Estimates of and Problems with Core Inflation in Hungary

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Abstract

The traditional CPI measure has many drawbacks, when used for very different purposes, and it is not at all surprising that a great deal of work has been devoted to its improvement. Besides seasonal adjustment, various other techniques have been developed to find the *"core"* inflation index. Although a generally accepted definition of core inflation does not exist, the literature converges towards identifying certain desirable properties that a "good" core index must possess.

After reviewing the literature we describe how the publication of a core index fits into the monetary policy strategy of the National Bank of Hungary. Monetary policy both in the form of setting the instruments and by communicating to the public is geared to arrive at a mutual understanding with the markets. By publishing a core inflation index, the NBH aims at providing the public with a price measure that can function as a co-ordination device between policy makers and market participants. As the "*index number*" problem is clearly connected with relative price changes, we analyze in some depth this issue, too. We argue that there have been clearly visible tendencies in relative price developments that jeopardize some of the traditional uses of inflation measures. Our results suggest that a substantial amount of noise and apparent seasonality have come about as a result of government decisions. Finally we muster some possible procedures to define core indices in Hungary, by comparing their smoothness and forecasting ability from several points of view. Our conclusion is that there is no overwhelming reason to abandon the current *"exclusion"* approach toward the core.

*The views expressed are those of the authors and do not necessarily reflect the official view of the Bank.

1. Introduction

The concept and measurement of core or underlying inflation has been given increasing attention recently. However, one can find several definitions in the literature, and different authors disagree on measurement as well. Most core definitions implicitly entail at least one of the following two requirements: the core must measure what part of inflation is attributable to monetary policy, and it must have little noise in a statistical sense, too. Most current core definitions intend to achieve both of these goals. The two requirements can be unified if one believes that monetary policy is less hectic than the real economy. Though this latter assumption does not appear to have any emprical foundation, we may say that it is implicitly contained in most core inflation definitions.

However, as Wynne (1999) points out, monetary inflation, that is inflation attributable to monetary policy, is not a well-defined concept. Even if we had the simple theory entailed by the quantity equation *cum* an exogenous supply of money we should notice that prices are determined jointly by the money supply, the output and the velocity processes. Providing the money supply is independent of the other two processes, the impact of monetary policy can be perfectly measured by money growth, and though it would have a positive correlation with the price index, it would not solely determine it. With an endogenous policy rule the problem is more difficult, as the underlying processes are not orthogonal. It is not by chance that today researchers studying the effects of money look for monetary innovations, i.e. shocks to monetary policy that are independent of the state of the economy. Inflation, however, cannot be attributed only to monetary suprises. For instance, a totally deterministic rule to increase the money supply by 20 per cent per year would certainly lead to a positive rate of inflation, but it would not necessarily involve any innovation in the statistical sense.

The core is frequently identified with the central tendency in price movements, a so-called common component in individual price changes. At first sight the common component and limited influence estimators (Dynamic Factor Index, median, trimmed means), proposed by Bryan-Cecchetti (1994) and Bryan-Cecchetti-Wiggins II (1997), pick on the smoothness or trend approach rather than wish to measure the effects of monetary policy. They assess which limited influence estimator is best capable of tracing trends, defined as a long moving average. This smoothness approach can be related to Blinder's proposal (Blinder (1997)) to define a core via its ability to predict future inflation.

Probably the most conservative approach is the "*ex food and energy*" method. The underlying idea is that we can somehow divine that certain events cause temporary price level changes. These events are frequently identified with temporary supply shocks, though nothing excludes the possibility that we would like to clean our inflation measure from temporary demand changes as well. It is widely believed that prices belonging to certain groups, like energy and foodstuffs, are dominated by such temporary factors, justifying their exclusion from the overall price index. This approach is simple, and has a lot of intuitive appeal that makes it acceptable not only to central banks but financial market participants as well. Though in no case does a clear theoretical foundation exist for the actual implementation, the individual instances that call for exclusion seem to be understandable.

A related issue is deducting the effects of indirect tax changes. The serious problem we encounter here is whether an indirect tax change is a temporary shift in the price level or in inflation. As Wynne (1999) points out there is no *a priori* reason to believe that inflation remains unaffected by an indirect tax change, at least for some time, and the empirical identification of the size of an indirect tax change is anything but easy.

It must be noticed that limited influence estimators can also result in filtering out temporary shocks. The difference between the exclusion methods and limited influence estimators lies in the nature of how zero weights are applied to certain prices. In terms of the limited influence estimators, zero weights are changing over time and are procedurally defined, whereas in the case of the (pure) exclusion methods exclusion is made once and for all, and is based on extraneous information.

Considering the above-mentioned problems this paper takes an agnostic and pragmatic view on core inflation measurement. Rather than aiming at an ideal construction, which may not exist, we start from the observation that core inflation indicators are used (or not used) by central banks that have different goals, operating procedures etc. We claim that central bankers may have their own purposes to calculate and publish core inflation, and these purposes are the main determinants of the adoption of any specific core inflation measure. We interpret the literature as coming up with criteria that a core inflation index must satisfy to be useful.

The paper illustrates this idea by explaining the use of core inflation in Hungary. To understand the context a short summary of the Hungarian macroeconomy and monetary policy is offered in Section 2. Then in Section 3 the Hungarian application of the core inflation concept is described. The topic of Section 4 is relative price changes that have caused substantial difficulties for monetary policy makers, and we see the search for a "core" as an attempt to alleviate many of these. In Section 5 we ask how potential core inflation measures perform in terms of requirements a useful measure must satisfy. Section 6 concludes by noticing that simple traditional core inflation measures have seemed to be superior to more fanciful indexes for the particular case of Hungary. The last qualification is important, since our whole approach is based on the idea that the best core measure is country and time specific.

2. Economic and Monetary Policy Background in Hungary

2.1. A Short History

Hungary is a transition economy with special features. The following is a brief overview of some of its characteristics that bear relevance on the understanding of its monetary policy and the inflationary process. For a more detailed analysis of the period before 1998, Surányi-Vincze (1998) can be consulted, whereas the most recent developments are covered in the various issues of the Quarterly Review on Inflation, published by the National Bank of Hungary. For a comparative analysis see Wyplosz (1999) and the studies in Cotarelli-Szapáry (1998), in particular Begg (1998).

At the beginning of the 1990s, Hungary, like other formerly socialist economies, had to undergo significant structural changes, and a large scale reorientation of trade. As a result output declined and unemployment rose in the early '90s, while there were sharp increases in the price level. As the country inherited a distorted relative price structure, inflation was accompanied by huge relative price changes.

Fiscal expansion and domestic demand led to recovery before 1995, which resulted in increasing indebtedness, and in high real wages. Monetary policy's "balancing" via devaluations and higher interest rates was unsuccessful. Returning to a sustainable fiscal path required genuine fiscal adjustment, which took place in 1995, and was supplemented by a step devaluation. Restoring solvency was accompanied by an adjustment of real wages, and this, together with accelerated

privatization in a stable macroeconomic environment, led eventually not just to recovery, but to rather high growth, too. Monetary policy was supporting fiscal policy by providing nominal predictability in terms of inflation and exchange rate changes.

Inflation in the 1990's showed ups and downs. First, the rate of increase in consumer prices accelerated, reaching its peak in the middle of 1991. Then came a rapid disinflation, followed by a period when the rate of inflation stabilized. In early 1995 a short episode of acceleration of inflation to levels comparable to those in 1991 occured, and it was followed by an almost continuous disinflation.

Table 1
Hungary: Some Macroeconomic Data

	GDP annual growth rate (%)	Central government debt, total (% of GDP)	Current account balance (% of GDP)	CPI (% change year on year)
1990	-3.5		1.1	28.9
1991	-11.9	74	1.2	35.0
1992	-3.1	78	0.9	23.0
1993	-0.6	90	-11.0	22.5
1994	2.9	87	-9.8	18.8
1995	1.5	85	-5.7	28.2
1996	1.3	72	-3.8	23.6
1997	4.6	63	-2.2	18.3
1998	5.1	61	-4.8	14.3
1999	4.3	61	-4.1	10.0

2.2. The policy of the National Bank of Hungary

The 1998 Annual Report of the NBH states: "*The National Bank of Hungary considers the sustainable reduction of inflation and – in the long run – achieving price stability as its most important tasks.*" In order to understand what these terms mean it is best to quote from the first Quarterly Report on Inflation, which summarizes the Bank's official stance on the nature of the inflationary process and its tasks therewith.

"*The National Bank of Hungary (NBH) sees three factors which are predominantly important in determining inflation. The development of aggregate demand and supply is the most important factor for sustainable disinflation. The second factor is inflationary expectations, which play a significant role both in producers' pricing behaviour and in nominal wage negotiations. The third component is imported inflation, which is the sum of foreign inflation and the*

nominal depreciation of the Forint. These three components determine the trend of inflation. The inflation rate can, of course, be influenced by ad hoc factors as well, such as tax changes or supply shocks causing one-off shifts in the price level. The National Bank of Hungary believes that the significance of rapid relative price changes and structural adjustments –which were major determinants of the inflation process earlier – decreased as the transition to a market economy ended."

Thus the Bank thinks in terms of a certain decomposition of actually observed inflation. It contains a trend determined by the three factors mentioned above, and a temporary component which has been predominantly influenced by certain relative price changes (See next Section).

The short-term framework of policy contains a crawling band for the nominal exchange rate, for which repeated announcements are made jointly by the government and the NBH. Within this framework the NBH's main short-term target is to keep the nominal exchange rate within the announced bands, if necessary by exchange market intervention, but also by setting appropriate short-term interest rates. Another quotation illustrates the principles followed.

