ISSN 1075-7007, Studies on Russian Economic Development, 2016, Vol. 27, No. 5, pp. 510–517. © Pleiades Publishing, Ltd., 2016.
Original Russian Text © A.A. Akaev, N.S. Ziyadullaev, A.I. Sarygulov, V.N. Sokolov, 2016.

MACROECONOMIC PROBLEMS

Medium-Term Forecast of the Dynamics of the Development of the Russian Economy

A. A. Akaev[a], N. S. Ziyadullaev[b], A. I. Sarygulov[c], and V. N. Sokolov[d]

[a] *Moscow State University, Moscow, 119991 Russia*
[b] *Institute of Market Problems, Russian Academy of Sciences, Moscow, 117418 Russia*
[c] *St. Petersburg State University of Architecture and Civil Engineering, St. Petersburg, 190005 Russia*
[d] *St. Petersburg State University of Engineering and Economics, Saint-Petersburg, 191002 Russia*
e-mail: nabi926@mail.ru

Received October 25, 2015; in final form, March 3, 2016

Abstract—Based on the simulation of medium-term economic dynamics under conditions of high inflation, the article analyzes the effectiveness of the monetary policy of the Bank of Russia and presents a forecast of economic growth in the near-term outlook (2015–2018) under different scenarios of change in the key interest rate.

DOI: 10.1134/S1075700716050026

Today, a topical subject of discussion is the inflation rate and the downturn in the economy, which leads to a decrease in real living standards. Inflation by the end of 2014, for the first time after the crisis year 2009, has once again become double-digit (11.4%) and economic growth declined from 4.1% (the average rate for 2010–2012) to 0.6%. The Russian economy was in a state of stagflation. In March 2015, inflation reached a peak of 17.5% year on year, but by the end of the year fell to 12.9% all the same, while the downturn in the economy at year-end 2015 was 3.7% (according to Rosstat). According to the forecast of the Bank of Russia for 2016, the downturn in the economy will be 1.3–1.5%, and inflation will be 6–7%; in 2017, it is expected to be 4%. For 2016, the Ministry of Economic Development predicts a small decline of 0.3% and inflation at a level of 7%. At the same time, the Ministry of Economic Development claims that the reduction of inflation to a level of 4% will not be achieved in the foreseeable future. Forecasts of experts and international institutions with respect to the depth of the continuing recession in 2016 range from 1.5 to 2.5%, while by the end of the year, inflation is forecasted at a level of 8–10%. In 2015, household consumption, according to Rosstat, decreased by 9%; this is the highest rate of decline in private consumption in the last 15 years. Thus, consumer demand ceases to be a factor in economic growth. The rate of contraction of investment in fixed productive capital in 2015 accelerated and amounted to 8.4%. All of this suggests that the recession will continue in 2016.

Priorities of economic and monetary policy. An analysis of the dynamics of Russian economic development in the new century shows that the choice in favor of stimulating growth should be prioritized. Only a relatively high and stable rate of economic growth at a level of 5–7% per annum will successfully solve strategic objectives of modernizing the economy and achieving a qualitative improvement in living standards.

As for inflation, it will continue to remain significantly higher than the inflation targets of the Bank of Russia, i.e., inflation slowing to 7% in September 2016 and achieving an ultimate goal of 4% in 2017. Many experts and researchers have repeatedly shown that Russian inflation has a largely monetary nature, which is primarily associated with high production costs and natural monopolies. Therefore, it is impossible to rein it in by merely tightening the monetary policy. Moreover, inflation of 7–8% per annum in the short term is quite acceptable for the Russian economy. One cannot set clearly unattainable objectives of reducing inflation. Fighting inflation at any cost, which was prioritized by the Central Bank in recent years, has had a detrimental impact on the production and destabilized the financial system.

Inflation targeting is not a policy that focuses exclusively on maintaining low and stable inflation. The international practice of inflation targeting provides strong evidence that, along with the solution of this problem, central banks simultaneously control the dynamics of other key macroeconomic indicators and especially the stability of output and employment dynamics. At the same time, these banks tend to avoid sharp jumps in interest rates and exchange rates, as well as to maintain the stability of the financial system

[1, p. 67]. That is how the US Federal Reserve System acts, which primarily responds to deviations in economic growth and employment from the potential trend.

