Sustainable trends and periodicity in consumer price indices indicate that the era of low energy prices is approaching

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IDG RAS

23 December 2012

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Abstract

Five years ago, we found three distinct periods characterized by sustainable quasi-linear trends in the difference between the headline consumer price index (CPI) and the core CPI in the USA. Then we revealed similar behavior in the differences between the CPI and indices of various consumer expenditure categories. We estimated the duration of these trends which varies in a wide range from 8 years to more than 20 years. The transition periods to new trends span shorter intervals of 2 to 5 years. The transition is characterized by a higher level of volatility in the studied CPI differences.

In this study, we revisit the revealed trends and transition periods using additional CPI estimates between 2008 and 2012. It is found that our major predictions are right: the headline CPI intersected the core CPI in 2011 and both variables have been evolving in sync since then. The difference between the core CPI and the index of energy has been suffering a transition period since 2008 with extremely high fluctuations. The index of food has been growing relative to the core CPI and did not reach its turning point. The difference between the core CPI and the index of housing passed through its transition period in 2008. When normalized to the CPI, the differences associated with energy and housing demonstrates clear periodicity. The observed trends and periodicity allow predicting the evolution of energy, food, and housing at a horizon of twenty five and more years. The consumer price index of energy may fall in 2013 by ten to twenty per cent from the 2012 level. The periodicity of the related normalized difference implies that this fall may extend into the second half of the 2020s. The housing index will be also falling relative to the core CPI, partly due to its energy related components. It is not excluded that the food price index will be rising another five to ten years. The secular fall in energy and housing prices may induce a lengthy period of very low inflation.

Key words: CPI, core CPI, energy, housing, food, trend, periodicity
JEL Classification: E31, E37, G12

Introduction

Consumer price index is a common measure of the growth in prices of goods and services. Historically, it provides one of the longest macroeconomic time series which is scrutinized by several generations of researchers in economics and also many other sciences. There are two general possibilities to understand the evolution of CPI. Firstly, one may reveal the driving forces behind the change in the overall level of consumer prices. This is an eternal topic for macroeconomics and headache for central banks. Secondly, the investigation of the internal structure and interaction between various categories of goods and services included in the headline CPI may reveal inherent links, which are also of great importance for economic theory as well as for producers and consumers.

The rate of CPI change is often used to characterize the average price inflation for consumers (Cecchetti, Chu, and Steindel, 2000). Potential causes of price inflation are studied in detail (e.g., Stock and Watson, 2008, 2010; Kitov and Kitov, 2010; Reis and Watson, 2010). Inflation associated with the CPI covers all principal expenditure categories of urban consumers as described by a representative basket of goods and services. This basket is characterized by fixed weights for given expenditure items, which are reconsidered about every ten years. Therefore, the Bureau of Labor Statistics (BLS) now relies on the personal consumption expenditures price index, PCEPI, in its official reports to the Congress and long-term inflation projections (FRB of San Francisco, 2003). A less volatile measure of the PCE price index is the core PCE price index, which excludes volatile and seasonal food and energy prices. Before 2000, the core CPI (CPI less food and energy) was used for these purposes (Bryan and Cecchetti, 1994). The short history of PCEPI measurements forces us to use the headline CPI.

Four years ago, Kitov and Kitov (2008) described several deterministic links between various components of the CPI in the USA. We started with the difference between the core and headline CPI and found two important features: sustainable quasi-linear trends and transition periods with elevated volatility. Then the consumer price index of energy, which gives approximately 9% of the CPI, was analyzed. In the beginning of 2008, we tentatively identified a new turning point in the difference between the CPI and the energy index and predicted an energy price fall relative to the core CPI through the first half of the 2010s.

It was also found that food, housing, transportation, and some other constituent parts of the overall CPI also demonstrate sustainable trends and turning points when the core/headline

CPI is subtracted. At the same time, the differences between the CPI and the price index of medical care, education, communication, other goods and services, and apparel do not show any turning points. These differences are well approximated by a straight line from the very beginning.

These observations suggest that the CPI components are driven by their own forces. In this regard, the secular evolution of any CPI component is hardly affected by other components. This makes their differences with the average CPI very informative. In essence, it is possible to foresee the evolution of the difference at time horizons from one to thirty years. The timing and length of transition periods allows predicting the period of high volatility, which may also affect real economy and the stock markets.

