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НАРОДНОХОЗЯЙСТВЕННЫЕ ПРОБЛЕМЫ

Managing the prime rate to counter the cyclic income contraction

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Abstract. This article proposes an approach to formalize the quantitative relationship between increments of the prime rate and income. Such knowledge provides the possibility of income management according certain prefixed goals. Furthermore, this article considers the possibility of parrying the cyclical decline in income via a corresponding reduction of the prime rate. A management strategy based on the established functional relationship between investments and the prime rate is proposed. It is shown that if the long-term investment trend is inversely proportional to the prime rate, then the trajectory of the concerned cycle depends on the square root of the prime rate. Consequently, its change leads to the divergence of investment component values. This fact provides the basis for developing an approach to parry the cycle contraction. The cycle model in the form of random oscillations of an elastic system under the influence of white noise provides a quantitative estimate of the variation in the prime rate, which in turn, yields the required change in the value of income. Since the considered approach is based on the most probable trajectory of the cycle, the resulting expressions will also lead to the most probable estimates. The applicability of the proposed approach to the analysis of the cycle behavior is demonstrated by the example of current deviations in US income.

Keywords: investments, cycle trajectory, cyclic contraction, managing prime rate.

JEL Classification: C22, C41, C53, C58.

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1. INTRODUCTION

In the seminal work of modern business cycle theory (Kydland, Prescott, 1982), as well as in subsequent ones (see, for example, (Kehoe, Midrigan, Pastorino, 2018)), the question of the “driving force” of cycles was always arising. Usually, some shocks were mentioned as a response to it, but the nature and cause of shocks were not formalized (Golosov, Menzio, 2020). This means that the mechanism of economic cycles, as well as its formal (mathematical) model in the framework of the modern theory of economic cycles, were not clearly defined. However, economists’ references to external shocks as the “driving force” of fluctuations in economic systems make possible to classify them as elastic ones. Recall that an elastic system, after the impact of an external shock, generates free oscillations with an exponentially decaying amplitude relative to the equilibrium state (Bolotin, 1984). Based on these considerations, a one-dimensional lumped model of the “investment → income” type was proposed in the form of a second-order nonlinear differential equation (Karmalita, 2020):

$$F\left(t, I, \ddot{X}, \dot{X}, X\right) = 0. \tag{1}$$

Here $I(t)$ and $X(t)$ are the investment and income functions respectively. Wherein, the function $I(t)$ is the sum of all $N(t) < \infty$ existing investments, each of which is represented in the form shown in Fig. 1.

C_j, ΔC_j, and T_j are the initial capital, return and duration of the investment j, respectively. Formally, the investment function can be written as follows:

$$I_j\left(t\right) = C_j + \Delta C_j / 2 + E_j\left(t\right), \tag{2}$$

where $E_j(t)$ represents the fluctuations of the investments with respect to the value ($C_j + \Delta C_j/2$). Since investments in a market economy are the result of independent activity of $N(t)$ agents, they have a random beginning (start). Therefore, the deviations $\varepsilon_{ji} = E_j(t_i)$ in Fig. 1 are stochastic due to the random

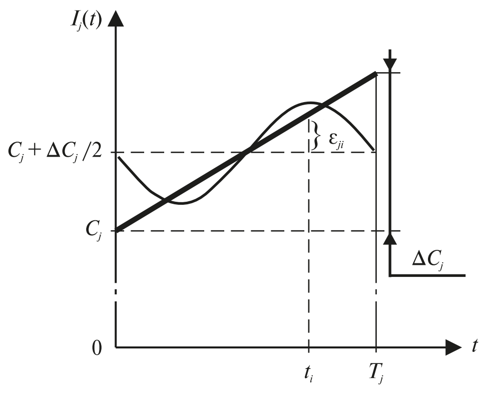

Fig. 1. Diagram of the investment j

(equiprobable) position of the moment t_i within the range 0, ..., T_j. Considering expression (2), the function $I(t)$ is represented by the sum of two terms:

