

WORKING PAPER
Credit Risk Model
on the Example of the Commercial Banks
of the Kyrgyz Republic

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Working Paper of the National Bank of the Kyrgyz Republic

Credit Risk Model of the Example of the Commercial Banks of the Kyrgyz Republic

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The views represented in this paper belong completely to the author and do not compulsory reflect the viewpoint of the National Bank of the Kyrgyz Republic.

Summary

The research results of the macroeconomic factors influence on the quality of the credit portfolio in the banking sector of the Kyrgyz Republic are represented in this paper.

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Key words: credit risk, non-performing loans, stress testing, banking sector.

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Introduction

The analysis and assessment of the loan portfolio quality (credit risk) in the banking sector is one of the main and important elements of macroprudential analysis and banking regulation. The analysis of the relationship between the key macroeconomic factors and the quality of the loan portfolio of the banking sector contributes to a better understanding of cross-sectoral dependencies in the economy, as well as to identification of the strengths and vulnerabilities in the financial sector.

At present, one of the most significant risks in the banking sector of the Kyrgyz Republic is the credit risk, which is due to a high share of lending operations in the total assets of the banking sector (on average more than 50 percent for 2010-2015). At the same time, the quality of these loans deteriorated in various crisis periods. Thus, at the height of the crisis in 1998-1999 the share of non-performing loans³ (NPL) in the aggregate loan portfolio of the banks in Kyrgyzstan was almost 31 percent, and in 2010, the share of non-performing loans reached almost 16 percent. These facts substantiate the relevance of developing a credit risk model for the commercial banks.

There are two main types of models used in modeling the credit risk of the banking sector. *The first type* is based on assessing the risk profile of the individual borrowers and is applied in the daily work of the commercial banks, which can be described as a model of individual credit risk or a structural model of credit risk. It should be noted that even with such modeling options, macroeconomic indicators can be used as explanatory variables to avoid problems of procyclicality in credit risk assessment. *The second type* of the credit risk models is based on macroeconomic modeling of the credit risks. The main purpose of the models of this type is to assess the changes in the credit risk exposure at the aggregated level, as well as the use of this exposure in assessment of the systemic risk. In our case, the model type based on macroeconomic modeling of the credit risk was also chosen.

In the presented working paper, *the object* of study is the commercial banks of the Kyrgyz Republic. *The subject of study* is the systemic and individual credit risks of the commercial banks of the Kyrgyz Republic, their factors and consequences of implementation.

The main *objective* of this working paper is to develop a model of the credit risk on the example of the commercial banks of the Kyrgyz Republic.

To achieve this objective, the following *task* has been set: to identify the correlation between the real sector of the economy and the banking sector and their quantification.

³ According to the Regulation of the National Bank of the Kyrgyz Republic “On classification of assets and related allocations to the loan loss provisions” dated July 21, 2004, No. 18/3, the non-performing loans include loans classified as substandard, doubtful, and losses.

The structure of the working paper is as follows: the first chapter presents a review of the scientific literature on modeling the credit risk and identifies the main macroeconomic factors that affect the quality of the banks' loans. The second chapter describes the data used, the methodology and specification of the model, as well as the results obtained.

1. Review of literature on modeling the credit risk

For the purpose of the scientific substantiation of the credit risk model, the literature and international experience were reviewed on the example of the commercial banks of the Kyrgyz Republic.

Currently, majority of the banking crisis studies are based on the use of panel data in modeling the impact of macroeconomic variables on the credit risk.

Podlich, Illyasov, Tsoy and Shaikh (2010), Kazarian, Ferrarier et al. (Financial Sector Assessment Program 2015), Grigorain, Melecky et al. (FSAP, 2016) concentrate their attention on the republics of the former Soviet Union, Pesola (2005) – on the Scandinavian countries, Kalirai and Scheicher (2002) – on Austria, Virolainen (2004) – on Finland, Quagliariello (2004) – on Italy, Pain (2003) – on the UK, Glogowski (2008) – on Poland, Gersl, Jakubik, Konecny and Seidler (2013) – on the Czech Republic and Germany.