"*Sustainable disinflation is possible only through the cooperation of fiscal and monetary policies. The maintenance of the preannounced crawling peg exchange rate regime influences the pricing behavior and inflationary expectations of market participants, and the gradual reduction in the monthly devaluation rate confirms the credibility of the monetary authorities' inflation forecast. (...) The significance of the exchange rate path lies in its credibility and sustainability, thus the expected depreciation is built-in within pricing behavior, reducing the inertia of inflationary expectations and enabling monetary authorities to set a lower goal for inflation."*

To summarize: for the NBH price stability is a long-term goal, which is only achievable by a process of sustainable disinflation. Sustainability is derived from the idea that too fast and not coordinated attempts to disinflate have frequently resulted in currency or capital market crises in developing countries where government and foreign debt were not negligible factors. The longer-term exchange rate strategy must be understood from this concept of sustainability. The NBH (together with the government) would normally not increase the rate of devaluation, though there exists no explicit promise to that effect, but the size of cuts in that rate is influenced by macroeconomic developments between two announcements. Deterioration in foreign debt level, acceleration of government indebtedness or

unfavorable inflationary developments (resulting in real appreciation) are taken, in particular, as indicators of a more delicate macroeconomic balance, and would, thus, militate against further cuts in the announced depreciation. Policy puts an emphasis on shaping expectations without "surprising" the public. The goal is to achieve a mutual understanding with the market. Policy both in the form of setting instruments (exchange rate bands and interest rates) and by communicating to the public is geared to arrive at this mutual understanding. The publication of the Quarterly Report is to be seen in this perspective. In the words of the first issue: "*The objective of the Quarterly is to regularly provide the public with a view on the current and expected path of inflation and also about how the central bank evaluates the macroeconomic environment which determines inflation. By doing so, it is hoped that a much wider public than before will be familiar with the objectives of monetary policy and the central bank's measures will be easier to follow and to understand."*

We conclude from the above description that the core inflation index, published by the NBH, has its main role in the communication strategy of the NBH. The Bank's internal analysis of inflation is quite detailed, and the inflation reports exhibit much more about inflation than just the CPI and the core, where the latter is called explicitly as the trend in inflation. By publishing a core inflation index the NBH aims at providing the public with a price index which can function as a coordination device, and can play a useful role in the improvement of mutual understanding between monetary policy and market participants. This price index (core inflation index) must reflect those developments that the NBH thinks important, and would take into account when making decisions. Or looking at it from another angle it must not contain irrevelant information. Thus, for example, a temporary increase in the rate of inflation due to nonpersistent supply shocks would not have an effect on central bank policies, therefore these should be somehow extracted from the core index.

3. Implementation of the Core Inflation Concept in Hungary

It can be argued that excluding known temporary shocks is reasonable provided we want to obtain a smooth inflation index that is a good predictor of future inflation and is, at the same time, close to the (*ex post* defined) trend. The Hungarian approach is indeed an exclusion approach. Since July 1998 the NBH has regularly published a core inflation index which excludes from the consumer price

index the effects of price changes in seasonal foodstuffs (eggs, potatoes, vegetables, fruit), solid and liquid fuel (coal, briquette, cooking coal, firewood, heating fuel) and gasoline. The core inflation index calculated in this way covers 91 % of the original consumer price index. The prices excluded are rather variable and the resulting core index is less variable than the total CPI. On the other hand, the respective relative prices do not have clear trends, thus, in the long term, the average core is close to the average CPI (See Section 5 below). With regard to good communicability these features are very important. At first the variability of the index may lead to confusion and the possibility of diverging expectations, which would result in difficulties with coordination. On the other hand, the NBH's rule of not cutting the rate of devaluation if there is a tendency towards "excessive" real exchange rate appreciation calls for an index which closely follows the level of the CPI, which is a sort of cost of living index (Cost of living considerations are crucial for setting wages, while nominal wages too high relative to the exchange rate can deteriorate the exporting sectors' profitability). It can be seen from Table II. in Wynne (1999) that this approach satisfies some important criteria, like being computable in real time, understandability, and not changing frequently. It is perhaps curious that recently the Hungarian Central Statistical Ofice (CSO) started to publish its core inflation index based on similar principles, but excluding some 20 per cent of the CPI. This may not follow the precept of being close to the CPI, which can be explained by the fact that the CSO does not possess policy motives. See, however, our results in Section 5.

We know that statistical definitions change sometimes. Indeed it is plausible that such changes give us very valuable information on the purposes of those who initiate them. The NBH deviated from the calculation of the core inflation after about one year. The break with the implicit rules was prompted by a specific event, but the case is interesting and we can learn some lessons from it. It was a governmental decision to cut subsidies for a number of patented drugs in the summer of 1999. It was also well known that cheap generic substitutes existed for each of these medicaments, thus economic rationality predicted that the resulting price increase would call for a very sharp substitution effect, and the drugs with higher consumer prices would lose market share almost totally. The CSO as an agency whose operations are directed by formal rules refused to accept this logic and, having no factual grounds for changing the weights attached to these drugs, used its old procedure to calculate its price index. This resulted in a substantial

increase in the rate of inflation, namely by 0.8 % in two months.[1] On the other hand the NBH changed its practice and redefined the core index, by excluding now drugs as well[2], but without making a full backward adjustment. As a result, in the following year the difference between the CPI and the NBH core was almost one per cent. This made an important qualitative difference: whereas the NBH core showed continuous disinflation, the CSO core indicated a reversal in the disinflationary process.[3]

Acting this way the NBH may have seemed to behave in an arbitrary manner. On the other hand, the drug price increase did not just qualify to being a temporary shock to the price level. In terms of the above economic reasoning, what happened in fact was a very gross case of erroneous measurement, i.e. substitution bias, which is a general property of the Laspeyres index. Was the NBH wrong to make the *ad hoc* adjustment? We think transparency did not suffer since the procedure was open and clearly explained and probably well understood. One may object that footnotes might also have done the trick. However, it is known that readers frequently fail to notice footnotes.

One may say that had the NBH introduced a limited influence estimator the problem would not have emerged at all. As similar cases can very well appear in the future, the introduction of a well-chosen limited influence estimator may be advisable. One traditional objection against this is the supposed difficulty with its understandability by the public (see Wynne (1999) Table II). However, it is doubtful whether the general public would care too much, whereas professional analysts must be intelligent and educated enough to absorb such a novelty (See our related results reported in Section 5).

4. Relative Price Issues[4]

Problems with defining a core inflation concept are related to relative price changes. Also as the above quotation shows that the National Bank of Hungary has been very much concerned with interpreting relative price changes. What are the

[1] Drugs had a weight of 1.8 %, and their index rose by 45 % in two months.
[2] A full deduction of the 0.8 % may overstate the substitution effect, but it is believed that this bias is not substantial.
[3] As we were not bound by previous publications, we made the full backward adjustment in our calculations. Thus, before mid-99 our data slightly deviate from the core time series published by the NBH.
[4] This section heavily draws on Vincze (1999).

sources of the most important relative price changes that may bear relevance on the core inflation problem?

1. Seasonality.

2. Other cyclical behavior at lower frequencies.

3. Indirect tax changes.

4. Government policies with respect to regulated prices.

5. Certain prices changing less frequently than others.

6. Supply shocks.

7. Relative demand shocks.

8. Trends in relative prices due, for instance, to productivity growth differentials.

In the folowing we will present a decomposition of the Hungarian CPI. We will not discuss each of the above problems, but many of these will recur during the investigation in different guises.

4.1. Relative Consumer Prices

At the beginning of transition there was a widespread feeling that transition would require very large changes in relative prices. The reason for this was obvious. Under the socialist regime the price system had not accomplished its function of equilibrating supply and demand, as social or other considerations militated for keeping certain prices low and others unreasonably high. (The latter was largely helped by the existence of trade barriers). Needless to say, price distortions might exist in any economy, not only in centrally planned ones. However, the common perception was that here the problem had been more marked, and the warranted changes larger. Certainly some of the required relative price adjustment occurred rather early in transition, usually following immediately upon price and trade liberalization. However, it has been observed that relative price adjustment has proved to be a rather prolonged process that has not come to an end in most of the countries concerned (See Koen-De Masi (1997)).

First we ask whether we are able to identify “tradable” prices. Obviously if two goods have identical physical attributes, but are consumed at different locations, their prices might not be necessarily the same. So for purists the concept of tradable

is a chimera. One can be more pragmatic, however, and can ask whether the main implication of tradability (the *Law of One Price*) is a satisfactory approximation. Usually we must avail ourselves with something even more modest, and we have to look for the fulfillment of the "*Law of One Price Change*", i.e. approximately identical rate of change, expressed, of course, in the same currency. We would have our best change of finding tradable prices that satisfy this definition if we were looking for intermediate goods. Goods and services whose prices make up the CPI usually have some non-tradable content (local services etc.), thus are not perfect candidates. Unfortunately, data availability causes us to confine our attention to the CPI basket. The question is whether it is possible to find some part of it that can, for practical purposes, be identified with a tradable price index.

Our approach of identification was the following. From standard microeconomics we can suppose that the marginal cost of products and services is some function of input prices as well as of the amount supplied. If markups are stationary then an approximately tradable good can be defined as one whose price depends only on foreign inflation and on the nominal exchange rate in the long run. Neither domestic demand in a small economy, nor other costs, like nominal wages, should have an impact on an ideal tradable price asymptotically. This reasoning suggested the specification of autoregressive distributed lag models for each price index that make up the Hungarian CPI, where regressors included the nominal exchange rate, nominal wages and seasonal dummies. The estimates of long run parameters are consistent in a wide range of circumstances (see Pesaran-Sin-Smith (1997)). If we disregard foreign inflation, which can be taken as approximately zero in view of the very low inflation in the EU, an (informal) pre-test of tradability is as follows: a good is hypothetically tradable if the nominal exchange rate alone is significant in its equation, and the long-run parameter of the exchange rate is not far from 1 (Because of the noisiness of individual series we could not really strive to have a more formal test).

Based on this probe less than half the prices pass the hurdle. A very important observation is that all the goods classified as durable belong to this category! Taking their aggregate index as the subject of the test one gets the same result with a long-run coefficient of 1.02. Next, one can test whether this aggregate is cointegrated with nominal exchange rates at different sample periods. Provided the answer is positive this subcomponent of the CPI can be regarded as a good approximation of a tradable price index.

Augmented Dickey-Fuller and Phillips-Peron tests were carried out for the difference of the log tradable price index and the log nominal exchange rate for three subperiods. It turned out that the period between the March stabilization in 1995 and the Russian crisis in 1998 is where the null of no cointegration can be rejected most confidently. Including the Russian crisis would lead to a weaker result, and for the whole period no cointegration can not be rejected at traditional significance levels.