Similar features were found in the differences of producer price indices in the USA (Kitov and Kitov, 2009). We applied an additional technique to the PPI analysis and normalized some differences to the overall PPI. This approach reveals some new features and it is worth to apply it to the extended CPI time series.

The remainder of the paper is organized as follows. In Section 1, we revisit our prediction on the evolution of the difference between the headline and core CPI in the USA after 2007. Section 2 re-analyses the differences between the (headline/core) CPI and the CPIs of energy, food, housing, transportation, apparel, other goods and services, communication, and education.

1. CPI and core CPI

The core CPI is often used as a reliable estimate of inflation trends over longer time horizons. It is a well-known fact that the monthly CPI readings reported by the BLS are highly volatile and may give misleading signals on the long-term trends (Rich and Steindel, 2005). Usually the prices of food and energy are excluded from the headline CPI in order to obtain a smoother time series. In the long ran the relative evolution of the core and headline CPI is more informative than a simple stochastic time series.

Figure 1 illustrates the evolution of the measured CPI and core CPI in the USA after 1957. Unfortunately, no estimates of the core CPI are available before 1957. Both indices are for all urban customers and seasonally adjusted. In Figure 1, one can observe that the curves are very close before 1980 - the core CPI practically evolved in sync with the CPI. After 1981, the curves

diverge with the core CPI growing faster than the CPI. The gap between the indices widens through 2000, and then the curves start to converge and coalesce in the first quarter of 2011.
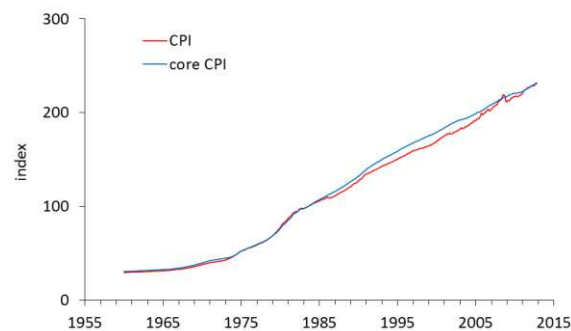

Figure 1. The evolution of the headline and core CPI in the USA.

A better view on the periods of the CPI and core CPI divergence and convergence is represented by the difference between these variables, as displayed in Figure 2. The difference is characterized by three distinct segments of quasi-linear trend and two short transition periods. Between 1960 and 1978, this difference is relatively stable and varies in a narrow range around +1 unit of index. Between 1979 and 1982, the curve falls to -2 and then suddenly changes its direction. From 1982 to 1999, the core CPI grows faster and a gap of about 10 units is created. The curve between 1982 and 1999 is well approximated by a straight line with a few small-amplitude deviations; the latter might be partially associated with measurement noise. The slope of the linear regression line presented in Figure 2 is -0.7 with R^2=0.96. In other words, during these eighteen years the headline CPI was growing by 0.7 units of index faster than the core CPI.

There was another period of high volatility between 1999 and 2002, which is similar to that observed between 1979 and 1982. The gap reached its peak value two times - in 1999 and in 2003. Since 2003, the gap has been closing in line with a faster growing headline CPI, i.e. the food and energy prices had relatively higher rates of growth. Nevertheless, the CPI was below the core CPI, as Figure 1 demonstrates. In 2008, we extrapolated the observed rate of convergence between the CPI and core CPI and estimated the intercept time somewhere between 2009 and 2010 (here we ignore a short term spike in oil prices in 2008). This negative linear trend was also a reliable one with R^2=0.91. The convergence was faster - approximately 1.6 units of index per year.

