TREND INFLATION INDICATORS

Carlos Coimbra**

Pedro Duarte Neves**

1. INTRODUCTION

The Consumer Price Index (CPI), is the most widely used indicator for analysing the behaviour of prices. However, it happens that occasionally the behaviour of the CPI might not reflect accurately the general trend of prices. In fact, some foodstuffs exhibit a high volatility, with a significant effect on the CPI. Additionally, some goods and services in the CPI record infrequent price adjustments, though significant ones. In these circumstances, the behaviour of the CPI will tend to reflect the irregular behaviour of some goods and services, and thus will not constitute necessarily the best way of identifying the trend of inflation.

This research aims at discussing the properties of a set of trend inflation indicators, developed as to lessen the effects of anomalous price changes like those pointed above. Trend inflation indicators are developed due to two reasons. Firstly, because the analysis of indicators which are less sensitive to erratic perturbations in some prices allow for a better accompanying of trend inflation; hence, sporadic and transitory perturbations shall not be confounded with the general trend of prices. Second, because the set of econometric techniques available for inflation forecasting are unable to predict the sporadic perturbations in the behaviour of the CPI. Therefore, when the anticipation of the forthcoming path of prices is required, a indicator for trend inflation is a more recommended variable to predict.

This paper comprises five additional sections: section 2 analyses the features of the monthly distribution of the year-on-year rates of change of the prices of the various goods and services included in the CPI. Based on the characterisation of this distribution, section 3 proposes a set of trend inflation indicators. A reference measure for inflation is required to analyse the behaviour of these indicators in the period under analysis. Such measure is proposed in section 4. Section 5 evaluates the behaviour of the trend inflation indicators, according to a relatively broad set of criteria. Finally, section 6 draws the major conclusions.

2. SECTIONAL DISTRIBUTION OF THE CPI

The CPI is strongly affected by the erratic behaviour of some prices. In effect, prices of some foodstuffs are highly unstable, and sometimes affect markedly the behaviour of the CPI. In addition, a set of CPI items record infrequent price adjustments but triggering non negligible impacts on the CPI.

These two aspects can be assessed by analysing the sectional distribution of the CPI, by a statistical analysis of the monthly distribution of the year-on-year rate of change of the various goods and services encompassed in the CPI, namely by studying the distribution’s dispersion, skewness and tails. The analysis is developed for the period running from January 1992 up to December 1996, and makes use of all 99 elementary items of the CPI, which is in fact the most disaggregated level released by the INE. A fairly short period was chosen due to the change in the CPI basis in January 1991. The year-on-year rate of change of the CPI is used instead of e.g., the chain rate of change, as it constitutes a relatively simple way of adjusting for seasonal fluctuations.

* The opinions of this paper represent those of the authors and are not necessarily those of the Banco de Portugal.

** Department of Statistics and Economic Research.
a) Dispersion

International empirical evidence suggests that the inflation rate is positively related to the dispersion of relative prices\(^1\). In a disinflation process — as that recorded in Portugal over the course of the last years — it becomes relevant to identify if inflation reductions are accompanied by a lower dispersion of relative prices. The standard deviation\(^2\) can be used in analysing the dispersion of the year-on-year changes in the CPI. Chart 1 shows the path exhibited by this statistic, as against the year-on-year rate of change of the CPI. The dispersion of price changes has exhibited a declining trend since 1993, though noticeable perturbations were recorded in the first quarter of 1995 and in the first half-year of 1996. Chart 1 clearly suggests that these increases in the sectional dispersion of the CPI issue some irregularity to the behaviour of year-on-year rate of change of the CPI.

A more detailed analysis — by breaking down the CPI into tradables and non-tradables\(^3\) makes the interpretation of this phenomenon more clear-cut. In fact, the standard deviation of the non-tradables’ sectional distribution exhibits a clearly decreasing trend from early 1993 onwards. As regards the tradable goods and services, the reduction is striking and the perturbations in the relative dispersion of the year-on-year price changes become more evident. A more disaggregated analysis indicates that such perturbations are linked to changes in prices of some foodstuffs.

b) Skewness

A second feature of a distribution consists of its asymmetry. Chart 2 presents an asymmetry measure\(^4\) of the distribution of the year-on-year rates of change of the CPI items. Notice that the high values scored by the coefficient of asymmetry in the first quarter of 1995 and over the course of the first four months of 1996 are linked to the above mentioned perturbations in the CPI behaviour.