Thus we adopted the durable subcomponent of the CPI, representing about 10-15 % of the total, as a proxy for the price index of tradables. One can see from Chart 2[5] that the relative prices of durables have followed a clear negative trend, and from Chart 3-7 that individual prices within this class have had the same property, making this subgroup exhibit a very high degree of internal similarity.

Having identified a price subaggregate that can be reasonably well explained by exchange rate movements we proceeded to investigate relative price changes. It appeared that further disaggregation was necessary. Both on *a priori* and statistical grounds one can distinguish seven further subaggregates.

1. Non-energy **administered (regulated) prices,** characterized by infrequent changes. Chart 2 shows that relative administered prices have exhibited a positive trend, and have grown substantially. They show a zigzag picture, undergoing short periods of large hikes, and more protracted periods of almost no change. This is true for most individual prices, though some of the individual relative prices have remained virtually unchanged on average (Chart 3-1).

2. Energy prices. **Energy prices** have partly been regulated, and also exposed to world price developments, i.e. supply shocks from our point of view. The relative energy price was declining at mild pace until 1995, when it rose steeply, followed by the continuation of an upward trend (Chart 2). This shape was due to deliberate policies, which had checked energy price increases before 1995 for social reasons, but the correction of the relative energy price was part of the fiscal adjustment package. From Chart 3-2 one can observe that individual prices within this subgroup show high variation.

Several utility and basic commodity prices are still regulated to some extent. In some periods governments were suspected of using price regulation to fight

[5] In the charts relative prices are defined as log ratios to the unadjusted CPI.

inflationary pressures by freezing certain prices belonging to their dominion. Indeed, this behavior was not unique to transition countries; many other developing countries saw something similar during stabilization attempts. These price freezes are usually discredited as myopic in the sense that they postpone rather than resolve the inflation problem. Again this claim must have a lot of relevance for particular cases. However, it would be a mistake to regard it as universal truth and deplore every government intervention in monopolistic price setting as unwise and short-termist. It is obvious that if price regulation is binding, monopolists could increase profits by setting their relative prices higher. Thus there is an inherent tendency, especially for private regulated monopolies, but also for state monopolies, provided that managers have preferences for higher profits, to elbow for price increases. Whether current relative prices are below or above competitive (marginal cost) prices must be largely private information, thus lobbying for higher prices is not inconceivable. By the same token, in an inflationary environment, where nominal prices should be changed from time to time and this repricing should be based on expectations on price formation elsewhere in the economy, regulated monopolists are prone to prefer mistakes on the upper side, that is, achieving higher *ex post* relative prices than expected. This is in sharp contrast with rational behavior in industries where competitive pressure is higher, since in those industries overpricing is as harmful as underpricing. The conclusion from the above reasoning is that regulated monopolists tend to constantly push towards relative price increases, but whether this is justified on efficiency grounds cannot be decided *a priori*, and the outcome may also depend on the extent of regulatory capture. The fundamental point here is that under imperfect competition *cum* regulation there is a range of indeterminacy for relative prices. This is why questions like the one raised by Blanchard (1998) seem not to be easy to tackle. Blanchard asks whether governments must decide to bring relative administered prices to their correct level before or after disinflation. This, however, might only be possible to decide if we accept that a unique correct level exists. This also means that governments cannot have a hands-off stance on this issue, and should take responsibility for price setting in this area. This should involve a clearly defined strategy, rather than some quantitative assessment of what the correct prices should be.

3. Excisable goods (alcohol, tobacco, car fuel). The separate treatment of this subgroup explains by the heavy tax burden[6] that distorts the evolution of the prices

[6] Excise taxes add up to roughly 5% of GDP in Hungary, or about 10% of gross budgetary revenues.

on these markets, making them, at the same time, very much dependent on the current fiscal stance. Excisable good relative prices do not show a zigzag pattern, but certain big changes have occurred in them. On the whole they exhibited a slightly negative price trend, which was notably reversed for some time in 1995 (Chart 3-6).

4. Processed food prices. These have been pretty stable in relative terms (Chart 2), and they constitute an internally coherent subgroup (Chart 3-4).

5. Non-processed food prices. These seem to be relatively stable in the long term, but have had cycles, exhibiting not just very large short-term fluctuations, but fluctuations that have apparently been persistent (Chart 2). The subgroup is not at all homogenous (Chart 3-5), showing that here local market effects clearly dominate.

Non-processed food prices provide an additional input to uncertainty in inflation. Besides the natural reasons for the existence of potentially large supply shocks, changing and unpredictable agricultural policies have played an important role. Initial relative price distortions existed but since agricultural price structures in western countries are also distorted it is difficult to see what the long-term behavior will be. This uncertainty is especially important for transition countries since CPI baskets sometimes contain as large a share of food prices as 40%, whereas large fluctuations in food prices may be uninformative about underlying trends.

Foodstuffs are certainly tradable and traded, despite significant barriers. Still trade barriers have caused substantial differences between the level of food prices in Hungary, and, say, those in Western Europe. EU accession can accelerate the disappearance of the gap, and even its expectation can have an effect on price determination in the interim period. Recent research has shown that the level of agricultural protection in transition countries varies (Banse (1999)), Hungary's being much lower than that of Poland or Slovenia, and even lower than that of the Czech Republic, which also has a lower level of protectionism than the EU average. It is not just current regulation but also the expectations of EU and accession country policies towards agriculture that shape agricultural decisions and, in consequence, prices. It would be difficult to argue that food prices in the world are set by unfettered markets, therefore one cannot even assume that relative price structures today prevailing in the EU will be what transition country relative prices will converge towards. The uncertainty regarding the future is clearly very high.

Thus, here again, we meet prices that are probably increasing in the medium term, but their path is heavily influenced not just by the weather *par excellence* uncertainty factor in agriculture, but also by government policies. With obvious modifications the previous conclusion applies here as well: under the present circumstances the construction of a government strategy towards agricultural prices is a must, if the reduction in uncertainty of future (general) price developments is desirable.

6. Services. These are almost the mirror image of durables, exhibiting a slight, but consistently positive, upward trend (Chart 3) and strong internal similarity (Chart 3-3).

It is remarkable that these prices seem to have a rather smooth upward relative trend. This phenomenon is not really particular to transition economies, it can be observed in several industrial countries, or probably everywhere. The most popular explanation (the Balassa-Samuelson hypothesis) relies on differential technological growth and wage equalization (See Kovács-Simon (1998)) for some support for differential productivity growth in Hungary). Changes in relative demand might also play a role. We must also notice that the smooth upward trend is definitely less steep than that of administered prices, and is much less noisy than that of either administered or food prices. Though the evolution of relative non-tradable prices is rather smooth and steady, in no way can we infer that present trends would continue *ad infinitum*. Nevertheless, we can expect only gradual changes in them.

7. Other tradables. This is in essence a "*rest of prices*" category. Their average relative price has had a slight negative trend (Chart 2), with the individual relative prices possessing smooth trends, both negative and positive (Chart 3-8).

Finally we judged 7 main headings – out of the 160 used by the CSO to calculate the CPI – to be problematic or misleading, which we did not include any of the previous categories.[7]

[7] Dropped headings include (imputed) rent of owner occupied dwellings (this highly dubious "good" accounts for more than 5% of the CPI), rents of local governments' flats, TV fee (a quasi-tax), gambling "*prices*" and "*other services*".

Table 2
Data of the 8 CPI-Subaggregate

	Basic Headings	Average Weight (1992-99)
Administered	10	7.00%
Durable goods	16	8.25%
(Processed) food	28	15.94%
Non-processed food	14	7.31%
Excisable (ABC)	6	16.07%
Other goods	46	17.14%
Energy	8	7.25%
Services	25	11.52%
Problematic (not included)	7	9.52%
	160	*100.00%*

4.2. The Cross-Sectional Variability of Prices

Traditionally economists considered the variability of prices as one of the main costs of inflation (See Driffill-Mizon-Ulph (1990)). The concept of variability can be understood either as the conditional variance of aggregate inflation, or as the (cross-sectional) variability of relative prices. There is a general expectation among economists to find positive correlation between relative price variability and the level of aggregate inflation, and there exists important literature (see, for instance, Cukierman (1982)) that formulated hypotheses with respect to the positive correlation between relative price variability and variance of aggregate inflation.

Relative price change distributions are usually found to be non-normal, and this was true for our sample, too. Recent models in Ball-Mankiw ((1994), (1995)) drew substantial attention among those who examined this problem in the context of transition economies. Assuming downward rigidity in prices, relative price changes must necessarily mean a rise in the average price level. From a theoretical point of view, it is doubtful whether specifically downward rigidity in prices exists. Why price reductions may not be very frequent phenomena can be explained provided that trend inflation is significantly positive, and changing prices is costly. In that case, keeping prices constant is equivalent to decreasing relative prices without incurring the costs of price changes. Thus, positive (large) inflation induces observed downward rigidity, which might not be present if price stability (zero inflation) would be the rule.

The same model can be used for arguing that higher relative variability of prices might give incentives to price makers, in circumstances of costly price changes, to price comparatively high, in effect to temporarily increase inflation when relative

price uncertainty is high. This idea has found its way into empirical research on transition inflation, with Coorey-Mecagni-Offerdal (1998), Pujol-Griffiths (1998), Wozniak (1998) reporting evidence in support of this hypothesis on different samples. One shortcoming of this literature seems to be its failure to draw a clear distinction between relative price variability implied by higher relative price uncertainty and that implied by permanent changes in relative prices. The latter obviously imparts some variability to cross-sectional relative inflation rates, even if that variation is perfectly foreseen.

Though separating uncertainty and predictability is not easy, some considerations may suggest that in transition countries in general, and in Hungary in particular, a large portion of relative inflation variability has been due to permanent relative price changes, thus it should not be identified with relative price uncertainty. In a similar vein high positive skewness of cross-sectional inflation rates, which has been found to positively correlate with inflation in the short term, may not be attributable to the positive skewness of underlying relative price shocks, as demanded by the Ball-Mankiw model, but can be completely foreseen. For instance, if it is well known in advance that some government influenced prices will be changed at some pre-specified date, then cross sectional skewness may be highly positive, but this has nothing to do with the skewness of unexpected relative price shocks.

