CYCLIC DYNAMICS OF INFLATION: EMPIRICAL ANALYSIS

Alexander Protasov,[1] Tatyana Kotcofana,[2] Polina Stazhkova[3]

Abstract: The paper is dedicated to the study of nonlinear dynamics of inflation. We hypothesize that in the second half of the twentieth century, inflation cycles replaced the pre-existing inflation-deflation cycles. This hypothesis is based on the study of data about price levels in various countries of the world for the period of 1950 to 2016. The paper shows some results of a spectral analysis that was applied to the dynamic series of prices. The results of the spectral analysis confirmed the hypothesis about the existence of inflation cycles.

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Introduction

Two characteristics can be distinguished among the features of modern inflationary processes, both in developed countries and in countries with emerging markets. The first characteristic is the permanent nature of inflation, and the second one is the uneven nature of inflation's development. The study of these characteristics has certain scientific and practical value. In particular, the study of the nonlinear dynamics of inflation makes it possible to predict the development of inflationary situations and apply adequate anti-inflationary measures. The observation of price dynamics in the world economy reveals that inflationary outbursts are periodic. An analysis of the rate of price levels in developed countries in the second half of the twentieth century shows that there is a clear periodicity in the acceleration and slowdown of inflationary processes. This means that inflation has acquired a permanent character, but it has also gained a new feature – cyclical dynamics. This fact raises questions about the existence of a specific "inflation cycle."

Unfortunately, the cyclical dynamics of inflation is not yet widely covered in economic literature. Although there are works with inflation cycles as a direct subject of research (Banerji, 2005), but there are very few of them. Most often, nonlinear dynamics of inflation is considered by researchers in the context of studying other macroeconomic issues: monetary policy and business cycles (Galí, 2008; Niemira and Klein, 1994), history of changing the role of money in the economy (Skene, 1992) or the relationship between inflation and economic growth (Simran, 2015; Malkina, 2006; Zoidov, 2001).

Thus, the aim of this paper is to demonstrate the historical dynamics of inflation on the example of developed countries and to isolate a cyclical component in a dynamic series of prices with the use of non-standard methods of statistical data processing.

Cyclic dynamics of inflation: historical data

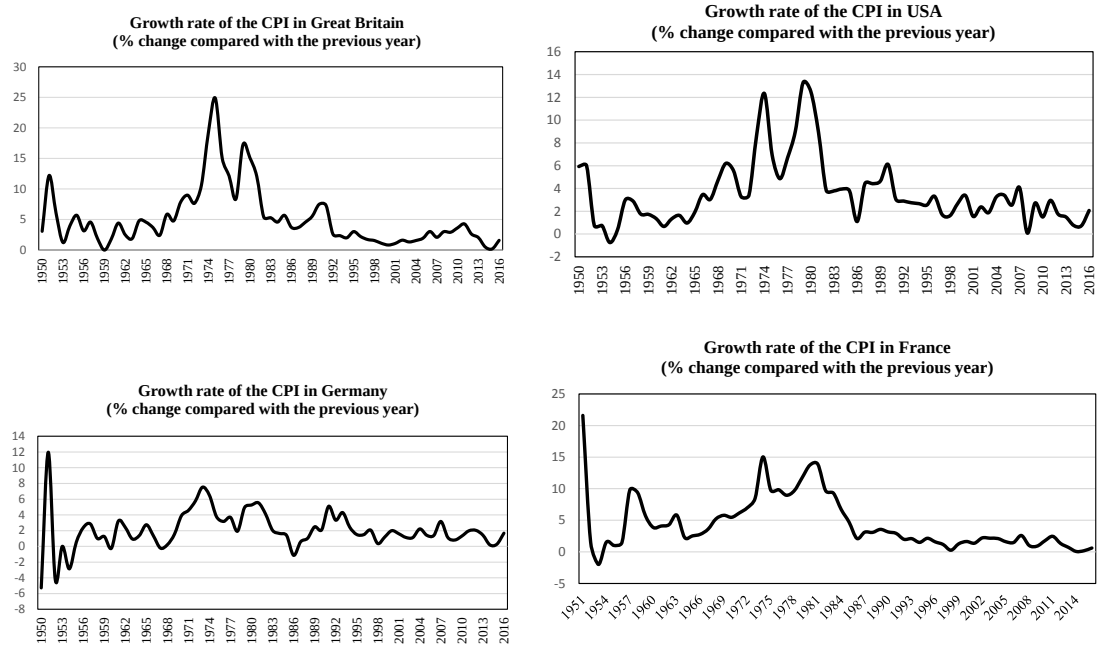
There is no clear definition of the inflation cycle in the studies on non-linear dynamics of inflation. Therefore, in this article the inflation cycle (IC) refers to a regular, relatively stable, rhythmic, regular and periodic reproduction of the alternating phases of acceleration and slowing of inflation. The acceleration phase is a consistent annual increase in the rate of price growth in relation to every preceding year, and the slowdown phase is a consistent annual reduction in the rate of price growth.