$$I(t) = \sum_{j=1}^{N(t)} I_j(t) = \sum_{j=1}^{N(t)} \left(C_j + \Delta C_j/2\right) + \sum_{j=1}^{N(t)} \varepsilon_j(t) = M(t) + E(t), \quad (3)$$

here $M(t)$ is the deterministic component of the investment function, and the investment fluctuations $E(t)$ are Gaussian white noise with the zero mathematical expectation and variance equal to:

$$D_\varepsilon = \sum_{j=1}^{N(t)} \Delta C_j^2 / 12. \quad (4)$$

It should be noted that the expression (3) confirms the legitimacy of the postulate (Cooley, Prescott, 1995) on the need to consider economic growth and fluctuations together. Thus, the income function can also be represented by two components $X(t) = L(t) + \delta X(t)$, where $L(t)$ is the long-term income trend due to the investment trend $M(t)$, and the deviations $\delta X(t)$ are caused by investment fluctuations $E(t)$. Income deviations include all known business cycles (Kondratiev, Kuznets, Juglar, and Kitchin) as well as other possible income fluctuations, that is:

$$\delta X(t) = \Xi_{Kon}(t) + \Xi_{Kuz}(t) + \Xi_{Jug}(t) + \Xi_{Kit}(t) + \ldots.$$

Income deviations is an order of magnitude smaller (Korotaev, Tsirel, 2010) than the values of $X(t)$, so they can be interpreted as small deviations of the latter. Therefore, to describe a specific cycle $\Xi(t)$ with period T_0, equation (1) can be linearized by reducing it to a second-order ordinary differential equation:

$$\ddot{\Xi}(t) + 2h\dot{\Xi}(t) + (2\pi f_0)^2 \Xi(t) = E(t). \quad (5)$$

The model (5) describes a linear elastic system with natural frequency $f_0 = 1/T_0$ and damping factor h, which is affected by white noise (Bolotin, 1984). Thus, the approach outlined above made it possible to move from modeling the results of observations of economic cycles to modeling the mechanism of their occurrence. According to the proposed model, income oscillations are induced by exogenous (investment fluctuations) and endogenous (system elasticity) causes.

The investment values (Fig. 1) relative to $(C_j + \Delta C_j/2)$ correspond to the period of the so-called sawtooth function $F_j(t)$, which is represented by an infinite Fourier series (Pavleino, Romadanov, 2007):

$$F_j(t) = \frac{\Delta C_j}{\pi} \sum_{l=1}^{\infty} \sin(2\pi l t / T_j) / l.$$

In particular, the first ($l = 1$) harmonic sin $(2\pi t/T_j)$ is shown in Fig. 1. This fact justifies the use of the frequency domain analysis to the processes occurring in economic systems. Therefore, let us consider the properties of the linear elastic system in the frequency domain described by its amplitude $A(f)$ and phase $\Phi(f)$ frequency characteristics (Fig. 2).

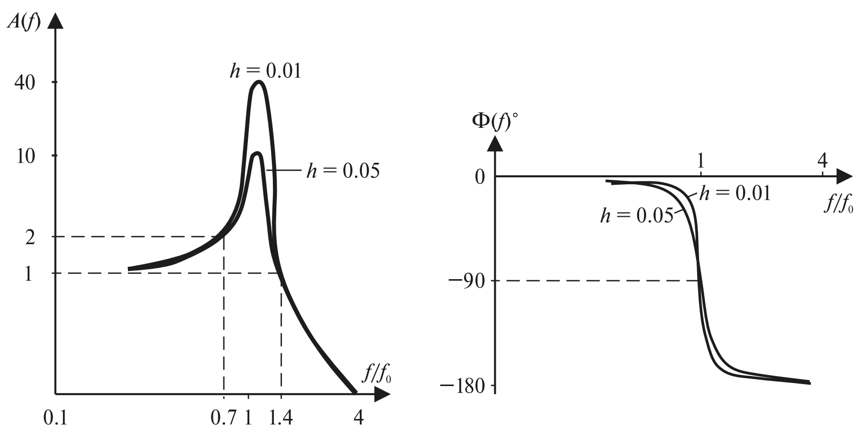

Fig. 2. Amplitude and phase frequency characteristics of the linear elastic system

$A(f)$ determines the ratio of the amplitudes of the input (investment) and output (income) harmonics. According to the shape of the characteristic $A(f)$, the values of random oscillations $\Xi(t)$ are determined mainly by harmonics in the vicinity of f_0 ($f_1 = 0.7f_0 \le f \le f_2 = 1.4f_0$).

