

FEATURE

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Decomposing the Retail Sales Index implied price deflator and the CPI

SUMMARY

This article examines the relationship between the implied price deflator derived from the Retail Sales Index and the change in prices calculated from a comparable price index constructed using components of the consumer prices index. A decomposition approach is used to highlight the contribution of different products to the difference in growth rates over time.

The consumer prices index (CPI) and the retail prices index (RPI) are price indicators derived for the purpose of measuring price change experienced by private households (see ONS 2004, 2008a). Alternative measures of price can be derived using the relationship that price is equal to value divided by volume. This is known as an implied price deflator (IPD). Outputs from the Retail Sales Inquiry (RSI) (see ONS 2008b) can be used to derive an IPD. The scope of the RSI is, by definition, limited to businesses that sell goods directly to the public, but may also include non-identifiable sales from business to non-households, sales to non-residents and also households which have been excluded from the CPI. In general, there are a range of scope, timing, coverage and definition differences between the CPI, RPI and the IPD (RSI) that ensure that there are differences between the three measures.

Figure 1 shows the IPD (RSI) for the all retailing sector plotted against the CPI

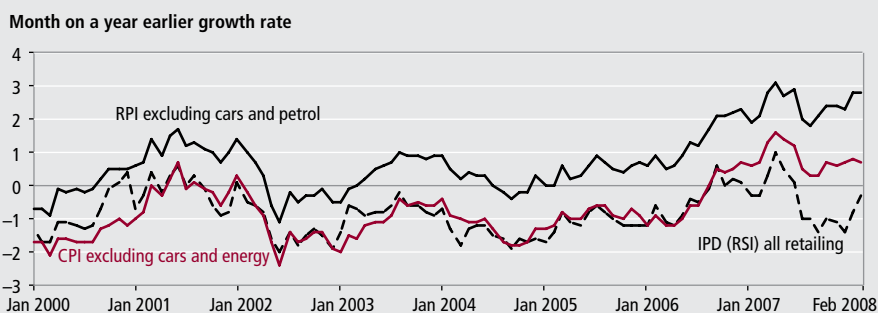
(all goods excluding cars and energy) and against the RPI (all goods excluding cars and petrol). The year-on-year change has been calculated. The IPD (RSI), CPI and RPI all show similar movements, but at different levels, which in part reflect the difference in scope, coverage and index construction methodology. Figure 1 suggests that the price change for the all retailing sector (IPD (RSI)) has been larger than normal in recent periods, and that since September 2006 there has been an increased difference when compared with the CPI and RPI. The most recent time period for February 2008 shows a reduction in the difference.

A decomposition approach is used to help understand the contributions that different products have on the difference shown in Figure 1.

Calculating different deflators

Comparisons between different deflator measures are only appropriate when the

Figure 1
Year-on-year change in prices



scope, coverage and methodology are conceptually similar. The commodity level deflators used in the compilation of the RSI are broadly consistent with the CPI and RPI. However, even though the underlying source data are the same, different methodologies will lead to differences between the published CPI, RPI and IPD (RSI). Differences are expected, as shown in Figure 1, due to the following reasons:

- the different deflator measures have been constructed to answer specific questions. For example, the CPI and RPI answer the question: ‘How much would it cost in the current time period, relative to the base time period, to purchase the same quantities of goods and services as purchased in the base period?’ This is different from the IPD (RSI), which effectively answers the question: ‘How much would it have cost in the base time period, relative to the current time period, to purchase the same quantities of goods and services as purchased in the current time period?’ This means that the weights used within the CPI and RPI compared with the IPD (RSI) will be different because they are fundamentally answering different questions
- the RSI estimates retail turnover within the retail industry. To provide accurate estimates of the volume of retail sales, some unique commodity series need to be specified to exclude service elements. For example, within the RSI, the telephone and telefax equipment product explicitly removes items such as subscriptions to the internet and mobile phones which are actually included within the CPI. This leads to differences in coverage between the indicators
- the compilation of the RSI uses time series of commodities based on the Classification of Individual

