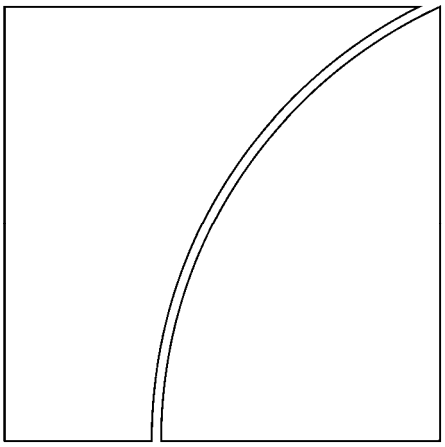
Irving Fisher Committee on Central Bank Statistics



# IFC Working Papers

No 3

# Design and evaluation of core inflation measures for Turkey

by Oğuz Atuk and Mustafa Utku Özmen

March 2009

BANK FOR INTERNATIONAL SETTLEMENTS

IFC Working Papers are written by the staff of member institutions of the Irving Fisher Committee on Central Bank Statistics, and from time to time by, or in cooperation with, economists and statisticians from other institutions. The views expressed in them are those of their authors and not necessarily the views of the IFC, its member institutions or the Bank for International Settlements.

Copies of publications are available from:

Irving Fisher Committee on Central Bank Statistics
Bank for International Settlements
Press & Communications
CH-4002 Basel, Switzerland

E-mail: publications@bis.org

Fax: +41 61 280 9100 and +41 61 280 8100

This publication is available on the BIS website (www.bis.org).



ISSN 1994-3865 (print)

ISSN 1994-3873 (online)

# Abstract

This study analyzes core inflation concept for Turkey from the perspective of design and evaluation. To our best knowledge, this is the first study to evaluate the performance of the core inflation measures for Turkey. We first define and calculate new core inflation indicators using the disaggregated price data for the time period of January 1994 to June 2007. The core inflation measures developed in this paper include weighted median, trimmed mean and volatility-based measures along with the permanent exclusion-based methods. Later, we evaluate the performance of the core inflation measures with regards to pre-defined criteria including unbiasedness, reduced volatility, trend tracking ability and predictive ability. Considering the significant shift in the inflation process in Turkey, we split the sample into two as pre- and post-2003 when evaluating the performance of the core inflation measures. Overall, no single core inflation indicator stands out alone as "the core" and therefore different core measures should be followed simultaneously to get a better understanding of the real trend of inflation and to identify various shocks hitting the inflation. However, limited influence estimators and volatility-based core measures perform relatively better compared to permanent exclusion-based methods. The study also provides an extensive analysis of the distribution of price changes at various aggregation levels.



JEL Classification Numbers: C13, C22, C43, E31.

Keywords: Inflation, core inflation, Turkey.

# Contents

# I. Introduction[1]

Identification of inflation process is vital for all economic agents in the market. Although the public attention on inflation relies simply on headline inflation, what matters basically for the policy authorities is the trend of inflation since headline inflation is mostly subject to different types of shocks, which mask the main inflation process. Therefore, central banks try to define different measures of inflation in order to extract the "correct" information from the inflation process. These types of efforts mainly lead to the concept of core inflation.

The theoretical discussion of core inflation initially departs from the idea of persistency. Inflation process may be divided into two components: persistent and transitory. Persistency argument states that what matters for the policy makers is the core, persistent part of the inflation, not the transitory part. The transitory part of inflation is mainly driven by temporary shocks, which affect the headline inflation in the short term, but are reversed in the periods to follow. That is to say, the policy makers should focus on core inflation that indicates the real trend in inflation process by reflecting demand pressures, permanent shocks in relative prices and changes in expectations while neglecting supply shocks. In short, this trend, or the underlying inflation, capture the persistent component in inflation for the policy horizon of the policy makers, removing the aspects that should not affect the policy maker's decision process.

Apart from the identification of the shocks, volatility and the issue of control stand as important arguments for the design and use of core inflation measures. Price changes in some items within the CPI basket are quite volatile. Whether the source of the volatility is definite or not, this volatility distorts the general perception of the price changes and makes it difficult for the policy maker to judge what the real price change for a specific period is. Moreover, some items of the CPI move mainly by non-monetary factors. For example, the price changes of administered goods and services are mainly determined by factors, which are out of control of the policy makers. Consequently, policy maker should somewhat take into account the volatile items and the issue of control while formulating the monetary policy, which provide the baseline for the use of core inflation measures adjusting for these effects.

The core inflation measures are especially useful under an inflation-targeting regime, where central banks try to achieve a specific target set for the future, generally for the medium term. The medium term may be defined as the period, which is long enough for the policy decisions to be effective or, alternatively, long enough for the fluctuations in the inflation to be smoothed out. Such a perspective, which relies on the prediction of future inflation behavior, enables the central banks to take preemptive action. However, as the headline inflation is subject to different sorts of temporary shocks and is quite volatile in nature, central banks require inflation indicators that are as noise free as possible, as well as having some predictive power for the future inflation. Therefore, effective core inflation measures, by providing better information about the fundamental trend of inflation, may serve as a useful operational policy guide for the central banks within the inflation targeting framework.

The general conditions for a core inflation measure to satisfy on theoretical basis are fairly straightforward. Roger (1998) suggests that a core inflation measure should be timely, credible, easily understood by the public and not significantly biased with respect to a targeted measure. Wynne (1999), also, states that the core measure should be computable in real time, be forward looking in some sense, be robust and unbiased, have a track record of some sort, have some theoretical basis, be understandable by public and not be revised. Among these conditions timeliness, non-revision, ease of computation and understandability may be classified as the practical conditions. Unbiasedness, reduced volatility and predictive ability on the other hand can be grouped as the empirical criteria.

[1] We would like to thank Cevriye Aysoy, Hakan Kara, Ümit Özlale, Erdal Özmen, M. Eray Yücel and two anonymous referees for valuable comments and useful contributions. Central Bank of Turkey, corresponding author: oguz.atuk@tcmb.gov.tr.

In summary, in an empirical setting, a core inflation measure should in the long run behave similar to the CPI inflation, but be less volatile than that, provide some information about the current inflation process, track the trend of inflation, and finally have predictive content for the future movements of headline inflation.

There is no clear unique way to define and measure core inflation. Instead, there are various methods to calculate core inflation measures. The effort to define the correct core inflation measure is somehow idealistic. This relies heavily on complete identification of the pricing behavior within the economy, which is mostly uncertain. Thus, it is not easy to design a measure, which may satisfy all the desired properties at once. Therefore, for operational purposes, following more than one indicator is important to analyze the differences in behavior of various measures in order to identify different temporary or idiosyncratic shocks hitting the prices in the economy. Finally, the choice of which core inflation measure to use depends on the empirical facts and the needs of the specific country.

In this study, alternative core measures for Turkey are calculated and their performances on a specified set of criteria are evaluated. In the next section a review of some common core measures in the literature is given. In Section III, the evaluation criteria of the measures are followed by the descriptive statistics of inflation rates and the structure of the CPI data in Section IV. Alternative core measures for Turkey are presented and evaluated in Section V.

## II. Methods to calculate alternative core measures

There are various ways to define core inflation measures in the literature. The design of the measures relies on the desired features of the indicators. One leg of the literature stems from the theoretical definitions of the core inflation concept. This mainly builds on the persistency argument and generalized aspect of inflation concept[2]. These models tied with the theory include structural vector auto regressions and unobserved component models. Recently, dynamic factor index models, which aim to provide real time estimates of underlying inflation, are developed[3]. As the functioning and the structure of the economy are not adequately identifiable, the use of the theoretical models is still limited. Plus, these measures are subject to revisions as new data is available and they are difficult to communicate with the public.

The second leg of the literature focuses on various statistical methods for calculating core inflation measures. In fact, as the uncertainties about the functioning of the economy and the general pricing behavior are present, statistical measures are introduced, in order to design core inflation measures that satisfy the basic empirical features. The statistical measures include methods like permanent exclusion, period-by-period exclusion, reweighting and limited influence estimators. This study focuses only on statistically developed core inflation measures and leaves model-based core inflation constructions, i.e. dynamic factor models, as a future extension.

### II.1. Permanent exclusion method

The most commonly used and known core inflation measures are those that exclude pre-specified items of the CPI basket permanently. A widely popular and traditional example is the CPI excluding food and energy. The idea of the permanent exclusion of certain items is two folds. First, some items are subject to supply shocks and the large price changes in these items are likely to reflect relative price changes rather than a general inflationary move.

[2] Roger (1998) provides a discussion of the core inflation as persistent inflation and as generalized inflation.

[3] Dynamic factor models use a broader set of data to display the estimates of the underlying inflation. Christadoro et al. (2005) and Amstad and Potter (2007) estimate dynamic factor models of core inflation for Euro area and US respectively. Giannone and Matheson (2007), on the other hand, use only disaggregated price data.

That is, the vulnerability of certain product group prices to supply shocks obscures accurate analysis of the general outlook of inflation. For example, unprocessed food prices are mainly subject to supply shocks and are a main source of volatility in the headline inflation, and therefore, may be excluded permanently. Second, the price changes of certain items are beyond the control of the policy makers. For instance, the development of energy prices, indirect taxes and (mortgage) interest payments are also generally excluded on the grounds that they are erratic and endogenous to monetary policy making (Silver, 2007). Therefore, the case for exclusion suggests that excluding these items and focusing on the ones over which the central bank has control may be desirable policy-wise.

The main advantage of using the permanent exclusion method is that it is quite easy to calculate and communicate with the public. Plus, this method mainly requires no assumptions or restrictions, and is not subject to revision. This way, the method is easy for the public to apprehend and accept. On the other hand, these types of measures are not very successful in removing all the supply shocks and the volatility since by definition the excluded items are definite and are not revised at all with data realizations. In addition, Amstad and Potter (2007) raise that removing volatility may also cause removing the early signs of any change in the inflation process.

### II.2. Period-by-period exclusion of volatile items method

The permanent exclusion-based core measures are not always successful in identifying and removing all the volatility and shocks in the price data. Thus, a period-by-period exclusion-based on specific criteria can be more appropriate. For example, food and energy are the most pronounced volatile groups in the CPI. But are they really? If we look at the food group in more detail, as the individual processed and unprocessed products, can we identify the main sources of volatility? If the answer to the latter question is yes then by excluding the whole group, instead of the volatile part, we may exclude an important signal of the general trend of inflation. To this end, to call a certain product volatile, a data driven analysis should be undertaken. This method proposes to identify volatile items and exclude them only in periods in which their price changes are significantly more volatile compared to the average price changes.

### II.3. Limited influence estimators

Limited influence estimators are measures, which simply remove a specified percentage from the tails of the distribution of price changes and re-compute the weighted average of the remaining price changes. The necessity of a core measure that is not influenced by extreme price variations as mentioned above, forms the basis for the limited influence estimators. The calculation of limited influence estimator is similar to that of the period-by-period exclusion-based methods. That is, the items that show extreme price variations relative to the general distribution of price changes for each month are identified and are then excluded from the calculation. The level of the measure as will be discussed in detail below determines the threshold value to call a variation extreme.

Empirical evidence as excellently summarized by Roger (2000), clearly indicates that the distribution of price changes in different countries and time periods are skewed to the right and have chronic excess kurtosis. As shown in Section IV, the same argument holds for the Turkish data for different time periods. Previous work done by Berkmen (2002) supports the findings between 1988 and 1998 period. Empirical studies also show that for right-skewed and leptokurtic distributions, limited influence estimators such as weighted median and trimmed mean are found to be more efficient than the standard weighted arithmetic mean. Ball and Mankiw (1994) provide some theoretical explanation for the use of limited influence estimators, where they suggest that the supply shocks can cause temporary skewness in the distribution of price changes. On the other hand, others propose that demand shocks may

also cause temporary skewness (Bakhshi and Yates, 1999). From this point, it is also argued that an increase in skewness may also be an indication of a persistent future inflation.

The non-normality of the distribution of cross sectional price changes, persistent kurtosis and fat tails of distribution, justify the use of measures like trimming. As Bryan and Cecchetti (1993) promote such measures in pursuit of efficient inflation estimation, Aoki (2001) raises one caution by suggesting that the changes in sticky prices tend to be large as they are infrequent. So, trimmed measures are likely to exclude these changes, while in fact these might be changes to which a central bank should respond. Other criticism focuses on the composition of the trimmed measures. These are the difficulties in obtaining forecasts of inflation and communicating the changes in inflation rate of trimmed measures over time compared with other measures whose compositions do not change in time.