$\Phi(f)$ is the difference between their phases, which is equivalent to the time delay of the output process with respect to the input process. It follows from the characteristics $\Phi(f)$ (Fig. 2) that investment manipulations lead to a tangible change in the intensity of the cycle with a time delay $T_0/4$, and its complete change after half the cycle period.

Model (5) not only explains the phenomenon of the cycle, but also provides its quantitative description in terms of h and f_0, as well as a cycle intensity (variance) D_ξ. This model, together with the presentation of the investment function in the forms of expressions (3) and (4), provides a theoretical basis for the mathematical solution of the income management problems. The purpose of this paper is developing an approach for investment management to counter the cyclic income contraction. To implement this, in the next section of the article, a quantitative relationship is established between the increments of a possible control factor and income. The last section is devoted to the quantitative analysis of the current state of the US economy using the provisions of the developed approach.

2. PARRYING THE POTENTIAL CYCLIC CONTRACTION

We will proceed from an existing fragment of the cycle Ξ (t) of interest with frequency f_0 on the time interval $t_1 \le t \le t_2$, where t_2 is the current moment in time. Moreover, we assume this fragment to be pseudo-stationary (Karmalita, 2020), that is, the evolutionary change in the parameters of model (5) over indicated time interval corresponds to the statistical variability of their estimates with a confidence level P. Furthermore, this fragment has a discrete representation with a sampling interval Δt, that is, $\Xi(t_i) = \Xi(\Delta t\, i)$, $i = 1, \ldots, n = (t_2 - t_1)/\Delta t$. Estimates $\tilde{\xi}_i = \tilde{\Xi}(t_i)$ of the considered cycle can be formed from the deviations $\delta X(t_i) = X(t_i) - L(t_i)$ of the income function by the method proposed in (Karmalita, 2023). Here and further in the text, the sign "$\sim$" denotes a quantitative estimate of the noted variable.

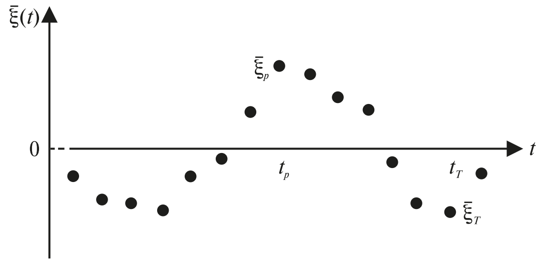

Fig. 3. Predicted trajectory of the cycle

The presence of a cycle trajectory allows to predict the future values $\bar{\xi}_{n+1}, \ldots, \bar{\xi}_{n+m}$ ($m = 1.5/\Delta t$) of the cycle using the Monte Carlo method (Karmalita, 2022) as shown in Fig. 3.

In the above figure, $\bar{\xi}_P$ and $\bar{\xi}_T$ are estimates of the peak and trough of the predicted cycle trajectory, respectively. Therefore, the estimated contraction in income from the considered cycle is $\Delta\bar{X}_c = \bar{\xi}_P - \bar{\xi}_T$.

Due to the stochastic nature of income oscillations, the cycle trajectory (amplitude) can be changed only by affecting the intensity σ_ε of investment fluctuations $E(t)$. Quantitatively, the relationship between intensities $\sigma_\xi = \sqrt{D_\xi}$ and $\sigma_\varepsilon = \sqrt{D_\varepsilon}$ is determined by the root-mean-square (*rms*) gain (K_σ) of the economic system (Karmalita, 2020): $\sigma_\xi = K_\sigma \sigma_\varepsilon$.

