

---

## Credit Market and Economic Growth of Russia: Modeling Mutual Influence

---

V.A. Byvshev<sup>1</sup>, N.E. Brovkina<sup>2</sup>

**Abstract:**

*An econometric model of the mutual influence of the credit market and main macroeconomic indicators of the Russian economy is discussed.*

*The obtained results show that the credit market has an obvious positive impact on the economic growth. Applying the model also made it possible to estimate the impact of gross domestic product (GDP) growth on the credit market.*

*The results have shown that GDP is a real driver of the credit market growth and its impact on the credit market considerably exceeds the influence of the existing credit market on the economic growth.*

**Keywords:** *Credit market, nominal and real gross domestic product (GDP), rate of real GDP growth, loans to non-financial organizations, loans to households, nominal and actual level of loans, rate of loans growth, Vector AutoRegression (VAR).*

**JEL Classification:** *G0, E44, O16.*

---

<sup>1</sup>Financial University under the Government, Moscow

<sup>2</sup>Financial University under the Government, Moscow, [nbrovkina@inbox.ru](mailto:nbrovkina@inbox.ru)

## 1. Introduction

A loan mediates a more rapid and efficient introduction of investments and helps to accelerate the turnover of funds. Using the VARX (p, q) open model of the Vector AutoRegression (VAR), it was determined that the growth rate of loans provided to non-financial organizations and households had a positive effect on the GDP growth rate (Byvshev and Brovkina, 2017; Makhdieva 2017; Natocheeva *et al.*, 2017). The study was based on the approaches known since the ISLM statistic Keynesian model of the aggregate demand introduced in the famous work of J. Hicks (Hicks, 1937). It remains an obligatory means of a high-quality discussion of the monetary theory (Mishkin, 2009).

By using the VARX (p, q) of the Vector AutoRegression, we investigate the mutual influence of GDP on the change in loans volumes, on the one hand, and loans provided to non-financial organizations and households on GDP, on the other hand. In the model under consideration, there are both lag endogenous variables, and current and lag exogenous variables as predefined variables. The use of such models for empirical research of cause-effect relations in macroeconomics and management estimation was promoted by Christopher Sims, a Nobel Prize winner (Sims, 1980; 1982; 2004; 2006).

## 2. Analyzing Indicators of the VARX Model (p, q) of the Vector AutoRegressive to Assess the Mutual Influence of GDP and Credit Market

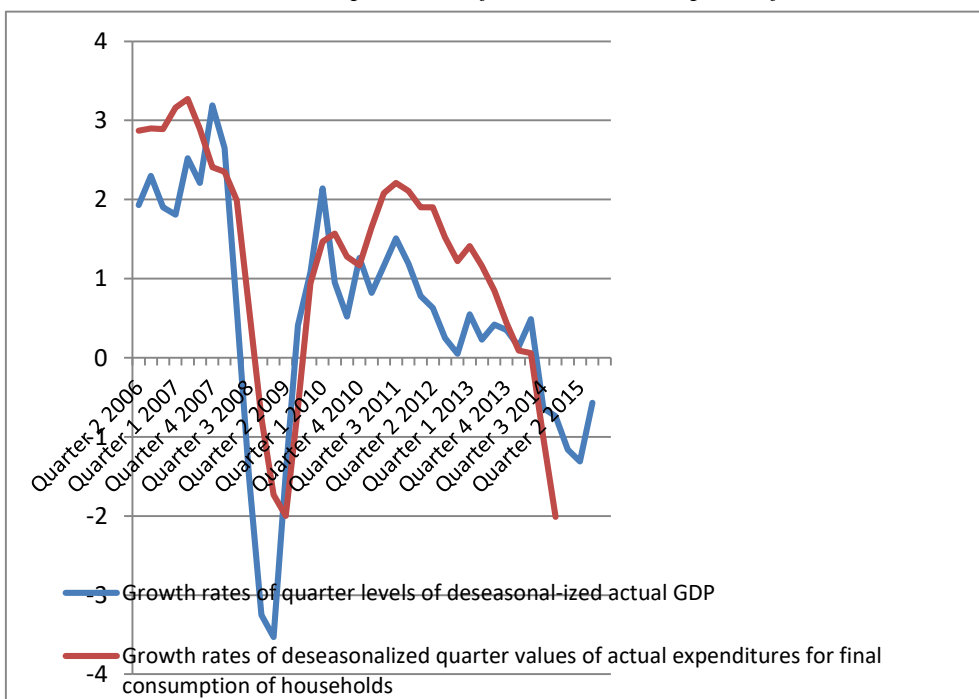
Using the deflator of the GDP value, expenditures for the final consumption of households, loans are transformed to comparable values, i.e. the nominal values have been converted into the actual ones. The variables put to a real form – deseasonalized GDP values, expenditures for the final consumption of households, loans to non-financial organizations and households - do not have a constant average level, change over time, i.e. they are non-stationary time series (Byvshev, 2008).