The transition to an inflation-targeting policy in the Russian Federation was carried out upon the deterioration of external economic conditions caused by Western sanctions and falling oil prices. The Central Bank of Russia, which possesses sufficient reserves to offset the deterioration of market conditions, could indeed postpone the targeting policy until there were favorable conditions for its implementation. However, the Central Bank decided on this very risky step with no experience of the targeting policy, and the negative results were not long coming. Moreover, even in the face of deepening recession, the Central Bank has seen its strategic goal only in inflation reduction. It is natural that the continuation of this policy by the Central Bank may lead to the country becoming trapped in low growth rates in the medium and perhaps in long term. Therefore, it is advisable to legally extend the functions of the Central Bank of Russia by entrusting it with the task of maintaining economic growth by measures of monetary policy.

Obviously, today and in coming years, the Central Bank should pay more attention to economic growth and pursue the active stimulating monetary policy. The prospects of recovering from the recession and the recovery of the real sector of the economy are now largely dependent on the possibilities of strengthening the stimulating role of the monetary policy of the Central Bank; otherwise, long-term stagnation in the Russian economy is possible. This is the increase in the actual and potential economic growth, which should be a priority of the Central Bank and the Russian government. Economic recovery and its sustainable growth require the availability of interest and loans; therefore, a tight monetary policy pursued by the Central Bank today is unacceptable. Many papers in scientific journals have been published about this (see, e.g., [2]).

Let us illustrate the above using mathematical modeling.

Mathematical models that describe economic dynamics during hyperinflation. In this paper, we propose a medium-term mathematical model of economic dynamics under the conditions of high inflation (10–30% per year) and unstable development. Using this model, the rates of inflation and economic growth (recession) are forecasted for Russia for 2015–2018. It is expected that, in the next year or two, one should not expect significant impulses from the innovative proposals capable of generating endogenous growth factors in the Russian economy. Under these conditions, the main source of funding the state budget deficit becomes money emissions. In turn, the emissive monetization of the state budget deficit is the main source of rising inflation.

Since the main factor in the inflation rate is growth in the money supply, a key role is played by the equilibrium condition in the money market, which is generally written as [1, p. 629]:

$$(M/P)^S = (M/P)^D = L(i,Y), \quad (1)$$

where M is the monetary base, P is the price level in the economy, i is the nominal interest rate; Y is real income (GDP); $L(i, Y)$ is the function of the demand for real money balances (actual money balances in hand of the population, or real cash balances), and superscripts S and D represent supply and demand. According to Fischer's identity [1, p. 630], nominal interest rate (i) is determined by the real interest rate (r) and expected inflation (π^e):

$$i = r + \pi^e; \quad \pi^e = \dot{P}^e/P^e, \quad (2)$$

where P^e is the expected price level in the economy and $\dot{P}^e$ is the rate (derivative) of price changes in the economy.

When designing a specific model of demand for money under conditions of high inflation, one usually relies upon the classical demand for money function, offered by P. Cagan [3] to describe the processes of hyperinflation, when the price level increases during the month by a mean of 50% or more a follows:

$$(M/P)^D = \exp(-\alpha\pi^e), \quad \alpha > 0, \quad (3)$$

where α is the coefficient of elasticity of demand for money by the rate of inflation. The Cagan function (3) shows the very rapid fading of demand for monetary assets as inflation expectations increase (π^e), which is very typical in the case of hyperinflation. Cagan's suggestion that it is advisable to build correction of expectations in accordance with the mechanism of adaptive expectations was also very successful as shown below [4, p. 158]:

$$\dot{\pi}^e = \beta(\pi - \pi^e), \quad (4)$$

where $\pi = \dot{P}/P$ gives the actual inflation rate; β is the parameter that characterizes the rate at which economic agents revise their expectations in accordance with the actual depreciation of money and $\beta > 0$. It is also assumed that the rate of growth of money supply is constant, i.e.,

$$\mu = \dot{M}/M = \text{const}. \quad (5)$$

The Cagan model (3)–(5) has a simple and elegant analytical solution [4, p. 158]:

$$\pi(t) = \mu + (\pi_0 - \mu)\exp[-(\beta t/(1 - \alpha\beta))]. \quad (6)$$

For an economy subject to hyperinflation, we can assume that $\pi_0 > \mu$. If agents change their expectations rationally, then $\alpha\beta < 1$ and, if $t \to \infty$, $\pi \to \mu$, which is consistent with the findings of the classical quantity theory of money [4, p. 159]: in equilibrium state $\pi = \mu$. If the agents change their expectations dramatically,

then $\alpha\beta > 1$ and $\pi \to +\infty$ at $t \to +\infty$, i.e., the economy cannot come to an equilibrium state. Due to its simplicity and relevance, the Cagan model has become the most popular demo model and therefore appears in all textbooks on macroeconomics (see, e.g., [1, p. 684; 4, p. 157–159, 5, p. 194]).

