A First Assessment of Some Measures of Core Inflation for the Euro Era

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A First Assessment of Some Measures of Core Inflation for the Euro Area

Juan-Luis Vega and Mark A. Wynne

Abstract: Core inflation plays an important role in the deliberations of monetary policymakers. In this paper we evaluate a number of measures of core inflation constructed using euro area data. In addition to the traditional exclusion-type core measures, we examine two newer ones, documenting their properties and evaluating their performance in terms of their ability to track underlying or trend inflation in real time. We focus on core measures derived from the Harmonized Index of Consumer Prices (HICP) as the European Central Bank has chosen to define its mandate for price stability in terms of this index, and because this is the only index of consumer prices that is compiled in an comparable manner across all members of the European Union. We document significant excess kurtosis in the cross-section distribution of price changes in the euro area, and show that several categories of prices are more volatile than those typically excluded from traditional measures of core inflation. Contrary to what one might expect, traditional measures of core inflation are not significantly less volatile than headline measures. We document the superior performance of alternative measures of core inflation in tracking trend inflation on average, but show that none of the various measures of core gave significant advance warning of the pickup in trend inflation at the beginning of 1999.

JEL Codes: E31, C43

Keywords: Core inflation, HICP, trimmed mean, weighted median, Edgeworth index

1. INTRODUCTION

Central bankers have long accepted that, in view of the long and variable lags in the transmission mechanism of monetary policy and the need for monetary policy to maintain a medium-term orientation, short-term transient inflation developments should not, in principle, unduly affect monetary policy decisions. One practical implication of this is that monetary-policy makers need to be able to decompose headline inflation figures into a trend component reflecting persistent sources of inflationary pressures, on the one hand, and a transient, reversible, component, on the other. It is the first of these components – customarily referred to as underlying or core inflation – which incorporates the most relevant information from the perspective of a monetary-policy maker and for which a monetary policy maker is ultimately responsible.

In the light of these policy needs, it is now routine for national statistical agencies and central banks to report and analyse an array of so-called core inflation measures that are supposed to give a better indication of the underlying inflation trend. At the most basic level, this typically involves eliminating regular seasonal fluctuations in certain classes of prices by statistical means. However further adjustments are typically also made, such as the exclusion of certain categories of prices on the grounds that they are too volatile to convey any useful information about underlying trends, and case-by-case adjustments for first-round effects of one-off special shocks, such as major changes in VAT. By far the most common and closely watched measures of core inflation are the so-called exclusion-based measures, specifically the "Ex. Food & Energy"-type measures constructed and reported by most statistical agencies. But in recent years there has been growing interest in alternative measures of core inflation.

The newer literature on core inflation has developed along two lines, reflecting different philosophies of what it is core-inflation measures should be capturing. One strand of the new literature seeks to bring some discipline to the practice of downweighting certain price observations by excluding them from the measure of core. This strand can be traced to the pioneering contributions of Bryan and Pike (1991) and Bryan and Cecchetti (1994), and argues that accurate measures of core inflation can be constructed on the basis of the properties of the cross-section distribution of price changes at a given point in time. A second strand defines core inflation as the persistent component of inflation, and explores ways in which this component can be isolated. The seminal paper in this vein of literature is Quah and Vahey (1995), and the thrust of this vein of the literature is that core inflation measures need to be based on the time-series properties of inflation and its determinants. Both of these approaches are surveyed and critiqued in Wynne (1999).

The various approaches suggested in the literature differ from each other in the information set which is considered to be relevant for estimating the underlying rate of inflation: whether or not the cross-section distribution of reported individual price changes may be informative; whether or not the time-series properties of observed individual price changes or the aggregate price level are to be taken into account; and, whether or not the information set should be widened to consider the interplay of economic variables other than prices themselves. As a consequence, the estimation techniques (and the identifying assumptions) used by each approach differ according to the various answers to such questions. No consensus has emerged yet on how best to proceed on the empirical side.

This paper focuses on the approach to core inflation measurement developed in the first strand of the newer literature, namely that of isolating the common (inflation) component in monthly price statistics. We will examine using euro-area data a particular subset of the various empirical measures which have been proposed: the limited-influence estimators of core inflation proposed by Bryan and Pike (1991) and Bryan and Cecchetti (1994); and Edgeworth or variance-weighted price index proposed by Diewert (1995) and Dow (1994) and implemented by Dow (1994) and Wynne (1997, 2001). We will compare the properties and performance of these measures of core inflation with a number of traditional "Ex. Food & Energy"-type measures.

The short history behind the HICP makes measures based on the information contained in the cross-section distribution of price changes of utmost interest to the European Central Bank (ECB). Besides those particular circumstances, the traditional motivation for looking at limited-influence estimators such as trimmed means is the observed tendency for the distribution of individual price changes to exhibit significant skewness and kurtosis at any particular point in time. This fact has been documented for many countries, by, among others Balke and Wynne (2000), Bryan, Cecchetti and Wiggins (1997), Ball and Mankiw (1995), and Vining and Elwertowski (1976). The observed skewness in the cross-section distribution of price changes can be used to motivate a statistical and an economic argument for limited-influence estimators of core inflation. The statistical argument is that the observed skewness reflects kurtosis in the underlying distribution of price changes, and in the presence of such kurtosis, a limited-influence estimator of the mean (such as the median or a trimmed sample mean) is a more efficient estimator of the population mean. The economic argument is based on the idea that there may be menu costs associated with changing prices. In the presence of such menu costs, firms will only choose to reset prices after they experience a cost shock if the shock is sufficiently large. A large transitory cost shock that causes a large number of firms to adjust their prices in the same direction at the same time may lead to a measured rate of inflation that is significantly greater or less than the underlying or trend rate. By trimming those price changes in the tails of the distribution, one presumably arrives at a more accurate measure of the underlying rate of inflation[1]. Whether one motivates the use of a limited-influence estimator of core inflation on statistical or economic grounds, in either case the idea is that extreme price movements convey relatively little information about the underlying inflation process. This is also the idea behind the Edgeworth measure, except that in the case of the Edgeworth measure, instead of discarding the biggest and smallest price changes each period, we simply assign a lower weight to the prices that tend to fluctuate the most. The differences between the various measures will be made more precise in the discussion below.

We will evaluate core measures in terms of their ability to track movements in trend inflation. This is the criterion used by Cecchetti (1997) and Bryan, Cecchetti and Wiggins (1997).[2] The ultimate objective is to see whether the limited-influence or Edgeworth measures of core inflation can deliver better performance than traditional measures of the "Ex. Food & Energy" type in terms of either of these criteria. It should be borne in mind that the results in this paper are subject to the very important caveat that they are based on a sample of data on inflation and relative price changes drawn from a period in which trend inflation has been very stable and there have been no (major) relative-price shocks.

The rest of the paper is structured as follows. Section 2 describes the data used for the study and introduces some notation. Some characteristics of the cross-section distribution of individual price changes in the euro area are also documented. In Section 3, the core measures under consideration are defined. In Section 4, the measures of core inflation are evaluated in terms of their ability to track trend inflation in real time. Section 5 concludes and suggests areas for future research.

2. DATA AND OTHER PRELIMINARIES

The primary source of raw data for this study is the Harmonized Index of Consumer Prices (HICP) compiled by Eurostat. Our focus on the HICP is dictated by the ECB's definition

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[1] Bakhshi and Yates (1999), however, argue – quite convincingly – that the economic argument for trimming observations in the tails is model dependent.

of price stability in terms of this price index.[3] As noted in the introduction, a major shortcoming of the HICP is its short history. Estimates of the aggregate HICP index are available from January 1990. Detailed sub-indexes are in turn available from January 1995 for most countries and from January 1996 for France. Furthermore, the HICP is an evolving measure of inflation in the euro area. There have been significant changes in the coverage and classification system of the HICP in recent years to make it a better measure of inflation.[4] These changes make it difficult to construct long time series of alternative measures of core inflation for the euro area. Finally, insofar as we want our measures of core inflation to detect or give advance warning of changes in trend inflation, the information in this sample is very limited, as there were few significant changes in trend inflation over this period.

Let us start by introducing some simple notation and definitions. Define the (annualized) percentage change at date t in the price of an individual good or service i over horizon h as

$$\pi_{i,t}^{h} = \frac{1200}{h} \times \ln\left(\frac{p_{i,t}}{p_{i,t-h}}\right) \tag{1}$$

Setting $h = 1$ we obtain the (annualized) monthly change in the price of item i; setting $h = 12$ we obtain the annual change in the price of item i. Statistical agencies routinely report inflation at several different horizons each month. Eurostat's monthly HICP release reports an annual inflation figure, a monthly inflation figure, and a 12-month average rate.[5] The annual inflation figure is defined as the percentage change in the HICP between a given month and the same month a year earlier. The monthly inflation figure is simply the percentage change between the given month and the previous month. The two measures have competing merits. The monthly inflation number has the virtue of being the most up to date information on inflation trends, but suffers from the drawback that it tends to be very volatile. The annual inflation number is less volatile, but achieves this reduction in volatility at a cost of being less timely. In crude terms, eleven twelfths (or more than 90 percent) of the inflation in the annual number occurred prior to

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[2] In an earlier version of this paper, Vega and Wynne (2001), we also looked at the ability of various core measures to predict future headline inflation. This criterion is emphasised by, among others, Blinder (1997), Freeman (1998) and Cogley (2000).

[3] The ECB's definition of price stability is explained in Issing, Gaspar, Angeloni and Tristani (2001).

[4] Eurostat recently published a compendium of reference documents on the HICP, explaining its development and construction. See Eurostat (2001).

[5] The 12-month average inflation rate compares the average price level over the most recent twelve months to the level over the preceding twelve months. This measure is of limited usefulness in assessing current

the month in question, and is in a very real sense a "bygone" for monetary policy purposes. In what follows we will investigate the properties of core measures constructed at both horizons.[6] We will be evaluating measures of core inflation in terms of their ability to track trend inflation in real time, so we need to define what we mean by trend inflation. We will employ a standard Hodrick-Prescott (HP) measure of trend, with the trend estimated as the HP-smoothed value (with smoothing parameter equal to 14,400) of annual Monetary Union Index of Consumer Prices (MUICP) inflation.