Non-stationary time series cannot be applied in the model if they are not co-integrated. Therefore, it is necessary to use the Box-Jenkins methodology to obtain a stationary series using the functional of consistent difference. In our case the growth rates of the indicators under consideration have the meaning of the values of relative differences. The graphs (Figures 1, 2) confirm that the dynamics of the growth rates of deseasonalized quarter levels of the real GDP, the deseasonalized quarter values of real expenditures for the final consumption of households in Russia, the growth rates of quarter values related to the loans provided to non-financial organizations and households are stationary ranks.

Indicators of the economic growth and credit market were chosen as referable variables (current endogenous variables) (Boldacchino *et al.*, 2017):

- ✓ Growth rate  $y_{1t}$  of deseasonalized quarter levels of the real GDP of Russia;
- ✓ Growth rate  $y_{2t}$  of deseasonalized quarter real expenditures for the final consumption of households in Russia;
- ✓  $y_{3t}$  – quarter levels of the growth rate related to loans provided to households;
- ✓  $y_{4t}$  – quarter values of the growth rates related to loans provided to non-financial organizations.

**Figure 1.** Growth Rates (in %) of Quarter Values of Deseasonalized Real GDP and Deseasonalized Actual Expenditures for Final Consumption of Households



**Source:** Compiled by the authors based on the data of the Federal Service of State Statistics.

Using the referable variables, we create

$$y_t = (y_{1t}, y_{2t}, y_{3t}, y_{4t})^T \quad (1)$$

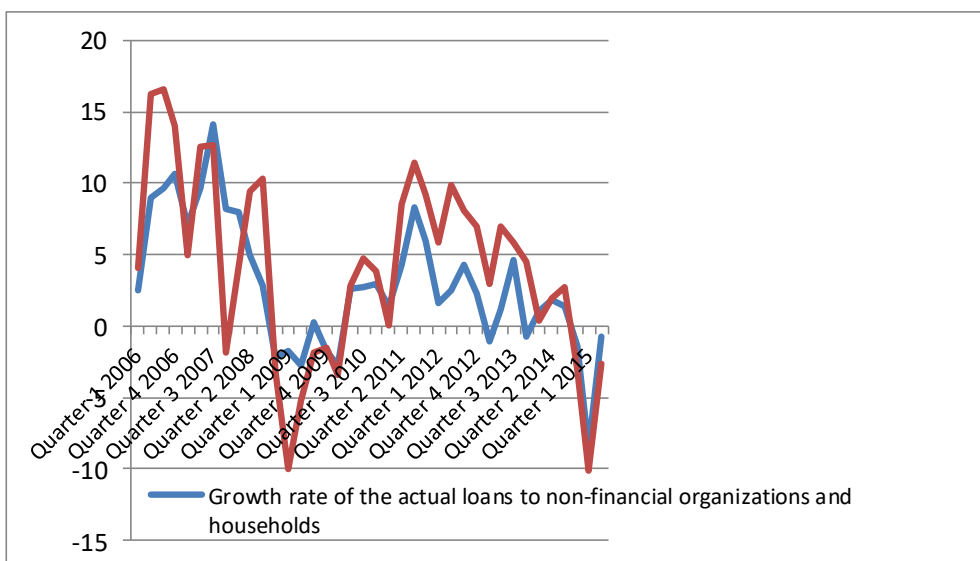
As a result of the preliminary calculations, the following three values were chosen as exogenous (explanatory) variables in the created model:

- 1)  $x_{1t}$  – binary fictitious variable of Western sanctions being available;
- 2)  $x_{2t}$  – binary variable of the world economic crisis in 2008-2009;
- 3)  $x_{3t}$  – quarter levels of the increase in the Brent oil price.

Using these variables, we create the vector of current exogenous variables:

$$x_t = (x_{1t}, x_{2t}, x_{3t})^T \quad (2)$$

**Figure 2.** Growth Rate (in %) of Quarter Levels of the Indebtedness on the Loans Actually Provided to Non-Financial Organizations and Households



*Source:* Compiled by the authors based on the data of the official website of the Bank of Russia.

### 3. Specification of the Model of Mutual Influence of the Credit Market and Real Economy of Russia

Preliminary studies make it possible to take the  $VARX(4,3)$  model as a variant of the  $VARX(p, q)$  model. It means that according to the assumption, lag values of the variables (1) with the maximum lag of 4 periods (4 quarters) and the values of exogenous variables (2) with the maximum lag of 3 quarters have an impact on the current levels of the variables (1) explained by the model.