Chart 4 shows the monthly pattern of basic statistics for the cross-sectional distribution of individual price changes. There is large variation, significant non-normality and little pattern. However, by applying a symmetric 5 % trim one could get a clear pattern (see Chart 5), (See the precise definition of trimming in the following section). There does not seem to exist any great difference among months with respect to skewness and kurtosis, whereas there is a well visible positive correlation between the mean and variance. It seems that most of the non-normality can be got rid of by trimming 10 %, whereas the close association between the mean and variance suggests a non-linear stochastic seasonal pattern in price making.

It would be needless to measure core inflation if relative prices never changed. This Section demonstrated that relative price variation has been a significant feature of the Hungarian inflationary process. On the other hand this variation has exhibited many varieties that do not lend themselves to easy generalization.

Thus there is little hope that some simple theory-based of treatment relative price changes, and a definition of an optimal core, would be possible.

5. Computing and Comparing Hungarian Core Inflation Indices

In this section we examine some proposed core inflation indices for Hungary. These include the NBH's offical core index, the CSO's core index, a narrow core that is obtained by excluding all *"volatile"* subgroups resulting in about 50 % exclusion, an optimal 18 % symmetric trimmed mean (see below), a 5 % symmetric trimmed mean, and a 5 %-15 % asymmetric trimmed mean (see the definition below).

The NBH and CSO core inflation indices were given naturally. Our narrow core was obtained by keeping the tradable, services, processed food and other non-durable subcategories. To arrive at the optimal trimmed mean estimator we defined the long-run trend in consumer prices by taking a 24-month moving average (We did not want to choose a 36-month average and losing too many data points thereby). The trend so defined proved to be free of seasonality, but had two large outliers in 1994:1 and 1994:3, as two-year window was unable to smooth out the large price hikes in 1995:1 and 1995:3. Some basic statistics for the trend and the original CPI appear in Table 3. See also Chart 6.

Table 3
Basic Statistics*

	Mean	Median	Standard deviation	Skewness	Kurtosis
CPI	1.47	1.4	0.66	1.58	8.04
Trend CPI	1.52	1.58	0.33	-0.46	2.21
NBH core	1.43	1.4	0.62	1.48	8.36
CSO core	1.45	1.4	0.55	1.61	9.1
Narrow core	1.36	1.3	0.57	1.64	9.92
Optimal trim	1.09	1.	0.47	2.08	12.91
5 % trim	1.27	1.2	0.53	1.68	10.24
Asymmetric trim	1.45	1.4	0.57	1.65	10.31

*The underlying data are monthly, seasonally adjusted (except for the trend), and given in percentage points.

Trimmed means are calculated in a way that dropped series - those with the lowest and those with the highest index concerning a given month - have the cumulated weight as close to the target as possible. That is

$$\Pi^{t}_{l,u} = \frac{\sum_{i \in \tau_t} \pi^{t}_{i} w^{t}_{i}}{\sum_{i \in \tau_t} w^{t}_{i}}$$

where $\prod^{t}_{l,u}$ is the *l%-u% (*asymmetric) trimmed mean of individual inflation rates. Here $\tau_t, \tau^{u}_{t}, \tau^{l}_{t}$ is a partition of the 160 base series' parameters such that

$$\forall i \in \tau^{l}_{t}, j \in \tau_t, k \in \tau^{u}_{t} : \pi^{t}_{i} < \pi^{t}_{j} < \pi^{t}_{k}$$

$$\left| l - \sum_{i \in \tau^{l}_{t}} w^{t}_{i} \right| = \min_{\tau^{l}_{t}}$$

$$\left| u - \sum_{i \in \tau^{u}_{t}} w^{t}_{i} \right| = \min_{\tau^{u}_{t}}$$

and *l* and *u* are the trimming bands' width, π^{t}_{i} is the *i*-th CPI-representative's monthly price change, w^{t}_{i} is the corresponding weight in the CPI, τ^{u}_{t} and τ^{l}_{t} corresponds to the series dropped out by the trimming process and τ_t consists of the (indices of the) series left in.

In order to find an optimal trim, we calculated root mean squared error statistics for the deviation between the trend and a number of trimmed means. We included also asymmetric trims, with bandwidths between 0 and 20%.

$$RMSE = \sqrt{\sum_{t} \left(\Pi^{t}_{l,u} - \overline{\Pi}_{t} \right)^{2}}$$

where $\prod^{t}_{l,u}$ is a trimmed mean with parameters *l* and *u*, and $\overline{\Pi}_{t}$ is the trend.

We selected as the "best" mean squared error estimate the 18% - 18% symmetric trim, though the 18% -17% asymmetric trim gave a somewhat better result. We added to the list the 5% symmetric trim that proved to have a "smoothing" effect on the cross-sectional distribution (see above), and had approximately the same exclusion level as the NBH core. The 15%-5% trim was included on an ad hoc basis, in order to have a trimmed mean that deviates less than the others from the actual CPI on average. Chart 7 shows the different core measures relative to the CPI.

All of the proposed core measures proved to be seasonal, and even after seasonal adjustment (with the X11 method) had a large outlier at 1993:1. To assess their quality we carried out three exercises: 1. Testing for cointegration with an

Augmented Dickey-Fuller (ADF) test, between the seasonally adjusted core measure and seasonally adjusted CPI. 2. Computing RMSE with respect to the trend as defined above. 3. Running a dynamic regression with the contemporary value and four lags of the monthly core index as regressors, and future 1-year CPI inflation as regressand.

With exercise 1 we intend to capture whether the core has a tendency to be aligned with the CPI, i.e. with the cost of living index, exercise 2 enables us to compare the ability of core measures to track the trend in inflation, whereas exercise 3 helps us see whether the core indices are able to provide information on future inflation at the 1-year horizon.

Table 4 contains the results of exercises 1 through 3.

Table 4
Performance of core Measures

	ADF statistics	RMSE	R^2 in the respective regression
NBH core	0.13	0.87	0.18
CSO core	-1.33	0.88	0.21
Narrow core	0.41	0.7	0.24
Optimal trim	-1.86	0.76	0.13
5 % trim	-1.49	0.83	0.16
Asymmetric trim	-1.7	0.88	0.17

The following conclusions can be derived from Tables 3 and 4. The NBH core and the CSO core are very similar by the statistics, indeed the CSO core fares a little bit better. However, as the drug price example demonstrates, the use of interim extraneous (qualitative) information, such as the "manual" adjustment applied to the NBH core, is a more reasonable procedure than sticking to a predetermined rule at every cost. The narrow core measure does a better job than the others at forecasting inflation, but none of the core measures seem to be very good at it. Also the narrow core produces a measure closest to the trend inflation in the RMSE sense. Though the optimal trim is good at tracking trend inflation (almost by definition) it performs rather poorly in most other respects, with the exception of having a low variance. The asymmetric trim gets the average core inflation closer to the average CPI inflation, but is almost indistinguishable in its other features from the exclusion-type core indices. It is very likely that the NBH and CSO cores are not far from this sort of asymmetric trimmed mean. More exclusion tends to underestimate the average inflation with respect to actual, suggesting that many temporary hikes in individual inflation rates are permanent price level increases. If we insist on having

a core measure that cannot deviate too much from the cost of living index in the long run, then the selected core index must take into account this requirement. The ADF tests suggest that the ratios of core measures to the CPI do not seem to be stationary, a result that might be driven by small sample bias in some cases (NBH core, CSO core, asymmetric trim), but not for the rest (see Chart 7).

6. Summary and Evaluation

In this paper we argued that core inflation has no unanimous definition in the literature, though a number of loosely connected requirements that are expected of a good "core" have been identified. On the example of Hungary we pursued a "functional" approach to core inflation, whereby a core index must contain information central bank policy with as little noise as possible. Noise and relative price changes are interrelated: noise manifests itself in some relative price variation, and changing relative prices makes difficult to disentangle noise from signal. We analyzed in detail the nature and reasons of relative price changes in Hungary, and concluded that their multiplicity makes it practically impossible to search for a core index based on simple theoretical arguments.

We examined several candidate core inflation indexes and found that none of them is perfect. In particular it emerged that smoothness of an index may be accompanied by divergence from the CPI in levels, which can give a false signal if real exchange rates are an important concern for the central bank. Our investigation indicated that it is prudent for the NBH to report and analyze several price indices, especially if noise and long-run relative price trends remain present in the data. There is no overwhelming reason to give up the *"ex food and energy"* approach even if we know that it is almost necessary that further definition changes will happen. However, experimenting with trimmed means must continue, though presently it does not seem to be the case that a trimmed mean measure can substitute for the official core index. Still, as an alternative, a well-chosen trim can be published, if the choice can be clearly explained. Nevertheless, a purely statistical approach, based on an unchangeable algorithm, does not seem to be feasible for the time being.

A substantial amount of noise and apparent seasonality have come about because of government decisions. Governments must be aware of their responsibility for price setting, whenever it exists, indeed in our case, an orderly devolution of this responsibility would be preferable to sweeping the problem under the carpet.