One of the arguments advanced for the use of limited-influence estimators of trend inflation has to do with the properties of the cross-section distribution of price changes at a given point in time. Specifically, in the presence of excess kurtosis (fat tails), the mean of the cross-section sample distribution may not necessarily be the most efficient estimate of the population mean[7]. Thus one of our first tasks is to characterise the cross-section distribution of individual price changes by examining a number of its moments. The q'th higher order central moment of the cross-section distribution of price changes at horizon h at date t is

$$m_{q,t}^{h} = \sum_{i} w_{i,t} (\pi_{i,t}^{h} - \overline{\pi}_{i,t}^{h})^{q} \qquad (2)$$

where $\overline{\pi}_{i,t}^{h}$ is the mean of $\pi_{i,t}^{h}$. The two moments that will be of most interest to us are the scaled third and fourth moments, that is the skewness and kurtosis of the distribution, defined respectively as:

$$S_{t}^{h} = \frac{m_{3,t}^{h}}{[m_{2,t}^{h}]^{(3/2)}} \qquad (3)$$

$$K_{t}^{h} = \frac{m_{4,t}^{h}}{[m_{2,t}^{h}]^{2}} \qquad (4)$$

Note that if the cross-section distribution of price changes at a given point in time is generated by a normal distribution, S_{t}^{h} would be equal to 0 and $K_{t}^{h} = 3$.

inflation, but does give some perspective on recent trends: it was used to assess the convergence criterion for price stability in the 1998 and 2000 Convergence Reports prepared by the European Commission.

[6] Somewhat surprisingly, the issue of the optimal horizon over which to measure inflation for monetary policy purposes is not one that has attracted a lot of attention in the literature on inflation measurement. The sole exception appears to be Cecchetti (1997).

[7] See Bryan and Cecchetti (1999a). The argument is that the probability of getting skewed samples increases with the kurtosis of the data generating process. That is, with a fat-tailed distribution, it is more likely to obtain a draw from one of the tails that is not compensated by an observation in the other tail.

Figure 1 shows the annual and monthly (non-annualised) inflation rates for the euro area from 1990 though July 2001, along with trend inflation as measured by the HP filter.[8] Inflation declined from a peak of just under 5 percent in July 1991 to less than 1 percent around the time of the launch of EMU (the trough was February 1999), before accelerating to rates close to 2 percent in late 1999 and early 2000, and peaking at 3.4 percent in May 2001. The short sample period, and the behaviour of inflation over the sample period, show clearly that any measure of core inflation for the euro area that is motivated by the desire to detect changes in trend inflation will perforce be subject to major caveats.[9]

Table 1 presents the classification structure of the HICP as of January 2000. The HICP has 12 two-digit Divisions (e.g. Food and Alcoholic Beverages), 39 three-digit Groups (e.g. Food) and 93 four-digit Classes (e.g. Bread and cereals). Table 1 also reports the weights of the various Classes, Groups and Divisions as of January 2000. Some of the component series (those in the shaded areas of the Table) at the three- and four-digit levels of disaggregation are only available for very short periods of time, or exhibit anomalous behaviour that is not easily explained. Some of the series are not reported at the Monetary Union (MU) level. For example the series 12.4 (Social protection) is not reported at the MU level but is available for some countries. Likewise the series 12.5.3 (Insurance connected with health) and 12.5.5 (Other insurance) are missing for most or all of the sample period at the MU level, so we work with the 12.5 sub aggregate (Insurance). Dropping the series 12.4 and consolidating the components of 12.5 leaves us with a maximum of 89 series at the four-digit level. Note also that the weights for some of the series are zero for several of the years in the sample. For example, the weights for series 06.2.1/3 (Medical services; paramedical products) and 06.2.2 (Dental services) (as well as the aggregate 06.2, Out-patient services) and 12.4 (Social protection) are zero for 1996-1999. Furthermore, a number of series exhibit other sorts of anomalous behaviour that raises questions about their accuracy. For example the series 4.3.2 (Services for the regular maintenance and repair of the dwelling) increases more or less monotonically from 1995:1 through 1999:8, at which point it declines for several months before resuming its monotonic increase in 1999:12. The series 6.6 (Out-patient services) exhibits a discontinuity (a decline) in 2000:1, primarily as a

[8] Note that the data in this Figure refer to the original eleven members of the euro area through December 2000, and include Greece from January 2001 following the conventions set by Eurostat for reporting the Monetary Union Index of Consumer Prices (MUICP).

[9] The fact that the aggregate HICP statistics are available for a longer period than the disaggregated statistics might seem to suggest that measures of core based on detecting the persistent component of inflation (for example, along the lines suggested by Quah and Vahey (1995)) might have a more solid basis. However a sample period of ten years is not really long enough to allow us to make strong statements about

result of a discontinuity in the series 6.2.1/3 (Medical and paramedical services). The series 9.2 (Other major durables for recreation and culture) exhibits a sharp increase between 1999:2 and 1999:3, which can be attributed to a sharp increase in the series 9.2.1/2 (Major durables for indoor and outdoor recreation, including musical instruments). The series 9.4 (Recreational and cultural services) exhibits sharp discontinuities between 1996:12 and 1997:1, between 1999:12 and 2000:1 and again between 2000:12 and 2001:1, all of which can be attributed to similar discontinuities in the series 9.4.2 (Cultural services). Finally the series 12.6 (Financial services n.e.c.) exhibits discontinuities between 1997:4 and 1997:5, and between 2000:12 and 2001:1. Consolidation of series to eliminate these anomalies leaves us with a maximum of 64 series at the four-digit level, and 28 series at the three-digit level.[10]

Table 2 presents some summary statistics for the cross-section distributions of price changes at 1, 3 and 12-month horizons. It shows average values over the period 1996:1-2000:12 for the mean, the median, the standard deviation, skewness and kurtosis of price changes in the euro area as a whole at different levels of aggregation. We characterise the properties of the cross-section distribution of price changes at the maximum level of disaggregation (the four-digit level which consists of 64 sub-aggregate series after consolidation) available for the HICP through the end of 2000.[11] The main point to note from the table is the significant excess kurtosis that is present in the cross-section distribution of price changes. We find excess kurtosis at the two-, three- and four-digit levels of aggregation, as well as when price changes are measured at the one-, three- and twelve-month horizons. Kurtosis ranges from 18.8 at the one-month horizon at the four-digit level to 3.8 at the two-digit level. At the twelve-month horizon, kurtosis ranges from 17.9 to 5.3. As argued in Bryan, Cecchetti and Wiggins (1997), in the presence of excess kurtosis trimmed mean estimators are superior estimators of the central tendency of the cross-section distribution of price changes, and thus of core inflation. The second important point to note from Table 2 is that there is very little skewness on average, although contrary to what we see with kurtosis, there is some tendency for skewness to increase with the horizon over which inflation is measured.

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the behaviour of inflation at very long (infinite) horizons. Furthermore, the HICP data for the years prior to 1995 are not strictly comparable to the later data, as they are estimates based on national CPIs.

[10] It seems contrary to the spirit of the trimming approach to measuring core inflation to eliminate series on the basis of these outliers. Indeed, in general one of the great advantages of the trimming procedure is that it eliminates the need for such seemingly ad hoc adjustments. However we suspect that these outliers are in most if not all cases driven not by relative price developments in particular sectors but rather by changes in the methods whereby raw price data are collected.

[11] Vega and Wynne (2001) provide alternative characterisations of the cross-section distribution of price changes using detailed data for individual countries in the euro area.

The results in Table 2 are comparable in many respects to those presented in Table 1 of Bryan, Cecchetti and Wiggins (1997). They report summary statistics for the cross-section distribution of US Consumer Price Index (CPI) and Producer Price Index (PPI) price changes at the 36-item and 32-item levels of aggregation respectively, albeit for a much longer sample period than we have here (1967 to 1997).[12] The characteristics of the cross-section distribution of prices at the euro area level are also observed at the level of individual countries in the euro area.[13] Indeed, several authors have previously documented the characteristics of the cross-section distribution of consumer prices in various euro area countries using national data. For example, Aucremanne (2000) shows that kurtosis in the cross-section distribution of the component series of the Belgian Consumer Price Index ranges from a high of 37.8 at the one-month horizon to 29.2 at the twelve month horizon over the period 1976:6-1999:10. Meyler (1999) reports that the average kurtosis in the Irish CPI over the period 1976-1999 is 41.5, with somewhat greater kurtosis in the latter half of the sample. Outside the euro area, Bakhshi and Yates (1999) show that average excess kurtosis in the cross-section distribution of the UK Retail Price Index (RPI) over the period 1974:02-1997:07 is 28.4.

Figure 2 plots the standard deviation, skewness and kurtosis of the cross-section distribution of annual and monthly price changes in the euro area over time. Besides the excess kurtosis feature referred to above, the Figure shows how the cross-section distribution of price changes can be very skewed at specific points in time, particularly when monthly changes are considered. Note that the well-known positive relationship between skewness and average inflation is also apparent in this Figure, especially when we look at the skewness in price changes at the twelve-month ($h = 12$) horizon. We see that the cross-section distribution of price changes exhibited considerable left skewness in the years 1997-1999 as inflation was falling, and then became more right skewed in 2000 and 2001 as inflation increased.

Table 3 reports the mean and standard deviations of the individual components of the HICP over our limited sample period at the lowest level (i.e. four-digit) level of aggregation. As we would expect, the volatility of individual price changes as measured by the standard deviation declines as the horizon over which inflation is measured is increased. The items that are excluded from a representative exclusion-type measure of core inflation (the "Ex. Energy and Seasonal Food" measure to be discussed in more detail later) are highlighted. Note that at the one-month horizon, the least volatile of these prices are "Electricity" and "Solid fuels" with standard

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[12] In earlier versions of this paper we reported results at the three-digit level of the HICP which has 33 component series. The results were similar in many respects to those reported here.

deviations of 6.3 and 6.2 respectively. However, note also that there are a lot of *other prices* that are *more volatile* than the *least volatile* component of the "Ex. Energy and Seasonal Food" measure. For example, "Clothing materials", "Garments" and "Other articles of clothing and clothing accessories" have standard deviations in excess of 10, while "Passenger transport by air" and "Passenger transport by sea and inland waterway" have standard deviations in excess of 30! Part of the high volatility observed at the 1-month horizon is due to the fact that the component series of the HICP as published by Eurostat are not seasonally adjusted, and there are well known seasonal patterns in the prices of clothing and travel.[14] However, even at the twelve-month horizon, where the least volatile component of the "Ex. Energy and Seasonal Food" measure is again "Solid fuels", several other prices are more volatile than the least volatile component of the traditional measure. For example, the standard deviation of the change in the prices of "Coffee, tea and cocoa" is 5.7, while that of "Telephone and telefax equipment" is 2.1. A non-trivial number of prices (specifically those for "Oils and fats", "Coffee, tea and cocoa", "Refuse collection", "Passenger transport by air", "Passenger transport by sea and inland waterway", "Postal services", "Telephone and telefax equipment", and "Telephone and telefax services") are more volatile than the least volatile component of the prices excluded from the "Ex. Energy and Seasonal Food" measure at *both* the one-month and twelve-month horizons. This raises the possibility that an exclusion-type measure of core more comprehensive than a traditional measure of core inflation such as the "Ex. Energy and Seasonal Food" measure, or an alternative measure such as the ones we will explore below, may do a better job than the traditional measure.[15]

Two conclusions can be drawn from this simple characterisation of the data:

1. There is significant excess kurtosis in the cross-section distribution of price changes in the HICP on average. This is consistent with the findings of many other authors for many other countries and time periods, and suggests that limited-influence estimators of the central tendency of the distribution may dominate the mean.
2. A significant number of components of the HICP outside of the categories usually excluded from a traditional measure of core inflation such as the "Ex. Energy and Seasonal Food" measure are as volatile, and in some cases significantly more volatile, than these components,

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[13] These results are reported in Vega and Wynne (2001).