In the Cagan model (3), inflation expectations (π^e) serve as the only demand factor. As in hyperinflation $\pi^e \gg r$, the latter (r) is neglected. There is also no issue (Y) in the model, and it is assumed that economic growth (recession) is missing. Obviously, at high inflation ($10\% < \pi < 30\%$), when the real interest rate (r) and inflation expectations (π^e) are comparable in magnitude, in demand function (3), the real interest rate must also be taken into account. In addition, the economy is undergoing significant changes, i.e., recessions and recoveries. In addition, in the model (3)–(5), the growth rate of the money supply (μ) is assumed to be constant, which is unacceptable in practice because μ is a control parameter, which requires a flexible regulatory policy by the Central Bank in order to stabilize inflation. Therefore, it is not surprising that attempts to use the Cagan model (3)–(5) for the Russian economy do not yield useful results [4, 5].

In [5, p. 194], with regard to the Russian economy, which developed under conditions of high inflation, it is proposed to use the following demand for the money function:

$$(M/P)^D = a/(b + c(\pi^e)^2), \tag{7}$$

where a, b, and c are constant parameters. In the demand function, the latter is reduced significantly more slowly than in the exponential demand function in the Cagan model (3). However, this demand function does not yield a satisfactory description of the dynamics of inflation under the conditions of an unstable economy.

Disadvantages of the Cagan model were partially eliminated in the Bruno–Fischer model [4, p. 159–164], which includes the dynamics of GDP, as well as the monetary financing of public deficits. The demand for the money function in this model expresses the specific demands in shares of GDP (Y) as follows:

$$(M/PY)^D = \exp(-\alpha\pi^e), \quad \alpha > 0. \tag{8}$$

It is assumed that the real issue[1] (Y) is growing at a constant rate, $q_Y = \dot{Y}/Y = \text{const}$, which is characteristic of a stable economy, adapt to hyperinflation, which is a very rare case. It is further assumed that the entire budget deficit (d in shares of GDP) is financed by the emission of currency as shown below:

$$\dot{M}/PY = d = \text{const}. \tag{9}$$

[1] Since we are talking about real income, issue Y is measured in constant prices.

In both the Bruno–Fischer and Cagan models (4), inflation expectations have an adaptive character. The Bruno–Fischer model (8)–(9) does not yield a simple explicit solution or require analysis using numerical methods. The model describes the case of hyperinflation well, but, like Cagan's model, does not yield a satisfactory result with high inflation and unstable development.

Mathematical model of economic dynamics under the conditions of high inflation. If we consider the value of expected inflation to be a random variable (as it is in practice), then the mentioned models for this purpose used the exponential law of probability density distribution (3) and (8) and the Cauchy distribution law (7), which have relatively rapidly decreasing tails, which is confirmed in the case of hyperinflation. This means that tails of distributions can be neglected. However, in the case of high inflation, there is instability and a significant probability of a spurt of expected inflation, which should be taken into account in practical calculations. Therefore, in these cases, distributions with thick tails should be used. This was first proposed in report [6], which was approved by prominent academic economists and mathematicians. To describe the demand function, it is proposed to use the power function

$$(M/PY)^D = k(r + \pi^e)^{-\alpha}, \quad \alpha > 0, \quad k = \text{const}, \tag{10}$$

which is a Pareto type distribution function [7, p. 7].

In addition to the demand function (10), let us assume the key prerequisites of the Cagan and Bruno–Fischer models. Following Cagan, we assume that there is an adaptive mechanism for the review of expectations (4). Following Bruno and Fischer, we assume that the entire state budget deficit is financed by emission of currency (9). However, we do not limit it (d) with a constant, assuming that the government will seek to gradually reduce the deficit, until the transition to a deficit-free budget in the medium term. We will also consider the real dynamics of GDP $q_Y = \dot{Y}/Y \neq \text{const}$ and real strategies of change of the key interest rate r and the rates of money supply regulation $\mu = \dot{M}/M \neq \text{const}$.