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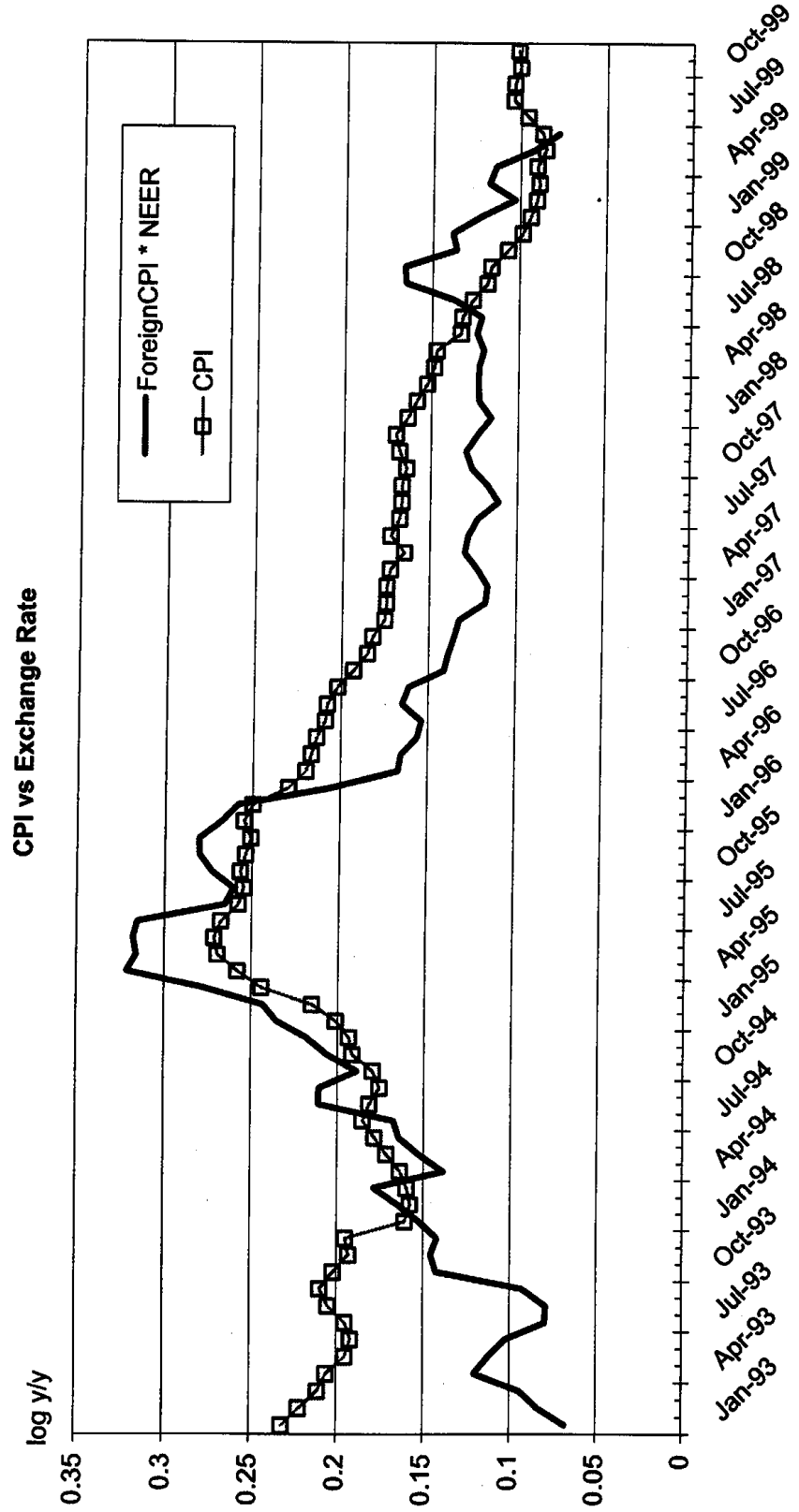
CPI vs Exchange Rate
log y/y
ForeignCPI * NEER
CPI
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Jan-93
Apr-93
Jul-93
Oct-93
Jan-94
Apr-94
Jul-94
Oct-94
Jan-95
Apr-95
Jul-95
Oct-95
Jan-96
Apr-96
Jul-96
Oct-96
Jan-97
Apr-97
Jul-97
Oct-97
Jan-98
Apr-98
Jul-98
Oct-98
Jan-99
Apr-99
Jul-99
Oct-99

Chart 1

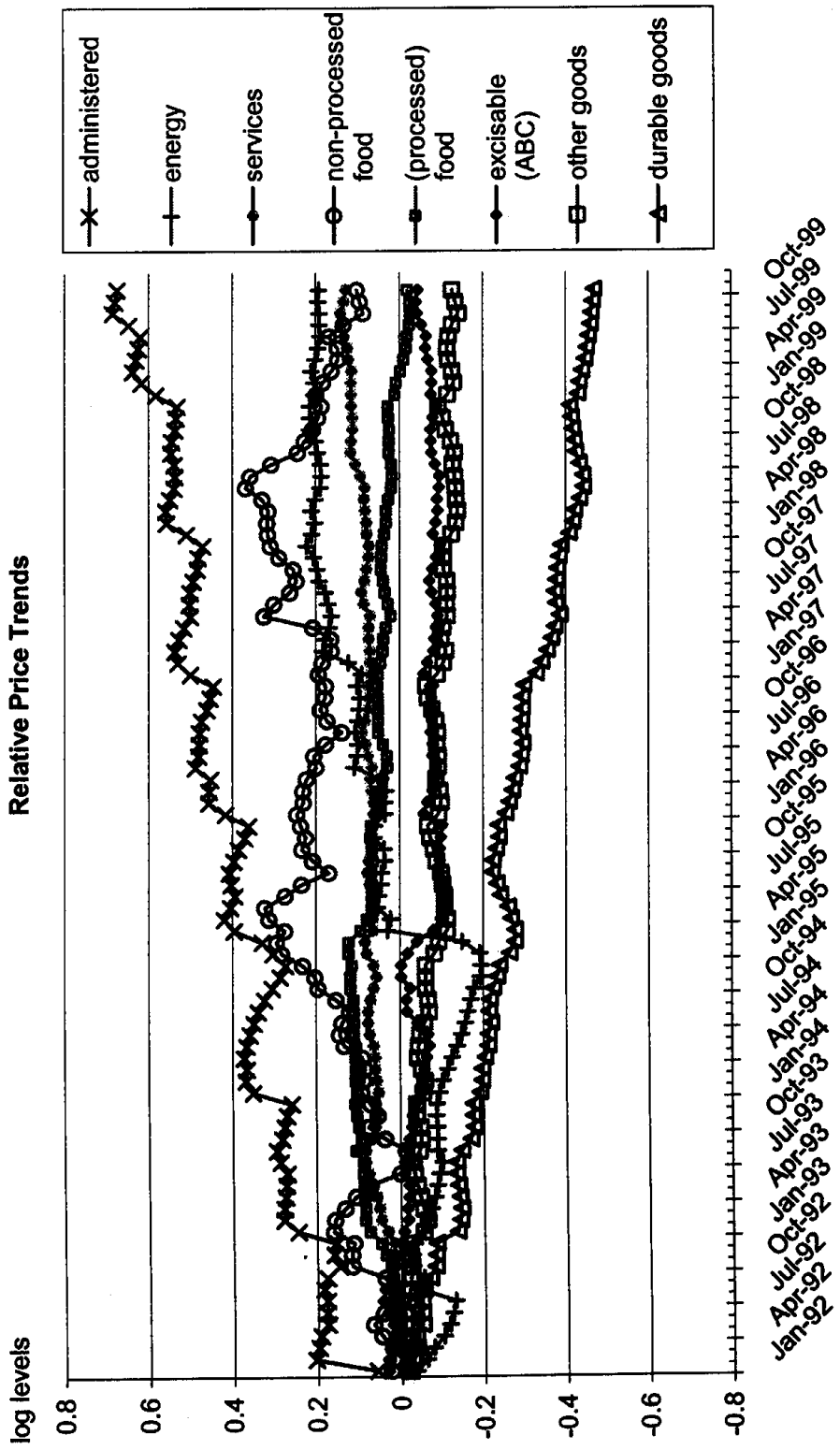
Relative Price Trends
log levels
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
Jan-92
Apr-92
Jul-92
Oct-92
Jan-93
Apr-93
Jul-93
Oct-93
Jan-94
Apr-94
Jul-94
Oct-94
Jan-95
Apr-95
Jul-95
Oct-95
Jan-96
Apr-96
Jul-96
Oct-96
Jan-97
Apr-97
Jul-97
Oct-97
Jan-98
Apr-98
Jul-98
Oct-98
Jan-99
Apr-99
Jul-99
Oct-99
administered
energy
services
non-processed food
(processed) food
excisable (ABC)
other goods
durable goods

