0 + \mathbf{q}_1)}$$

was an appropriate cost of living index. This formula is largely based on several assumptions, including that only small adjustments are needed to quantities between periods in ensure equality in the utility experienced. In fact, Bowley (1928) includes an extra term in the above formula, however Bowley (1938), in response to criticism in Frisch (1936), re-emphasises that this extra term is expected to be small and be of similar order to terms ignored elsewhere in the derivation. This demonstrates that in the interwar years economists' approach to the study of cost of living indices focused on establishing bounds for these indices and attempting to specify forms which might adequately measure a cost of living index under appropriate conditions.

The work of Diewert (1976, 1978) represented a significant step forward in the theoretical literature regarding the cost-of-living index (a concise and accessible summary of the arguments resulting from this work can be found in ILO et al. (2004 Chap. 17)). Diewert (1976) relies first on the idea that the utility function faced by a cost minimising consumer is linearly homogeneous. A utility function fulfils this property if for some positive constant λ it is possible to say that $U(\lambda \mathbf{q}) = \lambda U(\mathbf{q})$ where all elements of $\mathbf{q}$ are non-negative. Diewert (1976) defines an index number as having the property of being "superlative" if it is possible to show that for some aggregator function (read as utility function here to simplify things a little) the index number formula is a) exact for that aggregator function and b) that aggregator function is of a *flexible functional form*. Diewert (1976) defines a flexible functional form as referring to the property that the aggregator function can provide a second order approximation to any arbitrary function within the class of linearly homogeneous functions around a given point.[5] If an index number formula fulfils these criteria then it is said to belong to the class of superlative indices. Examples of such indices include the Fisher ideal price index as well as the Törnqvist price index discussed in Chap. 4 as well as a more general class of indices known as quadratic means.

It is worth noting that superlative index number formulae can be exact for differing aggregator functions, which also means that the form of the indices need not exactly coincide. Despite this it is usual when working with index numbers for the more common forms of superlative indices to provide numerically similar results. Evidence relating to this can be found in Hill (2006) and Chap. 19 of ILO et al. (2004). This might mean that the exact form of the superlative index being utilised is of less concern than that a superlative index is being used. However, it is often possible to check whether these formulae coincide as when data to estimate a Fisher index is available it is often also possible to construct a Törnqvist and other indices at little additional computational cost.

The work of Diewert (1976) is important in the development of a cost of living index as it identifies specific criteria for the identification of formulae which approximate cost of living indices. However, the approach relies significantly on a theoretical approach based on several assumptions. Breur and von der Lippe (2011) criticise the methodology of Diewert (1976), paying particular attention to some of the assumptions underlying the economic analysis. It is worth noting that their criticisms focus on assumptions which are not uncommon in the work of economics and without them it would be difficult to say much of interest using an analytical approach to the study of cost of living indices. Indeed, many of the assumptions criticised in Breur and von der Lippe (2011) are employed and quoted in almost all of the papers noted in this chapter and can be traced back to Frisch (1926). The assumptions underlying the work of Diewert (1976) can be questioned but they provide a base from which to discuss the applicability of index number

[5]Diewert (1976) succinctly defines second order approximation as if we have two functions $f(\mathbf{x})$ and $g((\mathbf{x}))$ and pick the point $\mathbf{x} = \mathbf{z}$, where $\mathbf{x}$ is an n dimensional vector, then the first function provides a second order approximation of the second if the level and the first and second order partial derivatives of the two functions are the same at the point $\mathbf{z}$.

formulae for measuring changes in the cost of living. The restrictions of such assumptions are discussed in the early literature on the subject such as Staehle (1935) and Klein and Rubin (1947) and so are not unknown in the literature on the subject of a cost of living index itself

Balk (1995) reviews a second approach to the consideration of cost-of-living indices, this time based on demand functions. To follow the arguments of Balk (1995) we note that we can define the Marshallian demand function $Q(\mathbf{p}, m)$ as giving the vector of consumption amounts of goods given a price vector $\mathbf{p}$ and an expenditure level m. If we have our period 1 prices $\mathbf{p}_1$ and impose the condition

$$\mathbf{p}_0 Q(\mathbf{p}_1, e) = \mathbf{p}_{0'}\mathbf{q}_0$$

where e is an expenditure level. It is worth noting that it need not be the case that $\mathbf{p}_{1'} Q(\mathbf{p}_1, e) = \mathbf{p}_{0'}\mathbf{q}_0$ based on this definition. $Q(\mathbf{p}_1, e)$ is some vector of quantities which was available under the budget line at time 0 but was not chosen. This implies that $u_0 = U(\mathbf{q}_0 \leq U(Q(\mathbf{p}_1, m)))$, and this must also mean that achieving the original level of utility at $\mathbf{p}_1$ must be more expensive than this new level of utility i.e. $C(\mathbf{p}_1, u_0) \geq C(\mathbf{p}_1, U(Q(\mathbf{p}_1, e))) = e$. From this we can state that $C(\mathbf{p}_1, u_0) \leq e$ hence

$$I^{01}_{Laspeyres-Konus} \geq \frac{e}{\mathbf{p}_0'\mathbf{q}_0}$$

and so if we were to give a consumer income of level e we would be undercompensating them. This result is credited to Staehle (1935) by Balk (1995). As we now have an overcompensation bound (courtesy of Könus (1924)) and this undercompensation bound it is possible to consider some averages of $(\mathbf{p}_{1'}\mathbf{q}_0)$ and e as defined above. Balk (1995) notes the compensations of Samuelson (1947), Malmquist (1953) and Frisch (1936) which are all second-order differential approximations of the amount $C(\mathbf{p}_1, u_0)$ and so these methods are equally accurate. This approach then requires further specification of the demand systems based on available data in order to provide solutions to the above, though this material is beyond the scope of this volume and interested readers are referred to Balk (1995).

12.4 How the Cost of Living Can Change Even if Prices Stay the Same

There are many problems with a cost-of-living index, even if we are able to operationalise some of the theoretical knowledge gained from the sources reviewed in this chapter. In this section, we note further difficulties which impinge on potential progress towards a cost of living index.

Könus (1939) noted that his conclusions were valid as long as the system of tastes and preferences which influenced consumption remained constant across time periods as well as the conditions affecting their environment. This is a significant issue in Index Numbers, especially for those areas of the subject where we are required to deal with new and disappearing goods as well as populations experiencing large-scale social change, things which affect consumption patterns, as we saw when looking at the composition of the basket of goods in Chap. 7. While we may be able to make a limited argument for such a situation over a very small period of time, it is difficult for economists to be confident in making such an assumption over long periods of time and this area represents a significant challenge to the process of estimating a cost-of-living index. Similarly, many of the results in theoretical papers, such as Balk (1995), consider expansions of functions around points which are close to the base period price vector, which implies that many of the conclusions may hold less robustly when prices are likely to change significantly over a short period of time.

Staehle (1935) notes several of the practical problems of operationalising the cost of living index in the light of the theoretical literature on the subject. One such problem is the requirement not only that the same commodities need to be available in each of the periods but also that other conditions need to be identical. For example, Staehle (1935) notes that conditions such as taxes, social services and climate need to be identical across periods of consumption, and groups these factors as the "milieu".

Following on from the "milieu" ILO et al. (2004) (see paragraphs 17.84–17.85) also note that consumers' utility functions of may alter across months of the year, and that as a result we may need to consider a setting which allows for month-specific utility functions. This can be seen by considering the utility gained from certain products in different month; the utility from Christmas tree lights is likely to be higher in December than July for many consumers while similarly sun protection products are likely to yield more utility in the summer months. The possibility for utility functions to vary in this way threatens to make the measurement of a constant utility function more difficult and as ILO et al. (2004) say it may be better for this reason if seasonal items are removed from current considerations of measures of cost of living.

A further criticism of much of the theoretical discussion of cost of living indices is that the analysis tends to be based on individual households. Such a criticism is made explicit in Breur and von der Lippe (2011), however, there have been attempts in the Index Numbers literature to define approaches which can incorporate the inflation experiences of a range of households, each of which faces different conditions and different prices.

A more recent development of this idea has been Crossley and Pendakur (2010) who develop a method which builds on the work of Pollak (1989) but requires that expenditures by households in the second period are proportional to those in the comparison period, thus removing the need for some of the more complex distributional assumptions surrounding incomes across heterogenous households.

This section highlights that there are several secondary issues which need to be dealt with before it would be possible to be confident that a macroeconomic measure of inflation could be interpreted as a cost of living measure.

12.5 What Do Price Indices Measure?

Over the years there has been some confusion regarding whether or not the price indices produced by NSIs can be considered to be measurements of changes in the cost of living, or otherwise as good approximations to this much sought after measure.

The arguments around the cost of living approach to index numbers are complex, more so for readers without an economics background, and so it is necessary to be careful when discussing some results which can be identified relating to the area. ILO et al. (20.82–20.83) give the interesting result that if in an N goods case in which a consumer's utility function is given as a Cobb-Douglas utility function, with taste parameters equal across goods, i.e. $U(\mathbf{q}) = \prod_{i=1}^{N} q_i^{\beta_i}$ and $\beta_i = \beta_j = \beta \forall i, j$, that is $U(\mathbf{q}) = (\prod_{i=1}^{N} q_i)^{\beta}$, then the simple Jevons index is a precise cost of living index. It is also possible to define preferences which yield the Carli as an exact cost of living index. ILO et al. (2004) suggest that the assumption of fixed ratios of amounts spent on goods, inherent in the Cobb-Douglas preferences, might be more palatable to economists than the fixed ratio of quantities amounts inherent in the argument supporting the Carli as a cost of living index.

ILO et al. (2004)'s argument was taken in some places as evidence that the Jevons was the best approach for use in elementary aggregates of the HICP/CPI as it better takes account of the substitution behaviour of consumers. We can see from this example that it is not always easy to communicate about the cost of living and cost of goods indices while making the limitations of these arguments clear. It is an example that in some cases an argument might be taken further than was strictly intended in informing the construction of price indices.

12.5.1 Is the CPI a Cost of Living Index?

In this section, we consider the work done by NSIs towards reporting cost of living indices and where they feel confident enough to present their statistics in this manner.

Clews et al. (2014) estimated retrospective superlative indices for the UK for 2007–2009, noting that this might help towards the eventual estimation of a cost of living index for the UK. Their results indicate that the superlative indices return a rate of inflation which is around 0.5% lower than the standard CPI over a twelve-month period. Such a result could have a significant impact on the interpretation of the official inflation rate. For example, the inflation rate fluctuated around 0 in 2015, so if these results are consistent over time the cost of living may have been decreasing.

In the USA, there is an explicit attempt to have the CPI measure the change in the cost of living via the C-CPI-U, which is a Törnqvist index, also a superlative index number formulae. Greenlees (2011) further expands this approach by using a constant elasticity of substitution approach on the preferences of consumers in order to "improve" preliminary estimates of this price index and compares the results with those from superlative indices. Although we do not consider the details in depth here it is notable that the USA is willing to make such a confident assertion regarding its price index while other countries are more cautious.

Canada, Australia, Eurostat and Japan all specify that their CPI measures the change in the cost of a fixed basket of goods and services. Most countries therefore make an explicit distinction between the cost of goods approach and cost of living approach, with the vast majority opting for the former rather than the latter.

We might pause at this point and ask whether it is possible for more countries to compile cost of living price indices, or at least move closer to using the approaches used by the BLS and in Clews et al. (2014). Most policy makers would probably prefer and would come closer to both economists' and consumers' understanding of inflation. With the types of indices produced by BLS on a regular basis and Clews et al. (2014) more data is needed and specifically expenditure data for the current period as well as the base period. This is much more laborious to collect than simple price quotes and as a result inflation estimates from such methods could be delayed by a year or more, something it would be unlikely most users would appreciate. Alternatively, users would have to be willing to use initial estimates which are then revised. While there are precedents for this, for example in the production of statistics relating to GDP, it has not been a common element of inflation reporting and so is likely to be controversial.

In addition to these practical concerns, if we are to use the established theory regarding a cost of living index; we must first make sure we are happy with the restrictions that such an approach requires. Greenlees (2011) in using a CES index to improve initial estimates of C-CPI-U notes that he must make the assumption that preferences conform to the CES form in order to progress his argument further.

While such assumptions are not uncommon in applied economic statistics it would require a substantial evaluation of the method and its assumptions before it could be considered for estimating inflation and the required assumptions for most countries.

12.5.2 The Recommendations of the Boskin Commission

The USA is the only major economy in which the official inflation measure is also labelled as a cost of living index. As a result, it is worth considering the process by which such an ambitious statement was made. A major step in the process of the CPI being framed in this manner was the "Advisory Commission to Study the Consumer Price Index" which reported its findings in 1996 (Advisory Commission to Study the Consumer Price Index 1996). Gordon (2000) reports the main findings of the committee's report and discusses some of the resulting criticism of them. The committee was chaired by M.J. Boskin and so the report and its findings have become commonly known as the "Boskin Commission". It is immediately obvious from the discussion of the findings of the commission in Gordon (2000) that the problem of measuring inflation was approached as a cost-of-living measurement problem; the cost-of-goods approach is not discussed and issues such as substitution are a central driver of the discussion in a way they need not be in a cost-of-goods approach.

The Boskin commission's biggest finding was that the US CPI was overstating inflation by around 1.1% (the plausible range from the report is 0.8–1.6%) per annum. Gordon (2000) notes that the commission was unable to conduct new research and was reliant on existing, and in some cases unpublished research. On introducing the cost of living index Gordon (2000) seems to present the Laspeyres and Paasche as upper and lower bounds of the "true" index, without any mention of the assumptions required to make this step, or the more nuanced discussion of the bounds in Könus (1939). The commission's overarching conclusion was that "a COL (cost of living) index could and should be developed" (Gordon 2000, p. 20). One of the most controversial outcomes of the report on a practical level was the introduction of the Jevons index at the lowest level of the index in order to reduce substitution bias. This may have been instrumental in the development of similar price indices around the world, which subsequently cited the Boskin Report as an example of the Jevons being used to remove substitution bias.

The outcome of the Boskin Commission was not welcomed by everyone and at times the report and papers surrounding it (e.g. Gordon 2000) may have contributed to the situation as they place a lot of weight on sources which were not always publicly available and at times might have benefited from closer scrutiny. However, the commission did not have such a luxury of time or resources. It is clear that the findings of the Boskin commission were key in the development of the US CPI and for better or worse led the USA to be the first country to identify its inflation measure with the cost of living concept as a guiding principle. It therefore makes it far more likely that adjustments will need to be made along the way, however it is clear that the BLS is leading the way towards measurement of a cost of living index and it is now down to economists and statisticians to convince practitioners of the properties of the new index.

12.6 Are We Close to a True Cost of Living Index?

Given the likely importance which would be placed by economists and policymakers in knowing how the cost of living has changed over a given period it is useful to consider the attempts which have been made to estimate a cost of living and how reliable they are likely to be.