The decision model is to obtain equations to describe and forecast calculations of rates of economic growth (q_Y) and inflation (π). Let us take the logarithm of both sides of Eq. (10) as follows:

$$\ln M - \ln P - \ln Y = \psi - \alpha \ln(r + \pi^e), \tag{11}$$

where $\psi = \ln k$, $k = e^{\psi}$.

Then, we differentiate both sides of obtained equation (11):

$$\mu - \pi - q_Y = -\alpha(\dot{r} + \dot{\pi}^e)/(r + \pi^e). \tag{12}$$

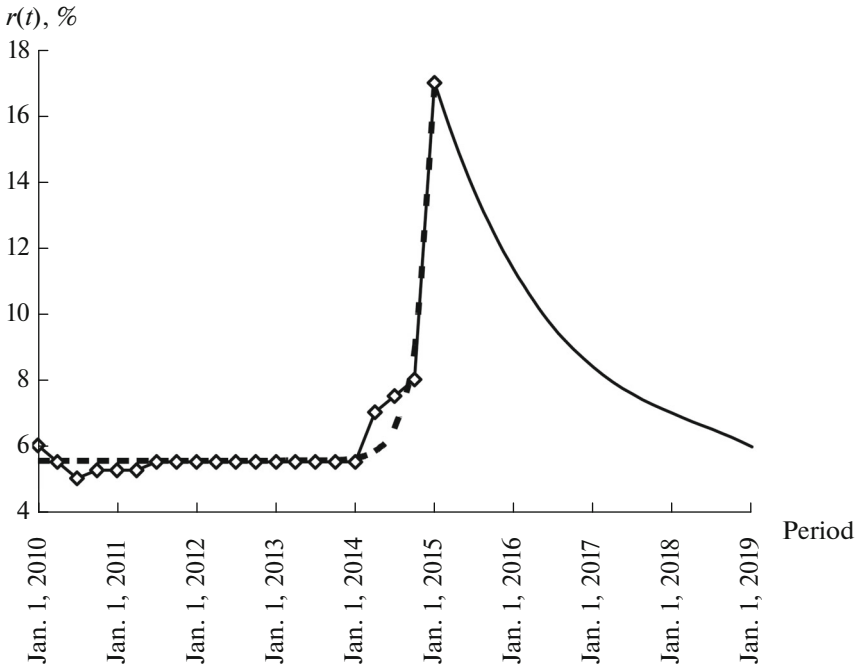

Fig. 1. Strategy of changing the key interest rate of the Central Bank.

Since in the retrospective analysis we can assume $\pi^e = \pi$, then equations (11) and (12) can be used to estimate the values of parameters k and α. We transpose the equation of monetary financing of the budget deficit (9) into the following form using (10):

$$\begin{aligned} \dot{M}/PY &= (\dot{M}/M)(M/PY) \\ &= \mu k(r+\pi^e)^{-\alpha} = d. \end{aligned} \tag{13}$$

Taking the logarithmic derivative of both sides of Eq. (13), we obtain

$$-\alpha[(\dot{r}+\dot{\pi}^e)/(r+\pi^e)] = \dot{d}/d - \dot{\mu}/\mu. \tag{14}$$

By combining Eqs. (12) and (14), we obtain the equation

$$q_Y + \pi = \mu + \dot{\mu}/\mu - \dot{d}/d, \tag{15}$$

which shows that, under the conditions of high inflation, the unstable noninnovative economy is completely determined by two factors, i.e., the growth rate of the money supply (μ) and the budget deficit (d).

Thus, to separate two variables of interest, i.e., the rates of inflation (π) and economic growth (recession, q_Y), it is necessary to obtain another equation. For this purpose, one can use the Lucas supply equation [1, p. 365], which describes issue deviations ($\overline{Y}$) caused by an unexpected deviation in the price level (P) in the absence of supply shocks as follows:

$$\ln Y - \ln \overline{Y} = b(\ln P - \ln P^e), \tag{16}$$

where b is the Lucas proportionality factor.

Differentiating both sides of this equation, we obtain:

$$q_Y = q_{\overline{Y}} + b(\pi - \pi^e), \tag{17}$$

where q_Y is the equilibrium growth rate to which the economy tends in the current situation.