*Symmetric trimmed mean* approach is simply removing (trimming) a specific percentage symmetrically from each tail of the distribution of the price changes and taking weighted average of the remaining price changes. That is, the price changes for a specific period along with the relative weights are first ordered and then the corresponding cumulative weights for each price change are calculated. Following that, the tails of the distribution are symmetrically trimmed (with the specified trimming percentage) and then the weighted average of the remaining part is calculated, which gives the trimmed mean inflation for that period.

*Weighted median* is a special form of trimmed mean, where, for a specific period, the two tails of the distribution are trimmed so that only the 50$^{th}$ percentile, which is the weighted median, of the ordered price changes remains in data. For detailed calculation procedures of limited influence estimators please refer to Appendix 1.

### II.4. Reweighting measures

Another set of methods focus on assigning new weights to items in CPI basket according to a pre-specified criterion. These methods named as reweighting methods, mainly use volatility as the criteria and penalize the items with higher volatility. In this methodology, the original weight of an item in the CPI basket is adjusted by a factor inversely related to the volatility of that item (i.e. double weighted measure)[4]. Another reweighting method takes into account the persistency of the price changes of items. As proposed by Cutler (2001), this measure assigns higher weights to items with higher predicted persistency. In practice, the main disadvantage of reweighting methods is that they assign alternative weights to the items, different from their share in the consumption basket, distorting the relative importance of the items included in inflation calculation.

Cutler (2001) followed Blinder's approach – of alternative definition of core inflation as the durable or persistent part of inflation – to distinguish the signal from the noise by identifying the persistent part of the inflation by estimating the following first order autoregressive model:

$$\pi_i^t = \alpha_i + \rho_i \pi_i^{t-12} + \varepsilon_i^t$$

where, $\pi_i^t$ is the monthly price changes for subgroup *i*, and $\hat{\rho}_i$ is taken to be the persistency indicator for the *i*$^{th}$ subgroup. If for the *i*$^{th}$ subgroup model, the value of $\hat{\rho}$ is found to be negative, then that subgroup is assigned zero weight and the remaining subgroups with nonnegative $\hat{\rho}$ values are reweighted in the calculation of the aggregate reweighted CPI.

[4] Bank of Canada follows a core inflation measure, among others, CPIW, which is an example of the double-weighted measure. CPIW assigns new weights to 54 components of the CPI, which are inversely related to the standard deviation of the change in relative prices of the items. For details, see Lafleche and Armour (2006).

## III. Evaluation of core inflation measures

As discussed above, in an empirical setting, a core inflation measure should in the long-run behave similar to, but be less volatile than CPI inflation, be able to track the trend of inflation, and also have predictive content for the future movements of headline inflation. Therefore, the empirical evaluation of different types of core inflation measures generally focuses on these properties as addressed below.

### III.1. Unbiasedness

A measure of core inflation is expected to be unbiased with respect to the headline inflation in the long-run. Although in the short-run, core measures and the headline may divert from each other, in the long-run these diversions should die out and the mean of core inflation is expected to be same as that of the headline inflation.

To illustrate this argument some studies simply focus on the unconditional means of core inflation measures and the headline over different time periods and compare whether they are similar[5]. Some studies do test for the unbiasedness of the core measures by different specifications. For example, Bryan and Cechetti (1994) decompose the CPI inflation as:

$$\pi_t = \pi_t^c + \nu_t$$

where, $\pi_t$ is the CPI inflation (in annual terms), $\pi_t^c$ is the underlying inflation and $\nu_t$ is a temporary disturbance term which can be interpreted as a relative price shock, at period t. In the case of no relative price shock, there should be no difference between the underlying and the headline inflation. Thus, if a core measure is a good proxy of the underlying inflation, then it should be unbiased with respect to CPI inflation. Under such a framework, to test for unbiasedness, $\beta_0 = 0$, $\beta_1 = 1$ coefficient restrictions are jointly tested in the following equation:

$$\pi_t = \beta_0 + \beta_1 \pi_t^c + \nu_t ,$$

Unbiasedness is an important evaluation criterion for core measures. Moreover, unbiasedness is particularly important if the core measures are to be used for forecasting path of the CPI inflation (Heath et al. 2004). The empirical studies suggest that the findings on the unbiasedness of the core inflation measures differ depending on the sample period[6]. Therefore, it is a common practice to test for unbiasedness in different sample periods, controlling for the regime changes or major shifts in the inflation process.

The presence of bias may result from the way the most volatile items are filtered by each indicator. Bias may also come from the divergence in the behavior of the sub-components. For instance, under such an outcome where services prices are more persistent than goods prices, and given that the share of services in core inflation measures is higher than that in the headline, core indicators may diverge from the headline inflation. Although an indicator is a biased estimator of the headline inflation, as Rich and Steindel (2007) put it, it may still provide useful information as long as the bias is stable over time and can be corrected for.

### III.2. Volatility

One of the main arguments for the construction and use of core measures is the volatility present in the headline inflation. Hence, the headline inflation does not provide a clear

[5] Clark (2001) reports the average rates of inflation both for the headline and the core measures. The time period he uses is over 30 years, and for the US price data, he finds that over a long-enough period, the unconditional means of the headline and the core measures are quite similar, if not the same.

[6] See Catte and Slok (2005), Amstad and Potter (2007) and Rich and Steindel (2005) for recent empirical findings.

indication of the real inflation process, as the conclusions or the remarks made may change substantially. In design of core inflation measures, the main goal is to minimize the excess volatility stemming from the price changes in sub-components. Obviously, a good core inflation measure should have a lower volatility compared to the headline inflation. This is perhaps the main evaluation criterion that all the studies regard as *sine qua non* for the core indicators.

To measure the volatility of the inflation measures, many studies focus on the standard deviation of the annual inflation of the indicator for a given sample period and compare it with that of the headline inflation. Coefficient of variation, which adjusts for the differences in mean of various indicators, is also widely reported[7]. The empirical findings on the volatility of core inflation measures reveal that the core measures are less volatile than the headline inflation in general. However, the reduction in volatility achieved by core measures varies across time periods and across countries (Catte and Slok 2005).

### III.3. Tracking the trend inflation and efficiency

As the headline inflation is subject to various shocks and is volatile in nature, it does not provide reliable information about the real trend of inflation. This leads to another important criterion that the core measures should satisfy in a way. That is, the core inflation measures should track the trend inflation somehow, expectedly more efficiently than the headline itself does.

Some studies simply report the similarity of the means of the headline and the core measures as an indication of the tracking ability of the core measures of the headline inflation[8]. In general, however, the tracking ability of the core measures is analyzed with respect to the trend inflation. The trend inflation, which is unobservable, can be computed – or approximated – in various ways. One way is to use the conventional filters such as the band pass filter. Alternatively, moving averages of the headline inflation is used to reveal the underlying trend inflation[9]. Once a measure of the trend inflation is calculated, then, each core inflation measure is analyzed according to its ability to follow that trend. To assess the tracking ability, root mean square error and mean absolute deviation are the generally accepted criteria.[10]

### III.4. Predictive ability

The core inflation measures are expected to have some predictive power on the movements of the headline inflation. This predictive ability can be analyzed in two parts: in-sample prediction ability and out-of sample forecasting ability. Core inflation measures should have some explanatory power for the headline inflation within the sample. As the policy makers are concerned with the future path of the inflation, core measures should also be able to help forecast the future inflation. For predictive ability, different methods are used in the literature.

---

7 In addition to these, Armour (2006) uses mean-absolute change in the year-on-year inflation in each month. Catte and Slok (2005) also define two additional measures of volatility. In companion to above, they propose the use of standard deviation of the first difference of the annual inflation as a measure of high-frequency volatility, along with the autocorrelation coefficients of the one-month inflation rates as a measure of persistency, i.e. lower volatility.

8 Clark (2001) puts it as a tracking-trend indicator. However, similarity of the means is rather an indicator of unbiasedness of the core measures.

9 To construct the trend inflation, Dolmas (2005) and Rich and Steindel (2005) uses Baxter-King (1999) band pass filter. Whereas, Bryan and Cecchetti (1993) and Clark (2001) use centered moving average of the headline inflation. This study follows the Bryan and Cecchetti approach.

10 The details of the calculation and evaluation of this criterion to the Turkish CPI data is given in section V.3.3.

Cogley (2002) proposes a model to test the predictive ability of a core measure in the sense that whether or not the current deviation between the core measure and headline inflation help explain the deviation of the current from the future inflation:

$$\pi_{t+h} - \pi_t = \alpha_h + \beta_h(\pi_t - \pi_t^c) + u_{t+h}$$

Here, $\pi_t$ is the headline inflation and $\pi_t^c$ is a measure of the core inflation.

This model inherits the idea of headline inflation converging to core inflation in the medium-run. Therefore, if the shocks to headline inflation are independent of the core inflation, then, the current deviation between the core and the headline will perfectly predict the transient part of the inflation, which will in fact be the level of adjustment in the headline inflation in the medium term. That is to say, this model carries the intuition that if the core measure is identifying the transient price changes, then, the core deviation should be indicating a reversal in the headline inflation. The $\beta_h$ coefficient measures the degree of how accurate the core deviation measures the size of the transitory part of inflation. Here, $\beta_h$ being higher (lower) than 1 in absolute value suggests that the current core deviation understates (overstates) the magnitude of the current transient inflation.

Another set of models focus on the marginal information added by the core measures on the information provided by an autoregressive framework. These models seek to measure the improvement realized by the introduction of core measures into the simple autoregressive forecasts of headline inflation. Consider the following model[11]:

$$\pi_t = \alpha_0 + \alpha_1\pi_{t-12} + \alpha_2\pi_{t-1}^c$$

where $\pi_t$ is the annual headline inflation and $\pi_t^c$ is a measure of core inflation. The predicted ability is measured as the marginal improvement in the $R^2$ of the forecast equation, on the $R^2$ of the baseline autoregressive equation, provided by the core measures[12].

It is reasonable in a sense that the policy makers seek a core measure, which is a good forecaster of the future headline inflation. However, considering the construction of the core measures, that they usually measure the trend inflation disregarding the temporary effects, it is not very reasonable to expect an indicator series to forecast headline inflation, which is indeed subject to temporary shocks. Due to this property of the core measures, their predictive and forecasting ability are relatively poor. This is why some researchers do not consider predictive ability as a desirable property of core measures. Although this may be the case, testing the predictive ability of the core measures is still informative for classification purposes.

## IV. Inflation in Turkey

Turkey experienced high levels of inflation in the 1990s. This high inflation environment continued in early 2000's, and only after 2002 a decent disinflation process started. The inflation was triggered by two major economic crises hitting the economy in 1994 and in 2001. Inevitably, in 1994, annual inflation jumped from around levels of 70 to 125 percent and from 30 to 70 percent in 2001. Starting with 2002, annual inflation started to come down significantly to single digit values, which marks the structural transformation in the inflation process in Turkey (Figure 1). Therefore, the first period from 1994 to 2002 is characterized

[11] Hogan et. al. (2001) name these type of models as the "indicator models". Lafleche (1997) first used these models for the core measures for Canada.

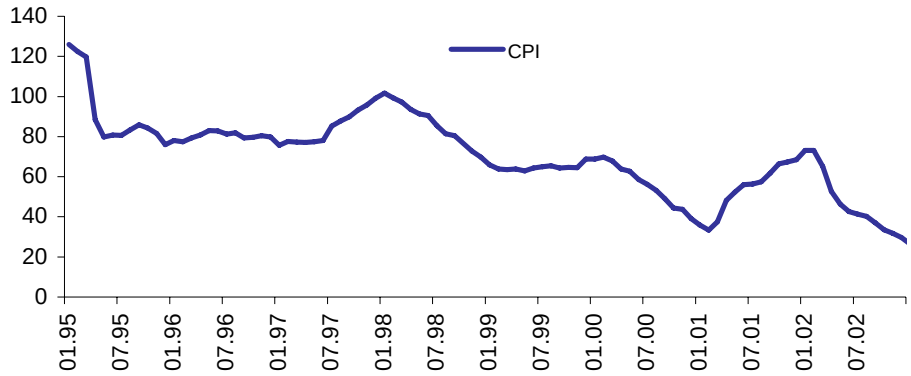
[12] To measure the additional information provided by the core measures, the model is first run in the autoregressive form (i.e. only the lagged value of the headline inflation) and the R2 is reported. Later on, each core measure is individually added to this simple model and the new R2 is calculated. The marginal change in the R2's of the two models is reported.

by a considerably high inflation, whereas, the latter period, from 2003 onwards, is characterized by the rapid and steadily declining inflation. The transition from the first to the second period is a true structural change not only in the inflation itself, but also in the organization and policy formulation. Second period coincides with the increased independence of the central bank, introduction of inflation targeting regime[13], and altogether a more determined monetary and fiscal policy for reducing inflation.