Chart 2

Chart 3
CPI Subindices Relative to the CPI

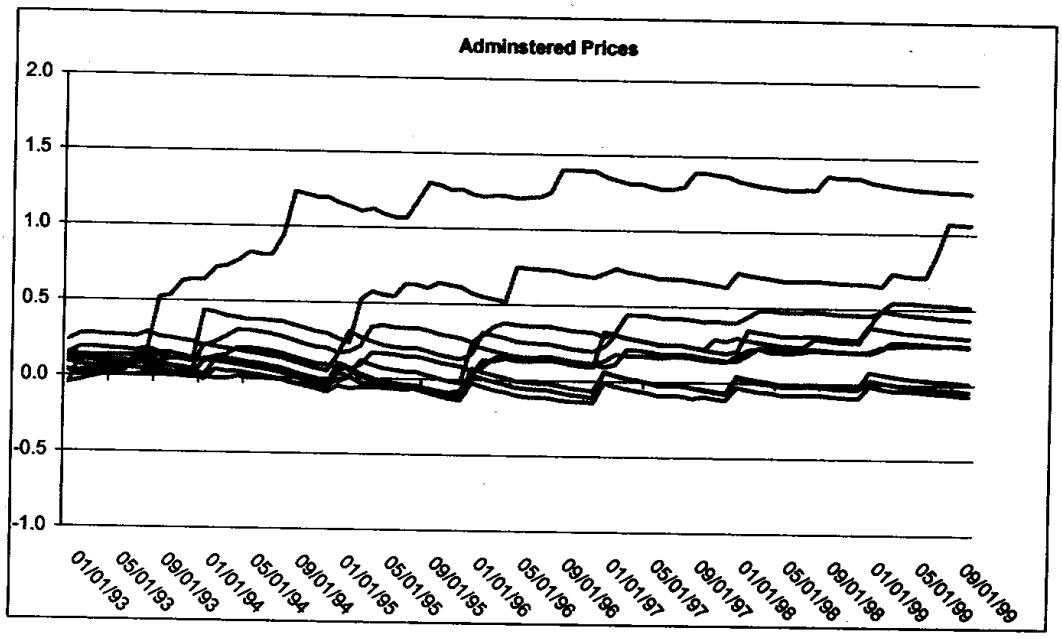

Chart 3-1

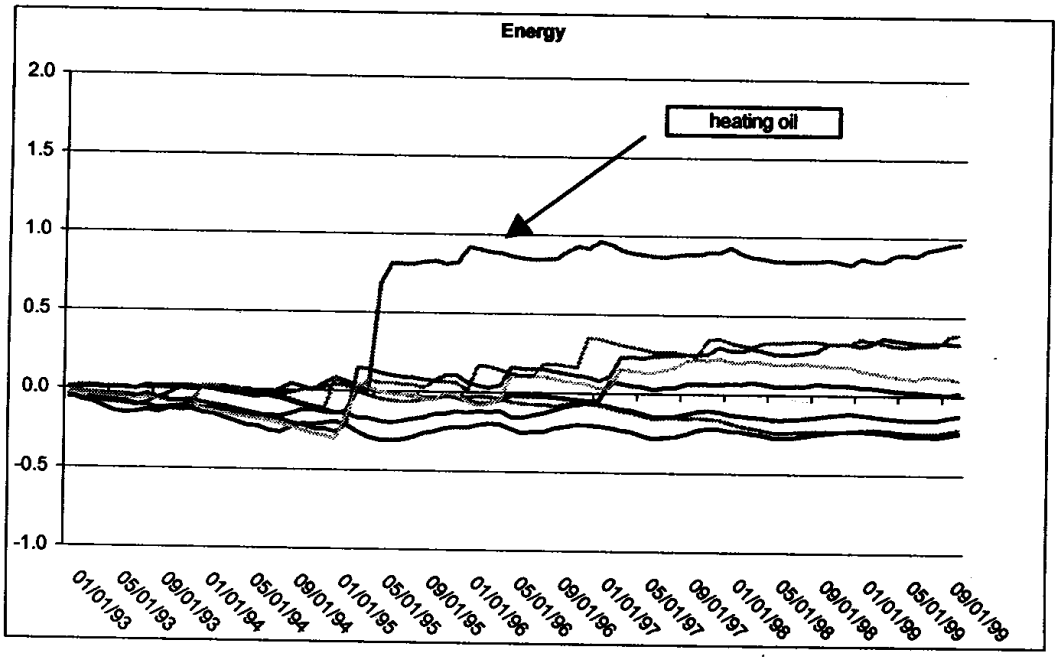

Chart 3-2

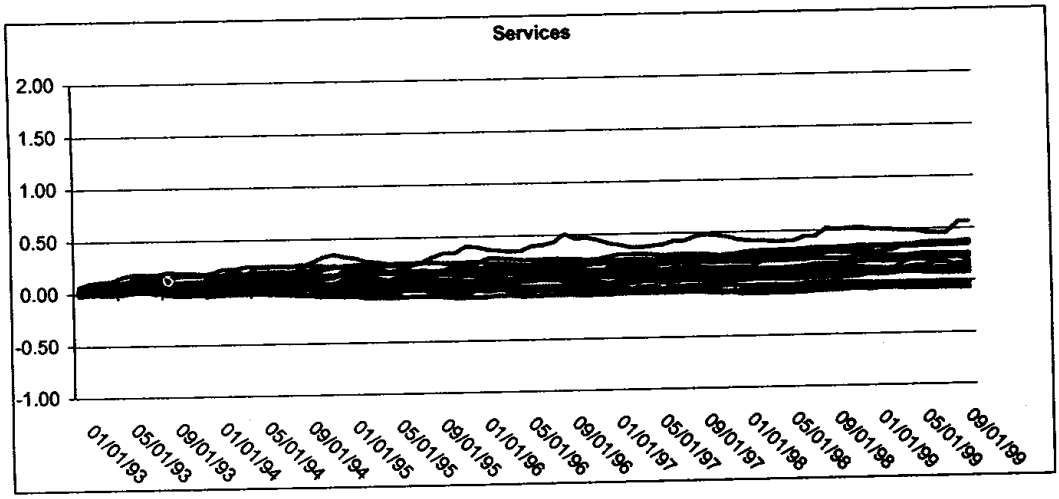

Chart 3-3

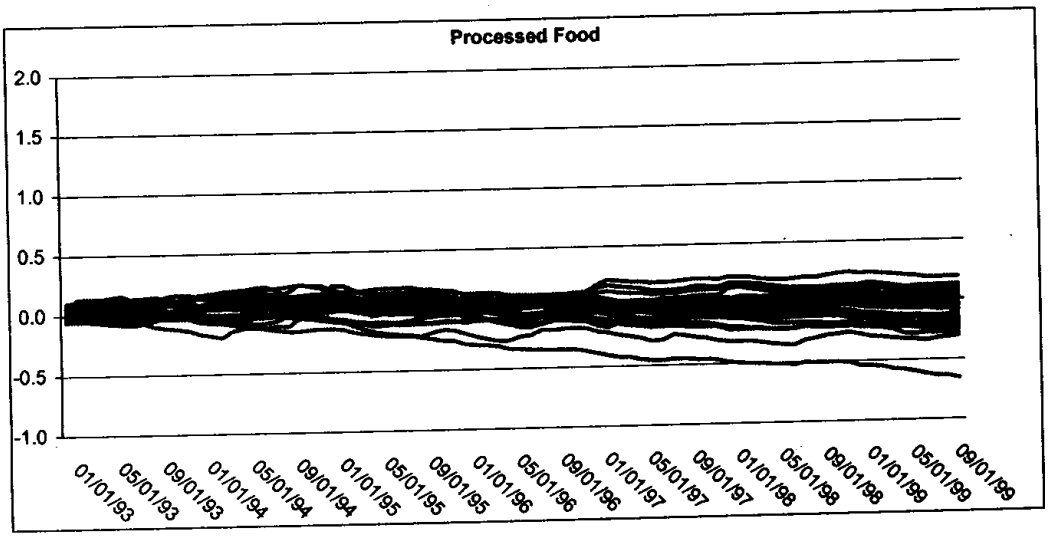

Chart 3-4

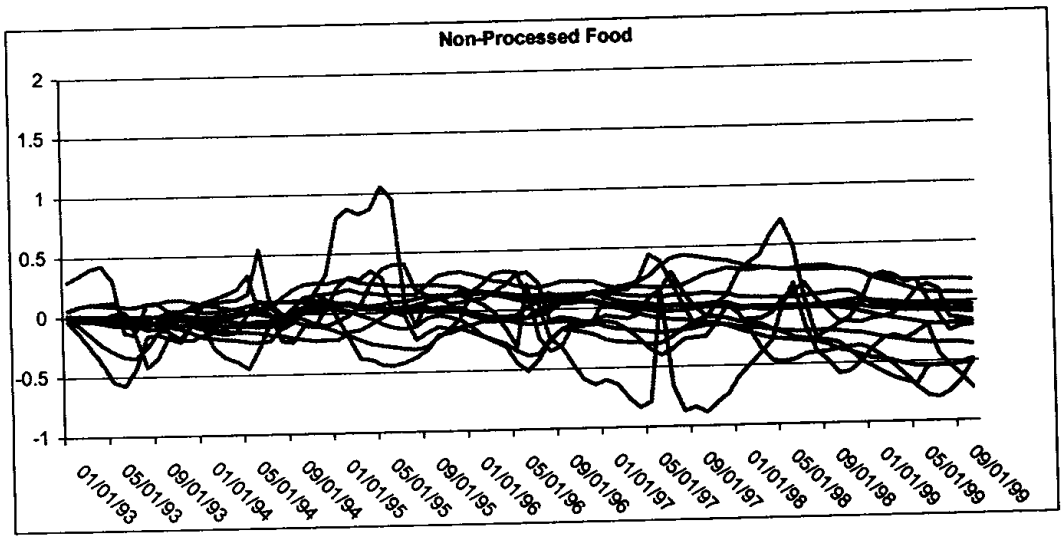

Chart 3-5

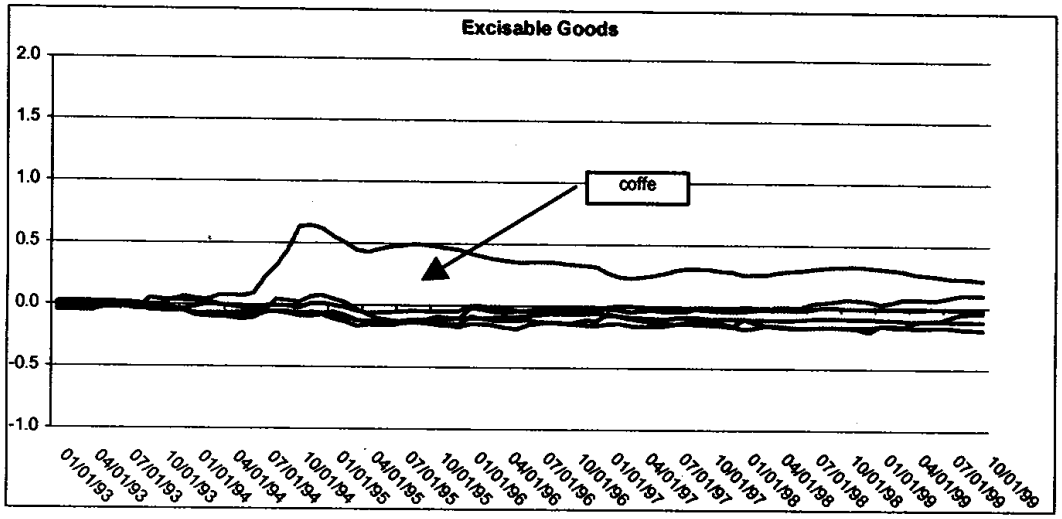

Chart 3-6

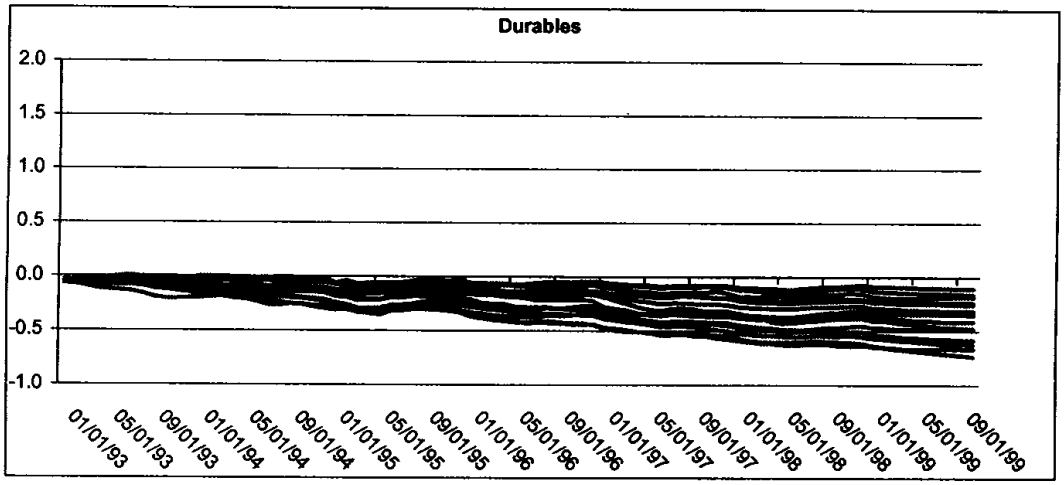

Chart 3-7

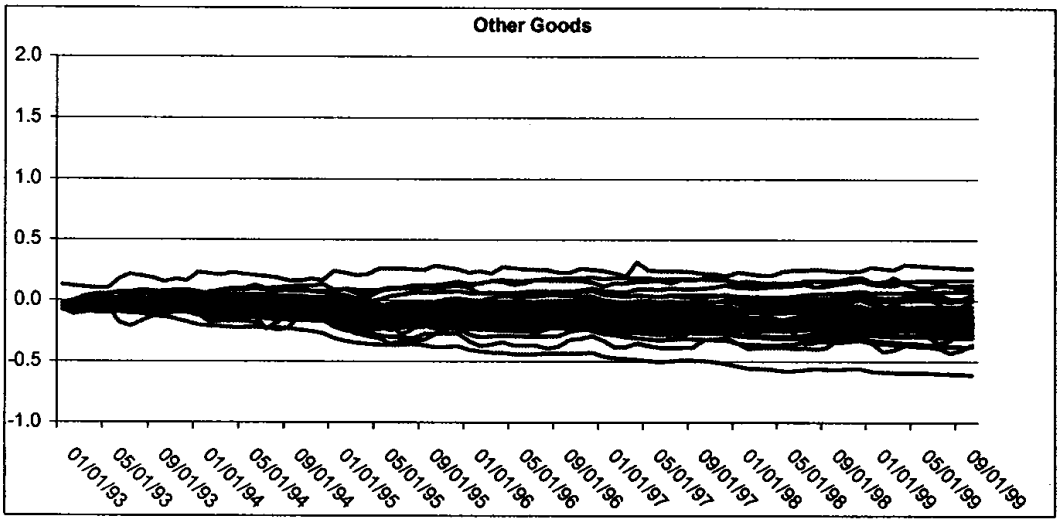

Chart 3-8