Applying the equation of the revision of expectations (4), we obtain

$$q_Y = q_{\overline{Y}} + \rho\dot{\pi}^e, \quad \rho = b/\beta, \tag{18}$$

where $\rho = b/\beta$ is the constant parameter that characterizes the degree of the influence of the rate of change in the inflation rate on the economic growth rate.

Next, we turn to Eq. (13), from which it follows that

$$\pi^e = (k\mu/d)^{1/\alpha} - r. \tag{19}$$

Therefore,

$$\dot{\pi}^e = (1/\alpha)(k\mu/d)^{1/\alpha}(\dot{\mu}/\mu - \dot{d}/d) - \dot{r}. \tag{20}$$

Substituting (20) into (18), we obtain the final equation for calculating the dynamics of economic growth (recession):

$$q_Y = q_Y + \rho[(1/\alpha)(k\mu/d)^{1/\alpha}(\dot{\mu}/\mu - \dot{d}/d) - \dot{r}]. \tag{21}$$

This equation, together with Eq. (15), allows one to define two variables of interest for us. Indeed, first calculating predictive dynamics of economic growth (q_Y) by the formula (21), then one can easily calculate the forecast inflation rate (π) by the formula (15) by substituting in the obtained values of q_Y.

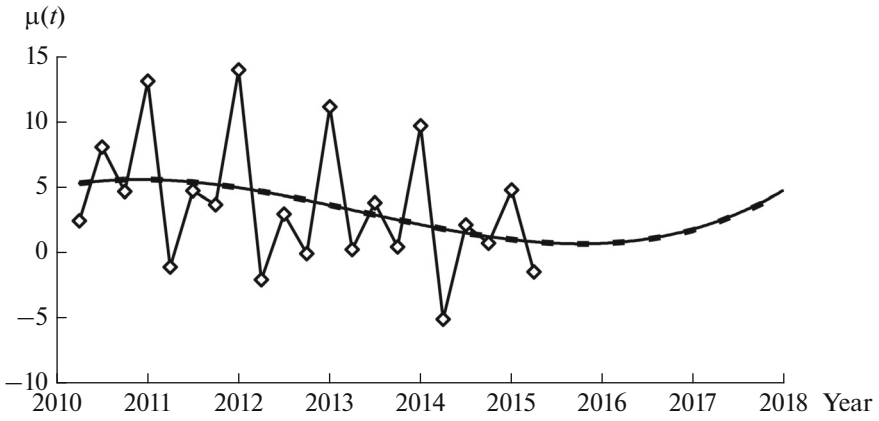

Fig. 2. Dynamics of the growth rate of the money supply.

For forecast calculations using formula (21), scenarios of three key variables are required, i.e., the real interest rate (r), the growth rate of the money supply (μ), and the state budget deficit (d). The scenario of reducing the key interest rate to 17% after its sharp increase at the end of 2014 was formulated by the Central Bank of Russia, i.e., a gradual decline to the equilibrium level of 6% by the end of 2017, as shown in Fig. 1. We have described this scenario by the logistic function in the period of 2010–2014 as follows:

$$\tilde{r}(t) = A/1 + fe^{-ht}) + \Delta,$$
$$A = 3.87; \quad f = 33.24; \quad h = 1.24; \quad \Delta = 0.055, \tag{22}$$

and by the following second-degree polynomial in the forecast period of 2015–2018:

$$\tilde{r}(t) = a_0 + a_1 t + a_2 t^2 \quad (a_0 = 0.17; a_1 = -0.0185; a_2 = 0.0012). \tag{23}$$

To grow the money supply, we have laid the following linear growth scenario:

$$\mu = \mu_0 + \mu_1 (t - T_0), \tag{24}$$

where μ_0 is growth rate of the money supply developed by early 2015 (Fig. 2)[2]; therefore, $T_0 = 2015$. Here, $\mu_0 = 0.018$ and $\mu_1 = 0.00013$.

With regard to the budget deficit, during numerical forecasting, it was assumed to be constant and equal to 2.6%, which was the hypothetic average value for 2014–2018.

Results of forecast calculations of the dynamics of inflation rate and economic growth (recession) rate are shown in Fig. 3.[3] As can be seen, the predicted depth of the recession was to be –4.4% by the end of 2015. Then, it is predicted that there will be a sharp jump from the bottom of the recession, which will grow into a rise and reach a growth rate of approximately 1.5% in 2017 and 1.8% in 2018. However, in 2016, there will still be a decline of 0.7%. At the end of 2015, inflation will be 14.5% and will continue to decline to a level of 10.8% by the end of 2016 and to 8% by early 2018.