Braithwait (1980) attempts to use the cost of living formula from Pollak (1975) which allows for classes of goods to be separated out to measure the difference between a Laspeyres price index and an estimate of the COLI. His empirical results suggest that the Laspeyres is generally biased by around 1.5% relative to the class of COLIs covered. The results also showed that the degree of price change, time covered and substitutability of goods all played a role in the determination of the exact size of this bias.

In their discussion of how well theories relating to COLIs fit the real-world data Breuer and von der Lipper (2011) estimate Törnqvist and Fisher indices and compare them to indices constructed using almost ideal demand systems approaches. Their results indicate that the demand systems-based COLI is higher than that based on the superlative index number formulae. They note that despite this experimental result the implementation of the complex demand systems methodology in a production environment would be impossible.

While there are methodological improvements which might be made in the estimation of a cost of living index, measuring a cost of living index is a much more complex task than measuring a cost of goods index. This is reflected in the fact that many of the works above are cautious in presenting results of a cost of living index. However, this work is likely to be important as we move ever closer to the ideal of being able to determine how much it would cost for a household to maintain its standard of living.

Economists and many users of inflation statistics might well favour a cost of living index over a cost of goods index. But at present it would be impossible for National Statistical Institutes to reliably produce a measure covering heterogeneous populations. Academic research and innovations in data collection may well lead to further developments in this area in the coming years and the topic remains an important one for economists for Index Numbers research. Although the current literature has not produced a robust methodology for measuring a cost of living index it has already allowed us to find out more about such indices and to make informed comparisons between cost of goods indices which we are able to calculate and cost of goods indices which are more elusive.

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13

Recent Developments: 2012–2016

13.1 Overview

The period from the Autumn of 2012 to the Spring of 2016 saw intense scrutiny of consumer price indices with two public consultations, two UK Statistics Authority monitoring and assessment reviews, two external UK Statistics Authority Reviews and a National Statistics Quality Review of the Living Costs and Food survey, a key source of weighting information. This degree of attention paid to the indices reflected an increasing focus on engagement with users of Official Statistics and the general public.

Four topics dominated this period:

- the inclusion of owner occupiers' housing costs in the CPI,
- the formula effect—that is, the difference between the RPI and CPI resulting from the use of different elementary aggregate formulae,
- whether there should be one main measure of inflation and what that should be and
- the status and future of the RPI.

R. O'Neill et al., *Inflation*, DOI 10.1007/978-3-319-64125-6_13

All four topics generated extensive discussion with experts holding different views. While these contested topics were well known and had been debated in some form for many years, new research was available which informed the debates, as well as important changes in how the indices were used. Researchers, including those at ONS, produced a number of research papers in the years from 2012 to 2016, which provided new insights to help the discussions in the UK context. There were other drivers for the work over this period, including concerns about the quality of weighting information and the development of new approaches such as web-scraping of price data.

This chapter examines the issues raised, the recommendations and the results of the subsequent consultations which guided developments in measuring inflation. It starts with a summary of the governance of consumer price indices and how this developed over the period in question. It is helpful to consider this at the start of the chapter, as the resulting committees are referenced in subsequent sections.

13.2 Governance

The previous governance arrangements for the methodology of consumer price measures saw the Chancellor as ultimately responsible for the methodology used to measure inflation, with advice provided by an expert group—the Retail Prices Index Advisory Committee. The group met intermittently between 1947 and 1994 with the last meeting discussing the treatment of owner-occupied housing (CSO 1994).[1]

From the second half of the 1990s consultation was carried out in an informal manner without a regular committee. The formal responsibility for most aspects of the RPI remained unchanged and rested with the director of the statistical office producing the index; from 1996, this was the director of the newly created Office for National Statistics.

[1] All the Retail Prices Index Advisory Committee reports are available from http://webarchive.nationalarchives.gov.uk/20160105160709/http://www.ons.gov.uk/ons/guide-method/user-guidance/prices/cpi-and-rpi/rpi-advisory-committee-historic-reports-1947-1994/index.html.

However the responsibility for the scope and definition of the index remained with the Chancellor of the Exchequer. It wasn't until 2004 that a Statistics Commission report recommended that the Chancellor should no longer be responsible for the scope and definition of the RPI (Statistics Commission 2004).

The Statistics and Registration Service Act (2007), which established the UK Statistics Authority, established new governance arrangements for consumer price indices. Changes to the methodology would now need to be approved by the UK Statistics Authority before they were referred to the Bank of England. A new group of experts was convened to advise the National Statistician, who in turn advised the Authority Board; it was called the Consumer Prices Advisory Committee (CPAC),[2] and was chaired by the National Statistician. The committee's scope included aspects of the Consumer Prices Index not covered by European Directives. Like the RPI Advisory Committee before it, the committee's membership included a range of expertise; for CPAC, representatives were drawn from the UK Statistics Authority, ONS, the Bank of England, Her Majesty's Treasury, academia, the media and consumer organisations. The group met fourteen times between July 2009 and April 2012. In 2010, it was decided that papers for meetings should be published but not detailed minutes, although brief notes of discussions were made available (ONS 2010e). Its role was advisory—it advised the UK Statistics Authority.

In September 2012, the chair of the UK Statistics Authority made a statement to the House of Commons Public Administration Select Committee that two reviews would be instigated. One would examine the governance arrangements for consumer price indices, and the other would consider whether the current range of consumer price indices best meets user needs (Public Accounts Select Committee 2013, p. 52). In May 2013, the UK Statistics Authority announced the two reviews, one of the governance and the other covering the wider effectiveness

[2]Consumer Prices Advisory Committee landing page: http://webarchive.nationalarchives.gov.uk/20160105160709/http://www.ons.gov.uk/ons/about-ons/who-ons-are/programmes-and-projects/other-development-work/consumer-prices-advisory-committee--cpac-/index.html.

of the current measures. The governance review was led by the deputy chair of the UK Statistics Authority, Professor Sir Adrian Smith (UK Statistics Authority 2014a) and the review of the range of consumer price measures was led by Paul Johnson, the Director of the Institute for Fiscal Studies (Johnson 2015).

The governance review was published in February 2014 and concluded that the governance was best served by two panels, a stakeholder panel and a technical panel. The stakeholder panel would consider the uses and applications of consumer price indices; the technical panel, as the name suggested, would advise on technical matters. These panels were advisory—they advised the National Statistician, who in turn advised the UK Statistics Authority Board. The new panels first met in joint session in December 2015; they met separately for the first time in January 2016,[3] with the intention of meeting three times a year.

13.3 The Formula Effect and the RPI Consultation: 2012

13.3.1 The Origins of the Formula Effect

The Harmonised Index of Consumer Prices (HICP) was created by Eurostat as part of the assessment of progress of Member States of the EU against convergence criteria for eligibility to join European Economic and Monetary Union (O'Donoghue and Wilkie 1998). The CPI is the UK version of the HICP. The national versions of the HICP, produced on a comparable basis, were also to be used to calculate an EU-wide measure of inflation.

The methodology of the harmonised index was designed to incorporate international best practice in Index Numbers and Price Statistics and to provide comparable measures across European states—it was

[3]At the time of writing, in the winter of 2016, two of the authors—JR and PAS are members of the technical panel.

not intended to replace the existing national measures at the time of its introduction. The HICP was introduced in 1996 in the UK and was produced alongside the RPI, which was the main measure of consumer inflation in the UK at the time.

The methodology of the HICP was different to the RPI in a number of ways, including: the households in scope, the classification scheme and particularly, the mathematical formulae used at the lowest level of the index. For the HICP, two formulae were used at the lowest level of aggregation—the "elementary aggregate level"—the Dutot, the ratio of arithmetic means of price quotes, and Jevons, the geometric mean of price relatives (see Chaps. 4 and 11). Other formulae were allowed, but only if they resulted in annual inflation rates which differed by less than 0.1%. This effectively ruled out the Carli formula which often doesn't produce comparable results (O'Donoghue and Wilkie 1998, p. 9).

For eight countries—Denmark, Greece, France, Italy, Luxembourg, Austria, Finland and the UK—the specification meant that they would need to change their existing price index methodologies. Although the HICP was not intended to replace national measures, some elements of the methodology of national measures were changed to come into line with the HICP. In most cases, countries changed completely at the elementary aggregate level to the Jevons formula at the time the HICP was introduced. All countries, except for Austria and the UK, introduced the change in formula for their national CPIs (ibid, p. 10).

13.3.2 The UK Position

The position in the UK was complicated by the implications of changing the RPI to be estimated on the same basis as the HICP. Removing the Carli formula from the RPI would have been judged a fundamental change to the index and have materially affected index-linked gilt holders as the resultant index would yield significantly different values of inflation. The difference between the RPI and the CPI resulting from different choices of formula at the lowest level of aggregation had been studied before 2010, but two events in that year raised it to prominence.

Difficulties in collecting comparable prices for clothing items throughout the year led to changes in instructions to price collectors, including the inclusion of sale prices in the January month and allowing small differences in clothing products to be considered comparable, which enabled more prices to be collected. These changes came into operation from January 2010 and resulted in a wider distribution of price quotes which in turn led to an increase in the difference between the inflation rates calculated from the RPI and CPI (Fig. 13.1; ONS 2011a) through the formula effect. As we have seen in Chap. 11, the difference is driven by the variability of price relatives.

Before December 2009, the formula effect accounted for 0.54 percentage points of the difference between the CPI and RPI annual inflation rates. By 2010, the difference had grown to 0.86 percentage points. Analysis of the contribution from categories of goods and services showed that it was the clothing and footwear division that accounted for almost all of the change; in fact, it contributed 0.30 out of the total of 0.32 percentage points (ONS 2011a, p. 1).

The second event affecting the importance of the debate of the differences between the RPI and CPI was the announcement from the

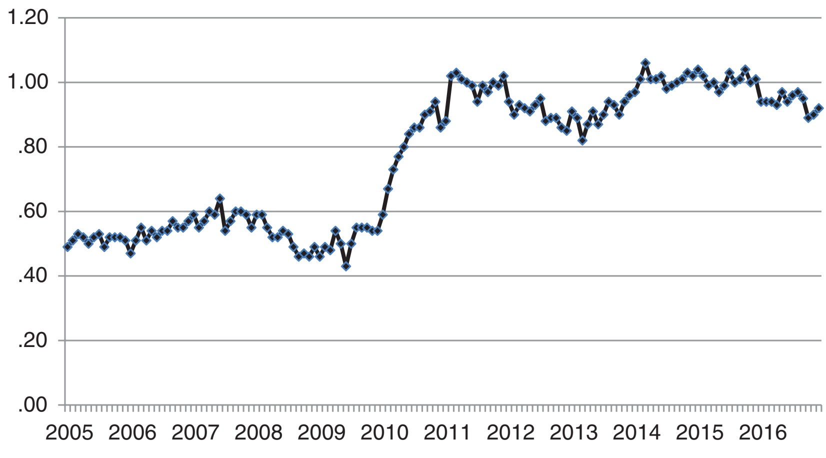

Fig. 13.1 Formula effect—the difference between the annual inflation rates calculated from the CPI and RPI due to their different elementary aggregation formulae, January 2005 to December 2016

Chancellor in June 2010 that the CPI would replace the RPI for indexing many state benefits and pensions (HM Treasury 2010, p. 21). This led to a growing interest in the difference between the two measures, both in the professional statistical world and in the public arena. A wide range of groups of people were adversely affected by the changes, and was discussed widely in newspapers and in reports from special interest groups.

Professor David Hand, the president of the Royal Statistical Society, wrote to the head of the UK Statistics Authority, Sir Michael Scholar, on 10 August 2010 raising concerns on a number of matters including the formula effect, noting that it had never been lower than 0.43 and had recently reached 0.86 percentage points (David Hand 2010). The letter expressed concern that a statistical treatment should result in a difference of such a magnitude given that the RPI and the CPI are widely used for legal and policy purposes. It recommended ONS investigate the reasons behind the size of the formula effect. This letter was included in the document pack for the September 2010 CPAC meeting; it was discussed further at the November meeting of the committee. Further letters between the Royal Statistical Society and the UK Statistics Authority on the subject of consumer price indices in 2010 and 2011 were exchanged (UK Statistics Authority 2010b, c, Jill Leyland 2010, UK Statistics Authority 2010d).

The UKSA had been carrying out an assessment of consumer price indices in 2010, and the assessment report was published in December 2010 (UK Statistics Authority 2010a). This confirmed the National Statistics status of the measures, subject to five enhancements being made. The third required ONS to publish more information about the history and reasons for differences between the RPI and CPI and the implications for the uses to which they are put. ONS subsequently published several articles (ONS 2011c, d) to meet this requirement; this generated furthered interest in the topic.

The appropriate uses of the two measures was the subject of a public meeting hosted by the Royal Statistical Society in January 2011. ONS gave an overview presentation of the two measures, their differences and how they are used (Davies et al. 2011). This meeting and other events were summarised in an ONS report to CPAC (Davies 2011); it noted that a key outcome of the discussions was the need to examine the evidence for the choice of formula used at the lowest level of consumer price indices. In particular, the use of the unweighted arithmetic and geometric means and the technical issues in this debate are explored in Chap. 11.

In response to the concerns about the magnitude of the formula effect, ONS instigated a programme of work to better understand the causes of the recent increase in the formula effect and to explore whether changes to the measurement of clothing inflation were needed (Bradley 2012); this was discussed at the CPAC meeting in February 2012.

ONS also instigated a study of the formula effect in other countries (Evans 2012). In the UK, the CPI, which is the UK version of the HICP, uses the Jevons formula for about two thirds of the elementary aggregates; the Dutot formula is used for a few items such as petrol and diesel with weighting information being available for the rest. The RPI, in contrast, uses the Carli formula for 55% of the elementary aggregates and 35% use the Dutot; others are treated differently. Very few countries outside of the EU produced more than one general measure of inflation. For EU countries, all produced both a version of the HICP and their own national measure but only the UK and Slovenia used different elementary aggregate formulae in their international and national measures and only the UK used the Carli. At the time of the analysis, Slovenia used the Jevons formula in their HICP and the Dutot formula in their national measure. This didn't lead to a significant formula effect as the difference between the Jevons and Dutot is usually much smaller than the difference between the Carli and Jevons, their average difference between 1998 and 2011 was 0.1 percentage points. Countries which had used the Carli formula in the past had changed to either the Dutot or the Jevons by the time of the enquiry. For example, Canada switched from the Carli to the Dutot in 1978 and then from the Dutot to the Jevons in 1995.

