<u>The impact of choice of base month and other factors on the relative performance of different formulae used for aggregation of Consumer Price Index data at an elementary aggregate level.</u>

David Fenwick

Director, Consumer Prices and General Inflation Division, Office for National Statistics, 1Drummond Gate, London SW1V 2QQ, United Kingdom.
Fax 44 171 533 5817, email: david.fenwick@ons.gov.uk

Abstract
The UK Harmonised Index of Consumer Price (HICP) is about one percentage point lower than the nearest national equivalent, the Retail Prices Index (excluding mortgage interest payments) or RPI(X). Half of this difference is due to the fact that the HICP uses the geometric mean to aggregate locally collected prices into elementary aggregates whilst the RPI and RPI(X) use a combination of the average of relatives (AR) and the ratio of averages (RA). This "formulae" effect is much larger in the UK than in most other countries. The paper considers three factors which may have contributed to this:

- *the relative broad item descriptions used in the UK for price collection;*
- *the treatment of centrally collected prices in the sample design, particularly in relation to stratification;*
- *the choice of January as a base month particularly for items which are affected by January sales.*

It presents theoretical and analytical evidence of the impact of these three factors and in particular discusses the initial results of a simulation exercise involving the re-calculation of the RPI using alternative base months including December as used by some other countries.

There are potentially important implications both for consumer price index methodology and for international comparability between indices.

1.0 Introduction

The Office for National Statistics publishes two main measures of consumer inflation:

- the Retail Prices Index (RPI), the main domestic measure, and its derivatives including RPI(X) which excludes mortgage interest payments and is used by the Government for targeting inflation;
- the Harmonised Index of Consumer Prices (HICP) which is calculated in each member state of the European Union as a comparative measure, as required by the Maastricht Treaty for Monetary Union convergence. Since January 1999 the HICP has been used by the European Central Bank as the measure for its definition of price stability across the Euro area.

The two indices share much of the same basic price data in their construction and the methodologies used to construct the two indices are very similar. However, the two indices differ in two important respects:

- in the HICP the geometric mean is used to aggregate prices at the most basic level whereas the RPI uses arithmetic means;
- the coverage of items included in the respective indices varies, most particularly the HICP excludes owner occupiers' housing costs (ie mortgage interest payments, house depreciation, council tax and buildings insurance).

A comparison between annual inflation rates as measured by RPI(X) (the RPI excluding mortgage payments) and the HICP respectively shows that the HICP is about one percentage point lower. For instance, when annual inflation based on RPI(X) stood at 2.6% in January 1999 the equivalent HICP rate was 1.6%. Further analysis showed that about half of this difference results from the use of different formulae to aggregate prices. This result is of interest for two reasons:

- it indicates that the impact of choice of formulae is much greater for UK measures of inflation compared with other countries. For instance, it is estimated that in France the choice of formulae has only a 0.1 percentage point effect on measured inflation;
- discounting major differences in the structure of retailing, it suggests that other methodological differences associated with the construction of price indices can and do have a significant influence on the performance of different formulae.

Against this background it was decided to investigate further the reasons for the striking difference in impact resulting from choice of formulae.

2.0 The theoretical issues and their practical consequences

2.1 The theoretical issues

The conceptual and statistical characteristics of different formulae are well documented both in terms of implicit assumptions which are being made regarding base weights and elasticities of substitution and their robustness of performance under different sets of circumstances.

To begin we should perhaps remind ourselves of the mathematical definition of the three different formulae currently used and how they relate to one another. If p_{10} to p_{no} denote base year prices for commodities 1 to n and p_{1t} to p_{nt} represent matching prices in a subsequent month t then:

Average of Relatives (AR): I_t =

$$AR: \quad I_t = \frac{1}{n}\sum_{i=1}^{n}\frac{p_{it}}{p_{i0}}$$

Ratio of Averages (RA): I_t =

$$RA: \quad I_t = \frac{\sum_{i=1}^{n} p_{it}/n}{\sum_{i=1}^{n} p_{i0}/n}$$

Geometric Mean (GM): I_t

$$G: \quad I_t = \left(\prod_i \frac{p_{it}}{p_{i0}}\right)^{1/n} = \frac{\left(\prod_i p_{it}\right)^{1/n}}{\left(\prod_i p_{i0}\right)^{1/n}}$$

Ideally an index should reflect actual expenditure, ie what we are attempting to measure is:

$$I_t = \sum_{i=1}^{N} \frac{W_{io} P_{it}}{P_{io}}$$

where for a fixed basket, W_{io} is actual expenditure in the base period and I_t is the true mean computed for all N prices. In the case of the RPI the N prices relate to a theoretical basket fixed in terms of composition, quantity and quality. As current data is not available to estimate the weights W_{io} at a very low level of aggregation, some assumptions have to be made.

It can be seen that if all weights are equal then the above arithmetic mean formula becomes AR. So we conclude that AR is appropriate if each price within an aggregate is considered equally important, ie if expenditure does not vary between items. However if the expenditures are proportional to the base price p_{io} so that quantity purchased does not vary between items then the formula becomes RA. So RA is most appropriate if base price is a good indication of the importance of each price quote. The extent to which the latter holds in practice clearly depends amongst other things on choice of base month and how prices in the base month are affected by sales and other seasonal influences.

Note that GM in analogous both to AR and RA insofar as it can be regarded as either the geometric mean of price relatives or the ratio of geometric mean prices.

The appropriateness of a particular formula depends in part on the underlying assumption about consumer behaviour. The application of RA is equivalent to assuming a zero elasticity of substitution both within the year and between years (and in that sense identical to an unchained index) because the relative quantities of different items remains constant. In contrast, the assumption of equal expenditure weights underlying the AR implies an elasticity of substitution of unity between years (and of zero within the year). However, for both the RA and AR shifts in purchasing patterns outside of the base period are ignored throughout the year between chain linking. This is in marked contrast to the geometric mean which assumes purchasing patterns in periods subsequent to the base period change so that expenditure shares remain constant ie there is a within year elasticity of substitution of 1. Note that like AR, the GM assumes that in the base period there is equal expenditure on each item.