For comparison, the actual inflation dynamics is shown in Fig. 4. As noted above, the actual inflation rate in 2015 was 13% and was lower than the forecast, and the decline (3.7%) was also slightly less than the forecast value.

The values of key parameters α and k (10) were evaluated using Eqs. (11) and (12), i.e., $\alpha = 0.33$ and $k = 0.25$. Then, the potential equilibrium growth rate of the Russian economy q_Y and the parameter ρ were evaluated using Eq. (18), where in the retrospective period, the actual data are used for $\pi = \pi^e$, $q_Y = 0.98\%$ for 2014–2015, and $\rho = -1.4$. Here, it should be noted that a detailed study has been conducted in [8, p. 27] and it is shown that the potential (structural) growth rate of the Russian economy has been steadily declining from 4.3% in 2009 to 1–2% in 2014. As can be seen, the obtained estimate of $q_Y \approx 1\%$ for 2014–2015 is consistent with these results.

Reasons why the Russian economy has fallen into a deep recession. The sharp increase in the key interest rate in December 2014 had a number of negative consequences for Russia's financial system and economy. First of all, it dramatically worsened the situation in the banking system and nearly suppressed its lending activity. The level of profitability of the banking system became negative; then, in early 2015, it returned to the near-zero mark. Borrowers no longer took out loans for developing and expanding production. For the majority of enterprises in the real sector, loans have become unaffordable. The influx of new borrowers decreased greatly. The liquidity crisis in the banking system spread to the commercial and industrial sectors.

[2] Source: http://www.cbr.ru/statistics/?PrtID=ms&Year=1993.
[3] Source: Rosstat data, in percent the corresponding month of the preceding year.

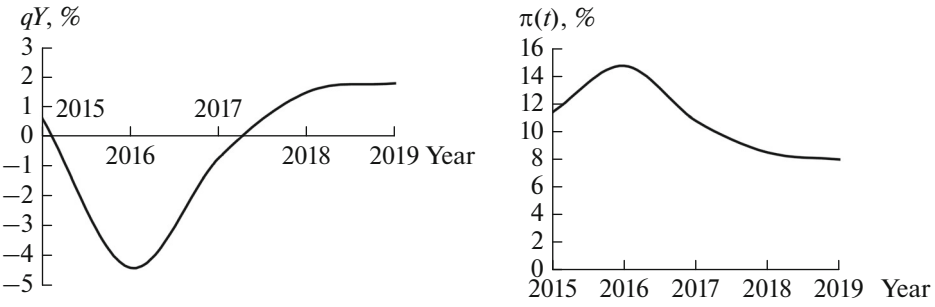

Fig. 3. Forecast dynamics of rates of economic growth (q_Y) and inflation (π) for the Russian economy in 2015–2019.

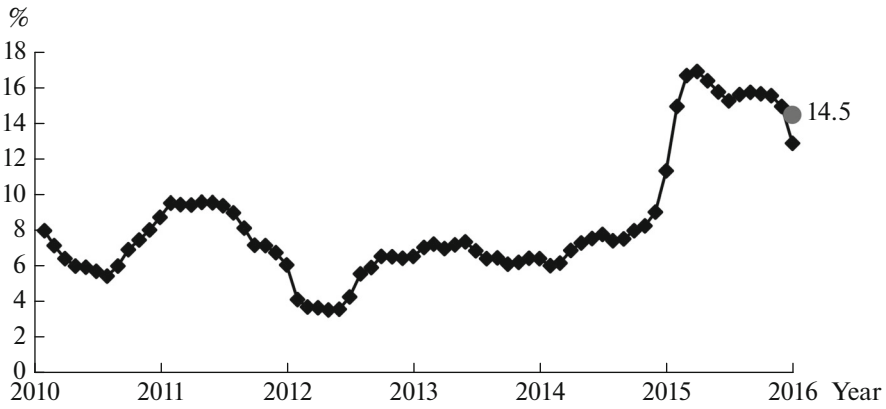

Fig. 4. Dynamics of actual inflation and forecast of its value (point at the end of 2015).