In order to better understand the choice of formula for elementary aggregates, ONS requested expert guidance from Professor Erwin Diewert from the University of British Columbia. Professor Diewert was chosen as an eminent academic of great experience who had made significant contributions to the Index Number field (Diewert and Fox 2016). He was asked to consider two broad questions:

- to assess the suitability of the Retail Prices Index (RPI) and the Consumer Prices Index (CPI) in meeting various purposes for which measures of consumer price inflation are generally used;
- to identify any weaknesses in either of these indices and to make suggestions as to how these weaknesses might be addressed, both in the short term as well as in the longer run.

Within his broader remit, the choice of elementary aggregate formula was included. Professor Diewert visited ONS in March 2012 to discuss the issues; his report was delivered in the Summer of 2012 (Diewert 2012). Professor Diewert made a number of short-term and longer-term recommendations. He considered the choice of elementary aggregate formula in his report, looking at each of the formulae used in practice. He examined the four main approaches to Index Number theory and applied them to the elementary aggregate formulae. His recommendations were clear—the Carli should be replaced in the CPI by the Jevons or the Carruthers, Sellwood, Ward and Dalen (CSWD) formula, which is the geometric mean of the Carli and the harmonic mean, as the Carli formula is upwardly biased. The Dutot formula was considered acceptable where an elementary stratum was narrowly defined.

13.3.3 ONS Research into the Choice of Elementary Aggregate Formulae

As part of building the evidence base to assist the National Statistician on the choice of elementary aggregate formulae in the RPI, ONS reviewed international practice and research alongside Professor Diewert's report. In addition, researchers at ONS had been studying aspects of Index Number practice using panel data from Kantar Worldpanel, a market research company. The data provided a more detailed level of information on consumer purchases than was conventionally available and allowed for investigation of aspects of the conventional wisdom regarding various elementary aggregate formulae.

To support the consultation, the ONS research investigated the substitution behaviour of consumers in response to price change

(Winton et al. 2012). This looked at the traditional element of Index Number theory that states that using the Jevons formula better represents the situation where consumers substitute in response to price change, while the Carli is better where little substitution takes place. This is based on very simple economic models of consumer behaviour, as was discussed in Chap. 12. The ONS research showed that such claims did not hold in practice; Winton et al. concluded that the economic approach to Index Numbers could not be used to select the most appropriate elementary aggregate formula.

Two other approaches to Index Number theory—the stochastic approach and the sampling approach—were also investigated (Elliott et al. 2012). For the stochastic approach, the distributions of price relatives for all elementary aggregates were examined to see whether their distributions were closer to normal or lognormal forms. The Jevons formula is an unbiased estimator when price relatives follow a lognormal distribution while the Carli is an unbiased estimator when they are normally distributed. Elliott et al. found that most elementary aggregate price relative distributions were neither normal nor lognormal, though most were better approximated by a lognormal than a normal distribution.

In the sampling approach, unweighted formulae at the elementary aggregate level are considered as estimators for population target indices under specified sampling schemes. The theoretical results show the sample Carli as an unbiased estimator of the Laspeyres population target under probability proportional to size sampling and the Jevons as the corresponding sample estimator for the Fisher index. Elliott et al. (2012) investigated whether this held for real data where the sampling was only partially proportional to size. The main conclusion of the work was that no unweighted formula provided a good approximation of a weighted formula. Elliott et al. (2012) also considered economic models with mixes of supply and demand effects; they showed that under different circumstances, each unweighted formula could become the best approximation to a weighted formula, depending on the way the economic models were specified initially.

The conclusions of the ONS research were:

- the economic approach to index numbers could not be used to select the best formula for elementary aggregates;
- the stochastic approach showed a weak preference for the Jevons;
- the sampling approach showed a weak preference for the Carli.

Overall, none of these approaches provided much support for any particular formula.

Of the traditional approaches to Index Numbers, this left only the axiomatic approach, and this had been covered in detail by Professor Diewert (Diewert 2012). His view was that the Carli failing the time reversal test was a significant result and counted heavily against the formula; in comparison, the Jevons formula passes this test. This is not a view shared by all commentators, and goes back to the problem of a lack of agreement over the significance of axioms for testing index number formulae.

ONS did explore the effects of the Carli index failing the time reversal test, through research into chain drift effects (Clews et al. 2013). Drift arises from the use of chain-linking which multiplies within year indices to provide long-run, multiple year indices (Ralph et al. 2015, p. 145). Where the Carli is used, multiplying Carli indices leads to spurious cross terms which result in larger index number values when compared to direct indices. ONS published research on estimating drift for different choices of elementary aggregate formulae (Clews et al. 2013). This work showed significant drift resulting from the use of the Carli; in comparison, the Dutot shows very little drift, as does the Jevons. This suggests that the axiomatic failing of the Carli is a problem in the practical implementation of the formula in a chained index.

13.3.4 Consultation on Improving the RPI

After the National Statistician had reviewed the evidence gathered by ONS, and received expert advice, she sought the views of the user community through a consultation (ONS 2012e), which was announced in September 2012. The consultation ran from the publication of the consultation document on 8 October 2012 until the end of November.

The same consultation included proposals for improving the measures of private rental prices in the RPI and the CPI.

The four options for improving the RPI were:

- No change, leave the formulae the same;
- Change the formula for clothing only; this would reduce the formula effect, but not eliminate it;
- Change the formula for all categories that use it; this would reduce the formula effect further, but not eliminate it;
- Change all formulae to match those in the CPI—this would eliminate the formula effect completely.

The invitation to respond to the consultation asked specific questions:

- Which option do you prefer?
- What are the methodological reasons behind your preference?
- Do the options have implications that you would like to draw to the attention of the National Statistician?

The consultation was advertised on the ONS website, in the Consumer Prices Bulletin, on the Royal Statistical Society's website and on social media. The ONS held four public meetings during the consultation period in London, Edinburgh, Cardiff and Belfast.

A large number of responses were received—406 in total: 99 were from institutions and the remaining 307 from private individuals. A summary of the responses was published in February 2013 (ONS 2013b). The preferences were split 322, 9, 4 and 7 respectively for the four options with the remainder not expressing a preference; the clear majority of respondents favoured the first option—"no change". Many explained the detrimental impact that a change would have on their savings, pensions and investments. Some respondents were concerned about the impact of a change on contracts and said they would consider legal action if a change was made. Other respondents objected to the use of a geometric formula on statistical grounds. Sixty-four of the responses were statistical in nature and 44 of those preferred option 1. Of these 64, four contained detailed statistical and economic analysis.

A large number of the statistical responses echoed the traditional view that the Jevons formula is suitable where substitution occurs and the Carli formula where it doesn't. Some respondents stated that including substitution behaviour was not appropriate for a consumer price index. There was also concern about a change of formula producing a break in the long-running RPI series with several responses noting that there was significant value in maintaining such a long-run series with few changes of methodology.

Some respondents commented on the time reversal axiom which figured strongly in the expert advice given by Professor Diewert in his report. There was disagreement about the importance of this axiom, which the Carli fails but the Jevons satisfies. The National Statistician's response summarised the statistical points raised and provided responses to them.

Part two of the consultation concerned making changes to the data used to calculate the index of private rental prices. The ONS proposed to use rental data from the Valuation Office Agency in England, with equivalent data from Wales, Scotland and Northern Ireland; this would increase the number of rental prices available to ONS from 1400 to about 800,000. On the question of the change in data, only 83 comments were received and two thirds of those supported the proposal.

13.3.5 Overall Conclusions

Taking together: the expert advice, ONS research and the responses to the consultation, the National Statistician came to the following conclusions:

- the Carli formula used in the construction of the RPI does not meet international standards and a new index should be created. The new index would be known as the RPIJ, with the Carli formula being replaced by the Jevons; this would be a version of the RPI which would meet international standards;
- the RPI has significant value as a long-running series and that it should be maintained in its current form. This would enable it to

continue to be used for long-term indexation and for index-linked gilts to meet user expectations;

- the change to the data source for the index of private rents should go ahead subject to approval by the Bank of England.

The Bank of England approved the change for the rental series—the Bank considered the change to be in line with the general principle that components should be measured as accurately as possible. At the same time, this change of the source of rental information was not considered a fundamental change to the index and not materially detrimental to index-linked gilts. The change was made for the February 2013 index, which appeared in March 2013.

The UK Statistics Authority Board accepted the three recommendations.

13.3.6 Introducing the RPIJ

In March 2013, ONS produced a paper on the new index which described the methodology and produced a back series for the RPIJ from 1997 to 2012 (Bird 2013). The article identified the elementary aggregates where the Carli formula had been replaced with the Jevons. It compared the RPI and the RPIJ, with the latter showing a lower inflation rate, which was as expected, as a geometric formula produces smaller values that an arithmetic one (unless all the values are the same, in which case, the two are identical). The new index was introduced alongside the RPI in the March 2013 Consumer Prices statistical bulletin.

In 2014, Peter Levell, an economist working at the Institute of Fiscal Studies, carried out an independent analysis of the conclusions the UK Statistics Authority had reached that the Carli index was flawed and that the Jevons provided a better basis for calculating price change at the unweighted elementary aggregate level (Levell 2014). He concluded that there was a sound case that the Carli formula was flawed and that the Jevons formula was to be preferred.

13.4 Owner Occupiers' Housing

13.4.1 OOH Consultation

Chapter 8 identified the treatment of owner occupiers' housing costs as perhaps the most challenging of commodities within the scope of consumer price indices. Housing can be considered to be unique among the commodities in the index, as it is a durable item which is sometimes treated as an investment and usually comes with a long-term credit arrangement. This section looks at the steps that were taken to decide on the most suitable approach for the UK. The development is described here for the whole period 2009 to 2016 rather than splitting it between two chapters.

There are three main ways of treating owner occupiers' housing costs in a consumer price index: the acquisition, payments and user costs approach (Berger 2009a):

- the acquisition approach takes into account the total value of goods and services delivered during a given period, whether or not they were wholly paid for by consumer within that period;
- the payments approach takes into account the total payments made for goods and services during a given period whether or not they were delivered;
- the user cost (consumption) approach takes account of the total value of all goods and services consumed during a given period.

For the majority of goods and services included within a consumer price index, there is only a short period between acquisition and consumption and the three approaches differ little. It is for durable goods and housing that differences arise.

The treatment of owner occupiers' housing (OOH) in consumer price indices was the main topic for the early meetings of CPAC and featured consistently in its work. A paper presented at the first meeting described the background to incorporating OOH costs into the RPI and then looked at the progress made by ONS on a measure for CPI

(Berger 2009a). Eurostat had funded a pilot study involving most EU member states for a number of years to identify the feasibility of incorporating OOH into the HICP using the net acquisitions approach, identified at the time as the most suitable approach to measuring costs associated with OOH for comparison purposes. The complexity of the subject meant that there was no set date by which all EU countries were required to be able to produce the HICP containing an OOH measure (at the time of writing, this is still the case). The paper considered the three major approaches—payments, use and acquisitions. The use approach can be divided into two types—narrow user cost and rental equivalence. This initial paper considered which approach was most suitable for the UK, taking into account both consistency with the conceptual framework of the HICP and the practicality of implementation. At this stage, the net acquisitions approach was considered to be the most suitable (Berger 2009a).

The Consumer Prices Advisory Committee (CPAC) held its first meeting in July 2009. At the second meeting in September 2009, ONS presented work they had carried out on a case study which calculated inflation including four approaches to measuring OOH—payments, rental equivalence, user cost and net acquisitions, covering the period from the start of the CPI in January 1996 to June 2009 (Berger 2009b). This paper invited the members of the committee to recommend one of the approaches for use in the UK. Annex F to the paper contained the results of the calculations with graphs comparing the values of inflation for each approach. The paper also reviewed the chosen approaches for a range of countries in their domestic measures of inflation; they showed that rental equivalence was used most frequently, though some countries didn't include a measure at all. The paper noted that if the UK's choice differed to Eurostat's choice, then the UK would have to produce three indices—the RPI family, a CPI including the net acquisitions measure and a CPI including the UK's choice of measure. Consideration of the four approaches resulted in one being dropped—the payments approach. This was not considered suitable for further consideration or development because of the inclusion of interest payments which was seen as being at odds with the use of the CPI in targeting inflation; this was similar to the situation where inflation targets based on the RPIX had previously excluded mortgage interest payments.

Further papers on the topic were presented at the following meeting of CPAC in December 2009. Firstly, a paper examined the treatment of OOH in the National Accounts, based on the 2008 System of National Accounts (ONS 2009b); the aim was to provide the members of the committee with useful reference information to help them decide on the best measure for the UK. Two more papers on OOH were presented to the committee at this meeting—one examined the net acquisitions measure in more detail, including the data sources for the measure and showing experimental series (ONS 2009c); the other presented the same topics for the rental equivalence measure (ONS 2009d). The documents set out criteria for judging the effectiveness of the measure using a wide variety of quality indicators. The committee members requested that ONS carry out similar work for the narrow user cost approach, to be presented at the next meeting.

The committee next met in March 2010, where the work on the narrow user cost approach was presented (ONS 2010a). With information on the three options for accounting for owner occupiers' housing costs available to the committee, it was time to consider what further steps would need to be taken to support the decision-making process. The summary position of the committee's thinking at this time was summarised in the paper: "Next Steps for OOH" (ONS 2010b). It stated that there were differing views within the committee and that ONS would carry out further work to help the committee come to an overall view. The paper proposed the trial production of the three measures of OOH and consultation with users to gain their views. During the discussions at committee meetings, members suggested improvements to all three measures which helped ONS to develop them further.

At the July meeting of CPAC, ONS presented a paper (ONS 2010d) which aimed to document all the necessary information on which a decision could be based. The paper was supplemented by eleven annexes covering details of the three approaches, the Eurostat position, a possible development plan, quality criteria to assess each approach and a set of references relevant to OOH.

Up to this point, the committee hadn't made papers or minutes available to the public and commentators suggested that this should change. A proposal for publishing papers with some exceptions was discussed by the committee and agreed (ONS 2010e). This included agreement that previous papers should be published.

At the September meeting, a paper was presented which summarised the work to date and the recommendations of the committee to be presented to the UK Statistics Authority Board (ONS 2010f).

There were four recommendations:

- ONS should develop CPI including housing indices using the net acquisitions and rental equivalence approaches to OOH;
- ONS should carry forward a programme of developmental work to improve the net acquisitions and rental equivalence OOH indices and report on progress to CPAC on a regular basis;
- ONS should publish the results of their research to date and consider whether to publish "in development" net acquisitions and rental equivalence CPI with housing indices on a regular basis;
- developing CPI with housing indices should be a high priority for ONS and sufficient resources (an estimated 30 months' full time equivalent of analyst time) should be made available to complete the work programme in the next two years, taking into account other priorities.

The paper also noted that the committee had recommended not continuing with development of the narrow user cost approach. The main reason being that it required an element of subjective judgement of the real rate of interest, the value of which influenced the measure in a significant way. ONS presented a development plan which would require two years' effort to improve the implementation of the net acquisitions (NA) and rental equivalence (RE) methods.