Also of relevance in consideration of the relative merits of these formulae are the statistical characteristics. In particular, AR can suffer from price bounce where a return to the original bases price does not necessarily lead to the index reverting to its original value. This feature can be removed by abandoning chain linking and the impact can be minimised by reducing the standard deviations of the price relatives (see Annex A). Also RA is less distorted than AR if one of the base period prices is abnormally low, such as during a sale, but has the drawback that an item of much higher than average price can dominate the index. This suggests that AR should be used when there is a great deal of price dispersion. Clearly price dispersion potentially can be reduced by stratification of outlets within a stratum, by the choice of elementary aggregates, generic or specific item descriptions and choice of base month.

2.2 Practical consequences of the theoretical issues

The above issues would be largely of academic interest if it wasn't for the fact that where price relatives vary the choice of formulae has a numerical impact on the index and measured inflation. In particular:

- GM is always lower than AR with the difference being proportional to the variance of the price relatives;
- GM is lower than RA if the price dispersion is increasing and vice versa

In addition, unlike arithmetic means which are linear functions and therefore unbiased estimators, the sample GM is a biased estimate of the population GM. The extent of the bias depends, amongst other things, on the extent to which a normal distribution can be assumed (and it is well known that in general prices are not normally distributed). It is hoped to address this issue in the current ONS research programme. In particular it is planned to test the assumptions about normality through the use of clustering techniques and then exploit modelling techniques to optimise the design of the elementary aggregates for any particular choice of formulae. Note that stratification, particularly by shop type, together with the method of sampling prices from large chain stores can reduce the effective sample size for some sub-indices to a relatively low number thus increasing by the second power the potential for bias.

Thus, in summary it can be seen that there is an interaction between sample design and the effective performance of different formulae. More particularly, and the focus of this paper, the extent of the "formula effect" (misleading referred to in many papers as formulae "bias" in price indices) is dependent on the amount of price dispersion in the data and whether this is increasing or decreasing.

This clearly has practical consequences since the amount of price dispersion in an index can be controlled to a certain extent by choice of statistical design.

The fact that we can influence the size of the "formula effect", and in particular minimise it, by taking a considered look at the way we sample prices is particularly relevant in a UK context where as already stated there is a relatively large difference in measured inflation when the GM is applied instead of a combination of AR and RA. This first came to light when a reconciliation analysis was conducted between RPI(X), which is used to set the national inflation target, and the HICP, which is used to compare inflation between countries in the context of Monetary Union and the Maastricht Treaty. This reconciliation showed that replacing a combination of AR and RA by the sole use of the GM currently reduces measured inflation in the UK by about 0.5 percentage points. In addition this gap has been growing over recent years independent of the rate of inflation (from 0.23 percentage points in 1989 to 0.53 percentage points in 1997). Investigations were started to understand why such a large difference resulted, why it was bigger now than in the past and what implications this had for current RPI methodology.

3.0 Factors investigated and the initial evidence

Prior to more detailed investigation, the initial view had been taken that there were two main reasons why the formulae effect is so great in the UK:

- the relatively broad item descriptions used in the UK. Other countries such as France and Austria define items much more tightly, in part to ensure that the sample of prices collected is more homogeneous;
- the use of January as the base period, particularly for items which are affected by January sales. Many other countries use December where there is likely to be less price dispersion.

3.1 Broad item descriptions

The advantage of the heterogeneous collection of items in the UK is that broad item descriptions broaden the coverage of items sampled, so the effective sample size is increased. However, it seems intuitively likely that broad item descriptions will result in greater variability of price relatives and, therefore, a greater formula effect. Moreover this view is supported by the fact that the formula effect has increased in the UK over recent years. This is consistent with the fact that any such effect is likely to have increased with the introduction in 1996 of broader item descriptions. In that year random sampling of outlets and locations was introduced and the sample design optimised. In particular:

- relatively tight item descriptions were replaced with more generic descriptions from which the price collector would then chose a representative item – for example *marmalade* and *strawberry jam* were replaced with *jar of jam*. This had the effect of making the sample of items more representative;
- the numbers of quotes for many clothing items and, to a lesser extent, furniture items were doubled. This was because of the variability in the price relatives previously observed in these two categories.

Initial investigations have focussed on the extent to which the "formula effect" can be identified with particular items or groups of items. Such an analysis is given in table 1 at Annex B for the major divisions of the HICP (we could equally have produced an analysis for RPI sub-headings but the use of HICP divisions provides for better international comparability). The salient points are:

- the formulae effect is particularly pronounced for clothing and, to a lesser extent, furnishings and household equipment and recreation and culture
- the overall contribution to the formulae effect of these three categories is fairly consistent throughout the period investigated with clothing accounting for 40%, furnishings and household equipment 20% and recreation and culture 10%. By way of comparison their respective weights in the HICP are 6.8%, 9.2% and 13.2% in 1998.
- as would be expected the formulae effect is lowest for those series associated with relatively homogeneous items and relatively little price dispersion, ie where the RPI uses RA, such as for alcohol, tobacco, food and soft drinks or where indices are calculated centrally, such as communication.

It should also be noted that the relatively large formulae effect for health in recent years and the diminishing formulae effect for education can be explained by the fact that each category covers relatively few items and that the prices of some of the items can be very volatile.

The underlying patterns of the formulae effect can be seen at a glance from the graphical presentations at Annex C.

This initial analysis points to three areas for further investigation and potential action:

- the desirability of tighter item descriptions for certain categories of items where there is relatively large price dispersion;
- a review of elementary aggregates to test for homogeneity in the groupings;
- a review of the choice of AR or RA for each elementary aggregate and which is the most appropriate (putting aside whether the GM is to be preferred).

In addition, and is to be expected, the biggest formulae effect is associated with items where January sales are particularly common, such as clothing and footwear and furniture & furnishings. This arises because some of the products priced will be at undiscounted prices while for others the depth of sales will mean some very low prices being offered. This will inevitably lead to a wide range of price relatives when the discounted prices return to their "normal" values. The paper now goes on to consider factors relating to choice of base month and the impact of that choice on the index.