[14] The lack of seasonal adjustment in the HICP is due again to the short sample period and the difficulty of establishing stable seasonal patterns with a limited amount of data.

[15] Note that the measure of core inflation for the euro area proposed by Deutsche Bank excludes a wide range of products in addition to the usual food and energy. See Monticelli and Buttiglione (2000).

suggesting that in terms of eliminating noise and obtaining a clearer signal about underlying trends the traditional measures may be dominated by other measures.

3. THREE MEASURES OF CORE INFLATION.

As noted in the introduction, we will consider the performance of three measures of core inflation. The first are the so-called exclusion measures of the "Ex. Food & Energy"-type that almost all national statistical agencies have been calculating since the 1970s; the second is the trimmed mean measure proposed by Bryan and Cecchetti (1994); and the third is Edgeworth or variance weighted index of Diewert (1995) and Dow (1994).

These three measures of core inflation have a number of attractive features.[16] Starting with the traditional "Ex. Food & Energy"-type measures, these measures (and variants thereof) have been computed for so long and receive such regular coverage in the media that they are relatively well understood. Furthermore, they use only contemporaneous price information and are not subject to major revisions (other than those due to data revisions). Their primary drawback is that the choice of which prices to exclude is somewhat arbitrary. Food and energy prices are typically excluded for historical reasons. But, as we have already noted, it is not always the case that food and energy prices are the most volatile on a month to month basis, or contain the least information about the underlying inflation rate. The trimmed mean measure of core inflation excludes prices on a less arbitrary basis, and can also be computed using only contemporaneous price data. The primary drawback of this measure is that it assigns zero importance to the largest price changes, which may not be always appropriate. It is not difficult, to imagine circumstances under which the price changes in the tails of the cross-section distribution are the *most informative* about changes in trend inflation.[17] Also, a trimmed mean measure of core inflation might not be easily understood by the general public, which would undermine its usefulness to a central bank seeking to use this measure of core inflation to explain its monetary policy decisions. The Edgeworth measure does not discard *any* price information in computing core inflation, but rather makes the weights of individual prices in the overall index depend on how "noisy" they are as measured by their variability. But it cannot be computed solely on the basis of contemporaneous price information. It also requires data on the history of relative prices to calculate the weights, and these weights may well change over time. Also, this

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[16] See Wynne (1999) for a critical review.

[17] See, for instance, Bakhshi and Yates (1999).

measure may suffer from the problem that it would be a relatively difficult measure to communicate to the general public.

3.1 The traditional "Ex. Food & Energy" measure of core inflation

Table 4 lists a number of "Ex. Food & Energy" or exclusion-type measures and shows the various categories of goods excluded from the different measures. These definitions exclude different groupings of food and energy products, and are presumably motivated by the experiences of statisticians in tracking individual prices. We will take as our benchmark measure in this category the "Ex. Energy and Seasonal Food" measure, which excludes the categories 01.1.3 (Fish), 01.1.6 (Fruit), 01.1.7 (Vegetables including potatoes and other tubers), 04.5.1 (Electricity), 04.5.2 (Gas), 04.5.3 (Liquid fuels), 04.5.4 (Solid fuels), 04.5.5 (Hot water, steam and ice), and 07.2.2 (Fuels and lubricants). Eurostat routinely reports the "All-items excluding energy" and "All-items excluding energy, food, alcohol and tobacco" measures of core as part of its monthly HICP news release.

3.2 The trimmed mean

Trimmed mean measures of core inflation have been calculated for a large number of countries following the demonstration by Bryan and Cecchetti (1994) that measures of this type tend to outperform traditional measures of inflation in the United States.[18] The weighted median of Bryan and Pike (1991) is a special case of the trimmed mean. To compute the (symmetric) trimmed mean of the cross-section distribution of price changes at a particular date t, start by ordering the observed price changes from highest to lowest, keeping track of the weights of the individual price changes. Next we define the cumulative weight from 1 to i as $W_{i,t} = \sum_{j=1}^{i} w_{(j),t}$, where $w_{(j),t}$ denotes the sorted *j*'th weight (and by definition $1 \geq w_{j,t} \geq 0$). This allows us to define the index set $I_{\alpha} = \{i : \alpha < W_{i,t} < 1 - \alpha\}$. The α-percent symmetric trimmed mean inflation rate is then defined as

[18] For example Japan (Bryan and Cecchetti, 1999b, Shiratsuka, 1997), the United Kingdom (Bakhshi and Yates, 1999), Belgium (Aucremanne, 2000), Ireland (Meyler, 1999), Portugal (Marques, Neves and Sarmento, 2000), Australia (Kearns, 1998), New Zealand (Roger, 1997), Columbia (Jaramillo, 1998), Spain (Alvarez and Matea, 1999) and France (Le Bihan and Sédillot, 1999).

$$\pi_t^h(\alpha) = \frac{1}{1-2\alpha} \sum_{i \in I_\alpha} w_{(i),t} \pi_{(i),t}^h \tag{5}$$

where $\pi_{(j),t}$ is the sorted j'th price change. If $\alpha = 0$ we obtain the weighted sample mean. For $\alpha = 0.50$ we obtain the weighted sample median.[19] We will consider trimmed mean measures calculated using $\alpha = 0.05$, $\alpha = 0.10$, $\alpha = 0.15$ and $\alpha = 0.50$.

3.3 The Edgeworth index

The motivation for looking at the Edgeworth index is that food and energy price changes or extreme price changes may contain useful information about underlying inflation trends, and that it is desirable to make use somehow of that information. So rather than discard food and energy prices every month in computing a measure of core, or discard the biggest and smallest price changes, the Edgeworth index assigns an importance to individual price changes based on their information content. The strength of the "signal" in the monthly price change is inversely related to the volatility of the price in question, so the Edgeworth index assigns weights as:

$$w_{i,t} = \frac{\frac{1}{\sigma_{i,t}^2}}{\sum_{i=1}^{N} \frac{1}{\sigma_{i,t}^2}} \tag{6}$$

where $\sigma_{i,t}^2$ denotes the variance of individual price changes. Dow (1994) and Wynne (2001) have estimated indexes of this type for the US. Diewert (1995) shows that, conditional on a specific model of price changes,[20] a maximum likelihood estimate of the Edgeworth index in a sample of T observations of N individual price changes is given by the following (T+N) equations:

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[19] There is no reason *a priori* why we have to trim the same amount form both ends of the cross-section distribution of prices. A number of authors have proposed and implemented asymmetric trimmed mean measures of core inflation. This is done by defining the index set $I_{\alpha_1,\alpha_2} = \{i : \alpha_1 < W_{i,t} < 1 - \alpha_2\}$. Now α_1 denotes the amount trimmed from the lower tail of the cross-section distribution, and α_2 denotes the amount trimmed from the upper tail. The (α_1, α_2)-percent asymmetric trimmed mean rate of inflation is then defined as $\pi_t^h(\alpha_1, \alpha_2) = \frac{1}{1-\alpha_1-\alpha_2} \sum_{i \in I_\alpha} w_{(i),t} \pi_{(i),t}^h$. Asymmetric trimming is appropriate of the cross-section distribution exhibits positive or negative skewness on average. Roger (1997) found such persistent skewness in New Zealand, Jaramillo (1998) in Colombia and le Bihan and Franck (1999) report similar skewness in French CPI data over the period 1980-1998.

[20] Specifically $\pi_{i,t} = \Pi_t + \varepsilon_{i,t}$, with $E(\varepsilon_{i,t}) = 0$ and $Var(\varepsilon_{i,t}) = \sigma_i^2$ for $i = 1, \ldots, N; \quad t = 1, \ldots, T$.

$$\hat{\Pi}_t^E = \frac{\sum_{i=1}^{N} \frac{\pi_{i,t}}{\hat{\sigma}_{i,t}^2}}{\sum_{i=1}^{N} \frac{1}{\hat{\sigma}_{i,t}^2}} \quad for \quad t = 1, \ldots, T \tag{7}$$

$$\hat{\sigma}_{i,t}^2 = \frac{1}{T} \sum_{t=1}^{T} (\pi_{i,t} - \hat{\Pi}_t^E)^2 \quad for \quad i = 1, \ldots, N \tag{8}$$

We compute the Edgeworth index by iterating on the above equations, starting with an initial estimate of $\hat{\Pi}_t^E$ as a simple mean of the cross-section distribution of price changes at each date, and using 24 observations to estimate the variances of the individual prices.[21]

3.4 Properties of the three core inflation measures

Table 5 reports some basic statistics to characterise the properties of these measures of core inflation. [22]As we would expect, all of the measures are less volatile at the twelve-month horizon than at the one-month horizon. However, what is perhaps surprising and noteworthy is that the traditional measures of core are not significantly less volatile than the headline measure. The standard deviation of the headline "All items" inflation rate is 1.8 percent at the one-month horizon and 0.6 percent at the twelve-month horizon. The standard deviations of the various exclusion measures of core inflation range from 1.5 to 2.1 at the one-month horizon, and from 0.3 to 0.7 at the twelve-month horizon. These findings ought to raise questions about how successful these measures are at eliminating undesirable noise. In contrast, the trimmed mean measures and the Edgeworth measure are less volatile than the headline measure, with standard deviations in

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[21] It goes without saying that using only two years worth of data to estimate the variances of individual price changes require some heroic assumptions. There is little we can do about this, again given the short history of the HICP and our interest in seeing how well these measures work in real time. Note, however, that the results are little changed if we use the entire sample to estimate the variances. Marques, Neves and Sarmento (2000) estimate a core inflation measure of this type for Portugal for the period 1993-1999. However they weight the individual price changes by the inverse of their standard deviations rather than their variances.

