FINDING OPTIMAL MEASURES OF CORE INFLATION IN THE KYRGYZ REPUBLIC

Ainura Uzagalieva

CERGE-EI

Charles University
Center for Economic Research and Graduate Education
Academy of Sciences of the Czech Republic
Economics Institute

WORKING PAPER SERIES (ISSN 1211-3298)
Electronic Version

261

Working Paper Series 261
(ISSN 1211-3298)

Finding Optimal Measures of Core Inflation in the Kyrgyz Republic

Ainura Uzagalieva

CERGE-EI
Prague, May 2005

ISBN 80-7343-053-3 (Univerzita Karlova v Praze, CERGE)
ISBN 80-7344-042-3 (Národohospodářský ústav AV ČR, Praha)

Finding Optimal Measures of Core Inflation in the Kyrgyz Republic

Ainura Uzagalieva*

The Center for Economic Research and Graduate Education of Charles University
and the Economics Institute of the Academy of Sciences of the Czech Republic
(CERGE-EI)
P.O. Box 882, Politických Vězňů 7
111 21 Praha 1, Czech Republic

Abstract

The ideal measure of inflation should reflect long-run price movements driven by actual demand in the economy and exclude short-term supply shocks. Considering that the CPI does not correspond to such a measure, the purpose of this research is to analyze alternative methods of core (or underlying) inflation and to choose a method suitable for measuring core inflation in the Kyrgyz Republic. The results can be useful for proper monetary policy reaction to inflationary shifts in the Kyrgyz Republic.

Abstrakt

Ideální měřítko inflace by mělo odrážet dlouhodobé pohyby cen poháněné skutečnou poptávkou v ekonomice a naopak vyloučit krátkodobé šoky na straně nabídky. Vzhledem k tomu, že CPI nesplňuje tato kritéria, předmětem tohoto článku je analyzovat alternativní metody měření ústřední inflace (core inflation) a vybrat metodu vhodnou pro měření ústřední inflace v Kyrgyzské republice. Výsledky tohoto výzkumu mohou být užitečné pro správnou volbu monetární politiky při reakcích na inflační posuny (zlomy) v Kyrgyzské republice.

Keywords: Kyrgyz Republic, inflation, core inflation, monetary policy, smoothing, optimality criteria.

JEL Classification: E31, E52

* I gratefuly acknowledge the financial and professional support of Economic Education and Research Consortium in the framework of the project "Finding Optimal Measures of Core Inflation in the Kyrgyz Republic" (grant No. R00-4501). I am especially grateful to Michael Beenstock, Wojciech W. Charemza, Jacek Cukrowski, Randal Filer, Sergej Slobodyan, Lubomír Lízal and Sarah Peck for helpful comments, advice and discussions.

1. Introduction

Inflation is one of the key issues of macroeconomic stability in transition countries, as it has a strong influence on many economic indicators such as the state budget, exchange rate, interest rate, wages, and level of poverty. Moreover, high inflation undermines the general trust in the political and economic system, impacting the inflow of direct investments. The success and efficiency of monetary policy in terms of inflation stability depends on whether inflation measure reflects long-term price movements or includes short-term structural shocks as well. The common inflation measure in transition economies is the consumer price index (CPI). It is identified as the average weighted price level of a set of selected goods and services that are included in a consumer basket. Such an inflation measure is impacted by both monetary and non-monetary factors.

The strong impact of non-monetary factors on an inflation measure can lead to significant volatility of price changes, raising the question of whether inflation is the result of a persistent, long-term trend or reflects only short-term shifts in prices. If an inflation measure contains short-term shifts, it can significantly complicate the task of controlling inflation for policymakers. Therefore, it is important to distinguish long-term price movements which are driven by actual demand in the economy and do not respond to various short-term shocks. Such an inflation measure, which is called core inflation, is defined as a sustained change in prices induced by monetary factors. The basic motivation for using core inflation thus is to ignore short-term price shifts of a temporary nature and to consider steady underlying economic fundamentals.

The main purpose of this paper is to analyze the methods of measuring core (or underlying) inflation and to determine a more suitable measure of core inflation that excludes exogenous factors from the general inflation signal in the Kyrgyz Republic (KR). This is because the inflation measure which is used by the central bank, the National Bank of Kyrgyz Republic (NBKR), for managing inflation is based on the CPI. Since the CPI is a rather weak indicator for measuring the basic inflation trend due to its high volatility and seasonal patterns (Figure 1), the issue of measuring core inflation in the KR is essential.

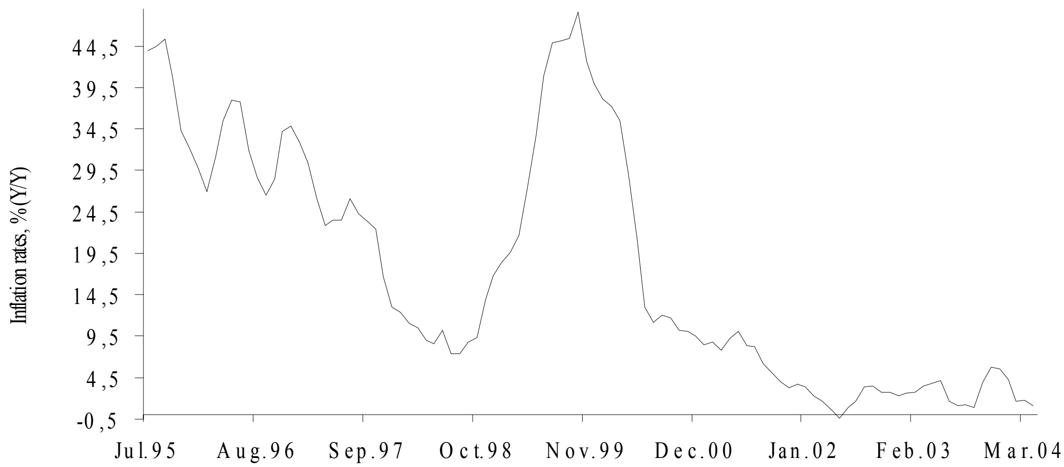


Figure 1. Inflation during July 1995 to April 2004: annualized monthly rates (Y/Y)

The high volatility and irregular fluctuations in the CPI, as depicted in Figure 1, stem from the strong impact of non-monetary factors to which the NBKR basically does not react or is not capable of influencing. The key sources of such factors in the KR are the high share of agriculture in the economy, the change of state-controlled prices and tariffs, periodicity or delays in price records, exchange rate fluctuations, and a heavy dependence on energy prices and energy products (e.g., oil products, fuel, and natural gas).

Undoubtedly, increases in prices caused by the specific factors mentioned above lead to an increase in the CPI. And, if the CPI increases beyond permissible limits, the NBKR will tighten its monetary policy. So, there is a question whether the action of the NBKR in a given situation is correct. Evidently, the presence of shocks, which are caused by short-term shocks and directly or indirectly included in the CPI, significantly complicates the main objective of the NBKR to control inflation. Besides, even if the central bank would not restrict its monetary policy, temporary shifts in the CPI caused by short-term shocks may reverberate through the economy for a much longer period. A measure that can smoothly approximate inflation would allow for more effective decision-making in the economy as a whole since short-term shifts in prices do not require a reaction from policymakers nor from other agent. Therefore, such shifts should be omitted from an inflation signal.

The paper consists of six sections with the following structure. The theoretical background for measuring core inflation and four alternative methods (e.g., exclusion, trimmed means, standard deviation trimmed means, and percentiles) are provided in Section 2. Section 3 presents information on the system of CPI measurement in the KR and the behavior of individual prices within the CPI and reveals that the CPI in the KR does not correspond to long-term price movements. The four alternative methods of measuring core inflation are analyzed and empirical results are reported in Section 4. Then, the derived inflation measures are compared in terms of a smoothness property by minimizing their distance from a smoothed CPI time series in Section 5. Section 6 summarizes the main findings and concludes with general remarks.

2. Conceptual framework

The concept of core inflation is rather new in the literature; it was first formally defined by Eckstein (1981) at the beginning of the 1980s. According to Eckstein core inflation is "the rate that would occur on the economy's long-term growth path, provided the path were free of shocks, and the state of demand were neutral in the sense that markets were in long-run equilibrium."[1] Eckstein linked the overall inflation measure in a Phillips curve equation to the following: the expected inflation measure, the gap between the actual and potential levels of economic activity, and the aggregate supply shocks. Then, he defined core inflation as the expected inflation. In the 1990s, the central banks of many countries[2] adopted inflation targeting regimes (Haldane 1995; Neumann and von Hagen 2002). Since the primary objective of the central bank under this regime is to maintain inflation within targets, the problem of measuring core inflation became urgent. This stimulated further studies and contributed to the development of somewhat different concepts as well as measures of core inflation.

Today, there is a wide range of literature worldwide concerning the issue of measuring core inflation. An example of work measuring core inflation in New Zealand

---

[1]See Eckstein (1981), page 8.

[2]Australia, Brazil, Canada, Chile, Czech Republic, Hungary, Israel, New Zealand, Peru, Poland, Singapore, South Africa, Spain, Sweden, Switzerland, Thailand, and the United Kingdom adopted an inflation targeting regime over the last decade.

is presented by Roger (1995, 1997). Research focused on measuring core inflation in the United States, Canada and Western Europe includes Arrazola and Hevia (2001), Blinder (1997), Bryan and Cecchetti (1993, 1994, 1995, 1996), Bryan, Cecchetti and Wiggins (1997), Cecchetti (1995, 1996), Claus (1997), Clark (2001), Cutler (2001), Johnson (1999), Smith (2004a, 2004b), and Quah and Vahey (1995). At the end of the 1990s, work on core inflation appeared in transition countries as well (Charemza, Makarova and Parchomenko 2000; Wozniak 1999). The methodology of measuring core inflation described in the cited literature can be divided into two main approaches: one is based on statistical methods and the other approach, the modeling approach, focuses on a conceptual problem – the problem of defining core inflation.

A structural approach to modeling core inflation was originally described in the paper of Quah and Vahey (1995). The theoretical framework behind this approach is that in the long run, inflation reflects the state of demand in an economy and does not influence the real output. However, unexpected inflationary shocks could cause significant shifts in the economic structure and thus in real output in the short and middle terms. According to Quah and Vahey (1995), inflation measurement based on the CPI could be erroneous because of its high sensitivity to various non-monetary factors. In this respect, the authors suggest breaking the inflation measure into core and residual parts using a time series of aggregated CPI data. Core inflation is the component of inflation that does not influence the real output in the long run and reflects the state of demand in an economy.