3.2 January base month

The current practice of using a January base month for the UK Retail Prices Index is based on the premise that January is a month in which few prices are at abnormally high or low levels on account of seasonal movements and that it is also the month where it is most likely that new goods will be adequately captured.

The assertion that this impacts on the formula effect can be tested by computing average seasonal factors for the latter. This has been done for all items and for the two categories clothing and furniture which account for most of the formula effect. The results are given in table 2 This table shows that for all three series the average seasonal factor is lowest for January ie the average formula effect tends to be much lower in that month and that in absolute terms the average deviation from the norm is greatest. Whilst prices may not be abnormally high in January there is clear evidence that winter sales reduce average prices significantly. We can therefore conclude, from table 2, that there is prima facia evidence that the impact of using the geometric mean will be greatest in January presumably because the variance of price relatives with a January base are likely to be particularly high.

Table 2: Average Seasonal Factors

Month	All items	3 Clothing	5 Furniture
Jan	0.9734	0.9307	0.9564
Feb	0.9854	1.0158	0.9776
Mar	1.0107	1.0183	1.0032
Apr	1.0311	1.0338	0.9860
May	1.0131	1.0246	1.0110
Jun	1.0102	1.0272	1.0111
Jul	1.0050	1.0289	1.0113
Aug	0.9958	1.0171	0.9980
Sep	0.9975	0.9705	1.0052
Oct	1.001	0.9960	1.0054
Nov	0.9921	0.9784	1.0072
Dec	0.9860	0.9575	1.0269

The extent of the depth of January sales can be seen by examining the month-on-month percentage change in prices between December and January. Although clearly influenced by the variation in December prices on November, this analysis - which is given in table 3 - does seem to indicate that the depth of January sales has increased overtime particularly for those goods such as clothing and footwear and household furnishings traditionally offered at knock down prices in sales. The latter conclusion is clearly consistent with the observation that, in the UK, the difference between the arithmetic mean and geometric mean indices has increased over recent years particularly in those categories of goods previously referred to.

Table 3 Average percentage price change January on December

Year	Food & Non-alcohol Drinks	Clothing & footwear	Household furnishings	Recreation & culture	Misc. goods & services
1989	0.79	-2.12	-0.59	0.25	1.47
1990	1.23	-2.14	-0.34	0.48	0.50
1991	0.69	-4.01	-1.73	0.11	0.72
1992	0.89	-5.36	-2.05	-0.11	1.24
1993	-0.11	-4.98	-2.84	-0.32	0.43
1994	0.55	-5.48	-2.66	-0.21	0.21
1995	1.50	-5.13	-2.26	0.31	-0.21
1996	0.51	-6.26	-3.17	0.10	-0.61
1997	0.71	-6.15	-3.72	-0.20	-0.10
1998	0.00	-7.33	-4.09	-0.20	0.10

In order to take this work forward and test what are so far hypotheses, an experimental database has been set up and a price index computed both on a January base month and on a December one based on those items which were priced continuously over the period under investigation (this requires deleting new or old items and new or old locations adopted or dropped at January chain linking – amounting to about a quarter of all price quotes).

It is far too early to come to even tentative conclusions but current indications suggest:

- the impact of moving from a January to a December base month is erratic and in particular can increase the index in one month and reduce it in another;
- this is particularly so when the index is computed using arithmetic means;
- the difference between the index computed on arithmetic means and one computed in a geometric mean reduces with a move to a December base month
- when using the geometric mean, moving to a December base month increases the measured monthly rate of inflation for the months immediately following (conversely reverting to a January base month reduces it).

3.3 Other possible factors: increasing use of central shop weights

It has already been noted that the RPI sample design was overhauled in 1996 when random sampling and broader item descriptions were introduced for some items. The impact of the introduction of broad items has been discussed in section 3.1. The introduction of random sampling may have contributed further to the formulae effect in two ways:

- the previous sample of shops was purposive and may have been more homogeneous than the range of shops which are now selected using random sample. Under the new sampling regime a particular price chain is defined both by the brand being priced and the outlet in which it is priced, so like broad item descriptions this may affect the variability of the price relatives;
- perhaps of more significance is the increasing use of central shop weights. Central shop weights are the weights given to prices obtained from large chains of multiples where prices are recorded centrally. For central shops, a single price is obtained from each relevant shop for each relevant item in the sample. That single price is used to represent the price movement of the entire range of products stocked by that shop for that particular item description and weighting is given by the duplication of that single price on the database used to construct the index. By contrast, when prices are collected locally a much broader range of products are priced for a particular item description and there is no duplication.

Table 4 shows that the increased use of central shop weights is most noticeable for food and soft drinks, clothing and footwear and household furnishings.

It is also interesting to note that there appears to be some correlation between the size of the formula effect and the increasing use of central shop weights. For instance:

- the proportion of clothing and footwear items with central shop weights jumped in 1992 and correspondingly the proportion of quotes represented by central shops has also increased;
- for food and soft drinks, the formula effect increases from 1992 which coincides with when the proportion of quotes represented by central shops increased substantially;
- for miscellaneous goods and services, the proportion of items with central shop weights increased in 1996 as did the formula effect.

Table 4 Use of central shop weights by HICP division

	Percentage of items with central shop weights					Percentage of central shop quote				
	Food & soft drinks	Clothing and footwear	Hhold furnishings etc	Recreation and culture	Misc goods & services	Food & soft drinks	Clothing and footwear	Hhold furnishings etc	Recreation and culture	Misc goods & services
1988	88	12	25	32	51	14	2	16	26	40
1989	77	12	23	25	39	14	3	12	22	33
1990	83	12	23	26	47	14	7	6	12	25
1991	89	12	36	42	47	24	5	10	12	28
1992	96	94	75	63	56	57	11	17	26	31
1993	90	93	88	51	50	55	11	21	25	32
1994	88	93	87	48	51	57	11	24	29	36
1995	97	92	86	48	47	57	12	23	27	33
1996	95	95	97	46	63	58	10	24	26	35
1997	93	95	93	46	61	58	14	25	24	33
1998	94	97	93	51	63	57	15	25	22	35

Finally another factor which may be contributing to differences between the formula effect in the UK and other countries is the extent to which stratification is used. Stratification should, in principle, lead to more homogeneous groupings. In the UK, items are generally stratified by region and/or shop type. However, the items which contribute most to the UK formula effect are stratified by shop type but not region. This compares with, for example, Austria where all items are stratified by region.

