STATISTICAL APPROACH TO CORE INFLATION

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Inflation, inflationary pressure etc. has been a traditional subject of statistics and economic analysis. It has received new dimensions in the last two decades when inflation of various sizes and length took place in different countries. Consequently anti-inflation policies have been carried out with different success.

Along with these efforts, issues regarding the measure of inflation have come into focus. It has been felt that traditional instruments (basically price indices, in particular the consumer price index – CPI) are not satisfactory to express the actual size of inflation. The reason of dissatisfaction can be divided into two types:

a) shortcomings of the traditional price indices in measuring actual price changes;
b) 'Noises' in actual price changes (i.e. even the 'best' indices) that prevent the quantification of inflation.

It should be stressed that the first issue – shortcomings, as poor samples, formula bias, insufficient treatment of quality and new goods, substitution bias in terms of commodities as well as outlets etc.[1] – are not considered in this paper. In other words, it is assumed that the respective price index is reliable enough in quantifying price development e.g. consumer price index is an accurate measure of the change of the purchasing power of households' income etc. The only concern of our consideration is to what extent these – otherwise 'good' – price indices are suitable to quantify inflation. So we are focusing on the second issue: the identification of actual inflation within the usual price indices.

Out of the set of various price indices the consumer price index is the sole subject of investigation in this article. The reason of this choice is that CPI is generally used as the indicator of inflation. However this compliance with the general practice doesn't mean the authors' agreement with this role of CPI. Other indices – e.g. the implicit price deflator of Gross output or GDP – might be more appropriate for the overall price development.

In this respect it is interesting to refer to the Regulation of the European Union on harmonized index of consumer prices: 'It is recognized that inflation is a phenomenon manifesting itself in all forms of market transactions including capital purchases, gov-

[1] *Chechetti, St. G.*: Measuring short-run inflation for central bankers. Working Paper 5786. National Bureau of Economic Research. Cambridge. MA. 1996. 26 p.; *Zsoldos, I.*: Kimagvazott infláció. The core of inflation. *Figyelõ*. 26 February 1998.

ernment purchases, payments to labour as well as purchases by consumers'.[2] Others attribute some deficiency of the CPI to 'error caused by applying the CPI to a problem it was never intended to address'.[3]

Nevertheless, the measure of inflation is going to be discussed in terms of consumer price index.

THE CONCEPT OF CORE INFLATION

Core inflation or underlying inflation (these terms are used as synonyms) has been the concern of growing number of economists, in particular of those involved in the financial and the business sector. For the time being, no unambiguous concept or definition exists for this term. Roughly speaking, core inflation is a subset of price movements in a given period. This subset is intended to express constant tendency of price development. It is excluding volatile price changes of individual commodities or groups of commodities. Those volatile elements are considered as noise, due to change in costs, productivity of and demand to particular goods and services. Other sources of noise include seasonal patterns, exchange rate changes, modifications in indirect taxes, asynchronous price adjustments, etc.[4]

A considerable amount of attempts has been made to meet this objective. Some of them try to clean CPI from the price changes of one or several of the following commodity groups, considered as especially 'noisy'[5]: food, seasonal items, administrative prices, services.

Another approach[6] consists of 'excluding taxes in order to reflect changes in the price level due to production costs, including import prices and profit margins'

Other type of attempt in estimating core inflation[7] applies one or several of the following devices

– seasonal adjustment
– smoothing procedures, as moving average
– weighed median of the individual price relatives
– trimming a given percentage of the highest and lowest price relatives.

A STATISTICAL MODEL FOR MONITORING CORE INFLATION

A decomposition model is put forward below with the aim to separate the two components outlined above within the price indices. I developed the idea of such a decomposition procedure in the late sixties, in order to analyse the development of the purchasing power of money.[8]

[2] Council Regulation (EC) No 2494/95 concerning harmonized indices of consumer prices. *Official Journal of the European Communities*. No L 257/1.-4. p.
[3] See Note 1.
[4] See Note 1.
[5] *Poole, W.*: Where do we stand in the battle against inflation? Report to the Shadow Open Market Committee. 8-9 March. 1992. and *Zsoldos, I.* m.a.
[6] *Lehtonen, M. – Hukkinen, J.*: Different indices of consumer prices. Bank of Finland Bulletin. 1997. No 1. 9 p.
[7] See Note 1.
[8] *Szilágyi Gy.*: Árstatisztika a makroökonomiában. Akadémiai Kiadó. Budapest. 1970. 190 p.

The model is labelled as ‘statistical’, as it differs from the attempts outlined above in the

– use of the total coverage of CPI (i.e. without the exclusion of certain groups of commodities),
– use of purely statistical tools (basically standard deviation).

As a starting point, and in general term, the CPI is conceived as a function (*f*) of two effects: CORE and NOISE

$$CPI = f\,(CORE, NOISE) \qquad /1/$$

To facilitate the interpretation it would be expedient if the interrelation takes the form of

$$CORE + NOISE = 1 \qquad /2/$$

In an idealtypical case when each price changes to the same extent, this extent would equal the core inflation; so in /2/ CORE would equal 1 and NOISE=0. The standard deviation of the individual price relatives would be zero as well. Consequently, the larger the standard deviation of the individual price relatives (or price indices of commodity groups) is, the larger may be the share of noise in the price rise.

In such a way /2/ can be satisfied with the help of the standard deviation (*S*) by the following ratio:

$$\frac{S}{(CPI^2 + S^2)^{1/2}} \qquad /3/$$

and

$$CORE = 1 - NOISE \qquad /4/$$

(Note that the denominator of /3/ equals the quadratic mean of the individual (group) price indices Q(CPI)).