The recommendations were presented to the UK Statistics Authority Board in the 2010 CPAC annual report (ONS 2010h). The Board met at the end of September 2010 and approved the plans to develop the net acquisitions (NA0and rental equivalence (RE) methods for OOH (ONS 2010i).

A progress report on the development of experimental series for both approaches was presented to the committee at the March 2011 meeting (Thomas and Miller 2011). It identified aspects of the methodologies for both approaches that were being developed. For the rental equivalence (RE) method, options to improve the private rents series used in both the CPI and RPI were being considered, with the recommendation that ONS should approach the Valuation Office Agency and the equivalents in Wales, Scotland and Northern Ireland regarding access to their databases of rental information. On the net acquisitions (NA) approach, improvements to the house price index, which was an input, together with the possibility of excluding land prices were being explored.

To help the development work, guidance was sought from the Government Statistical Service's Methodology Advisory Committee (MAC) at their May 2011 meeting; the MAC is a group comprising statistical experts drawn from academia, other National Statistical Institutes and private organisations. Statisticians within the Government Statistical Service submit papers outlining a topic together with questions for the group to discuss and provide advice.[4] ONS asked the group to comment on their current development work on the NA and RE approaches to OOH (Davies and Campbell 2011). The committee was supportive of the ONS work and provided suggestions on issues to explore when developing the methods; the advice was documented in the minutes which were presented at the following CPAC meeting (GSS 2011).

ONS progress with developing both OOH methods was reported in the May 2011 meeting of the committee (Green 2011a; Thomas et al. 2011). For the NA method, ONS was looking to improve the measurement of major repairs and maintenance, the effect of not including cash purchases in the house price index and the effectiveness of the measurement of stamp duty. For the RE approach, ONS was in discussions

[4]For a description of the group and its function, see: http://webarchive.nationalarchives.gov.uk/20160105160709/http://www.ons.gov.uk/ons/guide-method/method-quality/advisory-committee/index.html.

with the Valuation Office Agency (VOA) exploring the use of their rental data. Further progress was reported at the July 2011 meeting (Green 2011b); ONS noted that discussions had been held with the Welsh, Scottish and Northern Ireland administrations regarding use of their rental data. Progress on the NA approach was also reported, with further development of the extension of the minor repairs and maintenance measure to provide a major repairs and maintenance series (Thomas 2011).

The discussion at the November CPAC meeting considered the possible implications of the UK using a different method for including OOH. The committee's view was that it would be willing to see a UK headline measure different to that produced for Eurostat. It would mean three measures being produced—a UK headline measure, a measure for Eurostat and the RPI. The former would no longer be governed by HICP regulations and would need new governance arrangements (ONS 2011e).

A paper reporting progress on developing the two OOH measures set out a timetable for the committee to make a recommendation on which measure was to be used for the UK and when it would be implemented. This identified March 2012 as the date for a decision by the committee, followed by a public consultation, a final decision by the UK Statistics Authority Board in September 2012 and implementation in early 2013. For the European measure, draft regulations had been produced which required EU countries to produce quarterly OOH indices using the NA approach starting in the third quarter of 2014 (Thomas and Mistry 2011). A paper reported progress with developing the RE measure (Casey and Thomas 2011); a timetable had been agreed with the VOA where they would supply a rental series to ONS specifications by February 2012. Legal permission was being sought from the Scottish Government to use their rental data. For the NA approach, work was focussed on improvements to the repairs and maintenance and renovations series.

The development work on both the NA and RE methods was now almost complete. The committee signed off the NA methodology at the February meeting and final methodology for the RE approach was expected at the next meeting in April (ONS 2012a). The timetable for deciding the UK measure and for its publication was confirmed. The new CPI index containing a measure of OOH would be called CPIH, and the February 2013 index, published in March 2013 would be its first appearance. The UK Statistics Authority would be asked to decide whether this would then become the UK headline measure.

To assist the committee in their considerations of whether the NA or the RE approaches to OOH would be best for the UK, a paper (Campbell and Thomas 2012) was presented at the February 2012 meeting, identifying criteria to be used, based on previous work for the committee, together with considerations of standard statistical quality and the Code of Practice. It was recognised that some criteria would be more important than others, so importance levels of 1–3 were assigned to each criterion. Papers reporting the progress with both the NA (Thomas et al. 2012) and RE (Casey and Thomas 2012) approaches were presented at this meeting.

13.4.2 A Recommendation

At the April 2012 meeting, ONS presented a paper (Campbell and Mistry 2012) which took each of the criteria agreed at the February meeting and evaluated the two methods against each criterion; the paper also contained graphs showing the index series for both the NA and RE approaches between 1989 and 2011. A decision was reached at this meeting that the RE method should be recommended as the best for the UK; the reasons were set out in the CPAC April 2012 Meeting Summary Note (ONS 2012b). The committee felt that the RE approach better met the quality criteria, with the exception of the inclusion of imputed prices, which they didn't feel was a major issue. Other reasons for the adoption of this method included: the exclusion of asset prices, compatibility with National Accounts and the quality of the underlying data source.

13.4.3 The Public Consultation

Following the recommendation of the committee at the April 2012 meeting and its acceptance by the UK Statistics Authority, the National

Statistician sought the views of the public via a consultation (ONS 2012c). It was launched on 11 June 2012 and closed on August 31. The consultation sought views on two topics:

- whether the choice of rental equivalence as the method to reflect owner-occupied housing in a new measure of inflation—CPIH—would meet user needs;
- whether the CPIH should be accepted as the main measure of inflation rather than the CPI.

The number of responses, at twenty, was small, but in line with most consultations; the consultation on elementary aggregates was an exception with its 406 responses. Fourteen responses were from organisations, including Trade Unions, pension groups and the Royal Statistical Society; the rest were from individuals. While most were split between NA and RE approaches, and a few preferred the payments approach, all supported the inclusion of owner occupiers' housing costs in the measure of inflation.

Arguments against the RE method included: rental equivalence was based on an imputed transaction, while NA uses actual costs; rents charged reflected what the market would allow rather than the actual cost of shelter services and the movement of RE indices don't capture house prices in booms nor mortgage interest rates. Respondents supporting RE noted that NA includes the asset price and therefore capital gains which makes it less suitable for inflation targeting; also RE was a relatively simple approach to explain to those users who were less familiar with the full range of approaches.

The idea of using CPIH as the main measure of inflation in future was supported with some exceptions; some responses stated a preference for the RPI to be used for uprating purposes. ONS published a summary of the responses and a set of comments on the specific points raised by respondents (ONS 2012f).

The responses to the consultation were considered by CPAC at their September 2012 meeting. They came to the conclusion that no new points were raised, so the committee decided to stay with its recommendation for RE as the preferred measure of OOH. This recommendation was accepted by the UK Statistics Authority Board in September 2012 (ONS 2012d). The first publication of CPIH(RE) followed in March 2013 as an experimental statistic as planned, together with a paper which explained how it was calculated (Restieaux 2013).

13.4.4 UK Statistics Authority Assessment of Consumer Price Statistics

The two developments in consumer price statistics arising from the work on owner occupiers' housing costs and the formula effect resulted in two new measures of inflation (CPIH and RPIJ). The UKSA carried out a further assessment review (sooner than would normally have been expected after its initial assessment (UK Statistics Authority 2010)). It reported in July 2013 (UK Statistics Authority 2013a).

This review decided that CPI (and its variants, such as CPI-Y, that is, CPI minus indirect taxes) should continue to be National Statistics and the new measures CPIH and RPIJ could become National Statistics subject to specified improvements being made by the end of 2013. These recommendations included publishing advice on the strengths and weaknesses of the different measures of inflation and improved methodology and quality information.

In the following months, Prices Division in ONS carried out the actions specified in the assessment report and the UK Statistics Authority Assessment Committee wrote to ONS (UK Statistics Authority 2013b) agreeing that the requirements had been met and CPIH was granted National Statistic status in November 2013; this removed the experimental status from this measure of price change.

13.4.5 Concerns About the Rental Methodology

During the 2014 calendar year, commentators raised questions about the movements of the ONS private rental series when compared with rental data published by the Valuation Office Agency (VOA) using the same underlying data. ONS and VOA examined the methodology

(Campbell 2014) and identified four areas in which improvement could be made—particularly the identification of comparable properties in the sample of properties for which rents are obtained.

Concerns with the rental methodology led to an exchange of letters between the National Statistician and the chair of the UK Statistics Authority (UK Statistics Authority 2014b). This resulted in the CPIH having its status as a National Statistic suspended in August 2014. The methodology was of particular importance as it produced the indices of private housing rents which were incorporated into the OOH component of CPIH, the separate rental statistics output—the Index of Private Housing Rental Prices—and the rental components of the CPI, RPI and the various sub-indices.

Improvements to the OOH methodology were developed by ONS working with the VOA (Lewis and Restieaux 2014). The CPIH and the Index of Private Housing Rental Prices were recalculated and compared to other rental statistics, including those produced by the private sector. This analysis identified a range of reasons why the statistics were different; for example, the VOA rental statistics were averages which include changes in the composition of the rental market, while the ONS rental statistics were price indices which factor out compositional differences.

The improvements for the OOH component of CPIH were made alongside the usual annual updates to consumer price statistics and appeared in the March 2015 statistical bulletin. Changes to the rental components of the CPI, RPI and RPIJ were made at the same time.

13.4.6 UK Statistics Authority Re-Assessment

Following the work to improve the methodology behind the rental series, the UK Statistics Authority re-assessed the housing component of CPIH, publishing its report in March 2016 (UK Statistics Authority 2016). They concluded that insufficient work had been carried out for the statistics to regain their National Statistics status. The recommendations made included more work to quality assure rental data, to monitor the variation over time relative to other rental indicators and to explain the differences, and to explain further the decision to choose RE as the measure for the UK. This work resulted in the CPIH regaining National Statistic status in July 2017.

13.5 The Johnson Review

13.5.1 Background to the Review

The years 2009–2013 saw many changes to the methodology of consumer price indices, and this had attracted a lot of attention from both the statistical and economic community as well as the general public. A number of questions had been raised during the many consultations and public meetings and it was clear that there was concern over whether the measures being produced were the right ones, and whether they were using the best methodologies.

To address these concerns, the UK Statistics Authority decided to commission an external, wide-ranging review of consumer price indices. On 16 May 2013, Sir Andrew Dilnot asked Paul Johnson, the Director of the Institute of Fiscal Studies, to carry out a review of UK consumer price statistics.[5]

The original date for the completion of the review with the delivery of a report was Summer 2014; however, the wide range and complexity of the issues meant that more time was needed to complete the work and the final report was delivered in January 2015.

In order to undertake the review, an expert group was convened to advise Paul Johnson and support was also provided by staff from within ONS. This group consisted of five respected experts with national and international experience—John Astin, Bert Balk, Richard Barwell, Robert Hill and Martin Weale. A range of ONS staff who worked in the price statistics, economics and methodology groups at ONS supported the review, including dedicated support from two members of staff.

[5] https://www.statisticsauthority.gov.uk/news/statistics-authority-launches-reviews-of-price-indices/ (accessed 10 June 2017).

13.5.2 The Terms of Reference

The complexity of the measurement of consumer price inflation with its large research and experience base, meant that no review could examine all aspects of the methodology and use. Therefore, the review had to be selective in its approach. The UK Statistics Authority set the terms of reference as follows:

- recommend a framework of consumer prices statistics that will understand and best meet the needs of users, and be accountable, flexible, transparent and no more burdensome than is clearly justified;
- promote recognised and high-quality statistical standards;
- consider the arguments for using cost of living or cost of goods concepts;
- consider how public and private sectors can best work together, using all possible data to maximise quality and efficiency;
- work within the findings of the Authority's review of the governance arrangements and structures supporting the production of price statistics.

In carrying out the review, further constraints had to be applied to the work conducted. The review would not seek to re-examine issues already explored in detail in previous work; for example, it didn't reconsider the arguments explored in the choice of elementary aggregate formulae in the RPI. The review had also to limit the degree of detail for each topic it examined.

To assist the review, ONS was asked to carry out new work on a few selected topics. Given the limits of time and available ONS resources, great care was taken over what new work was commissioned. The output of this research work was published as a set of research papers issued alongside the review report.

Consultation with a wide range of users and commentators was an essential part of the review. The groups consulted included: HM Treasury, the Ministry of Defence, the Department for Work and Pensions; the

Bank of England, the Royal Statistical Society, the Low Pay Commission and the Consumers' Association. The final report was published in January 2015 (Johnson 2015).

Within the terms of reference, the review considered two questions:

- what should we be measuring?
- how should we measure it?

The review recognised the fundamental point that when measuring inflation, there are many choices that can be made for what exactly we are trying to measure. It is useful to consider three broad aspects of measuring inflation where choices have to be made:

- the concept or concepts being targeted;
- the number of variants of inflation measures that are needed;
- the many technical choices of measurement for specific items.

The following sections look at each of these types of choices in turn, some of which have informed the discussions elsewhere in this book.

13.5.3 Inflation Concepts

The review looked at three variants of what can be meant by "inflation":

- a measure of the change in prices between two time periods;
- the increase in the spending required to achieve the same level of welfare between two time periods;
- the increase in payments made by households to achieve the same level of consumption between two time periods.

The first type of index is a traditional price index in which the change in price of a fixed representative basket of goods between two time periods is measured, with weights applied to account for different expenditures on different types of goods and services; this is a cost of goods concept. It is the traditional measure that National Statistics Institutes produce for assisting central banks in setting interest rates and targeting inflation.

The second type of index is known as a cost of living index and is much more difficult to measure. At the time of the review, ONS had been developing an approximate cost of living version of the CPI and this work was completed in time to provide evidence for the review (Clews et al. 2014). A few commentators prefer this type of measure and a few National Statistics Institutes have attempted to produce them on an experimental basis.

The third type of measure is sometimes called a household index. It aims to more closely match the actual payments that households make and so is more in tune with the experience of consumers.

13.5.3.1 Concept 1: A Price Index

The review considered which of the measures currently produced best meet this need. The candidates were the RPI, RPIJ, CPI and CPIH. The conclusion was the latter—it was judged to be the best measure of price change in the household sector. Although the CPIH was not yet a national statistic, the review recommended this measure. The issue with the quality of contributing data was seen as a temporary position and would be addressed in time.

13.5.3.2 Concept 2: A Cost of Living Index

Like several National Statistics Institutes, ONS had been looking at calculating a version of a cost of living index for some time. There are several methods that could be used and these were identified in Chap. 12. The simplest approach is to use a superlative index formula such as the Fisher or the Törnqvist at the upper levels of the aggregation structure (Ralph et al. 2015, Sects. 8.6 and 12.4). This approach to estimation had been taken by Australia, New Zealand and the US. The main difficulty being that weights are needed at the current time period as well as for the reference period. As "current" weighting information is only available with a lag of 1–2 years, such indices can only be calculated retrospectively. There are further complications arising as weighting data is on an annual basis when it is required on a monthly basis. ONS used annual weights and investigated the sensitivity to changes in the weights, which was found to be small.