The US experience (see Annex C, extract from paper by Lequiller, INSEE) is also of interest. In the USA it was found that the introduction of new price chains with an abnormal initial price (eg a sale price), when combined with the use of AR biased the index upwards by 0.25 per cent. These are the conditions which potentially exist in the UK, and the proposition that this may be a contributory factor to the formula effect needs to be tested.

4.0 Conclusions

Reviewing the relative large impact of choice of formulae on the measured level of inflation in the UK has highlighted a number of factors for further investigation. These essentially relate to sampling issues and how they inter-react with the statistical characteristics of the different formulae which can be used at the elementary aggregate level. Further studies will have to be conducted to confirm whether they are critical features of the methodological design of the UK consumer price index which will need to be reviewed to improve index construction and, in the context of the Harmonised Index of Consumer Prices, international comparability.

Acknowledgements

The research reported in this paper has been a collaborative effort which is ongoing. The author would like to thank Jim O’Donoghue for the initial work he undertook to identify the issues, Michael Baxter for his contribution to the statistical theory, and to Dawn Camus and Damon Wingfield for the research subsequently conducted. Thanks are also due to colleagues who contributed to helpful discussions.

Annex A

Price Bounce

Suppose that there is an elementary aggregate of prices in two consecutive January's, say 1997 and 1998, and in a subsequent month, say November 1998. Denote these prices by $\{x_i\}$, $\{y_i\}$ and $\{z_i\}$. An index for the latest month based on January 97 can be calculated directly from the $\{x_i\}$ and $\{z_i\}$, ignoring the $\{y_i\}$ (it is assumed that there is no change in locations, outlets or varieties in January 98). Alternatively, it can be computed as a chained index

$$I^{chained}_{Nov98/Jan97} = I_{Nov98/Jan98} \ x \ I_{Jan98/Jan97}$$

If a formula can be expressed as $f(\{y_i\})/f(\{x_i\})$ (as RA and GM can be), then clearly

$$\frac{f(\{z_i\})}{f(\{x_i\})} = \frac{f(\{y_i\})}{f(\{x_i\})} \ x \ \frac{f(\{z_i\})}{f(\{y_i\})}$$

In this case, these two methods will always give identical values. However, AR cannot be expressed in this form. The difference between the results from the two methods is known as the price bounce effect. For a single chaining it is

$$direct - chained = \frac{1}{n}\sum\left[\frac{z_i}{y_i} x \frac{y_i}{x_i}\right] - \left[\frac{1}{n}\sum\frac{y_i}{x_i}\right] x \left[\frac{1}{n}\sum\frac{z_i}{y_i}\right]$$

which is just

$$cov\left(\frac{y_i}{x_i},\frac{z_i}{y_i}\right) = \rho\left(\frac{y_i}{x_i},\frac{z_i}{y_i}\right) x \ SD\left(\frac{y_i}{x_i}\right) x \ SD\left(\frac{z_i}{y_i}\right)$$

where p $\left(\frac{y_i}{x_i},\frac{z_i}{y_i}\right)$ is the correlation between successive price relatives

In the long run, there is negative correlation between successive price relatives since a price in a particular outlet hardly ever keeps rising or falling faster than average, and very abnormal price movements in one year are generally followed by significant movements in the opposite direction. This means that the covariance is negative, hence that the directly calculated price index is less than the chained one. This effect will cumulate over time with each annual chain.

This effect can only be removed completely by abandoning annual chaining. However the effect can be minimised by reducing the standard deviations of the price relatives, which in any case should be done if the aim is to reduce the difference between AR and GM as indicated in the main paper. For example a change in base month might reduce the standard deviation and therefore price bounce. It would also be desirable to make the correlation between successive price relatives smaller, but it is not obvious how this can be done.

Table 1: Variability of Formulae effect by Sub-Divisions of HICP

Annex B

A. HICP - Formula effect: annual averages (per cent)

		Formula effect - 12 month rate								
		1989	1990	1991	1992	1993	1994	1995	1996	1997
	HICP ALL-ITEMS	-0,23	-0,26	-0,36	-0,34	-0,43	-0,42	-0,39	-0,45	-0,52
10000	FOOD AND NON-ALCOHOLIC BEVERAGES	-0,05	-0,01	-0,02	-0,09	-0,16	-0,18	-0,11	-0,21	-0,26
20000	ALCOHOLIC BEVERAGES, TOBACCO AND NARCOTICS	0,00	-0,03	0,03	0,01	-0,04	-0,04	-0,04	0,02	-0,11
30000	CLOTHING AND FOOTWEAR	-1,07	-1,21	-2,07	-1,90	-2,61	-2,47	-2,36	-2,61	-3,24
40000	HOUSING, WATER, ELELCTRICITY, GAS AND OTHER FUELS	-0,11	-0,15	-0,17	-0,18	-0,17	-0,15	-0,13	-0,14	-0,15
50000	FURNISHINGS, HOUSEHOLD EQUIPMENT AND ROUTINE MAINT	-0,59	-0,59	-0,79	-0,92	-0,95	-1,01	-1,06	-1,12	-1,14
60000	HEALTH	-0,35	-0,34	-0,24	-0,29	-0,61	-1,44	-0,04	-0,90	-0,79
70000	TRANSPORT	-0,06	-0,09	-0,12	-0,08	-0,12	-0,09	-0,10	-0,13	-0,12
80000	COMMUNICATION	-0,02	-0,01	-0,03	-0,04	-0,04	-0,03	-0,02	-0,04	-0,11
90000	RECREATION AND CULTURE	-0,25	-0,25	-0,34	-0,35	-0,39	-0,30	-0,30	-0,32	-0,39
100000	EDUCATION	-0,13	-0,33	-0,31	-0,20	-0,24	-0,18	-0,10	-0,08	-0,11
110000	HOTELS, CAFES AND RESTAURANTS	-0,12	-0,19	-0,22	-0,14	-0,22	-0,18	-0,19	-0,15	-0,16
120000	MISCELLANEOUS GOODS AND SERVICES	-0,27	-0,33	-0,37	-0,34	-0,40	-0,44	-0,39	-0,55	-0,55