Consumption by Purpose (COICOP) classification system. The RSI commodity price indicators are calculated using an arithmetic mean across products. The published RPI is also calculated using an arithmetic mean, but using the RPI Advisory Committee classification system. The CPI uses COICOP classifications and geometric mean. There will be differences between the three series based on these methodological differences

- to ensure consistency within the RSI, commodity deflators are re-referenced to a base year of 2000=100. This is due to some constructed series using a different base period. The reference period for the RPI is January 1987=100, and for the CPI is 2005=100
- the RSI commodity deflators undergo further processing, as the RSI results are published using the Standard Industrial Classification. Broadly, the commodity deflators for the RSI are aggregated across industries using weights based on the value of sales from the Annual Business Inquiry (ABI) from the year 2000, using a harmonic mean
- the aggregate level IPD (RSI) may be influenced by the level of sales in an individual sub-industry. For example, within the household goods sector, very strong sales of personal electrical goods during December mean the electrical stores implied price deflator, which has a different downward trend compared to that for the other two component sub-sectors, has an impact on the overall implied price deflator for December
- chain-linking is used for the CPI and RPI, but is not currently used within the RSI. For example, higher-level CPI and RPI aggregates (above the basic item level) are constructed by weighting together unlinked components and then re-referencing the aggregates

Further information about the construction and the relationship between the CPI and RPI can be found in ONS (2004).

To ensure comparability, a version of the CPI has been calculated using an arithmetic mean of detailed COICOP commodity deflators as used within the IPD (RSI). This is referred to in this article as the CPIa and will help remove one aspect of difference between the different deflator measures.

Figure 2 shows the CPIa series over recent periods. The CPIa still displays an increase in difference against the IPD (RSI) deflator over recent time periods, particularly from September 2006. The difference between the IPD (RSI) and CPIa at September 2007 is 2.58 percentage points. This difference can be decomposed into contributions from each individual product deflator.

Decomposing deflators into contributions from individual products

Decomposition of the percentage movements of the deflators by product allows the contribution of individual products to be assessed, and also how this contribution of each product changes over time.

Let $I_t^{R,D}$ be the IPD (RSI) at time t . The percentage change in the IPD (RSI) between two time periods, t and t_0 , can be shown to be

$$\Delta I_{t,t_0}^{R,D} = 100 \times \left\{ \sum_i \left(\frac{\omega_i^{R,t_0} - \omega_i^{R,t}}{I_i^{C,t_0} \sum_j \frac{\omega_j^{R,t}}{I_j^{C,t}}} \right) + \sum_i \frac{\omega_i^{R,t}}{I_i^{C,t}} \left(\frac{I_i^{C,t}}{I_i^{C,t_0}} - 1 \right) \right\} \quad (1)$$

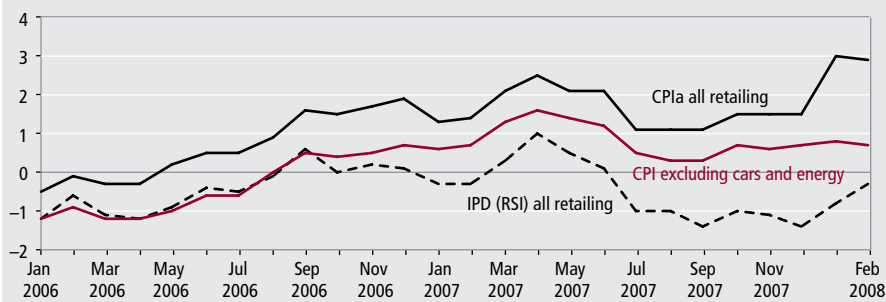
where $\omega_i^{R,t}$ is the current weight of product i at time t for the RSI (these weights can also be expressed in terms of the RSI weights based on sales for each industry and the RSI weight within each industry for each product), $I_i^{C,t}$ is the CPI for product i at time t , where $i = 1, \dots, 44$ and $j = 1, \dots, 44$.