Four countries with developed market economies (USA, Great Britain, Germany, and France) were selected for the empirical analysis of the cyclical dynamics of inflation. The study of the dynamics of consumer price indices in these countries from 1950 to 2016 confirms the existence of cyclical fluctuations in inflation levels. First, in all the analyzed countries there was a stable presence of alternating phases of acceleration and slowing down of price growth rates. This can be seen in Figure 1. For example, in the USA during 1968-1969 there was an annual increase in the rate of growth in consumer prices: 1968 – 4.7%; 1969 – 6.2%. Then in 1970 trend has been replaced by an opposite one and during the next two years there has been an annual slowdown in the price growth rate: 1970 – 5.6%; 1971 – 3/3%. In the subsequent period (1972-1976) the picture of inflation dynamics was repeated.

[1] St. Petersburg State University, a.protasov@ spbu.ru
[2] St. Petersburg State University, tankotsofan@mail.ru
[3] St. Petersburg State University. p.stazhkova@spbu.ru

The annual rate of price growth accelerated from 3.4% in 1972 to 12.3% in 1974, and during the next two years there was a gradual slowdown from 6.9% in 1975 to 4.9% in 1976. Thus, each inflation cycle consists of a phase of acceleration and a phase of slowing inflation.

Figure 1: Dynamics of inflation in developed countries (1950 - 2016)



Source: Authors

Secondly, the periodicity is traced in the dynamics of fluctuations in the rate of inflation. That is, fluctuations have a clear direction that changes after a certain period of time. Thirdly, there is a rhythm of fluctuations in the inflation rate. This means that the duration of the phases of acceleration and slowing of inflation in neighboring cycles (i.e., cycles that follow one another) often coincides. However, over time, as follows from the graphs presented in Figure 1, the inflation rhythms can vary. The change in the rhythms of inflation cycles, as our analysis has shown, is associated with the impact on the price dynamics of shocks of a different nature. For example, the sharp rise in world prices for hydrocarbons in 1973 - 1975, or the switching of state regulation from the Keynesian model to a monetarist model, as it had happened at the turn of the 1970s and 1980s.

Table 1 shows the grouping of consumer price growth indices and the inflation cycles in the respective countries. Analysis of Table 1 shows that during the period from 1950 to 2016, the UK, Germany and Canada experienced 16 complete ICs, 17 ICs were observed in the United States, and 15 in France. The average duration of IC for these countries was: 3.8 years in the US, 4 years in Germany, 4.1 years in France and Great Britain, 3.9 years in Canada.

Such differences in the dynamics of inflationary processes in the countries represented show that inflation in each country has specific features. This is due to the economic conditions of reproduction processes, pricing practices, monetary circulation and anti-inflationary policies, dominance of intangible assets and global competitiveness (Pashkus et al., 2016), as well as features of state regulation of the economy. (Kirillovskaya et al., 2016) However, it is clear that for all the countries studied, the uneven development of the inflationary situation is common. It manifests itself in a cyclical nature.

Empirical analysis of inflation cycles

The results of the spectral analysis of the dynamic series of prices confirm the existence of inflation cycles. This method of data processing was chosen due to two main reasons. First, it eliminates the need to apply the procedure for removing the trend from the original series. This is important because the long-term trend determines the long-wave dynamics of inflation, so removing it becomes impractical.

Secondly, this method allows identifying the most powerful harmonics in the frequency spectrum of price fluctuations and thereby determining the cyclical fluctuations that have a determining influence on the dynamics of inflationary processes. There is a brief description of the method of spectral analysis below, a more complete version of which can be found in (Granger and Hatanaka, 2015; Harvey, 1975; Sitnikova, 2009; Glazyev, 1991).

The long price series are oscillatory processes, similar in shape to the sinusoid. In mathematical form, the sinusoidal series can be represented as following:

$$X(t)=A\cdot\cos(\omega t-\varphi),$$

Where A is an amplitude of the oscillations of the values of the series; $\omega = \frac{2\pi}{T}$ – angular frequency; φ – phase shift; T – time; $1/T=f$ – frequency (the number of oscillations per unit of time).

