Office for National Statistics

Identifying food price anomalies to support the Sustainable Development Goals

Details of the methodology used to apply the UN methodology for the Sustainable Development Goals Indicator 2.c.1, Food Price Anomalies, to the UK.

Contact:
Ben Hillman
SustainableDevelopment@ons.gov.uk

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Notice

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We have corrected an error in sections 2, 4, and 6, under headings "Overview of methodology", "Computing weighted average and standard deviation", and "Observations on the indicator". The previous version did not include a seasonal adjustment element for months, and all values revised with each update to the time series. This seasonal adjustment element has now been included in the method guidance and figures, and the values are non-revising.

This happened because of a misinterpretation of the UN methodology.

Table of contents

1 . Background

We use a methodology to apply the UN methodology for the Sustainable Development Goals Indicator 2.c.1, Food Price Anomalies to the UK. The UN methodology can be found on the United Nations Sustainable Development Goals metadata page.

These are Experimental Statistics; they are not yet fully developed and have not been submitted for assessment to the UK Statistics Authority. They are published in order to involve customers and stakeholders in their development, and as a means to build in quality at an early stage.

The Sustainable Development Goals (SDGs) are central to the UN's radical and ambitious Agenda 2030 for a more inclusive, sustainable and prosperous world that leaves no one and nowhere behind by 2030. It brings economic, environmental and social goals together in a holistic agenda with a view to, for example, ending climate change, eradicating poverty, and reducing inequalities.

The UN member states, including the UK, committed to this ambitious agenda in 2015. The Office for National Statistics (ONS), as the national statistics institute, is responsible for monitoring and reporting SDG data for the UK. More information about SDG data, plus analysis and update reports is available.

2 . Overview of methodology

The UN methodology requires four steps:

1. Calculate two compound growth rates (CGRs) for food prices for each month; the first is calculated on a rolling quarterly basis and the second on a rolling annual basis.

2. For each month compute weighted averages and weighted standard deviations using the same calendar month across all previous years.

3. Calculate annual and quarterly normalised scores for each month by subtracting the corresponding weighted mean and then dividing by the corresponding weighted standard deviation.

4. Combine the normalised scores of the quarterly and annual CGRs into a single indicator value for each month, with more weight on the annual CGR; the headline indicator is then the rolling 12-month average of the combined single indicator.

When the headline indicator has a value greater than one, the change in price is considered anomalous compared to historical values, meaning that food prices have seen an unusual rise.

3 . Calculating the compound growth rates

The Office for National Statistics (ONS) measure of the inflation experienced by consumers, Consumer Prices Index (CPI), has been identified and confirmed as suitable for measuring changes in food prices by topic experts. Though the price for specific items could be used to calculate the indicator and is used in the examples given in Felix G. Baquedano, 2015 (PDF, 585KB), the food categories in the CPI provide a broad view of prices and are made up of "shopping baskets" of representative goods. As such, they are the best measure of the price changes consumers face in the UK. An indicator is calculated for the headline "all food", as well as for each subcategory (such as "bread and cereal").

From the UN methodology, the compound growth rates (CGRs) from time A to B are calculated

$$CXGR_B = \left(\frac{P_B}{P_A}\right)^{\frac{1}{B-A}} - 1$$

where

$CXGR_B$ is the quarterly ($CQGR_B$) or annual ($CAGR_B$) compound growth rate in month B, depending on whether the time period A to B is 3 months or 12 months. Note that $CXGR_B$ is used in formulae when they apply to both the quarterly and the annual case.

P_A is the price index in month A

P_B is the price index in month B

B – A is the time, in months, between periods A and B; 3 for the quarterly rate and 12 for the annual rate.

4 . Computing weighted average and standard deviation

For each year, the weighted averages of previous annual and quarterly compound growth rates (CGRs) are calculated. These, along with weighted standard deviations, are used to assess whether the year in question is anomalous compared to previous values.