The analysis of the level of asymmetry of the CPI’s sectional distribution delivers important indications. Asymmetry rises with the difference between the central location measures (the mean, the median and the mode)\(^5\). Price distributions are usually biased meaning that significant price increases are more likely to occur than significant price reductions. The sign of the measure of skewness determines the sign of the distribution’s asymmetry. In the period under review, positive skewness dominated the CPI distribution. This feature is particularly noticeable in the sectional distribution of the non-tradables. The level of skewness is clearly higher for the tradables than for the non-tradables. The CPI’s distribution was negatively skewed up to mid 1993 and in early 1996, reflecting the negative skewness of the tradable’s distribution.

The sign of the skewness measure is central in characterising the sectional distribution of the CPI. In fact, if a distribution exhibits a significantly positive (negative) asymmetry the year-on-year change in the CPI is higher (lower) than the trend growth (i.e., the pace of change in prices scoring the highest frequencies) of most prices. Hence, chart 2 indicates that in the first quarter of 1995 the year-on-year rate of change of the CPI stood above the growth trend in most prices, while in early 1996 the situation was exactly the opposite.

c) Characterisation of the tails

The mean is a central location measure sensitive to extreme observations. The concept of weight of the tails is a third feature of a distribution, thus indicating if the occurrence of outliers is more or less probable. A distribution is said to be leptokurtic if the tails of the distribution concentrate a larger proportion of observations than the normal distribution. In this case, the probability of an observation being an outlier is higher than in

---

\(^1\) See for example Grier and Perry (1996).
\(^2\) When calculating the standard deviation, each CPI item is weighted by the respective share in overall CPI.
\(^3\) For a definition of the goods and services comprised in the tradables and non-tradables items see Nascimento (1990).
\(^4\) The measure of skewness considered is the ratio \(m_3/m_2^{3/2}\), where \(m_3\) is the third moment in relation to the mean, and \(m_2\) is the second moment in relation to the mean.
\(^5\) In a positively skewed distribution, the relation mean>median>mode always holds; a negatively skewed distribution is obtained otherwise.
the normal distribution (6). A leptokurtic distribution raises difficulties for estimation and inference, since extreme observations are bound to be fairly

(6) An example of a fat-tailed distribution is a T-student with 5 degrees of freedom; the uniform distribution is an example of a light-tailed distribution.
frequent, therefore jeopardising the usage of the mean as central location measure.

Chart 3 shows a measure of the kurtosis of the CPI distribution (7). A positive value recorded by this measure indicates a leptokurtic (i.e., fat-tailed) distribution. The CPI sectional distribution is in fact leptokurtic confirming findings for other countries (Bryan and Cecchetti, 1994). For the sample period, the tradables’ distribution is more leptokurtic than that of the non-tradables.

The main features of the CPI’s sectional distribution can be illustrated by using a sequence of box-and-whiskers plots, excluding extreme observations (8) (see chart 4). Outliers are excluded in the chart because the magnitude of some discrepant price changes is sometimes considerable, blurring the interpretation of the box-and-whiskers plot.

Chart 4 must be read as follows: the central point stands for the median; the lower (upper) point of the segment above (below) the median is the third (first) quartile, while the upper (lower) point represents the upper (lower) contiguous value; the former values are defined as the maximum (minimum) values of the distribution that yet do not correspond to outliers. The narrowing of the inter-quartile interval, defined as the dis-

(7) The measure of Kurtosis is given by \( \frac{m_4}{m_2^2} - 3 \), where \( m_4 \) is the fourth moment in relation to the mean.

(8) A year-on-year change in prices is said to be discrepant, extreme or an outlier if it is not placed in interval \([F_L - 1.5 d_F; F_U + 1.5 d_F]\), where \( F_L \) and \( F_U \) stand for the lower and upper quartiles, respectively, and \( d_F \) is the inter-quartile interval. This criterion corresponds to the definition for a moderate outlier. See Murteira (1993).
tance between the first and the third quartile, indicates a reduction in dispersion; the existence of asymmetry explains the fact that the median does not stand halfway between the first and the third quartiles; finally, the existence of kurtosis is suggested by the lengthy distance between the third (first) quartile and the contiguous upper (lower) value.

