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WHAT ARE CONSUMER PRICE STATISTICS GOOD FOR?

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This paper studies five different aspects of inflation. Undoubtedly, there are manifold requirements made on the consumer price index. It is designed to measure changes in the cost of living and the cost of holding money, to serve as basis for calculating real interest rate and real exchange rates and to fulfil the coordinating role of a core inflation index. The authors of this paper believe that seeking to capture inflation in terms of a single "universal" indicator may lead to an oversimplification of the concept. In its current form, the Hungarian consumer price index does not "purely" suit any one of the theoretical concepts of inflation. The objective of this paper is to draw up a number of proposals related to the methodology of consumer price statistics, which appear to be one of the best data sources. In an attempt to make full use of this quality and illustrate the problems noted above, we shall propose a set of indicators, for analytical purposes, designed to be appropriate for the various "areas of application".

Keywords: inflation measurement, real exchange rates, real interest rates, core inflation

JEL classification index: E3, E4

1. INTRODUCTION

Today, changes in consumer prices is a closely monitored indicator of macroeconomic development. The performance of central banks is, sometimes almost solely, evaluated in terms of inflation reflected by changes in the level of consumer prices. This paper focuses on the problems faced by the current Hungarian system of consumer price statistics from the viewpoint of the central bank and macroeconomic analysis. We shall propose a few expedient changes to the current system, and also seek the possibility of a recombination of existing information as a means for assisting macroeconomic analysis.

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How did the Hungarian Central Statistical Office (HCSO) define the CPI on introduction? Related documents define it as the price index *of household consumption purchased at actual prices*. It is in effect designed to measure the change in the cost of purchasing a fixed market basket *of consumer goods* and *services* redefined every year, representing average consumption patterns during the basic period (of two years ago). This basket includes only *purchased* goods and services, thus goods for investment and production purposes, as well as those obtained not by the direct spending of money, such as goods and services produced within the households and public services, are excluded. When designing the CPI, it was an important consideration that it should be consistent with the category of purchased household consumption used in *GDP statistics*. This accounts for the exclusion of the prices of *second-hand goods* (with the only exception of second-hand cars) from the CPI.

The CPI is one of the best economic statistics, thanks to the nature and frequency of data collection. The calculation of the Hungarian CPI also has an established routine, ranging from the collection of information by means of set methods to the publication of statistical indicators produced by the application of various computing procedures. However, numerous courses can be taken in order to obtain "working" aggregate indices. The proper use of weights remains an unresolved issue in many respects. Clearly, different objectives require the use of different weights, and expenditure weights may, and occasionally should, be abandoned. The selection of the appropriate weights needs a certain amount of research.

The subsequent five sections will look into five possible areas of application of consumer price statistics. In section 2 CPI is examined in its role as a cost-of-living index, in section 3 as the measure of the cost of holding money. Section 4 deals with the calculation of real rates of interest, and section 5 and 6 discuss real exchange rate indicators and core inflation, respectively. The conclusions are summed up in the final chapter, alongside an analysis of certain practical aspects of CPI methodology.

2. THE CPI AS A MEASURE OF THE COST OF LIVING

Although seen by most users as a cost-of-living index, the Hungarian CPI does not fully correspond to the theoretical description. Moreover, within the current framework of price statistics it cannot even be turned into such an index. The reasons are associated with consumer price indices *in general,* such as the ignorance of the substitution effect and the treatment of consumer durables price measurement, quality change and the new goods problem, in addition to *Hungary-*

specific factors, self-consumption and *benefits in kind* provided by employers and the government. These are of special significance because economic progress and the restructuring of public institutions are likely to bring about changes that might be easily mistaken for increases in the cost of living by a flawed CPI. The source of the problem is that although self-consumption and benefits in kind are crucial to economic well-being, they are excluded from the CPI. Thus, since prices and quantities of such *non-purchased items of consumption* cannot be monitored directly, their inclusion in a cost-of-living index raises major technical difficulties.

Self-consumption comprises all non-market goods (such as home-produced crops, meat, etc.) and services (such as cleaning, cookery, mending, gardening, etc.) produced by households. Its significance is in reverse proportion to the stage of economic development, with a larger amount of goods and services taken to market in the advanced economies than in less developed agricultural countries, which latter typically rely on household production. Although it is difficult to find convincing data in support of the argument, in the wake of the dramatic fall in female employment in the first half of the 90s, there was, in all likelihood, a steady upsurge in self-consumption in Hungary. According to our rough calculations, self-consumption accounted for about one-twentieth of household consumption in 1995–96. Using the concept of *opportunity cost*, the *price* of self-consumption is derived from the amount of time and work devoted to it, since it is paid work and/or time of leisure that is given up when engaging in the above activities. Ignoring self-consumption will introduce a special bias into international (or inter-regional) comparisons of living standards. As self-consumption holds greater significance in low-income countries, expressing relative welfare simply in terms of money income or wages will put a downward bias into the relative situation of less developed regions or countries.

Benefits in kind, representing the other main type of non-purchased consumption, consist of *fringe benefits*, provided by employers, and state-provided *public services*, such as health, education, etc., and *public goods*, such as infrastructure, safety, clean environment, etc. The former is to be paid for in the form of lower net wages, reduced by the value of employer-provided benefits. The latter are financed via taxes, which are deducted from the net wage level. It is this lopsided consideration of the phenomenon which gives rise to some difficulty. Standard income or earnings indices and the CPI reflect the effect of *financing* exclusively. Consider the situation when, as a result of tax changes, employees start to be given pay rises instead of the "free" use of company cars. In connection with public services, it is *indirect taxation* that may be a problem. Newly privatised services may trigger a drop in indirect taxes and consequently in prices, which the CPI would reflect as a fall in prices with a welfare-boosting effect. At the

same time, the financing of higher standard (better quality) public goods may also be realised via indirect tax hikes. New motorway construction, for instance, may be funded via levying higher taxes on petrol, which will be registered as a price increase. The above are all represented by traditional statistics as changes affecting price or income levels even if there has not necessarily been a change in well-being. What makes the issue of benefits in kind unique in Hungary is that the tax system is expected to be modified via cuts in the direct costs of employment and a *systematic* decline in state involvement. The potential reduction in the employment-related tax burden might shift compensation from benefits in kind towards wage-type payments, making the previously implicit cost of the goods provided by firms explicit in the process. The withdrawal of the state, as long as it entails indirect tax cuts, may imply a decrease in gross prices.