Similarly, let I_t^C be the CPI at time t . The percentage change in the CPI between two time periods, t and t_0 , can then be shown to be

$$\Delta I_{t,t_0}^C = 100 \times \left\{ \sum_i \frac{I_i^{C,t}}{I_i^{C,t_0}} (w_i^{C,t} - w_i^{C,t_0}) + \sum_i \frac{I_i^{C,t_0} w_i^{C,t_0}}{I_j^{C,t_0} w_j^{C,t_0}} \left(\frac{I_i^{C,t}}{I_i^{C,t_0}} - 1 \right) \right\} \quad (2)$$

Figure 2
Year-on-year change in prices

Month on a year earlier growth rate



where $w_i^{C,t}$ is the CPI product weight (based on expenditure) for product i at time t , $i = 1, \dots, 44$ and $j = 1, \dots, 44$.

Full details of the derivation of (1) and (2) are given in McCrae *et al* (2008).

Equations (1) and (2) can then be used to decompose the contributions of the products between given time points. This can be used to show which product had the greatest, or least, contribution to the index point difference between the IPD (RSI) and CPI over different time periods. Rounding may have an impact between the estimates used in this article and published estimates.

In particular, the decomposition method can be used to identify three separate causes of differences between the CPIa and IPD (RSI):

- changes in the CPI weights over time. These differences emerge because the broad commodity level indices in the CPIa are chain-linked. For example, the weight of other goods is around 0.23 per cent of the total weight in the aggregate CPIa in 2007 and 0.33 per cent in 2006. This difference leads to a contribution to the difference between the aggregate IPD (RSI) and the CPIa of around -0.17 points
- changes over time in the effective retail sales product current value weights in the IPD (RSI). For example, the weight of alcoholic beverages in 2006 was 4.3 per cent, and in 2007 was 4.2 per cent. This difference leads to a contribution to the difference between the aggregate IPD (RSI) and the CPIa of around

+0.13 points. In practice though, this source makes little contribution to the aggregate difference between the IPD (RSI) and the CPIa, and

- the difference between the deflated current weight of products in the RSI (expressed in base year prices but current period quantities) and the CPIa weights for the same product. For example, the weight of bakery products and cereals in the RSI is 3.1 per cent in 2007 and in the CPIa is 3.4 per cent. This difference leads to a contribution to the difference between the aggregate IPD (RSI) and the CPIa of around +0.02 points

Comparison between implied deflators for the RSI and a derived CPI

Table 1 summarises the largest contributions to the percentage difference in the annual growth rate of the IPD (RSI) for all retailing and the CPIa at September 2007. **Table 2** presents a similar summary for the annual growth rates at September 2006. The data used in both tables were available as published in December 2007. Subsequent revisions to the original estimates may change the deflator estimates slightly, although this will not impact on the conclusions.

Table 1 shows that the information processing equipment product had the greatest contribution to the difference in the annual growth rates for the IPD (RSI) and CPIa at September 2007. Column 1 shows that this product contributed +1.52 per cent of the +2.58 per cent difference between the IPD (RSI) and the CPIa (compare with Figure 1). Other products to have a significant positive contribution to the increased difference include garments, audio and visual equipment, non-alcoholic beverages and fruit. Some products had negative contributions to the difference, although these were offset by greater positive contributions. Overall, 32 products contributed positively to the percentage difference, while only 12 products contributed negatively. The full decomposition and contributions by all products is given in McCrae *et al* (2008).

Table 2 shows that the furniture and furnishings product had the greatest contribution to the difference between the IPD (RSI) and CPIa between September 2005 and September 2006. This is a significant change from the difference between September 2006 and September 2007 where it had the largest negative contribution to the percentage difference.

Table 1

Largest contributions to the percentage point difference between the annual growth rates of the IPD (RSI) and CPIa, September 2007

Product	Using 2000 deflator weights	Using 2005 deflator weights
Top five		
Information processing equipment	1.52	1.53
Garments	0.43	0.38
Audio and visual equipment	0.36	0.47
Non-alcoholic beverages	0.33	0.31
Fruit	0.33	0.33
Bottom five		
Telephone and telefax equipment	-0.19	-0.14
Travel goods and other personal effects	-0.19	-0.19
Games, toys and hobbies	-0.21	-0.20
Other goods	-0.24	-0.18
Furniture and furnishings	-0.63	-0.61
Percentage difference in deflators	2.58	2.73
Percentage growth: CPIa	1.12	1.12
Percentage growth: IPD (RSI)	-1.46	-1.61