From expression (4) it follows that a change in the number of investments and their returns will affect the intensity of $E(t)$, that is, the value of σ_ε. Consequently, manipulations with the intensity of investments provide a change in the cycle amplitude, which will lead to a change in the cyclic contraction — ΔX_c.

The return of the investments j can be represented as a function of their interest and duration $\Delta C_j(t) = \alpha_j C_j R(t) T_j$, where $R(t)$ is the bank prime loan rate (hereinafter the prime rate), and $\alpha_j = \text{const}$. Accordingly, the expression for the deterministic component of the investment function can be reduced to the following expression:

$$M(t) = \sum_{j=1}^{N(t)} \left(C_j + \quad C_j/2\right) = \sum_{j=1}^{N(t)} C_j + R(t)\sum_{j=1}^{N(t)} \beta_j,$$

where $\beta_j = \alpha_j C_j T_j / 2$. The generally recognized existence of an inverse relationship between investment activity and the prime rate in (Blanchard, 2017) allows us to present it as $N(t) = k/R(t)$, where k is a constant. The sums in the above expression for $M(t)$ can be written in the following form:

$$\sum_{j=1}^{N(t)} C_j = C_{av} N(t); \quad \sum_{j=1}^{N(t)} \beta_j = \beta_{av} N(t),$$

where C_{av} and β_{av} are average values of C_j and β_j. Therefore, the final expression for the investment trend will be:

$$M(t) = C_{av}k / R(t) + \beta_{av}k = A\,R^{-1}(t) + B. \tag{6}$$

According to the above approach, the expression for σ_ε reduces to the following form:

$$\sigma_\varepsilon = \sqrt{\sum\nolimits_{j=1}^{N(t)} \Delta C_j^2 / 12} = \beta_{av}\sqrt{k\,R(t)/3} = D\,R^{1/2}(t). \tag{7}$$

From expressions (6) and (7) it follows that a change in the prime rate will affect the values of $M(t)$ and $E(t)$ in opposite directions. For example, at the cycle contraction stage, decreasing $R(t)$ leads to an increase in the long-term trend $L(t)$ and a reduction in the cyclic contraction. As mentioned in Introduction (see Fig. 2), the change in the intensity (amplitude) of the cycle ends with a time delay $T_0/2$. This fact prompts us to start managing the prime rate while reaching at(approaching) peak time (t_P) to fend off the cycle contraction. As for the relationship between $N(t)$ and $R(t)$, the transition to a new value $N(t)$ will occur with some delay τ_I concerning the change in the prime rate. Its value can be estimated by comparing the dynamics of current changes in $R(t)$ and the gross value of private investment. In case of $\tau_I > T_0/2$, the beginning moment for the primary rate change should be $t_s = t_T - \tau_I$, that is, it should be earlier than the above t_P.

We will proceed from known prime rate $R(t_2)$ at the current moment t_2. One of the possible variants for the management strategy may be decreasing the prime rate to the value $R(t_p) = R(t_2) - \Delta R$ after reaching the cycle peak. This will increase the value of the income trend by ΔL while reducing the cycle contraction by $\Delta\xi$. Maintaining sustainable income at moment t_T can be formulated, for example, as satisfying the following condition $\Delta L + \Delta\xi = \Delta X_c$.

As above changes of income components are commensurate with the cyclic contraction ΔX_c, they constitute small variances of the income function. Therefore, the linear model (5) for the transition from income to investments can be applied. The investment trend $M(t)$ is a slow changing function, so the maximum frequency of its spectrum is significantly less than the natural frequency of the cycle f_0. From Fig. 2, which shows the amplitude frequency characteristics $A(f)$, it follows that the economic system gain in this part of the spectrum can be taken as equal to 1. In this case, we get that $\Delta L \approx \Delta M$.