Investment demand in the economy, which began to decline as early as 2012, has accelerated and continued until 2014. Great uncertainty in economic policy provoked large-scale capital outflow, which, along with increased volatility in the currency market and the rising cost of borrowing, significantly affected investment demand in 2014. This significant reduction in investment demand was the main reason for recession in 2014. December's sharp rise in the key interest rate led to a reduction of investment demand, which plunged the economy into a crisis recession. A record decline in consumer demand must be added to this, which followed a sharp drop in real wages and income.

At the same time, the devaluation of the ruble and Western sanctions have created good preconditions for rapid growth in the Russian economy in the coming period due to the process of import substitution, but the launch of this mechanism has proved to be impossible due to a lack of investment. Of course, in the presence of investment, import substitution could significantly revive recovery economic growth. However, the contraction of investment due to the tight monetary policy of the Central Bank did not allow one to reduce to practice benefits from the weakening of the ruble, which makes Russian manufacturers more competitive on domestic and export markets.

A sharp increase in the key interest rate under the conditions of economic downturn was unacceptable because it is obvious that the economy is facing a deep recession, and it occurred (see Fig. 3). In this case, economic theory clearly recommended reducing the rate in order to increase aggregate demand and pull the economy out of the recession. S. Glaz'ev was correct in stating that "Always and everywhere, a reduction in money supply and a rise in the interest rate are accompanied by a drop in production and investment" [9]. In [10], it was also shown that, among other things, high interest rates stimulate inflation expectations.

Thus, today, the Russian economy and its real sector are experiencing an acute deficit of liquidity. Only the expansion of money supply could lead to a pickup and the further growth of the economy. Therefore, the saturation of the economy with liquidity is the most important task of the Central Bank of Russia. In circumstances where the level of monetization of the Russian economy is very low, only 46% of GDP, there is still a possibility of absorbing the financial resources in noninflationary terms. For example, it is known that monetary policy, which is consistent with a permanent reduction in inflation, is an unexpected sharp increase in money supply upwards, followed by slow growth [1, p. 633]. It follows from this that the decline

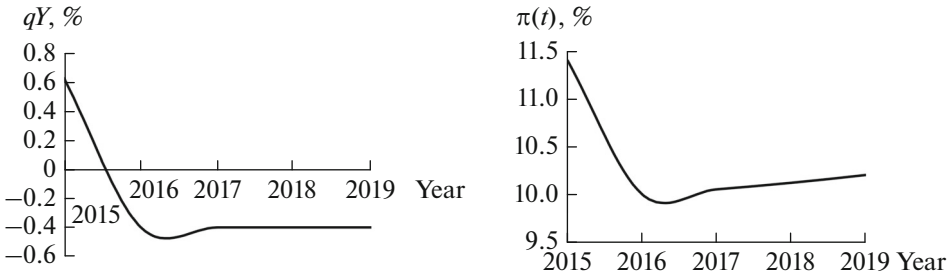

Fig. 5. Forecast dynamics of rates of economic growth (q_Y) and inflation (π) for the Russian economy at the fixed key interest rate $r = 5.5\%$, $\dot{r} = 0$.

in inflation may be accompanied by a temporary, unusually high growth in the money supply.

Ruble exchange rate under the condition of oil-price volatility. The main consequence of the reduction of oil price for the Russian economy was the weakening of the national currency. In general, the devaluation of the national currency is a natural reaction of petroleum-exporting countries to lower oil prices, since it allows one to reduce real wages and avoid significant decline in production, as well as to balance the state budget. However, there should not have be an explosion in devaluation that leads to a financial crisis and deep recession in the economy. As noted in [9], devaluation could be carried out in a planned manner with a previously announced target exchange rate while taking measures to stabilize the exchange rate at a new level, which hinders the rise of a speculative wave.

Taking into account the high volatility of oil prices, as well as the current policy of the Central Bank, we should expect high volatility of the ruble, which would have extremely negative consequences. Indeed, a significant increase in speculative turnover in exchange market is a direct result of sharply increased volatility of the ruble after the implementation of the free-floating regime by the Central Bank. Thus, the exchange rate shock in December 2014, caused by the pressure of a strong speculative attack, was a consequence of the policy of the Central Bank. The experts were right in saying that the Central Bank has made a mistake in deciding to eliminate the speculative attacks on the ruble through market mechanisms, whereas it should operate using the measures of exchange controls, e.g., by introducing regulatory restrictions on the cross-border movement of capital, as noted by Jacques Sapir [11].