An approach based on statistical methods was initially provided in the papers of Bryan and Cecchetti (1993, 1994), Bryan, Cecchetti and Wiggins (1997), Cecchetti (1996). Generally, this approach is applied to disaggregated CPI data using cross-section and time-series methodologies. The cross-section methodology deals with constructing core inflation on a period-by-period basis using information on the CPI across its components (Bryan and Cecchetti 1993, 1994; Bryan, Cecchetti and Wiggins 1997; Cecchetti 1996; Wozniak 1999). Bryan and Cecchetti defined core inflation as "the component of price changes which is expected to persist over the medium-run horizon of several years."[3] According to the time-series methodology, core inflation is

---

[3] See Bryan and Cecchetti (1993), page 4.

measured based on the statistical properties of the time-series in the disaggregated CPI data (Blinder 1997; Cutler 2001; Smith 2004a, 2004b). This methodology is focused on measuring core inflation with high predictive power through three steps: *(1)* choosing time-series that produce better forecasts from the components of CPI; *(2)* finding the optimal weights; and *(3)* re-weighting CPI components in a way that the chosen time-series (in step *1*) have larger weights.

The statistical methods of analysis, which are applied to the cross-sectional variation of prices, distinguish two basic categories of problems: noise and bias. Noise refers to all temporary shocks which do not impact prices in the long run and fade away with time, however, such shocks have a strong influence on prices in the shorter frequencies (e.g., month and quarter). Bias is related to a change in weights if CPI is calculated based on permanent weights (if CPI is calculated on constant weights the weighting bias becomes insignificant) or to measurement errors. The measurement errors arise from the possibility of mistakes when recording the price of a good. In the literature (Bryan, Cecchetti and Wiggins 1997; Cecchetti 1996; Hanousek and Filer 2001a, 2001b; Roger 1995, 1997; Wozniak 1999), four alternative methods of defining core inflation are described: the exclusion method, the trimmed means method, the standard deviation trimmed means method, and the percentile method. A brief overview of each method is presented below.

2.1. Exclusion method

The exclusion method omits certain categories or whole groups of goods and services from CPI prices which are traditionally highly sensitive to supply shocks and are usually self-transient. Such categories are, for example, agricultural goods, electric power, natural gas, other kinds of fuel, and tobacco. The agricultural goods (e.g., grains, fresh fruits and vegetables) are the most highly volatile component due to their high sensitivity to seasonal factors and natural supply shocks, so the rational for excluding these components from the basket is pretty obvious. With regards to electric power and natural gas, the main reasons why economists decided to include them in that category were derived from the oil shocks of the 1970s (Clark 2001). Later when oil markets recovered from the shocks, it was recognized that even if oil prices are not as volatile as the prices of agricultural foods, they still could largely be influenced by supply shocks. The same reasoning is true for the state-controlled goods and services or price controls (i.e., regulated industries). Therefore, the exclusion of all these items should yield an inflation measure that is close to the central tendency and reflect the state of demand in the economy (Roger 1995, Wozniak 1999). This method zeros out the weights of goods to be excluded from the basket when calculating the weighted-average level of prices.

However, this method has serious disadvantages if seasonal factors are important as in an economy like the KR, for example, due to the high share of agriculture. Besides, expenses on foods, energy and rental fees, which should be excluded from the basket, might represent the largest portions of families' budget, especially in low-income countries. Under these circumstances, the intuitive exclusion of too many components from the basket may result in excluding not only noise and bias, but also a signal, increasing the chance of losing important information. This would make the concept of core inflation too suspicious for the public. Therefore, one has to be very careful in choosing the number of goods from the basket for exclusion in order to avoid the possibility of losing important information.

2.2. Trimmed means method

The trimmed means method is the systematic exclusion of the largest jumps and falls in prices no matter what group of goods they belong to. By zeroing out the weights, the maximal spikes and minimal drops are excluded from a range of price fluctuations in a given period of time, and then the average weighted price of the rest is calculated. This method allows one to lower the undesirable properties of the sample mean (such as maximal dispersion, bias, abnormal distribution), and therefore, it has attracted much attention from the majority of central banks. According to Wozniak (1999), the intuition behind this method is that the sample mean gives a distorted estimation of true inflation due to extraneous price disturbances. Therefore, the approach argues for a symmetric exclusion or rejection of a given percentage of data with extreme jumps or falls (minimum and maximum) from the distribution of prices. If distribution is symmetric relative to average prices, the exclusion of extreme values does not change the sample mean. But, if distribution is asymmetric, exclusion changes the sample mean upward (positive asymmetry) or displaces it downwards (negative asymmetry). Positive asymmetry specifies that distribution is skewed towards positive values, and negative asymmetry specifies that distribution is skewed towards negative values. If the distribution of prices were approximately normal, then the sample means from that distribution could be the best estimator of the true mean because it would be unbiased.

The economic motivation of the trimmed means method is mainly related to the dynamics of relative prices, which temporarily affect the aggregate price level, causing upward or downward short-term shifts. There are various theoretical models attempting to explain the causal relationship between relative prices and the inflation level. According to these models, the shape of price distributions gives basic intuition on how individual price changes contribute to the general inflation level. In particular, there are models which show that large fluctuations in relative prices cause higher inflation (Ball and Mankiw 1994, 1995), and on the contrary, there are models showing that an increase in inflation causes a fluctuation of relative prices (Mussa 1977; Shleshinski and Weiss 1977). The main link between individual price changes and the aggregate inflation level is the behavior of firms. Ball and Mankiw (1995) explained this link using a concept of menu costs which states that a firm's response to inflation depends on whether its price adjustments are costly or not. If price adjustments are costly for a firm, it will not change its prices. However, if inflation is so high that by adjusting prices an enterprise can avoid certain losses, it will increase its prices as well.

2.3. Standard deviation trimmed means method

The standard deviation trimmed means method is based on the exclusion of all extraneous price jumps or falls if in a given month some prices increased or decreased too strongly compared to the same months of other years. The details are considered by Bryan, Cecchetti and Wiggins (1997), and Wozniak (1999). The basic idea of the method is to exclude all price jumps or falls in a given period that are more remote compared to the change of prices in the corresponding periods included in the whole sample. At the same time, it is possible to throw out price jumps asymmetrically. For example, if in any period there was strong inflation resulting from a sharp jump in certain prices (e.g., distribution is skewed towards positive values), then exclusion will eliminate variables only at the one end. Only large jumps are omitted, thus it is suggested to exclude the highest price jumps or falls on a period-by-period basis. The main drawback of the method, however, is the fact that prices are excluded without knowledge of the sources of noise. Consequently, this method can discard pretty useful information in prices if outliers contain important news as, for example, the change of state controlled prices that play a very important role in forming price expectations for future periods.

2.4. Percentiles method

Lastly, the basic idea of the percentile method concerns achieving an unbiased estimator. Since the sample mean is the unbiased estimator of the true mean, the percentile of price distribution corresponding to the sample mean should also be an unbiased estimator of the mean of empirical distribution (Roger 1997; Wozniak 1999). For instance, the sample mean of the CPI corresponds to the 50^{th} percentile at the symmetric distribution of prices. With positive asymmetry, when the distribution is skewed to the right, the percentile of underlying inflation is above *50*. With negative asymmetry, when the distribution is skewed to the left, the percentile is below *50*. In other words, the k-percentile of core inflation is defined as the k-percentile of the weighed distribution of price changes during a given time and the median CPI always corresponds to the 50^{th} percentile. Clearly, the median CPI or the 50^{th} percentile of the CPI will not always correspond to the mean of the CPI depending on the shape of the distribution. Therefore, the task of the method is to compare all price distributions within the CPI and find those percentiles which correspond to the sample mean.

In comparison to other methods described above, this method takes into account all the available observations. The key of the analysis is based on the proposition that the distribution of price changes within the CPI in a certain period presents an individual sample in the whole population of price distributions. Such samples are interpreted as the set of underlying price changes. The most acceptable way of comparing the underlying price changes across different periods is to use the whole empirical sample of distributions. The fact that the method takes into account all the available observations is very attractive and useful for less advanced transition economies where the price setting mechanism is still adjusting to a market one.

2.5. Optimality criteria

The accuracy of inflation measures derived on the basis of the four alternative methods is to be assessed in accordance with an optimality criterion. However, there is no one formal criterion by which the accuracy of core inflation measure can be assessed. Therefore it is reasonable to choose criteria based on their suitability to monetary purposes. The literature considers the following important attributes or criteria desirable for core inflation (Wynne 1999). The suitability of core inflation as the indicator of current and future inflation is necessary. This implies that the ideal inflation measure is a smooth measure that closely approximates the general inflation trend. Timeliness and computability in real time is another important issue, so that history does not change much upon including new data. It should be transparent enough for the public and policymakers. This attribute suggests that the public might challenge a measure which excludes too many goods from the consumer basket as it can significantly deviate from the true cost of living index. In addition, the core measure should follow the same trend as the headline inflation, i.e., there should be a close relationship between measured and core inflation.

Taking into account the above-mentioned attributes, the property of smoothness receives the main attention in this paper. The optimality criteria for choosing the efficient measure of core inflation are the comparisons of the root mean square error (further RMSE) and the mean absolute deviation (further MAD) relative to a benchmark trend. The *12th*, *24th* or *36th* monthly moving average trends, which are initially proposed by Bryan and Cechetti (1995, 1996, and 1997), were adopted as the benchmark trend in many studies (see, for example, Wozniak 1999; Berkmen 1999; Clark 2001). However, since these criteria are arbitrary, alternative smoothing methods are experimented in this study and based on minimizing their standard deviations around the actual inflation rates, the benchmark trend is chosen. This issue is more carefully addressed in section 5.

3. The CPI as a measure of inflation in the Kyrgyz Republic

One of the key decisions the government of he KR took to eliminate hyperinflation at the beginning of the 1990s was to introduce a national currency (KGS) under a floating exchange rate regime. As a result, a typical two-tiered banking system, including a central bank and commercial banks, was established. According to the law[4] on the NBKR, the main purpose of the central bank is to manage inflation that is measured by the CPI. The NBKR influences the money market through traditional instruments of monetary policy.[5] The exchange rateis freely determined on the basis of spot and other exchange rates on the foreign exchange market.[6]

The dynamic of inflation measured by the CPI and basic macroeconomic indicators during 1992-2004 is demonstrated in Table 1 (in the Appendix). The period of severe hyperinflation and deep structural imbalances is 1992-1994, when annual inflation reached the four-digit level as the immediate result of trade and price liberalization and the introduction of the value-added tax. During 1995-1997, inflation fell to the two-digit level and most macroeconomic indicators improved significantly. However, the financial crisis in Russia, which heavily hit the economy of KR in 1998, intensified a potential internal crisis and led again to high inflation. According to the NBKR,[7] the effect of monetary policy measures taken to reduce inflation during 1998-1999 was displaced by the influence of external non-monetary factors beyond the control of the NBKR. As the crisis events faded, prices began to stabilize and the improvement of the external conditions regarding the KR contributed to a decrease in the inflation rate during 2000-2004.