[22] Note that we report descriptive statistics for two variants of the trimmed mean measures at the twelve-month horizon. One is the measure obtained from trimming the distribution of annual price changes (i.e. price changes over the past twelve months). The second is the measure obtained by compounding the trimmed mean of monthly price changes over the past twelve months. In comparing trimmed mean measure of core at the twelve-month horizon with traditional measures, it is not obvious which of the two alternatives is the most appropriate. However, as the Table shows, the characteristics of both variants of the trimmed mean measures are remarkably similar.

some cases that are half those of the headline rate of inflation at both the one-month and twelve-month horizons.

4. TRACKING TREND INFLATION.

While the lower volatility of the trimmed mean measures and the Edgeworth measure alone ought to make these measures of core inflation of interest, the lower volatility in and of itself does not make the measures useful for monetary policy purposes. The volatility of any candidate measure of core inflation can be made arbitrarily low with a sufficiently aggressive approach to discarding "uninformative" price changes. The literature on core inflation suffers from the absence of a well-articulated theoretical framework within which to evaluate the various measures of core inflation that have been proposed over the years. However, the common thread running through the existing literature is that core inflation is some sort of proxy for underlying trend inflation, and it seems sensible to evaluate measures of core inflation in terms of their ability to track this trend. We will evaluate different measures on the basis of their ability to track this trend as measured by the root mean square error statistic, $RMSE = \sqrt{\sum_{t=1}^{T} (\Pi_t^* - \overline{\Pi}_t)^2 / T}$ where Π_t^* is our candidate measure of core inflation at date t and $\overline{\Pi}_t$ is our measure of trend inflation. We will define trend inflation using the well-known Hodrick-Prescott filter, with smoothing parameter λ= 14,400. We will also look at the bias of the various measures, where the bias is defined as $Bias = \sum_{t=1}^{T} (\Pi_t^* - \overline{\Pi}_t) \ / T$. While the bias statistic is closely related to the RMSE, it does convey useful additional information about the characteristics of the various inflation measures, and allows us to see whether there are any systematic differences between the various measures of core and the defined trend.

We noted at the outset that part of our motivation for looking at the various candidate measures of core conflation is to have information on the underlying trend that is available in real time. Obviously the Hodrick-Prescott measure of trend can be computed in real time, which begs the question of why not simply use this measure of trend directly. The reason of course is the well-known tendency of the Hodrick-Prescott filter to produce distorted estimates of the trend at end-points of sample. This issue is discussed at some length in Baxter and King (1999), and has to do with the fact that the filter is susceptible to significant compression and leakage (along with phase shift) at sample end-points. Thus Baxter and King argue that the Hodrick-Prescott filter does not really produce as many useful estimates of trend as there are observations in the sample. Baxter and King's preferred band-pass filter arguably produces more accurate measures of trend and cycle, but entails a loss of observations at the beginning and end of the sample. This will be true of all measures of trend based on two-sided filters.

Table 6 reports the RMSEs and biases for the various measures of core inflation over the sample period, and Figure 3 plots these statistics for the trimmed mean measures as functions of the amount of trim.[23] Starting with Table 6, note that the 5% and 10% trimmed mean measures do better at tracking trend inflation than any of the conventional exclusion type measures of core inflation. The 15% trimmed mean and the weighted median do better than some but not all of the conventional measures: the weighted median is dominated by all but the "All items excluding energy", "All items excluding energy and unprocessed food" and "All items excluding energy, food alcohol and tobacco" measures (although these are the traditional measures that receive the most attention). The Edgeworth index does not perform particularly well in terms of tracking trend inflation: its RMSE is 0.501, although again it does do better than some of the traditional exclusion type measures of core. All of the trimmed mean measures outperform the Edgeworth measure. Note however that the measure of "core inflation" that does best in terms of minimising the RMSE is the headline inflation rate: its RMSE of 0.281 is less than the RMSEs of all of the candidate measures of core, though close to the RMSEs of the 5 percent and 10 percent trimmed means.

Figure 3 – which depicts RMSE and bias as a function of the trim confirms what one might suspect from the results reported in Table 6, namely that the gains from trimming come with only a small amount of trim. Bryan, Cecchetti and Wiggins (1997) use plots of the RMSE as a function of the trim to estimate the optimal trim. They find strong U-shaped relationships between the RMSE and the amount of trim in US Consumer Price Index and Producer Price Index data for the period 1967 to 1997. This allows them to estimate the optimal trim rather precisely. Our results using euro area data do not allow similar precision. We estimate the optimal amount of trim in terms of minimising RMSE somewhat imprecisely at 3%, but the true number could well be a lot larger. This imprecision should come as no surprise, given the short sample of data on euro area inflation.

[23] All trimmed mean measures are computed at the 4-digit level of disaggregation.

Figure 4 gives us some insight into the performance of the various measures by showing how well they did at detecting the change in trend inflation that occurred in late 1998.[24] Panel A of the Figure shows headline and trend inflation in the euro area since January 1997, while panels B, C and D show some of the traditional exclusion type measures, the trimmed mean measures and the Edgeworth measure respectively. Recall that one of the main motivations for constructing measures of core inflation is to get a better sense of changes in trend inflation in real time. What strikes one immediately in this Figure is that *none* of the measures of core inflation gave any significant advance warning of the pickup in trend inflation, as measured by the HP filter, in late 1998. (The trough in the HP trend was in September 1998, while the trough in the headline inflation rate was in February 1999.) That is, none of the measures of core inflation turn up before the upward trend in headline inflation becomes apparent. Of the traditional exclusion-type measures, the two that typically receive the most attention "All items excluding energy, food, alcohol and tobacco" and "All items excluding energy and seasonal food" did a remarkably poor job at detecting and tracking the shift in trend. Some of the other traditional measures that do not receive as much attention did a better job, although mainly in terms of tracking the acceleration in headline inflation than in terms of giving advance warning. The various trimmed mean measures also do a poor job at detecting the shift in trend, and are consistently below it from the beginning of 1998 through the end of the sample. Arguably the Edgeworth measure does worst of all: it is roughly stable through the middle of 2000, before posting a dramatic increase in the latter half of 2000.

Before concluding, it is worth taking a more detailed look at the trimmed mean measure of core try to get some sense of what accounts for its superior performance. In particular, it is interesting to see which prices are discarded by the trimming procedure as being the least informative about trend inflation developments. In Table 7 we report the frequency with which each category of prices is excluded from the calculation of the trimmed mean when we trim 15 percent from the cross-section distribution. The Table shows the frequency with which a category of prices is excluded from the top of the distribution, the frequency with which it is excluded form the bottom of the distribution, the frequency with which it is excluded from either tail, and the frequency with which it is included. Note that only two classes of prices, "Bread and cereals" and "Restaurants and cafés" are always included in the calculation of the trimmed mean. No class or prices is always excluded, although the prices of "Fruit" and "Liquid fuels" are excluded more

[24] It is too early to see how well they did at detecting the change in trend inflation that seems to have occurred in the middle of 2001.

than 90 percent of the time. The prices of "Passenger transport by air" and "Passenger transport by sea and inland waterway" are also selected for frequent exclusion.

5. CONCLUSIONS AND DIRECTIONS FOR RESEARCH

The short sample of data on which this study is based means that any conclusions must necessarily be accompanied by strong caveats. We believe that posing the question of core inflation measurement as that of detecting changes in trend inflation in real time is the most sensible way to choose between competing measures of core. However, over the time period for which we have detailed information on the composition of the HICP, there have not been any major fluctuations in trend inflation, which limits the ability of this criterion to distinguish between the different measures with any degree of certainty. As Figure 1 shows, inflation trended down for most of the period, before reversing course in late 1998 or early 1999 (the exact date depends on the measure of trend chosen). The upward trend may turn out to have been reversed in 2001, although (at the time of writing) it is too soon to tell for sure.

With these caveats in mind, we believe that our analysis justifies a number of conclusions. First, the excess kurtosis that characterises the cross-section distribution of consumer price changes in a number of countries, both in the European Union and elsewhere, is also apparent in the cross-section distribution of price changes in the HICP at the euro area level. The cross-section distributions of price changes seem to be characterised by excess kurtosis at the lowest level of disaggregation (which is the country-level four-digit level) and at the highest level of disaggregation (which is the euro area level two-digit level). Second, a detailed examination of the time series properties of the component series of the HICP reveals that a significant number of price series are significantly more volatile than those that are typically excluded from the traditional exclusion-type measures of core inflation. This suggests that in terms of eliminating noise, it may be possible to do better than the traditional measures. Third, we also show that the traditional measures of core inflation are not significantly less volatile than the headline rate, whereas some newer alternative measures are. Fourth, when it comes to tracking trend inflation, as defined by the HP filter, the 5 percent and 10 percent trimmed mean measures of core do better than any of the traditional measures, but only about as well as the headline measure. And finally, after examining the real-time performance of the various measures of core over the first couple of years of EMU, we find that none of them give any meaningful advance warning of the pickup in trend inflation that occurred around the time of the launch of EMU.

In terms of directions for future research, only the passage of time will allow us to draw stronger conclusions about the ability of different measures of core inflation to track trend inflation and provide timely signals of changes in underlying trends in real time. Thus it might be useful to explore other criteria by which the merits of alternative measures of core could be assessed. We noted at the outset that while we have limited time series information on the HICP for the euro area, we have very detailed cross-section information, since all component series are reported for all member states. It would be useful to explore ways in which we could make better use of the HICP detail available at the level of the member states to derive optimal core inflation measures at the euro area level. Finally, it would be useful to explore ways in which we could make greater use of the longer time series that area available for national Consumer Price Indexes, perhaps by creating synthetic HICPs for the 1970s and 1980s, to strengthen our conclusions about the superiority of non-traditional measures of core inflation.