HICP - Contributions to formula effect: annual averages

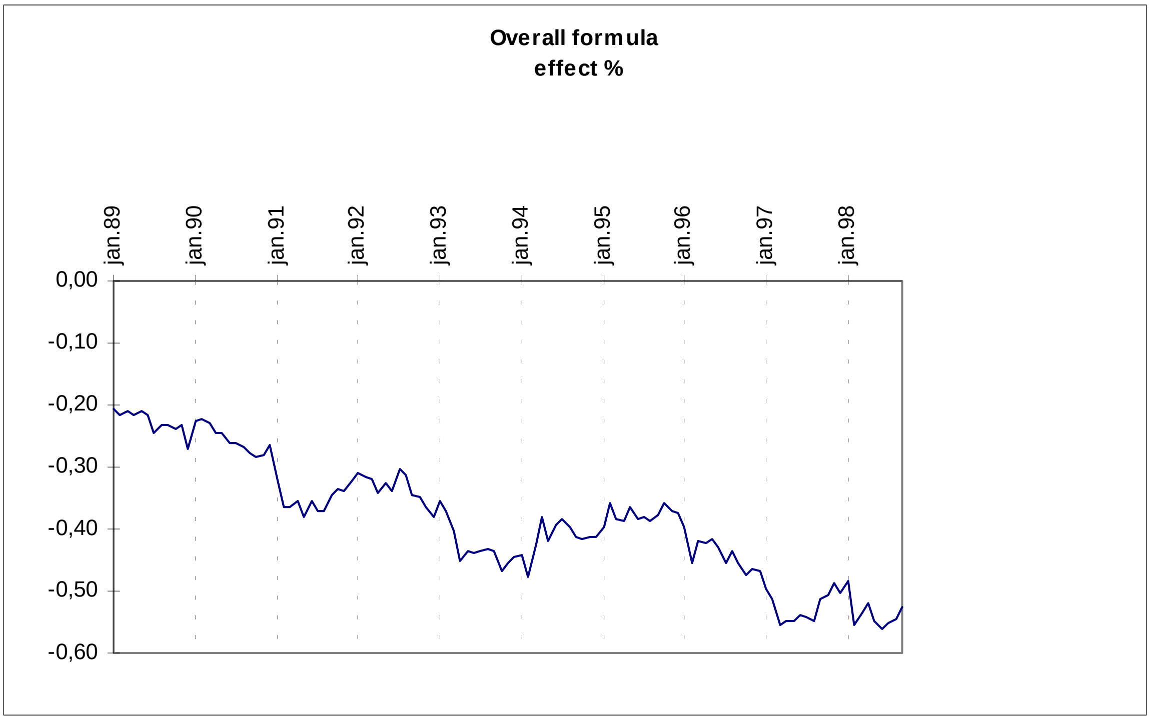
		Contribution to formula effect - 12 month rate								
		1989	1990	1991	1992	1993	1994	1995	1996	1997
	HICP ALL-ITEMS	-0,23	-0,26	-0,36	-0,34	-0,43	-0,42	-0,39	-0,45	-0,52
10000	FOOD AND NON-ALCOHOLIC BEVERAGES	-0,01	0,00	0,00	-0,01	-0,03	-0,03	-0,02	-0,03	-0,04
20000	ALCOHOLIC BEVERAGES, TOBACCO AND NARCOTICS	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	-0,01
30000	CLOTHING AND FOOTWEAR	-0,09	-0,11	-0,17	-0,14	-0,18	-0,18	-0,16	-0,18	-0,23
40000	HOUSING, WATER, ELELCTRICITY, GAS AND OTHER FUELS	-0,02	-0,02	-0,02	-0,02	-0,02	-0,02	-0,02	-0,02	-0,02
50000	FURNISHINGS, HOUSEHOLD EQUIPMENT AND ROUTINE MAINT	-0,04	-0,05	-0,06	-0,07	-0,08	-0,08	-0,09	-0,10	-0,11
60000	HEALTH	0,00	0,00	0,00	0,00	0,00	-0,01	0,00	-0,01	-0,01
70000	TRANSPORT	-0,01	-0,02	-0,02	-0,01	-0,02	-0,02	-0,02	-0,02	-0,02
80000	COMMUNICATION	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
90000	RECREATION AND CULTURE	-0,02	-0,02	-0,03	-0,03	-0,04	-0,04	-0,04	-0,04	-0,05
100000	EDUCATION	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
110000	HOTELS, CAFES AND RESTAURANTS	-0,02	-0,02	-0,03	-0,02	-0,02	-0,02	-0,02	-0,02	-0,02
120000	MISCELLANEOUS GOODS AND SERVICES	-0,01	-0,02	-0,02	-0,02	-0,02	-0,02	-0,02	-0,03	-0,03