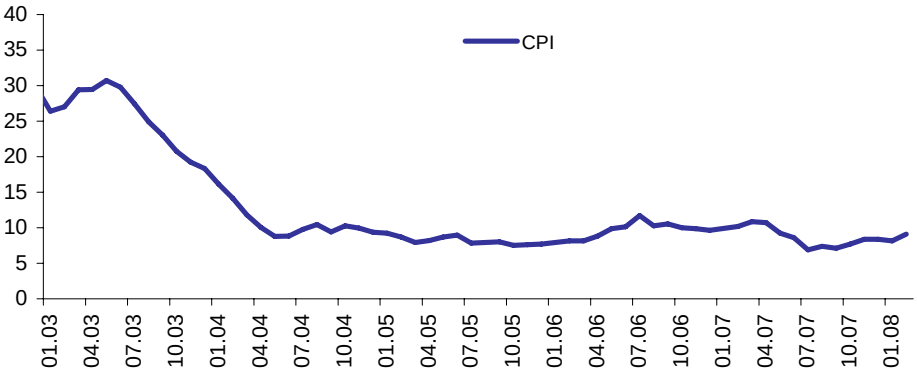
Figure 1

**Annual CPI inflation**

1994–2002




2003–2007




The regime change and the shift in the inflation dynamics are significant. Therefore, it is useful and necessary to take this structural shift of the inflation process into account while analyzing the recent behavior of inflation in Turkey.

Two different consumer price indices are used to calculate consumer inflation from 1994 to 2007. The first price index, with a base year of 1994 remained in use until 2004. This price index was constructed in a way that the relative weight scheme and coverage of the index remained fixed throughout the life of the index. Later, a new price index utilizing a different computation methodology with the base year 2003 is introduced. The new index is a chain index where the coverage and the weighting scheme are updated annually. In addition, the 1994 base year index uses arithmetic mean as the calculation methodology, while the 2003 base year index uses geometric mean instead.

[13] Central bank introduced implicit targeting at the beginning, before going to explicit targeting in 2006.

## IV.1. Turkish CPI data

Before going further into different core inflation methods, a review of the descriptive statistics of the consumer price series would provide useful insights to the statistical properties of Turkish price data.

In this study, we calculate and analyze core inflation measures using the disaggregate consumer price data from 1994 to 2007. However, as stated above we base our analysis in two different samples; that is we split the sample into two from 2003[14]. The choice of splitting the sample into two periods is justifiable as the behavior of price changes differ significantly. First, Table 1 shows the descriptive statistics of the headline CPI inflation for selected sample periods[15].

Table 1

**Descriptive statistics of CPI inflation**

| | **Annual Inflation** | | | **Monthly Inflation** | | |
|---|---|---|---|---|---|---|
| | **1994-2007** | **1994-2002** | **2003-2007** | **1994-2007** | **1994-2002** | **2003-2007** |
| Mean | 49.98 | 70.72 | 13.12 | 3.33 | 4.57 | 0.86 |
| Median | 56.27 | 72.92 | 9.95 | 2.94 | 4.3 | 0.81 |
| Stdev | 32.14 | 19.62 | 7.14 | 2.83 | 2.66 | 0.79 |
| Min | 7.52 | 29.75 | 7.52 | –0.57 | 0.58 | –0.57 |
| Max | 125.89 | 125.89 | 30.74 | 23.38 | 23.38 | 3.1 |

The table shows that both the mean and the standard deviation of the annual inflation are lower in the after-2003 period. The monthly mean and median inflation rates of the pre 2003 period are significantly higher than those of the period of 2003 onwards. Another interesting point is that in the 1994–2002 sample, the minimum monthly change is positive, that is, no negative monthly price change is reported for that period.

As stated above, in this study, we use disaggregated Turkish consumer price series. The 1994-based index is available at four-digit level, whereas the 2003-based index is available at three, four and five digit levels. The digits in the price data refer to the aggregation levels. Starting from 11 digits, the price data is aggregated (in order) to seven, five, three and two digits. Thus small digit data refer to higher aggregation levels, such that the main expenditure groups are in two digit levels[16]. In the 1994 index, there are 103 four-digit series. In the 2003 index, there are 44 three-digit, 94 four-digit and 150 five-digit series. The monthly price change distributions differ significantly across different indices and at different aggregation levels. Table 2 shows the descriptive statistics of the distribution of monthly price changes[17].

[14] The 2003-base year price index is published from January 2005, but the data is available from January 2003. Therefore, in the analysis, we use the old index for the pre-2003 period and the new index starting from 2003.

[15] The full sample is from February 1994 to June 2007.

[16] For instance, two-digit group of 01 is the “food and non-alcoholic beverages group”. The three-digit group of 011 is “food” subgroup. The four-digit group of 0111 is “bread and cereals”. The five-digit group of 01111 is “rice” and so on.

[17] These results are obtained by pooling all cross-sections.

Table 2

**Descriptive statistics of the disaggregated monthly price changes**

| | Mean | Median | Stdev | Kurtosis | Skewness |
|---|---|---|---|---|---|
| 2003_5 digit | 0.72 | 0.40 | 3.48 | 77.09 | 3.79 |
| 2003_4 digit | 0.73 | 0.36 | 2.99 | 29.79 | 2.51 |
| 2003_3 digit | 0.75 | 0.40 | 2.46 | 16.96 | 2.40 |
| 1994_4 digit* | 4.76 | 2.96 | 8.09 | 51.57 | 5.57 |

*1994–2002 sample period.

First, average mean, median as well as the standard deviations of the monthly price changes in the pre-2003 period are significantly higher than those of the after-2003 period. Second, the improvement in the distribution of price changes (in terms of skewness and kurtosis statistics) is evident.

The main observation from these figures is that the distributions of price changes of the items in Turkish CPI, as expected, are not normal, i.e. leptokurtic and skewed to the right. Indeed, the distributions of price changes at each aggregation level are found skewed to the right with excess kurtosis (Table 2). As expected, the distribution of price changes improves as the aggregation level of the series increases. When the sampling period is changed, using data between February 1994 and December 2004, the distribution of price changes shows a more significant deviation from normal distribution (with higher skewness and kurtosis statistics). These findings question the reliability of the central tendency measure, the arithmetic mean, as an indicator of the general trend of inflation. For a complete analysis of the distributional properties of price changes one may refer to Appendix 2.

# V. Core inflation measures for Turkey

## V.1. Exclusion-based methods

### *V.1.1. Permanent exclusion*

In this study, four measures of permanent exclusion-based methods are analyzed. The measures are the result of the work[18] of Technical Committee[19] formed to develop core inflation measures for Turkey. Currently eight core measures under the name “Special CPI Aggregates (SCA)” are published periodically along with the price indices. The measures used in the study are:

*CPI Excluding Unprocessed Food Products (SCA-B):* Indicator B is calculated by excluding the prices of unprocessed food from the CPI. Hence, the CPI is adjusted for supply shocks originating mostly from agricultural production.

*CPI Excluding Energy (SCA-C):* C aggregate is obtained by excluding energy prices from the CPI. “Energy”, which does not exist as a main group within the CPI, corresponds to the sum of energy items within and outside of houses. Within this framework, the energy item is made

[18] Special CPI Aggregates for Turkey, Core Inflation Technical Committee Report, Central Bank of Turkey, February 2005.

[19] Technical Committee of Core Inflation was formed by the experts of the Central Bank of Turkey, Turkish Statistical Institution, State Planning Organization and Undersecretariat of Treasury in 2004 and developed new core measures for CPI with the introduction of the new price index with base year 2003.

up of the sources of energy used within the houses for heating and cooking purposes; expenses of tap water and out-of-house items such as fuel-oil.

*CPI Excluding Unprocessed Food Products and Energy (SCA-D):* With indicator D, the CPI is adjusted for shocks that could arise from the prices of not only unprocessed food products, but also from energy items.

*CPI Excluding Unprocessed Food Products, Energy, Alcoholic Beverages, Tobacco and Gold (SCA-H)*: Indicator H is obtained by excluding alcoholic beverages and tobacco products (whose prices are administered by indirect taxes), and gold (which is vulnerable to international price shocks) from SCA-D.[20]

### *V.1.2. Period-by-period exclusion of volatile items*

The standard deviation and mean of the monthly inflation of all subgroups for each month are first calculated. Then, at five-digit aggregation level, the monthly inflations of all indices are checked with the calculated total mean and standard deviation for the whole sample. Four levels of volatility thresholds (1, 1.5, 2 and 2.5 standard deviations) are analyzed. That is, the items, which fall outside of 1, 1.5, 2 or 2.5 standard deviations of the mean are called volatile, according to the level of threshold used for the specific month and are excluded from calculating the average inflation rate.

The list of the most volatile items with the appropriate frequencies is given in Appendix 3.

### *V.1.3. Limited influence estimators*

Symmetric Trimmed Mean: Following the definition given in II.3, at each month, the price changes of each series along with their corresponding weights in the CPI are first ordered. Then the trimming percentage is decided on the cumulative weights of the ordered series. Apart from the trimming percentage, the aggregation level of the price indices used is also of importance for the calculation. As shown in section IV.1, the skewness and kurtosis of the price changes drop as the level of aggregation increases. Thus, in theory as the aggregation level of the data increases, lesser trim percentage is needed to achieve a more efficient measure. In this study, at five-digit aggregation level, symmetrical trimmed means are calculated for each percentage level (i.e. from 1 to 99 percent) and the optimal trim ratios for each aggregation level are obtained[21].

Weighted Median: A special case of symmetric trimmed mean, weighted median is calculated using two different aggregation levels. Due to data availability, for 1994–2002 period, 4-digit price data is used. For 2003–2007 period, the calculations are done using the 5-digit aggregation level.

In the presence of nonnormal, leptokurtic and right-skewed distribution of price changes, the use of symmetric filters may exclude valuable information on the right side of distribution, which is part of measured inflation. The way to deal with this issue as in Roger (1997) is to center the trim above 50$^{th}$ percentile, a level where the average price changes of the core measure is in line with that of the headline. However, in this study, only symmetric limited influence estimators are calculated and this issue (mean percentile estimator) is left for future work.

---

[20] The permanent exclusion based methods described are available from the TURKSTAT from 2003. We calculated the history of these measures from 1994 onwards. To calculate the series we used the 4-digit level indices available for the 1994 base year index and the weighting scheme of the (new) 2003 base year index. Then, we combined the two series. This methodology enables us to utilize the most up-to-date information regarding the spending behavior of the households.

[21] In this study, for three levels of aggregation (3, 4 and 5-digit inflation data) optimal trimmed means are calculated. For 1994 base year index, trimmed mean is calculated from 4-digit level prices.

### *V.1.4. Reweighting measures*

Cutler Measure: First of all, to implement Cutler's methodology to the Turkish CPI data, the length of the series is an important issue. The length of the CPI series with 2003 base year makes it impossible to draw valid inferences about the sign of the parameters. In order to overcome this limitation the new index with 2003 base year and the old one with base year 1994 are aggregated at the 4-digit level for all matching 85 subgroups available. Aggregating two different CPI series can be criticized on the grounds that they are structurally and methodologically different as mentioned above. Thus, as will be seen on the next section, the weak performance of the resulting Cutler measure can be attributed to this aggregation methodology.

## V.2. Descriptive statistics of core inflation measures

As discussed in the previous section different core inflation measures are calculated for Turkish consumer price series for the period of 1994–2007. These are CPI excluding unprocessed food (SCA-B), CPI excluding energy (SCA-C), CPI excluding unprocessed food and energy (SCA-D), CPI excluding unprocessed food, energy, alcoholic beverages, tobacco products and gold (SCA-H), weighted median (WM), optimal trimmed mean[22](TR_M), measures excluding volatile items (V_1, V_1.5, V_2 and V_2,5) and the persistency-reweighted Cutler measure (CM). Before discussing the performance evaluation of these measures, we present the descriptive statistics of the measures calculated. Table 3 presents the descriptive statistics of the monthly inflation for the headline CPI along with the core measures for different sample periods.