More recent timepoints are given higher weights to ensure that the most recent price changes are not overshadowed by larger historic changes. For each target year (that is the year we want to assess against all previous values), the weights of the previous timepoints will therefore differ. Annual and quarterly weights are calculated separately. To calculate weights, the following process is used:

- assign an integer value to each year/quarter in the food price index series (up to but not including the target year/quarter), the first year/quarter having a value of 0, the second a value of 1 etc.
- sum these values for each target year.
- divide the value by the sum of the values to give the weight for that year/quarter for the target year.

To calculate the weighted average, sum the product of each index number's CXGR and weight and then divide that sum by the sum of the weights

$$\mu_{\mathrm{x}} = \frac{\sum_{i=1}^{T_X} w_i \; CXGR_i}{\sum_{i=1}^{T_X} w_i}$$

where T_X is the number of months of CXGRs T_A for annual and T_Q for quarterly) and W_i is the weight in month $_i$.

The weighted standard deviation is calculated by the formula

$$\sigma_X = \sqrt{\frac{\sum_{i=1}^{T_X} w_i \; (x_i - \mu_{\mathrm{x}})^2}{\sum_{i=1}^{T_X} w_i \; (\frac{T_X - 1}{T_X})}}$$

μ_Q and $_Q$ refer to the quarterly mean and standard deviation, while μ_A and $_A$ refer to the annual mean and standard deviation.

This is done separately for both the rolling quarterly and the rolling annual values.

5 . Calculating the Indicator

The combined indicator is then calculated as

$$I_t = 0.4 \left(\frac{CQGR_t - \mu_{Qt}}{\sigma_{Qt}} \right) + 0.6 \left(\frac{CAGR_t - \mu_{At}}{\sigma_{At}} \right)$$

- where I_t is the monthly indicator in month t
- $CQGR_t$ is the compound quarterly growth rate in month t
- $CAGR_t$ is the compound annual growth rate in month t
- μ_{Qt} and $_{Qt}$ are the weighted quarterly mean and weighted quarterly standard deviation for month t using the same calendar month across all previous years
- μ_{At} and $_{At}$ are the weighted annual mean and weighted annual standard deviation for month t using the same calendar month across all previous years

The weightings of the quarterly and annual indicators are determined by Principal Component Analysis in Felix G. Baquedano, 2015 (PDF, 585KB), though the UN methodology for indicator 2.c.1 directs that 0.4 and 0.6 should be used as the general case.

The headline indicator is then a rolling 12-month unweighted arithmetic average of this combined indicator.