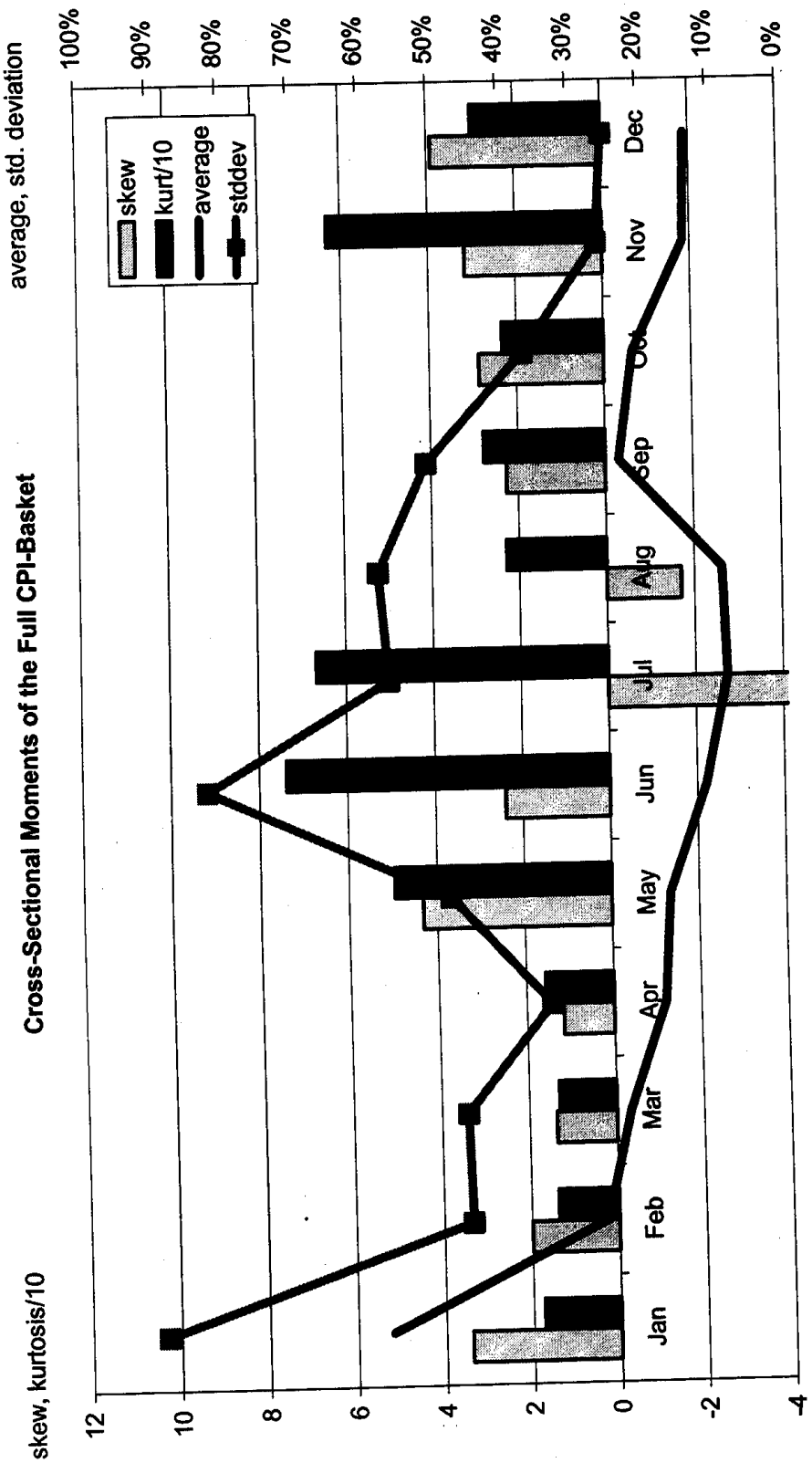
Cross-Sectional Moments of the Full CPI-Basket
skew, kurtosis/10
average, std. deviation
skew
kurt/10
average
stddev
12
10
8
6
4
2
0
-2
-4
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

Chart 4

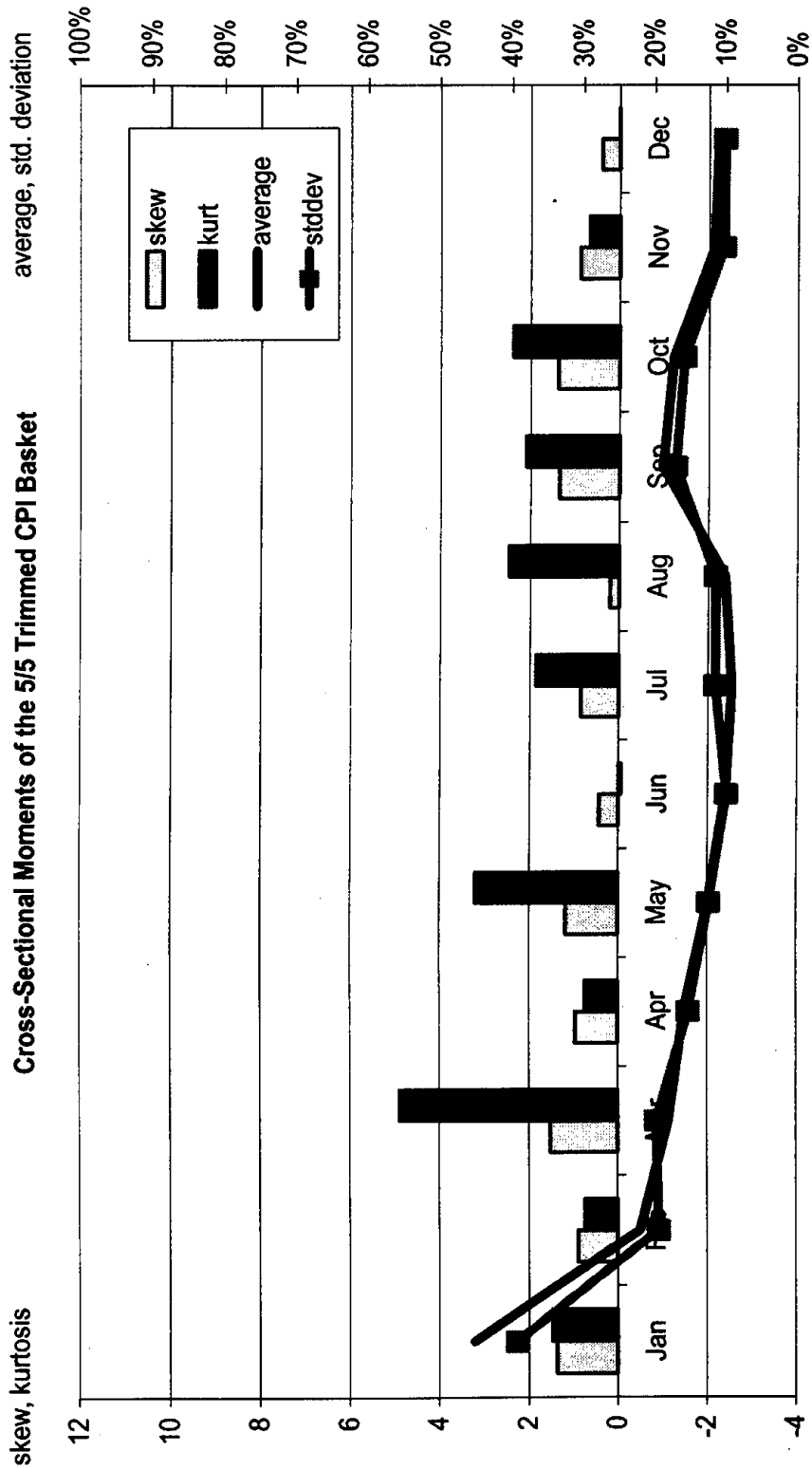
Cross-Sectional Moments of the 5/5 Trimmed CPI Basket
skew, kurtosis
average, std. deviation
skew
kurt
average
stddev
12
10
8
6
4
2
0
-2
-4
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Jan
Apr
May
Jun
Jul
Aug
Oct
Nov
Dec