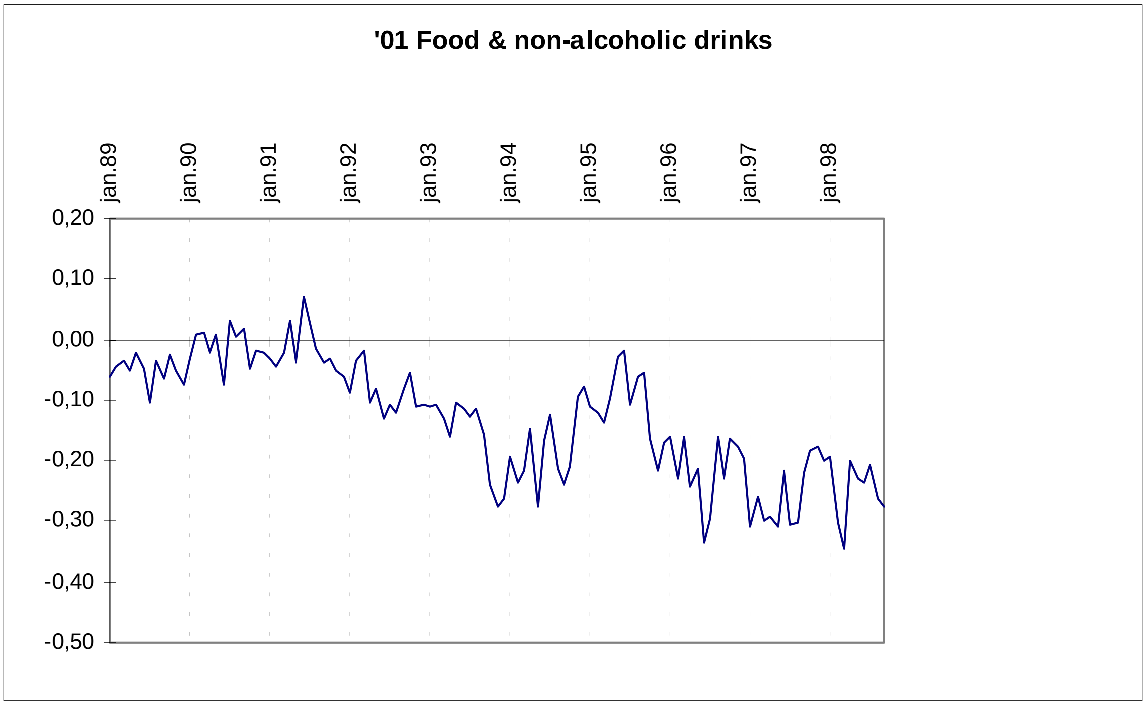
HICP - Contributions to formula effect: annual averages: % of total

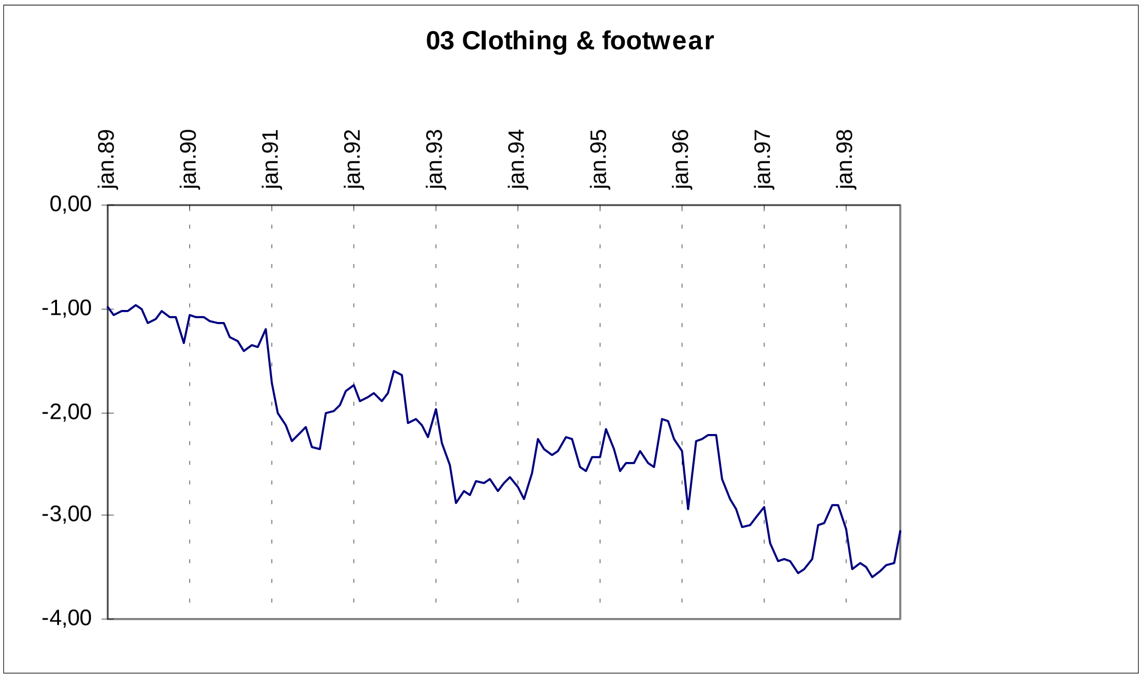
		Contribution to formula effect - 12 month rate								
		1989	1990	1991	1992	1993	1994	1995	1996	1997
	HICP ALL-ITEMS	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0
10000	FOOD AND NON-ALCOHOLIC BEVERAGES	4,0	0,8	0,9	4,3	6,0	6,9	4,4	7,2	7,7
20000	ALCOHOLIC BEVERAGES, TOBACCO AND NARCOTICS	0,0	0,9	-0,3	-0,1	0,7	0,6	0,8	-0,3	1,5
30000	CLOTHING AND FOOTWEAR	41,4	40,9	46,8	41,4	42,5	41,6	41,1	40,5	43,5
40000	HOUSING, WATER, ELELCTRICITY, GAS AND OTHER FUELS	6,6	7,4	6,2	6,8	5,2	4,6	4,7	4,4	3,8
50000	FURNISHINGS, HOUSEHOLD EQUIPMENT AND ROUTINE MAINT	19,5	17,5	17,0	21,9	18,2	19,3	22,5	22,3	20,2
60000	HEALTH	1,0	0,8	0,5	0,7	1,1	3,2	0,6	1,4	1,1
70000	TRANSPORT	4,3	6,1	6,2	4,3	4,6	3,6	3,9	4,6	3,5
80000	COMMUNICATION	0,1	0,1	0,2	0,2	0,2	0,1	0,1	0,2	0,4
90000	RECREATION AND CULTURE	10,2	8,9	9,2	9,9	10,4	9,5	10,6	9,6	9,7
100000	EDUCATION	0,5	1,2	0,8	0,5	0,5	0,4	0,2	0,2	0,2
110000	HOTELS, CAFES AND RESTAURANTS	6,6	8,8	7,3	4,6	5,5	4,3	5,2	3,7	3,3
120000	MISCELLANEOUS GOODS AND SERVICES	5,8	6,4	5,4	5,5	5,2	5,8	5,8	6,1	5,1