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Table 1
Classification structure of HICP as of January 2000

Division			Group			Class		
Two Digit Code	Description	Weight	Three Digit Code	Description	Weight	Four Digit Code	Description	Weight (2000)
01	Food and non-alcoholic beverages	0.16302	01.1	Food	0.14879	01.1.1	Bread and cereals	0.02627
						01.1.2	Meat	0.04111
						01.1.3	Fish	0.01166
						01.1.4	Milk; cheese and eggs	0.02268
						01.1.5	Oils and fats	0.00576
						01.1.6	Fruit	0.01142
						01.1.7	Vegetables including potatoes and other tubers	0.01562
						01.1.8	Sugar. jam; honey; syrups; chocolate and confectionery	0.01035
						01.1.9	Food products n.e.c.	0.00393
			01.2	Non-alcoholic beverages	0.01423	01.2.1	Coffee; tea and cocoa	0.00487
						01.2.2	Mineral waters; soft drinks and juices	0.00937
02	Alcoholic beverages and tobacco	0.040	02.1	Alcoholic beverages	0.01719	02.1.1	Spirits	0.00350
						02.1.2	Wine	0.00739
						02.1.3	Beer	0.00630
			02.2	Tobacco	0.02268	02.2.0	Tobacco	0.02268
03	Clothing and footwear	0.078	03.1	Clothing	0.06250	03.1.1	Clothing materials	0.00063
						03.1.2	Garments	0.05775
						03.1.3	Other articles of clothing and clothing accessories	0.00235
						03.1.4	Cleaning; repair and hire of clothing	0.00177
			03.2	Footwear, including repairs	0.01545			0.01545
04	Housing, water, electricity gas and other fuels	0.156	04.1	Actual rentals for housing	0.05820			0.05820
			04.3	Maintenance and repair of the dwelling	0.01661	04.3.1	Materials for the regular maintenance and repair of the dwelling	0.00765
						04.3.2	Services for the regular maintenance and repair of the dwelling	0.00896
			04.4	Water supply and miscellaneous services relating to the dwelling	0.02745	04.4.1	Water supply	0.00860
						04.4.2	Refuse collection	0.00675
						04.4.3	Sewerage collection	0.00531
						04.4.4	Other services relating to the dwelling n.e.c.	0.00585
			04.5	Electricity, gas and other fuels	0.05325	04.5.1	Electricity	0.02175
						04.5.2	Gas	0.01525
						04.5.3	Liquid fuels	0.00941
						04.5.4.	Solid fuels	0.00114
						04.5.5	Hot water; steam and ice	0.00570

05	Furnishings, household equipment and routine maintenance of the house	0.079	05.1	Furniture and furnishings, carpets and other floor coverings	0.03137	05.1.1	Furniture and furnishings	0.02755
						05.1.2	Carpets and other floor coverings	0.00286
						05.1.3	Repair of furniture; furnishings and floor covering	0.00052
			05.2	Household textiles	0.00675			0.00675
			05.3	Household appliances	0.01154	05.3.1/2	Major household appliances whether electric or not and small electric household appliances	0.01040
						05.3.3	Repair of household appliances	0.00114
			05.4	Glassware; tableware and household utensils	0.00569			0.00569
			05.5	Tools and equipment for house and garden	0.00463			0.00463
			05.6	Good and services for routine household maintenance	0.01865	05.6.1	Non-durable household goods	0.01037
						05.6.2	Domestic services and home care services	0.00828
06	Health	0.03906	06.1	Medical products, appliances and equipment		06.1.1	Pharmaceutical products	0.01168
						06.1.2/3	Other medical products; therapeutic appliances and equipment	0.00385
			06.2	Out-patient services		06.2.1/3	Medical services; paramedical services	0.00944
						06.2.2	Dental services	0.00689
07	Transport	0.156	07.1	Purchase of vehicles	0.05012	07.1.1	New and second-hand motorcars.	0.00430
						07.1.2/3	Motor cycles and bicycles	0.04581
			07.2	Operation of personal transport equipment	0.08485	07.2.1	Spares parts and accessories	0.00928
						07.2.2	Fuels and lubricants	0.04156
						07.2.3	Maintenance and repairs	0.02363
						07.2.4	Other services in respect of personal transport equipment	0.01037
			07.3	Transport services	0.02122	07.3.1	Passenger transport by railway	0.00430
						07.3.2	Passenger transport by road	0.00524
						07.3.3	Passenger transport by air	0.00442
						07.3.4	Passenger transport by sea and inland waterway	0.00110
						07.3.5	Combined passenger transport	0.00550
						07.3.6	Other purchased transport services	0.00070
08	Communications	0.024	08.1	Postal services	0.00229			0.00229
			08.2	Telephone and telefax equipment	0.00258			0.00258
			8.3	Telephone and telefax services	0.01946			0.01946
09	Recreation and culture	0.094	09.1	Audio-visual, photographic and information processing equipment		09.1.1	Equipment for the reception. recording and reproduction of sound and pictures	0.00625

						09.1.2	Photographic and cinematographic equipment and reproduction of sound and pictures	0.00164
						09.1.3	Data processing equipment	0.00355
						09.1.4	Recording media	0.00409
						09.1.5	Repair of audio-visual equipment and related products	0.00093
			09.2	Other major durables for recreation and culture		09.2.1/2	Major durables for indoor and outdoor recreation, including musical instruments	0.00221
						09.2.3	Maintenance and repair of other major durables for recreation and culture	0.00005
			09.3	Other recreational items and equipment, gardens and pets		09.3.1	Games, toys and hobbies	0.00424
						09.3.2	Equipment for sport, camping and open-air recreation	0.0031
						09.3.3	Gardens, plants and flowers	0.00707
						09.3.4/5	Pets and related products; veterinary and other services for pets	0.00427
			09.4	Recreational and cultural services		09.4.1	Recreational and sporting services	0.01078
						09.4.2	Cultural services	0.01518
			09.5	Newspaper; books and stationery		09.5.1	Books	0.00756
						09.5.2	Newspapers and periodicals	0.01039
						09.5.3/4	Miscellaneous printed matter; stationary and drawing materials	0.00366
			09.6	Package holidays				0.01195
10	Education	0.09404			0.09404			0.09404
11	Restaurants and hotels	0.08792	11.1	Catering services	0.07272	11.1.1	Restaurants and cafés	0.06509
						11.1.2	Canteens	0.00763
			11.2	Accommodation services	0.01520			0.01520
12	Miscellaneous goods and services	0.07422	12.1	Personal care		12.1.1	Hairdressing salons and personal grooming establishments	0.01192
						12.1.2	Appliances. Articles and products for personal care	0.01666
			12.3	Personal effects n.e.c.		12.3.1	Jewellery clocks and watches.	0.00564
						12.3.2	Other personal effects	0.00496
			12.4	Social protection				0.00227
			12.5	Insurance		12.5.2	Insurance connected with the dwelling – Contents insurance	0.01608
						12.5.3	Insurance connected with health	
						12.5.4	Insurance connected with transport	
						12.5.5	Other insurance.	
			12.6	Financial services n.e.c.				0.00388

			12.7	Other services n.e.c.				0.00838
Total	12		**Total**	39		**Total**	93	

Notes to Table 1: Shaded areas denote categories of HICP that we consolidate because of the absence of some components at the MU level or because of the anomalous behaviour of some components at the MU level. There are in principle 93 series at the greatest level of disaggregation reported by the HICP (the class or four-digit level). However, some of these series are not reported at the MU level. For example the series 12.4 (Social protection) is not reported at the MU level but is available for some countries. Likewise the series 12.5.3 (insurance connected with health) and 12.5.5 (Other insurance) are missing for most or all of the sample period at the MU level, so we work with the 12.5 sub aggregate (Insurance). Dropping the series 12.4 and consolidating the components of 12.5 leaves us with a maximum of 89 series. Note also that the weights for some of the series are zero for several of the years in the sample. For example, the weights for series 06.2.1/3 (Medical services; paramedical products) and 06.2.2 (Dental services) (as well as the aggregate 06.2, Out-patient services) and 12.4 (Social protection) are zero for 1996-1999. Furthermore, a number of series exhibit other sorts of anomalous behaviour that raises questions about their accuracy. For example the series 4.3.2 (Services for the regular maintenance and repair of the dwelling) increases more or less monotonically from 1995:1 through 1999:8, at which point it declines for several months before resuming its monotonic increase in 1999:12. The series 6.6 (Out patient services) exhibits a discontinuity (a decline) in 2000:1, primarily as a result of a discontinuity in the series 6.2.1/3 (Medical and paramedical services). The series 9.2 (Other major durables for recreation and culture) exhibits a sharp increase between 1999:2 and 1999:3, which can be attributed to a sharp increase in the series 9.2.1/2 (Major durables for indoor and outdoor recreation, including musical instruments). The series 9.4 (Recreational and cultural services) exhibits sharp discontinuities between 1996:12 and 1997:1, between 1999:12 and 200:1 and again between 2000:12 and 2001:1, all of which can be attributed to similar discontinuities in the series 9.4.2 (Cultural services). Finally the series 12.6 (Financial services n.e.c.) exhibits discontinuities between 1997:4 and 1997:5, and between 2000:12 and 2001:1.

Table 2

Summary statistics for the cross-section distribution of HICP price changes at the MU level

	$h = 1$					$h = 3$					$h = 12$				
	Mean	**Median**	**Std. Dev.**	**Skewness**	**Kurtosis**	**Mean**	**Median**	**Std. Dev.**	**Skewness**	**Kurtosis**	**Mean**	**Median**	**Std. Dev.**	**Skewness**	**Kurtosis**
2 digit level	1.8	1.9	5.1	-0.1	3.8	1.8	1.7	3.2	-0.2	3.6	1.7	1.6	1.4	-0.5	5.3
3-digit level	1.8	1.6	6.5	0.1	6.8	1.8	1.7	4.1	0.3	5.8	1.7	1.5	2.0	0.5	7.0
4-digit level	1.8	1.6	10.0	0.4	18.8	1.8	1.6	6.6	0.3	18.5	1.7	1.4	3.0	0.9	17.9

Notes to Table 2: Data are averages over 1996:1 to 2000:12. h denotes the horizon over which inflation is measured, with $h = 1$ denoting monthly changes, $h = 3$ denoting three-month changes, and $h = 12$ denoting twelve-month changes.

