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MONETARY AND NON-MONETARY DETERMINANTS OF INFLATION VOLATILITY

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The dynamics of inflation of the Republic of Belarus for 2003–2017 years, on the basis of statistical analysis has been constructed an econometric model of inflation on monthly data from January 2012 to December 2016. To account for the conditional heteroscedasticity and autocorrelation of the generalized model used autoregressive conditional heteroske-dasticity (GARCH-model) for the study of inflation based on the statistics of the National Bank of Republic of Belarus.

Key words: ARCH-model; GARCH-model; indicator of inflation; basic rate of inflation; augmented Dickey – Fuller test.

МОНЕТАРНЫЕ И НЕМОНЕТАРНЫЕ ФАКТОРЫ ВОЛАТИЛЬНОСТИ ИНФЛЯЦИИ

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Исследуется динамика инфляции Республики Беларусь за 2003–2017 гг., на основе статистического анализа была построена эконометрическая модель инфляции по помесячным данным с января 2012 г. по декабрь 2016 г. С целью учета условной гетероскедастичности и автокорреляции использована обобщенная модель авторегрессионной условной гетероскедастичности (GARCH-модель) для исследования инфляционных процессов на основе статистических данных Национального банка Республики Беларусь.

Ключевые слова: ARCH-модель; GARCH-модель; индикатор инфляции; базовый уровень инфляции; расширенный тест Дики – Фуллера.

An important problem for the economies of many developed and developing countries is inflation. Main problem affects even those countries that do not exceed the annual inflation rate of 2-3 % per year (according to the World Bank, this level is acceptable and has no significant adverse effect on the economic and social spheres). The inflationary target of different countries is defined in its specific way; mainly the main difference lies in the measurement of its three parameters: time horizon, the price level and the inflation benchmark width

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Juliet Abakumova, senior lecturer at the department of analytical economics and econometrics, faculty of economics. abakumova@tut.by fluctuation range. As a measure of inflation is more preferable to use the consumer price index. However, permanent changes occur in the CPI calculations in connection with the introduction of new products, or due to an increase in demand for some goods. Because of this, price stability is not to be assumed zero, but rather a slightly positive CPI growth. This prompted the public authorities of many countries to choose as inflation benchmark – the level of 2 % per annum. To comply with this guideline, requires constant monitoring of the level of inflation (for example, real-time monitoring of all its components), and to take the necessary decisions to retain or prevent inflation, it is necessary to clearly distinguish between the mechanisms of its formation (commodity, currency devaluation and the devaluation of currencies worldwide). The main reason (generator) of inflation is fast growth of effective demand for goods and services of industrial and consumer goods in relation to their proposal. One of the most important reasons of the imbalance of effective demand and the supply of goods may be outstripping of the growth of budget expenditures compared to the GDP growth, due to their large share in the economic turnover.

For the Republic of Belarus, the problem of inflation is also relevant, as the periods of lower prices replaces periods of prices growth, which has its negative effects on the stability of the economy.

Among the causes of inflation there are monetary and non-monetary factors, which are divided into smaller factors. The relevant factors for the Republic of Belarus are: the state budget deficit, the growth of money supply (monetary factors) and non-monetary factors – imbalances in the economy, the negative balance of foreign trade. All these factors have an influence on inflation. In order to provide the economical policy action aimed to reduce the rate of inflation and achieve its natural level, there is the need of understanding of the mechanism of inflation, and that means the need of the constant real-time monitoring of all the main economic indicators.

Measuring inflation tend to use price indexes that characterize the change in prices over time. The most visible of which are the indexes of consumer prices, retail prices index, the GDP deflator [1; 2]. In Belarus, as an official indicator of inflation calculated by the Ministry of applied statistics – the consumer price index. It is calculated on the basis of international standards, it is well known to all segments of society; the method of its calculation worked out and agreed upon at the level of international experts (IMF, Eurostat, etc.). In the consumer basket CPI Republic of Belarus includes about 450 items of goods and services (in the US – 300, in the UK – 350 goods and services). In some special cases, as the inflation indicators can be used:

• producer prices index (an important indicator of the currency market, reflects the dynamics of prices for national products, and covers all stages of production);

• GDP deflator (usually quarterly index characterizes the changes in wages, profits and fixed assets as a result of changes in prices and nominal net taxes) [3].