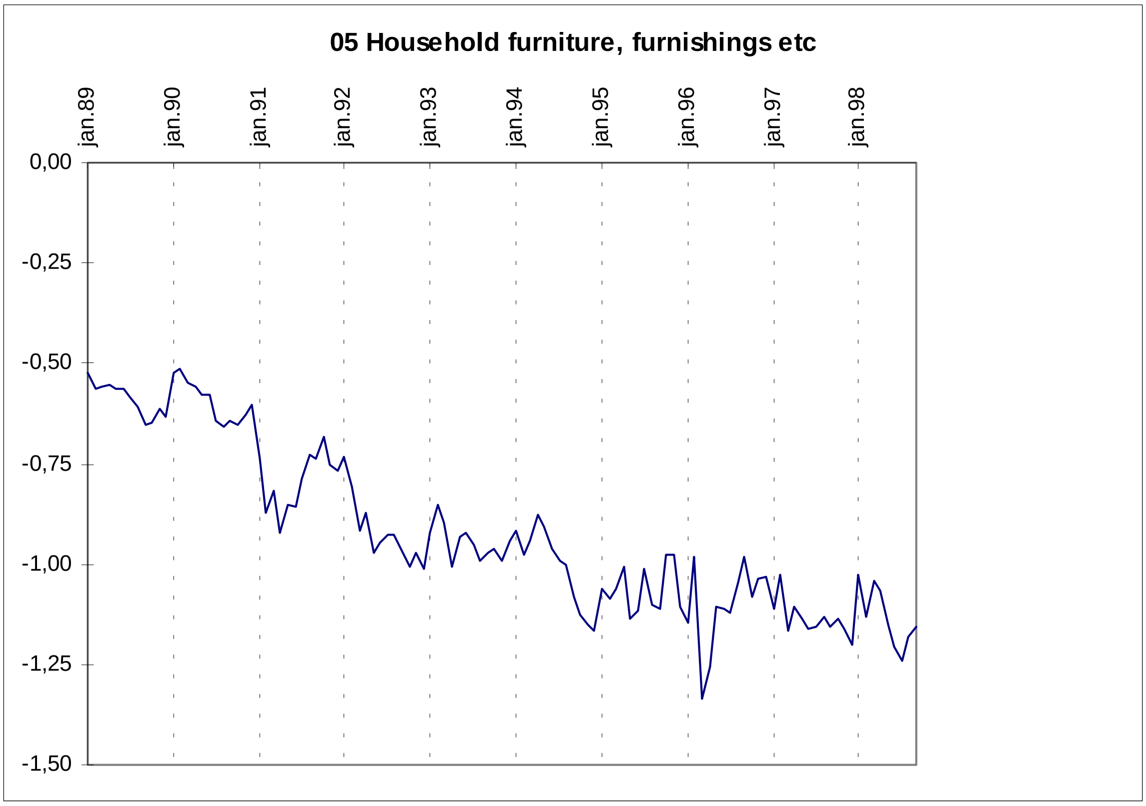
Variability of formulae effect by sub-divisions of HICP: graphical presentation