Table 3
Four-digit disaggregation of HICP
Basic descriptive statistics

Four-digit code		Weight	Mean $h=1$	Mean $h=12$	Standard deviation $h=1$	Standard deviation $h=12$
01.1.1	Bread and cereals	0.0269	1.4	1.3	1.3	0.7
01.1.2	Meat	0.04246	2.3	1.5	5.2	2.8
01.1.3	Fish	0.01203	3.0	3.7	11.4	1.5
01.1.4	Milk; cheese and eggs	0.0225	1.3	0.8	2.6	1.4
01.1.5	Oils and fats	0.00607	-0.6	-1.6	7.0	3.7
01.1.6	Fruit	0.01174	4.1	1.9	23.2	3.6
01.1.7	Vegetables including potatoes and other tubers	0.01579	2.2	2.1	35.5	4.5
01.1.8	Sugar. jam; honey; syrups; chocolate and confectionery	0.01044	1.3	1.1	1.4	0.4
01.1.9	Food products n.e.c.	0.00387	1.3	1.1	1.5	0.6
01.2.1	Coffee; tea and cocoa	0.00553	-0.4	0.2	8.5	5.7
01.2.2	Mineral waters; soft drinks and juices	0.00948	0.9	0.7	1.4	0.7
02.1.1	Spirits	0.00376	0.9	0.8	1.8	0.6
02.1.2	Wine	0.00819	1.9	1.8	1.8	0.9
02.1.3	Beer	0.00693	0.9	0.8	1.7	0.6
02.2.0	Tobacco	0.02277	3.8	3.9	5.2	1.1
03.1.1	Clothing materials	0.00065	1.1	1.0	12.7	0.7
03.1.2	Garments	0.05966	0.7	0.8	14.3	0.3
03.1.3	Other articles of clothing and clothing accessories	0.00252	1.2	1.1	11.0	0.3
03.1.4	Cleaning; repair and hire of clothing	0.00182	1.3	1.3	1.8	0.3
03.2.0	Footwear, including repairs	0.01567	1.5	1.5	11.7	0.5
04.1.0	Actual rentals for housing	0.06247	2.0	1.9	1.5	0.6
04.3.1	Materials for the regular maintenance and repair of the dwelling	0.0087	1.8	1.7	1.4	0.5
04.3.2	Services for the regular maintenance and repair of the dwelling	0.00957	1.7	1.5	3.1	1.1
04.4.1	Water supply	0.00904	2.6	2.6	3.7	0.7
04.4.2	Refuse collection	0.00707	3.7	4.0	6.4	1.6
04.4.3	Sewerage collection	0.00575	3.1	3.2	5.1	1.4
04.4.4	Other services relating to the dwelling n.e.c.	0.00571	2.5	2.4	3.1	0.4
04.5.1	Electricity	0.02194	-0.0	-0.1	6.3	1.4
04.5.2	Gas	0.01336	5.5	5.5	12.1	7.3
04.5.3	Liquid fuels	0.00807	6.8	8.3	57.1	19.5
04.5.4.	Solid fuels	0.0012	1.3	1.7	6.2	1.0
04.5.5	Hot water; steam and ice	0.00518	7.0	6.3	11.1	10.2
05.1.1	Furniture and furnishings	0.02912	1.4	1.3	1.8	0.3
05.1.2	Carpets and other floor coverings	0.00322	0.7	0.5	2.3	0.6
05.1.3	Repair of furniture; furnishings and floor covering	0.00086	2.4	2.3	4.6	1.0
05.2.0	Household textiles	0.00689	1.2	1.0	5.1	0.4
05.3.1/2	Major household appliances whether electric or not and small electric household appliances	0.01076	-0.6	-0.6	1.1	0.3
05.3.3	Repair of household appliances	0.0011	2.9	2.8	3.1	0.7
05.4.0	Glassware; tableware and household utensils	0.00577	1.5	1.5	2.2	0.3
05.5.0	Tools and equipment for house and garden	0.0051	0.6	0.5	0.9	0.2

05.6.1	Non-durable household goods	0.00994	1.2	1.0	1.5	0.9
05.6.2	Domestic services and home care services	0.00831	3.0	2.9	3.1	0.5
06.0.0	Health	0.03186	2.7	2.8	4.1	1.3
07.1.1	New and second-hand motorcars.	0.00429	0.9	0.8	2.9	0.9
07.1.2/3	Motor cycles and bicycles	0.04464	1.1	1.0	2.3	0.9
07.2.1	Spares parts and accessories	0.00973	0.0	-0.1	1.8	0.5
07.2.2	Fuels and lubricants	0.04014	4.2	4.7	21.1	7.7
07.2.3	Maintenance and repairs	0.02466	2.5	2.4	1.9	0.4
07.2.4	Other services in respect of personal transport equipment	0.01126	1.8	1.7	2.6	0.3
07.3.1	Passenger transport by railway	0.00473	1.7	1.8	4.2	0.4
07.3.2	Passenger transport by road	0.00563	2.5	2.4	2.6	0.6
07.3.3	Passenger transport by air	0.00401	3.2	1.6	30.7	1.5
07.3.4	Passenger transport by sea and inland waterway	0.00084	6.6	4.5	39.2	4.0
07.3.5	Combined passenger transport	0.00579	2.9	2.8	2.9	0.7
07.3.6	Other purchased transport services	0.00077	2.4	2.1	5.4	1.1
08.1.0	Postal services	0.00237	2.0	1.8	7.7	2.3
08.2.0	Telephone and telefax equipment	0.00253	-6.7	-7.3	10.3	2.1
08.3.0	Telephone and telefax services	0.01916	-3.6	-3.7	8.2	1.8
09.1.1	Recreation and culture	0.09692	1.2	0.9	7.4	0.5
10.0.0	Education	0.00877	2.4	2.5	3.4	0.4
11.1.1	Restaurants and cafés	0.0623	2.3	2.2	1.1	0.4
11.1.2	Canteens	0.0078	1.9	2.0	2.1	0.4
11.2.0	Accommodation services	0.01515	4.7	3.2	24.0	0.8
12.0.0	Miscellaneous goods and services	0.06979	1.8	1.6	1.7	0.6

Notes to Table 3: Sample period: 1996:1-2000:12.

Table 4 Definition of exclusion-type measures of core inflation	
Measure	COICOP/HICP codes of prices excluded at the four-digit level
All items- Excluding energy	04.5.1, 04.5.2, 04.5.3, 04.5.4, 04.5.5, 07.2.2
Excluding seasonal food	01.1.3, 01.1.6, 01.1.7
Excluding energy and seasonal food	01.1.3, 01.1.6, 01.1.7, 04.5.1, 04.5.2, 04.5.3, 04.5.4, 04.5.5, 07.2.2
Excluding energy and unprocessed food	01.1.2, 01.1.3, 01.1.6, 01.1.7, 04.5.1, 04.5.2, 04.5.3, 04.5.4, 04.5.5, 07.2.2
Excluding alcoholic beverages and tobacco	02.1.1, 02.1.2, 02.1.3, 02.2.0
Excluding energy, food, alcohol and tobacco	01.1.3, 01.1.6, 01.1.7, 02.1.1, 02.1.2, 02.1.3, 02.2.0, 04.5.1, 04.5.2, 04.5.3, 04.5.4, 04.5.5, 07.2.2
Excluding housing, water, electricity, gas and other fuels	04.1.0, 04.3.1, 04.3.2, 04.4.A, 04.5.1, 04.5.2, 04.5.3, 04.5.4, 04.5.5, 05.1.1, 05.1.2, 05.1.3, 05.31_2, 05.3.3
Excluding education health and social protection	06.1.1, 06.1.2_3, 06.2.1_3, 06.2.2, 06.3.0, 10.X0, 12.4.0
Excluding liquid fuels and fuels and lubricants for personal transport equipment	04.5.3, 07.2.2

Notes to Table 4: Source: Eurostat.

Table 5 Measures of core inflation Descriptive statistics				
	Mean		Standard Deviation	
	$h=1$	$h=12$	$h=1$	$h=12$
All items	1.7	1.7	1.8	0.6
All items excluding - energy	1.6	1.4	1.7	0.5
- seasonal food	1.8	1.6	1.9	0.7
- energy and seasonal food	1.6	1.4	1.6	0.4
- energy and unprocessed food	1.5	1.4	1.5	0.3
- alcoholic beverages and tobacco	1.8	1.6	2.0	0.7
- energy, food, alcohol and tobacco	1.5	1.4	1.9	0.3
- housing, water, electricity, gas and other fuels	1.7	1.5	2.1	0.6
- education, health, and social protection	1.8	1.7	2.0	0.7
- liquid fuels and fuels and lubricants for personal transport equipment	1.7	1.5	1.6	0.6
Trimmed means - 5%	1.4	1.4* 1.4	1.2	0.3* 0.4
- 10%	1.4	1.3* 1.4	1.0	0.3* 0.3
- 15%	1.3	1.3* 1.3	0.9	0.2* 0.3
- 50%	1.4	1.3* 1.4.	0.7	0.3* 0.2
Edgeworth	1.5	1.6* 1.3	1.1	0.7* 0.4

Notes to Table 5: Sample period: 1996:1-2001:7. At annual horizons (h=12) we report the mean and standard deviation of the trimmed mean of the annual changes in prices (denoted with asterisks *) along with the mean and standard deviation of the twelve-month compounded trims, along with the mean and standard deviation of the trims of the twelve month changes in individual prices. Note that the sample period for the trimmed means is 1995:1 – 2000:12.

Table 6 **Comparison of traditional (exclusion type) measures of core and trimmed mean**		
Measure of core inflation	**RMSE**	**Bias**
All items	0.281	-0.040
All items excluding - energy	0.504	-0.271
- seasonal food	0.327	-0.056
- energy and seasonal food	0.471	-0.321
- energy and unprocessed food	0.512	-0.327
- alcoholic beverages and tobacco	0.329	-0.070
- energy, food, alcohol and tobacco	0.529	-0.323
- housing, water, electricity, gas and other fuels	0.305	-0.196
- education, health, and social protection	0.313	-0.025
- liquid fuels and fuels and lubricants for personal transport equipment	0.444	-0.215
Trimmed means - 5%	0.284	-0.207
- 10%	0.288	-0.220
- 15%	0.315	-0.258
- 50%	0.349	-0.247
Edgeworth	0.501	-0.374

Notes to Table 6: Traditional measures are computed on an annual (year over year or 12-month) basis. Trimmed means and weighted median are compounded (over 12 months) trims of monthly changes. The Edgeworth index is computed on the basis of one month price changes and then compounded over twelve months.