Recall that the cyclic values ξ_j correlate with their intensity σ_ξ, which can be represented as $\xi_j = d_j\sigma_\xi$. So, the cycle increment can be written as $\Delta\xi = d_j\Delta\sigma_\xi$, and for the cycle trough the value $d_T = \xi_T / \sigma_\xi$. Considering expressions (6) and (7), as well as $\sigma_\xi = K_\sigma\sigma_\varepsilon$, then the sustainable income condition is reduced to the following form:

$$\Delta X_c \approx \Delta M + K_\sigma d_T \sigma_\varepsilon = \left|\frac{dM(R)}{dR}\right|_{R(t_2)} \Delta R + K_\sigma d_T \left|\frac{d\sigma_\varepsilon(R)}{dR}\right|_{R(t_2)} \Delta R =$$
$$= A\,R^{-2}(t_2)\Delta R + K_\sigma(\xi_T/\sigma_\xi)D\,R^{-1/2}(t_2)\Delta R.$$

Thus, for the economic system under consideration, the presence of estimates of ΔX_c, A, D, K_σ, ξ_T, σ_ξ allows us to determine the required decrease in the current prime rate as follows:

$$\Delta\bar{R} \approx \frac{\Delta\bar{X}_c \Delta R^2(t_2)}{\tilde{A} + \tilde{K}_\sigma(\bar{\xi}_T/\tilde{\sigma}_\xi)\tilde{D}R^{3/2}(t_2)} = \frac{\Delta\bar{X}_c R^2(t_2)}{\tilde{C}_{av}\tilde{k} + \tilde{K}_\sigma(\bar{\xi}_T/\tilde{\sigma}_\xi)\beta_{av}\sqrt{\tilde{k}/3}R^{3/2}(t_2)}.$$

In addition to establishing the above relationship between the increments ΔR and ΔX_c, the provisions of the proposed approach are applicable to the conceptual analysis of economic cycles behavior. An example of such an analysis is carried in the next section.

3. THE CURRENT CYCLIC CONTRACTION IN US INCOME

In econometric studies, to quantify the income function $X(t)$ the gross domestic product (GDP), hereinafter $G(t)$, is usually used. Recall that the value of GDP is a monetary estimate of manufactured goods and provisioned services for a certain period ΔT:

$$G(t) = \int_{t-\Delta T}^{t} X(t)\,dt = \int_0^t k(\tau)X(t-\tau)\,d\tau = G_L(t) + g(t)$$

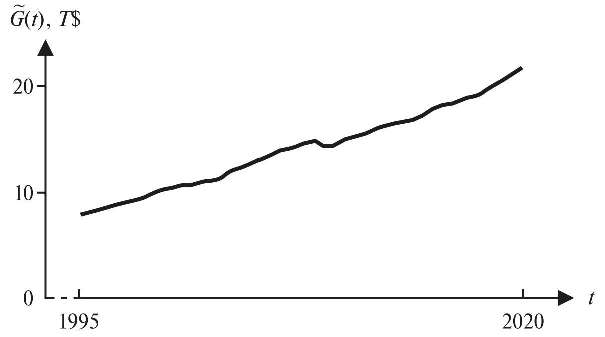

Fig. 4. Real *GDP* estimates of the US economy

Source: Federal Reserve Economic Data (2023) (https://fred.stlouisfed.org).

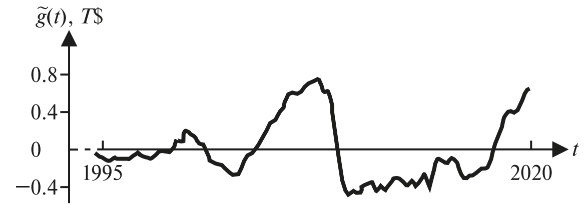

Fig. 5. Estimations of GDP deviations

where $G_L(t)$ and $g(t)$ are the long-term trend and deviations of GDP*,* respectively. In other words, the GDP function can be interpreted as the result of measurements of the income function using an estimator, inertial properties of which are described by the impulse response (*IR*) function $k(\tau)$:

$$k(\tau)=\begin{cases}1, & 0\le\tau\le\Delta T;\\ 0, & \tau<0,\ \tau>\Delta T.\end{cases}$$

Let us consider the quarterly GDP estimates $\tilde{G}(t)$ of the US economy for the period 1995–2019 shown in Fig. 4.