Table 3

**Descriptive statistics of monthly changes of core measures**

| **1994–2007** | **CPI** | **SCA-B** | **SCA-C** | **SCA-D** | **SCA-H** | **WM** | **TR_M** | **V_1** | **V_1.5** | **V_2** | **V_2.5** | **CM** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean | 3.33 | 3.32 | 3.29 | 3.3 | 3.26 | 2.72 | 2.75 | 2.57 | 2.78 | 2.91 | 3.02 | .. |
| Median | 2.94 | 2.83 | 2.4 | 2.87 | 2.96 | 2.57 | 2.6 | 2.37 | 2.59 | 2.71 | 2.73 | .. |
| Stdev | 2.83 | 3.26 | 3.09 | 3.09 | 3.01 | 2.64 | 2.71 | 2.46 | 2.65 | 2.76 | 3.01 | .. |
| **1994–2002** | **CPI** | **SCA-B** | **SCA-C** | **SCA-D** | **SCA-H** | **WM** | **TR_M** | **V_1** | **V_1.5** | **V_2** | **V_2.5** | **CM** |
| Mean | 4.57 | 4.58 | 4.52 | 4.54 | 4.51 | 3.85 | 3.85 | 3.58 | 3.85 | 4.04 | 4.2 | .. |
| Median | 4.3 | 4.16 | 3.97 | 4.09 | 4.08 | 3.59 | 3.42 | 3.21 | 3.5 | 3.6 | 3.61 | .. |
| Stdev | 2.66 | 3.33 | 3.07 | 3.09 | 2.95 | 2.58 | 2.72 | 2.46 | 2.65 | 2.74 | 3.05 | .. |
| **2003–2007** | **CPI** | **SCA-B** | **SCA-C** | **SCA-D** | **SCA-H** | **WM** | **TR_M** | **V_1** | **V_1.5** | **V_2** | **V_2.5** | **CM** |
| Mean | 0.74 | 0.73 | 0.75 | 0.75 | 0.71 | 0.45 | 0.54 | 0.51 | 0.59 | 0.63 | 0.61 | 0.75 |
| Median | 0.75 | 0.74 | 0.64 | 0.80 | 0.71 | 0.48 | 0.54 | 0.48 | 0.57 | 0.64 | 0.60 | 0.63 |
| Stdev | 0.61 | 0.51 | 0.70 | 0.60 | 0.66 | 0.26 | 0.25 | 0.25 | 0.31 | 0.35 | 0.42 | 0.90 |

The table shows that in the full sample, the mean inflation of exclusion-based measures is close to that of the headline. Whereas, the mean monthly weighted median and trimmed inflation, along with the volatility-based measures have lower means (consistent with high

[22] The optimum is selected based on an efficiency criterion, which will be discussed in detail in following sections. For the record, the optimal trim ratio is found to be 18 percent from each tail of the price change distribution for a given month.

skewness and kurtosis values given in Table 2). In the after-2003 sample, apart from the Cutler measure, SCA-C and SCA-H, all the core measures have a standard deviation lower (or equal to) than that of the headline inflation. Table 4 presents the descriptive statistics for the annual inflation rates.[23]

Table 4

**Descriptive statistics of annual changes of core measures**

| **1994–2007** | **CPI** | **SCA-B** | **SCA-C** | **SCA-D** | **SCA-H** | **WM** | **TR_M** | **V_1** | **V_1.5** | **V_2** | **V_2.5** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean | 49.98 | 49.44 | 48.91 | 49.08 | 48.53 | 39.57 | 39.60 | 36.54 | 39.86 | 42.43 | 44.16 |
| Median | 56.27 | 59.70 | 54.86 | 56.75 | 55.27 | 49.88 | 48.65 | 43.00 | 48.31 | 50.88 | 53.21 |
| Stdev | 32.14 | 32.37 | 32.09 | 31.78 | 32.06 | 26.82 | 26.34 | 23.91 | 25.90 | 27.74 | 29.23 |
| **1994–2002** | | | | | | | | | | | |
| Mean | 49.98 | 49.44 | 48.91 | 49.08 | 48.53 | 39.57 | 39.60 | 36.54 | 39.86 | 42.43 | 44.16 |
| Median | 56.27 | 59.70 | 54.86 | 56.75 | 55.27 | 49.88 | 48.65 | 43.00 | 48.31 | 50.88 | 53.21 |
| Stdev | 32.14 | 32.37 | 32.09 | 31.78 | 32.06 | 26.82 | 26.34 | 23.91 | 25.90 | 27.74 | 29.23 |
| **2003–2007** | | | | | | | | | | | |
| Mean | 13.12 | 12.27 | 12.94 | 12.75 | 11.94 | 7.99 | 8.97 | 8.71 | 9.68 | 10.26 | 10.36 |
| Median | 9.95 | 9.54 | 9.83 | 9.42 | 9.08 | 5.81 | 7.06 | 6.85 | 7.77 | 8.44 | 7.94 |
| Stdev | 7.14 | 6.32 | 7.11 | 6.92 | 6.84 | 5.39 | 4.96 | 4.40 | 4.73 | 5.01 | 5.42 |

The descriptive statistics for the annual inflation figures show that in the after-2003 period, all the measures have lower means and standard deviations than the headline annual inflation. The finding is no surprise considering the sample period. As discussed above, after-2003 period is marked by strong disinflation process. Therefore, as the trend inflation is decreasing and the core measures are better able to follow the trend, while the headline is subject to positive temporary shocks, core measures signal to lower average values.

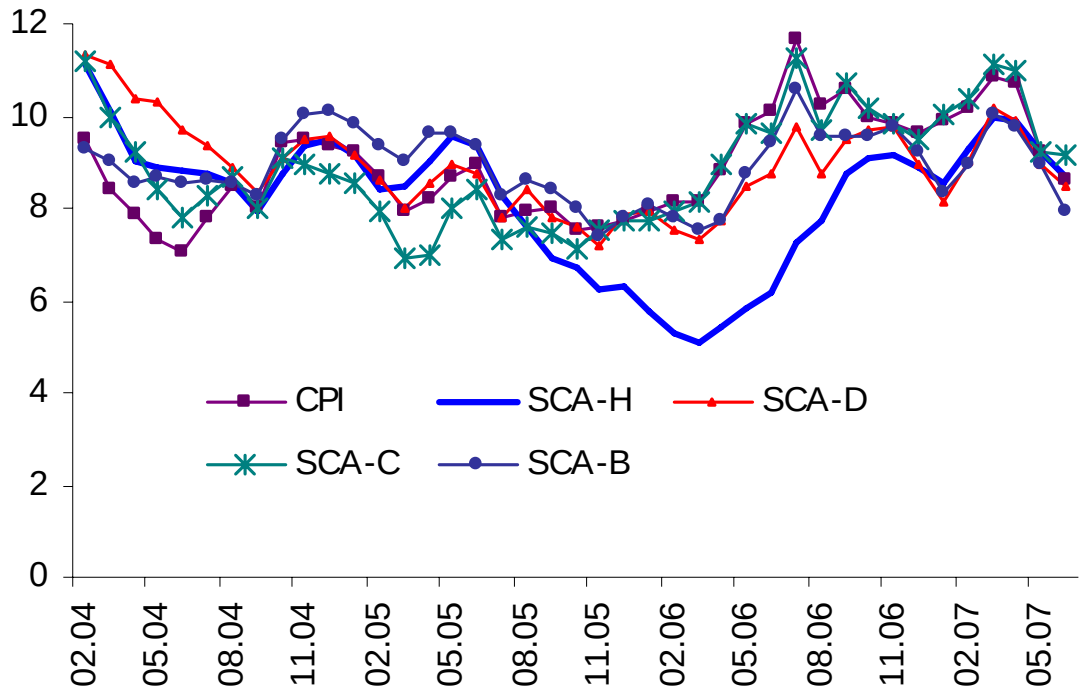
Usually, the core measures are calculated from monthly inflation data, whereas the evaluation or the comparisons mainly rely on the annual inflation. Therefore, before going into the evaluation, we present the annual inflation of various core measures. The annual inflation of the traditional permanent exclusion-based measures move quite closely to the headline inflation, whereas, other measures show a greater variety (Figure 2).

[23] Cutler measure is available from 2003 onwards. Therefore, the annual inflation of this measure starts from 2004 and is not comparable with other measures. Therefore, the descriptives of the Cutler measure in terms of the annual inflation is not reported.

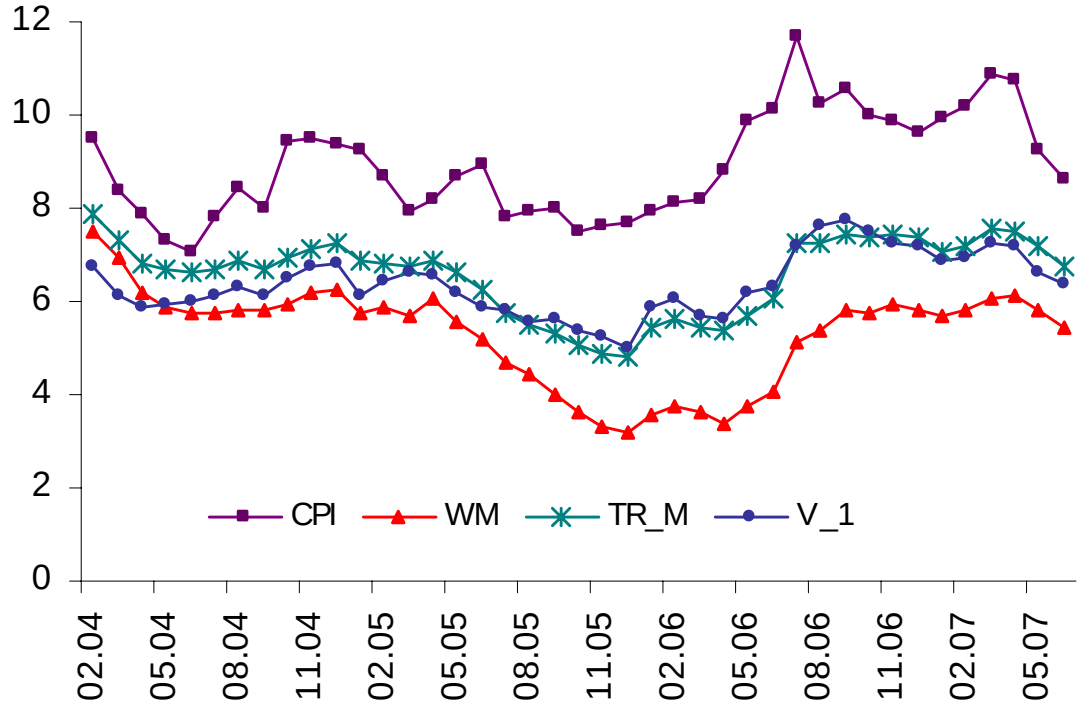
Figure 2

**Annual change of core inflation measures**

Permanent exclusion methods




Others



As discussed previously, the distribution of price changes of the headline inflation is not normal with high excess kurtosis and skewness. It is however reported that the distribution of monthly price changes improve significantly in some core measures (Table 5). Details on distribution issues are analyzed in Appendix 2.

Table 5

**Distributional statistics of monthly change of core measures**

| | Mean | Median | Stdev | Kurtosis | Skewness |
|---|---|---|---|---|---|
| CPI | 0.72 | 0.40 | 3.48 | 77.09 | 3.79 |
| TR_M | 0.52 | 0.40 | 0.62 | 1.31 | 0.85 |
| V_1 | 0.49 | 0.37 | 1.18 | 4.39 | –0.11 |
| V_1.5 | 0.53 | 0.39 | 1.49 | 6.59 | –0.03 |
| V_2 | 0.55 | 0.39 | 1.73 | 6.71 | 0.10 |
| SCA-H | 0.66 | 0.42 | 2.52 | 36.59 | 2.93 |
| SCA-B | 0.69 | 0.40 | 2.63 | 59.43 | 4.02 |
| SCA-C | 0.70 | 0.40 | 3.48 | 76.09 | 3.74 |
| SCA-D | 0.66 | 0.39 | 2.62 | 59.92 | 3.99 |

The descriptive analysis of the core measures will not be final without the discussion of the excluded items from the core measures. Some of the measures, i.e. the trimmed mean and volatility-based measures exercise period-by-period exclusion. Generally, seasonal items (i.e. unprocessed food, clothing, package holidays) are excluded in these measures. In addition, items whose prices are sensitive to exchange rate (i.e. computers, airfreight, durable goods) are also excluded, as their changes are volatile. It is also noted that the coverage of the volatility-based measures is higher than the coverage of the optimal trimmed mean inflation. In contrast to most of the permanent exclusion-based methods, energy items are mostly kept in the period-by-period exclusion-based core measures[24]. The details and the list of the excluded items along with the frequency are presented in Appendix 3.

## V.3. Evaluation of core measures

In the above section, the core inflation measures calculated from the Turkish consumer price data along with a presentation of the descriptive statistics are introduced. In this section, all calculated core inflation measures are evaluated in accordance with the empirical criteria entitled in the third section, namely, unbiasedness, volatility, tracking the trend inflation and predictive ability[25]. The core measures are evaluated on the basis of annual inflations.