Table 7 Frequency with which individual; prices are excluded by trimming 15 percent of the distribution				
	Excluded from bottom of distribution	Excluded from top of distribution	Excluded	Included
Bread and cereals	0	0	0	100
Meat	15.152	19.697	34.848	65.152
Fish	22.727	39.394	62.121	37.879
Milk; cheese and eggs	6.061	4.545	10.606	89.394
Oils and fats	37.879	10.606	48.485	51.515
Fruit	39.394	51.515	90.909	9.091
Vegetables including potatoes and other tubers	36.364	50	86.364	13.636
Sugar. jam; honey; syrups; chocolate and confectionery	3.03	1.515	4.545	95.455
Food products n.e.c.	9.091	3.03	12.121	87.879
Coffee; tea and cocoa	46.97	9.091	56.061	43.939
Mineral waters; soft drinks and juices	9.091	0	9.091	90.909
Spirits	10.606	1.515	12.121	87.879
Wine	3.03	7.576	10.606	89.394
Beer	13.636	3.03	16.667	83.333
Tobacco	3.03	21.212	24.242	75.758
Clothing materials	36.364	31.818	68.182	31.818
Garments	31.818	39.394	71.212	28.788
Other articles of clothing and clothing accessories	19.697	28.788	48.485	51.515
Cleaning; repair and hire of clothing	3.03	6.061	9.091	90.909
Footwear, including repairs	22.727	40.909	63.636	36.364
Actual rentals for housing	0	4.545	4.545	95.455
Materials for the regular maintenance and repair of the dwelling	0	3.03	3.03	96.97
Services for the regular maintenance and repair of the dwelling	4.545	6.061	10.606	89.394
Water supply	6.061	9.091	15.152	84.848
Refuse collection	7.576	22.727	30.303	69.697
Sewerage collection	7.576	19.697	27.273	72.727
Other services relating to the dwelling n.e.c.	4.545	16.667	21.212	78.788
Electricity	19.697	6.061	25.758	74.242
Gas	10.606	31.818	42.424	57.576
Liquid fuels	43.939	48.485	92.424	7.576
Solid fuels	25.758	18.182	43.939	56.061
Hot water; steam and ice	22.727	42.424	65.152	34.848

Furniture and furnishings	1.515	3.03	4.545	95.455
Carpets and other floor coverings	7.576	1.515	9.091	90.909
Repair of furniture; furnishings and floor covering	4.545	10.606	15.152	84.848
Household textiles	18.182	16.667	34.848	65.152
Major household appliances whether electric or not and small electric household appliances	18.182	0	18.182	81.818
Repair of household appliances	1.515	10.606	12.121	87.879
Glassware; tableware and household utensils	1.515	3.03	4.545	95.455
Tools and equipment for house and garden	1.515	1.515	3.03	96.97
Non-durable household goods	1.515	3.03	4.545	95.455
Domestic services and home care services	0	7.576	7.576	92.424
Health	3.03	7.576	10.606	89.394
New and second-hand motorcars.	10.606	9.091	19.697	80.303
Motor cycles and bicycles	1.515	3.03	4.545	95.455
Spares parts and accessories	18.182	1.515	19.697	80.303
Fuels and lubricants	34.848	39.394	74.242	25.758
Maintenance and repairs	0	3.03	3.03	96.97
Other services in respect of personal transport equipment	10.606	7.576	18.182	81.818
Passenger transport by railway	4.545	9.091	13.636	86.364
Passenger transport by road	3.03	10.606	13.636	86.364
Passenger transport by air	43.939	37.879	81.818	18.182
Passenger transport by sea and inland waterway	28.788	43.939	72.727	27.273
Combined passenger transport	0	13.636	13.636	86.364
Other purchased transport services	15.152	21.212	36.364	63.636
Postal services	18.182	15.152	33.333	66.667
Telephone and telefax equipment	65.152	0	65.152	34.848
Telephone and telefax services	42.424	4.545	46.97	53.03
Recreation and culture	19.697	40.909	60.606	39.394
Education	1.515	16.667	18.182	81.818
Restaurants and cafés	0	0	0	100

Canteens	6.061	6.061	12.121	87.879
Accommodation services	25.758	50	75.758	24.242
Miscellaneous goods and services	0	1.515	1.515	98.485

Notes to Table: Frequency with which particular prices are excluded from calculation of mean by employing a 15% trim. Inflation measured at one-month horizon. Sample period: 1996:1 – 2001:7.

Figure 1
Euro area inflation and trend, 1990-2001

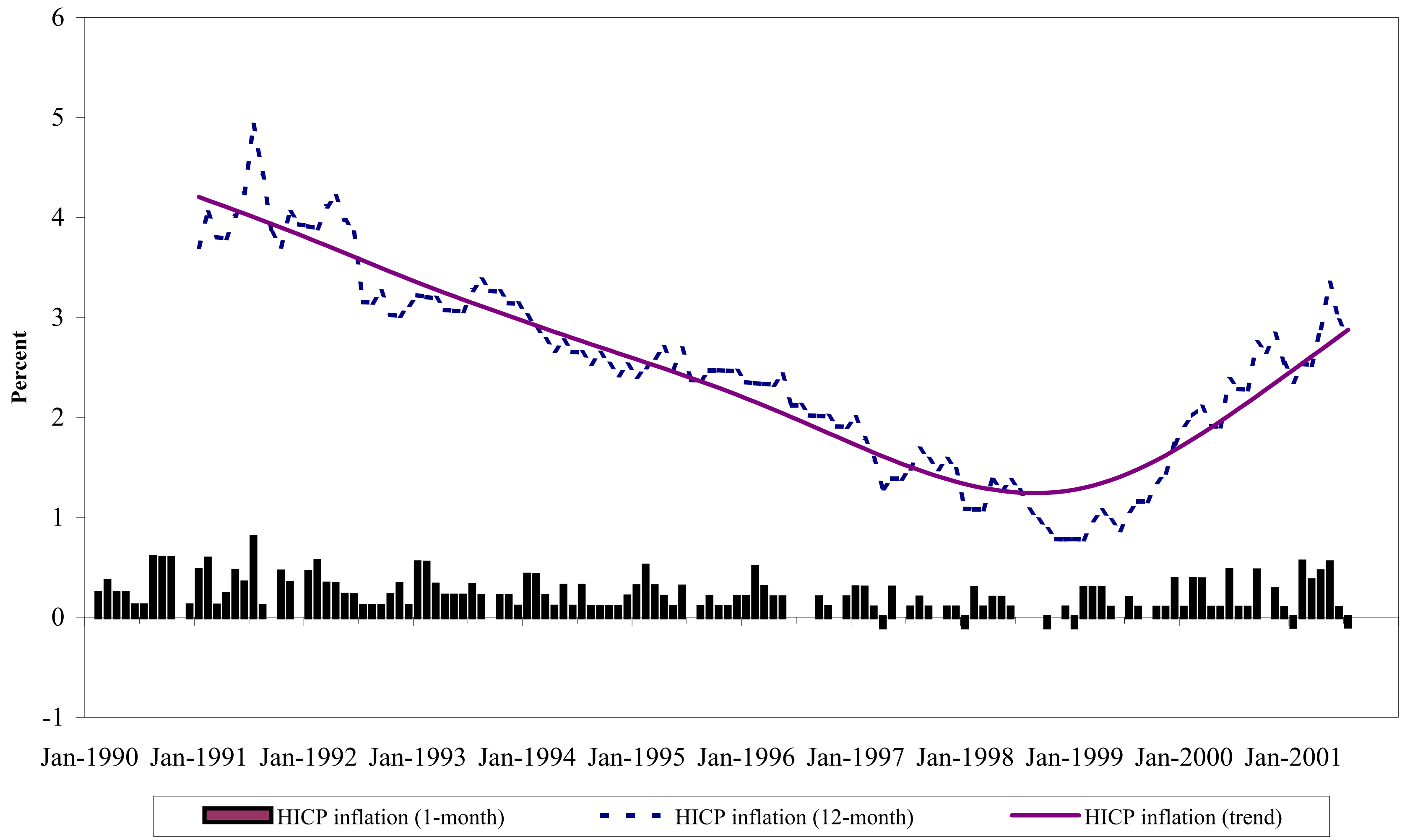

Figure 2a
Standard deviation of cross-section distribution of price changes in the euro area at the four-digit level

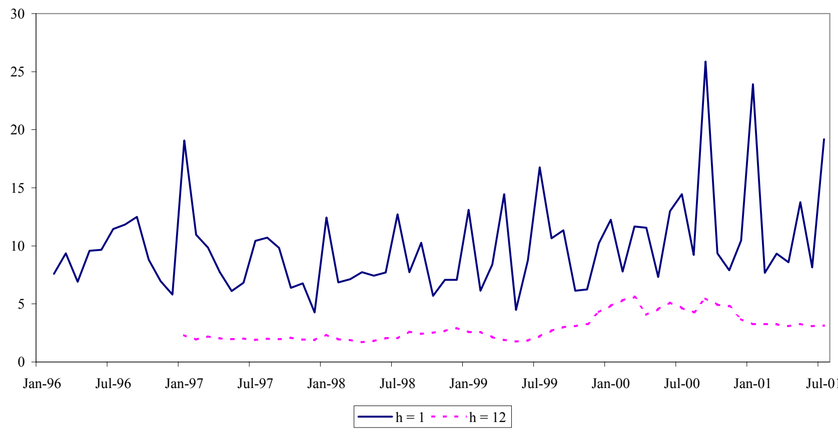

Figure 2b
Skewness of cross-section distribution of price changes in the euro area at the four-digit level

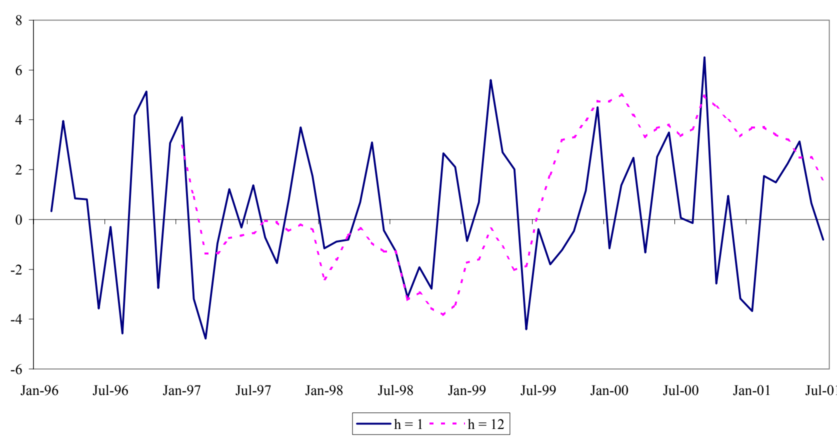

Figure 2c
Kurtosis of cross-section distribution of price changes in the euro area at the four-digit level