In this case, the sampling interval is $\Delta t = \Delta T \approx 0.25$ years. To increase the representativeness (number of samples) of the empirical data, additional terms were calculated via linear interpolation of quarterly GDP estimates. Thus, the sampling interval was reduced to $\Delta t = \Delta T/2 = 0.125$ year, and the number of samples increased to $n = 199$. The GDP deviations $\tilde{g}_i = \tilde{g}(t_i) = \tilde{g}(\Delta t\, i)$ in Fig. 5 were calculated following the regression $G_{Li} = 0.054i^2 + 57.289i + 7522.289$ obtained by the least squares method (Brandt, 2014).

If we proceed to the dimensionless interval of sampling $\Delta t = 1$, then the results of the frequency data analysis will be presented in terms of relative natural frequency $0 \le \theta \le 0.5$. Amplitude spectrum $A_{\tilde{g}}(\theta)$ shown in Fig. 6 was determined by the Fourier transform (see, for instance, Cho, 2018) of the deviations $\tilde{g}_i$.

It should be noted that the mode (peak) of each cycle in Fig. 6 corresponds to the frequency $\theta_h = \sqrt{\theta_0^2 - (h\,\Delta t/2\pi)^2}$, which is its natural frequency corrected for damping. From the viewed spectrogram the estimates (pick coordinates) of the natural frequencies of the cycles are $\tilde{\theta}_{Kuz}$ ($\theta_{Kuz} \approx 0.0093$ ($\tilde{T}_{Kuz} = \Delta t/\tilde{\theta}_{Kuz} = 0.125/0.0093 \approx 13.5$ years), $\tilde{\theta}_{Jug} \approx 0.0198$ ($\tilde{T}_{Jug} \approx 6.3$ years) and $\tilde{\theta}_{Kit} \approx 0.0344$ ($\tilde{T}_{Kit} \approx 3.6$ years). The frequency values were determined with a resolution $\Delta\theta = 0.5/2048 \approx 0.00024$.

From the Wiener–Khinchin theorem it follows that the cycle intensity is correlated with the area under its amplitude spectrum: $D_\xi = \int_0^{0.5} A_\xi^2(\theta)d\theta$. Fig. 6 clearly demonstrates that the Kuznets swing is dominant. Its trajectory can be formed from GDP deviations $\tilde{g}_i$ using a low-pass *FIR* filter, as suggested in (Karmalita, 2023). The fragment of the trajectory formed in this way is shown in Fig. 7.