When extrapolating the structure of the difference into the future, we suggested that it would be increasing during the next 8 years as a mirror reflection of the trend observed between 2002 and 2008. The projected trend is shown by green line in Figure 2. Since 2008, the actual curve was above and below the green line. Seemingly, we have missed an important feature of the difference which is best seen in a different representation.
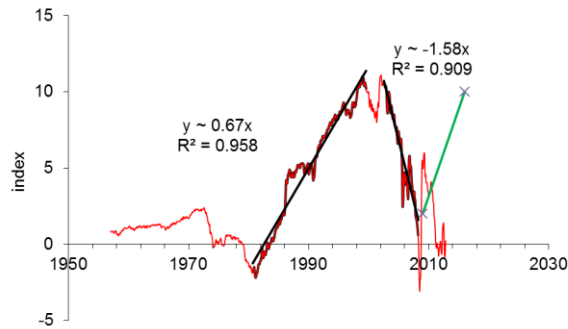

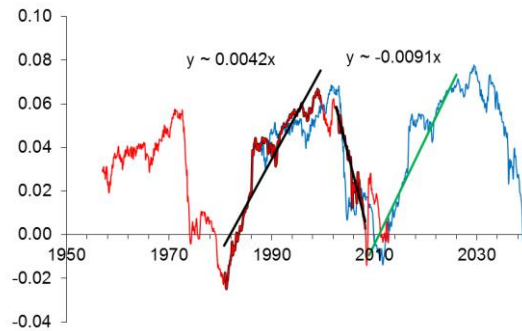Figure 2. The difference between the core and headline CPI.

Figure 3. The evoluton of the differnce between core and healine CPI normalizd to the headline CPI. Blue line represents the original curve shifter by 30 years ahead. The new trend is shown by green line. The blue line is shifted up by 0.011 relative to the red line in order to match the high/low peaks.

If to assume that the evolution of the core and headline CPI is driven by independent stochastic processes like random walks, then the deviation between these indices would be a stochastic trend itself. From Figure 3, it is more reasonable to assume, however, that there is a deterministic trade-off between these variables, which provides the observed repeated shape of the normalized difference. For purely stochastic and independent variables such a periodic behavior is highly unlikely.

5

There are several simple conclusions from the existence of periods and linear trends in the difference between the CPI and core CPI. Firstly, the consumer prices of food and energy are driven by forces which are independent on those behind other goods and services. Secondly, there are breaks in these forces, when the direction of action reverses. Thirdly, one can extrapolate the evolution of the difference between the CPI and core CPI at a horizon of about thirty years. Fourthly, there exist relatively short transition periods. These periods are characterized by an elevated volatility.

2. Long-term trends and periodicity in consumer price indices of energy, food, and housing

Following the approach developed in Section 1, we extend our analysis to the difference between price index related to individual expenditure categories and the headline (or core) CPI. Table 1 illustrates the change in the weights of major categories since 1996. The portion of energy increased from 6.7% to 9.7%, while the category of other goods and services lost about 4%. The input of food almost returned to its 1996 level despite it lost 2% in 2006 relative to 1996. The core CPI shrank by 1.5% mostly because of energy.

Table 1. CPI-U by expenditure category and commodity and service group. The evolution of relative importance.

Expenditure category	Relative importance, 2011, %	Relative importance, 2006, %	Relative importance, 1996, %
All items (CPI-U)	100	100	100
All items less food and energy	76.01	77.40	77.53
Energy	9.68	8.71	6.70
Food	15.26	13.88	15.77
Housing	41.02	42.69	41.35
Apparel	3.56	3.73	5.52
Transportation	16.875	17.25	16.95
Medical care	7.06	6.28	7.36
Education and communication	6.80	6.03	-
Recreation	6.04	-	-
Other goods and services	3.385	3.48	7.12

The CPI of energy is not a major expenditure subcategory. Energy prices are distributed over other major indices. The relative evolution of the core consumer price index and the CPI of energy is displayed in Figure 4 for the period between 1960 and 2012. Before 1980, these two indices had been growing almost at the same rate with small-amplitude fluctuations around 10

units of price index. Between 1981 and 1999, the difference grew from -10 to almost 80 units. Between 2002 and 2008, a period of intensive growth in the energy index was observed. Qualitatively, one can distinguish three periods of linear trend and three turning periods with a higher volatility. The last turning point was in 2008 and the index of energy is likely on a declining path relative to the core CPI. However, the extremely high volatility masks the new trend in the difference.
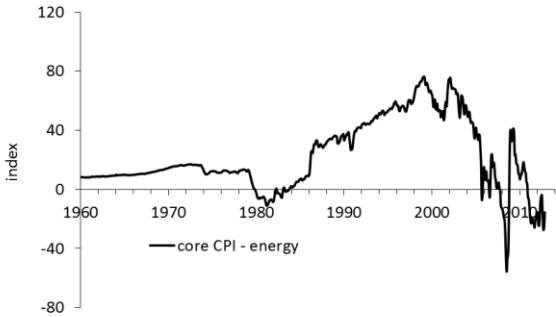