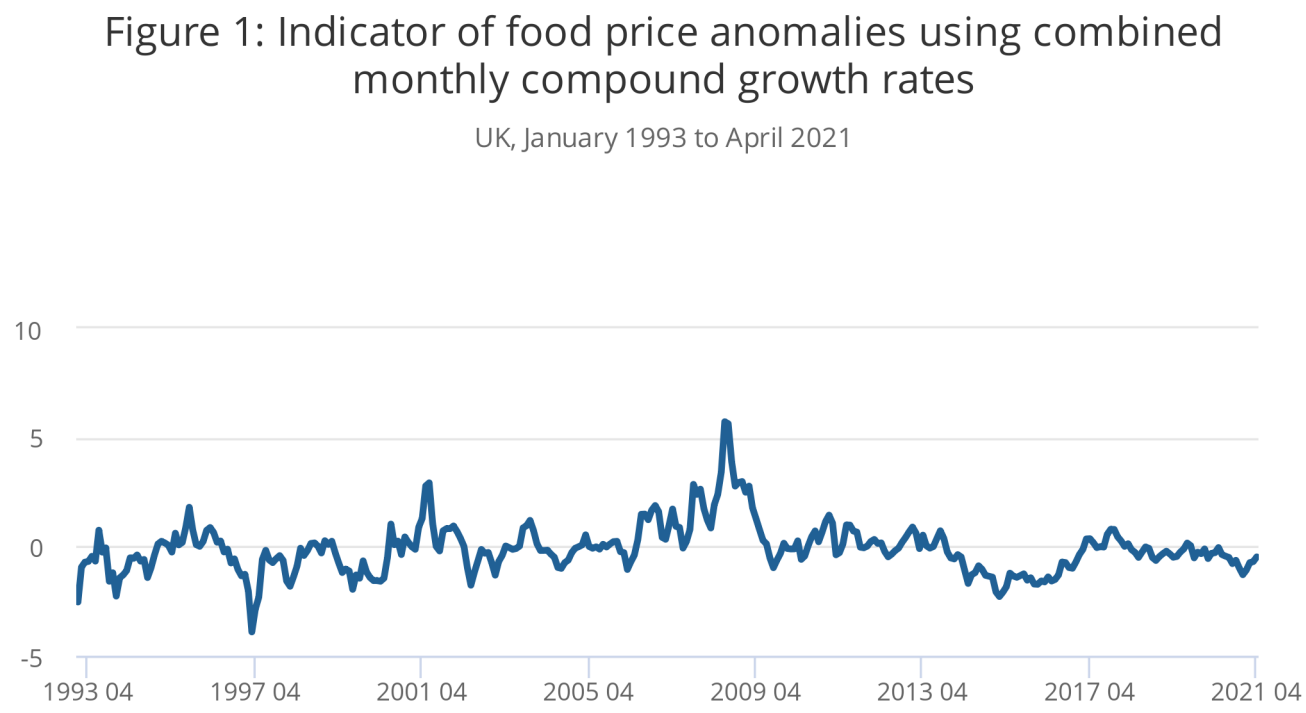
6 . Observations on the indicator

The annual and quarterly indicators are normalised scores similar to z-scores. Both normalised scores and z-scores, in this instance, indicate how out of the ordinary the food price change is; the z-scores across all price changes in the same month of the year for the same food item have a mean of zero and a standard deviation of one. For the normalised scores, it is the weighted average that is zero and weighted standard deviation that is one. A score above one indicates that the price change in those months was more than one standard deviation (or weighted standard deviation) above its normal price change and so is considered “anomalous”.

The normalised scores are used instead of z-scores to reduce the effect of large historical values that might overshadow recent anomalous changes.

Figure 1: Indicator of food price anomalies using combined monthly compound growth rates