Table 2

Largest contributions to the percentage point difference between the annual growth rates of the IPD (RSI) and CPIa, September 2006

Product	Using 2000 deflator weights	Using 2005 deflator weights
Top five		
Furniture and furnishings	1.53	1.51
Other items for personal care	0.64	0.61
Games, toys and hobbies	0.39	0.39
Carpets and other floor coverings	0.30	0.31
Information processing equipment	0.27	0.23
Bottom five		
Pharmaceutical products	-0.31	-0.27
Decorating and DIY supplies	-0.31	-0.30
Stationery and drawing materials, etc.	-0.34	-0.34
Alcoholic beverages	-0.44	-0.42
Meat	-0.56	-0.56
Percentage difference in deflators	0.96	0.78
Percentage growth: CPIa	1.58	1.58
Percentage growth: IPD (RSI)	0.62	0.80

Figure 3
Year-on-year change in prices

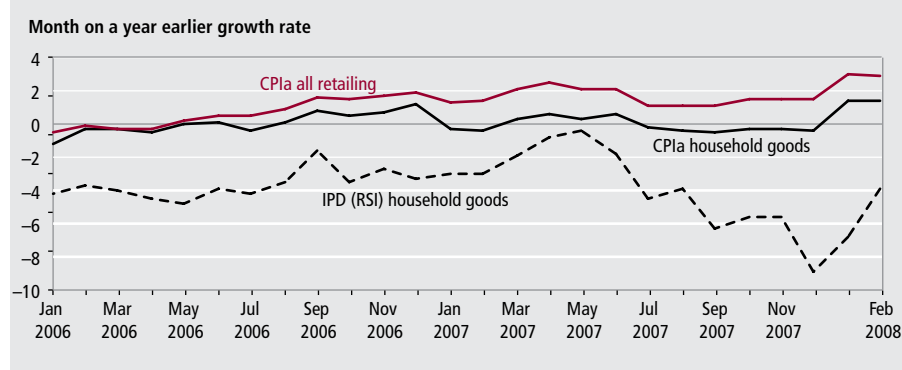


Table 3
Largest contributions to the percentage point difference between annual growth in 2007 and 2006 of the IPD (RSI) and CPIa

Product	Using 2000 deflator weights	Using 2005 deflator weights
Top five		
Information processing equipment	1.25	1.29
Meat	0.74	0.73
Non-alcoholic beverages	0.53	0.53
Alcoholic beverages	0.43	0.41
Sugar, jam, honey, syrups, chocolate, etc.	0.37	0.35
Bottom five		
Travel goods and other personal effects	-0.41	-0.40
Carpets and other floor coverings	-0.47	-0.46
Games, toys and hobbies	-0.60	-0.59
Other items for personal care	-0.62	-0.58
Furniture and furnishings	-2.16	-2.13
Percentage difference in growth	1.62	1.95
Percentage difference in growth: CPIa	-0.46	-0.46
Percentage difference in growth: IPD (RSI)	-2.08	-2.42

Table 4
Largest contributions to the percentage point difference between the annual growth rates of the IPD (RSI) for household goods and the equivalent CPIa, September 2007

Product	Using 2000 deflator weights
Top five	
Information processing equipment	4.89
Audio and visual equipment	1.86
Recording media	0.49
Sugar, jam, honey, syrups, chocolate, etc.	0.34
Books	0.26
Bottom five	
Other goods	-0.26
Travel goods and other personal effects	-0.27
Carpets and other floor coverings	-0.33
Decorating and DIY supplies	-0.38
Furniture and furnishings	-1.61
Percentage difference in deflators	5.83
Percentage growth: CPIa	-0.52
Percentage growth: IPD (RSI)	-6.35

The information processing equipment product again had a positive contribution to the percentage difference between these two time periods.

The change of impact for the furniture and furnishings product between September 2005 to September 2006, and September 2006 to September 2007 is due to the change in the weights used within the CPI for these years.

Comparing columns 1 and 2 in both Table 1 and Table 2 shows that there is little impact if the deflator weights used by the IPD (RSI) were updated to 2005 information from the ABI, rather than deflator weights based on 2000 information from the ABI. This suggests that the difference between the IPD (RSI) and CPIa arises from more fundamental differences in methodology than simply from the RSI using base year 2000 weights.