Figure 4. The difference between the core CPI and the index for energy between 1960 and 2012. There are three periods of linear trend and three turning periods. The most recent transition period started in 2008.
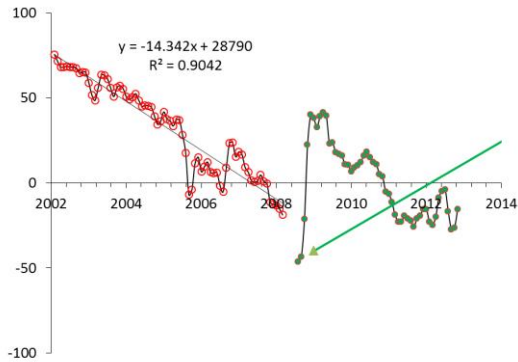

Figure 5. Same as in Figure 4, for the period after 2002. Linear trends are shown.

Figure 5 provides a detailed view of the most recent period. The energy index grew much faster than the core CPI between 2002 and 2008. Linear regression gives a slope of -14.3 for the difference curve. Since 2008, the energy price volatility has been at a very high level and one can likely classify the past four years as a period of bifurcation. Currently, there is no clear indication of the direction and slope of the next linear trend, however. At the same time, the price index of energy likely reached its peak value in 2007. We expect no further increase in oil (and

7

thus energy) price beyond that dictated by the secular price increase. We also expect the current volatility period is close to its natural end and the difference of the core and energy CPI will be growing along the new trend shown by green line in Figure 5.

Following the procedure described in Section 1, we now analyze this difference in relative terms. Thus, we have normalized the difference in Figure 4 to the core CPI. Figure 6 illustrates the new pattern. In contrast to Figure 4, the amplitudes and periods of long term fluctuations are similar and the overall evolution seems to be repeatable. Figure 6 also illustrates the assumption of repeatability. We have shifted the original curve by 27 years ahead and obtained a striking similarity in the amplitude and timing of the energy price falls and rises. This pattern is similar to the trajectory in Figure 3 but the period is slightly different due to the input of the food index.

From the current difference between black and red curve, one can expect the energy index is approaching a sharp negative correction, as it was observed 27 years ago. A 0.2 to 0.3 step in the normalized index is converted into 45 to 70 units of index. With the current level of around 250, the energy index fall by 50 to 70 points means a 20% to 25% drop in energy prices. In this case, the energy index will return to the long term sustainable trend stretching into the late 2020s. One cannot exclude the possibility that the era of low energy prices is approaching with the total fall by 40% to 50% from the current level. This effect was observed between 1981 and 1999.
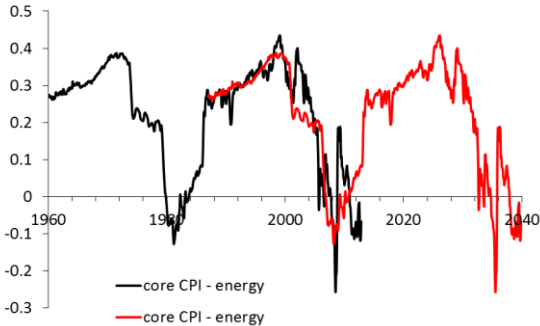

Figure 6. The difference between the core and energy CPIs normalized to the core CPI. Red curve represents the original (black) curve shifted 27 years ahead.

Some important conclusions are straightforward. The growth of the energy index relative to the core CPI is likely defined by quasi-linear mechanisms, which include bifurcations when

the difference reaches predefined peak values. The bifurcation cause is not clear, but the transition period lasts several years and is accompanied by elevated volatility. The latter feature is common for many physical processes.