The official inflation data of the KR can be obtained from the National Statistics Committee of the KR (NSC KR) through publications and WebPages (http://nsc.bishkek.su). The price indexes published by the NSC KR include the producer price index, the agricultural price index, and the consumer price indexes. The CPI is measured by the Laspeyres formula:

(1)
$$CPI^t = \frac{\sum_{i=1}^{K} p_i^0 q_i^0 \frac{p_i^t}{p_i^0}}{\sum_{i=1}^{K} p_i^0 q_i^0}.$$

[4]The policy-making board of the central bank is insulated from politicians and is given exclusive power in setting the instruments of monetary policy in order to maintain its primary goal, price stability.

[5] Nowadays the most actively used instrument of monetary policy in the KR is open market operations.

[6]Pursuant to the Law of the Kyrgyz Republic "On Operations in Foreign Exchange" as of 05.07.95, No 7-1, Article, the activity of the NBKR on the foreign exchange market is limited to smoothing abrupt fluctuations in the exchange rate, while keeping international reserves at an adequate level, i.e., it allows speculative shocks.

[7] See Annual Report of NBKR (1998).

The consumer basket of the average city dweller in the KR includes at present *343* goods and services *(K=343)*, which are divided into three large groups - foods, non-foods and paid services. The weights of the index (q_i^0, $i=1,2, \ldots,K$) are determined on the basis of actual consumer expenses in the base period. The structure of these expenses is established by the state budget inspections over the whole population of the KR.

The NSC KR changed the structure of the consumer basket three times. The first change took place in 1995 when the Parliament of the KR altered the minimum level of the consumption budget. The next change was in 1998 when it included services in the consumer basket (education, public health and notary offices) as separate observations. And, in 2001, the number of components in the basket was increased from *305* to *343*. As a result, during 1992-2003, the share of paid services increased from *11%* to *15%*, the share of non-foods decreased from *32%* to *27%*, and the share of foods stood at the level of 1992, which accounts for *58%*. The sample of the CPI used in this paper, therefore, covers *305* categories of consumer goods for the period of July 1995 to December 2001 and *343* categories for the period January 2002 to April 2004. The CPI is presented as the weighted average of individual CPIs of all components, i.e.,

$$CPI_t = \sum_{i=1}^{K} w_{i,t}\pi_{i,t} \quad , \qquad (2)$$

where w_{it} is the weight of i's component of the CPI in period t, and π_{it} is individual inflation of i's component in period t. The $w_{i,t}$ in formula *(2)* is defined as

$$w_{i,t} = \frac{p_{i,t-1}q_i^0}{\sum_{j=1}^{K} p_{j,t-1}^0 q_j^0} \quad , \qquad (3)$$

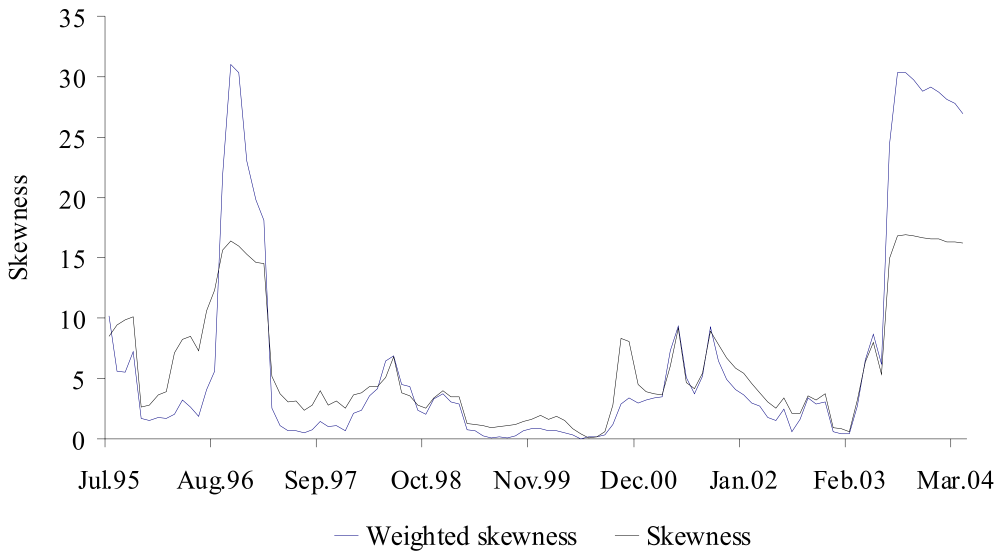
which means that $w_{i,t}$ is not a constant, but depends on the period chosen as the basis. There are several possibilities: *(1)* previous month, *(2)* December of the previous year, and *(3)* the same month or period of the previous year. The constants are q_i's, which represent the structure of actual consumption expenses in the base period. Consequently, under the calculation of monthly the CPI, the weights $w_{i,t}$ change every month because absolute and relative prices also change every month. The same phenomenon occurs when the quarterly inflation rates are calculated.

To see the rational for determining a core inflation or long-run inflation measure in the KR, it is necessary to obtain a picture of individual CPI distributions for all components; in statistical terms it is necessary to calculate the basic descriptive statistics of those distributions, i.e., *mean*, *variance*, *skewness*, and *kurtosis*. The necessity to calculate descriptive statistics stems from the fact that they give basic intuition on how individual price changes contribute to the general inflation level. Since the monthly data for the KR contain a seasonal pattern that has a period of approximately *12* months, we apply one *12*-month differencing between periods t and t-*12*. This allows a decrease in variance caused by the seasonal pattern. Consequently, at monthly frequency the above-mentioned statistical moments are calculated using annualized monthly (Y/Y) data.

When plotting the distributions of individual price changes in the CPI, the weights of the consumption basket are used as the number (or frequency) of having equally weighted individual inflation components in the total CPI. In other words, the weights represent the probability of having a certain level of individual inflation rate in the total CPI. The skewness and kurtosis of monthly, quarterly and annual distributions of individual inflation rates are shown in Table 2 (in the Appendix). According to the literature (Green 2001), normal distributions are characterized by the kurtosis equal to *3*. However, in the case of the KR, both the mean and median of kurtosis at each frequency are much higher than *3*, meaning that the sample distributions are not normal. Such price distributions (high kurtosis and excess positive skewness) are evidence of big price jumps which dominate the inflation process.

To see a more accurate picture of price distributions on the basis of KR data, the dynamic of weighted and unweighted skewnesses is drawn on the basis of annualized monthly inflation rates. Figure 2 demonstrates that the peak of skewnesses is marked in 1996 and the second highest point takes place in 1995.

a) Skewness



b) Kurtosis

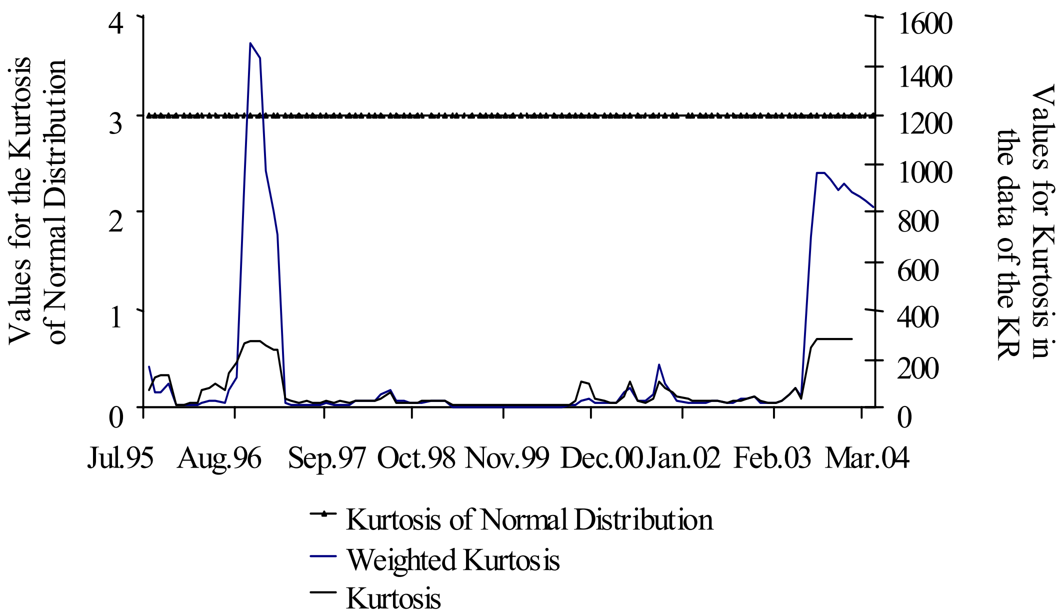


Figure 2. The descriptive statistics of price distributions in the period of moderate inflation (January 1995 to December 2000): a) skewness; b) kurtosis

In all subsequent years (except 2000), there is a clear tendency of the coefficient of skewness to decline; however, price distributions remain positively skewed. The shape of the price distributions, in particular high points presented in Figure 2, show the fact that large price adjustment processes in the economy of the KR took place in 1995, 1996 and 2003.

The government abandoned price controls on alcoholic drinks, tobacco, some items related to housing except electricity, gas and hot water supply, and notary services during these years. Besides, a number of important programs and projects, which were focused on achieving social progress by means of domestic resources,[8] supporting the small business sector,[9] and providing private enterprises in agricultural and tourism sectors with financial and technical assistance,[10] were adopted as well in 1995-1996. Within such projects and programs over a thousand business plans were prepared and implemented in order to provide small business sectors with training, technical assistance, expert service and financial resources. Reform measures were also taken in the public and state sectors in order to lay off low qualified personnel and reduce inefficient state facilities and services.