Table 3 gives the difference in annual growth rates between 2006 and 2007 (difference between the expanded Table 1 and Table 2). The information processing equipment product had the largest positive contribution, while the furniture and furnishings product had the largest negative contribution to the change over this period. Again, there was little impact if the deflators were updated to 2005 information from the ABI (column 2 in Table 3).

An example of a specific sector comparison: household goods

The decomposition approach can also be used for the decomposition of products within different industry sectors. For example, the household goods stores sector comprises three sub-sectors:

- furniture, lighting and household articles not elsewhere classified
- electrical household appliances and radio and television goods, and
- hardware, paints and glass

Figure 3 shows the IPD (RSI) for household goods and the equivalent CPIa for household goods as well as the CPIa for all retailing. This shows that there is an increase in the divergence between the deflators over the recent periods.

Table 4 gives a summary of the percentage point contributions to the difference in these deflators. In this case, the difference is primarily driven by the information processing equipment product, which has a large positive contribution to the difference in the annual growth rate at September 2007. However, there is a large negative contribution in recent years from

the furniture and furnishings product.

Table 5 gives a summary between September 2005 and September 2006. The main difference occurs for the furniture and furnishings product which now contributes the largest positive contribution to the percentage difference. The information and processing equipment product also contributes significantly.

Table 6 gives the difference in annual growth rates between 2006 and 2007 (difference between expanded Table 4 and Table 5). The results are similar to Table 3. The information processing equipment product had the largest positive contribution, while the furniture and furnishings product had the largest negative contribution to the change over this period.

Table 5

Largest contributions to the percentage point difference between the annual growth rates of the IPD (RSI) for household goods and the equivalent CPIa, September 2006

Product	Using 2000 deflator weights
Top five	
Furniture and furnishings	1.89
Information processing equipment	1.17
Audio and visual equipment	1.05
Other items for personal care	0.97
Games, toys and hobbies	0.33
Bottom five	
Garments	-0.42
Natural or artificial plants and flowers	-0.43
Glassware, tableware and household utensils	-0.43
Stationery and drawing materials etc.	-0.45
Decorating and DIY supplies	-0.91
Percentage difference in deflators	2.42
Percentage growth: CPIa	0.85
Percentage growth: IPD (RSI)	-1.57

Table 6

Largest contributions to the percentage point difference between annual growth in 2007 and 2006 of the IPD (RSI) for household goods and the equivalent CPIa

Product	Using 2000 deflator weights
Top five	
Information processing equipment	3.72
Audio and visual equipment	0.81
Sugar, jam, honey, syrups, chocolate, etc	0.76
Works of art and antiques	0.54
Natural or artificial plants and flowers	0.53
Bottom five	
Games, toys and hobbies	-0.57
Travel goods and other personal effects	-0.58
Carpets and other floor coverings	-0.65
Other items for personal care	-0.83
Furniture and furnishings	-3.50
Percentage difference in growth	3.41
Percentage difference in growth: CPIa	-1.37
Percentage difference in growth: IPD (RSI)	-4.78

The magnitude of impact is roughly similar, although in the opposite direction.

Detailed decomposition analysis of the products and their contribution to the percentage difference for household goods is given in McCrae *et al* (2008). Similar comparisons can be made for other sectors.

Future work

The analysis set out in this article is based on an initial investigation into the reasons for differences between the CPIa and IPD (RSI). It identifies a number of potential reasons for the differences, and explores in detail their impact using a decomposition method which provides more detail on where differences occur.

This article does not consider whether

these differences are desirable in terms of the target variables being measured. However, it does open up a number of areas for further investigation in ONS into the methods use to compile these series. In particular, the next stages of investigation will involve consideration of the impact of chain-linking on the RSI. This is planned for implementation during 2008, along with re-referencing the index to a base year of 2005. Differences in the source data used for weights in both CPIa and the RSI also need to be examined in more detail, to establish if these represent conceptual differences or estimation error (for example, sampling error). Once complete, ONS will publish a further article setting out the findings of this research.

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