Benefits in kind are problematic even at the theoretical level since it is difficult to determine the output of a number of state-provided services and public goods. (For example, in public health, should output be measured in terms of the number of hospital days or the improvement in life expectancy?) It is also difficult to give the quantity of output. ("How many *units* of public safety?") Clearly, correct measurement faces serious difficulties. Thus, even an ideal cost-of-living index could only be an imperfect measure bound by constraints. If, for example, following Nordhaus (1998), the level of indirect taxes is assumed to move in conjunction with the level of public goods, then it will be possible to calculate a cost-of-living index based on *net* consumer prices. Since there is no single price index that could by itself gauge the impact on well-being of direct taxation and employers' benefits, it would be vital to create consistency between income, consumer and price statistics.

The inference to be drawn from our analysis is that failing to measure the cost of a fixed level of *utility* (or well-being), the current Hungarian CPI is not a cost-of-living index. Published every month and lacking subsequent revision, it would be worthwhile to transform it into a *measure of the cost of inflation* (i.e. of holding money) (see section 3). At the same time, attempts should be made to introduce a cost-of-living index published less frequently (say, on quarterly or annual basis). This index would differ from the current CPI in several respects:

- To reduce the *substitution* bias, it would be expedient to use the combined and geometrically weighted Fisher or Tornquist indices. As this assumes the estimation of current expenditures, these combined index formulae could serve as the basis for *revising* the cost-of-living index, initially published as a Laspeyres index. The system of price collection should also tackle the problem of *substitution* across outlets and times of purchase, for example, via the

direct comparison of prices from different shops and across different times of purchase.

- It would also be important to bring *new goods* into the sample as fast as possible. This requires the monitoring of *current* consumer habits via additional sources of statistical information (such as *scanner data*, widely used in large shops or other "unconventional" *real time* techniques).
- *Quality change* should be treated by hedonic regressions or should be recalculated into physical quantities. Would this be possible in a continuous manner even to a limited extent, then the price index could be subsequently adjusted for the effect of the quality change.
- It seems worthwhile to impute the price of consumer durables on the basis of *rental equivalence*. The latter could probably be done only with the item of housing. Where there is a viable second-hand market (like for cars), the *user-cost* approach might also be tried. However, as we are rather sceptical about the above alternatives, we would recommend the exclusion of consumer durables from the cost-of-living index.
- The concept of cost-of-living index in our view would be a *theoretical approximation of the level of well-being (utility) available at given prices and incomes rather than of purchased consumption*. This would require the harmonisation of the categories of income level, consumption level and price level, which could create a framework for including certain non-purchased items of consumption into the price index and for defining the prices of such.

3. THE CPI AS THE INDEX OF THE COST OF HOLDING MONEY

Can it be said that although flawed as a cost-of-living index, the Hungarian CPI can be used as a measure of households' *monetary expenditures*? It cannot, unfortunately. The reason is that the CPI includes an item with a significant weight (namely, OOH, 5.9%) that is not associated with actual monetary expenditure. At the same time, it excludes a couple of items that involve monetary expenditure (such as second-hand goods and capital goods). Furthermore, the use of consumer expenditure weights does not necessarily reflect the relative needs for holding cash.

With a view to our forthcoming inferences it is worth noting that the above interpretation of the CPI is close to the definition of the harmonised index of consumer prices (HICP), used by the Eurostat. A European Commission report (EC, 1998) states that the HICP is partly an index of households' "final monetary consumption expenditure" (p. 10), and partly an indicator of the effects of

inflation on economic agents, including households, with regard to holding money (p. 8).

Our starting point in constructing a consumer price index that measures the cost of holding money is the direct costs of stable inflation and those associated with *holding cash balances*. In this way, not all the above-listed costs of inflation are taken into account: costs not related to holding cash, such as indexation costs due to unstable inflation, or those related to taxation and manageable by changing taxation rules, are excluded. Our theoretical starting point is in fact the *loss in well-being known as the shoe-leather cost* of predictable-rate inflation, due to households' transactions-based demand for money.

Let us take a look at the practical aspect, i.e. which prices and in what index form should be aggregated in order to satisfy the theoretical requirements. The question of *"which prices"* seems easier to answer. According to the quantity theory of money a price index should comprise all the prices that can be linked to monetary (cash-based) transactions. In addition to purchased *consumption,* this index may comprise household and company *investment* expenditures as well as firms' spending on *raw materials and factors of production*, i.e. wages and interest payments, in addition to producer prices. Moreover, unlike cost-of-living indices, this price index would comprise the prices of investment goods themselves rather than the imputed price index of the services such capital goods provide. Even though constructing a price index comprising any other prices than those derived from household consumer expenditures sounds a daring project that falls beyond the scope of the present study confined to domestic consumer price statistics, it is by no means unprecedented in international experience. In terms of the Brussels document which lays down the basic principles of the *HICP*, the European Commission would *in principle* approve of the existence of a price index that covers *all* types of market (monetary) transactions (EC, 1998).

In addition to determine which prices should constitute the monetary expenditure price index, the principles of aggregating these prices into an *average* should also be laid down. The difficulty here arises from the fact that depending on the different statistical assumptions, the aforementioned theoretical considerations lead to a variety of indexing formulae, which makes *a priori* choice difficult. Of course, one can stick to the use of weights derived from the *household expenditure structure*. Our theoretical considerations, however, allow this only subject to major restrictions as it is not at all certain that the expenditure-based weights will reflect the relative cash requirements of individual goods. Therefore there is no ground for giving preference to expenditure-based weights. Let us consider the literal interpretation of the *cost of stable inflation*. As here the welfare loss defined as "shoe-leather cost" stems from the existence of cash transactions, the logical way of obtaining the *average of the individual prices is by giving them*

weights according to their relative needs for cash. Accordingly, larger weights would be given to day-to-day consumer purchases, frequently and typically settled in cash (or one of its close substitutes e.g. the debit card) and to investment goods and durables (such as houses, cars), still often paid for in cash in Hungary, than to goods paid for with bank transfer or credit. *Non-purchased* items of *consumption* would be automatically given zero weights, as they involve no cash transaction whatsoever. However, as the operationalisation and empirical measurement of the relative cash requirements of transactions seem to be rather cumbersome, devising a weight system based specifically on the literal interpretation of the cost of holding money is not feasible.