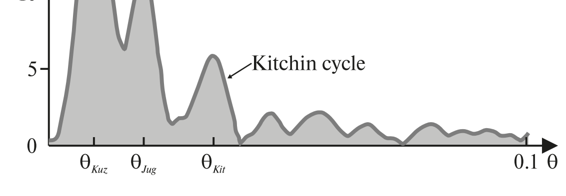

Fig. 6. The amplitude spectrum of estimates $\tilde{g}_i$

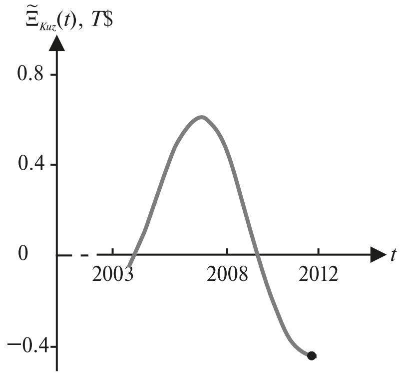

Fig. 7. Fragment of the recovered trajectory of Kuznets swing

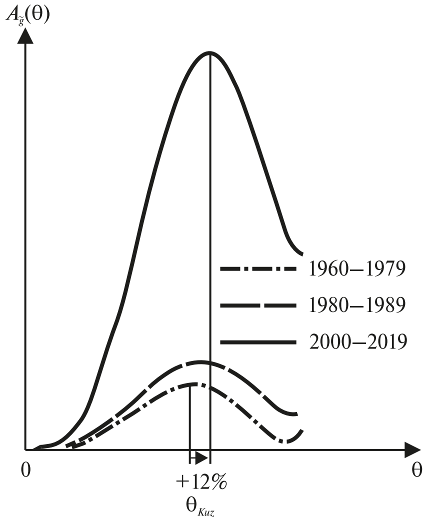

Fig. 8. Trends of natural frequency of cycles θ_{Kuz}

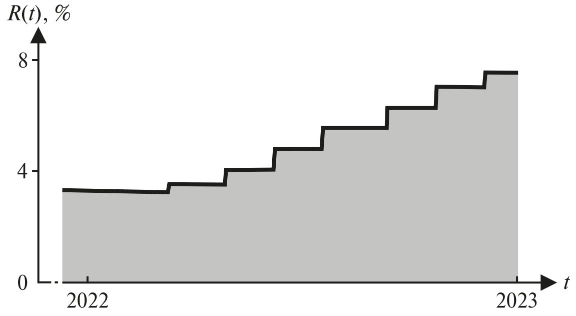

Fig. 9. A retrospective fragment of the change in the prime rate

Source: Federal Reserve Economic Data (2023) (https://fred.stlouisfed.org).

The cross-correlation coefficient (Brandt, 2014) of this fragment with deviations of GDP estimates (see Fig. 5) at the contraction stage is $\tilde{r}_{\tilde{g}\tilde{\Xi}_{Kuz}} \approx 0.94$. It means that the Kuznets swing was a determining factor of the 2008 recession. In other words, the latter was mainly due to the dynamics of investments lasting 9–19 years. Therefore, predicting the behavior of income contraction can be reduced to considering the subsequent behavior of only the Kuznets swing.

Knowing the moment of reaching the last trough of the Kuznets swing and its duration $\tilde{T}_{Kuz}$, it is possible to determine the moments of the subsequent peak (t_P) and trough (t_T). However, due to technological and managerial progress in the economy, the characteristics (parameters) of economic systems are changing. As a result, the period of the Kuznets swing in the predicting interval (say, 2020–2027) may be different. Therefore, the use of the above-defined estimate of T_{Kuz} for forecasting purposes should be justified. So, the trend of estimates $\tilde{\theta}_{Kuz}$ for the period 1960–2020 was analyzed.

To define a sustainable trend in a time series, we need to have at least three of its consecutive values, so the estimates $\tilde{\theta}_{Kuz}$ were determined on a 20-year time base, and their trend is shown in Fig. 8.

As shown in Fig. 8, the value θ_{Kuz} grows by 12%. This growth is almost linear in time and manifests itself in a continuous increase in the frequency of each cycle by an average $\approx$ 2.4%. The relative frequency resolution $\delta\theta = \Delta\theta / \tilde{\theta}_{Kuz} \approx 0.00024 / 0.0093 = 2.6\% > 2.4\%$, which allows us to use the estimate $\tilde{T}_{Kuz} \approx 13.5$ years to predict the time interval of the next contraction in the Kuznets swing. Its last trough (symbol «•» in Fig. 7) was in the 3rd quarter of 2011, so the next peak may be in $t_p = 2011.75 + 6.75 = 2018.5$ (the middle of 2018). Accordingly, the moment of the predicted trough will be $t_r = 2025.25$ (the first half of 2025).