The dynamical series X_t, which describes the oscillatory changes in time of the values of any statistical indicator (for example, price indices or their increments), consists of the sum of harmonics that are periodic over a certain frequency interval with amplitudes and phases constant around average. These oscillatory changes in each given point in time are $X(t_1); X(t_2); \ldots, X(t_n)$, with $t_1, \ldots t_n$ as specific points in time in which the investigated indicator of the dynamic series takes specific values. These oscillatory changes are described by the probability density with the use of indicators of mathematical expectation (μ), variance (σ^2), autocovariance function (γ) and spectral density function (S(f)):

$$\mu = \int_{-\infty}^{+\infty} X_f(X)\mathrm{d}X;$$

$$\sigma^2 = \int_{-\infty}^{+\infty} (X-\mu)^2 f(X)\mathrm{d}X;$$

$$\gamma_{[(t]_1; t_2)} = \int_{-\infty}^{+\infty} [(X_{t1}-\mu)(X_{t2}]-\mu) f(X)\mathrm{d}X;$$

$$\hat{S}(f_i) = \frac{1}{2\pi}\left[\gamma_0 + 2\sum_{\tau=1}^{N-1}\gamma_{(\tau)}\cos 2\pi f_i \tau\right],$$

Where $\hat{S}(f_i)$ is an estimate of the power of the spectral density function (SDF), which makes it possible to analyze the frequencies of the oscillatory processes in a given dynamical series and it is also related to the autocovariance function $\gamma_{[(t]_1; t_2)}$ by mutual Fourier transform. $\gamma_{(\tau)}$ is autocovariation with a lag τ ; N is the length of given series; f_i is a frequency of oscillations of the index of the series.

In any given point of time, the value of the series can be represented as a Fourier series in the form of a sum of sin and cos:

$$X(t) = A_0 + \sum_{i=1}^{n-1} A_i(\cos\omega_i - \varphi) + A_n\cos\omega_n t,$$

with $\omega_n = 2\tau f_i$; f is main frequency, determined by the length of the series $f = \frac{1}{N}$. The variance of the series is represented as the sum of the squares of the amplitudes of the oscillations (harmonics):

$$1N\sum(Xt-A0)2=12Nt=1\sum Ai2n-1i=1+An2$$

Since the dynamic series, and especially the series of prices, are filled with a "mixture" of regular and irregular (random) oscillations, a procedure is performed to estimate the contribution of the variances that make up the totality of the oscillatory processes in the investigated series to the overall variance of the oscillatory process. In particular, the dynamic process can be represented by the sum of elementary oscillations with random amplitudes and phases (Glazyev, 1991). In this case, the variance of the random process is obtained in the form of a continuous sum of variances of all oscillations:

$$\sigma^2 = \int_n^n \mathrm{d}F(\omega).$$

The contribution to the total dispersion of a dynamic process with frequencies from a certain interval (ω, ω+dω) is equal to dF(ω). The function F(ω) is the spectral distribution function of the dispersion of the oscillatory process with respect to frequencies, $S_{(\omega)} = \frac{\mathbf{d}F(\omega)}{\mathbf{d}\omega}$ is a function of the spectral density of the distribution of the dispersion of the oscillatory process over a continuously varying frequency.

The peak points on the SDF graphs determine the average amplitude of the oscillation amplitude in the defined frequency interval. Thus, the SDF makes it possible to estimate with mathematical rigor an individual harmonic (oscillations with a certain period) as part of the overall process from SDF values or from SDF graphs. In other words, the SDF shows the presence of periodic oscillations at the any given interval and their variance. This method was used to determine the presence of oscillations in the dynamics of inflation, its period (frequency) and amplitude.

Table 1 shows the periods of the observed cyclic components in the dynamics of the growth rates of consumer price indices in the studied countries with developed markets and the power value of the spectral density function for the corresponding frequency.

Table 1: Results of the spectral analysis of the dynamics of the CPI growth rates

Countries	Periods of cyclical components (in years)	Values of the SDF
USA	8,3 6,2 5,0 4,2 3,1 2,6 2,3	11,4 10,2 19,8 7,6 3,3 3,8 2,7
Germany	12,5 8,3 4,2 3,1 2,6 2,3	9,6 13,6 5,7 4,9 6,0 4,8
France	8,3 5,6 5,0 3,6 2,5	35,7 45,9 45,6 34,3 8,6
Great Britain	10,0 4,6 2,3	38,4 37,4 5,03

Source: Author

Conclusion

The conducted research has shown that the development of inflationary processes has inherited the property of multicyclicity. The method of spectral analysis made it possible to reveal cycles of different duration in dynamic series of prices. In particular, over the past 65 years, the dynamics of inflation in developed countries have seen harmonics characteristic of the rhythms of Kondratiev waves, Kuznets swings, business cycles and shorter Kitchin cycles, all of which have wide coverage in economic literature. The same analysis revealed the presence of specific 2 to 4 yearlong fluctuations that do not fit into the well-known cycles. This confirms the hypothesis of inflation cycles existence.

The nonlinear dynamics of inflation is determined by the intensity of the distribution conflicts, the strengthening and weakening of which creates impulses for the cyclical development of inflationary processes. This statement follows the traditions of post-Keynesian theory (Palley, 1996), the theory of "conflict inflation" (Rosenberg and Weisskopf, 1981; Gordon, 1981), and our previous research. In (Protasov, 2013; Protasov, 2015 ; Kotcofana, 2007), it is shown that inflation is a monetary expression of the fundamental distributional conflict of the capitalist economy – the struggle of various social groups and classes for their shares in the national income.

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