3. INDICATORS FOR TREND INFLATION

The characterisation of sectional distribution of the year-on-year rates of change of prices shows that the CPI can be affected by irregular price changes in some goods and services, and thus may not reflect correctly the general trend of prices. This section presents some indicators developed as to identify general trends in the behaviour of prices.

a) CPI excluding outliers

Discrepant year-on-year price changes are identified for each month. A year-on-year change in prices is considered extreme (or discrepant) if it is not placed in interval \([F_L-1.5d_F, F_U+1.5d_F]\), where \(F_L\) and \(F_U\) stand for the lower and upper quartiles respectively, and \(d_F\) is the inter-quartile interval\(^{(9)}\). Those goods and/or services recording a discrepant year-on-year price change are excluded from the CPI of the respective month. Consequently, the year-on-year rate of change is calculated for the remaining goods and services.

b) Trimmed mean

Trimmed means\(^{(10)}\) are calculated by eliminating a given percentage of the highest and lowest price changes. Therefore, a 10 per cent trimmed mean is a mean calculated on the 80 per cent central observations of the CPI, thus eliminating the 10 per cent lowest and the 10 per cent highest price changes. The usage of trimmed means for analysing the behaviour of inflation is proposed by Bryan and Cecchetti (1994) and Cecchetti (1996)\(^{(11)}\). When a distribution is leptokurtic, the trimmed mean is a more efficient estimator of the mean of the universe than the usual sample mean.

c) Weighted median

The weighted mean consists of a particular case of the family of trimmed means, corresponding to a 50 per cent trimmed mean. At first, the CPI goods and services are monthly ranked according to the respective year-on-year rates of change. Afterwards, the monthly median is calculated. This measure is referred to as a weighted median, since each good or service is weighted by its share in the overall CPI. The application of this indicator is suggested by Bryan and Cecchetti (1994) and Cecchetti (1996)\(^{(12)}\).

d) Underlying inflation

Nascimento (1990) presents an application of the concept of underlying inflation to the Portuguese case. In line with the procedure commonly adopted by most OECD countries, the calculation of the indicator for underlying inflation is based on the CPI excluding items “non-manufactured foodstuffs” and “energy products”. These items are excluded due to the high volatility of the respective prices, linked to exogenous shocks. Most European Central Banks calculate underlying inflation indicators, adopting a definition which is quite similar to that mentioned above.

e) CPI excluding tradable foodstuffs

This measure is calculated from the CPI excluding tradable foodstuffs. As mentioned before, the greatest part of CPI’s irregularity is due to the behaviour of the prices of some foodstuffs, thus justifying this calculation.

f) First main component

The principal components method is a statistical analysis technique that utilises the year-on-year rates of change of the CPI elementary items to form a set of linear combinations of these

\(^{(9)}\) This criterion corresponds to the definition for a moderate outlier. See Murteira (1993).

\(^{(10)}\) See for example Murteira (1993).

\(^{(11)}\) This indicator is regularly published by some Central Banks, as is the case of the Bank of England.

\(^{(12)}\) See footnote 11.
rates, which are the principal components\(^{(13)}\). This technique can be interpreted as one that identifies the general trend in prices, through the estimation of the first principal component. The underlying assumption here is that the price change of each CPI item reflects not only specific factors but also the general behaviour of prices. As regards the CPI, the first principal component accounts for

\(^{(13)}\)For a description of this method see for example Chatfield and Collins (1986).
about 57 per cent of the overall change in the CPI items’ year-on-year rates of change. By analysing the estimated weights of each CPI item, we see that in general the first principal component ascribes larger weights to goods and services exhibiting lower variability in the sample period, that is to say, to non-foodstuff components and to items exempted of administered controls (14).

Chart 5 plots indicators a) to f), comparing these to the behaviour of the CPI year-on-year rate of change (15). Most trend inflation indicators are less irregular than the CPI. This aspect is particularly noticeable as regards the trimmed mean and the first principal component. Notice that the raise in the year-on-year rate of change of the CPI in early 1995 reflects the erratic behaviour of some items, which is not noted in the behaviour of those two trend inflation indicators. Likewise, the sharp fall in the year-on-year rate of change of the CPI in the first quarter of 1996 reflected the anomalous behaviour of some goods and services, which however did not account for an equally sharp downwards trend of the growth in prices.

4. A REFERENCE MEASURE FOR INFLATION

The former section described some trend inflation indicators. The properties of these indicators can be analysed in two ways. The first consists of comparing the behaviour of the CPI with the behaviour of the trend inflation indicators in periods when the CPI is particularly irregular. This procedure was illustrated at the end of the former section. An alternative procedure consists of comparing the behaviour of the trend inflation indicators with another reference measure of inflation trend.