The inflation rate in Belarus until 2011 (fig. 1) is gradually approaching the world standards. But in 2011, which is taken for the beginning of the financial crisis, there was a sharp increase of the inflation rate, it was driven almost threefold devaluation of the national currency in high import capacity conditions of the Belarusian economy. As a result, there was a decrease in purchasing power, increased business and the outflow of skilled labour. Studies (including the IMF) showed that in the period 2010–2011 the situation on the world market does not allow to restore high economic growth rates envisaged in the program of socio-economic development of Belarus for 2006–2010, due to an increase in exports of Belarusian goods. In this connection, the emission credits was the main source of funding for economic for 2010–2011. Until 2010, the internal emission policies were in power proceeds from the sale of state property and foreign loans of the IMF and the EU, which have assumed the specific conditions of their production: the restructuring of the economy, the tightening of monetary policy, private sector development, liberalization of the tax system. But dew to no practical actions taken these funding sources have been closed.

Inflation in 2014 decreased from 16.5 to 12.0 % in 2015, the main inflation factor was the exchange rate of the Belarusian ruble, and also the restrained increase in the regulated prices of some goods and services held by the government, which helped to reduce the impact of non-monetary factors on inflation in the country. The inflation rate in 2016 was 10.6 % against the forecast of 12 % (14.5 % – IMF), as a result of the financial and exchange rate stability. In 2017 according to government data of the Republic of Belarus, the main objective of monetary policy is to reduce inflation to 9 %.

Foreign experience of the countries coming to the inflation targeting regime shows that it is based on objectively determined factors associated with a particularity of the world and national economies. Searching for a new nominal anchor of monetary policy was caused by failure of monetary targeting within increasing openness of the economy. Target monetary indicators in different periods could only large economy or country which is not involved in any global processes [1]. One of the major reasons for not carrying out such a policy was the instability of the links between the dynamics of monetary aggregates and target macroeconomic

indicators. Experience has shown that countries using inflation targeting easier adapted to the crisis conditions in 2009. Coming to inflation targeting allows not only to keep inflation rate on appropriate level, but also reduce the volatility of other key macroeconomic indicators. In the developing countries, characterized by a high degree of dollarization of the economy may be justified smoothing excessive volatility, of the national currency. Figure 2 graphically presented cooperative rate of inflation on the basis of the analysis of 2014 and 2015. The Republic of Belarus and some other developed and developing countries, are targeted using inflation mode.



Fig. 1. Planned and actual inflation in the Republic of Belarus in 2004–2016 (forecast: 2017)



Fig. 2. According to the IMF data of inflation of Belarus and some countries (with inflation targeting) in 2014-2015

During the period of 2012–2015 government funded state programs carried out by the tight monetary policy. According to "The main directions of the monetary policy of the Republic of Belarus for 2015" the monetary policy instruments were aimed to achieve the inflation target, taking into account the prevailing limitation of internal and external macroeconomic conditions. The main role were taken by the interest rate policy, the priority of which was to maintain positivity in the level of interest rates in the economy, which is one of the most important conditions for price stability and the confidence of depositors. Monetary policy of the National Bank of Belarus, which caused decline in monetary aggregates, promotes the stabilization of price growth, restoration of the national currency stability and some growth, international and foreign currency reserves, but has a negative impact on real activity in the economy.

Considering the slowdown in inflation volatility in the refinancing rate by the end of 2016 it amounted to 18 % per annum. Reduced refinancing rate is for a reduction in price of credit resources, stimulating domestic demand, which may lead to serious problems for the economy. From fig. 3 it can be seen that in many developed countries there is a trend: the level of the refinancing rate is consistently below the inflation rate, but in many countries (including Belarus), on the contrary: inflation above the refinancing rate, which generally means the state limit mode.

The most important factor affecting the growth of inflation, is the dynamics of monetary base, that is the most liquid and quick reversal part of the entire money supply. However, if we compare the rate of inflation and the volume of money supply M2 growth (fig. 4), you may find that the inflation rate in Belarus almost doesn't depend on the growth of the money supply, the correlation coefficient between these indicators (within 2002–2016 period) amounted to 0.38. In the end of 2016 there was a sharp increase in the balances of legal persons for transferable deposits in the national currency, which created a strong increase in the ruble money supply M2. This happened as the result of strong monetary policy of the authorities, even when the nominal volume of the M2 holding the narrow framework of the (monetary targeting regime), its change – reducing the



Fig. 3. Official rate of inflation and refinancing rate in several countries in 2016



Fig. 4. The value of the indicator (M2 indicator of growth), and the inflation rate (CPI) in 2003–2016

purchasing power of all that the ruble money supply. Policy of targeting monetary and when there is a large amount of cheap and available financial resources, provided on the one hand, the overall financial peace of mind in the country for 2016 stable exchange rate of the Belarusian ruble, relatively low inflation and lowered the devaluation expectations.