Consequently, price reforms, job creation in the real sector through opening new private small and medium-sized firms, and an increase in the demand of labor, especially, in reviving sectors such as agriculture, trade, catering, and services, stimulated large structural changes in the economy. The shapes of price distributions, which are shown in Figure 2, presumably indicate just how sensitive inflation is to such structural shifts in the economy, since the distribution of prices is asymmetric if the inflation level is sensitive either to positive or negative shocks in the economy. In general, the dynamics of prices within the CPI, in particular, strongly asymmetric price distributions, indicate the fact that the CPI is highly sensitive to factors that cause short-term shifts in prices. In other words, the influence of non-monetary factors on prices, as it is mentioned in Section 1, which are beyond the direct control of the NBKR, is high in the KR.

[8] See, for example, the long-run development strategy named the National Strategy for Sustainable Human Development (NSSHD).

[9] See, for example, the Program of United Nation Industrial Development Organization (UNIDO) focused on the technical assistance to small and medium size enterprise development.

[10] See, for example, the Program of the Swiss agency Helvetas.

As it is shown, seasonal pattern and irregular fluctuations characterize the dynamic of the CPI, which contains *343* components. In this respect, the cross-section rather than the time-series methodology is applied in order to disregard temporary shifts in the general inflation signal. This is because of the large number of time-series to be forecasted, consequently, the large amounts of random variation under a relatively short time span in the CPI data would, generally, lower the forecasting performance of the time-series models (Franses and van Dijk 2005; Miler and Williams 2003). Therefore, this study focuses on the variation of components within the CPI and analyze four alternative methods (e.g., exclusion, trimmed means, standard deviation trimmed means, and percentile) of measuring core inflation.

4. Model specification and estimation results

Cecchetti (1996) provides a rather simple technique, connecting concepts mentioned in section 2 with the formulas in several steps. A change in the price of individual goods in the consumer basket (*i*) is defined by the expression

$$\dot{p}_{i,t} = \dot{P}_t + \dot{x}_{i,t} \quad , \tag{4}$$

where $\dot{P}_t$ is a trend change and a most suitable measure of core inflation, and $\dot{x}_{i,t}$ is relative inflation, which reflects a simultaneous burst caused by a change in the price of an individual component in the consumer basket. The CPI is the weighted average of all basket components, i.e.,

$$\pi_t = \sum_i w_{i,t} \, \dot{p}_{i,t} \, . \tag{5}$$

Summing up the above mentioned expressions, we obtain

$$\pi_t = \dot{P}_t + \sum_i w_{i,t} \, \dot{x}_{i,t} \quad , \tag{6}$$

where the second term represents the group of noises (n_t) and bias (b_t) tied to core inflation $\dot{P}_t$ for all *t*; more precisely,

$$(7) \qquad \pi_t - \dot{P}_t = \sum_i w_{i,t}\, \dot{x}_{i,t} = n_t + b_t \,,$$

where n_t is a stationary noise with zero mean and b_t is a bias that could be represented as $b_t = \mu_b + \omega_t$ (μ_b and ω_t are the bias of measurements and weights, respectively).

If the inflation of an individual component i in k is determined as

$$(8) \qquad \dot{p}_{i,t}^{k} = \frac{p_{i,t+k} - p_{i,t}}{p_{i,t}} \quad ,$$

since the inflation of an individual component in the expression *(8)* is obtained from the measure of individual price change

$$(9) \qquad \pi_t^k = \dot{p}_{i,t}^k = \frac{1}{k}\overbrace{[\ln(p_{i,t+k}) - \ln(p_{i,t})]}^{\bullet} = \frac{1}{k}\ln(\overbrace{\frac{p_{i,t+k}}{p_{i,t}}}^{\bullet}),$$

then the result will be the following specification of inflation:

$$(10) \qquad \pi_t^k = \dot{P}_t^k + \mu_b + \sum_{j=1}^{k}(\omega_{t+j} + n_t) \cdot$$

At a rather large value of k (considering the assumption that stationary noise has zero mean), the bias resulted from the change of weights and stationary noise cancel each other out and the last component of the expression *(10)* turns to zero. The bias of μ_b measurements can be derived from existing data as a difference between the actual CPI time series and core inflation measure. The efficient measure of core inflation is defined by comparing inflation measures, which are derived using the above-mentioned four alternative methods, on the basis of their RMSE and MAD relative to the benchmark trend. Therefore, the question of choosing an adequate benchmark trend is crucial for deriving core inflation measure.

Previous studies focused in measuring core inflation (Berkmen 1999; Bryan and Cechetti 1995, 1996, and 1997; Wozniak 1999; Clark 2001) chose arbitrarily centered moving averages (CMA) as the benchmark trend. The CMA based benchmark trend appears to be irrelevant for the data of the KR, since it does not closely approximate the general inflation trend in the KR (Figure 3).

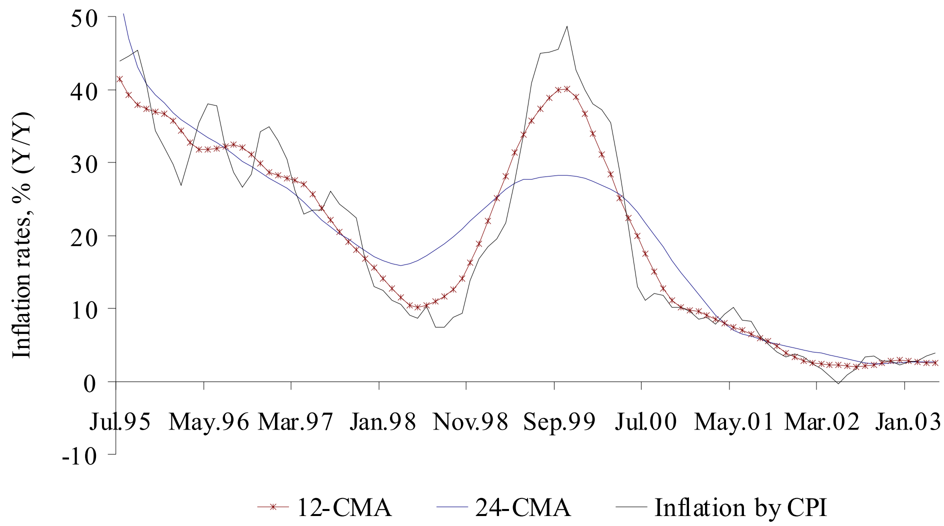


Figure 3. Centered moving averages and the actual inflation rates

As Figure 3 shows, there is a "slow" reaction of CMAs, which include *12* and *24* month periods, to actual CPI rates. In particular, the CMA trends either overstate in some periods or understate in other periods the time series of the CPI. Therefore, other alternative smoothing and filtering methods are included in the study. These are the Hodrick-Prescott (HP) filtering, logarithmic smoothing, powered smoothing, and the polynomial trends. To choose the appropriate benchmark trend from the set of simulated trends, the standard deviation of each series from the actual inflation rates are computed and compared. Then, based on minimizing these deviations, the Hodrick-Prescott filter with the smoothing parameter *10* (HP-10) is chosen as the benchmark trend. Figure 4 demonstrates further that this trend closely approximates the dynamics of the actual inflation rates.

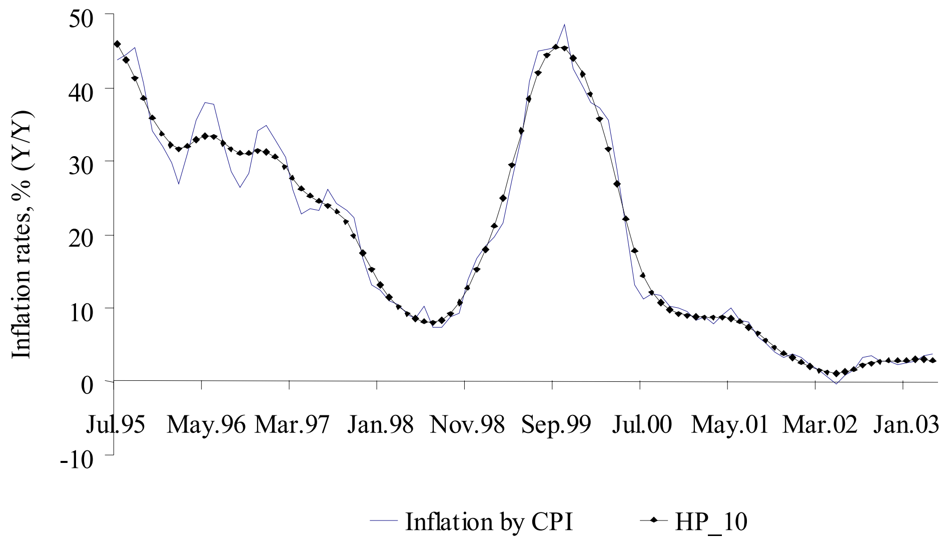


Figure 4. Benchmark trend: a Hodrick-Prescott filter

The alternative inflation measures derived by our four methods are compared with the benchmark trends on the basis of MAD and RMSE, which are defined as follows:

(11) $$MAD = \frac{1}{N}\sum_{i=1}^{N} | y_i |, \text{ and}$$

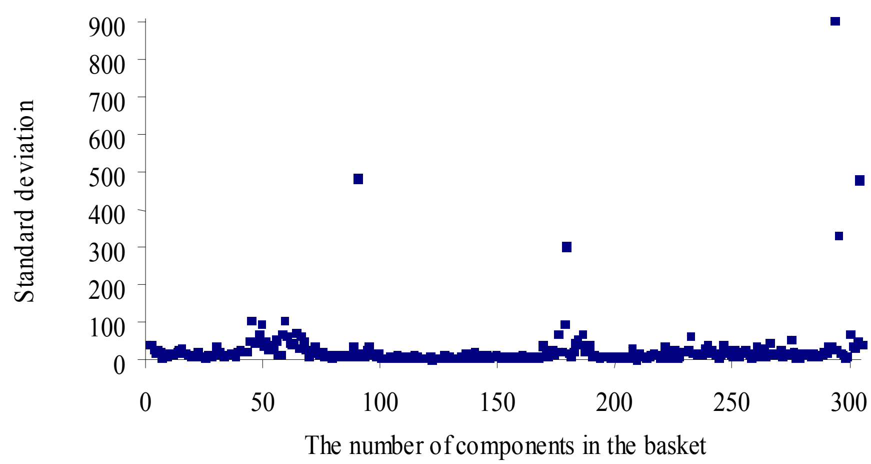
(12) $$RMS = \sqrt{\frac{1}{N}\sum_{i=1}^{N} (y_i)^2},$$

where y_i is the distance between the derived inflation measure and the benchmark trend. Computed MAD and RMSE for all estimators are sorted in ascending order and better measures derived by each method are chosen. Below means obtained by the alternative four methods are examined in detail.