The price index of food is the third biggest subcategory. As for the energy index, it is instructive to use the core CPI as the reference. Figure 7 displays the difference between the core CPI and the index for food for the period after 1960. This curve differs from that in Figure 5. The first large change in the difference occurred in 1973 and lasted only 7 years. Around 1980, the difference started to grow from -7.0 to 13.0 in 1996. Since 2003, the food price index has been slowly catching up the core CPI.
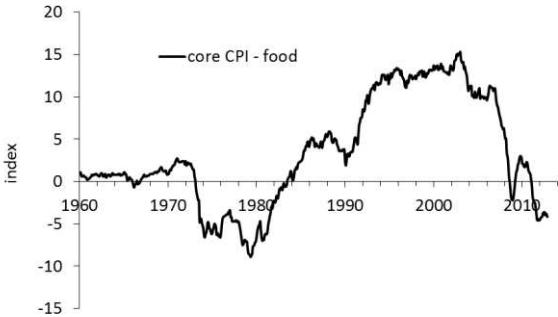

Figure 7. The difference between the core CPI and the price index of food between 1960 and November 2012.
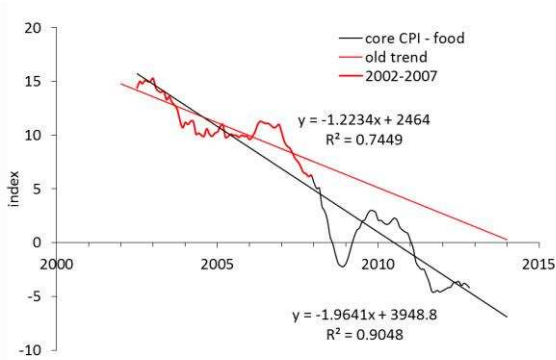

Figure 8. The difference between the core CPI and the price index of food between 2002 and 2012.

In 2008, extrapolating the linear trend (red line) we estimated the intercept point when the food price index would reach the core CPI. According to Figure 8, this should happen in 2014. This was our initial estimate of the turning point. The zero line was considered as a natural level of resistance. In the beginning of 2009, the difference reached a local bottom and turned to

a positive one, although not for long. The growth in food prices restarted in 2010. In 2011, the difference had a shelf, which might be misinterpreted as a manifestation of the transition to a positive trend. Since October 2011, the difference has not been changing.

There are three possibilities of the future evolution. Firstly, the possibility of a turn in 2012 is not excluded. Secondly, the difference may suffer a further fall before it reaches its absolute historical minimum (-8.5) observed in 1979. Figure 7 illustrates this assumption and implies that with the current values of the level (-4.5) and the rate of fall (-2 units of index per year) the bottom (-8.5) will be reached in 2014. Thirdly, the bottom may be expressed in relative terms. Figure 9 displays the difference between the core and food CPI normalized to the core CPI. The minimum was in 1974 and much deeper than in absolute terms. Falling along the current trend, the normalized difference will reach the bottom only in the 2020s. This is the worst case scenario involving a significant rise in food prices through the 2010s.
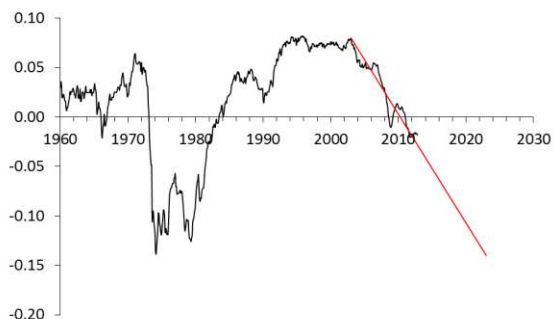

Figure 9. The difference between the core CPI and the price index of food normalized to the core CPI. The current trend (red line) will reach the bottom in 2023.

The consumer price index of housing comprises approximately a half of the headline CPI. In the beginning of 2008, we successfully identified a turning point in the difference between the CPI and the housing index and predicted the housing index to fall relative to the CPI during a lengthy period of eleven years. It was an accurate prediction and the new CPI estimates demonstrate the presence of a turning point. Figure 10 shows the evolution of the difference between the CPI and the housing index since 1967. (The BLS started reporting on the housing index in 1967.) There are distinct segments with the difference growing and falling at approximately the same pace, except the period after 2008.

10

Figure 10. The difference between the headline CPI and the CPI of housing.