The results were published in a paper which accompanied the review report (Clews et al. 2014). The properties of the mathematical form of the index formula mean that in most economic circumstances the cost of living measure is lower than the cost of goods measure—this is what was found. The review recommended that ONS continued to develop this measure and produce this type of measure on an annual basis as an experimental statistic.

13.5.3.3 Concept 3: A Household Index

The review considered the case for producing this type of index in additional to the conventional price index. A household index asks the question: by how much would income have to increase to meet the rising costs faced by households? The exact specification of such an index wasn't agreed; however, a number of possibilities were discussed. For example, it could include mortgage interest and could treat the costs of insurance differently to the traditional price index. The CPIH would account for the net cost of insurance, which is the premiums paid minus the claims paid out, while a household index might just include the costs of the premiums ("gross" payment rather than "net").

The review concluded there was a case for developing a household index, but not as one measure to cover the household expenditure of all households. Such a measure would need to be produced for different types of households which face different costs. It noted that this differed to the price index case which has a sound foundation as a coherent overall measure. The review also recommended that household indices should be produced alongside comparable measures of income.

Looking internationally, the Australian Bureau of Statistics has produced similar household measures but with several versions applicable to different household types (ABS 2017). In addition, to avoid confusion between a set of household indices and the main measure, household indices should be produced annually rather than monthly. The overall recommendation of the review was to proceed with developing a set of household indices for a range of household types as experimental measures.

13.5.4 The Position of the RPI

As noted above, the review didn't re-examine the consultation on how price quotes should be combined at the lowest level of the index. It did take a view on the National Statistician's conclusion that the Carli formula does not meet international best practice. ONS produced an alternative measure—the RPIJ—which replaced the Carli formula with the Jevons formula. The review rejected the RPI (and the RPIJ) as an effective measure of consumer price inflation, not just because of the use of the Carli, but for other methodological reasons including the population coverage and treatment of some commodities such as insurance and owner-occupied housing.

The review did consider the overall position of the RPI as a consumer price index. It noted that although the measure possesses methodological flaws, it cannot be simply discarded. It is used in Government gilts, commercial contracts, some pension schemes and a number of Government measures.

There is another, different attribute of the measure which came out of the RPI consultation—its value as a long-running measure produced on similar terms. The CPI, in contrast, was only introduced in 1996. To help with economic modelling, the CPI was calculated back to 1989 using the price microdata that had been retained; the microdata for the period before 1989 had not been kept. Despite the lack of such data, ONS was asked to produce a version of the CPI back to 1950. To achieve this, a set of modelled series were produced using time series techniques (O'Neill and Ralph 2014).

The review recommended that the UK Statistics Authority should move to end the use of the RPI as soon as possible. It should re-state the position that the RPI is flawed and it should not be used for any new purposes and should be ended for all purposes except those where a contractual commitment has been made. It also recommended that derived series such as the pensioner series should be discontinued. If these series were needed, they should be reconstituted based on the CPIH.

13.5.5 Improvements to the Methodology

13.5.5.1 Price Quotes

The review examined the sources of price information and how price quotes are combined. For sourcing, it recommended that ONS move more quickly towards the use of web scraped and supermarket scanner data, setting out a detailed plan for how a move would be made towards greater use of these sources.

At the elementary aggregate level, the review recommended that ONS should publish clear criteria for how it chooses the formula used to combine price relatives.

13.5.5.2 Expenditure Weights

The price changes for each commodity type are weighted together to produce an overall measure of price change, with the weights being the expenditure shares. The review looked at the sources of the weights. Chapter 9 considered this topic in detail and the challenges in producing high-quality expenditure information. The weights for the CPI come mostly from a combination of the Living Costs and Food Survey (LCF), National Accounts data and, in places, market research data.

The review expressed concern about the quality of the weighting data from the LCF; in particular, the trend of falling response rates. It was also concerned about the need for more detailed weighting information to support the production of household indices for different types of household—this would require expenditure weights to be derived from expenditures from sub-samples of the overall sample of households.

The volatility of some expenditure weights was also examined. In some cases, the National Accounts weights were highly volatile (e.g. those relating to annual expenditure on gas) and as a result the review suggested that weights should be derived from several years' worth of data.

13.5.6 Other Methodological Recommendations

The Johnson review also considered the changes in the types of outlets that consumers visit, with switching from corner shops to supermarkets to on-line shopping. It recommended ONS to explore how this "outlet substitution" effect was being captured in consumer price indices.

On housing, the review supported the use of the rental equivalence method for including owner occupiers' housing costs. It recommended that ONS ensure that the differences between rental price indices and the average price measures produced by the Valuation Office Agency were understood and explained. It also recommended the inclusion of Council Tax in the CPIH.

The review noted that discounting of products was included in the current methodology but only to a limited extent. Multi-buy discounts weren't currently included, for example. The review was concerned that the wide range of types of multi-buy discounts wasn't being included sufficiently and recommended that ONS study the changing nature of discounting and its effects on consumer price indices.

13.5.7 Public Consultation

In the light of the recommendations, the National Statistician launched a public consultation to capture the views of institutions and members of the public who use and have an interest in consumer price indices (UK Statistics Authority 2015a). The consultation ran for fourteen weeks from 15 June to 15 September 2015. As usual with consultations, a number of specific questions were identified, and respondents were asked to submit their views.

The consultation document asked specific questions in four areas:

- measuring prices across the economy—should the ONS identify a main measure and what should it be? Should the measure be governed by legislation?
- should ONS seek to measure inflation for household types? How should it go about this?
- which sub-indices of the RPI do you use and which should be discontinued?
- are the priorities identified in the future work plan of ONS (published alongside the consultation document) appropriate and should council tax be included in the CPIH?

Four public events were held in the Summer of 2015 in London, Belfast, Edinburgh and Cardiff; several additional meetings were also held.

After the consultation closed, the UK Statistics Authority reviewed all the responses and published a summary in November 2015 (UK Statistics Authority 2015b). Responses were received from individuals, businesses and public bodies; there were 84 responses in total with 24 from individuals.

Half the respondents felt that the CPIH should be the main measure while others supported the RPI, or the proposed household inflation index. Some felt that no main measure should be identified. The preference was that the main measure should not be governed by legislation. There was strong support for measures of inflation for different household types, and that these should be constructed using a payments type approach.

For the RPI, the sub-indices, such as RPIX and RPIY were reported as the most used, with an important presence of the RPIX in financial contracts, with less support for other sub-indices and analytical indices. Some respondents felt that all of the RPI family should be maintained, and some suggested they should all be discontinued.

For the work plan, respondents mostly disagreed with the priorities and suggested changes; the main suggestion was that the development of the household index should be a high priority.

13.5.8 Outcome of the Review and the Consultation

In the response to the consultation, the National Statistician said that in deciding how to move forward, he would consider the recommendations of the Johnson Review and the public consultation and would take into account the views of the regulatory part of the UK Statistics Authority together with the views of the newly formed Advisory Panels on Consumer Prices.

The Advisory Panels presented their advice to the National Statistician in March 2016. They broadly supported the identification of a "main measure" though acknowledging that the broad range of uses meant that a number of measures would be required. The majority view supported a move to the CPIH using the rental equivalence approach to measure owner occupiers' housing costs as the main measure.

13.6 Concluding Remarks

This chapter has looked at an intense period of analysis, consultation and change. The Office for National Statistics produced a large number of discussion documents together with research papers which explored the many topics that arose over this period. The most significant recommendations for change were subject to public consultation and the responses carefully examined and taken into account when decisions were made. The sequence of consultations and reviews is summarised in Box 13.1.

Further scrutiny was provided by the Johnson Review which delivered an extensive examination of consumer price indices; the resulting recommendations informed the future development of the indices. A National Statistics Quality Review examined the aspects of the methodology behind the Living Costs and Food Survey. A range of recommendations were made and several work programmes were initiated as a result.

Box 13.1: Summary of Consultations, UKSA Reviews and UKSA Assessment Reviews, National Statistics Quality Review

Consultations

Year	Topic
2009	Measurement of Mortgage Interest Payments within the Retail Prices Index
2010	Redesign of the Consumer Price Indices Statistical Bulletin
2010	Change in the method to measure seasonal items
2011	Measurement of car prices
2012	Amending the RPI is constructed at the lowest level of aggregation
2015	Measuring Consumer Prices—the options for change (following the Johnson Review)

UKSA Reviews

Year	Topic
2013	Governance
2013	Johnson Review of consumer price indices

UKSA Assessment Reviews

Year	Topic
2013	Statistics on Consumer Price Inflation, Report 257
2015	Statistics on Consumer Price Inflation including Owner Occupiers' Housing Costs, Report 322

National Statistics Quality Review

Year	Topic
2016	Living Costs and Foods Survey

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14
Other Price Indices

Throughout this book, we have concentrated on the history and development of the measurement of consumer prices. In many ways, this is the most complex part of the story, with many methodological and political challenges and a high public profile influencing the route taken. But there are many other measurements of price changes which form part of the kaleidoscope of information which helps us to understand the evolution of prices, and the interrelationships of different pricing pressures in the economy. In this chapter, we examine the range of types of price indices currently produced, and how they differ in their approaches and methods from the Consumer Prices Indices.

The main area where price information has been utilised over a long period is to help in the understanding of business output and the economic development of the country. A range of price indices reflecting the prices paid, or charged, by businesses have therefore been used, and the first part of this chapter concentrates on the current versions of such measures:

R. O'Neill et al., *Inflation*, DOI 10.1007/978-3-319-64125-6_14

- the Producer Price Index (PPI), known as the Wholesale Price Index until 1983, which measures the costs of goods as they leave the factory gate, and which has the longest pedigree;
- Import and Export Price Indices (IPI and EPI) which cover the costs of goods as they cross the border of the UK;
- the Services Producer Price Index (SPPI), which performs a similar function to the PPI, but covers the costs of services provided to businesses (as distinct from those provided to consumers, even though some of the services are the same).

The second part of this chapter covers a small range of other price indices—the House Price Index (HPI), implied deflators, and also looks at the mechanisms which support the calculation of Purchasing Power Parities (PPPs).

14.1 The Producer Price Index

The prices of inputs of raw materials for industry have been available from a variety of sources for much longer than retail prices have been systematically collected. In the nineteenth century, a major source of price information for commodities was imports, and collated prices were published in *The Economist*, and in many articles. Some price statistics for selected commodities were published by the Board of Trade in its *Miscellaneous Statistics of the United Kingdom*, for about 25 years from 1855, but when they were discontinued, there was no official publication concerned with prices across the economy. The main efforts in the area of price compilation were the province of universities, and there is a sequence of papers read to the Royal Statistical Society (and its antecedent the Statistical Society of London) on measures of producer prices over more than a century, starting with Jevons (1865).

The first systematic compilation of prices was by W. Stanley Jevons, one of the founders of mathematical methods in economic thinking. He was one of the people who first formulated the idea of utility, which has had an influence on the debate about elementary aggregates and leads to the elementary aggregate that bears his name (see Chap. 11).

Table 14.1 Weighted and unweighted producer price indices for selected years, from Sauerbeck (1886)

Year	Unweighted index	Weighted index
1849	74	72.5
1873	111	115.2
1885	72	71.2

NB The different numbers of decimal places appear in the original

Jevons had spent time working as an assayer in the Sydney Royal Mint in Australia, and after completing his studies continued an interest in the value of gold. He published a book on the social effects of a large fall in the value of gold (Jevons 1863) and then, while working as Professor of Political Economy at Queen's College, Liverpool, continued to investigate the effects of the value of gold. This led to a paper, read to the Statistical Society of London (Jevons 1865), providing a series of producer prices (in fact, for many years, they were called *Wholesale Price Indices*, but in this account, we have standardised the terminology on Producer Price Indices (PPI)), based on the purchasing power of gold and using an unweighted index, with annual values from 1782 to 1865. Jevons's idea was that there was an underlying change in all prices and that this could be estimated from a series of commodities; he argued for the use of the geometric mean to obtain this estimate.

The challenge of estimating changes in long runs of prices was picked up by Sauerbeck (1886), who was also interested in the supply of precious metals and its impact on commodity prices. He took a similar range of commodities to that used by Jevons, extracting prices from official publications and from information supplied by businesses, and produced a run of annual price indices from 1846 to 1885. His approach contrasted with Jevons as he used the unweighted arithmetic mean to construct his indices. Sauerbeck also calculated weighted versions of his index for three example years, which did not affect the long-run pattern of price change (Table 14.1), though the differences would be important in a modern analysis of similar statistics.

Publication of prices information moved back into the official sphere early in the twentieth century with a large project from the Labour Branch within the Statistics Department of the Board of Trade, which gathered together price information from a variety of sources as far back as could be reasonably discovered and where price information was reasonably continuous—in many cases the same sources as had been used by Jevons and Sauerbeck. Forty-five broad commodity groups were used, and a further innovation was added by introducing weights in the arithmetic averaging (effectively moving to a Laspéyres index). These indices were published in a report to Parliament (Board of Trade 1903) containing tables for many commodities, and also a continuous series of overall producer prices from 1800 to 1902 using data from Jevons's and Sauerbeck's earlier publications, suitably adjusted to a base year of 1871. The most recent information was taken in each case, and no account was made for the differences in methods used in the index construction. This report was also the first official compilation of retail prices, for which sources were much poorer (see Chap. 5).

The publication of the Board of Trade's index was then continued, until 1921, in the Labour Gazette. Sauerbeck's index was also updated regularly in The Statist, so both unweighted and weighted indices were available to interested parties. In addition, there were other unweighted indices calculated in the Economist and The Times. All of these indices were based on relatively small numbers (between 22 and 47) of commodities. In some cases, the commodity prices were averages, in the Board of Trade's case mainly average prices of imports or exports, though some of the other indices involved one, or at most a few, prices for particular commodities. Contrast this with the corresponding index compiled in the USA by the Bureau of Labor Statistics, which used 90 commodities and more than 250 price quotes (Flux 1921).

During the First World War, it became quite difficult to obtain all the necessary price inputs because imports and exports did not operate under market conditions. Even when prices were available, the averaging of import and export prices did not account for quality change, or change in the composition of goods within particular classifications. There were some notable lags in changes in the Board of Trade's price index as compared with other indices, as the price was measured on importation, not when an order was placed.