Under the transactional definition of monetary theory, the deterioration in the purchasing power of money caused by an increase in the money supply affects *each* price to an *equal extent*. Price changes in this context can be traced back to one common monetary factor, namely a change in money supply. It is possible to construct a model in which *inflation is given as the common and universal component of the individual price changes*. With reference to the menu costs of inflation and to the work of Cecchetti and Groshen (2000) there are *two kinds of price* setters assumed to be active in the economy. One controls the prices that can be changed flexibly, i.e. at any time and only at negligible cost (such as food and petrol). The other group can only change its prices at infrequent intervals because of the high costs incurred. As the agents of the first group can frequently modify their prices, which implies that pricing errors are easy to correct, it is not in their interest to capture or take account of the universal or permanent component of the price changes perceived. It is the prices determined by this group which make aggregate price indices noisy. By contrast, the other group would incur losses by "misinterpreting" the underlying trend of inflation, so prices controlled by them tend to change much more "smoothly", i.e. in closer conjunction with the general trend. The analyst's task with regard to this model is to filter out the common and universal component of individual price changes.

Constructing a monetary expenditure price index on the basis of the social cost of inflation needs above all co-ordinating of the sample of the price index with its definition. This would require knowing household spending habits from the point of view of holding money. In the absence of this, the *"second best solution"* would be:

- to omit the imputed item of *OOH*, which represents no monetary expenditure,
- to consider the direct inclusion in the price index of housing-related monetary expenditure, i.e. *market rents paid for flats and houses as well as selling prices of housing units,* in addition to rents paid to local authorities, and
- to bring into the sample the widest possible range of goods purchased via mon-

etary transactions. This should at the very least cover *second-hand goods* (as such a price index would not be expected to comply with the SNA principles). The inclusion of *capital goods and certain types of investments* (such as bond or share subscriptions, insurance, etc.) relevant to household expenditures could also be considered; and, naturally, to incorporate into the price statistics new, so far excluded, goods.

Most of the above proposals would require only minor or one-off changes in the current consumer price statistics.

4. REAL INTEREST RATES

Traditional macromodels contain one aggregate good, and international macromodels sometimes contain, two. In the latter case, too, the two goods are aggregated via some linearly homogeneous function into one intratemporal utility function. This way it is possible to define the exact price index of the aggregate, treated as one single good, and hence, to determine the real interest rate (Obstfeld and Rogoff, 1996). Provided that relative price changes follow a trend and are predictable, which is a plausible assumption in respect of Hungary, then the individual goods will vary in their *"respective"* expected real interest rates. Even if the assumption of linear homogeneity is adhered to, the "correct" rate of interest will not be identical to that calculated on the basis of the CPI aggregate, defined with expenditure weights. The deviation would not be large if a constant elasticity of substitution (CES) aggregate closely approximated the utility function. Nevertheless, "introspection" tells us that this would not be the case as the elasticity of intertemporal substitution is not likely to be homogeneous across individual goods. (Will a change in the price of next month's hot water have the same effect on today's demand for hot showers as an increase in air fares with the same timeframe will have on the demand for holiday abroad?) Thus, the joint emergence of two reasons (may) justify the need for defining a separate CPI relevant to the calculation of real interest rates: (1) differentiation of intertemporal substitutability and (2) foreseeable relative price changes.

The question is if it is possible to construct a price index that adequately reflects the different elasticities of intertemporal substitution. Valkovszky and Vincze (2000) propose such an index, in which the weights are derived assuming preferences that correspond to a generalisation of the utility functions most common in the literature. The reasoning is retraced here in more detail and in a slightly different form.

The starting point is Houthakker's addilog utility function:

$$u(C_{1t},...C_{nt}) = \sum_{i=1}^{n} \frac{C_{it}^{1-\sigma_i}}{1-\sigma_i} \tag{1}$$

where C_{it} is the consumption of the ith good at period t, and the σ_i–s are positive parameters. The assumption is that the consumer will maximise the utility functional

$$U(C_1,...C_t,...) = \sum_{t=1}^{\infty} B^{t-1} u(C_t). \tag{2}$$

The (intratemporal) first-order conditions relating to the individual goods are given as:

$$\forall i: \quad \frac{C_{it}^{-\sigma_i}}{P_{it}} = \Lambda_t \tag{3}$$

where P_{it} is the price of the good i at t, and Λ_t is the Lagrange multiplier, i.e. the marginal utility of nominal wealth.

The following difference equation describes the evolution of the Lagrange multiplier:

$$\Lambda_t = I_t \mathrm{BE}_t(\Lambda_{t+1}) \tag{4}$$

where I_t is the gross nominal interest rate ($I_t = e^{i_t \Delta t}$), and B is the subjective discount factor.

Switching to natural logarithms in the following section (denoting logarithms with lower case letters) and taking time differences (for the period $\tau := \Delta t = t_e - t_b$), the following can be derived:

$$\Delta\lambda = -\sigma_i \Delta c_i - \Delta p_i \tag{5}$$

$$\Delta\lambda = -\tau\beta - \log\left(\prod_{j=t_b}^{t_e-1} I_j\right) = -\tau\beta - \iota(t_b, t_e) \tag{6}$$

where $\Delta\lambda_i = \lambda_{it_e} - \lambda_{it_b}; \Delta_{c_i} = c_{it_e} - c_{it_b}; \Delta p_i = p_{it_e} - p_{it_b}$.

(In (6) the [stochastic] terms included in (4) have been ignored.)