4.1. Exclusion method

The preliminary analysis of individual price changes in the KR for the period July 1995 to April 2004 shows significant price fluctuations. The standard deviations of individual CPI prices across time, which are calculated on the basis of annualized monthly data (*Y/Y*), vary greatly; the lowest value of deviations is *3.4*, while the highest is *905.1*. The standard deviation of CPI components across time throughout the whole period considered is shown in Figure 5(a). The five most volatile components are cologne, garlic, notary services, lipstick, and rent (per sq. m). After excluding these components from the basket some outlying items, which fluctuate greatly, still remained in the sample (Figure 5(b)).

a)



b)

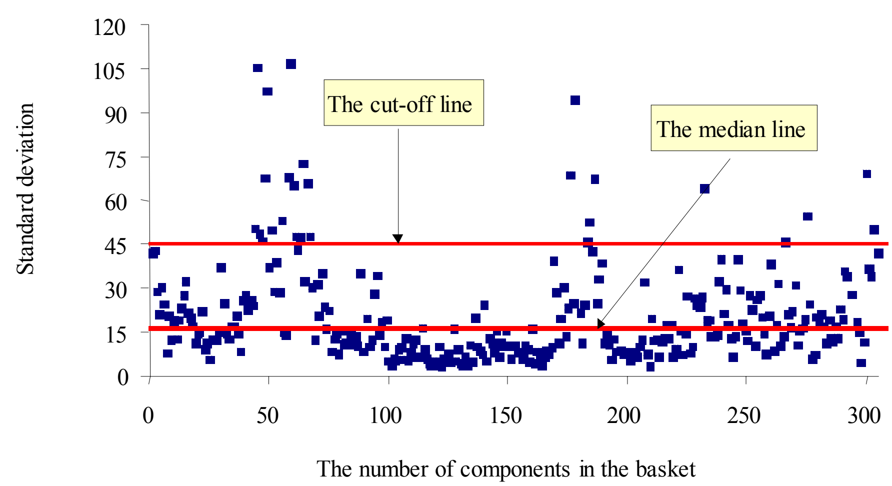


Figure 5. The standard deviation of individual price changes: a) including 5 highly volatile components; b) excluding 5 highly volatile components

These outlying items are at least twice as variable as the items lying at the median level of the standard deviations. Therefore, in order to exclude too volatile components from the basket, a cut-off point for exclusion is defined as the product of the median level of standard deviations for the annualized monthly inflation, which is *15.03*, and *2.50*. The components whose standard deviations exceed the cut-off point, which is *45.09*, are excluded from the CPI.

The total number of goods and services excluded from the basket is *31*, which are fruits and vegetables, rental fees, and imported goods (Table 3 in the Appendix). The exclusion of these components from the basket significantly improves the inflation measure; its deviation from the benchmark trend measured by both RMSE and MAD is the lowest. However the suitability of this method to the conditions of the KR is questionable. The reason for this is that due to the high share of agriculture in the economy of the KR, policymakers pay great attention to the seasonal factors that cause price changes. Besides, expenses on foods, energy and rental fees, which are excluded from the basket, compose the largest portion of families' budget. The size of weights, which are zeroed out systematically under the calculation of the average-weighted price of the rest of the components in the basket, is *0.1883*, on average, for 1995 to 2003. In other words, about *20%* of all information is thrown out every time when calculating core inflation. Under these circumstances, the intuitive exclusion of components from the basket might increase the chances of losing important information and make the concept of core inflation too suspicious for the public.

4.2. Trimmed means method

The trimmed means method is based on regular removal of the greatest jumps, allowing one to lower the undesirable properties of a sample mean. An intuitive explanation is as follows: the sample mean gives a distorted estimation of true inflation due to extraneous price disturbances. In the case of the KR the population distributions of CPI changes is not normal, not known, and vary over time, so finding a good estimator is problematic. In this regard, the author uses the fact that the sample mean is a function of the random variables: $CPI_1, \ldots, CPI_{343}$. It is also considered that, theoretically, the distribution of the sample mean can be found through using two characteristics of distributions: the mean and variance which do not depend on the density $f(\cdot)$. Therefore, the trimmed mean estimators, which are devised from means, can be examined and compared. To find the efficient trims, the CPI distributions are trimmed at monthly frequency using the annualized monthly data.

According to the technique, which is in detail described and tested by Berkmen (1999), Nyman (1999), and Wozniak (1999), the components of the CPI are ordered in ascending order ($CPI_1, \ldots, CPI_{343}$ according to the value of CPI) with their appropriate weights ($w_1, \ldots, w_{343}$). Then, W_i is defined as a cumulative weight from j (the first component assigned for averaging) to i (the last component assigned for averaging) as $W_i = \Sigma w^i_j$ in order to determine the set of observations for averaging, i.e., i components such that

$$(13) \qquad \alpha/100 < W_i < (1- \alpha /100) .$$

Consequently, the obtained set of CPI components (i.e., I_α) used for calculating the weighted trimmed means is

$$(14) \qquad \chi_\alpha = (1/ (1- 2\alpha / 100)) \sum_{i \in I\alpha} w_i * CPI_{i.}$$

The weighted trimmed means can represent two special cases: the sample mean, χ_0; and the sample median, χ_{50}.

The procedure is performed with the *1%* step of trimming, starting from *1%* of the observations and ending with *49%*, from both tails by the weights of the consumer basket. By sorting derived means according to RMSE and MAD, 6 better performing measures from the set of *49* trimmed means are chosen (Table 4 in the appendix). However, none of these measures, which are *1%*, *2%*, and *3%* of trimming from both tails of distributions, can sufficiently smooth the inflation measure during the whole period of the sample. This is because the general inflation level is much more volatile during 1995-2000 compared to subsequent years. Therefore, the author decided to compare the RMSE and MAD of the derived means for the periods July 1995 to December 2000 and January 2001 to April 2004 separately. According to the results, one can smooth the time series of CPI rates by omitting only *2%* of observations during the first period, while excluding *26%* of observations is necessary during the second period to minimize the distance of the derived measure from the benchmark. In general, in high inflation periods a smaller percentage of trimming is sufficient, and in the periods of moderate inflation, trimming with larger percentages is preferable.

4.3. Standard deviation trimmed means method

For measuring core inflation by this method, the extraneous jumps or falls of prices should be excluded from the distribution of individual price changes, leaving the remaining prices for averaging. The literature suggests that observations above and below *1* to *3* standard deviations from the mean be discarded (see, for example, Wozniak 1999). The reason for this is that the normally distributed variables contain 68.2% of observations within *1* standard deviation from the mean, *95.4%* of observations within *2* standard deviation from the mean, and *99.8%* of observations within *3* standard deviation from the mean (Green 2001). Thus, it is suggested to exclude outlier price jumps or falls on a period-by-period basis.

To find the cut of points for the CPI data of the KR, first, the standard deviations of individual price changes within the CPI are calculated on the period-by-period basis. An example of monthly price deviations on the period-by-period basis is presented in Figure 6.

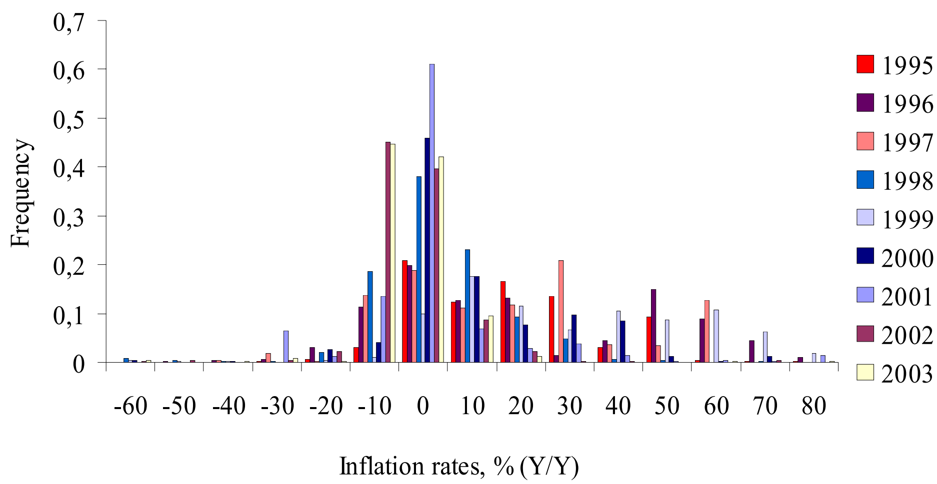


Figure 6. CPI on the period-by-period basis: covering only the months of September during 1995-2003

It should be noted that the empirical distributions of individual price changes have a very wide range. The same is true for the standard deviations of price changes on the period-by-period basis. Therefore, exclusion from the CPI is applied with varying standard deviations, depending on the range of their medians. Five alternative measures are calculated for the whole sample period and separately for the periods with highly volatile dynamic of inflation (January 1995 to December 2000) and less volatile dynamic of inflation (January 2001 to April 2004). These are the means obtained by excluding jumps and/or falls above and below *1*, *1.5*, *2*, *2.5*, and *3* standard deviations. For each resulting trimmed set of observations, i.e., for each standard deviation, the weighted-average level of prices are computed and compared against the benchmark trend.

The comparison of obtained means with the benchmark trend on the basis of RMSE and MAD shows that the optimal threshold of trimming is above and below *3* standard deviations for the period 1995-2000 and above and below *1.5* standard deviations for the period 2001-2004. In other words, during the periods of high price volatility, a smaller percentage of exclusion (i.e., below and above *3* standard deviation) improves the behavior of the inflation measure at which both the RMSE and MAD values around the benchmark trend are low. During more tranquil periods, however, exclusion with a more narrow range of cut-off points (*+-1.5* standard deviation) is desirable (see Table 5 in the Appendix). We should remark that prices are excluded without knowledge of the sources of noises. Consequently, this method can discard useful information if outlier prices contain important news, for example, the change of state controlled prices that play a very important role in forming price expectations. This is the main drawback of the method.

4.4. Percentile method

The essence of the analysis is based on the assumption that the empirical distribution of price changes, which we observe each month (quarter, year), is the individual sample of the whole population of price changes. Consequently, we compare the set of changes in underlying prices. The most acceptable way to make such a comparison is to use the empirical sample of distributions. It is achieved by smoothing all possible normalized observations both by CPI components and time periods on each frequency of observation (Roger 1997; Wozniak 1999). At the symmetric distribution of individual prices (median), the percentile of underlying inflation is equal to *50*. Figure 7 demonstrates the sample mean percentiles calculated over the entire sample period of KR data at monthly frequency.