### *V.3.1. Unbiasedness*

In this section, unbiasedness of the core measures is evaluated. For this purpose, we discuss the testing procedure proposed by Bryan and Cecchetti (1994) as described previously for Turkish data.

Before going in to the analysis, it is important to stress that unbiasedness is a condition for a core inflation measure to satisfy over the long run. Thus, conducting such tests when the

[24] For instance, for the volatility-based method (V_1), while the fresh food item is excluded almost 70% of the time, most frequently excluded energy item (natural gas) is only excluded 20% of the time.

[25] In this section, all core measures but Cutler measure are analyzed due to unavailability of this measure from 1994.

length of inflation data is not adequate to perform a long run analysis, it is very likely to witness that this condition is not satisfied. As seen in the descriptive tables, there is a level difference between the headline and the core measures over the disinflation period. In the long run, shocks hitting the inflation can cancel out and the average tendency of the core inflation measures do not differ significantly from the headline inflation. However, in our sample, which is short in nature, the shocks hitting the inflation are mostly positive. That is, the shocks are one-way only. Therefore, in such an environment, any form of unbiasedness tests would not yield meaningful results.

Nonetheless, in this study we performed the tests for informative concerns. The annual Turkish CPI inflation and the entire core measures used in the study between the periods 1994 and 2007 are found to be non-stationary[26]. This is mainly due to the structural change of the price data with the start of a distinct disinflation period. For this reason, the tests carried out for unbiasedness, presented in section III.1, are modified for first differences of both the CPI and core measures. However, working with first-differenced series is likely to lead to long-run divergent movements between the headline and the core measures, while keeping a stable relation between the first differences. Indeed, as the results are not meaningful, they are not reported. To sum up, to test for unbiasedness, a longer sample is needed. And in the presence of non-stationarity, a more plausible way to proceed is to use the cointegration framework as proposed in Marques, Nevent and Sarmento (2003).

### *V.3.2. Volatility*

The volatility of headline inflation and various core measures are compared in this section. The measures of volatility are calculated from annual inflation figures. Table 6 presents three different volatility measures for the two sample periods: Standard deviation of the year-on-year inflation, mean absolute deviation of the change in year-on-year inflation and the standard deviation of the change in year-on-year inflation.

Table 6

**Volatility of annual inflation of core measures**

| | **1994–2002** | | | **2003–2007** | | |
|---|---|---|---|---|---|---|
| | **Standard dev.** | **Mean abs. dev. of first difference** | **Std. dev. of first difference** | **Standard dev.** | **Mean abs. dev. of first difference** | **Std. dev. of first difference** |
| CPI | 19.62 | 2.91 | 4.60 | 7.14 | 0.90 | 1.16 |
| SCA-B | 19.85 | 3.62 | 6.20 | 6.32 | 0.74 | 0.91 |
| SCA-C | 20.92 | 3.51 | 5.45 | 7.11 | 1.04 | 1.42 |
| SCA-D | 19.62 | 3.37 | 5.63 | 6.92 | 0.76 | 0.88 |
| SCA-H | 19.92 | 3.17 | 5.27 | 6.84 | 0.77 | 1.01 |
| WM | 15.05 | 2.82 | 4.57 | 5.39 | 0.47 | 0.65 |
| TR_M | 15.52 | 2.73 | 4.73 | 4.96 | 0.46 | 0.65 |
| V_1 | 14.07 | 2.27 | 3.92 | 4.40 | 0.45 | 0.60 |
| V_1.5 | 15.20 | 2.65 | 4.47 | 4.73 | 0.53 | 0.72 |
| V_2 | 16.55 | 2.85 | 4.76 | 5.01 | 0.58 | 0.77 |

[26] Indeed, the CPI and all the core measures are found to be first difference stationary I(1) using Augmented Dickey-Fuller test.

In pre-2003 period, according to the table it is not easy to distinguish the differences in the volatility of the headline inflation and the core measures, as mixed results are reported. However, in the after-2003 sample, all of the core measures, except for the SCA-C, are less volatile than the headline inflation in all three benchmarks. TR_M and V_1 measures are the least volatile core measures in the second sample[27].

These findings suggest that the core measures (except for SCA-C) considered in this study satisfy the primary criterion of having lower variability than headline inflation in the after-2003 period.

### *V.3.3. Tracking the trend inflation and efficiency*

To evaluate the trend-tracking ability of the various core inflation measures, first of all, trend inflation should be defined and computed. Indeed, the selection of benchmark trend inflation is crucial in comparing the efficiencies of alternative core measures. As discussed previously, the sample arithmetic mean is no longer minimum variance unbiased estimator of the first moment if the normal distribution assumptions of the price changes are violated. To calculate the most efficient estimator of the first moment of the distribution of price changes, a benchmark of the general trend of inflation is needed. Then, the efficiency of a candidate series is judged on its ability to track the movements in the benchmark trend inflation (Bryan, Cecchetti, Wiggins II, 1997).

The differences in the new and former price indices as mentioned above are the major limitations in linking two series to construct a longer time series that is necessary for efficiency analysis. To this end, to minimize the structural discrepancies between two indices, the weighting scheme of the new index is extended for past data to construct a longer time series. That is, a time series covering January 1994 to June 2007, with the weights of the 2003 index is constructed to calculate 18, 24 and 36-month centered moving averages of monthly headline inflation as the general trend.[28]

In this study, 18, 24 and 36-month centered moving averages of the monthly headline inflation are taken as the benchmark series. Root mean square error (RMSE) and mean absolute deviation (MAD) are taken as the efficiency criteria[29]. Bryan, Cecchetti, Wiggins II (1997) applied a bootstrap procedure and generated 10,000 samples for each of the subcomponents of the CPI. Then they checked the relative efficiencies of the alternative core measures they had developed using RMSE and MAD criterion. They found that the most efficient measure was 7 percent[30] trimmed mean. They then compared these findings using available historical data and found that 9 percent trimmed mean was the most efficient. Berkmen (2002) in her study to develop trimmed mean measures for the Turkish price series, replicated the bootstrap procedure and found that the most efficient trimmed mean measure

---

[27] Considering the variability of the monthly inflation, TR_M again provides the lowest volatility compared with other indicators. It is also noted that almost all of the indicators, other than SCA-C, have a reduced volatility in terms of monthly inflation; while the reduction in the volatility of the permanent exclusion based indicators is not significant. For details, see Appendix 4.

[28] To calculate a 36-month centered moving average 18-month forecasts and backcast of the series are necessary to obtain the statistics for the tails of the series. June 1995 is considered to be adequate for the lower tail so no further backcasts are used, but starting from the most recent month (i.e. June 2007) 18-month inflation forecasts are incorporated to the series.

[29] Root Mean Squared Error is calculated by using $RMSE = \sqrt{\frac{1}{n}\sum_1^n (\pi_t - \pi_t^{trend})^2}$, while Mean Absolute Deviation is calculated by using $MAD = \frac{1}{n}\sum_1^n \left|\pi_t - \pi_t^{trend}\right|$, where $\pi_t$ is the monthly inflation of a candidate measure and $\pi_t^{trend}$ is the monthly trend (benchmark) inflation.

[30] $\alpha$ percent-trimmed mean refers to trimming $\alpha$ percent from each tail of the distribution, therefore the total trim percentage is $2\alpha$ (14 percent in this case).

was 5 percent and 3 percent using RMSE and MAD measures, respectively. Similarly, using historical Turkish price series the optimal trimmed means were 31 percent and 19 percent respectively.

Table 7 summarizes the calculated efficiency measures for the core measures under study. For all three different benchmarks used, first of all, the most efficient trimmed mean measure was found to be 18 percent trimmed mean using both the RMSE and the MAD criteria. Then the efficiency of this measure with respect to the other alternative measures are checked and it is found to be the most efficient. The efficiency gain of the optimal trimmed mean is remarkable. Trimming 18 percent from each tail increases the efficiency by about 34 percent using 36-month centered moving average as the benchmark. One interesting finding is that the deviation of the CPI excluding energy prices from the benchmark is even higher than that of the headline CPI for all the benchmarks analyzed. This finding limits the use of the SCA-C aggregate as a core measure alone since the excluded component, namely energy, moves in line with the general trend for the time period analyzed. Similarly, the same argument holds for the Cutler measure, where no efficiency gain with respect to the headline inflation is found.

The trend-tracking ability comparison of the core measures yields that the TR_M (optimal trimmed mean) is a more efficient indicator than the other core indicators. On the other hand, the trend-tracking ability of the permanent exclusion-based measures is not very different than the headline inflation itself.

Table 7

**Efficiency measures of core inflation indicators under various benchmarks***

| | **RMSE_36** | **RMSE_24** | **RMSE_18** | **MAD_36** | **MAD_24** | **MAD_18** |
|---|---|---|---|---|---|---|
| CPI | 0.62 | 0.61 | 0.59 | 0.50 | 0.48 | 0.47 |
| SCA-B | 0.55 | 0.53 | 0.51 | 0.46 | 0.44 | 0.41 |
| SCA-C | 0.69 | 0.68 | 0.66 | 0.56 | 0.54 | 0.54 |
| SCA-D | 0.61 | 0.59 | 0.56 | 0.50 | 0.48 | 0.46 |
| SCA-H | 0.61 | 0.59 | 0.56 | 0.50 | 0.48 | 0.46 |
| WM | 0.47 | 0.44 | 0.45 | 0.42 | 0.39 | 0.39 |
| TR_M | 0.41 | 0.38 | 0.38 | 0.34 | 0.32 | 0.31 |
| V_1 | 0.46 | 0.43 | 0.44 | 0.37 | 0.35 | 0.34 |
| V_1.5 | 0.44 | 0.42 | 0.42 | 0.37 | 0.35 | 0.34 |
| V_2 | 0.43 | 0.41 | 0.40 | 0.37 | 0.35 | 0.34 |
| V_2.5 | 0.49 | 0.48 | 0.47 | 0.42 | 0.41 | 0.39 |
| Cutler | 0.88 | 0.87 | 0.86 | 0.72 | 0.70 | 0.68 |

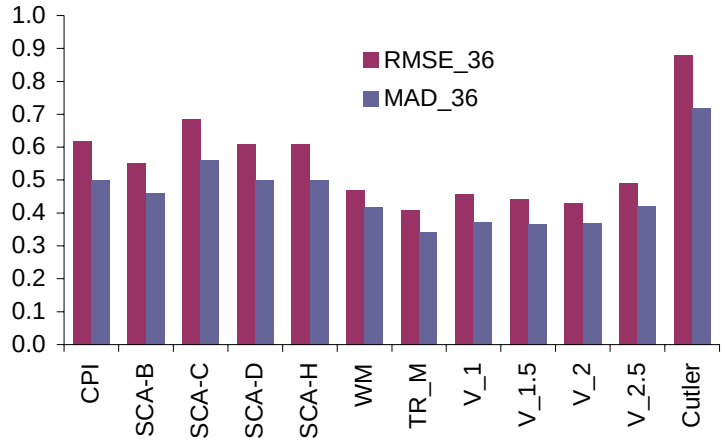
*RMSE and MAD are Root Mean Squared Errors and Mean Absolute Deviation respectively. 36, 24 and 18 refers to the number of months used in calculating the trend inflation as averages.

The relative efficiencies of the measures are robust to different set of benchmarks, namely 18, 24 and 36-month centered moving averages of the headline inflation. Trimming 18 percent from each tail of the price distribution provides maximum efficiency gain for all benchmarks and the evaluation criteria used (Figure 3). For instance, when the 36-month moving average of CPI is used as the benchmark, (Figure 3.a), both RMSE and MAD criteria give the same ordering of the efficiencies. Also, when MAD is used as the evaluation criterion, for example, then, the choice of the benchmark series does not make a difference in the ordering of the efficiencies.