The linearised Euler equation relating to the individual goods is given by

$$\Delta c_i = \frac{1}{\sigma_i}\left[\iota(t_b, t_e) + \tau\beta - \Delta p_i\right]. \tag{7}$$

Assuming the existence of a g_i factor for each good, giving the impact of the change in the consumption of the given good on total demand in a linear way, the aggregate effect can be written as

$$\sum_i g_i \Delta c_i = \sum_i \frac{g_i}{\sigma_i}\left[\iota(t_b, t_e) + \tau\beta - \Delta p_i\right]. \tag{8}$$

The price index we wished to determine is given by

$$\pi = \sum_i \frac{g_i}{\sigma_i} \Delta p_i \tag{9}$$

The above equations allow one to *"calibrate"* the parameters $1/\sigma_i$. Take 0 as the base year, with each individual price index assuming the value of 1. Choose the unit of measurement so that the basic-period consumption of each good equal one unit. Expenditure weights W_i are known for both the base and the current periods.

$$W_i = \frac{P_i C_i}{S} \tag{10}$$

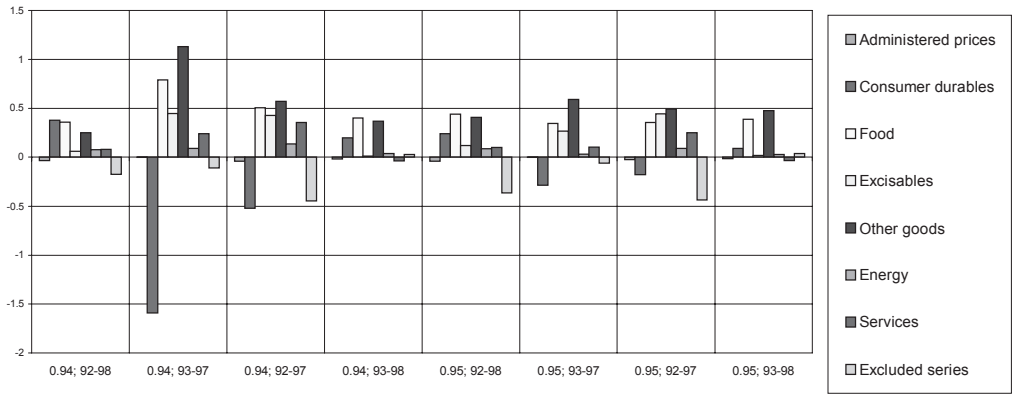
where S denotes total household consumer expenditure.

Taking the logarithmic difference of equation (10) and using (6) and (7), the required parameters are as follows:

$$\frac{1}{\sigma_i} = \frac{\Delta w_i - \Delta p_i + s}{\Delta\lambda - \Delta p_i}. \tag{11}$$

In the right-hand side w_i and p_i are known from consumer price statistics. The value of s can be calculated from National Accounts Statistics. The calculation of $\Delta\lambda$ would require a rate of interest with a suitable maturity, which, however, can be approximated with the realised values of short-term interest rates. Time preference is a free parameter, which can take various values in the range of 0.95 and 0.90 at an annual rate. (The upper bound is being regarded as normal in developed countries.) The formulae derived in the aforementioned manner were

applied to a division of clusters obtained by slightly modifying the classification defined by Valkovszky and Vincze (2000) and to different base and current years, with various subjective discount-rate parameters. The CPI data series belonging to the individual clusters are listed in the Appendix to their work.



Note: The horizontal axis shows the parameter β and the time periods on which the calculations are based.

Figure 1. Weights derived from the elasticity of substitution for different beta parameters and time periods

Figure 1 shows the weights derived for the individual groups varying according to the different periods and values for parameter β. It is clear from the figure that the cluster of the series we *a priori* regarded as "disturbing" (first of all, the imputed rent for OOH, as well as gambling, donations, etc.) *"is misbehaving"* (the model is generating negative weights). Therefore, the subsequent exclusion of these series – within the framework of this model – is also justified on empirical grounds.

Unfortunately, but by no means surprisingly, durable goods also have to be stripped out as not only is their weight fluctuating but it is also changing signs. As already noted in connection with the cost-of-living index, when consumers time their purchases of durable goods, they are not merely making a decision of intertemporal substitution, but also of investment. If there is a substantial change in the expected (relative) price trend of a durable good, this will not only change the real rate of interest on that good in relation to a particular time period, but also the return on investment in that particular good seen as an asset-providing future utility in the form of a yield. The underlying difficulty is that "demand" for the *consumption* of durable goods may behave very differently from demand

for *buying* such goods. While experience shows non-durable consumption to be smooth (strongly autocorrelated), the pattern of durables purchases tends to be much more hectic. This is also reflected in the Hungarian data in the abrupt change in the weight of durables. It is perhaps by no accident that the weights in the US CPI are not replaced every year, and five-year average weights are used instead. The real price of the consumption of a durable good is rent (or user cost), which is found by deducting from the purchase price the present value of the future price less depreciation. However, in addition to giving rise to a number of new and serious difficulties relating to operationalisation, this rent would also require special treatment that is theoretically incompatible with the current framework. The reason is that at any given date the price of consumption (the rent) is not independent of the prevailing rate of interest.

Finally, the cluster of administered prices has also been excluded on practical grounds, as it has only a small weight (mostly a [small] negative value) across a broad range of parameters and seems to be almost completely independent of the time period. The demand for such services, with the only possible exception of 650-TELEPHONE, has rather low price elasticity, and there is hardly any possibility of their intertemporal *"substitution"*. Thus the impact of movements in such prices on the real interest rate defined in the above sense is indeed small.