In the period under analysis, the CPI behaved somewhat irregularly, due to various different reasons. Hence, in 1992 the structure of the Portuguese indirect taxation was significantly altered. In what concerns the Value Added Tax (VAT), the zero rate was eliminated; consequently, the goods and services formerly taxed at the zero rate moved to the reduced rate (5 per cent). The former 8 per cent rate also was abolished, the corresponding goods and services thereafter being taxed at 5 per cent or at the normal rate (which decreased from 17 to 16 per cent). Still in 1992, the tobacco tax raised strikingly. These changes in the structure of indirect taxation triggered noticeable effects on the year-on-year change of the CPI. In January 1995, the VAT normal rate rose from 16 to 17 per cent. As mentioned above the prices of some foodstuffs posted a strikingly irregular behaviour in early 1995 and in the first quarter of 1996. These events altogether resulted in the above stated irregularity in the CPI’s behaviour in the period under analysis.

In the period considered, two kinds of perturbations affected the CPI. On the one hand, the CPI level shifted in a more or less permanently manner as a reflex of the 1992 changes in indirect taxation. On the other hand, those irregularities in the CPI’s behaviour due to specific perturbations in some prices were in most cases corrected afterwards.

The CPI can be smoothed by utilising moving averages, which eliminate the second type of effects, but would (inconveniently) smooth the temporary change of scale due to the fiscal alterations recorded in 1992. An alternative process consists of utilising central location measures which are less vulnerable to outliers. We chose to use the median of the CPI’s year-on-year change rates, for a 19-month time span (16). For example, the 19-term median referring to January 1996 (see chart 6) consists of a sample median of the year-on-year rate of changes of the CPI in period April 1995 — October 1996.

5. TREND INFLATION INDICATORS: BEHAVIOUR IN PERIOD 1992-1996

This section analyses the behaviour of the trend inflation measures described in section 3 between January 1992 and December 1996. Our utilisation of a relatively short time span is chiefly due to the

(14) The utilisation of the first principal component (FPC) raises the empirical issue of the change in scale that needs to be applied to the FPC, as to express it in the same unit of the CPI. This issue is approached in section 5.
(15) Chart 5 presents the trimmed mean at 10 per cent. The authors of this paper analysed a wide range of trimmed means (at 5, 10, 20, 25 and 30 per cent); however, the main findings drawn in section 6 were not altered.
(16) The main findings of this paper are not altered with the utilisation of different reference measures for inflation.
important changes in the structure of the CPI, namely the changes of its basis in 1976, 1983 and 1991. Therefore, our preference goes to the possibility of operating with a consistent clarification of the CPI items, instead of opting for a wider time span, with which the empirical properties of our trend inflation indicators could possibly be better identified.

The behaviour of the trend inflation measures is analysed in comparison to the reference measure of inflation presented in the preceding section. The criteria are: the existence and magnitude of the bias, the trend indications for prices, and the lag of indications for this trend.

a) Bias

Most trend indicators are biased in comparison to the reference measure for inflation (see Table 1). Over the sample period, the underlying inflation and the CPI excluding tradable foodstuffs exhibit price increases about 1.3 and 0.8 percentage points respectively above those recorded by the reference measure of inflation. This result indicates that both foodstuffs and energy products recorded price increases below those of most remaining goods and services. On the other hand, the median, the trimmed mean and the CPI excluding outliers recorded lower price increases than the reference measure for inflation, thus reflecting that the formerly stated predominance of positive skewness in the distribution of the CPI.

b) Trend Indications

Different measures can be utilised as to evaluate the closeness of our trend indicators to the reference measure of inflation (17). This paper presents the results for the Mean Square Residual, defined as $EQM = \Sigma (Y_t - Tend_t)^2/n$, where $Y_t$ stands for the value of a given trend inflation measure in moment $t$, and $Tend_t$ is the value of the reference measure in moment $t$.

Bias must not constitute a sufficient justification to reject an indicator. For example, an indicator that regularly overestimates inflation by 1 percentage point would deliver precise indications on the turning points of inflation’s trajectory. As is commonly known, MSQR can be written as the sum of the variance of the mean error and the square mean deviation between the trend inflation indicator and the reference measure for inflation trend (18).