Considering (1) and (2), the specification of the VARX model (4, 3) shortly looks like:

$$y_t = a_0 + A_1 y_{t-1} + A_2 y_{t-2} + A_3 y_{t-3} + A_4 y_{t-4} + B^{(0)} x_t + B^{(1)} x_{t-1} + B^{(2)} x_{t-2} + B^{(3)} x_{t-3} + u_t \quad (3)$$

Here

$$a_0 = (a_{10}, a_{20}, a_{30}, a_{40})^T \quad (4)$$

is a vector of desired invariables; the symbol  $A_s = (a_{ij}^{(s)})$ , where  $s = 1, 2, 3, 4$ , denotes the square matrices  $4 \times 4$  of the required coefficients for the lagged endogenous variables  $y_{t-s}$ :

$$y_{t-s} = (y_{1t-s}, y_{2t-s}, y_{3t-s}, y_{4t-s})^T \quad (5)$$

symbols  $B^{(s)} = (b_{ij}^{(s)})$ , where  $s = 0, 1, 2, 3$ , are the  $4 \times 3$  matrices of the desired coefficients for current (2) and lag (6) exogenous variables

$$x_{t-s} = (x_{1t-s}, x_{2t-s}, x_{3t-s})^T \quad (6)$$

and finally,

$$u_t = (u_{1t}, u_{2t}, u_{3t}, u_{4t})^T \quad (7)$$

is a vector of random disturbance reflecting the impact on the levels of variables (1) of factors that are not taken into account in the model. This is a detailed specification of equation 3 let's say (3)':

$$\left\{ \begin{array}{l} y_{it} = a_{i0} + \sum_{j=1}^{j=4} a_{ij}^{(1)} \cdot y_{jt-1} + \sum_{j=1}^{j=4} a_{ij}^{(2)} \cdot y_{jt-2} + \sum_{j=1}^{j=4} a_{ij}^{(3)} \cdot y_{jt-3} + \\ \quad + \sum_{j=1}^{j=4} a_{ij}^{(4)} \cdot y_{jt-4} + \sum_{j=1}^{j=3} b_{ij}^{(0)} \cdot x_{jt} + \sum_{j=1}^{j=3} b_{ij}^{(1)} \cdot x_{jt-1} + \\ \quad + \sum_{j=1}^{j=3} b_{ij}^{(2)} \cdot x_{jt-2} + \sum_{j=1}^{j=3} b_{ij}^{(3)} \cdot x_{jt-3} + u_{it}; \\ \quad \quad \quad i = 1, 2, 3, 4. \end{array} \right. \quad (3)'$$

It is known that if in the model of equation (3) the components of all vector variables  $y_t$  and  $x_t$  are stationary time series (in our case this is true for the variables  $y_{1t}, y_{2t}, y_{3t}, y_{4t}, x_{3t}$ , consistent estimates of all parameters of this model are made by the method of least squares, and all standard tests are correct (Verbeek, 2004). At the same time, each model equation can be estimated independently from others (Verbeek, 2004; Slepov et al., 2017; Allegret et al., 2016).

#### 4. Estimated Model of Mutual Influence of the Credit Market and Real Economy of Russia

It is necessary to emphasize that all referable variables found in the estimates of the equations are significant. Recognized by the  $t$  – test as insignificant, the predefined variables are removed when making the model. Every equation of the estimated model has successfully passed all standard econometric tests. Below there are the estimates of the equations (3)' of the model (3) and the characteristics of the quality of the equations' specification – the coefficients of  $R^2$  determination (the volatility share of the endogenous variable of the equation explained by the volatility by predefined variables of this equation) and estimates of standard deviations of random disturbances.

**The first equation:** *The impact of the growth rate of the indebtedness on the loans is distributed to non-financial organizations and households on the real GDP growth rate.*

$$\left\{ \begin{array}{l} y_{1t} = 0,46 \cdot y_{1t-1} + 0,05 \cdot y_{4t-1} + 0,35 \cdot y_{1t-3} - 0,08 \cdot y_{2t-3} + 0,01 \cdot y_{3t-3} \\ \quad - 2,5 \cdot x_{2t} + \\ \quad + 0,026 \cdot x_{3t} - 1,0 \cdot x_{1t-1} + 0,8 \cdot x_{1t-2} + \\ \quad + 1,9 \cdot x_{2t-3} + u_{1,t}; \\ \sigma_{u_1} = 0,34\%; R^2 = 0,966. \end{array} \right. \quad (8)$$

The available statistical information (Table 1) made it possible to find a meaningful positive impact (with one quarter lag) of the actual loans provided to non-financial organizations on the real GDP growth rate. The growth of the actual loans to non-financial organizations by 1% increases the real value of GDP (for fixed values of other predefined variables) by 0.05% in the 1st quarter. This is almost twice more than the impact of the oil price growth. An increase in the price for oil in the current period by 1% increases the country's GDP by 0.026%. Loans to households also have (with three quarters lag) a little incentive effect on the real GDP. The increase in actual loans to households by 1% increases (under fixed values of other predefined variables) the real GDP by 0.01% in 3 quarters.

The world economic crisis in 2008-2009 had a significant negative impact on the growth rate of real GDP. In the current period, GDP decreased by 2.5%. However, in 3 quarters its impact on the growth rate of Russia's real GDP happened to be positive. GDP increased by 1.9%.

The sanctions of Western countries affect the growth rate of real GDP with one quarter lag. In the current period, GDP decreased by 1.0%. However, in 2 quarters the impact of sanctions on the growth rate of Russia's real GDP happened to be positive. GDP grew by 0.8%.