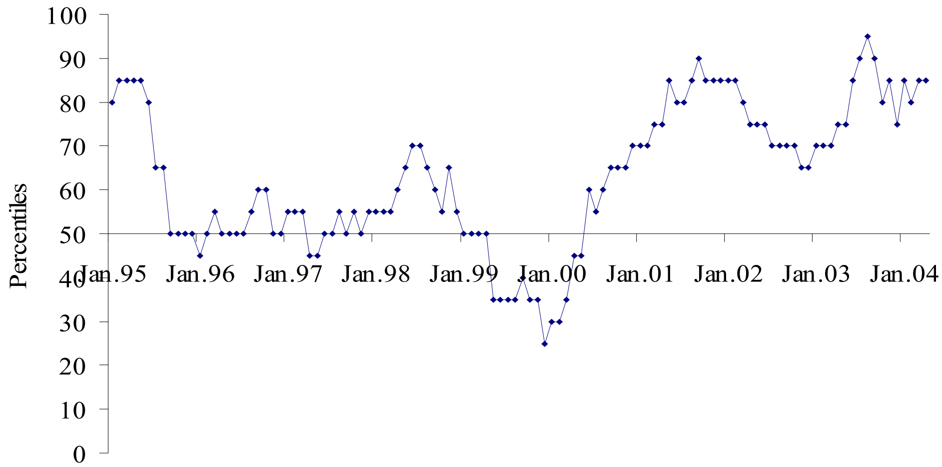


Figure 7. Sample mean percentiles: annualized monthly inflation rates, Y/Y

The annualized monthly observation of the sample mean ranges from the *25th* to *95th* percentiles, meaning that as little as *25%* or, at other times, as much as *95%* of the CPI categories experience price changes that are smaller than the recorded CPI. The median level and the mean of sample mean percentiles, which are *65* and *63* percentiles, respectively, are quite close. Therefore, the range of prices for the comparison of percentile values with the benchmark trend is chosen according to both average and median levels of sample means. Table 6 (in the Appendix) presents six better performing measures chosen by RMSE and MAD from the set of percentiles within the range *50-80*. The *55th* percentiles have the lowest values of RMSE and MAD for the period 1995-2000, when inflation is characterized by a highly volatile pattern, while in more stable periods, i.e., during 2001-2004, the *65th* percentiles correspond to the optimality criterion.

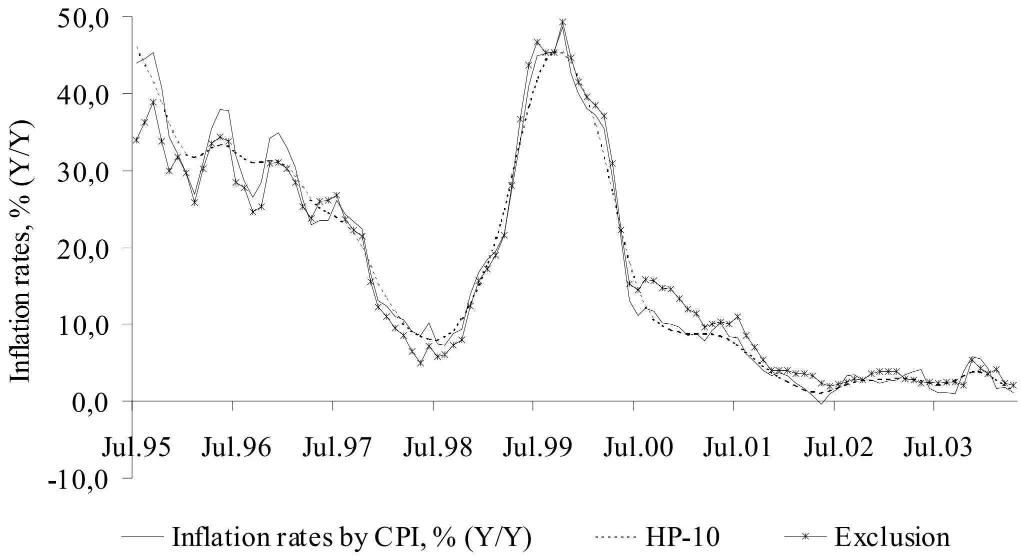
5. Finding optimal measures

As it was mentioned earlier, core inflation should satisfy the property of smoothness. To check this property, we compare derived inflation measures with the benchmark trend (e.g., HP-10) on the basis of RMSE and MAD. Table 7 (in the Appendix) presents the better performing inflation estimators from the set of measures derived from each alternative method. As it is shown, eliminating extraneous price jumps/falls from the CPI that lie beyond *+-3.0* standard deviations and excluding *31* components from the basket allow one to significantly improve the inflation measure in terms of its smoothness. Two other measures, which are the *55^th^* percentile means and trimmed means obtained by censoring *1%* of observations from both tails of distributions, significantly lose in terms of efficiency. The comparison of alternative methods during the whole sample period shows, consequently, that means obtained by the exclusion method and the exclusion of unusual jumps yield better results compared to the trimmed means and percentile methods.

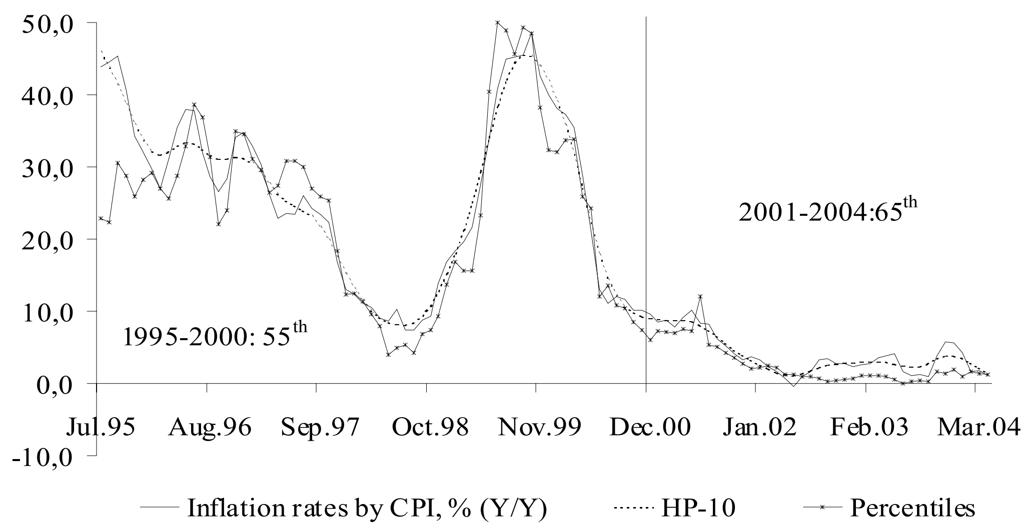
However, as it was mentioned earlier, both the exclusion and standard deviation trimmed means methods have serious drawbacks, which might limit their practical advantageousness due to the conditions of the KR. First, expenses on goods and services, which are excluded from the basket by the exclusion method, compose the largest portions of families' budget. Besides, the high share of agriculture in the economy of the KR does not allow excluding too many seasonal goods as policymakers pay great attention to the seasonal factors of the economy. A disadvantage associated with the standard deviation trimmed means method is the high probability of losing important information because prices are excluded from the CPI without knowledge of the source of price jumps or falls. If outlier prices contain information which is important in forming future price expectations, then excluding these prices is not desirable. In general, the intuitive exclusion of important components from the basket might increase the chances of losing necessary information. Thus, it can make both private and public opinion suspicious to the concept of core inflation as the long-run inflation measure.

Figure 8 shows the dynamic of smoothed inflation measures chosen by RMSE and MAD from the set of measures derived by four alternative methods.

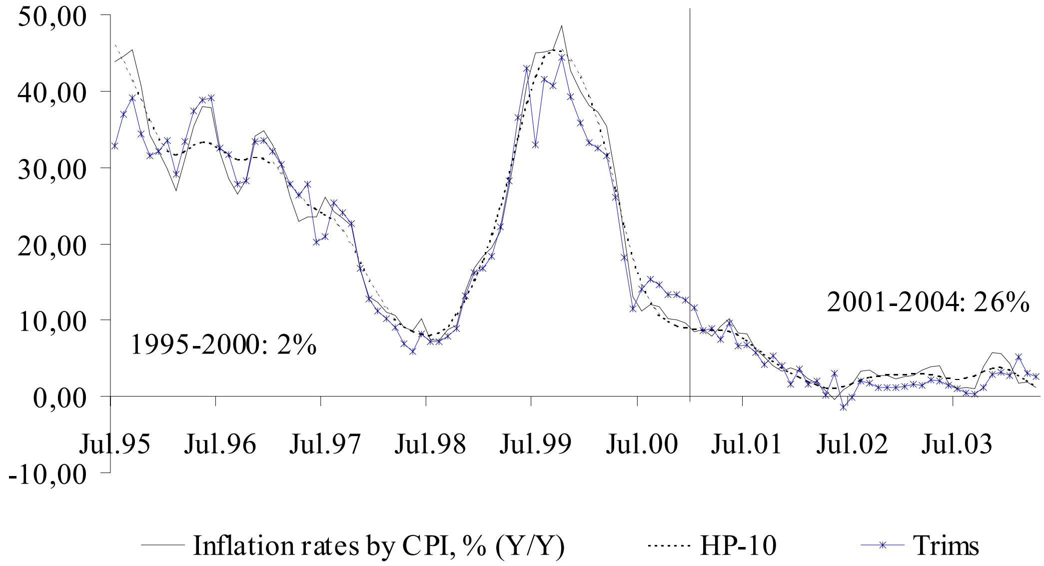
a) Exclusion



b) Percentiles



c) Trimmed means



d) Standard deviation trimmed means

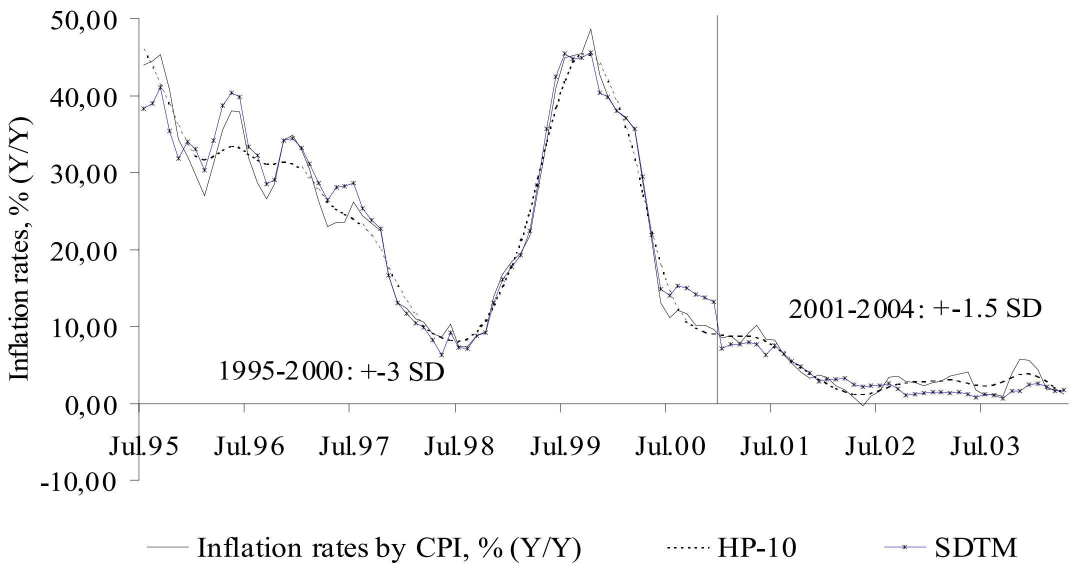


Figure 8. Core inflation estimators: a) exclusion; b) percentiles; c) trimmed means; and d) standard deviation trimmed means