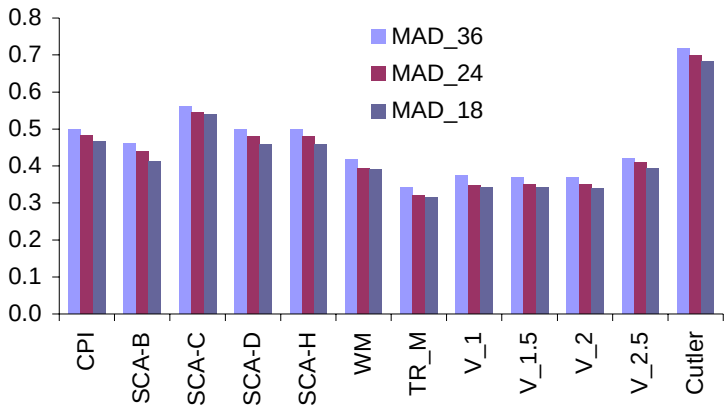
Figure 3

**Efficieny Measures of the Core Indicators**

a. Same benchmark, different criterion




b. Different benchmark, same criterion




### *V.3.4. Predictive ability*

To test for the predictive ability, various equations are estimated as discussed previously. For this study, the indicator model, as done in Hogan, Johnson and Lafleche (2001) is used to determine the information content of each core measure that improve the simple autoregressive forecast of total CPI. The following form of equation is estimated:

$$\pi_t^{CPI} = \beta_0 + \beta_1 \pi_{t-12}^{CPI} + \beta_2 \pi_{t-1}^{c} + \nu_t$$

where $\pi^{CPI}$ and $\pi^{c}$ are the annual CPI and core inflation measures respectively. First differences of the above form of equations are performed to satisfy stationarity conditions on the annual core inflation series. Initially, the above equation is estimated without the core measure, i.e. the CPI is modeled as a simple autoregressive form and the coefficient of determination ($R^2$) of the estimation is noted. Then each core measure is added to this simple autoregressive model and the marginal increases in the $R^2$s are reported in the Table 8.

Table 8

**Indicator tests***

| Marginal Changes in $R^2$ values | | | |
|---|---|---|---|
| | **Full Sample** | **1995–2002** | **2003–2007** |
| SCA-B | 0.20 | 0.18 | 0.31 |
| SCA-C | 0.18 | 0.18 | 0.09 |
| SCA-D | 0.17 | 0.16 | 0.16 |
| SCA-H | 0.17 | 0.16 | 0.16 |
| WM | 0.19 | 0.18 | 0.29 |
| TR_M | 0.23 | 0.22 | 0.33 |
| V_1 | 0.26 | 0.24 | 0.31 |
| V_1.5 | 0.25 | 0.23 | 0.35 |
| V_2 | 0.21 | 0.19 | 0.37 |
| V_2.5 | 0.23 | 0.21 | 0.34 |

The equations are estimated again for three different time periods. According to the table, the information added to the simple autoregressive model prediction by the TR_M and volatility core measures increased in the 2003–2007 sample period. While, between the same periods, an improvement in the marginal $R^2$ contribution is only observed in SCA-B measure among all permanent exclusion-based measures analyzed. SCA-C measure is the only measure where the marginal contribution of information to the autoregressive CPI model decreases.

Overall, although all permanent exclusion-based measures but SCA-C have additional explanatory power over an autoregressive model prediction, their marginal contribution to the headline inflation prediction is lower compared to that of other indicators under study. Especially in the 2003–2007 period, the improvements in the marginal contribution to $R^2$ values are more significant.

With the drawbacks mentioned in section III.4, tests on predictive ability are used for their informative content only. Because in some cases, policy makers may also be interested in seeing the in-sample or out-of-sample predictive ability of the core inflation measures. However, the tests on predictive ability, if used alone, can be misleading for comparison between alternative core measures, especially in disinflation period, where the high proportion of the volatility of headline inflation is attributed to the noise, which is excluded in core measures. Another caution about the predictive ability analysis lies in the possibility that the results may be biased in a way that the measures with a higher coverage, which in fact contain some of the excess volatility, tend to better predict the headline inflation. Therefore, considering trend tracking ability and the predictive ability, it is strictly emphasized that the trend tracking ability of a core measure is a much more desirable property than its predictive ability.

The trend tracking ability, predictive ability and the level of volatility of the core measures may be used for ranking purposes for evaluating the core measures. The performance of various indicators in terms their rankings are summarized below (Table 9).

Table 9

**Summary of performance in after-2003 sample**

By ranking*

| | Lower Volatility | Trend Tracking | Predictive Ability |
|---|---|---|---|
| SCA-B | 7 | 7 | 6 |
| SCA-C | 10 | 10 | 10 |
| SCA-D | 9 | 9 | 9 |
| SCA-H | 8 | 8 | 8 |
| WM | 5 | 5 | 7 |
| TR_M | 3 | 1 | 4 |
| V_1 | 1 | 4 | 5 |
| V_1.5 | 2 | 3 | 2 |
| V_2 | 4 | 2 | 1 |
| V_2.5 | 6 | 6 | 3 |

*The rankings are formed as follows: For volatility, the least volatile indicator; for the trend tracking, most efficient indicator gets the highest ranking (for trend tracking, the ranking is robust to different benchmark and evaluation criteria). Whereas, for predictive ability, the indicator with the highest contribution to prediction gets the highest ranking.

The results of the summary table suggest that there is no single indicator, which performs the best regarding all the evaluation criteria. While, TR_M and V_1.5 and V_2 perform reasonably better compared to other measures. Performance of permanent exclusion-based methods is poorer compared to others, SCA-C having the poorest performance as expected.

## VI. Conclusion

In this paper, commonly used core inflation methods are outlined and these methods are applied to Turkish consumer price index. Among these methods are the permanent exclusion methods, which are officially published by Turkish Statistical Institute, as well as other measures, which, some are calculated for the first time, such as limited influence estimators, period-by-period exclusion methods, re-weighting measures.

It is evident that there is no single best core inflation measure that satisfies all the desired properties and account for all types of shocks. Therefore, defining more than one indicator is necessary to identify different temporary or idiosyncratic shocks hitting the prices in the economy.

For the case of Turkey, a need for various core measures increased with the start of a disinflation period from year 2002. The period before this year is characterized by considerably high inflation, where the core inflation measures and the headline inflation do not deviate significantly from each other. Thus, in this period all the core inflation measures analyzed in the study yield similar results and move in line with the general trend of inflation. Therefore, the information content of the core measures is limited. However, with the start of the disinflation period the measures yield more diversified results, requiring objective evaluation criteria to compare them.

Four evaluation criteria are used to compare the properties and performance of the measures under study. The first criterion is to test the unbiasedness of measures with respect to headline inflation in the long-run. This criterion showed to be not determinative, as the sample length is not adequate enough to perform a stable unbiasedness analysis. Second criterion compared the relative volatility of the measures with respect to the headline inflation. Accordingly, V_1 and optimal TR_M measures are found to be least volatile core measures whereas the permanent exclusion-based measures showed a poor performance in removing the volatility inherent in the headline inflation. The third criterion is to test the trend tracking ability of the measures. For all different benchmark trend inflation measures used, the optimal TR_M is found the most efficient measure. The permanent exclusion-based measures have no significantly better trend tracking ability than the headline inflation. Finally, the fourth criterion tests the additional predictive ability of the measures over the autoregressive movements of the headline inflation. All measures, especially period-by-period exclusion methods and limited influence estimators, show significant additional explanatory powers.

The results of the evaluation criteria suggest that in a structurally changing environment, static core inflation methods such as permanent exclusion-based measures are not very successful in identifying and removing all the shocks in the prices compared to more dynamic methods such as the limited influence estimators and the period-by-period exclusion-based core measures. The period-by-period exclusion-based core measures can be called a modification of asymmetric trimmed mean. That is, period-by-period exclusion-based core measures are nothing but asymmetric trimmed means for a specific period, where the trim ratio (asymmetric) changes each period. More specifically, they are dynamic versions of asymmetric trimmed means. Therefore it is not surprising to find the performances of these two types of measures are alike.

Among all core measures analyzed in the study, the performance of the optimal trimmed mean (18 percent from each tail) is worth mentioning. The measure with low volatility and high predictive power is also the most efficient measure in tracking the trend of inflation. However, the concept of core inflation in an emerging economy, like in Turkey, that is prone to different types of shocks should not be limited to a single measure. Monetary authorities should monitor alternative core measures to get insights of the inflation process stemming from the differences between these measures. Moreover, apart from static measures, which are easy to communicate, continuously updated dynamic measures, which are more successful in identifying and removing shocks, should be developed and followed.

# Appendix 1:
# Calculation methods of limited influence estimators

### *a. Trimmed Mean*

As mentioned previously on Section IV, three levels (3, 4 and 5-digit level) of disaggregated CPI series are used in the calculations. For each level, the monthly inflation rates of the series along with their weights in the CPI basket (denoted by {x1, x2,…, xn}, and {w1, w2,…, wn} respectively) are ordered. The cumulative weight of the ordered $i^{th}$ series, is denoted by: $W_i = \sum_{i=1}^{n} w_i$ . Following the notation of Bryan, Cechetti and Wiggins II (1997) the set of observations to be used in $\alpha$ percent trimmed mean calculation is the *i*'s satisfying the $\frac{\alpha}{100} < W_i < (1 - \frac{\alpha}{100})$ condition, which is called $I_\alpha$. Thus, the weighted arithmetic mean formula is given by:

$$\bar{x}_\alpha = \frac{1}{1 - 2\frac{\alpha}{100}} \sum_{i \in I_\alpha} w_i x_i .$$

### *b. Weighted Median*

As given in section II.3, the weighted median is a special case of trimmed mean, where the two tails of the distribution are trimmed so that only the 50$^{th}$ percentile, which is the weighted median, of the ordered price changes remains in data. Following the above formula, weighted median is $\bar{x}_{50}$ . Noting that a continuity adjustment of the price changes, which are discrete in nature, can be made (Silver, 2007), in this study no such adjustment is made. That is, the weighted median is the discrete observation that is greater than the 50$^{th}$ percentile of the observations under $I_\alpha$ .

# Appendix 2:
# Distribution characteristics of consumer price changes in Turkey

A certain price index is actually a sample drawn from aggregate population of prices. Thus the distribution characteristics of price changes can only be measured from this particular sample noting that they can differ from those of the population distribution due to factors like measurement error and compilation methodology. A measure can be called a robust estimator of central tendency if such measure is minimally affected, if not unaffected, by unusual sample distributions of price changes.

It is trivial that the sample mean is the best estimator of the population mean if the population distribution of price changes is approximately normal. If the normality condition is not satisfied then the sample mean may not be the best estimator.

Roger (1997), aiming to develop a robust measure of core inflation for New Zealand verified the finding that "high kurtosis makes the sample mean a less efficient and less robust estimator of the population, or underlying, mean price change than is an order statistic such as the median".

Following the notation of Bryan and Cechetti (1996) skewness and kurtosis of the distribution of price changes are calculated as follows:

The inflation in an individual component *i* of CPI at time t is denoted by $\pi_{it}$. The mean inflation in each time period is:

$\prod_t = \sum_i w_i \pi_{it}$ , where $w_i$'s are the weights of the individual components. Then the higher-order central moments are calculated with the following formula:

$$m_r(t) = \sum w_i (\pi_{it} - \prod_t)^r$$

The scaled third moment skewness is:

$$S_t = \frac{m_3(t)}{\left[m_2(t)\right]^{(3/2)}}$$

Finally the scaled fourth moment kurtosis is:

$$S_t = \frac{m_4(t)}{\left[m_2(t)\right]^{(2)}}$$

The efficiency of the estimators that put higher weight on the tails of the distribution (with respect to estimators that put lower weight), falls as the kurtosis of a distribution increases. That is to say, for distributions where the kurtosis of the distribution is less than 3, the kurtosis of the normal distribution, the most efficient estimators put relatively high weight on the tails. For distributions with kurtosis level greater than 3, the most efficient estimator puts lower weight on the tails. Trimmed mean is a common example of an estimator that puts relatively low weight in the tails.

The skewness and kurtosis of the distribution of monthly consumer price changes in Turkey is given below in Table A1.

Table A1

**Descriptive statistics of the disaggregated monthly price changes**

| | Mean | Median | Stdev | Kurtosis | Skewness |
|---|---|---|---|---|---|
| 2003_5 digit | 0.72 | 0.40 | 3.48 | 77.09 | 3.79 |
| 2003_4 digit | 0.73 | 0.36 | 2.99 | 29.79 | 2.51 |
| 2003_3 digit | 0.75 | 0.40 | 2.46 | 16.96 | 2.40 |

The distribution statistics are calculated cross-sectionally. That is, at each aggregation level the price changes of all components of the CPI at all available sampling period are compounded to form one series of price changes. Alternatively, the distribution of price changes can be analyzed at different aggregation levels. Expectedly, as the aggregation level increases (from five digit to three digit level) the kurtosis and skewness statistics improve, but the distribution of price changes being right skewed and leptokurtic at all aggregation levels, depart from the normal distribution. The kurtosis measures being significantly higher than 3 indicate that measures that put lower weight on tails, such as trimmed mean, weighted median, are more efficient estimators than simple weighted means.

On this study to calculate the core measures, depending on the definition of the measure, first the “noisy” part of the price changes are filtered out. And then weighted arithmetic average of the remaining price changes are taken to calculate the core measures. This calculation methodology enables us to calculate the distribution statistics of the “remaining” price changes of each core measure. This in turn provides insights about the performance of each measure in identifying and removing the “noisy” part of price changes (Table A2).