**Table 1.** The Current Values of the Model Variables (3)

Year/quarter	$y_{1t}$	$y_{2t}$	$y_{3t}$	$y_{4t}$	$x_{1t}$	$x_{2t}$	$x_{3t}$
2003QII	1.12	-0.11	31.91	10.62	0	0	-14.86
2003QIII	1.69	1.61	19.57	9.66	0	0	4.28
2003QIV	1.82	3.85	14.21	6.70	0	0	3.14
2004QI	1.88	8.70	14.31	4.40	0	0	13.38
2004QII	1.93	1.73	21.82	7.88	0	0	8.43
2004QIII	1.51	2.39	16.91	8.00	0	0	14.54
2004QIV	1.12	3.07	17.39	10.19	0	0	10.05
2005QI	1.75	1.58	2.50	-1.74	0	0	3.31
2005QII	1.52	4.82	16.32	5.55	0	0	6.43
2005QIII	1.76	2.79	21.50	7.01	0	0	19.21
2005QIV	2.06	4.18	18.60	4.26	0	0	-5.18
2006QI	1.93	-1.72	4.12	2.45	0	0	5.40
2006QII	1.93	6.39	16.22	9.01	0	0	11.36
2006QIII	2.30	1.92	16.58	9.67	0	0	0.03
2006QIV	1.90	4.80	14.00	10.68	0	0	-14.95
2007QI	1.81	-0.92	4.94	7.13	0	0	-3.10
2007QII	2.52	6.62	12.62	9.67	0	0	11.86
2007QIII	2.21	2.62	12.70	14.09	0	0	15.78
2007QIV	3.19	3.80	-1.84	8.22	0	0	20.42
2008QI	2.65	-1.69	4.17	7.99	0	0	8.04
2008QII	0.62	4.71	9.38	4.95	0	1	26.49
2008QIII	-1.49	2.79	10.28	2.82	0	1	-4.44
2008QIV	-3.25	0.17	-3.19	-2.24	0	1	-50.39
2009QI	-3.53	-7.33	-10.03	-1.71	0	1	-26.48
2009QII	-1.46	-0.86	-5.27	-2.74	0	1	38.18
2009QIII	0.41	-1.28	-1.87	0.22	0	0	14.31
2009QIV	1.08	2.08	-1.52	-1.75	0	0	11.54
2010QI	2.14	2.42	-3.39	-2.71	0	0	3.70
2010QII	0.95	2.27	2.82	2.62	0	0	-1.26
2010QIII	0.52	-0.44	4.74	2.72	0	0	-2.26
2010QIV	1.26	1.56	3.85	2.90	0	0	11.96
2011QI	0.82	1.03	0.09	1.42	0	0	10.46
2011QII	1.16	3.27	8.53	4.24	0	0	8.45
2011QIII	1.51	1.83	11.46	8.33	0	0	-12.28
2011QIV	1.19	2.03	9.23	6.00	0	0	5.06
2012QI	0.78	2.49	5.90	1.61	0	0	9.53
2012QII	0.63	1.80	9.92	2.48	0	0	-9.41
2012QIII	0.25	0.83	8.04	4.29	0	0	-1.20
2012QIV	0.05	2.25	6.93	2.31	0	0	-4.51
2013QI	0.55	-0.19	2.92	-1.08	0	0	7.18
2013QII	0.23	2.69	7.01	1.19	0	0	-0.30
2013QIII	0.42	0.98	5.87	4.61	0	0	12.53
2013QIV	0.35	-0.20	4.50	-0.71	0	0	-7.87
2014QI	0.14	0.13	0.39	1.09	0	0	1.21
2014QII	0.49	-0.62	1.91	1.81	1	0	4.73
2014QIII	-0.64	1.14	2.73	1.42	1	0	-5.30
2014QIV	-0.74	-0.62	-3.05	-1.41	1	0	-25.20
2015QI	-1.16	-8.61	-10.16	-8.55	1	0	-33.77
2015QII	-1.31	0.14	-2.63	-0.79	1	0	19.30

*Source:* Calculated by the authors.

Diagnostic procedures of equation (8) of the model (3) are carried out:

Equation 8.1. Figure 1.1 shows: 1) the graph of random balance  $\tilde{u}_{1t}$  in the estimated first equation (8) of the model (3); 2) the graph of the autocorrelation function (ACF) of balance  $\tilde{u}_{1t}$ ; 3) the graph of the particular autocorrelation function (PACF) of balance  $\tilde{u}_{1t}$ . This balance can be interpreted as white noise errors. The results of the Box-Ljung test (Nosko, 2011) confirm this conclusion:

*Box-Ljung test*

*data: eq1res*

$X\text{-squared} = 0.0029428, df = 1, p\text{-value} = 0.9567$

Equation 8.2. The results of the Breusch-Pagan-White test (Nosko, 2011) allow interpreting random disturbance  $u_{1t}$  in the first equation of the model (3) as homoscedastic:

*studentized Breusch-Pagan test*

*data: est3*

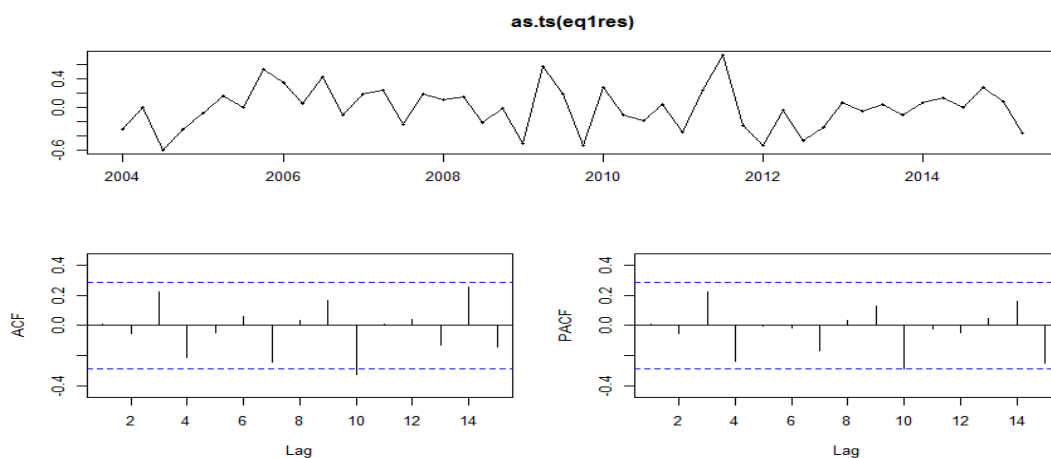
$BP = 6.5332, df = 9, p\text{-value} = 0.6856$

Equation 8.3. The results of the Breusch-Godfrey test (Nosko, 2011) confirm the results, i.e. they allow stating that there is no autocorrelation in random disturbance  $u_{1t}$  in the first equation of model (3):

*Breusch-Godfrey test for serial correlation of order up to 1 data: est3*

$LM\ test = 0.0030831, df = 1, p\text{-value} = 0.9557$

**Figure 1.1.** Graphs of Random Balance  $\tilde{u}_{1t}$  and its Functions ACF and PACF



Equation 8.4. The results of the Ramsey test (Nosko, 2011) allow stating the correctness of the specification of the first equation of model (3):



RESET test data: est3

RESET = 0.77832,  $df1 = 1$ ,  $df2 = 35$ ,  $p\text{-value} = 0.3837$

Equation 8.5. The results of the Shapiro-Wilk test (Royston, 1982) allow accepting the hypothesis about the normal law of distributing random disturbance in the equation (8) of model (3):

Shapiro-Wilk normality test

data: eq1res

$W = 0.98441$ ,  $p\text{-value} = 0.7874$

The equation (8) of model (3) has successfully passed all diagnostic procedures.

**The second equation:** *The impact of the growth rate of the indebtedness on the loans is distributed to non-financial organizations and households on the rate of growth of actual household expenditures for the final consumption.*

$$\left\{ \begin{array}{l} y_{2t} = 1,5 + 0,9 \cdot y_{1t-1} - 0,75 \cdot y_{2t-1} + 0,18 \cdot y_{3t-1} - 0,27 \cdot y_{4t-1} + \\ \quad + 1,6 \cdot y_{1t-2} - 0,4 \cdot y_{2t-2} - \\ \quad - 0,6 \cdot y_{2t-3} + 0,27 \cdot y_{4t-4} - 2,3 \cdot x_{1t} - 1,5 \cdot x_{2t} - \\ \quad - 0,06 \cdot x_{3t-2} - \\ \quad - 6,2 \cdot x_{1t-3} + u_{2,t}; \quad (9) \\ \sigma_{u_2} = 1,0\%; \quad R^2 = 0,90. \end{array} \right. \quad (9)$$

The estimation (9) of the second equation of model (3) revealed a significant positive impact of the growth rate of the indebtedness related to the loans actually provided to households on the second indicator of the economic growth in the country – the growth rate of real household expenditures for the final consumption. The increase in the actual loans to households in the previous quarter by 1% increases (under fixed values of other predefined variables) the final consumption of households on average by 0.18% in the current quarter. On the contrary, an increase in actual loans to non-financial organizations in the previous quarter by 1% decreases the actual final consumption of households by 0.27% in the current quarter. However, in four quarters, the growth of the actual loans to non-financial organizations by 1% increases the actual final consumption of households by 0.27% on average.

The western sanctions and the world economic crisis greatly affected the current actual level of the households' final consumption. Thus, the sanctions in the current period reduced this level by 2.7%, and in three quarters the sanctions decrease the actual household expenditures for the final consumption by 6.2%.