As Figure 8 demonstrates, means obtained by the standard deviation trimmed means method are the best; MAD and RMSE are the lowest. The second best result is obtained by the exclusion method, at which MAD and RMSE are lower compared to the trimmed means and percentile methods. Despite the fact that the percentile method has poor results, it has an important advantage compared to the other methods. Namely, it takes into account all the available observations. Therefore, one should not reject it completely, especially, when in some periods the dynamics of aggregate price levels have large leaps relative to other periods as in the case of the KR.

As it is already mentioned, the CPI of the KR is characterized by large fluctuations from 1995 to 2000, while during 2001 to 2004 its pattern is much smoother. Taking this into account, RMSE and MAD of the derived means are compared separately for the periods July 1995 to December 2000 and January 2001 to April 2004. The analysis of the alternative methods in the environment of low inflation only shows that the *65^{th}* percentiles of the CPI are the most suitable measure of core inflation (see Table 7 in the Appendix). The MAD and RMSE of these percentiles from the benchmark trend is the lowest among all alternatives estimated during 2001-2004. This indicates the fact that during periods of more stable inflation, the core inflation measure is more distanced from the median of the CPI. In more volatile periods, on the contrary, it is close to the median of the CPI. In other words, when the aggregate CPI has a steady downward trend after a large spike, the methods based on exclusion perform especially well. When the aggregate CPI is low and more diverse in its changing pattern, the percentiles and trimmed means methods are better for measuring core inflation.

6. Conclusion

The success and efficiency of monetary policy in terms of inflation stability depends on whether the inflation measure reflects long-term price movements or includes short-term shocks as well. This paper presents information on the system of inflation measurement in the KR and argues that the inflation measure based on the CPI does not correspond to the ideal inflation measure. High volatility of the CPI, which stems from its strong sensitivity to various non-monetary factors and structural (supply) shocks, significantly complicates the main goal of the central bank, to control inflation.

In this respect, this study investigates four alternative methods (e.g., exclusion, trimmed means, standard deviation trimmed means, and percentile) of measuring core inflation.

The sample covers a full set of the disaggregated CPI data for the period of 1995-2004. Inflation measures obtained on the basis of four alternative methods are examined based on the property of a long-term inflation measure – the smoothness property. This property is evaluated by minimizing the distance (RMSE and MAD) between derived inflation measures and the benchmark trend (HP-10) of the CPI. The results suggest that in periods of large decline in inflation (when all or almost all CPI components decrease steadily), the standard deviation trimmed means and exclusion means are preferable, while in periods of more diverse change across CPI items, the percentile means are robust. Since inflation was falling during most of the years included, the exclusion and the standard deviation trimmed means methods seem to yield better results for the whole period. However, these methods have a serious disadvantage because exclusion occurs at the intuitive level and the probability of losing important information is high. In this respect, four methods are compared in periods of low inflation only. It reveals that the percentile method, which takes into account all the available observations, is robust.

In general, this research is the first attempt to study and test the alternative methods of measuring core inflation on the basis of KR data. Therefore, the results of this research should not be considered a definitive answer to what is the appropriate measure of core inflation in the KR. Rather it sheds some light on the way of filtering out noises and short-term shifts in price changes in order to get a smoothed inflation measure. The results show that additional research is necessary. In particular, it is desirable to test alternative methods on the extended data with changing inflation trends. Also, a more convincing theoretical approach for separating actual time series that are highly sensitive to exogenous shocks into smooth and stationary components is necessary.

Appendix: Tables

Table 1. Basic macroeconomic indicators of the KR

Main indicator	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Inflation rate, (%, Y/Y):	2034	1366	87	32	35	13	17	39	9	4	2	6
-foods	2876	980	73	41	39	15	117	45	10	0	2	5
-non-foods	1063	940	73	13	20	6	11	30	7	1	1	2
-paid services	440	5790	509	38	42	18	23	36	16	22	4	18
GDP(%, rate)	-16	-16	-20	-5	7	10	2	4	5	5	0	7
Budget deficit (% of GDP)	-14	-7	-8	-12	-5	-5	-3	-2	-2	0.4	-1	-1
External debt (mln.US $)	4	290	446	608	764	928	1480	1699	1703	1677	1785	1966
Export (mln.US$)	824	679	568	489	562	677	601	527	573	560	629	…
Import (mln. US$)	1102	834	674	704	1034	817	955	712	652	564	685	…
Exchange rate, KGS/US$ (end of the period)	#	8	11	11	17	17	29	45	48	48	46	44

Source: NBKR, NSC, MF, WDI

Table 2. Skewness and kurtosis of CPI distributions:
annualized monthly data

	Weighted		**Unweighted**	
	Skewness	Kurtosis	Skewness	Kurtosis
Mean	7.3	200.3	6.2	78.0
Median	3.1	22.8	3.9	30.9
Standard deviation	9.7	370.9	5.1	91.7

Sources: NSC, calculations of the author

Table 3. Standard deviations (SD) of prices during July 1995 to April 2004

		SD	Weights								
			1995	1996	1997	1998	1999	2000	2001	2002	2003
#	Excluded items:		0.0489	0.0492	0.0455	0.0503	0.0533	0.0554	0.0585	0.0766	0.0766
1	Cologne	905	0.0004	0.0004	0.0004	0.0004	0.0006	0.0007	0.0008	0.0027	0.0027
2	Garlic	486	0.0002	0.0003	0.0002	0.0003	0.0007	0.0005	0.0008	0.0011	0.0011
3	Notary services	481	0.0005	0.0012	0.0013	0.0013	0.0006	0.0006	0.0006	0.0009	0.0009
4	Lipstick	333	0.0004	0.0004	0.0004	0.0004	0.0006	0.0007	0.0008	0.0025	0.0025
5	Rent per sq.m	303	0.0017	0.0017	0.0019	0.0019	0.0026	0.0029	0.0021	0.0025	0.0025
6	Onion	107	0.0065	0.0062	0.0047	0.0066	0.0058	0.0059	0.0081	0.0050	0.0050
7	Pear	106	0.0007	0.0006	0.0005	0.0006	0.0005	0.0005	0.0004	0.0004	0.0004
8	Grapes	97.6	0.0013	0.0010	0.0009	0.0006	0.0007	0.0009	0.0009	0.0009	0.0009
9	Shoes repair	94.6	0.0014	0.0014	0.0015	0.0015	0.0012	0.0012	0.0012	0.0011	0.0011
10	Spring onion	72.9	0.0003	0.0003	0.0002	0.0003	0.0003	0.0003	0.0004	0.0003	0.0003
11	Postal service	69.5	0.0004	0.0004	0.0004	0.0004	0.0004	0.0003	0.0003	0.0024	0.0024
12	Slippers	68.7	0.0004	0.0004	0.0005	0.0005	0.0002	0.0002	0.0002	0.0002	0.0002
13	Fresh cabbage	68.3	0.0022	0.0025	0.0020	0.0022	0.0021	0.0019	0.0019	0.0018	0.0018
14	Cherry	67.9	0.0007	0.0006	0.0005	0.0006	0.0005	0.0006	0.0005	0.0005	0.0005
15	Water	67.7	0.0074	0.0075	0.0083	0.0085	0.0081	0.0111	0.0135	0.0263	0.0263
16	Tumip	65.7	0.0014	0.0016	0.0014	0.0015	0.0015	0.0013	0.0013	0.0014	0.0014
17	Beetroot	65.6	0.0014	0.0017	0.0013	0.0014	0.0013	0.0014	0.0015	0.0013	0.0013
18	Detergent	64.3	0.0040	0.0038	0.0040	0.0040	0.0064	0.0062	0.0061	0.0057	0.0057
19	Envelopes	55.0	0.0002	0.0002	0.0002	0.0002	0.0003	0.0002	0.0002	0.0007	0.0007
20	Nuts	53.2	0.0017	0.0015	0.0009	0.0016	0.0017	0.0012	0.0011	0.0012	0.0012
21	Paint	52.7	0.0005	0.0006	0.0007	0.0007	0.0018	0.0014	0.0014	0.0020	0.0020
22	Apple	50.7	0.0041	0.0035	0.0031	0.0036	0.0030	0.0029	0.0025	0.0025	0.0025
23	Telegraph	50.3	0.0006	0.0005	0.0005	0.0005	0.0004	0.0004	0.0003	0.0001	0.0001
24	Lemon	49.8	0.0009	0.0009	0.0007	0.0008	0.0011	0.0010	0.0009	0.0011	0.0011
25	Apricot	48.7	0.0014	0.0012	0.0010	0.0012	0.0010	0.0006	0.0006	0.0006	0.0006
26	Aubergine	47.9	0.0007	0.0008	0.0007	0.0008	0.0008	0.0007	0.0007	0.0008	0.0008
27	Carrot	47.8	0.0042	0.0052	0.0039	0.0041	0.0038	0.0041	0.0045	0.0040	0.0040
28	Pumpkin	47.5	0.0001	0.0001	0.0001	0.0001	0.0003	0.0002	0.0001	0.0001	0.0001
29	Strawberry	46.3	0.0016	0.0011	0.0013	0.0016	0.0016	0.0012	0.0012	0.0015	0.0015
30	Cement	46.1	0.0012	0.0015	0.0016	0.0016	0.0032	0.0038	0.0032	0.0044	0.0044
31	Theater tickets	45.8	0.0003	0.0002	0.0003	0.0003	0.0002	0.0002	0.0001	0.0008	0.0008