The difference between the *core* CPI and the housing index normalized to the core CPI provides a more informative representation. Figure 11 demonstrates that this normalized difference is characterized by an almost constant duration of negative and positive trends. The current linear trend has a positive slope and the housing index will likely be falling the next 8 to 10 years. The trajectory of the normalized difference is much smoother and demonstrates sharp turning points, with the latter one in June/July 2008. The regressions in Figure 11 are characterized by high coefficients of determination, R^2, between 0.84 and 0.99. Interestingly, the slopes have a tendency to increase in absolute terms: from $0.0062y^{-1}$ to $0.0086y^{-1}$. The relative rate of the housing index fall is now 40% faster than that between 1986 and 1996. Considering the current trend, we expect that the housing price index will demonstrate negative growth relative to the CPI, which includes the housing index by definition.
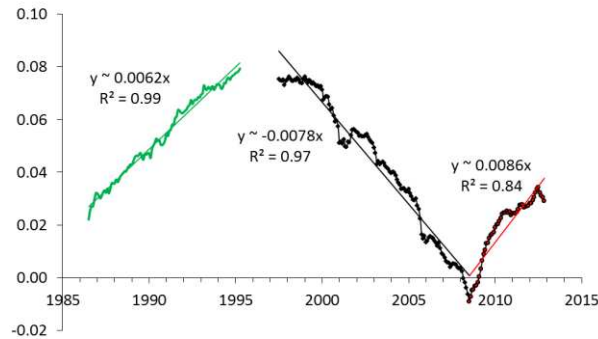

Figure 11. The difference between the *core* CPI and the CPI of housing normalized to the core CPI. Three distinct periods with sustainable linear trends are marked with the relevant regression lines and equations.

11

The difference for the transportation index had a longer period of positive slope – between 1980 and 2004, as Figure 12 demonstrates. During this period the difference was evolving at a rate of 1.5 units per year and reached the level of 30 units of index. In 2008, we concluded that a transition period had started and a negative slope was developing. This transition is also characterized by high volatility. The slope of the current linear trend is difficult to estimate. In any case, the prices for goods and services related to the index for transportation are likely to be growing faster than the headline CPI.

To complete the list of major expenditure categories Figure 13 depicts the differences of the headline CPI and the indices of education, communication, apparel, other goods and services, and medical care. These differences are characterized by the absence of turning points since 1980. There is no indication of a transition to a new trend. Two slopes are positive (communication and apparel) and the other three are negative. Therefore, the input of education, medical care and the index of other goods and services in the headline CPI is growing over time. Since the slopes are constant the evolution of all five indices is well predicted.

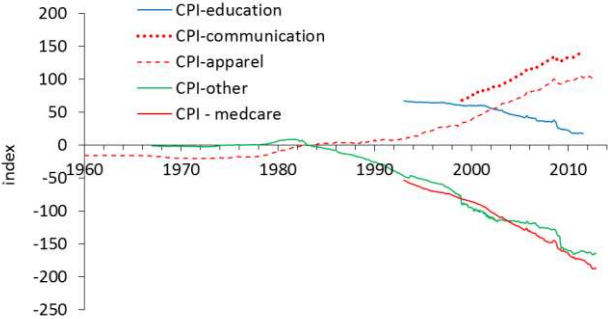Figure 12. The difference between the headline CPI and the index of transportations between 1983 and 2012.

Figure 13. The difference between the headline CPI and the indices of education, communication, apparel, other goods and services, and medical care.

Conclusion

We have revised the evolution of the differences between the headline CPI, the core CPI, and the CPIs for major expenditure categories and energy. All principal findings of our previous study, i.e. sustainable quasi-linear trends and volatile transition periods, are validated. We have also revealed a remarkable periodicity in the most important differences associated with energy and housing. These trends and periodicity unambiguously reveal the complex internal structure and deterministic dynamics of consumer prices. The interaction between these prices (i.e., goods and services) is defined by economic forces of unknown nature. It is clear, however, that random shocks to supply/demand cannot serve as the driving forces.

The current configuration of trends indicates that the US economy is likely approaching a period of very low, if not negative, price inflation. Our analysis shows that the headline CPI will lag behind the core CPI. A possibility of price deflation since 2012 also follows from our analysis of the change in labor force as the driving force behind inflation (Kitov and Kitov, 2010), as validated by the case of Japan (Kitov, 2010).

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