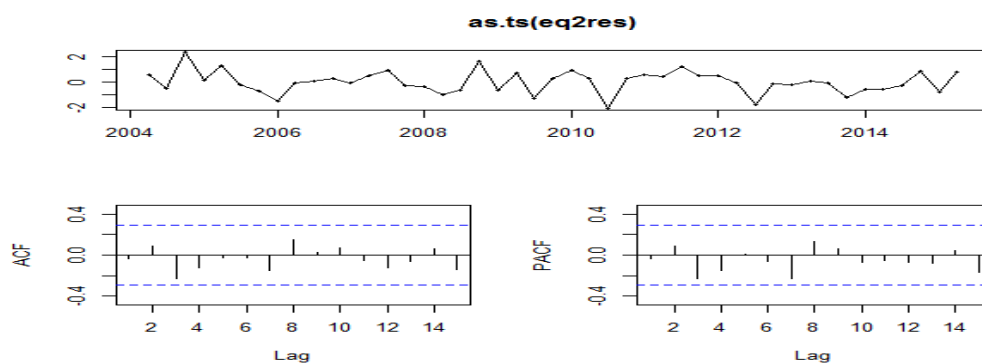
Diagnostic procedures of equation (9) of model (3):

Equation 9.1. Figure 2.1 shows 1) the graph of random balance  $\tilde{u}_{2t}$  in the estimated second equation (9) of model (3); 2) the graph of ACF of balance  $\tilde{u}_{2t}$ ; 3) the graph of the PACF of balance  $\tilde{u}_{2t}$ . It is possible to see that this balance can be interpreted as white noise errors, and in fact, the results of the Box-Ljung test confirm this conclusion:

*Box-Ljung test data: eq2res*

$X\text{-squared} = 0.047675$ ,  $df = 1$ ,  $p\text{-value} = 0.8272$

**Figure 2.1.** Graphs of Random Balance  $\tilde{u}_{1t}$  and its Functions ACF and PACF



Equation 9.2. The results of the Breusch-Pagan test allow interpreting random disturbance  $u_{2t}$  in the second equation of model (3) as homoscedastic:

*studentized Breusch-Pagan test data: eq2est5*

$BP = 8.3665$ ,  $df = 12$ ,  $p\text{-value} = 0.7559$

Equation 9.3. The results of the Breusch-Godfrey test allow stating that there is no autocorrelation in random disturbance  $u_{2t}$  in the second equation of model (3):

*Breusch-Godfrey test for serial correlation of order up to 1 data: eq2est5*

$LM\ test = 0.061731$ ,  $df = 1$ ,  $p\text{-value} = 0.8038$

Equation 9.4. The results of the Ramsey test make it possible not to reject the hypothesis about the correct specification of the equation (9) of model (3):

*RESET test data: eq2est5*

$RESET = 2.1242$ ,  $df1 = 1$ ,  $df2 = 31$ ,  $p\text{-value} = 0.155$

Equation 9.5. The results of the Shapiro-Wilk test allow accepting the hypothesis about the normal law of distributing random disturbance in equation (9) of model (3):

*Shapiro-Wilk normality test data: eq2res*

$$W = 0.99157, p\text{-value} = 0.9837$$

Equation (9) of model (3) has successfully passed all diagnostic procedures.

**The third equation:** *The impact of the growth rate of real GDP on the rate of growth of the indebtedness of the loans is distributed to households.*

$$\begin{cases} y_{3t} = 2 \cdot y_{1t-1} + 0,5 \cdot y_{3t-1} - 1 \cdot y_{4t-1} + 3 \cdot y_{1t-2} - 0,6 \cdot y_{2t-2} - \\ -0,25 \cdot y_{3t-3} + 0,6 \cdot y_{3t-4} - 10 \cdot x_{2t-1} - 6 \cdot x_{1t-2} + 16 \cdot x_{2t-2} - \\ -0,2 \cdot x_{31t-2} - 4,5 \cdot x_{2t-3} + 0,1 \cdot x_{3t-3} + u_{3,t}; \\ \sigma_{u_2} = 3,2\%; R^2 = 0,93. \end{cases} \quad (10)$$

The estimation (10) of the third equation of model (3) showed an exceptionally strong positive impact of the change in the country's real GDP during two preceding quarters on the level of household loans in the current quarter. The real GDP growth of the country in the previous quarter by 1% increases (under fixed values of other predefined variables) the level of real household loans in the current quarter by 2% on average, and by 3% in two quarters.

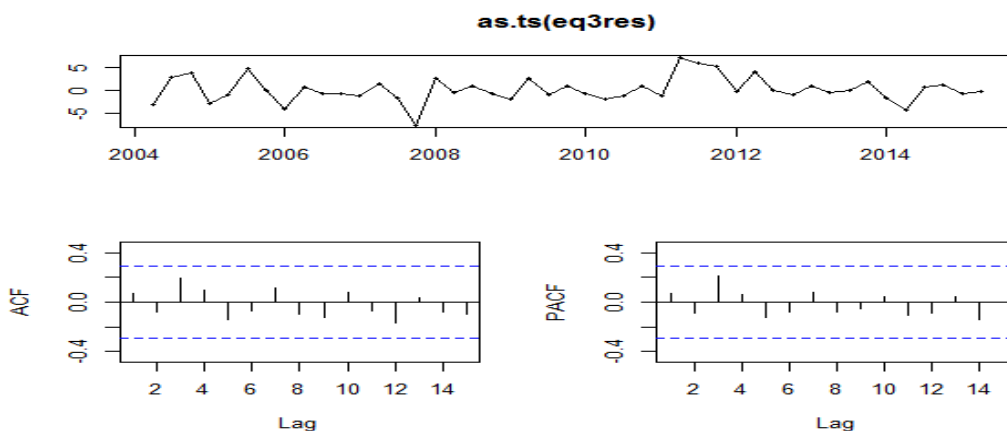
Diagnostic procedures of equation (10) of model (3):