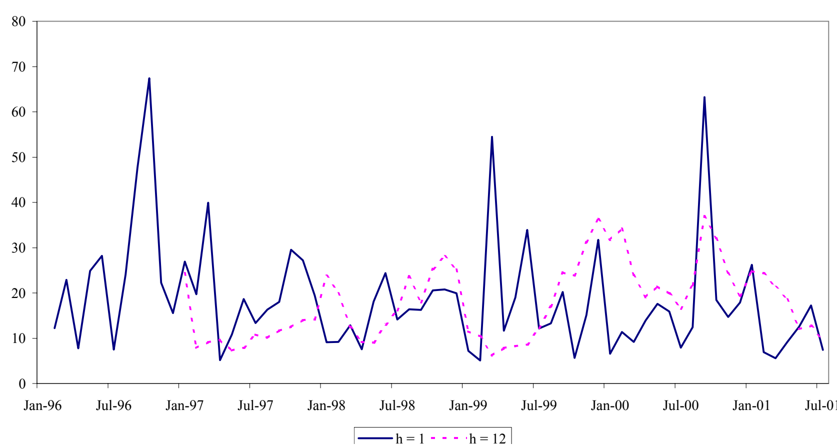

Figure 2c
Kurtosis of cross-section distribution of price changes in the euro area at the four-digit level

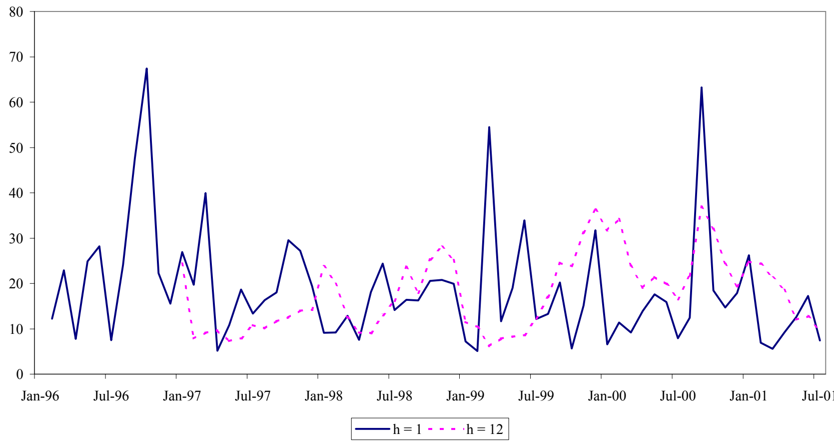

Figure 3
RMSE and bias as a function of trim

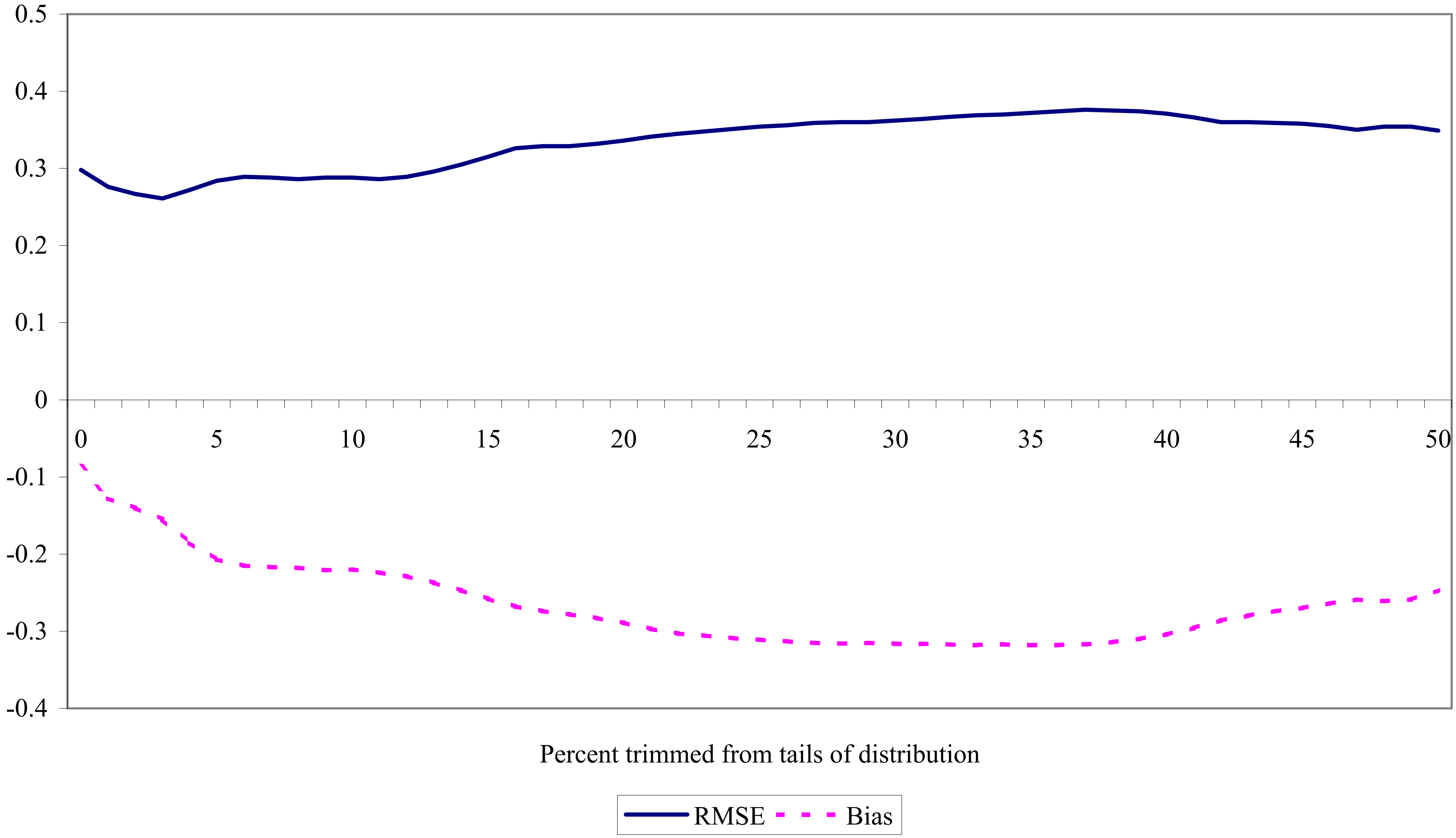

Figure 4A
Recent behaviour of core measures

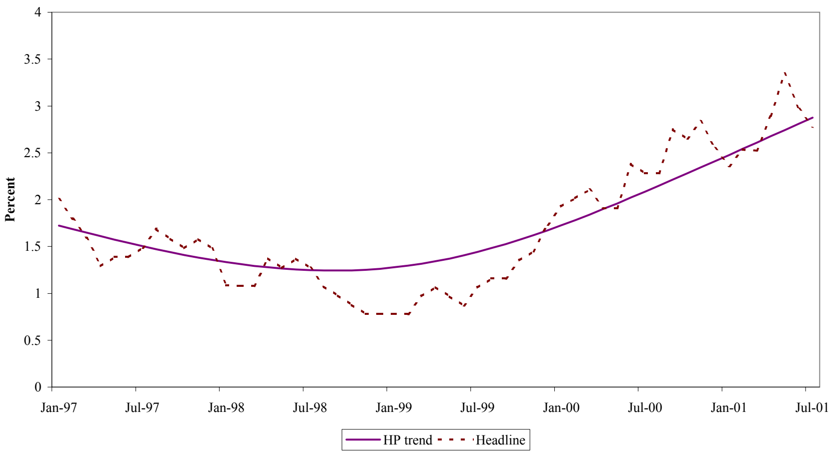

Figure 4b
Recent behaviour of core measures

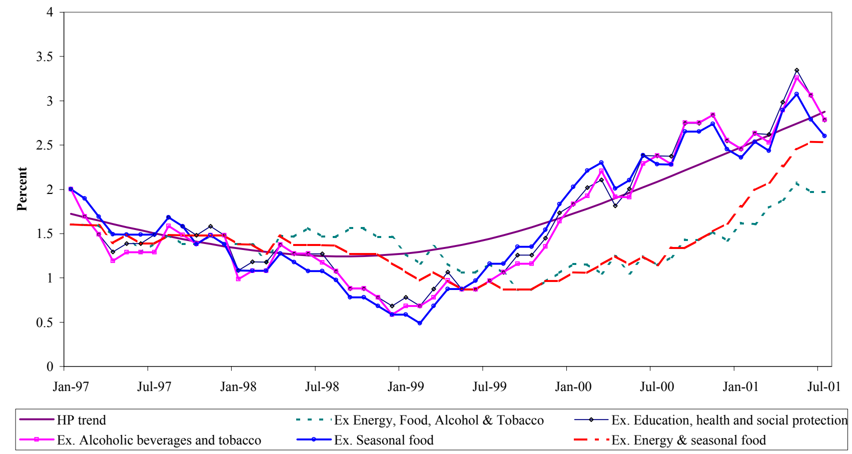

Figure 4c
Recent behaviour of core measures

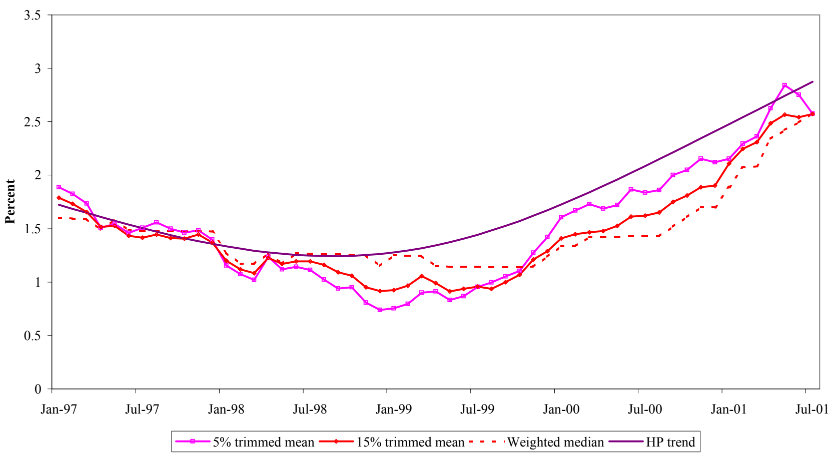

Figure 4d
Recent behaviour of core measures