Table A2

**Distributional statistics of monthly price changes of core indicators**

| | Mean | Median | Stdev | Kurtosis | Skewness |
|---|---|---|---|---|---|
| CPI_5digit | 0.72 | 0.40 | 3.48 | 77.09 | 3.79 |
| TR_M_5digit | 0.52 | 0.40 | 0.62 | 1.31 | 0.85 |
| V_1 | 0.49 | 0.37 | 1.18 | 4.39 | –0.11 |
| V_1.5 | 0.53 | 0.39 | 1.49 | 6.59 | –0.03 |
| V_2 | 0.55 | 0.39 | 1.73 | 6.71 | 0.10 |
| SCA-H | 0.66 | 0.42 | 2.52 | 36.59 | 2.93 |
| SCA-B | 0.69 | 0.40 | 2.63 | 59.43 | 4.02 |
| SCA-C | 0.70 | 0.40 | 3.48 | 76.09 | 3.74 |
| SCA-D | 0.66 | 0.39 | 2.62 | 59.92 | 3.99 |
| Cutler | 0.72 | 0.35 | 3.01 | 31.03 | 2.57 |

The improvement of the distribution in limited influence estimators is evident. The optimal trimmed mean is found to be the most successful measure in identifying the components in the CPI that distort the distribution. On the other hand, performance of the permanent exclusion methods are relatively poor, since by definition these measures exclude fixed items, which may not be the source of noise all the time.

# Appendix 3:
# List of excluded items

### *a. List of items excluded from Trimmed Mean Indicator*

Table A3

**List of items excluded from Trimmed Mean Indicator**

| Categories (5 digit level) | | Exclusion frequency |
|---|---|---|
| 1131 | Fresh fish and sea products | 94.34% |
| 1171 | Leaf and stem vegetables | 92.45% |
| 1145 | Egg and related products | 88.68% |
| 1161 | Fresh fruits | 88.68% |
| 3121 | Garments for men | 86.79% |
| 3122 | Garments for women | 86.79% |
| 1172 | Potatoes and other tuber vegetables | 84.91% |
| 3212 | Footwear for women | 84.91% |
| 1125 | Poultry | 83.02% |
| 3123 | Garments for children | 81.13% |
| 7111 | Purchase of new motor cars (diesel) | 81.13% |
| 8200 | Telephone and telefax equipments | 77.36% |
| 9120 | Photographic and cinematographic equipment | 77.36% |
| 9600 | Package holidays | 77.36% |
| 4530 | Liquid fuels | 75.47% |
| 12310 | Jewelery (gold) | 75.47% |
| 3211 | Footwear for men | 73.58% |
| 9130 | Information processing equipment | 73.58% |
| 7330 | Transport of passengers by airplane | 69.81% |
| 9111 | Television sets, video-cassette players and recorders | 66.04% |
| 9112 | Equipment for the reception, recording and reproduction of sound | 66.04% |
| 3213 | Footwear for children | 62.26% |
| 9510 | Books | 60.38% |
| 5312 | Clothes washing machines, clothes drying machines and dish washing | 58.49% |
| 9150 | Repair of audio-visual, photographic and information processing equipment | 58.49% |
| 5315 | Other big household appliances | 56.60% |
| 7220 | Fuels and lubricants | 56.60% |
| 5311 | Refrigerators, freezers and fridge-freezers | 54.72% |

| | | |
|---|---|---|
| 4521 | Natural gas | 52.83% |
| 5313 | Cookers | 52.83% |
| 5320 | Small electric household appliances | 50.94% |
| 7113 | Purchase of new motor cars (gasoline) | 49.06% |
| 5112 | Bedroom furniture | 47.17% |
| 9410 | Recreational and sporting services | 47.17% |
| 7323 | Transport of passengers by overland | 45.28% |
| 6132 | Therapeutic appliances and equipment | 41.51% |
| 1141 | Whole milk | 39.62% |
| 5113 | Living and dining room furniture | 39.62% |
| 12540 | Transport insurance | 39.62% |
| 2202 | Other tobacco products | 37.74% |
| 5611 | Cleaning and maintenance products | 37.74% |
| 1124 | Meat of ovine | 35.85% |
| 6131 | Eyeglasses and contat lenses | 35.85% |
| 7130 | Bicycles | 35.85% |
| 1174 | Dried vegetables | 33.96% |
| 1181 | Sugar | 33.96% |
| 3124 | Garments for infant | 32.08% |
| 12120 | Other appliances for personal care | 32.08% |
| 1115 | Pasta products | 30.19% |
| 1152 | Margarine and other vegetable fats | 30.19% |
| 4522 | Liquefied hydrocarbons (butane, propane, etc.) | 30.19% |
| 5120 | Carpets and other floor coverings | 30.19% |
| 1162 | Dried fruits | 28.30% |
| 2201 | Cigarettes | 28.30% |
| 4100 | Rent | 28.30% |
| 4540 | Solid fuels | 28.30% |
| 1122 | Meat of veal | 26.42% |
| 1153 | Other oils | 26.42% |
| 2130 | Beer | 26.42% |
| 6232 | Services of medical auxiliaries | 26.42% |
| 1126 | Other preserved or processed meat and meat preparations | 24.53% |
| 1127 | Other fresh, chilled or frozen edible meat | 24.53% |
| 1143 | Other milk products | 24.53% |
| 1184 | Confectionery products | 24.53% |
| 4420 | Refuse collection | 24.53% |
| 5330 | Repair of household appliances | 24.53% |

| | |
|---|---|
| 6110 Pharmaceutical products | 24.53% |
| 1113 Bread | 22.64% |
| 5622 Household services | 22.64% |
| 9220 Musical instruments | 22.64% |
| 12111 Hairdressing for men | 22.64% |
| 12321 Travel equipments and other personal accessories | 22.64% |
| 12322 Other personal accessories n.e.c. | 22.64% |
| 12530 Health insurance | 22.64% |
| 1221 Mineral or spring waters | 20.75% |
| 1222 Soft drinks | 20.75% |
| 1223 Fruit juices | 20.75% |
| 2121 Wine from grape or other fruit | 20.75% |
| 3130 Other articles of clothing and clothing accessories | 20.75% |
| 7340 Transport of passengers by sea and inland waterway | 20.75% |
| 7360 Other purchased transport services | 20.75% |
| 9142 Blank types and cds | 20.75% |
| 9520 Newspapers and magazines | 20.75% |
| 10500 Other education programmes | 20.75% |
| 11201 Hotel accomodation | 20.75% |
| 11202 Other accomodation services | 20.75% |
| 12130 Appliances and products for personal care | 20.75% |
| 12400 Social services | 20.75% |
| 1151 Butter | 18.87% |
| 2110 Spirits and liqueurs | 18.87% |
| 4410 Water supply | 18.87% |
| 6212 Doctor fee | 18.87% |
| 6300 Basic hospital services | 18.87% |
| 7230 Maintenance and repairs of personal motor cars | 18.87% |
| 7240 Other services in respect of personal transport equipment | 18.87% |
| 7311 Intra-city transport of passengers by train, tram, underground railway | 18.87% |
| 9310 Games, toys and hobbies | 18.87% |
| 10300 Post-secondary pre-university education | 18.87% |
| 12112 Hairdressing for women | 18.87% |
| 12520 Housing insurance | 18.87% |
| 12620 Other financial services n.e.c. | 18.87% |
| 1116 Other cereals | 16.98% |
| 1211 Coffee | 16.98% |
| 6220 Dental services | 16.98% |

| | | |
|---|---|---|
| 8100 | Postal services | 16.98% |
| 10100 | Pre-primary and primary education | 16.98% |
| 12700 | Other services n.e.c. | 16.98% |
| 1144 | Cheese | 15.09% |
| 5314 | Heaters, air conditioners | 15.09% |
| 5402 | Cutlery, flatware and silverware | 15.09% |
| 7322 | Transport of passengers taxi | 15.09% |
| 9430 | Games of chance | 15.09% |
| 10200 | Secondary education | 15.09% |
| 11101 | Catering services | 15.09% |
| 1111 | Rice | 13.21% |
| 1175 | Preserved or processed vegetables and vegetable-based products | 13.21% |
| 3140 | Cleaning, repair and hire of clothing | 13.21% |
| 5621 | Domestic services | 13.21% |
| 6231 | Services of medical analysis laboratories and X-ray centres | 13.21% |
| 7312 | Inter-city transport of passengers by train, tram, underground railway | 13.21% |
| 7321 | Intra-city transport of passengers by bus | 13.21% |
| 8300 | Telephone and telefax services | 13.21% |
| 9350 | Veterinary and other services for pets | 13.21% |
| 9421 | Photographic services | 13.21% |
| 9422 | Other cultural services | 13.21% |
| 11102 | Catering services (drinks) | 13.21% |
| 1114 | Pastry cook products | 11.32% |
| 1213 | Cocoa | 11.32% |
| 3220 | Repair and hire of footwear | 11.32% |
| 4510 | Electricity | 11.32% |
| 5200 | Household textile | 11.32% |
| 7210 | Spare parts and accessories of personal transport equipments | 11.32% |
| 1112 | Flour and other cereals | 9.43% |
| 5401 | Glass and crystal-ware for decoration | 9.43% |
| 5403 | Non-electric kitchen equipments and utensils | 9.43% |
| 5612 | Other non-durable household articles | 9.43% |
| 9141 | Recording media for sound and picture | 9.43% |
| 9320 | Equipment for sport, camping and open-air recreation | 9.43% |
| 10400 | University education | 9.43% |
| 1182 | Jams, marmalades and honey | 7.55% |
| 1212 | Tea | 7.55% |
| 9540 | Stationery and drawing materials | 7.55% |

| | | |
|---|---|---|
| 1183 | Chocolate and cacao products | 5.66% |
| 1190 | Other food products n.e.c. | 5.66% |
| 3110 | Clothing materials | 5.66% |
| 5111 | Kitchen furniture | 5.66% |
| 5522 | Hand tools, garden tools and other miscellaneous accessories | 5.66% |
| 4310 | Materials for the maintenance and repair of the dwelling | 3.77% |
| 5521 | Small electric accessories | 3.77% |
| 6120 | Other medical products | 1.89% |

### *b. List of excluded volatile items (according to the benchmark)*

Table A4

**List of Excluded Volatile Items**

| Categories (5-digit level) | | Exclusion frequency | | | |
|---|---|---|---|---|---|
| | | **1 stdev** | **1.5 stdev** | **2 stdev** | **2.5 stdev** |
| 1171 | Leaf and stem vegetables | 68% | 60% | 49% | 38% |
| 1145 | Egg and related products | 55% | 49% | 42% | 36% |
| 1125 | Poultry | 53% | 42% | 34% | 26% |
| 1131 | Fresh fish and sea products | 53% | 38% | 26% | 19% |
| 1161 | Fresh fruits | 51% | 40% | 38% | 34% |
| 3122 | Garments for women | 49% | 42% | 34% | 23% |
| 3212 | Footwear for women | 47% | 32% | 17% | 11% |
| 3121 | Garments for men | 45% | 38% | 28% | 11% |
| 1172 | Potatoes and other tuber vegetables | 36% | 25% | 19% | 15% |
| 3123 | Garments for children | 36% | 32% | 28% | 19% |
| 9600 | Package holidays | 36% | 26% | 17% | 8% |
| 3211 | Footwear for men | 28% | 25% | 9% | 6% |
| 9510 | Books | 28% | 21% | 11% | 8% |
| 8200 | Telephone and telefax equipments | 26% | 15% | 13% | 2% |
| 9120 | Photographic and cinematographic equipment | 26% | 15% | 11% | 9% |
| 3213 | Footwear for children | 25% | 15% | 4% | 2% |
| 12310 | Jewelery (gold) | 21% | 9% | 6% | 6% |
| 4521 | Natural gas | 19% | 13% | 2% | .. |
| 7130 | Bicycles | 19% | 11% | 8% | 8% |
| 9130 | Information processing equipment | 19% | 8% | 4% | 4% |
| 7330 | Transport of passengers by airplane | 17% | 15% | 9% | 6% |
| 12540 | Transport insurance | 17% | 11% | 4% | 2% |
| 9111 | Television sets, video-cassette players and recorders | 15% | 9% | 8% | 4% |
| 5311 | Refrigerators, freezers and fridge-freezers | 13% | 6% | 4% | .. |
| 5312 | Clothes washing machines, clothes drying machines and dish washing | 13% | 6% | 4% | .. |
| 7340 | Transport of passengers by sea and inland waterway | 13% | 13% | 6% | 2% |
| 2121 | Wine from grape or other fruit | 11% | 6% | 2% | 2% |
| 4530 | Liquid fuels | 11% | 6% | 2% | .. |
| 5313 | Cookers | 11% | 2% | 2% | .. |
| 7113 | Purchase of new motor cars (gasoline) | 11% | 6% | 2% | .. |

