Elementary aggregate formula

At the lowest level of aggregation in consumer price statistics (called the "elementary aggregate" level), there is often a lack of reliable expenditure data to weight products together. For example, we may know how much is spent on apples in the UK, but we do not know how much is spent on the different types of apples such royal gala, braeburn and red delicious. In these circumstances, elementary aggregate formulae are applied which give equal weight to each price observation. There are three main average techniques which can be applied and they are described below. Annex A provides a breakdown of formulae used in each index.

Carli

The Carli formula takes the rate of change in each price, and then takes the arithmetic average of those changes. The method is also known as the average of price relatives (AR). The use of Carli is effectively prohibited by a legally binding European regulation in the Harmonised Index of Consumer Prices (HICP), the CPI in the UK, because it can be shown in certain circumstances that the use of Carli combined with chain linking of in-year indices introduces an upward bias known as 'chain drift'. The Carli formula is used in the RPI in about 30 per cent of items. More information on chain drift is available in an ONS article *Comparing Class Level Chain Drift for Different Elementary Aggregate Formulae Using Locally Collected CPI Data*[1]

$$I_{t,0} = \frac{1}{n}\sum_{i=1}^{n}\frac{p_{i,t}}{p_{i,0}}$$

where $I_{t,0}$ is the price index, n is the number of price quotes, and $p_{i,t}$ is the price of item i at time t.

Dutot

The Dutot formula takes the arithmetic average of the prices in each period, and then calculates the rate of change. The formula is also known as the ratio of average prices (RA). The Dutot formula is used in the RPI in about 30 per cent of items and it is also used in the CPI (although to a much lesser extent). The Dutot index is usually is used for homogeneous items as the formula implicitly gives greatest weight to the highest priced product.

$$I_{t,0} = \frac{\sum_{i=1}^{n}\frac{p_{i,t}}{n}}{\sum_{i=1}^{n}\frac{p_{i,0}}{n}}$$

where $I_{t,0}$ is the price index, n is the number of price quotes, and $p_{i,t}$ is the price of item i at time t.

[1] http://www.ons.gov.uk/ons/guide-method/user-guidance/prices/cpi-and-rpi/comparing-class-level-chain-drift-for-different-elementary-aggregate-formulae-using-locally-collected-cpi-data.pdf

Jevons

The Jevons formula uses the 'geometric mean'. A geometric mean is obtained by multiplying all the numbers together and then taking the *nth* root of the product. For the Jevons formula, we take the geometric mean of the rate of change (also known as the geometric mean (GM) of price relatives) or the ratio of the geometric mean of prices. Both of these calculations produce the same result. The Jevons formula is used in over 60 per cent of items in the CPI. The Jevons formula cannot be used when prices fall to zero.

$$I_{t,0} = \sqrt[n]{\prod_{i=1}^{n} \frac{p_{i,t}}{p_{i,0}}} \qquad I_{t,0} = \frac{\sqrt[n]{\prod_{i=1}^{n} p_{i,t}}}{\sqrt[n]{\prod_{i=1}^{n} p_{i,0}}}$$

where $I_{t,0}$ is the price index, n is the number of price quotes, and $p_{i,t}$ is the price of item i at time t.

Worked examples showing the application of these formula has been provided in the excel spreadsheet titled "Elementary aggregate formula example". Each example uses micro price data available on the ONS website[2]. For simplicity, the sample size for each item have been reduced to 5.

Consumer substitution and the use of Jevons

ONS research[3] has shown that many National Statistics Institutes (NSIs) have moved towards using the Jevons formula over the last 15-20 years. Some of these NSIs have sited consumer substitution as reason for using this formula. However, this reasoning appears to be because of a misinterpretation of the analysis presented in Consumer Price Index Manual[4]. Professor Diewert's conclusion[5] on this approach is instructive. He finds "the Consumer Price Index Manual has a section in it which describes an economic approach to elementary indexes. This section has sometimes been used to justify the use of the Jevons index over the use of the Carli index or vice versa depending on how much substitutability exists between items within an elementary stratum. If it is thought that there is a great deal of substitutability between items, then it is suggested that the Jevons index is the appropriate index to use. If it is thought that there is very little substitutability between items, then it is suggested that the Carli or the Dutot index is the appropriate index to use. This is a misinterpretation of the analysis that is presented in this section of the Manual…..The economic approach cannot be applied at the elementary level unless price and quantity information are both available.

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[2] http://www.ons.gov.uk/ons/guide-method/user-guidance/prices/cpi-and-rpi/cpi-and-rpi-item-indices-and-price-quotes/index.html

[3] http://www.ons.gov.uk/ons/guide-method/user-guidance/prices/cpi-and-rpi/improving-the-timeliness-of-the-cpi-and-rpi-publication.pdf

[4] ILO/IMF/OECD/UNECE/Eurostat/The World Bank (2004). Consumer Price Index Manual: Theory and Practice, Geneva, International Labour Office.

[5] http://www.ons.gov.uk/ons/guide-method/user-guidance/prices/cpi-and-rpi/erwin-diewert-report-on-consumer-price-statistics-in-the-uk.pdf

Annex A: Formulae used in the RPI and CPI (2012 weights)

	RPI	CPI
Carli	27%	0%
Dutot	29%	5%
Jevons	0%	63%
Other/weighted formula	43%	33%