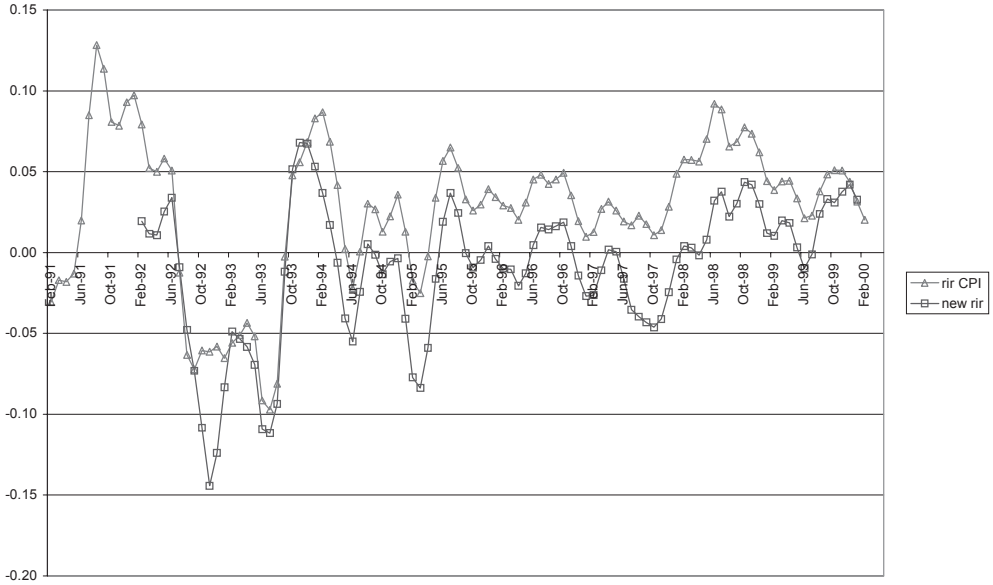


Figure 2. Real interest rates (ex ante), computed using the seasonally adjusted CPI and the modified CPI

Figure 2 shows the results of our investigation of real interest rate calculation. Two versions of real interest rates have been calculated using the yields on three-month government securities: one with the original CPI and the other with the price index re-weighted via the proposed procedure. (Perfect foresight is assumed in both cases.) Both the CPI and the price index of our construction have strong seasonality, a property not assumed of interest rates. Therefore, we started out with (separately) adjusting seasonally the series of both the CPI and the price index considered relevant to the real rate of interest. It is these seasonally adjusted indices that were then related to the interest rate data. One peculiarity appearing from the figure is that the modified real interest rates are nearly always lower than those calculated with the CPI and that they have, very often in the past, been in the negative range. Another intriguing feature is that over the last two years these modified real rates have been nearly always positive and most recently showed but slight deviation from the real rates calculated with the CPI. To prevent anyone drawing hasty conclusions about the effect of monetary policy on aggregate demand, it should be noted that the modified real rates are intended to measure the effect on consumption and not on purchases. As investment is a major component in the fluctuation of household spending, establishing the relationship between real interest rates and aggregate demand requires some insight into investment developments as well as the relevant price (yield) indices.

Clearly, correct appreciation of the durables price index and the question of weights call for further research. Our calculations have made it clear that the traditional utility functions are less than satisfactory, but the more general form we have proposed may also prove to be too simple. The model of our choice is apparently incapable of handling the *"dual nature"* of consumer durables. Excluding them, however, may lead to significant bias. In our case their relative price follows a considerable negative trend. This would not be a problem by itself as the permanent trend leads to only one constant error in the *absolute* level of the real interest rate, which will hardly hinder the evaluation. The real limitation to the method is that – apart from the demand for investment goods not involved in direct consumption – it is exactly through their effect on the *timing of the acquisition* of durable goods that the real rates of interest govern the output gap. Consequently, assuming *"pure"* consumption only – i.e. such that takes no account of the (different) depreciation of goods in any way – the macromodel based on traditional intertemporal optimalisation neglects a highly important, if not *crucial* factor, even if the addilog utility function is being used.

5. REAL EXCHANGE RATES AND THE CPI

The domestic *nontradable/tradable relative price,* i.e. the *"internal real exchange rate"* (Kovács and Simon, 1998) plays an important role not only in theoretical but also in empirical research. The *internal real exchange rate* is not a real exchange rate in the usual sense of the term since it is not the relative price of a product made in two different countries that it measures. If every real exchange rate were only an indicator of an unobservable variable of the economy, then one could say that the internal real exchange rate is the indicator of the indicator. This is so because under certain assumptions changes in the internal real exchange rate, calculated exclusively from domestic prices, provide useful information on the fluctuations in other real exchange rate indicators. Standard methods for calculating the internal real exchange rate *a priori* divide domestic prices into tradable and non-tradable prices. In the section below we shall propose an alternative method for the calculation of the *internal real exchange rate.* Under the proposed method, which relies exclusively on consumer prices, division is not dichotomous and is endogenously determined.

Valkovszky and Vincze (2000) estimated dynamic regressions for the 160 strata price indices of the Hungarian CPI and calculated the long-term coefficients of the exchange rate and the wage cost. The aforementioned paper makes use of the regression results only to the extent that the long-term coefficient of the exchange rate for nearly all consumer durables is around 1, and that of wages is practically 0. This criterion is labelled as the *"tradability"* criterion. In the following, we shall attempt to define a continuous *tradability – non-tradability* scale, using heuristic methods, with (in the long term) exclusively exchange-rate-dependent prices on one endpoint and exclusively wage-dependent prices on the other endpoint. This is hoped also to facilitate the construction of a RER-relevant price index in which the weights increase according to the degree of *non-tradability*.

We can formally argue as follows. By definition, the price of the *i*th commodity is the product of the marginal cost and the *mark-up*. Written in logarithms:

$$p_i = \mu_i + mc_i \,. \qquad \text{(I)}$$

The *mark-up* parameter (μ) is the function of *"perceived"* demand. Under perfect competition, it is equal to 0, otherwise it normally takes a positive value. Provided that the supply of a product is fixed, such as that of fresh vegetables, the price is determined by demand regardless of production costs (of some past date). Here it is the *mark-up* that assumes all fluctuations in demand.

The marginal cost function depends on our assumptions relating to the production function. The log-linear approximation to be used in the paragraphs below is given as

$$mc_i = \theta_i + \varepsilon_i e + \omega_i w \qquad \text{(II)}$$

where e is the nominal exchange rate, w the logarithm of the nominal wage and θ_i comprises other effects. (The formula is based on the assumption that there are no sectoral wage differences.) Other effects may include technological change, the effect of capital accumulation on marginal productivity or even foreign prices. This formula is often used to describe closed economies, including either the wage only or the wage as well as the capital cost. The latter, however, is not a component of the marginal cost, insofar as the capital stock is assumed to be predetermined in the short run.