But on the other hand there were deficiencies of the economic system found, this economic system can not exist without the cheap financial resources. As a result the number of unprofitable enterprises, debtor and creditor indebtedness increased, the share of non-performing loans, real incomes have fallen.

The potential development of the market economy is determined by the prevalence of monetary relations. As a rule, in international practice to assess the degree of saturation of the money economy uses monetization ratio, which is calculated as the ratio of average broad money (can be determined and other monetary indicators) to GDP at current prices. According to calculations, the monetization factor for broad money in Belarus with the 2006–2014 does not exceed 30 %, from 2015–2016 this indicator were about 40 %. On average in the world, the figure is 125 %, and the highest level in Japan more than 200 % (negative inflation). Practice shows that in countries with a high inflation rate of monetization – a low, and in countries with a low inflation rate of monetization – high.

If the amount of money in comparison with GDP in the economy is small, the loans are too expensive, businesses can not develop normally, create jobs and modernize production. Figure 5 shows that the monetization rate is very low, even when compared with the developing countries, such as Russia – at least 50 %. It is possible that such a low level due to the fact that some indicators are not included in the monetary aggregates, such as foreign currency underlying the population at home, or the informal sector, the money found in offshore, etc. The low monetization of the Belarusian economy limits the opportunities for economic growth, increases the risks of destabilization and limits the choice of potential tools for the implementation of the necessary economic policy. However, we must remember the fact that artificially raise the level of monetization of the economy is impossible. Growth of monetization is possible only against the background of strengthening the credibility of the economic policy, improving the investment climate, growth, increased propensity of savings.

The experts of the International Monetary Fund and the World Bank forecasts that the economy of Belarus will start to recover in 2018 (fig. 6).

It should be considered that the impact of the volatility of the various economic indicators at the level of prices may increase, then decrease because of the correlation of the factors considered relationships and transfer mechanisms. For example, when the factors are complementary, the overall efficiency of their influence will increase.

The development of inflation also depends on the factors of demand and production costs. However, analyzing, using a variety of statistical methods and models based on the statistics of various countries economy data shows that the dynamics of all price indicators (CPI, the index of industrial producer prices, etc.) is directly determined by the change in the money supply. To improve a statistical significance of the model, logarithms of economic indicators were used as it variables, and for the variable output (gross domestic product) and monetary exchange rate a deviation of the relevant indicators from the trend (gap, valrate ir)



Fig. 5. The monetization ratio (M3), the rate of inflation and sufficient cash in 2006-2016

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Fig. 6. The forecasted values of inflation according to the world's leading experts in 2017–2019

was introduced in the model. In this research, monthly data were used, in light of this cleaning of the series from seasonal and cyclical components was held.

According to the analysis of publications of Russian and foreign authors on the subject of inflation modeling, were selected and analysed variables, which, according to the point of view of many economists, have an influence on the volatility of inflation (see table) [2; 4]. Different versions of correlation of inflation rate model were built on the basis of selected indicators. Proposed model for short-term or medium-term forecasting is a dynamic model of economic, which is constructed to analyse and further adjustment of monetary policy and describes the relationship between the major macroeconomic indicators (inflation, GDP, exchange rate, interest rates and monetary aggregates) [5].

The hypothesis of stationarity of the time series (test for a unit root) with the usage of the extended Dickey – Fuller test (ADF) (see table) was tested.

To perform all the above calculations and empirical analyses based on them the software package *EViews 5.1.* was used.

Indicator	Symbol	Specification	t _{ADF}
Endogenous variable: consumer price index	СРІ	I(1), none	-2.59 (10 %)
Exogenous variable: inflation (inertia)	CPI _{t-1}	I(1), none	-2.59 (10 %)
The average exchange course BYR/US Dollar	Valrate	I(1), C	-2.91
Average exchange rate gap	Valrate_ir		
Average refinancing rate (NB)	Ref	I(1), none	-1.95
Average rate of overnight interbank loans	Mbk	I(1), none	-1.95
Cash in turnover (non-seasonal components)	M0_sa	I(1), C	-2.91
Transferable ruble deposits (non-seasonal components)	M1_M0_sa	I(1), trend&C	-3.48
Fixed-term time ruble deposits and securities issued by banks (outside bank circulation) (non-seasonal components)	M2_M1_sa	I(1), trend&C	-3.48
Foreign currency deposits	M3_M2	I(1), C	-2.91
Producer price index	Ррсі	I(1), C	-2.91
GDP gap in constant prices	Gap	I(1), none	-1.95
Nominal average monthly salary (non-seasonal components)	Wage_sa	I(0), trend&C	-3.48
The official number of unemployed (non-seasonal components)	Lunemp_sa	I(0), trend&C	-3.48

Resulting unit root test ADF (log)

Indicators of a nominal average monthly salary and official number of the unemployed are stationary of the level, other factors are integrated with respect to the first differences.