Flux (1921) described a new methodology for calculation of the Producer Price Index to be implemented by the Board of Trade. He preferred to follow Jevons in the use of the geometric mean to estimate the underlying change in prices, and explained why this approach should be used. The geometric mean was not explicitly weighted, but approximate weights were introduced by first dividing the economy into eight commodity groups which had approximately equal importance, and second by calculating unweighted indices separately for each of these commodity groups, based on multiple quotes for different products, in such a way that the number of quotes was proportional to the importance of the different products. This was a rather clever way to include the weighting while still maintaining a relatively straightforward unweighted geometric mean calculation. Changes in the relative weights of different commodities could be made by changing the number of quotations. Although there were restrictions in the ratios of the weights because the number of quotes could only be an integer, as long as sufficient quotes were included, this was of minor importance. The weights were adjusted for some products to reflect their use in further stages of manufacturing—for example coal was an important part of the manufacture of iron and steel goods, and its price was therefore included to some extent in the prices for iron and steel. The element of expenditure on coal that was part of the iron and steel industry was therefore removed from the weight for coal. This principle had already been used in the Board of Trade's arithmetic index and formed the basis of the "net sector output" indices which would be formalised later (see Box 14.1).

Flux (1921, p. 180) also proposed the use of chainlinking, which allowed for different commodities to be added or dropped, depending on their availability and importance, without requiring recalculation or revision of the whole index. This method had first been developed in the USA. The new index was re-calculated for 1913 to give an idea of changes using the new approach, while neatly stepping over the challenges of obtaining prices during the war years.

The 1921 version of the index expanded the range of manufactured goods for which prices were obtained, although the difficulty of defining a standard product and obtaining suitable quotes was acknowledged (Flux 1921). Nevertheless, the index was largely an index of raw materials, with little coverage of finished and intermediate goods.

Box 14.1: Net and Gross Weighting for PPIs

Weighting of PPI indices is undertaken on two different bases. The weight derived directly from the sales of products is called the gross weight. It ignores any double counting of inputs—so for example, coal used in the manufacture of iron and steel gets counted in the weight for coal in the index construction. This means that any increase in the price of coal is felt twice in the index—once in the coal index, and once through the influence of the coal price on the iron and steel index.

Net weighting involves removing the double-counting element, by reducing the weight of coal (in this example) in the coal index by the amount of coal that is used in the manufacture of iron and steel, so that the price contribution only appears once. "Net sector" indices can be constructed to follow the aggregation structure—weights are calculated for a sector, with any transfers *within* the sector netted out (not double-counted). Any transactions *between* the sector and another sector continue to receive their full weight. So at a low level in the aggregation, say a detailed industry, only transactions between businesses within that industry are netted out. This may be a relatively small amount, so the total of transactions is only a little smaller than for the gross weight. But at the next level up the sector is larger, and more transactions are included in the netting out. Ultimately, at the whole economy level, all intermediate transactions are netted out (and the total of all net transactions is therefore smallest), and the index counts price influences only once.

Of course, although the monetary value of the net sector transactions is lower than the gross sector, both the weights are expressed in parts per thousand. But the net sector weights are different at different levels of aggregation, and the indices therefore have to be re-calculated at each level, and cannot simply be aggregated from lower-level indices. For more details see Luckwell (2014).

The prices which were used in 1921 were collected weekly (as the prices for import and export series had been) and averaged over the weeks in the month. This shows the historical difference for the collection of the Retail (and later Consumer) Prices Indices, which had a single reference day when prices were obtained. This practice persists to the present, but now instead of a weekly price collection with the averaging performed by the Board of Trade, there is a monthly price collection, where businesses are asked to supply the average of the price of the particular good for which they quote over a particular month. Price changes and their effective date are collected in some cases and used to calculate this average.

14.1.1 Rebasing

By 1933, the weighting of the Producer Price Index had become very outdated, still being based on quantities from the 1907 Census of Production, and Flux (1933) described how it was to be updated to use the results of the 1924 Census. This update was slightly delayed, so as to allow a move directly to the results of the 1930 Census, with the re-based series published from 1935 (notably faster than the same process on the Consumer Prices Index, see Chap. 5). This seems to have been the first time that the PPI was re-based without a substantial change to the underlying methodology, now a regular maintenance process for these statistics.

A new system of Producer Price Indices was introduced in 1951, making use of much improved information on sales and, crucially for input indices (see Box 14.2), purchases by businesses collected in the 1948 Census of Production (Stafford 1951; Smith and Penneck 2009). The new Standard Industrial Classification, introduced in 1948, also provided a logical framework within which to construct indices. But at the same time, a number of substantial methodological changes were made. One of these changes was to move from the geometric mean of the 1921 index, the first example of an official national price index using this approach, back to the arithmetic mean. The arithmetic approach was, and remains, the staple of producer price indices, where weighting information is available at the lowest level. Contrast this with consumer price indices (Chap. 10) where the geometric mean has become the international convention for elementary aggregate calculation when no weights are available.

The new price index also expanded the coverage of the statistic, still producing a set of price indices which focused on the raw materials and primary inputs such as energy, but now extending widely to finished goods for the first time, and covering some intermediate goods as an aid to understanding the relationship between the other two sets of indices. There was a separate finished goods index, constructed on a gross weight basis (Box 14.1). Stafford (1951), however, was clear that there was relatively little use for aggregate indices covering a number of sectors, or for the whole economy. The Board of Trade would instead produce a series of sectoral series, suggesting that any users could find a reasonable series to meet their needs from among those available. This would also avoid confusion with the "all items" index from the 1930s version of the PPI (which had a much smaller coverage), which continued to be published until 1954. However, by the time the series were ready, an aggregate index continued to be produced.

Box 14.2: Input and Output Indices

Producer prices can be measured at the prices that goods are sold by their producers, or at the prices they are bought by their users. The difference will reflect transport or delivery costs and that prices of goods being bought must include an element for purchase of imports. Conceptually, different price quotes should be obtained for both situations, and could then be used to construct separate output indices and input indices. In practice, most countries collect only a single set of prices, but do use information on sales (turnover) and on purchases to construct two sets of weights. Additionally, the inputs of one industry are likely to be a combination of the outputs of several other industries, so the input weights may be quite different from the output weights. For more details see Luckwell (2014). Conceptually, the national accounts would like both indices so that inputs and outputs can be separately deflated.

Stafford (1951) considers the issue of how prices are to be chosen and collected for the construction of the index. He concludes that "there is no practical way of making the sample random", a challenge that was only picked up and finally solved in the 1990s (see below). Resource limitations restricted the range of quotes which could be compiled regularly, and most quotes were obtained from list prices, rather than prices actually paid in a period, which might be affected by long-term contracts. Prices continued to be collected "on certain days of the month" and not one specific day. Stafford shows a keen awareness of the difficulties in dealing with quality change, particularly in some areas such as women's fashion goods which continue to be challenging to this day. Seasonal goods are largely excluded, or dealt with on a case-by-case basis.

The expansion of the PPIs to cover finished goods was a substantial undertaking, and it was five years later in 1956 that Phillips (1956) was able to report, in yet another paper read to the RSS, that the project was substantially complete. The new indices were based on more than 5000 price quotes from 1500 businesses and 120 trade associations, all supplied voluntarily. Most were monthly, reflecting "average daily prices" by the simple expedient of getting businesses to give the date on which prices changed (as is still done today). A few were quarterly, where price changes were generally less frequent. The calculations were all done by hand in a few days at the end of each month, though Phillips did suggest that the system would lend itself to "machine computing". The indices were calculated with net weights (see Box 14.1). The indices were quite quickly taken up by businesses as an objective means to uprate contract costs, apparently without any official sanction for their use in this role, and this has continued to be a main use of PPIs. The Board of Trade restricted the revisions to aggregate indices in response to these uses, to avoid changes to contract prices already agreed.

Most of the indices were constructed with equal weighting of commodities. But where there were known differences in output of major businesses, or occasionally where other information could be obtained, the indices contained an element of weighting at the lowest level. The indices were re-based with a 1954 = 100 base from March 1958.

At the beginning of the 1970s, the whole range of economic statistics was reorganised into a coherent system, in response to the reports of the Estimates Committee (e.g. Estimates Committee 1966). This led to a regular five-yearly cycle of re-basing for the PPIs, with weighting information derived from the Annual Sales Inquiries, and (on the input side) from the five-yearly Purchases Inquiry.

14.1.2 Sampling in PPIs

Stafford (1951) had articulated the conceptual need for sampling, and Phillips (1956, Annex A) was already considering the necessity of sampling more intensively where there was a greater dispersion of price movements. But procedures still relied on the voluntary provision of price information by businesses and trade associations. These were recruited in occasional waves of replenishment when the sample sizes had reduced too much, through attrition, or through businesses ceasing to trade. Product-based surveys (the Quarterly and Annual Sales Inquiries) covered many industries from the introduction of the new system of industrial statistics from around 1970 (Smith and Penneck 2009), and these provided information which was used for PPI recruitment and weighting.

Many of the problems of defining prices for items, including dealing with seasonal items, dealing with quality changes and coping with discontinued products, are already documented in Phillips's article, and show that the issues considered in Chap. 8 apply in the same way to producer prices. Phillips offers good advice on the need for accurate item descriptions, and the need to monitor them for changes; it is clear that businesses were largely very cooperative in this process.

The range of products covered by product surveys was substantially expanded in 1992 with the introduction of the PRODCOM (Products of the European Communities) survey, driven by an EU Regulation. This product detail, collected using a stratified sampling design (for which each business had a specified probability of being included), led to the possibility of a designed approach to PPI sampling. Another element making a designed sample practical was that the PPI was made a compulsory survey in 1991, so that sampled businesses would be required to participate. This was part of a substantial move during the 1990s that made almost all of the voluntary business surveys compulsory under the Statistics of Trade Act 1947 in Great Britain and Statistics of Trade and Employment (Northern Ireland) Order 1988 in Northern Ireland.

Under the new design, weighted PRODCOM responses in year t-2 were taken as the first phase of a two-phase sample for the PPI in year t with the smallest businesses (with fewer than 10 employees) excluded. The edited PRODCOM responses form a frame of business—product pairs, and products (defined by the standard EU classification CPA (Classification of Products by Activity)) are selected from these pairs in a second phase of sampling (and in fact also a second stage of sampling since the products are clustered within businesses). The selected businesses are contacted, and discussions take place to identify suitable products from their range to price. These should be products in the correct product category which are representative of the business's UK production in that category—ideally representing a substantial portion of the business's UK sales.

The prices collected using the new sampling design then contribute to the PPI using the weighted sales value, which gives a proper representation—particularly it corrected an under-representation of smaller businesses, and made it easier to incorporate new products in the index. The indices on this designed sample were phased in during 1999–2000 (for more details see Richardson 1999; Smith et al. 2003). The PPI was based on around 9000 price quotes each month at this stage, but budget pressures in the ONS have led to reductions in sample sizes across a range of surveys in recent years. The PPI sample size was cut by a quarter in 2007, but also re-balanced to approximately maintain the quality of the high-level indices, though at the expense of some lower-level series The PPI is currently based on 6750 price quotations each month.

14.1.3 PPI Price Collection

The prices which are collected for use in the PPI need to be well defined so that any changes in product quality can be recognised, and the price adjusted if necessary. The definitions for prices are that they should:

- be net of any discounts which are normally applied
- exclude value-added tax (VAT)
- be the order price, that is the price that would be obtained for an order placed at the time the price is given
- be the average price for the month in question
- be ex-works, excluding any separate delivery charge.

The price should be an average over the month, and this is made easier for businesses by asking for prices and their effective dates, which in principle allows for the calculation of the average price. There is still scope for respondents to misunderstand the intent of this, however, and there is probably some measurement error relative to the statistical concept.

The use of order prices is straightforward for businesses contributing prices, since this is the price with which they would negotiate new contracts. When the price indices are used for deflation, the deflator should reflect the prices *paid* in a particular period, rather than the prices contracted. The prices paid reflect a range of contracts negotiated over different periods, so the deflator needs to be lagged, with different lags weighted together to reflect different contract periods. This combination of weighted lags is most important in industries with long contracts and is not needed at all in some industries. The lagged deflators have been used in the calculation of the Index of Production (see ONS 2000, Sect. 4.2.2) based on a timing and pricing survey which gathered information on contract lengths and lags. The timing and pricing survey has however apparently not been updated since 1996.

Prices were originally collected using a "shuttle card", which would be posted back and forth between the statistical office and the business providing the price information. But the straightforward nature of price collection in most periods, requiring only the collection of one (or perhaps a few) prices, together with a check that the specification of the product has not changed, makes it a natural proposition for automated collection. PPI was one of the first surveys to move to telephone collection, with responses provided to an automated system using the telephone keypad. More recently, price collection is moving (with many other surveys) to the web.

14.2 Import and Export Prices

At the beginning of collections of producer prices, many of the sources of prices for basic commodities, particularly those that were produced in small quantities domestically, were from published import price tables. Giffen (1879) describes an early attempt to calculate price indices from the volume and value of exports. This strategy was used for a long time in Unit Value Indices (UVIs) and Average Value Indices (AVIs), derived from the total quantities (numbers in UVIs and weights in AVIs) and total values of exports and imports. The tariffs in moving goods across the border were part of the responsibility of HM Customs

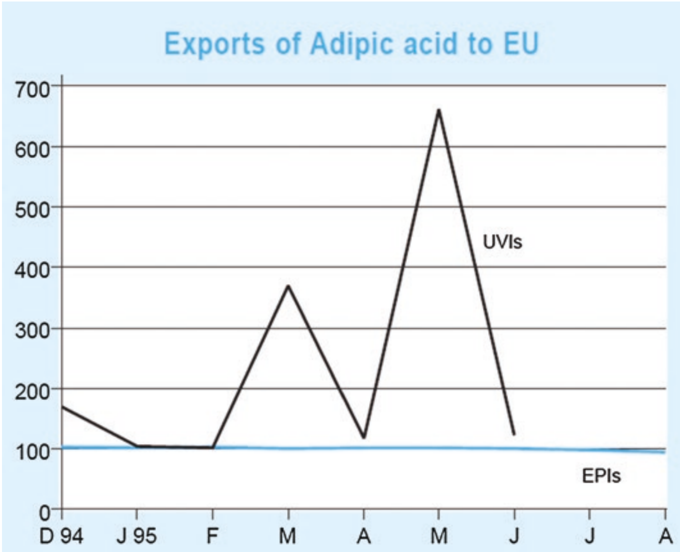

Fig. 14.1 Unit Value Index and Export Price Index for exports of adipic acid (used in the manufacture of nylon) to the European Union. Taken from Williamson and Ruffles (1997), © Crown copyright 1998. This information is licensed under the Open Government Licence v3.0. To view this licence, visit http://www.nationalarchives.gov.uk/doc/open-government-licence/

& Excise (now HMRC), who were therefore responsible for these indices. Such an approach, using broad commodity classifications, does not account for variations in the composition of the commodity groups, a problem Giffen already recognised, and which was highlighted again in Stafford's discussion of Phillips (1956). The approach did however provide a very comprehensive coverage of commodities, eventually in 11,000 groups, although even within such fine detail, there was considerable variation (Williamson and Ruffles 1997). The extreme volatility of some UVIs can be seen in Fig. 14.1.