| | | | | | |
|---|---|---|---|---|---|
| 7220 | Fuels and lubricants | 11% | 2% | .. | .. |
| 9112 | Equipment for the reception, recording and reproduction of sound | 11% | 8% | 4% | 2% |
| 12530 | Health insurance | 11% | 6% | 4% | 2% |
| 12700 | Other services n.e.c. | 11% | 4% | 4% | 2% |
| 2201 | Cigarettes | 9% | 9% | 8% | 6% |
| 4522 | Liquefied hydrocarbons (butane, propane, etc.) | 9% | 2% | .. | .. |
| 5112 | Bedroom furniture | 9% | 6% | 4% | .. |
| 5113 | Living and dining room furniture | 9% | 2% | 2% | .. |
| 5315 | Other big household appliances | 9% | 6% | 4% | 4% |
| 5330 | Repair of household appliances | 9% | .. | .. | .. |
| 6110 | Pharmaceutical products | 9% | 6% | 4% | .. |
| 9410 | Recreational and sporting services | 9% | 4% | 2% | .. |
| 12620 | Other financial services n.e.c. | 9% | 6% | 4% | 2% |
| 1174 | Dried vegetables | 8% | 4% | 4% | 4% |
| 1181 | Sugar | 8% | 2% | 2% | .. |
| 5320 | Small electric household appliances | 8% | 2% | .. | .. |
| 5611 | Cleaning and maintenance products | 8% | 4% | .. | .. |
| 7312 | Inter-city transport of passengers by train, tram, underground railway | 8% | 6% | 6% | 4% |
| 9150 | Repair of audio-visual, photographic and information processing equipment | 8% | 4% | 2% | 2% |
| 9430 | Games of chance | 8% | 8% | 6% | 6% |
| 9520 | Newspapers and magazines | 8% | 2% | .. | .. |
| 10100 | Pre-primary and primary education | 8% | 2% | 2% | 2% |
| 10200 | Secondary education | 8% | 4% | 2% | 2% |
| 11202 | Other accomodation services | 8% | 4% | 2% | .. |
| 12520 | Housing insurance | 8% | 6% | 4% | 2% |
| 1141 | Whole milk | 6% | .. | .. | .. |
| 1184 | Confectionery products | 6% | 2% | 2% | .. |
| 1211 | Coffee | 6% | .. | .. | .. |
| 2110 | Spirits and liqueurs | 6% | 4% | 4% | 4% |
| 2202 | Other tobacco products | 6% | 4% | 2% | 2% |
| 4410 | Water supply | 6% | .. | .. | .. |
| 4420 | Refuse collection | 6% | 4% | 2% | 2% |
| 4540 | Solid fuels | 6% | 2% | .. | .. |
| 6131 | Eyeglasses and contat lenses | 6% | 4% | 2% | 2% |
| 6231 | Services of medical analysis laboratories and X-ray centres | 6% | 6% | 6% | 2% |
| 6232 | Services of medical auxiliaries | 6% | .. | .. | .. |

| | | | | | |
|---|---|---|---|---|---|
| 7311 | Intra-city transport of passengers by train, tram, underground railway | 6% | 4% | 2% | .. |
| 7321 | Intra-city transport of passengers by bus | 6% | .. | .. | .. |
| 7322 | Transport of passengers taxi | 6% | 4% | 4% | 2% |
| 7323 | Transport of passengers by overland | 6% | 6% | 4% | 2% |
| 10400 | University education | 6% | 4% | 4% | 2% |
| 2130 | Beer | 4% | 2% | 2% | 2% |
| 6220 | Dental services | 4% | 4% | 4% | 2% |
| 6300 | Basic hospital services | 4% | 4% | 2% | .. |
| 7360 | Other purchased transport services | 4% | 2% | .. | .. |
| 8100 | Postal services | 4% | 2% | 2% | 2% |
| 9310 | Games, toys and hobbies | 4% | .. | .. | .. |
| 9422 | Other cultural services | 4% | 2% | .. | .. |
| 10300 | Post-secondary pre-university education | 4% | 2% | 2% | 2% |
| 12321 | Travel equipments and other personal accessories | 4% | 2% | .. | .. |
| 1114 | Pastry cook products | 2% | .. | .. | .. |
| 1115 | Pasta products | 2% | .. | .. | .. |
| 1124 | Meat of ovine | 2% | 2% | .. | .. |
| 1127 | Other fresh, chilled or frozen edible meat | 2% | 2% | .. | .. |
| 1152 | Margarine and other vegetable fats | 2% | .. | .. | .. |
| 1153 | Other oils | 2% | .. | .. | .. |
| 1162 | Dried fruits | 2% | .. | .. | .. |
| 1182 | Jams, marmalades and honey | 2% | .. | .. | .. |
| 1212 | Tea | 2% | .. | .. | .. |
| 1223 | Fruit juices | 2% | .. | .. | .. |
| 3124 | Garments for infant | 2% | .. | .. | .. |
| 5120 | Carpets and other floor coverings | 2% | .. | .. | .. |
| 5402 | Cutlery, flatware and silverware | 2% | .. | .. | .. |
| 6132 | Therapeutic appliances and equipment | 2% | .. | .. | .. |
| 6212 | Doctor fee | 2% | 2% | 2% | 2% |
| 7240 | Other services in respect of personal transport equipment | 2% | 2% | 2% | .. |
| 9141 | Recording media for sound and picture | 2% | 2% | .. | .. |
| 10500 | Other education programmes | 2% | .. | .. | .. |
| 11201 | Hotel accomodation | 2% | .. | .. | .. |
| 12111 | Hairdressing for men | 2% | .. | .. | .. |
| 12112 | Hairdressing for women | 2% | .. | .. | .. |
| 12120 | Other appliances for personal care | 2% | .. | .. | .. |
| 12400 | Social services | 2% | 2% | 2% | .. |

# Appendix 4:
# Volatility of month-on-month inflation

Table A5

**Volatility Measures for month-on-month Inflation**

| | Standard dev. | Coefficient of Variation | Standard dev. | Coefficient of Variation |
|---|---|---|---|---|
| | 1994–2002 | | 2003–2007 | |
| CPI | 2.66 | 0.58 | 0.79 | 0.91 |
| SCA-B | 3.33 | 0.73 | 0.62 | 0.77 |
| SCA-C | 3.07 | 0.68 | 0.88 | 1.03 |
| SCA-D | 3.09 | 0.68 | 0.71 | 0.84 |
| SCA-H | 2.95 | 0.65 | 0.79 | 1.00 |
| WM | 2.58 | 0.67 | 0.38 | 0.77 |
| TR_M | 2.72 | 0.71 | 0.36 | 0.62 |
| V_1 | 2.46 | 0.69 | 0.39 | 0.68 |
| V_1.5 | 2.65 | 0.69 | 0.45 | 0.70 |
| V_2 | 2.74 | 0.68 | 0.49 | 0.73 |
| V_2.5 | 3.05 | 0.72 | 0.55 | 0.82 |

## References


Amstad, M. and S. M. Potter (2007), “Real time inflation gauges for monetary policy makers”, mimeo,

Aoki, K. (2001), “Optimal monetary policy responses to relative-price changes”, Journal of Monetary Economics, vol.48, no.1.

Armour, J. (2006), “An evaluation of core inflation measures”, Bank of Canada Working Papers, 2006–10.

Bakhshi, H. and T. Yates (1999), “To trim or not to trim? An application of a trimmed mean inflation estimator to the United Kingdom”, Bank of England Working Papers, no.97.

Ball, L. and N. Mankiw (1994), “Asymmetric price adjustment and economic fluctuations”, Economic Journal, vol.104.

Baxter, M. and R. G. King (1999), “Measuring business cycles: approximate band-pass filters for economic time series”, The Review of Economics and Statistics, vol.81, no.4.

Berkmen, P. (2002), “Measuring core inflation for Turkey – trimmed means approach”, Central Bank Review, 2002-2.

Bryan, M. F. and S. G. Cecchetti (1993), “Measuring core inflation”, NBER Working Paper Series, no.4303.

Bryan, M. F., Cecchetti, S. G. (1996), “Inflation and the distribution of Price changes”, NBER Working Paper Series, no.5793.

Bryan, M. F., Cecchetti, S. G. and R. L. Wiggins II (1997), “Efficient inflation estimation”, NBER Working Paper Series, no.6183.

Catte, P. and T. Slok (2005), “Assessing the value of indicators of underlying inflation for monetary policy”, OECD Economics Department Working Papers, no.461.

Christadoro, R., Forni, M., Reichlin, L. and G. Veronese (2005), “A core inflation indicator for Euro Area”, Journal of Money, Credit and Banking, vol.37, no.3.

Clark, T. (2001), “Comparing measures of core inflation”, Federal Reserve Bank of Kansas City Economic Review, Second quarter 2001.

Cogley, T. (2002), “A simple measure of core inflation”, Journal of Money, Credit and Banking, vol.34, no.1.

Cutler, J. (2001), “Core inflation in UK”, Bank of England Discussion Papers, no.3

Dolmas, J. (2005), “Trimmed mean PCE inflation”, Federal Reserve Bank of Dallas Working papers, no.0506

Figueiredo, F. M. R. (2001), “Evaluating core inflation measures for Brazil”, Banco Central do Brasil Working Papers, no.14.

Giannone, D. and T. Matheson (2007), “A new core inflation indicator for New Zealand”, CEPR Discussion Papers, no.6469.

Heath, A., Roberts, I. and T., Bulman (2004), “Inflation in Australia: Measurement and modelling”, Reserve Bank of Australia Conference, 2004.

Hogan, S., Johnson, M. and T. Laflèche (2001), “Core inflation”, Bank of Canada Technical Report, no.89.

Johnson, M. (1999), “Core inflation: a measure of inflation for policy purposes”, BIS Conference proceedings, June 1999.

Laflèche, T. (1997), “Statistical measures of the trend rate of inflation”, Bank of Canada Review, Autumn 1997.

Laflèche, T. and J. Armour (2006), “Evaluating measures of core inflation”, Bank of Canada Review, Summer 2006.

Marques, C. R., Neves, P. D. and A. G. da Silva (2000), “Why should central banks avoid the use of the underlying inflation indicator?”, Banco de Portugal Working Papers, 2005-5.

Marques, C. R., Neves, P. D. and L. M. Sarmento (2003), “Evaluating core inflation indicators”, Economic Modelling, vol.20(4), 99, July.

Morana, C. (2000), “Measuring core inflation in the Euro Area”, ECB Working Paper Series, no.36.

Pederson, M. (2006), “An alternative measure of core inflation”, Banco Central de Chile Working Papers, no.366.

Rich, R. and C. Steindel (2005), “A review of core inflation and an evaluation of its measures”, Federal Reserve Bank of New York Staff Report, no.236.

Roger, S. (1997), “A robust measure of core inflation in New Zealand, 1949–96”, Reserve Bank of New Zealand Discussion Paper, no.G97/7.

Roger, S. (1998), “Core inflation: concepts, uses and measurement”, Reserve Bank of New Zealand Discussion Paper, no.G98/9.

Roger, S. (2000), “Relative Prices, inflation and core inflation”, IMF Working Papers, no.00/58.

Silver, M. (2007), “Core inflation: Measurement and statistical issues in choosing among alternative measures”, IMF Staff Papers, vol.54, no.1.

Smith, J.K. (2005), “Inflation targeting and core inflation”, Canadian Journal of Economics, vol.38, no.3.

Smith, J.K. (2004), “Weighted median inflation: is this the core inflation?”, Journal of Money, Credit and Banking, vol.36, no.2.

Special CPI Aggregates for Turkey, Core Inflation Technical Committee Report, Central Bank of Turkey, February 2005.

Taillon, J. (1997), “Review of literature on core inflation”, Statistics Canada Analytical Series, no.4.

Taillon, J. (1999), “Core inflation: a weighted median index”, Statistics Canada Analytical Series, no.7.

Vega, J. and M. A. Wynee (2001), “An evaluation of some measures of core inflation for the Euro Area”, ECB Working Paper Series, no.53.

Velde, F. R. (2006), “An alternative measure of core inflation”, Federal Reserve Bank of Chicago, Economic Perspectives, Quarter 1, 2006.

Wynee, M. A. (1999), “Core inflation: A review of some conceptual issues”, ECB Working Paper Series, no.5.