In practice the problem of nonstationarity of the time series is widespread (their structural properties are constantly changing) due to dynamic processes in the modern economy. As a result normal statistical forecasting methods do not always work. Also when constructing econometric models some basic assumptions of the ordinary least squares (OLS) are often violated. At the moment quite a lot of models have been suggested, which describe a similar condition of the time series. For example, Autoregressive Conditional Heteroscedasticity (ARCH) model, proposed by R. Engle [6] through the example of the modeling of inflation processes in the UK, and later generalized GARCH, proposed by Bollerslev [7].

ARCH models were developed to account empirical regularities in the financial data. The class of ARCH models with discrete expectation time, directly observable variables are formulated in terms, while models of stochastic variability in discrete or continuous time include hidden state variables. It means that in the basis of ARCH model lies the idea of describing the dynamics of variability through a weighted average number of the model errors from the previous period. However, when using the ARCH model, some difficulties often arise due to the large number of indicators and long lags [7]. To resolve this problem the generalized model – GARCH was proposed:

$$\sigma_t^2 = b_0 + \alpha_i e_{t-i}^2 + \beta_i e_{t-j}^2.$$

To define the conditional variance in GARCH-models, all the coefficients in the existing linear ARCH model with an infinite order must be positive. GARCH model describe a relatively large number of time series very good, also this type of model is quite easy to use and is suitable for accurate forecasting.

In the function of the information base, statistical data of the National Statistics Committee and National Bank of the Republic of Belarus were used, the model was constructed for the period from January 2012 to December 2016. According to the results of tests for signification (ADF test and Granger test) from the model, the most of variables was excluded, and from the rest the following model was constructed:

$$CPI = 2.876 + 0.724CPI_{t-1} + 0.096M0_{sa} + 0.009M1_M0_{sa_{t-3}} + (p) (0.01) (0.00) (0.00) (0.00) + 0.167PPCI - 0.057Valrate_{ir} + 0.205Ref + GARCH(1, 0); (0.00) (0.00) GARCH = 0.0000227 + 1.888e_{t-1}^{2} (p) (0.00) (0.00) (2$$

According to the results obtained in the model (1): the increase of cash in circulation by 1 %, the inflation level will increase by 0.000 6 points. The increase in transferable ruble deposits by 1 % leads to the increase in the inflation rate by 0.000 09 points. If the index of producer prices of industrial products will increase by 1 point, then inflation increases by 0.167 points. As an indicator of the exchange rate its break is taken (break detection is one of the most effective methods of the research in the identification of imbalances in the economy), the increase in this indicator by 1 % will lead to a decrease in inflation by 0,000 57 points. The elasticity of inflation at a discount rate increased to 0.205 points.

In case of equal-zero indicator of all exogenous factors in the model, the inflation rate (CPI) is equal to 3,886 (autonomous level of inflation).

Equation 2 is a generalized autoregressive conditional heteroscedasticity model (generalized ARCH process): GARCH(1, 0) is represented as the ARCH(∞) model. Coefficient of the delay (lag), or the constant volatility is equal to 0.0000227, in other words, the equation (2) imitates the volatility as a sum of constant volatility and linear functions: absolute values of several last price changes and function, reflecting the degree of influence of previous estimates on current values. The final model has good statistical qualities and is possible for further usage as a forecasting model.

Belarus still has a long way to a sustained high economic growth but the high level of inflation, dollarization, low monetization significantly complicate this way. The problems of inflation, devaluation, monetization and dollarization and must be solved comprehensively and fundamentally. It means not only the adherence to the objective of maintaining price stability and ensuring exchange rate flexibility, but also involves the implementation of a whole complex of interrelated measures to stimulate structural change in financial assets and liabilities in favour of the national currency. Without trust in the Belarusian ruble, the Republic of Belarus will not be able to recover the positive growth of its economy.

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