The change to free movement of goods within the European Union removed the direct source of an important part of the information used in export indices through the removal of border controls. It was replaced by the Intrastat survey, which introduced additional challenges due to late response and the need for imputation of non-response.

The net result was that the quality of the AVIs became unsatisfactory. A pilot price collection for export price indices (EPI) was introduced in 1993 as part of the process of strengthening UK economic statistics in the Chancellor's Initiative (Jenkinson and Brand 2000). It was soon extended to cover 2500 price quotes each month/quarter for manufactured products sold to the export market. In general terms, it uses the same approach as the PPI, with price quotes provided by businesses for products with defined characteristics. The main difference is that the characteristic also includes the export market to which the product is being sold, as this can have an effect on prices, because of the variability in exchange rates. Gradual attrition in the sample has led to a current sample size of 2100 (Pegler 2016).

Price collections and indices for imported raw materials were already available and formed a part of the input prices for the PPI, but these covered a smaller selection of goods, largely raw materials. Therefore, the number of quotes for the Import Price Indices (IPIs) was smaller than for EPIs, numbering around 900 up to 1999. Some goods are traded on world markets, and in these cases, it is both possible and relatively efficient to use the market values in the construction of the indices. Otherwise, quotes are obtained from businesses that buy direct from overseas, or from agents who import goods, in which case the price charged to UK businesses is the one that is requested. The coverage of the IPI collection was extended from 1999 following a review by Oulton (1995) which suggested that imports of intermediate goods (such as car parts) were becoming more important, and indeed, they have continued to grow in importance with the globalisation of the production process. The series currently uses 1900 quotes, only a little less than the EPIs.

In both the EPIs and IPIs, there is only partial coverage of the commodity groups, and the remaining commodities are covered by using PPIs with an adjustment based on the relationship between EPIs/IPIs and PPIs for the commodities where information on both is available.

There is a manual dealing with the construction of import and export price indices (ILO et al. 2009), based on the PPI manual. The UK implementation has largely relied on a panel of respondents for both of these, with top-up recruitment to replace losses. Customs records gathered as goods cross the UK border have formed the basis of lists identifying potential sample members. The same data source provides the weights for EPIs and IPIs, the business weights based on the imports/exports within headings of the Combined Nomenclature (a classification used for tariffs).

At the end of 2016, ONS announced that there would be substantial increases in the sample sizes for Import and Export Price Indices (Pegler 2016), to bring them to approximately the same size as the PPI collections, around 6000 quotes per month. This will have the twin benefits of improving the accuracy of the existing indices and extending the coverage—in EPIs the indices will cover 76% of total export activity, up from 57%, and the IPIs will cover 67%, up from 41%. At the same time, EPI and IPI will move to a random sampling procedure in the same way as PPI (see above), using the customs declarations recorded by HMRC as a sampling frame. Initially, the sampling process is focussed on rejuvenating the existing samples, which have become outdated, but in the longer term, it is expected that a rotation procedure will be included so that there is periodic refreshing and updating as well as a distribution of the response burden.

14.3 Services Producer Price Index

> “It has sometimes been suggested that rent, professional, intellectual, and even artistic services, should find a place in any Index Number that represents the consumption of a nation. The only answer to this contention is, I fear, that it is impossible to include them.” (Board of Trade 1903, p. 432)

For almost a century, this opinion from the Board of Trade remained a truism, but with the increasing importance of the service sector to many economies worldwide, and certainly in the UK, it became important to obtain better information for deflation of services activity. Japan was the first to start price collection for services, with the Bank of Japan introducing collection in 1985, although it took a little while before statistics were publishable, first appearing in 1991. The UK was one of the leaders in developing services producer price indices (SPPIs), which were originally called Corporate Services Price Indices[1] (with some justification, as they covered only services provided by businesses to other businesses, and not those provided to consumers, which are conceptually included in the CPI). They were first introduced in 1995 (Price 1996), covering only selected industries in the service sector. There are considerable challenges within the services sector in defining a standard service which can be priced on a regular basis, so each service industry needs its own development to define and sample suitable "products". There is now an international manual dealing with the methodology for developing SPPIs (OECD and Eurostat 2005). Prices are generally more stable in services industries (presumably because services are less susceptible to fluctuations in the prices of material inputs, although they may be affected by their own service needs or indirectly by taxes), and therefore, the UK's collection is quarterly. There is a long-standing aim to move to monthly collection, but this has not been realised in a time of constrained resources.

Sampling for the SPPI is more limited than for the PPI, since there is no equivalent of PRODCOM providing detailed information on the products of the service industries. A more limited Services Turnover Survey has been run every five years to provide information for re-weighting. However, the continuing growth in the importance of the services sector has once more been highlighted by Bean (2015), who called for increased detail in the measurement of services. This is already generating developments in measurement of services, and the Service Turnover Survey has been strengthened by increasing its sample size from 8000 to 20,000 respondents so that it forms a suitable basis for sampling the SPPIs. This survey is expected to develop into SERVCOM, a full service sector equivalent of PRODCOM, collecting detailed sales by type of service.

At the end of 2016, ONS announced a forthcoming increase in the sample size of the SPPI (alongside EPIs and IPIs, Pegler 2016), and

[1] They were later called the Service Sector Price indices (SSPIs) before moving to the modern name.

SPPI will also be moved onto a two-stage random sample using business-service product pairs from the Services Turnover Survey as a frame for the second stage of sampling. As with EPI and IPI, this will initially focus on updating the SPPI price sample, but in the longer term, it is likely that rotational sampling will be introduced. The survey basis of the first phase (the Services Turnover Survey/SERVCOM) means that the similarities between the sampling for SPPI and PPI will be greatest; EPI and IPI are sampled largely from an administrative source.

14.4 House Price Index

The measurement of changes in house prices has always been a considerable challenge. There are often difficulties in specifying products for PPIs and even more for SPPIs, but for houses, each product is unique, and may change hands only at long intervals. A number of methodological innovations have been introduced to house prices to try to deal with these problems. The possible bases for house prices are:

- repeat sales
- hedonic models
- methods based on appraisals of prices for tax purposes and sales (SPAR method, De Vries et al. 2009).

Wang and Zorn (1997) review the use of indices based on repeat sales and their target statistics, and compare with other approaches including hedonic regression.

In the UK, there has been a wide range of house price indices from official sources and from private sector sources (principally the larger lenders who have datasets covering large numbers of mortgage-based house sales). Even among the official sources, there were competing versions produced by different departments, and this led to a review in 2010 of the provision of house price information, and eventually to a single official house price index produced using data from a number of departments and sources (ONS et al. 2016).

The UK House Price Index (HPI) has been published since 2016 and uses the hedonic method. A model of (log) prices is constructed using price information from sales (from registrations of sales with land registry departments in Northern Ireland, Scotland and England & Wales), and characteristics of residential dwellings taken from Council Tax, a local dwelling tax administered by local authorities but with valuations from the Valuation Office Agency. The characteristics provided from the Council Tax valuation in England and Wales are address (which allows matching with sale price data), property type, total floor area, number of rooms and number of bedrooms. Similar information is derived from different sources in Scotland and in Northern Ireland, where the structure is slightly different. The fitted values from the model provide the prices for a basket of dwellings which remains fixed during a year, and is updated each year. The basket uses recent data to reflect the types of dwellings being purchased during the period, and the prices of the different types of dwellings are weighted together using information on previous periods' residential dwellings sales. The indices from different years are chained together to form a continuous series.

The longest running official house price index goes back to 1968, so historical series have been constructed by chaining the original index to the new index, which has been calculated back to 1995 in England and Wales, 2003 in Scotland and 2005 in Northern Ireland.

House prices present further challenges, as there is wide public interest in the average price of a house (in a way that does not exist in other price indices where the items are not sufficiently comparable for this to be meaningful). The change in the basket of dwellings from year to year means that the prices in different years are not directly comparable, as they compare different mixes of property types. Indeed, the differences in calculation of the average price were one of the largest discrepancies between the different official indices before harmonisation. The approach adopted in the HPI is to use the index to update a base basket of transactions, with this base basket updated less frequently than the index basket—every five years. This means that consistent information is available using a relatively up-to-date mix of properties, but that the average price for a given period will be revised each time the base basket changes.

14.5 Implied Deflators

The construction of Gross Domestic Product (GDP) follows a complex process using a wide range of data sources. Different price indices feed into these calculations in different places, for the purpose of deflating different components to constant prices. At the end of all the calculations, there are estimates of GDP at constant prices (i.e. with deflators applied) and at current prices, and the ratio of these two quantities gives the *GDP implied deflator*—a measure of price changes within the economy. In a way this speaks back to the index numbers problem mentioned in Chap. 3. Conceptually, the implied deflator not only reflects the weighting together of all the deflators, but it also includes sectors not covered by price indices, and a wide range of other adjustments which are used within the construction of GDP, so it is not a conceptually pure price index calculation. The GDP implied deflator therefore reflects the prices of all domestically produced goods and services in the UK economy. It includes the prices of investment goods, government services and exports, and excludes the price of imports. This wide coverage makes it an appropriate deflator for series which are not closely related to particular sectors, such as public expenditure.

Other implied deflators can be derived from other series. For example, there is an implied deflator for the retail sector based on the ratio of current price (value) to constant price (volume) estimates of retail sales, and another for household expenditure.

14.6 Purchasing Power Parity

Purchasing Power Parity (PPP) is a measure of the spending power of money, usually in different places (so forming a spatial index, rather than the temporal index of the CPI), used to compare the relative purchasing power of different currencies. There is a specific price collection in the UK for use in calculation of PPPs. Some of the required prices are already collected for the purposes of calculating the CPI and RPI (see Chap. 8), but they are supplemented by further collections which take place only in London, and use much more specific item descriptions than the standard collection. The price index calculated is Fisher-like, in being a geometric mean of Laspéyres and Paasche indices. Every six years, a countrywide collection covers the same items, providing an adjustment factor which allows the London prices to be adjusted to be representative of average prices across the UK. These adjusted prices are used to calculate the series for the UK which is input to the PPP process.

The prices for different countries in PPPs are combined using the EKS (Èltetö-Köves-Szulc) method which ensures transitivity—that the comparison between two countries is not affected by whether or not prices are compared with an intermediate country. The UK has used the same approach to calculate relative regional consumer price levels (e.g. ONS 2011), which show the price levels in different regions every six years using the same information as is used to adjust the London collections to represent the rest of the country.

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15
A Look to the Future

In this book we have tried to describe the history and current practice involved in the use of Index Numbers for the measurement of the economic variable of inflation. Hopefully, the preceding chapters have conveyed that the process of arriving at the current state of practice and thinking has been a complicated one; informed by developments in theoretical arguments, the resources available to those gathering data and advances in technology. The story of Official Statistics is one of continuous improvement, and the number of unanswered questions remaining in the study of Index Numbers remains substantial, so it seems reasonable to assume that the field will continue to experience changes in the coming years. It is also likely that many of those changes will affect the measurement of inflation in the UK. In this chapter, we turn our attention to is the ways in which the field of Index Numbers and inflation measurement is likely to change over the next few years. We hold back from making predictions for the subject but highlight some current areas in which further developments seem most likely at the time of writing. The list of issues is by no means exhaustive, however, it is hoped they may stimulate the interested reader to consider where future contributions may be made to the subject.

R. O'Neill et al., *Inflation*, DOI 10.1007/978-3-319-64125-6_15

15.1 Web Scraping

The Billion Prices Project[1] (BPP) was set up in 2007 as a response to a controversy regarding the official measurement of inflation in Argentina. The project uses web scraping as a means to obtain price quotes for a wide range of items from which price indices can then be compiled using methods established in the literature. In 2012, The Economist began using the BPP estimate of inflation rather than the official measure for Argentina, see The Economist (2014) for more information on this issue. BPP also produce price indices for other countries and areas using the data collected via software which are relatively easy to expand.

Given the large amount of data, and the seemingly reliable results from compiling indices from such methods, it is not surprising that National Statistical Institutes have shown an interest in the technology of web scraping for the collection of prices for use in the compilation of inflation statistics. The Office for National Statistics Big Data Project focused one of its strands of work on this area specifically (Breton et al. 2016), collecting data on groceries from supermarket websites where possible. The resulting data revealed some interesting insights into the compilation of price indices and is likely to be an additional tool in the approach of NSIs as a tool which can be scaled up to collect large samples of data.

Additional methodological issues will be raised by the use of web scraped data. As web scraping allows daily price collection at little extra cost, there is an immediate opportunity to compile a daily price index. Such an approach would bring with it a large number of attendant questions: how often should such an index be chained, how should a monthly inflation measure be compiled? How often should the base prices be changed?

One tempting prospect for using web scraped data to compile price indices is to take the arithmetic mean of prices for a good during a given month and compare this to a mean from the base month. Alternatively, it would be possible to take the average of price ratios for price quotes spaced one month apart.[2]

[1] http://www.thebillionpricesproject.com/ (accessed 11 June 2017).

[2] We ignore for the moment the fact that different months will have different number of price quotes, although this is an additional issue to address.

At the moment, NSIs are using to use web scraping technology to replicate part of the existing data collection involved in the construction of a price index. This is not an unsurprising first step and makes sense in order to test some of the properties of the technology. However, the availability of a rich daily data may allow for more detailed consideration of inflation statistics, in a manner analogous to the world of financial time series which has developed with ever increasing frequencies of data. It will be interesting to see how such data are put to use in the future development of price indices. It is possible that the availability of a large scale, low-cost data set will significantly increase the flexibility of the construction of price indices, especially compared to the information which has traditionally been available to price statisticians.

Web scraping introduces several challenges alongside the opportunities for developing price indices. The data collected from price scraping will be incomplete, for example transactions conducted in small-scale stores which do not conduct their business online would be excluded from the sample collection, which may introduce a bias. It is also possible that some important information regarding the prices may be difficult to measure, for example availability of certain items is not always obvious when shopping online until completing a transaction. At the same time it may be more difficult to record and identify discounts being offered when goods are sold online. It is also difficult to identify which items are available across defined geographical areas which will affect the construction of indices compiled on this basis.

The above considerations highlight that the inclusion of Big Data sources into measures of inflation is not likely to be as quick or as straightforward as some advocates would like. The ONS issues regularly update on its progress in incorporating such sources, noting some of the difficulties involved. These difficulties in the incorporation of new data sources into such complicated statistics sometimes frustrates those with less experience of the compilation of such, as in the Bean[3] Review (see Bean 2015) which took ONS to task for such data sources not having

[3]It is notable that a review of the production Economic Statistics was carried out by a well-respected Macroeconomist; we can only assume that no Econometricians/Economic Statisticians were available to head such an enquiry.

been integrated more quickly into Official Statistics. It is also worth noting that such work is expensive and requires significant computing and labour costs, while ONS operates within a budgetary environment which has required it to consult users on which of its current outputs it would be able to curtail, see ONS (2013b) for more details. In the UK, there is increasing pressure to make uses of data sources such as web scraped data in the compilation of statistics such as inflation, which will only be met by changing the Government Statistical Service infrastructure, and may mean that other organisations such as PriceStats (http://www.pricestats.com/), who are also able to use such data to develop commercial products, may be better placed to breakthroughs in such work.