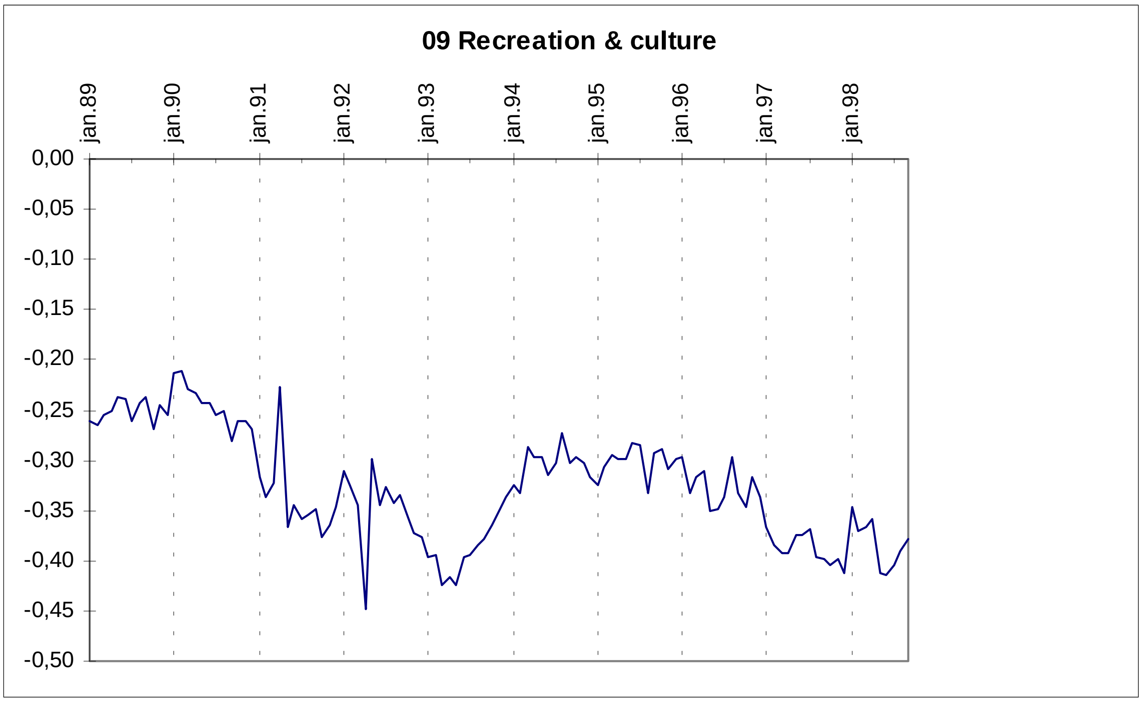
Annex C



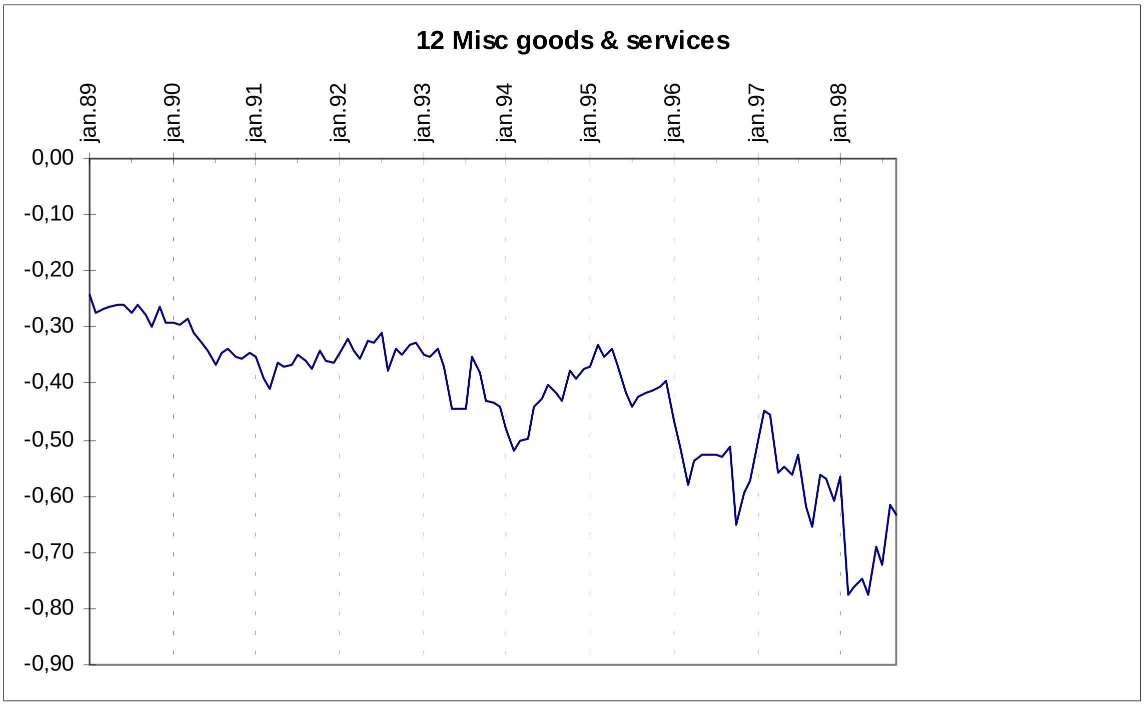



03 Clothing & footwear
jan.89
jan.90
jan.91
jan.92
jan.93
jan.94
jan.95
jan.96
jan.97
jan.98
0,00
-1,00
-2,00
-3,00
-4,00


05 Household furniture, furnishings etc
jan.89
jan.90
jan.91
jan.92
jan.93
jan.94
jan.95
jan.96
jan.97
jan.98
0,00
-0,25
-0,50
-0,75
-1,00
-1,25
-1,50



09 Recreation & culture
jan.89
jan.90
jan.91
jan.92
jan.93
jan.94
jan.95
jan.96
jan.97
jan.98
0,00
-0,05
-0,10
-0,15
-0,20
-0,25
-0,30
-0,35
-0,40
-0,45
-0,50



12 Misc goods & services
jan.89
jan.90
jan.91
jan.92
jan.93
jan.94
jan.95
jan.96
jan.97
jan.98
0,00
-0,10
-0,20
-0,30
-0,40
-0,50
-0,60
-0,70
-0,80
-0,90

ANNEX D

Extract from paper by Lequiller

The US formula bias was, by construction, much greater than the French one[19.] The reason is that 20% of the component products in 70% of the entry-level items in the US CPI are systematically replaced at random each year. This highly sophisticated procedure eliminates product-selection bias and provides an automatic 1/5 renewal of products tracked by the index[20.] However, the procedure was vulnerable to a formula bias similar to the one described in appendix 11, §2: whenever the initial price of the new product selected at random was low (because of special offers or seasonal factors), the subsequent price rises in the US index were automatically overstated. Conversely, when the initial price was too high , the subsequent decreases were automatically understated (Moulton 1996). This error proved to be particularly large – an estimated 0.25 percentage points – for the US index of fresh fruits and vegetables. In the French index, the problem affected only one-third of the CPI weighting: one notable exception was, precisely, fresh products, for which another (unchained) formula is used. Nor was the French index affected by special offers, since new products are never introduced when they are on special offer. All the factors that accentuated the bias due to the use of arithmetic means in a chained index in the US were therefore absent in France[21]. In 1996, BLS undertook a specific correction to eliminate the bias with effect from 1996[22] .

[19] We use the past tense because in the US as in France – the formula bias is a thing of the past, since BLS started correcting it in 1996. Rather than introducing a geometric mean, as in France, the Bureau corrected the implicit weightings of the chained index.

[20] There might be a product-selection bias if, for example, all price collectors chose the same brand of milk chocolate to represent the “milk chocolate”entry-level item. The US procedure avoids this problem thanks to its probabilistic product-selection method.

[21] For the sake of completeness, however, we should note the recent discovery that the problem did exist in the French index at an intermediate level of aggregation (Poinat 1996). The resulting bias proved to be a negligible 0.01 percentage points or so per year

[22] BLS did not, however, revise the index series. The 0.25-point formula bias, therefore, still applies to the years prior to 1996. This explains the difference between the Boskin Commission's 1.3-point bias for the years prior to 1996 and its 1.1-point bias for the years after 1996