If a producer also produces for exports and is a price-taker on the foreign markets, then ε=1 and ω=0 in the above equation. Such a producer can be regarded as the ideal *tradable* producer. By contrast, in the case of the *"producer"* of services employing exclusively domestic labour ε=0 and ω=1 would be relevant, and the *"good"* produced could be called the ideal *non-tradable* good. Naturally, consumer goods and services can almost never be regarded as purely tradable if for no other reason than simply because transportation costs impose certain limits to goods arbitrage. One may conclude that if it were possible to estimate them accurately we would obtain significant non-zero ε and ω coefficients for each strata. Considering, however, the inaccuracy of the data and the omitted variable bias, the values for one or perhaps both parameters are expected to be non-significant. This may be especially true of goods with a fixed supply over the short term, the price fluctuations of which may appear to a large extent as fluctuations in the *mark-up*.

Let us assume the availability of estimates for the parameters e_i and w_i. After normalising them proportionately, the coefficients obtained from the equation

$$\begin{aligned}
&\varepsilon_i^* = \frac{\varepsilon_i}{\varepsilon_i + \omega_i} && \omega_i^* = \frac{\omega_i}{\varepsilon_i + \omega_i} \\
&E = \sum_{i=1}^{K} w_i \varepsilon_i^* && \Omega = \sum_{i=1}^{K} w_i \omega_i^* \\
&\varepsilon_i' = \frac{\varepsilon_i^*}{\mathrm{E}} && \omega_i' = \frac{\omega_i^*}{\Omega}
\end{aligned} \qquad \text{(III)}$$

can be adopted. (If neither of the parameters is significant, normalising will not be possible and that particular item is to be *"dropped"*.) Then the base price index of the remaining goods can be written as

$$\Delta p_t = \sum_{i=1}^{K} w_i (\varepsilon_i^* + \omega_i^*) \Delta p_{it} = \mathrm{E} \sum_{i=1}^{K} w_i \varepsilon_i' \Delta p_{it} + \Omega \sum_{i=1}^{K} w_i \omega_i' \Delta p_{it} \ . \qquad \text{(IV)}$$

From the above formula, the following relative tradable/non-tradable price index (real exchange rate index) can be constructed:

$$\Delta rer_t = \sum_{i=1}^{K} w_i \varepsilon_i' \Delta p_{it} - \sum_{i=1}^{K} w_i \omega_i' \Delta p_{it} = \sum_{i=1}^{K} w_i (\varepsilon_i' - \omega_i') \Delta p_{it} . \qquad \text{(V)}$$

Equation (II) was estimated by dynamic regression in the differences and levels (with a linear trend in this latter case) to determine the long-term parameters of the two independent variables. The parameter estimates for the first case will presumably have a downward bias. As it is not absolute values but only ratios that we are interested in, this is perhaps not a great problem. In the second case the quality of the estimates cannot be expected to be very good because of collinearity. We have made the estimations with both (monthly) seasonal *dummies* and without *dummies* in both cases, thus obtaining altogether four estimates for each parameter.

The following algorithm was used to determine the *tradability* index of each of the 160 CPI strata. First we checked whether the individual long-term parameter estimates were significant. If either parameter of an estimate proved to be significant and its pair insignificant, then the normalised parameters were taken to be 1 and 0, respectively. When both parameters appeared to be significant, they were normalised according to (III). When neither parameter was significant, we omitted the estimate concerned. In this way we obtained 0–4 estimates for each item of the CPI. Then we checked for the discrepancy between these estimates. In the absence of a meaningful (normalised) parameter estimate or when there were several estimates which diverged *"in an excessive degree"*, the item in question was deleted. Otherwise it was the (unweighted) average of the estimates that were regarded as the *bottom line* estimates obtained from the procedure.

The procedure outlined above was applied to a high number of selection parameter combinations. The individual selection parameters of the estimation are as follows:

t – denotes an acceptance level associated with a probability value (related to the *t*-statistics). Should the computed test statistics result in a higher value for the parameter under review, it will render the tested (long-term) coefficient insignificant through accepting the null hypothesis, which assumes the tested pa-

rameter to be 0.

a – denotes the (lower) critical value for the denominator in the formula of the long-term parameters. Should the denominator be lower than *a* (that is: closer to zero), it will render the values of both long-term coefficients unreliable.

s – controls what level of deviation is tolerable between the estimates obtained from the four kinds of regressions. When it is 1, then the *"diametrically opposite"* estimates (one purely *tradable* and the other purely *non-tradable*) for the reviewed item are also acceptable (the result then is ntr = 0.5, tr = 0.5). By contrast, when *s* = 0, only the unanimous estimates or the single significant estimate can be kept.

n – is the number of the series (max. 160) that *"produce"* suitable estimates with the selection criteria under consideration.

The selection of the parameter *t* had a major influence over the results. If the *t*-test criterion relating to the dynamic regression estimation is dropped (that is the critical probability of the *t*-statistic *t* = 1), then the results will be qualitatively different from those that would be obtained using the standard significance levels. A further shortfall of these results was their lack of robustness relating to the value *s.* Conversely, if one chose a small critical probability (*t*), changing *s* did not lead to a qualitative modification in the results.