15.2 Recommendations of the Johnson Review

As part of the programme of development in price indices overseen by the UK Statistics Authority, a comprehensive review of price indices was carried out by the head of the IFS, Paul Johnson (see Johnson 2015). The recommendations of this review made for the UK environment a relevant place to start when considering how price indices may alter in the next few years. Here we will consider a few of the recommendations which point to the medium-term future of the development of inflation statistics in the UK.

One of the central conclusions of the report is that the current form of the CPI is not accepted as the way in which inflation should be measured on a continued basis. An improved CPIH, which includes a measure of owner-occupied housing is identified as preferable. Substantial progress towards this target is already being made, as evidenced by the National Statistician's announcement in November 2016 that from March 2017, the CPIH would be the preferred measure of inflation for the UK[4] (see Pullinger 2016). This announcement

[4]Note there is a slight difference between the preferred and official rate of inflation, it is possible for the UK statistical framework to prefer a measure of inflation which is not adopted by the rest of Government as the official rate of inflation.

followed on from the UKSA's review of the incorporation of the inclusion of owner occupier's housing (OOH) costs in official price indices, as detailed in UK Statistics Authority (2016) which made several recommendations for improvement of the statistics before they could be classified as National Statistics. Johnson (2015) was not the first to recommend the inclusion of an improved measure of OOH in official measures of inflation, for example Eurostat has long acknowledged that the omission of such a measure from the HICP/CPI is a weakness of the measure, as discussed in Eurostat (2012). The review has promoted the development of such a measure in the UK and will help motivate the refinement and improvement of methods of measuring of OOH inflation in the coming years.

A group of the recommendations made in Johnson (2015) relate to the future of the RPI, which was also discussed in the 2012–2013 consultation on the improvement of the RPI, see ONS (2012). Johnson concludes that the RPI has reached the end of its useful life as a measure of inflation, particularly for official uses.[5] The recommendations go further and suggest that related measures should be discontinued and that little further attention should be paid to the RPI. The recommendations stop short of suggesting that the RPI should no longer be calculated at all, but neither should it be developed alongside the measure of CPI and CPIH. Undoubtedly, there will remain some people who stand opposed to such moves, as evidenced by some of the replies included in ONS (2013a). The existence of multiple inflation measures compiled using different data, populations and methods will remain confusing to non-specialist users as long as the RPI and CPI indices are treated on a somewhat equal footing. By making it clear that RPI is considered to be a less preferred measure, and treating it as such, the Johnson review may have proposed a path by which UK statisticians can move on from the time-consuming debate regarding which elementary aggregate formula to use. Though some will be disappointed to see the RPI treated more definitely as a secondary index, having a single measure

[5] A similar conclusion is reached regarding the RPIJ index, which itself was only initiated in response to the discussions around the differences relating to the CPI-RPI formula effect.

of inflation which is consistent with international statistical standards is likely to help move attention away from the ongoing RPI–CPI debate to potentially more interesting areas of research, such as the compilation of indices based on differing income levels and perfecting the measurement of owner-occupied housing within CPI type measures.

As part of the research which supported the Johnson review, ONS compiled a retrospective superlative price index (Clews et al. 2014), which gave levels of inflation which were noticeably lower than those produced by the CPI. Johnson (2015) proposed that such a practice should be continued on an annual basis. This would be a significant addition to the range of inflation statistics available in the UK and follows an approach already used in the USA, as described in Cage et al. (2003), in which a Törnqvist index is estimated to measure inflation. The production of such indices would potentially further the discussion of the difference between inflation measures based on the cost of goods and cost-of-living approaches, and the development of such indices over a long period of time is likely to be of significant value to those who have an interest in the way in which inflation is measured, including academic researchers.

The Johnson review also made other recommendations, such as the incorporation of scanner/web scraped data (see Sect. 15.1), a more formal statement of the decision-making process for determining the appropriate elementary aggregate formula, the inclusion of items in the basket of goods, the weightings of items and quality change, and reviewing the sampling approach for obtaining price quotes. The recommendations of Johnson (2015) are wide ranging and have impacts on other outputs produced by ONS, such as the Living Costs and Food Survey which is utilised to produce weights for the CPI. The programme of work is unlikely to fundamentally change the nature of the existing measures of inflation in the UK, however it highlights a number of changes which would modernise the existing metrics and provide a more detailed and nuanced set of inflation statistics. The review recommendations reflect that there is still a lot of work to be done in bringing the current practices of inflation measurement in the UK into line the findings of theoretical Index Numbers literature which now seem within the grasp of NSIs. Although not all of the changes suggested will be practical, it is a worthy set of targets to help define the next stages of the development of inflation measures in the UK, just as such measures have developed over the course of the life of this book.

15.3 Inflation by Demographic Group

One of the assumptions behind the economic approach to inflation measurement, discussed in Chap. 12, is that people have comparable preferences, both within a given time period if we are comparing two people and across time as we move from one period to another. It would seem sensible to recognise that there is only so far we can stretch this assumption; pensioners and students for example are likely to have very different consumption patterns. If this is indeed true, then it would seem reasonable for us to expect that the level of inflation an individual, or household, faces is likely to be determined, in part, by their demographic characteristics. This is also reflected in Johnson (2015) which recommends producing an annual analytical publication reporting the inflation experience of a range of household types, something which was attempted initially using officially available data to calculate revised weighting patterns in Flower and Wales (2014a, b).

Demographic characteristics which might influence the rate of inflation households experience are not limited to age, and they may also include geography, socio-economic status, gender and even dietary choice. Flower and Wales (2014a, b) calculated differences based on income as well as some other groups. There are frequent requests for the ONS to produce regional measures of inflation which would be a further extension. In the long term as the cost of obtaining data and processing it to produce index numbers continues to fall, there may be more scope for such alternative measures of inflation to be constructed.

Indices for different groups of individuals would be interesting and would no doubt lead to further economic research on the distributional effects of inflation, however, it is much less clear how these measures might be useful in a more practical setting. It is unlikely that companies will change their prices depending on a person's socio-economic status, or that benefits, such as the state pension, would be allowed to increase at different rates in neighbouring areas. As a result it seems that the first uses of such a set of indices would be to describe in more detail what is happening in the UK and then feed into research which attempts to explain and understand the differences.

There are some considerations which make the construction of sub-indices based on characteristics of sub-populations quite challenging. For example, would such an approach require that all of the sub-indices, across all of the ways in which we might perform this split, be constrained to the overall headline measure of official inflation? If not how would we make sense of a set of geographical measures which can be combined to produce a different level of overall inflation? Further issues arise in that we would need to consider whether the same methodology supporting a national measure is still appropriate and can be transferred across to more detailed indices wholesale. As when we make changes in any complicated statistical process, trying to do something so fundamentally different to what has gone before will necessitate making a range of decisions, which is why it may be a long time before we see sub-indices included in the official releases of inflation statistics. However an appetite clearly exists so it's likely indicate that they will one day be included.

15.4 Accounting for Fashion

Inherent in much of the discussion of the economic approach to Index Numbers (see Chap. 13 for details) is the assumption that in some way, the consumption of a given item yields a constant marginal utility across periods, while tastes relating to these items remain constant. It is quite possible to think of items where this is not the case, such as clothing or smartphones (consider how tastes change quickly towards individual models of smartphone or how certain colour palettes change popularity in clothing over time), and as a result, incorporating them into the economic concept of inflation is more difficult.

The inclusion of fashion items in a reliable and comparable manner in a price index has been a contentious issue, and some of the leading thinkers in the area have failed to find a practical solution to the problem. When discussing improvements to the RPI with the ONS, Diewert (2012, pp. 85–86 and recommendation 3) concluded that the strong seasonality of fashion goods means that they are not appropriate for inclusion in the RPI (it would seem the argument would carry over to the CPI environment). One of his recommendations for improving the RPI is to drop fashion goods until methods are changed to incorporate monthly baskets and methods based on a rolling year GEKS approach (for detail on the rolling year GEKS method of index construction, see Diewert 2012, Chap. 7). That one of the most distinguished scholars in the field of Index Numbers would recommend the removal of fashion goods from an inflation measurement is a testament to the complexity of the task facing economic statisticians in measuring the changing price level for such goods. Greenlees and McClelland (2010) also demonstrate the difficulty of isolating the inflation of a small subset of fashion goods, for which it might be possible to track information using scanner data, and it is this research which helped inform some of the conclusions in Diewert (2012). It may seem that this conclusion is something of a defeat for the field of Index Numbers. However, it simply reflects the challenges and provides a spur to further research. As we get access to more data, as well as insights from fields such as behavioural economics, it may be possible to improve the approach to fashion items within inflation; it would be much more worrying if Diewert (2012) had attempted to disguise the weaknesses of the current methodology. It is likely therefore that understanding of this area will improve in the future and this will then allow future generations of inflation producers to revisit the way in which fashion goods are incorporated into inflation measures.

15.5 Changes in the Weights Used in Index Numbers

It is worth remembering that prices are not the only input to the construction of a set of weighted index numbers. We have discussed at length the efforts which have been involved historically in providing meaningful weights to the process of inflation measurement. It is expected that this process will itself continue into the future, and it is worth considering how changes in the measurement of expenditure statistics might impact on measures of inflation. This area could have filled a book on its own, and as with Index Numbers, it is an area of investigation in which much work remains to be done. This is reflected in the National Statistics Quality Review of Living Costs and Food Survey Data (Ralph and Manclossi 2016) which made 30 recommendations aimed at improving the data collection, processing and quality of the statistics produced by the survey. Such developments are likely to have direct impacts on the development of price indices, particularly if they lead to the incorporation of scanner data. It is developments like this which serve as a reminder that measures of inflation take inputs from several other areas of Official Statistics and that changes in these areas will consequently have significant impacts on them.

15.6 Who Will Determine the Future?

The future of inflation statistics will see the involvement of a number of groups, most of whom have played a significant role in the previous discussions of Index Numbers, and the current crop of official measures has evolved from those wide-ranging and mutually beneficial discussions.

There is little doubt that the work of academic researchers will continue to play a large role in the understanding of and development of Index Numbers as a subject, combining aspects of economics, statistics and the growing discipline of data science. The major developments of the twentieth century in the academic literature surrounding Index Numbers had profound impacts on the way we view the subject matter. The work of Fisher (1922) in introducing the axiomatic approach, the first formalisation of the cost-of-living approach and the determination of superlative indices in Diewert (1976) were all significant new contributions to the discussion of the use of Index Numbers in the measurement of inflation. It is likely that contributions develop into the future of Index Numbers, for example the initial work on the introduction of web scraped data in price indices (see Naylor et al. 2014).

The history of the development of price indices in major economies such as the UK and USA has been driven forward by a series of reviews and investigations undertaken at the behest of some part of the Government infrastructure. We have seen evidence of this in this book as well when considering the historical development of the UK measure of inflation. Examples include the Boskin commission in the USA (Boskin 1996), and the Cost-of-Living Inquiry of 1947 (Ministry of Labour & National Service 1947) and the Johnson review (Johnson 2015) in the UK. Many of these reviews have made significant contributions to the development of the applied world of Index Numbers. In many cases, it is the work of such reviews which helps to bring the practical implications of work completed in the academic sphere into the world of practising statisticians. This is usually achieved by bringing the worlds together to some extent and allowing each to learn from the other and suggest problems or issues which might affect the development of the subject. It was the work of the Boskin commission which made the Cost-of-Living framework of the BLS measures of inflation more explicit, while the Johnson review may help, eventually, to consign the use of the RPI to the history books with its recommendation that the index should not be used for any new purposes and discontinued as soon as practicable.

As the organisations charged with the production and practical development of inflation measures, National Statistical Institutions will no doubt continue to play a significant role in the development of Index Numbers and not just via their contribution in the irregularly spaced reviews mentioned above. On a day-to-day basis it is NSIs who are forced to confront the diverse range of issues which affect the compilation of an index number series. They operate in a world in which items do not remain available from period to period, are faced with classifying and selecting representative items from a dizzying array of consumer goods and services, selecting a representative sample and dealing with the thorny issue of how to include owner-occupied housing in a price index. Such institutions are rarely allowed to become mired in abstract arguments regarding the fashionability of clothing items, for example, as they are still expected to have such common goods represented in the measures of inflation on a monthly basis. It is then reasonable to expect that NSIs will continue to have a significant contribution to make to the development of Index Numbers, especially at the more applied level of the subject, and it will be interesting to see how Index Numbers continue to develop in their hands.

There are other groups who may or may not be involved in the evolution of the subject of Index Numbers to a greater or lesser extent. As Searle (2015) notes, governments have often had a direct involvement in the development of inflation measures, although their concern is typically centred more around the numbers being produced than the properties of the index itself. It is easy to think that governments who operate under inflation-targeting regimes will continue to exert some influence in the development of such measures. Through consultation, modern producers of statistics can allow their users to become involved in the development of such metrics. An example of this was the 2012–2013 consultation on improving the RPI which saw the original measure left unchanged in favour of a historically consistent series which was of use to existing users. As it becomes easier for users of statistics to communicate their needs and feelings, it is fair to expect them to have a greater say in the development of inflation statistics. As data become more widely available, there is a growing number of other organisations which might be able to contribute to the development of Index Numbers. Companies such as Google who have a significant contribution to make in the collection and analysis of large data sets may contribute to the development of a Big Data price index for example.

Index Numbers has never been the sole concern of National Statistical Institutes, and it is not likely that this will be the case in the future. The dialogue between the different bodies with an interest in Index Numbers is one of the things that is interesting about the subject. Theoretical results will be examined for their practical implications, and there is the opportunity for competing concerns to be balanced in the current methodology of the official inflation measure. Exactly how this process is managed in the future is likely to help determine the areas of most concern in Index Numbers, however, it is likely that many groups will have a say in this process.

15.7 Conclusions

When setting out to write this book, we intended to inform readers about how and why the current methodology for compiling inflation statistics had arisen. In doing this we knew that we would inevitably be commenting on a process which is far from at an end and so in this chapter we have considered some of the areas which will be of concern to those interested in Index Numbers in the years to come. We may of course be completely wrong about what will be the focus of this process; however, we hope that the material in this chapter, and this book more generally, has demonstrated that there is much about measuring inflation which we still don't know, and much which we know which has yet to be incorporated into measures which are reported by NSIs. The fact that Index Numbers remains an active area of research demonstrates that there is much still to be discussed in the subject.

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