Equation 10.1. Figure 3.1 shows: 1) the graph of random balance  $\tilde{u}_{3t}$  in the estimated third equation (10) of model (3); 2) the graph of ACF of balance  $\tilde{u}_{3t}$ ; 3) the graph of PACF of balance  $\tilde{u}_{3t}$ . This balance can be interpreted as white noise errors. The results of the Box-Ljung test confirm this conclusion:

*Box-Ljung test data: eq3res*

*X-squared = 0.2614, df = 1, p-value = 0.6092*

**Figure 3.1.** *Graphs of Random Balance  $\tilde{u}_{3t}$  and its Functions ACF and PACF*



Equation 10.2. The results of the Breusch-Pagan test allow interpreting random disturbance  $u_{3t}$  in the third equation of model (3) as homoscedastic:

*studentized Breusch-Pagan test data: eq3est4*  
*BP = 8.7009, df = 12, p-value = 0.7282*

Equation 10.3. The results of the Breusch-Godfrey test make it possible to state that there is no autocorrelation in random disturbance  $u_{3t}$  in the third equation of model (3):

*Breusch-Godfrey test for serial correlation of order up to 1 data: eq3est4*  
*LM test = 0.42296, df = 1, p-value = 0.5155*

Equation 10.4. The results of the Ramsey test make it possible not to reject the hypothesis about the correct specification of the equation (10) of model (3):

*RESET test data: eq3est4*  
*RESET = 0.26931, df1 = 1, df2 = 31, p-value = 0.6075*

Equation 10.5. The results of the Shapiro-Wilk test allow accepting the hypothesis about the normal law of distributing random disturbance in the equation (10) of model (3):

*Shapiro-Wilk normality test data: eq3res*  
*W = 0.95907, p-value = 0.1126*

Equation (10) of model (3) has successfully passed all diagnostic procedures.

**The fourth equation:** *The impact of the growth rate of the real GDP on the growth rate of the indebtedness on the loans is distributed to non-financial organizations.*

$$\left\{ \begin{array}{l} y_{4t} = 2 \cdot y_{1t-1} - 0,9 \cdot y_{2t-1} + 0,3 \cdot y_{4t-1} - 0,5 \cdot y_{2t-2} - 0,3 \cdot y_{4t-2} + \\ + 2,8 \cdot y_{1t-3} - 0,8 \cdot y_{2t-4} + 0,3 \cdot y_{3t-4} - 4,7 \cdot x_{2t} + 7,5 \cdot x_{2t-2} - \\ - 5,5 \cdot x_{1t-3} + u_{4,t}; \\ \sigma_{u_2} = 2,2\%; R^2 = 0,89 \end{array} \right. \quad (11)$$

The estimation (11) of the fourth equation of model (3) also revealed strong positive impact on the change in the country's real GDP in the previous quarters on the level of actual loans to non-financial organizations in the current quarter. Thus, an increase in the real GDP in the previous quarter by 1% increases the average level of the indebtedness on the loans distributes to non-financial organizations in the current quarter by 2%, and by 2.8% in three quarters.

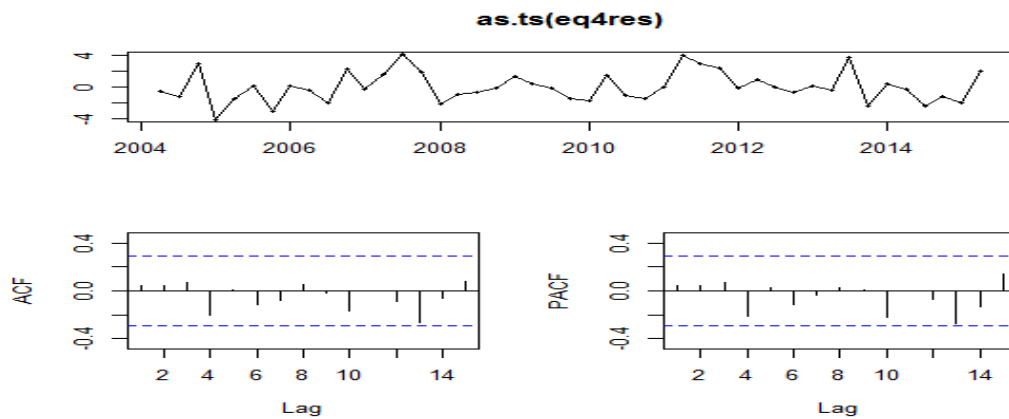
Diagnostic procedures of equation (11) of model (3):

Equation 11.1. Figure 4.1 shows: 1) the graph of random balance  $\tilde{u}_{4t}$  in the estimated third equation (11) of model (3); 2) the graph of ACF of balance  $\tilde{u}_{4t}$ ; 3) the graph of PACF of balance  $\tilde{u}_{4t}$ . The results of the Box-Ljung test confirm that this balance can be interpreted as white noise errors:

*Box-Ljung test data: eq4res*

*X-squared = 0.097949, df = 1, p-value = 0.7543*

**Figure 4.1.** Graphs of random balance  $\tilde{u}_{4t}$  and its Functions ACF and PACF



Equation 11.2. The results of the Breusch-Pagan test allow interpreting random disturbance  $u_{4t}$  in the fourth equation of model (3) as homoscedastic:

*studentized Breusch-Pagan test*

*data: eq4est4*

*BP = 5.1551, df = 13, p-value = 0.6186*

Equation 11.3. The results of the Breusch–Godfrey test allow stating that there is no autocorrelation in random disturbance  $u_{4t}$  in the fourth equation of model (3):

*Breusch-Godfrey test for serial correlation of order up to 1 data: eq4est4*

*LM test = 0.6207, df = 1, p-value = 0.6891*

Equation 11.4. The results of the Ramsey test make it possible not to reject the hypothesis about the correct specification of the equation (11) of model (3):

*RESET test data: eq4est4*

*RESET = 0.0087233, df1 = 1, df2 = 30, p-value = 0.6043*

Equation 11.5. The results of the Shapiro-Wilk test allow accepting the hypothesis about the normal law of distributing a random disturbance in equation (11) of model (3):

*Shapiro-Wilk normality test data: eq4res4*

*W = 0.97106, p-value = 0.3161*

Equation (11) of model (3) has successfully passed all diagnostic procedures.

## 5. Conclusion

All equations of the VARX model (p, q) of VAR have been successfully diagnosed, which allows us to consider the model and the conclusions based on it as adequate. The results obtained with the aid of the VARX (p, q) open model confirm the opinion about the necessity to achieve higher GDP growth rates because GDP is a real driver for the credit market growth.

At the same time, even though the structure of loans to non-financial organizations needs transformations, the credit market has an obvious positive impact on the economic growth. An increase in the indebtedness on the loans to non-financial organizations by 1%, increases the real GDP by 0.05% in the 1st quarter, which is two times higher than the impact of the oil prices' growth rate. The impact of the loans to non-financial organizations and households on the GDP growth would be greater if the investment loans dominated in the debt structure of non-financial organizations, and mortgage loans for purchasing real estate in new buildings were dominant in the structure of the household debt.

## References:

- Allegret, J.P., Raymond, H. and Rharrabti, H. 2016. The Impact of the Eurozone Crisis on European Banks Stocks, Contagion or Interdependence. *European Research Studies Journal*, 19(1), 129-147.
- Baldacchino, J.P., Camilleri, C., Grima, S., Bezzina, H.F. 2017. Assessing Incentive and Monitoring Schemes in the Corporate Governance of Maltese Co-operatives. *European Research Studies Journal*, 20(3A), 179-197
- Byvshev, V.A. 2008. *Econometrics*. Moscow, "Finansy and statistika", pp. 480.
- Byvshev, V.A. and Brovkina N.E. 2017. The impact of the credit market in the country's GDP. *Banking Services*, 4, 2-9.
- Hicks, J.R. 1937. Mr. Keynes and the "Classics": A Suggested Interpretation. *Econometrica*, 5, 147-159.
- Makhdieva, Y.M. 2017. Social/Economic Preconditions and Prospects for the Development of Education Insurance in Russia. *European Research Studies Journal*, 20(4A), 160-174
- Mishkin, F.S. 2009. *The Economics of Money, Banking and Financial Markets*, 9th Edition. Upper Saddle River N.J., Prentice Hall, pp. 706.

- Natocheeva, N.N., Rovensky, Y.A., Belyanchikova, T.V. and Rusanov, Y.Y. 2017. The Diversification of Banking Capital Sources and Cash Flow Granularity in Merger and Acquisition Transactions. *European Research Studies Journal*, 20(4A), 501-514.
- Royston, P. 1982. An extension of Shapiro and Wilk's W test for normality to large samples. *Applied Statistics*, 31, 115-124.
- Sims, C. 1980. Macroeconomics and Reality. *Econometrica*, 48(1), 1-48.
- Sims, C. 1982. Policy Analysis with Econometric Models. *Brooking Papers on Economic Activity*, 1, 107-164.
- Sims, C. 2004. Econometrics for Policy Analysis: Progress and Regress. *De Economist*, 152(2), 167-175.
- Sims, C. 2006. Rational Inattention: Beyond the Linear Quadratic Case. *The American Economic Review*, 96(2), 158-163.
- Slepov, V.A., Burlachkov, V.K., Danko, T.P., Kosov, M.E., Volkov, I.I., Ivolgina, N.V. and Sekerin, V.D. 2017. Model for Integrating Monetary and Fiscal Policies to Stimulate Economic Growth and Sustainable Debt Dynamics. *European Research Studies Journal*, 20(4A), 457-470.
- Verbeek, M. 2004. *A Guide to Modern Econometrics*, 2nd Edition. Chichester, Wiley, pp. 446.