One way of avoiding that MSQR, as a criterion of choice between reference measures for inflation, jeopardises an indicator with the above mentioned properties consists of transforming our variables as to attribute them the same mean of the reference measure for inflation. Such change in scale would always become necessary as the mean of the first principal component is nil by definition.

The chosen procedure consists of building regressions using the ordinary least squares method, where a reference measure of trend inflation is the dependent variable, and each of our trend inflation indicators are the independent variables. The values estimated through this equation are changes in scale of the original trend inflation in-

(17) Other reference measures beyond MSQR were considered: the standard deviation of the distribution of the trend deviations, the absolute deviation of the trend inflation indicator around the reference measure of inflation, and the mean absolute deviation between deviations around the trend. Our findings are not altered by using these different criteria.

(18) Formally, $EQM = DP^2 + ENV^2$, where $DP$ is the standard deviation of the distribution of the deviations around the trend, and $ENV$ is the average bias in the sample period.
dictators. This ad-hoc procedure ensures that the means of the trend inflation indicators equal that of the reference measure for inflation in the estimation period. Under these circumstances, the trimmed mean and the first principal component record the least MSQR, as shown in Table 1. The weighted median follows. The underlying inflation, the CPI excluding foodstuffs and the CPI excluding outliers do not seem to provide significant advantages over the CPI.

A second procedure for analysing the proximity the proposed indicators to the reference measure of inflation trend consists of calculating simple linear correlation coefficients between the changes in the year-on-year rate of change of two consecutive months recorded by the trend inflation measures and the reference measure. This procedure evaluates the correlation between indications of slowdown or acceleration in prices as assessed by our trend inflation indicators and by the reference measure of inflation trend. The trimmed mean and the first principal component score correlations above those of the CPI itself (see Table 1). The median and the CPI excluding outliers record lower correlations than the CPI, but higher than those of the underlying inflation and of the CPI excluding tradable foodstuffs\(^{19}\).

### c) Leads and lags of indicators

A desirable feature of a trend inflation indicator consists of the ability of delivering in advance indications on the forthcoming behaviour of inflation. The criteria mentioned in the former paragraph are an efficient method of assessing the lead or lag of our trend inflation trend indicators. Chart 7 exhibits the behaviour of the MSQR criterion for different lead and lag periods. According to this criterion, the indicators considered provide contemporaneous indications on the behaviour of inflation. The CPI excluding outliers presents a slight indication of a 1-period lead.

This kind of analysis can also be developed by using the simple linear correlation coefficient between the changes in the year-on-year rate of change of two consecutive months recorded by the trend inflation measures and the reference measure of inflation trend. Most indicators presented are more strongly related to contemporaneous indications (see chart 8). Underlying inflation, and to a lesser extent the CPI excluding tradable foodstuffs, behave as lagged indicators for inflation trend.

### 6. CONCLUSIONS

The main conclusions to be drawn from this research are the following:

i) the sectional distribution of the year-on-year rates of change of the CPI is generally ske-
Chart 7
MEAN SQUARE RESIDUAL
Consumer price index

Excluding outliers

Trimmed mean (10 per cent)

Median

Underlying

Excluding tradable foodstuffs

First principal component

Note: (-) indicates the trend indicator is advanced in relation to inflation.
Chart 8
CORRELATION BETWEEN INDICATORS OF LEADS/LAGS IN PRICES

Consumer price index

Excluding outliers

Trimmed mean (10 per cent)

Median

Underlying

Excluding tradable foodstuffs

First principal component

Note: (-) Indicates the trend indicator is advanced in relation to inflation.
wed, positively sometimes and negatively others; it is leptokurtic and exhibits a significant number of extreme price changes. Under these conditions, the year-on-year rate of change of the CPI does not always deliver an adequate measure for the general trend in prices;

ii) the CPI excluding tradable foodstuffs and underlying inflation do not follow the reference trajectory of inflation as accurately as other indicators; furthermore, they describe the behaviour of inflation with some delay;

iii) the CPI excluding outliers and the weighted median exhibit some desirable features. However, tests made indicate that these constitute worse trend indicators than the trimmed mean and the first principal component. Note, however, that the CPI excluding outliers presents some evidence (though not a clear-cut one) of constituting a 1-month leading indicator for inflation;

iv) among all indicators considered, the trimmed mean and the first main item are the most adequate indicators for the general trend in prices, according to the criteria utilised in section 5.

REFERENCES