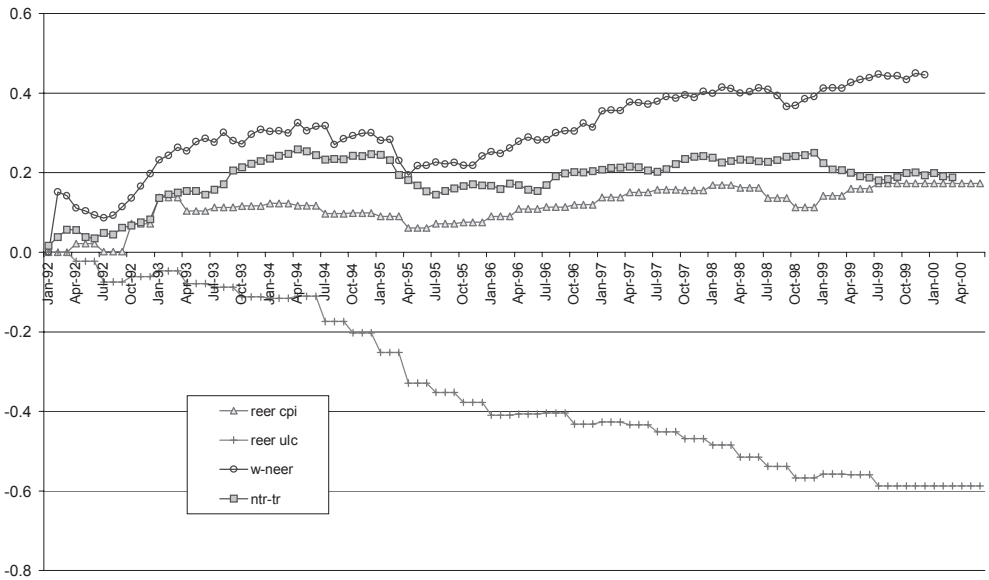


Figure 3. Various real-effective exchange rate indices

Figure 3 compares the *internal real exchange rate* we computed to the real exchange rates based on the CPI and the ULC, *"in circulation"* in the National Bank, as well as the (seasonally adjusted) wage level in basket currency terms. The figure clearly shows that like the *"dollar wage"* and unlike the CPI-based real exchange rate, the internal real exchange rate is a good indicator of the real appreciation seen between 1992 and 1995, as well as of the correction in the wake of the 1995 stabilisation package. By contrast, under the regime following the 1995 adjustment, the internal real exchange rate no longer reflects the "appreciation" indicated by the wage data. This provides evidence for the view that the increase in wages expressed in foreign currency terms is covered by the increase in productivity, in other words, there is no deterioration in the country's competitiveness. It is also noteworthy that the internal real exchange rate reflects the Russian crisis differently from the series of the other indices, which reflected short-term exchange-rate volatility without delay.

This section has been the description of an experiment aimed to construct an internal real exchange rate index which is a good proxy for "genuine" real exchange rate indices. Although our approach was essentially heuristic, we also tried to test for robustness in respect of arbitrary choices, with particular regard to estimating the *tradability* parameter and to choosing between parallel estimates.

6. CORE INFLATION: EXPECTATIONS AND COORDINATION

Even the very term *core inflation* reflects the desire of many to capture an inherent and presumably essential feature of reported inflation indices. Valkovszky and Vincze (2000) analysed the concept of core inflation as presented in the literature. They found that by core inflation the different authors refer to things that have similar, but not identical, properties. Supporters of one view claim that core inflation is a price index over that monetary policy exerts (direct) influence. On another view it is something that contains small temporary "noise". In fact, the accurate definition of both criteria would require some kind of a "model" in order to reveal if they are identical or what differences they have. The cited paper concludes that, from another, "functional" point of view, core inflation plays the role of a coordination instrument and it shapes expectations concerning the actions of the National Bank of Hungary.

It seems worthwhile to consider what these two views mean when the focus of our investigation is the role of core inflation in influencing expectations. To this end, we wish to use a very simple model that may provide assistance in understanding the significance of the above criteria.

This model is a version of the classical monetary model. Take the logarithmic form of the quantity equation

$$p_t = m_t - y_t + v_t. \tag{A}$$

Let us assume that the velocity of circulation of money depends on the nominal rate of interest, which, supposing a constant real interest rate normalised to 0, is identical to the rate of inflation expected by the private sector:

$$v_t = \gamma(E_t p_{t+1} - p_t). \tag{B}$$

The output is given as the sum of two independent supply shocks with zero expected value, one of which (ε_t) is a white noise and the other (q_t) has positive autocorrelation. Therefore,

$$y_t = q_t + \varepsilon_t, \text{ and} \tag{C}$$

$$q_t = \rho q_{t-1} + \eta_t \tag{D}$$

where $0 < \rho < 1$.

Let us assume that the instrument of monetary policy is m_t, which is set by the following rule

$$m_t = \alpha q_{t-1} \tag{E}$$

where $\alpha > 0$.

This means that the central bank is capable of observing the smoother component of supply and will influence the quantity of money after a one-period lag as a function of this term. Due to the positive autocorrelation, positive feedback ($\alpha > 0$) means the stabilisation of the price level. This is an *ad hoc* rule, but it reflects meaningful monetary policy objectives. This is how a monetary policy maker seeking price stability should respond to real shocks. The assumption for the real variable reflects the existence of real shocks that are completely temporary and nothing much can be done about them. Yet there are also (relatively) permanent shocks which deserve a response even after a lag. It is assumed here that the central bank has the ability to accurately separate these shocks after a one-period lag. At the same time, it is also assumed that the central bank can only communicate this information with a certain amount of noise. Let us suppose that the central bank is communicating a variable uc_t which is observable to the private sector. In the equation

$$\varepsilon_t = uc_t - u_t \tag{F}$$

u_t and uc_t are independent from each other, implying that both variables correlate with, but are less noisy than, ε_t. Let us define the core price index pc_t as:

$$pc_t = p_t + uc_t \tag{G}$$

(A "justification" for the definition is to be given later.)

The set of information on which the private sector relies when forming its expectations must also be defined. It comprises the price index, the core price index and total output (p_t, pc_t, y_t). This implies that the information available for the private sector is not as "good" as that for the central bank. Here follows a solution of the model by standard techniques.

Let us find the expectations of the private sector by the following formula:

$$E_t p_{t+1} = \beta_1 p_t + \beta_2 y_t + \beta_3 uc_t. \tag{H}$$

After the substitutions the following expression is given for the price index:

$$(1 + \gamma - \gamma\beta_1) p_t = \alpha q_{t-1} + (\gamma\beta_2 - 1) y_t + \gamma\beta_3 uc_t. \tag{J}$$

As

$$q_t = y_t - uc_t + u_t$$

and

$$E_{t-1} y_t = \rho q_{t-1},$$

applying the expected value operator to equation (J) and solving it gives

$$E_t p_{t+1} = \frac{1}{(1 + \gamma - \gamma\beta_1)} (\alpha + \rho\gamma\beta_2 - \rho)(y_t - uc_t). \tag{K}$$

Equations (H) and (K) lead to $\beta_1 = 0$, $\beta_2 = -\beta_3 = \beta$.
The solution can be summed up in the following two formulae:

$$E_t p_{t+1} = \beta (y_t - uc_t), \tag{L}$$

where

$$\beta = (\alpha - \rho)/(1 + \gamma - \gamma\rho)$$

and

$$p_t = (1/1+\gamma)((\alpha - \rho + \beta\gamma\rho)q_{t-1} + (\beta\gamma - 1)\eta_t - \varepsilon_t - \beta\gamma u_t). \qquad \text{(M)}$$

The results we have found important can be summed up in the following propositions:

(1) To be able to forecast, it is sufficient for the private sector to know y_t–uc_t. That is, as uc_t is the log ratio of the total price index and the core price index, it is neither the current prices nor the core price index by itself, but their ratio that provides useful information for forecasting future prices. Clearly, this is a specific characteristic of the model, arising possibly from its excessive simplicity. But the varying significance of y_t–uc_t must also be true of more complicated models. This is because y_t–uc_t is equal to q_t–u_t, the best estimate of the private sector for the permanent supply term, i.e. the variable on the basis of which the central bank determines money supply.