Chart 5

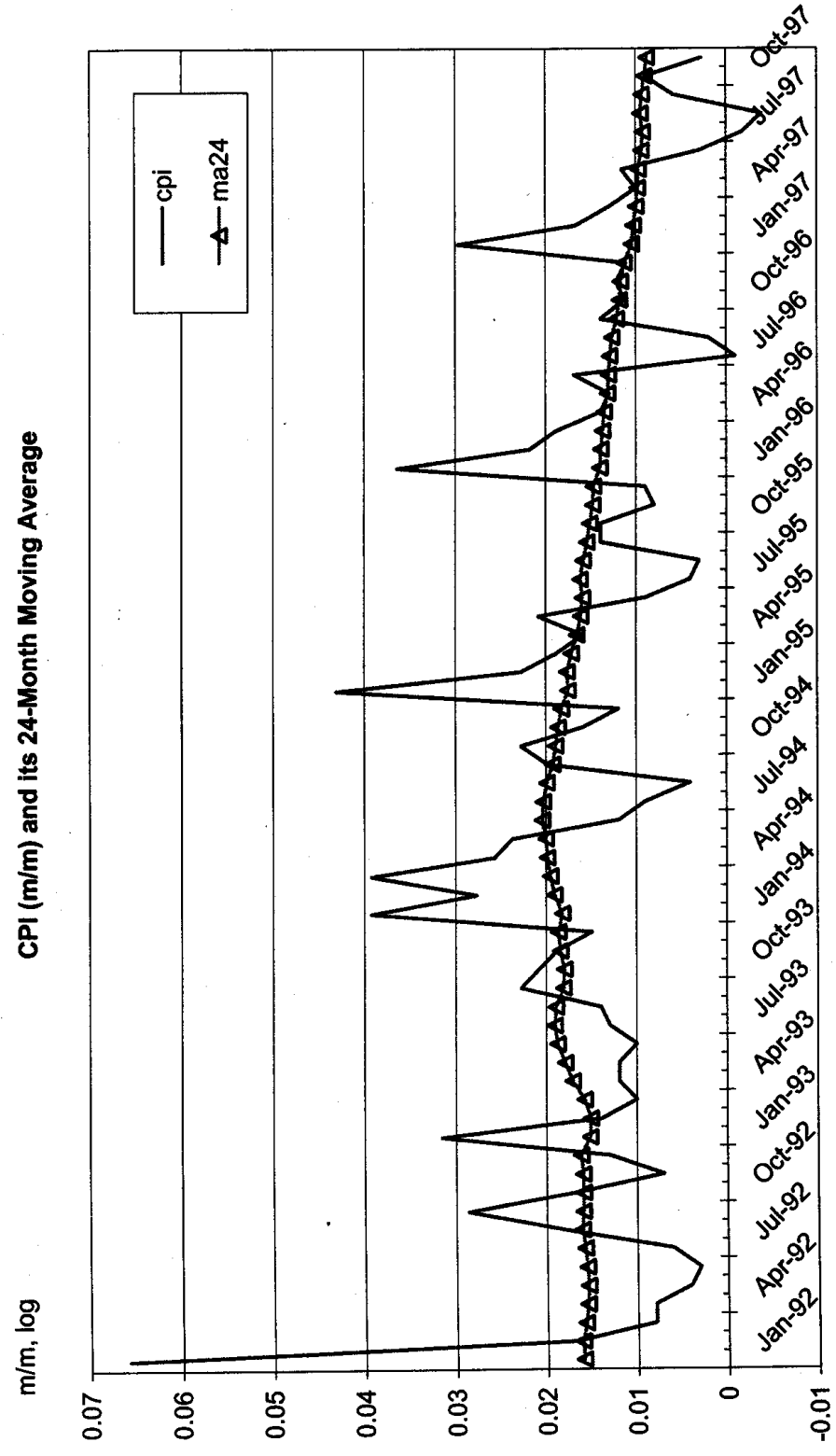
CPI (m/m) and its 24-Month Moving Average
m/m, log
cpi
ma24
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
-0.01
Jan-92
Apr-92
Jul-92
Oct-92
Jan-93
Apr-93
Jul-93
Oct-93
Jan-94
Apr-94
Jul-94
Oct-94
Jan-95
Apr-95
Jul-95
Oct-95
Jan-96
Apr-96
Jul-96
Oct-96
Jan-97
Apr-97
Jul-97
Oct-97

Chart 6

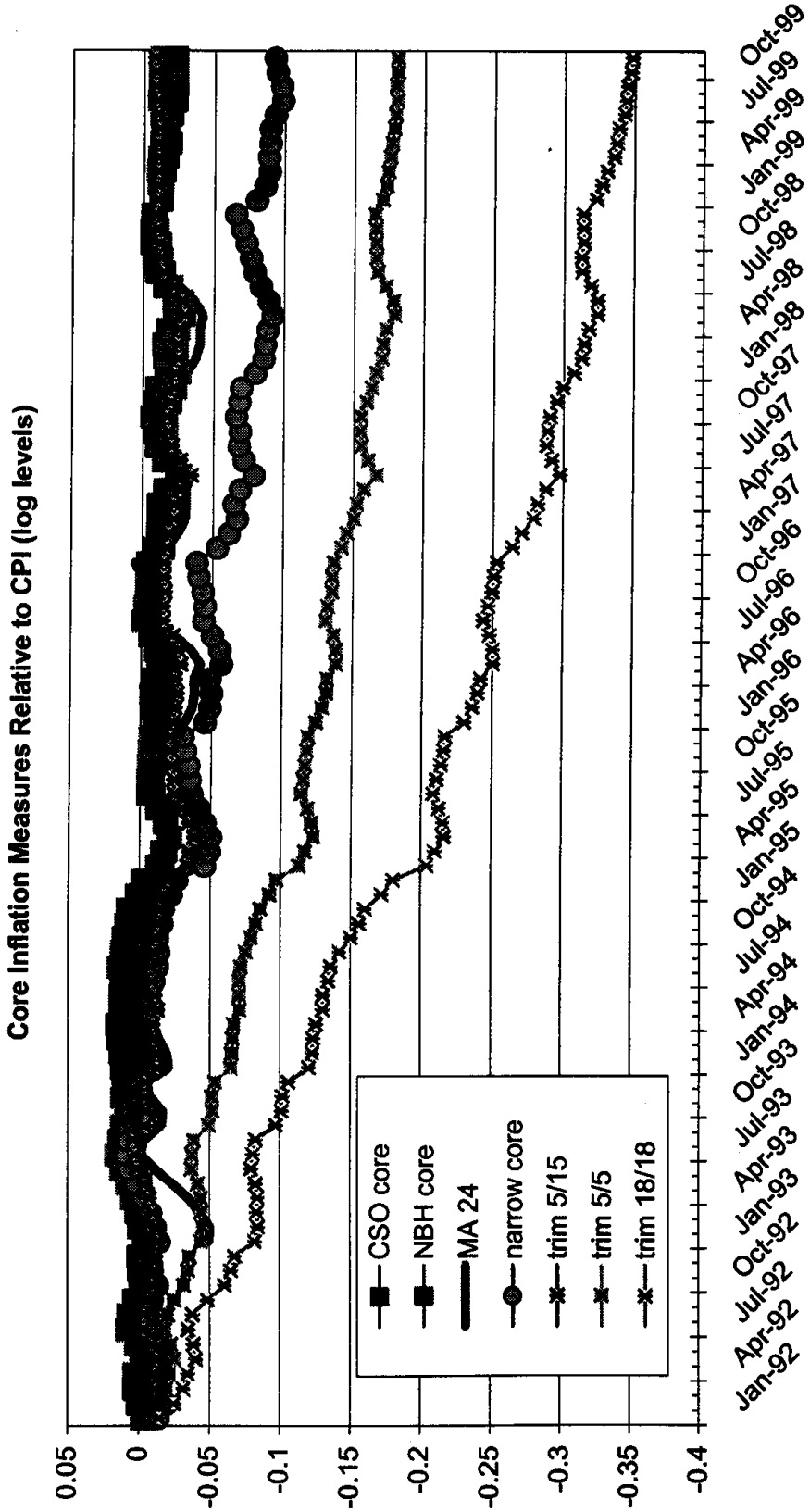
Core Inflation Measures Relative to CPI (log levels)
0.05
0
-0.05
-0.1
-0.15
-0.2
-0.25
-0.3
-0.35
-0.4
CSO core
NBH core
MA 24
narrow core
trim 5/15
trim 5/5
trim 18/18
Jan-92
Apr-92
Jul-92
Oct-92
Jan-93
Apr-93
Jul-93
Oct-93
Jan-94
Apr-94
Jul-94
Oct-94
Jan-95
Apr-95
Jul-95
Oct-95
Jan-96
Apr-96
Jul-96
Oct-96
Jan-97
Apr-97
Jul-97
Oct-97
Jan-98
Apr-98
Jul-98
Oct-98
Jan-99
Apr-99
Jul-99
Oct-99

Chart7