Central Bank of Russia needs a new exchange rate policy aimed at ensuring the long-term stable real exchange rate of the ruble, based on the fact that the current oil prices (55 ± 5 dollars/bbl) will be steady for the next ten years. After all, ensuring the stability of the national currency is the main function of the Bank of Russia. In addition, the dynamics of the ruble exchange rate, according to experts, has a strong influence on the inflation expectations of the population. Consequently, the main condition for the stability of inflation is the stability of the ruble.

Strategy of maintaining the equilibrium key interest rate. In [12], three main shortcomings of the monetary policy of the Central Bank of Russia were identified, and above all excessive tightening of the monetary policy, which has led to a deepening recession in the economy. The authors showed that, consequently, the GDP of Russia in 2014 was 3% lower than the potential output. They also calculated that the equilibrium key interest rate does not exceed 6.25%, so its increase in 2014 from 5.5% to 9.5% by November was one of the main factors slowing down economic growth. We modeled this significant occasion, supposing in the formula (21) $\dot{r} = 0$ at $r = 5.5\%$, i.e., constant level of the interest rate. Along with this, we also took the budget deficit as a constant ($\dot{d} = 0$, $d = 2.6\%$), and established a small growth scenario (24) to the money supply. The results of forecast calculations according to the formulas (21) and (15) are shown in Fig. 5.

As can be seen from considering the dynamics of economic recession (q_Y), in this case the downturn in 2015 would have been small, about 1 p.p., and the depth of the recession would only be 0.5%; however, there is then stagnation. It is also clear that inflation would fall to a level of about 9.8%, and would then begin to grow slowly. Thus, the simulation also confirms the conclusion that the sharp increase in interest rates in late 2014 has led to a deep recession in the economy and to rising inflation.

ACKNOWLEDGMENTS

This article was prepared with financial support from the grant of the Russian Scientific Foundation (project No. 14-28-00065) “Structural and Cyclical Paradigm of Economic and Technological Updating of Macrosocial Systems (The World and Russia in the First Half of the 21st Century).

REFERENCES

1. D. Romer, *Higher macroeconomics* (GU VShE, Moscow, 2014) [in Russian].

2. M. Ershov, "What economic policies does Russia need under sanctions?," Vopr. Ekon., No. 12, 37–53 (2014).
3. Ph. Cagan, *Studies in the Quantity Theory of Money,* Ed. by M. Friedman (University of Chicago Press, Chicago, 1956), pp. 25–117.
4. E. A. Tumanova and N. L. Shagas, *Macroeconomics* (Infra-M, Moscow, 2004) [in Russian].
5. A. D. Smirnov, *Lectures on Macroeconomic Modeling* (GU VShE, Moscow, 2000) [in Russian].
6. A. A. Akaev, "The model of economic dynamics with high inflation," in *Proc. 3rd International Symposium Multiphase Systems* (Inst. Okeanol. Ross. Acad. Nauk im. P. P. Shirshova, 2015).
7. V. M. Petrov and A. I. Yablonskii, *Mathematics of Social Inequality* (LIBROKOM, Moscow, 2013) [in Russian].
8. S. Sinel'nikov-Murylev, S. Drobyshevskii, and M. Kazakova, "Decomposition of Russia's GDP rates in 1999–2014," Ekon. Polit., No. 5, 7–37 (2014).
9. S. Yu. Glaz'ev, "On the Monetary Policy of the Central Bank," Ekspert, No. **28**, 35–38 (2015).
10. A. Kolomiets, "Inflation and interest rates in modern Russian economy," Vopr. Ekon., No. 12, 101–115 (2014).
11. Zh. Sapir, "Russia: Lessons learned from the crisis," Ekspert, No. **4**, 18–21 (2015).
12. A. Apokin, D. Belousov, I. Goloshchapova, I. Ipatova, O. O. Solntsev, "On the fundamental shortcomings of modern monetary policy," Vopr. Ekon., No. 12, 80–100 (2014).

Akaev, Askar Akaevich, Dr. Sci. (Tech.), professor, full-member of the National Academy of Science of the Kyrgyz republic
Ziyadullaev, Nabi Saidkarimovich, Dr. Sci. (Econ.), professor, deputy director
Sarygulov, Askar Islamovich, Dr. Sci. (Econ.), head of department
Sokolov, Valentin Nikolaevich, Dr. Sci. (Econ.), professor, leader
Translated by S. Avodkova