(2) How is our definition of the core price index justified? The following two formulae for the original and the core price index can be derived from the above model:

$$p_t = m_t + v_t - q_t - \varepsilon_t$$

$$pc_t = m_t + v_t - q_t + u_t.$$

Our assumption is that the variance of u_t is smaller than that of ε_t, i.e. the core price index is indeed less volatile than the original price index. Therefore, the core price index may be seen as a price index free from temporary supply shocks to the largest possible extent.

(3) Parameter b in the price forecast of the private sector is positive (numerically negative) if the intensity of the feedback (α) is bigger (numerically smaller) than the output persistence parameter (r). If the two latter parameters are identical, the prices will behave as white noise. The intention to avoid this may explain why monetary policy makers would not make (α) equal to (ρ) even if it were in their power to do so. Another possible explanation is that even if α = ρ would be optimal, monetary policy has no accurate knowledge of ρ.

(4) The smaller is the variance of u_t, the smaller is that of the price index. In other words, the reduction in the error of the information relating to the relevant variable will reduce the variance in prices. This result is clearly what we have expected.

(5) If the correlation of η_t and u_t is different from zero, this may reduce or, conversely, increase the variability of prices. This leads to the possible interpre-

tation that the implication of non-zero correlation is that the error in the private sector's estimate of the permanent supply shock may be smaller or larger (depending on the parameters) than it would be if η_t and u_t did not correlate.

What bearing do the above statements have on the criteria set up to judge how "correct" core inflation is? It is clear that just as we intuitively thought, the observation error variance will increase the variance in prices. Hence what makes an information variable better than another is the degree of accuracy with which it approximates the actual conditioning variable and thus the monetary policy decision. This does not necessarily imply that core inflation must have a smaller variance than inflation. This requirement is met, nevertheless, provided that the variance of the temporary supply shock is significantly bigger than that of the permanent component. On the other hand, the variance criterion is plausible when it is the various core inflation candidates that are to be compared.

7. SUMMARY AND ECONOMIC POLICY CONCLUSIONS

Consumer price indices have come to fulfil numerous practical functions and are often incorporated into regulations and treaties. Such an "application" for Hungary is the Treaty of Maastricht. Satisfying the Maastricht criteria will soon become a relevant issue to Hungarian economic policy. As things are, compliance will become vital when the country's accession to the European Monetary Union will be up for decision. At the same time, the country's "progress" towards satisfying these criteria also seems to have some relevance to the more general and imminent issue of EU membership. As the CPI measures inflation convergence, which is one of the Maastricht criteria, this is one more reason why the issue of CPI measurement should not be neglected.

We have found that the definition of the Hungarian CPI as a "pure" cost-of-living index is not acceptable for several reasons and that changing it into such an index would not be an easy task. Even though the Hungarian CPI cannot be directly regarded as a "monetary" price index either, it would be possible to change it into that by means of introducing minor changes in its sample and using appropriate weights. The majority of our proposals would require only minute or one-off changes in the current system of consumer price statistics. Last but not least, as noted earlier, redefining the Hungarian CPI, which is published on a regular basis, as a monetary expenditure price index would also be consistent with the concept of the HICP, the official price index of the European Union. In this sense the existence of such a price index would take the system of Hungarian institutions a step closer towards meeting the harmonisation obligations. However, the question is whether Hungary should take great pains over the quality

and new goods bias from the point of view of the HICP. The answer is that she does not have to, but is allowed to. The HICP itself can be regarded as a mixed construction, which, besides its declared purpose of being a suitable measure of the costs of inflation, also embraces other cost-of-living type considerations. Therefore it would not run contrary to the HICP concept if the Hungarian CPI (Hungarian HICP) were transformed into an index that would be a better gauge of changes in the cost of living. The pertaining Eurostat directives contain no strict methodological constraints, and naturally, the EU recognises the discretion of national statistical agencies as to the (specific) modes of taking account of the effects of quality change, etc.

On the other hand, we have found the current CPI to be unsuitable as a cost-of-living index. Consequently, there is need for a separate cost-of-living index, which could be published on a less frequent basis. Different from the current CPI in several aspects, it could be published by the HCSO on a quarterly or annual basis. We believe that this price index would be more suitable for the indexation of welfare expenditures and the purposes of wage negotiations than the annual price index derived from the monthly CPIs. The existence of two consumer price indices could admittedly lead to some confusion. We can trust nevertheless that the economic agents would find a way to pick out and combine the bits of information most relevant to their different purposes. The National Bank of Hungary is one of the institutions that would find the existence of two consumer price indices quite a challenge in the formulation of monetary policy objectives and the selection of instruments.

Our other proposals are not for regularly published consumer price indices, but for indicators derived from disaggregated consumer prices in order to be used as *analytical devices*. The available information can be used to serve a number of different ends. One is the calculation of real exchange rates with the help of a specially weighted price index we have constructed. We have also found that demand for durable goods requires special considerations. We have calculated a "data-dependent" internal real exchange rate index based on consumer prices. It needs further research to assess whether this index can explain the errors in other (traditional) real exchange rate indicators and whether it is capable of predicting any foreign currency market pressure. We have also described what considerations are to be made when selecting a core inflation index. In our view, in terms of its true function, a core inflation index provides information on monetary policy and this is the basic concept which should guide its makers. The points made in the above passage and in the one relating to the cost-of-living indices demonstrate that, contrary to current practice, greater importance should be attributed to price indices computed at lower than monthly frequency: this also holds good for consumer price statistics.

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