UK, January 1993 to April 2021



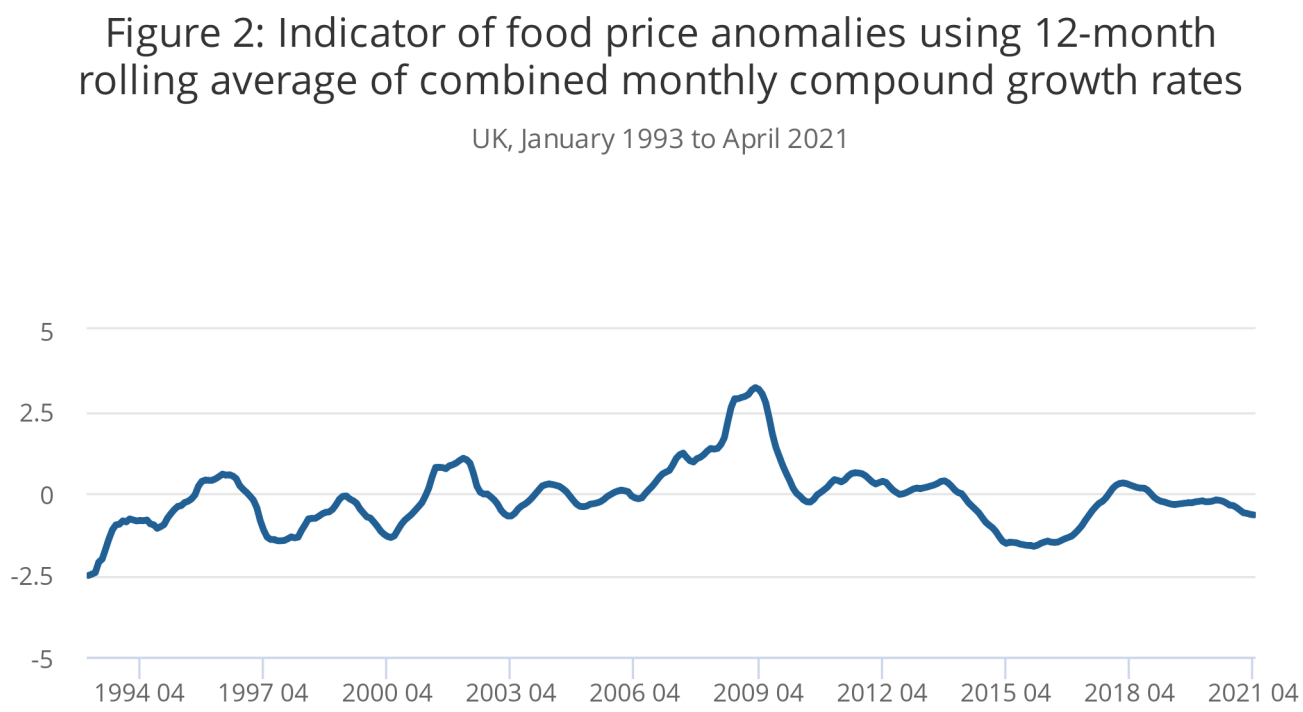
Source: Office for National Statistics – Consumer Prices Index

The combined monthly indicator is an average of these two indicators and uses Principal Component Analysis to determine their relative importance. Not all properties of the distributions carry across to the combined quarterly and annual indicator, which do not have equal weights. The combined indicator therefore does not have a weighted standard deviation of one.

An annualised version of this indicator takes the headline indicator’s value in December to give an average of the calendar year, though if a sequence of anomalous price movements does not fit into a calendar year then a price alert might be missed.

Figure 2: Indicator of food price anomalies using 12-month rolling average of combined monthly compound growth rates

UK, January 1993 to April 2021



Source: Office for National Statistics – Consumer Prices Index

The averaging over 12 months smooths out the price movements, though it can also delay raising a price warning by several months compared with the unsmoothed combined indicator. This means that it displays general trends rather than immediate "alerts", and for this reason the unsmoothed combined indicator is also of some utility. Caution is advised when reading the unsmoothed combined indicator as it displays more noise.

It must be stressed that each month's indicator value is based on the underlying growth rates, so a negative indicator value could still mean a positive growth rate that month; that it is negative means that the past 12 months (or past month, for the combined indicator) have been lower than expected based on all the available growth rates.

7 . Acknowledgements

The author would like to acknowledge the invaluable assistance provided by the National Institute of Statistics of Rwanda during their collaboration with the Office for National Statistics (ONS) on this indicator, as well as ONS experts in prices, index numbers and data time series.

8 . Related links

UK data for the Sustainable Development Goals
Webpage | Updated as necessary
Information about the Sustainable Development Goals (SDGs) - a universal call to action to end poverty, protect the planet and improve the lives and prospects of everyone, everywhere. The 17 Goals were adopted by all UN Member States in 2015, as part of the 2030 Agenda for Sustainable Development.

Sustainable Development Goals: collecting and reporting UK data
Webpage | Last updated 3 September 2019
Find out more about the Sustainable Development Goals (SDGs), what they measure and access the latest data collected by the Office for National Statistics.

Consumer price inflation, UK: April 2021
Bulletin | Released 19 May 2021
Price indices, percentage changes, and weights for the different measures of consumer price inflation.