Sources: NSC KR, NBKR

Table 4. Trimmed means after 2-side censoring of price distributions

The whole sample period				January 1995 to December 2000				January 2001 to April 2004			
Trims %	RMSE	Trims %	MAD	Trims %	RMSE	Trims %	MAD	Trims %	RMSE	Trims %	MAD
2	3.1	2	2.4	2	3.5	2	2.8	26	1.9	26	1.5
4	4.3	4	2.8	4	5.1	4	3.4	34	2.0	34	1.7
6	5.1	6	3.3	6	6.1	6	4.3	32	2.1	32	1.7
28	5.5	28	3.8	28	6.7	12	4.9	8	2.1	8	1.7
8	5.7	8	3.8	14	7.1	8	5.0	10	2.1	10	1.7
16	5.8	16	4.0	8	7.1	28	5.1	4	2.2	4	1.7

Sources: NSC KR, calculations of the author

Table 5. Standard deviation trimmed means

The whole sample period				January 1995 to December 2000				January 2001 to April 2004			
Cut-of	RMSE	Cut-of	MAD	Cut-of	RMSE	Cut-of	MAD	Cut-of	RMSE	Cut-of	MAD
+-3.0	2.5	+-3.0	1.9	+-3.0	2.9	+-3.0	2.3	+-1.5	1.3	+-1.5	1.1
+-2.5	2.9	+-2.5	2.2	+-2.5	3.4	+-2.5	2.7	+-1.0	1.6	+-1.0	1.4
+-2.0	3.4	+-2.0	2.5	+-2.0	4.1	+-2.0	3.2	+-3.0	1.7	+-3.0	1.2
+-1.5	7.8	+-1.5	5.2	+-1.5	9.9	+-1.5	7.6	+-2.0	1.8	+-2.0	1.5
+-1.0	10.6	+-1.0	7.3	+-1.0	13.4	+-1.0	10.8	+-2.5	1.8	+-2.0	1.5

Sources: NSC KR, calculations of the author

Table 6. Percentile means

The whole sample period				July 1995 to December 2000				January 2001 to April 2004			
Percen-tiles	RMSE	Percen-tiles	MAD	Percen-tiles	RMSE	Percen-tiles	MAD	Percen-tiles	RMSE	Percen-tiles	MAD
55	4.9	55	2.8	55	6.2	55	4.5	65	1.1	65	0.9
60	4.9	60	2.8	60	6.2	60	4.5	60	1.3	60	1.2
50	5.9	50	3.5	50	7.4	50	5.7	55	1.8	70	1.4
65	6.1	65	3.8	65	7.8	65	6.2	70	1.8	55	1.6
70	9.9	70	6.4	70	12.6	70	10.3	50	2.3	50	2.1
75	13.4	75	9.2	75	17.0	75	14.8	80	5.5	75	4.5
80	17.6	80	12.6	80	22.2	80	20.2	75	8.2	80	4.9

Sources: NSC KR, calculations of the author

Table 7. Inflation estimators and the property of smoothness

	The whole sample period			July 1995 to December 2000			January 2001 to April 2004		
		RMSE	MAD		RMSE	MAD		RMSE	MAD
Exclusion		2.9	2.0		3.4	2.6		1.3	1.1
Sample means percentile	55	4.9	2.8	55	6.2	4.5	65	1.1	0.9
Standard deviation trimmed means	+-3.0	2.5	1.9	3.0	2.9	2.3	1.5	2.8	2.3
Trimmed means	2%	3.1	2.4	2%	3.5	2.8	26%	1.9	1.5

Source: NSC, the calculation of the author

References

Annual Report of the National Bank of Kyrgyz Republic (1998)

Arrazola, M., Hevia, J. (2001) An alternative measures of core inflation. *Economic Letters*, No.1

Ball, L., Mankiw, N.G. (1994) Assymetric Price Adjustment and Economic Fluctuations. *Economic Journal*, Vol. 104, No.423

Ball, L., Mankiw, N.G. (1995) Relative Price Changes as Aggregate Supply Shocks. *The Quarterly Journal of Economics*, Vol. CX (1)

Blinder, A.S. (1997) Commentary on Measuring short-run inflation for central bankers. *Review. Federal Reserve Bank of St. Louis, May/June*

Bryan, M.F., Cecchetti, S.G. (1993) Measuring Core Inflation. *NBER Working Paper*, No. 4303

Bryan, M.F., Cecchetti, S.G. (1994) Measuring Core Inflation. [in.] N. G. Mankiw. *Monetary Policy*, (ed.), Chicago: University of Chicago Press for NBER

Bryan, M.F., Cecchetti, S.G. (1995) The Seasonality of Inflation. *Economic Review of the Federal Reserve Bank of Cleveland*, No. 29 (2nd Quarter)

Bryan, M.F., Cecchetti, S.G. (1996) Inflation and the Distribution of Price Changes, *NBER Working Paper*, No. 5793

Bryan, M.F., Cecchetti, S.G., Wiggins, R.L. (1997) Efficient Inflation Estimator. *NBER Working Paper*, No. 6183

Berkmen, P. (1999) Inflation Measurement for Central Banks. *The Central Bank of the Republic of Turkey Working Paper*, Cardiff Business School

Cecchetti, S.G. (1995) Inflation Indicators and Inflation Policy. *NBER Working Paper,* No. 5161

Cecchetti, S.G. (1996) Measuring Short-Run Inflation for Central Bankers. *NBER Working Paper,* No. 5786

Charemza, V., Makarova S., Parchomenko V. (2000) Underlining inflation and the methods of forecasting. Unpublished manuscript

Clark, T.E. (2001) Comparing Measures of Core Inflation. *Federal Reserve Bank of Kansas City, Economic Review* (second quarter)

Claus, I. (1997) A Measure of Underlying Inflation in the United States. *Bank of Canada Working Paper,* 97–20

Cutler, J. (2001) Core inflation in the UK. *External MPC Unit Discussion Paper No. 3*, London: Bank of England, March.

Hanousek, J., Filer, R. (2001a) Evaluating Imperfections and Biases in Price Indexes During Transition. *CERGE-EI Working Paper*, No.186

Hanousek, J., Filer, R. (2001b) Consumers' Opinion of Inflation Bias Due to Quality Improvements in Transition in the Czech Republic. *CERGE-EI Working Paper*, No.184

Green, W. (2001) *Econometric Analysis*. Fourth Edition, Maxwell Macmillan International Publishing Company

Eckstejn, O. (1981) *Core Inflation*. New York: Prentice Hall

Fischer, S. (1981) Relative Shocks, Relative Price Variability, and Inflation. *Brookings Papers on Economic Activity*, No.2

Fischer, S. (1982) Relative Price Variability and Inflation in the United States and Germany. *European Economic Review*, No.18

Franses, P.H., van Dijk, D. (2005) The forecasting performance of various models for seasonality and nonlinearity for quarterly industrial production. *International Journal of Forecasting,* Vol. 21

Haldane, A.G. (1995) *Targeting Inflation*, (ed.) London: Bank of England

Johnson, M. (1999) Core Inflation: A Measure of Inflation for Policy Purposes. *The Bank of Canada Working Paper*

Miller, M., Williams, D. (2003) Shrinkage estimators of time series seasonal factors and their effect on forecasting accuracy. *International Journal of Forecasting,* Vol.19, iss. 4

Mussa, M. (1977) The Welfare Cost of Inflation and the Role of Money as a Unit of Account. *Journal of Money, Credit and Banking*, No. 9

Neumann, M., Jurgen, H. (2002) Does Inflation Targeting Matter? *The Federal Resreve Banks of St. Louis*, July/August 2002

Nyman, M. (1999) *Alternative Measures of Underlying Inflation. Methodological Discussion and Empirical Results, Handelsbanken Markets*. Cardiff Business School

Quah, D., Vahey, S. (1995) Measuring core inflation. *The Economic Journal*, No. 105

Roger, S. (1995) Measures of Underlying Inflation in New Zealand, 1981-1995. *Reserve Bank of New Zealand Discussion Paper*, G95/5

Roger, S. (1997) A Robust Measure of Underlying Inflation in New Zealand, 1949–1996. *Reserve Bank of New Zealand Discussion Paper, G97/7*

Smith, J. K. (2004a) Weighted median inflation: Is this core inflation? *Journal of Money Credit and Banking*, No. 36

Smith, J.K. (2004b) Better Measures of Core Inflation? Unpublished manuscript

Shleshinski, E., Weiss, Y. (1977) Inflation and Cost of Price Adjustment. *Review of Economic Studies*, No. 54

Wynne, M. (1999) Core inflation: a review of some conceptual issues*, DG Research, European Central Bank*, Frankfurt am Main

Wozniak, P. (1999) Various Measures of Underlying Inflation, *CASE-CEU Working Paper*, No. 25

Individual researchers, as well as the on-line and printed versions of the CERGE-EI Working Papers (including their dissemination) were supported from the following institutional grants:

- Economic Aspects of EU and EMU Entry [Ekonomické aspekty vstupu do Evropské unie a Evropské měnové unie], No. AVOZ70850503, (2005-2010);
- Economic Impact of European Integration on the Czech Republic [Ekonomické dopady evropské integrace na ČR], No. MSM0021620846, (2005-2011);

Specific research support and/or other grants the researchers/publications benefited from are acknowledged at the beginning of the Paper.

Published by
Charles University in Prague, Center for Economic Research and Graduate Education (CERGE)
and
Economics Institute (EI), Academy of Sciences of the Czech Republic
CERGE-EI, Politických vězňů 7, 111 21 Prague 1, tel.: +420 224 005 153, Czech Republic.
Printed by CERGE-EI, Prague
Subscription: CERGE-EI homepage: http://www.cerge-ei.cz

Editors: Directors of CERGE and EI
Managing editors: Deputy Directors for Research of CERGE and EI

ISSN 1211-3298
ISBN 80-7343-053-3 (Univerzita Karlova v Praze, CERGE)
ISBN 80-7344-042-3 (Národohospodářský ústav AV ČR, Praha)

CERGE-EI
P.O.BOX 882
Politických vězňů 7
111 21 Praha 1
Czech Republic
http://www.cerge-ei.cz