It should be noted that the actual behavior of the cycle is due to both endogenous and exogenous causes. The latter include investment fluctuations $E(t)$, the manipulation of which leads to a change in the intensity (amplitude) of the cycle. It follows from expression (7) that a change in $R(t)$ leads to a change in the intensity of the cycle. If, for example, at the stage of cyclic contraction, the prime rate rises, then the trough of the cycle would fall lower. And the delay between investments and income (see Fig. 2) will postpone the achievement of a new trough for the future. Such a cycle metamorphosis can be illustrated by the example of one component of the Kuznets swing — its modal harmonic $S_{Kuz}(t) = A_{R(t)} \cos 2\pi f_{Kuz}(t - t_p)$. Recall that at this frequency, the time delay between investments and income is a quarter of the period, that is, $\tau_{Kuz} = T_{Kuz}/4 \approx 3.375$ year.

As you know, the prime rate was reduced to 3.25% on March 16, 2020, and did not change until March 17, 2022 (Fig. 9).

Considering the value of τ_{Kuz}, the amplitude $A_{3.25}$ of the Kuznets modal harmonic stabilizes in the third quarter of 2023, remaining unchanged at the through moment (Fig. 10).

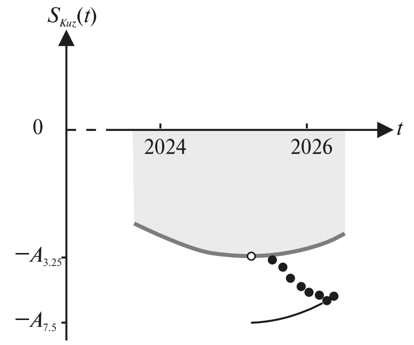

Fig. 10. Metamorphosis of the Kuznets harmonic due to the growth of the prime rate

The first increase in the primary rate in 2022 to 3.5% (see Fig. 9) will lead to a change in the amplitude $A_{R(t)}$ in the third quarter of 2025 (symbol «•» in Fig. 10). This and subsequent changes in the harmonic trajectory are estimated as $S_{Kuz}(t) = A_{3.25}\sqrt{R(t)/3.25}\cos 2\pi f_{Kuz}(t-t_p)$.

4. CONCLUSIONS

Representing investments as the sum of a deterministic trend and their fluctuations in the form of white noise made it possible to establish a functional relationship between these components and the prime rate. For a deterministic trend, this dependence is inversely proportional, and for investment fluctuations, it is the square root of the rate. In other words, a change in the rate affects the values of investment components in opposite directions.

The cycle model in the form of random oscillations of an elastic system under the influence of white noise provided an approach to quantify the variation of the prime rate according to the desired change in income. The feasibility of the proposed approach is demonstrated by parrying the cycle income contraction.

Since the considered approach is based on the most probable cycle trajectory, the resulting expressions will also provide the most likely estimates.

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Управление базовой ставкой с целью противодействия циклическому сокращению доходов

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Аннотация. В статье предлагается подход к формализации количественной зависимости между базовой ставкой и вариациями дохода, базирующийся на стохастическом описании инвестиций. Установление этой зависимости обеспечивает возможность управления доходами в соответствии с принятым целеполаганием. В частности, рассматривается пример преодоления циклического сжатия дохода с соответствующим изменением базовой ставки. Предложена стратегия управления доходами, в основе которой лежит установленная функциональная связь между составляющими инвестиций и базовой ставкой. Показано, что при обратно пропорциональной зависимости долгосрочного тренда инвестиций от значений ставки, траектория цикла зависит через корень квадратный ее значения. Поэтому изменение базовой ставки приводит к разнонаправленным результатам в значениях тренда и траектории цикла. Этот факт послужил основой для разработки алгоритма преодоления циклического снижения доходов. Модель цикла в виде случайных колебаний упругой системы под действием белого шума позволила получить количественную оценку вариации базовой ставки, обеспечивающей требуемое изменение величины дохода. Поскольку рассмотренный подход основан на наиболее вероятной траектории цикла, то полученные выражения будут приводить и к наиболее вероятным оценкам. Возможность применять предлагаемый подход к анализу поведения цикла продемонстрирован на примере текущих отклонений доходов США.

Ключевые слова: инвестиции, траектория цикла, циклическое сжатие, управление базовой ставкой.

Классификация JEL: C22, C41, C53, C58.

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