/3/ has some favourable properties:

– monotonous increase along with the increase of standard deviation,
– zero and 1 as lower and upper limit, respectively.

With the help of CORE and NOISE shares, the overall CPI can be decomposed into a partial price index, limited to the underlying inflation P(CORE), and a price index due to the noise effect P(NOISE):

$$P(CORE) = (CPI - 1)\,CORE + 1 \qquad /5/$$
$$P(NOISE) = (CPI - 1)\,NOISE + 1$$

consequently

$$CPI = P(CORE) + P(NOISE) - 1$$

The economic interpretation of this decomposition can be manifold. E.g.one may say that the overall CPI quantifies the change of the purchasing power of the household incomes, P(CORE) shows the change of the purchasing power of money.

NUMERICAL ILLUSTRATIONS

Two kinds of numerical illustration are put forward in the following. First, a number of theoretical (sometimes extreme) examples enlighten the behaviour of the model, then the procedure is being illustrated with the help of actual data.

Theoretical cases

Table 1 presents three 'model cases'. For the sake of simplification, the consumer price index is limited to three items (*A*, *B*, *C*) and the weighing pattern is the same in all cases.

Table 1

Three 'model cases'

Commodity groups	Weights	Price indices		
		Case 1	Case 2	Case 3
A	50	120	168	160
B	40	120	120	70
C	10	120	120	120
CPI total	*100*	*120*	*144*	*120*

Case 1 is the extreme situation, referred to above, in which all prices rise to the same extent (20 per cent); consequently, the CPI amounts 120, the standard deviation equals zero, as well as the NOISE effect. The core inflation is the same as the CPI total.

Case 2 differs from case 1 on account of item *A*. The higher price rise (68 per cent vis-à-vis 20 per cent produces a higher overall CPI (144 per cent) and a slight noise effect:. 16.4 per cent of the price movement is due to this noise. So the core inflation (136.8 per cent) lies slightly below the CPI.

The overall price index in *Case 3* is the same as in the initial example (120 per cent), but the behaviour of the individual items significantly differs from each other. It means that the noise effect is high: one third of the total price movement. Consequently the underlying inflation (113.3) is only partially responsible for the overall price raise.

The results of these calculations are summarised in Table 2.

Table 2

Analysis of the 'model cases'

Inflation indicators	Case 1	Case 2	Case 3
CPI	120	144	120
Standard deviation	0	24	42.4
NOISE	0	0.164	0.333
CORE	1	0.836	0.667
P (NOISE)	100	107.2	106.7
Core inflation; P (CORE)	120	136.8	113.3

Actual figures

Table 3 displays the Hungarian consumer price index, in CORE–NOISE breakdown for two consecutive years, 1994 and 1995. Consumer prices rose at a considerably higher rate – almost 10 percentage points – in the second period than one year earlier.

Table 3

Consumer price indices in Hungary

Inflation indicators	1994/1993	1995/1994
Consumer price index	118.8	128.2
NOISE	0.087	0.107
CORE	0.913	0.893
P (NOISE)	101.6	103.1
Core inflation; P (CORE)	117.2	125.1

In addition to the higher speed of rising prices, 1995 was ‘noisier’ than 1994. Therefore the share of noise was by 2 percentage points higher. The core inflation amounted 125 per cent, so it differed by 8 percentage points from that of previous year, contrary to the 10 points of the CPI.

THE EFFECT OF DISAGGREGATION

As any statistical procedures, the method presented so far is not exempt from drawbacks. It can be labelled as ‘disaggregation-sensitivity’. As the magnitude of the standard deviation is subject to the degree of disaggregation, so are our NOISE and CORE measures. Generally, more detailed basic data result in higher noise.

Table 4 illustrates this effect, by comparing the analysis of the 1995/94 CPI in two different breakdowns: 160 basic headings (as the data in Table 3), and a more aggregate grouping by 24 items.

Table 4

The disaggregation effect
(Hungary 1995/1994)

Inflation indicators	Breakdown of 160	Breakdown of 24
CPI	128.2	128.2
NOISE	0.107	0.069
CORE	0.893	0.931
P (NOISE)	103.1	102.0
Core inflation; P (CORE)	125.1	126.2

The aggregate figures show a lower noise and a higher core. In our example the difference amounts 1 percentage point. There is little doubt about the detailed data to be more reliable.

In some cases, however, limited availability permits no choice between sets of data of different aggregation schemes. In such instances we have to 'work with what we have', but care has to be taken on the uniformity of the classification. Comparison has to be made in uniform breakdown. E.g. when comparing Hungarian and German inflation, basic headings can not be compared because of different classifications in the two countries. However, the aggregation of 24 proved to be comparable. This comparison is carried our in Table 5, for a span of three years: 1992–1995.

Table 5

Comparison of CPI in Hungary and Germany, 1995/1992

Inflation indicators	Hungary	Germany
CPI	186.6	108.1
NOISE	0.130	0.052
CORE	0.870	0.948
P (NOISE)	111.2	100.4
Core inflation; P (CORE)	175.4	107.7

This table compares a relatively high and a very low inflation (annual rate 23.1 and 2.6 per cent, respectively). However, beyond this obvious statement there are striking differences between the natures of the developments. The German inflation was almost 'noiseless'. Therefore the core inflation and CPI were almost the same. Price behaviour in Hungary was different, the share of noise being 13 per cent. So the core inflation was by 11 percentage points lower than the price rise measured by the CPI.