Podlich, Illyasov, Tsoy and Shaikh (2010) have developed a multifactor portfolio model of the credit risk that is used by the National Bank of the Republic of Kazakhstan during macro-stress testing of the banking sector of the Republic of Kazakhstan. This model is based on panel data and assesses the impact of macroeconomic parameters (oil price, nominal exchange rate, real GDP of Russia and Kazakhstan, production by the major industries of the economy: mining, manufacturing, construction and trade) on the banks' credit risk (for non-working loans).

In the Financial Stability Reviews of the Russian Federation (2012-2014), the Central Bank of the Russian Federation presents the results of the macro-stress testing of the banking sector in Russia, which is conducted using the macroeconomic model of the credit risk. The real GDP growth rate, the consumer price index, the value of a bi-currency basket (a basket of dollars and euros), the growth rate of foreign direct investment and the growth rate of real incomes of the population are used in modeling the banks' credit risk as a macro parameter.

Kazarian, Ferrarier et al. (2015), an econometric model of the credit risk, the results of which were used in the stress tests of the banking sector in Georgia, was developed within the framework of the International Monetary Fund's (IMF) and the World Bank's Financial Sector Assessment Program (FSAP). Real GDP growth and the nominal interest rate on the long-term loans were used as explanatory variables.

Grigorain and Melecky et al. (2016), within the framework of a similar FSAP program, developed a model of the credit risk, the results of which were used in the stress tests of the banking sector in Tajikistan. The authors came to the conclusion that the level of non-performing loans of the banking sector of Tajikistan is influenced by the real GDP growth, the exchange rate, the nominal interest rate on the long-term loans, CPI and remittances.

Gersl, Jakubik, Konecny and Seidler (2013) presented the current stress testing tool used by the National Bank of the Czech Republic to assess the financial sustainability of the banking sector in the Czech Republic. The model estimates the impact of macroeconomic indicators on the

level of default of the loan portfolio in the banking sector. The authors identified the following macro parameters as significant factors affecting the level of probability of default of the banking sector loan portfolio: the real GDP growth rate, the level of interest rates in the interbank market, the exchange rate (CZK / EUR).

Pesola (2001), using panel data, built an econometric model to assess the relationship between the dependent variable (losses on the banks' loans and corporate bankruptcies per capita) and the macroeconomic indicators. His results indicate that high corporate and household debt combined with negative macroeconomic shocks, such as increase of the interest rates above the expected value, or falls of GDP below forecasts, have become the causes of the banking crisis in the countries of North Europe.

Kalirai, Scheicher (2002) proposes a credit risk scheme in Austria that assesses the dependence of the share of loan loss provisions in the loan portfolio on such major macroeconomic variables as economic activity (GDP, unemployment, investment, bankruptcy, etc.), consumer price index, indicators of the households' state and the corporate sector, financial market indicators and foreign economic indicators. The following variables were defined as the final parameters that influence the change in the level of reserves in the banks' loan portfolio: industrial production, M1 monetary aggregate, IFO, short-term nominal interest rates (up to 3 months) and stock indices such as ATX, DAX and EuroSTOXX.

The macroeconomic model of the credit risk for Finland described by Virolainen (2004) has highlighted the relationship between the corporate sector default rate and the key macroeconomic indicators, including GDP, interest rates and corporate sector debt.

Pain (2003), in addition to the study of macroeconomic aggregate variables, analyzed such bank factor, as the loan portfolio, and its effect on the losses of the banks in the UK. The results of his work indicate that such macroeconomic variables as GDP growth, real interest rates and bank variables characterizing an increase in lending to risky borrowers influence the reserves on the banks' losses.

Quagliariello (2004) when studying the Italian banking system for the period from 1985 to 2002 has established how the economic environment affects the activities of the banks. Based on the modeling results, stress testing is conducted to assess the impact of macroeconomic shocks on the Italian banking system, in particular on the level of loss provisions and the share of non-performing loans.

Merton's single-factor model used by Jakubik and Schmieder (2008), provided an opportunity to assess the bank's credit risk in the corporate sector and the household sector in the Czech Republic and Germany. The authors came to the conclusion that the main macroeconomic determinants such as interest rates, exchange rates, inflation, GDP growth and the level of debt

load can result in a default probability for the corporate sector in both countries, with the exception of the household sector. In addition, macro-stress tests have shown that the effect of the macroeconomic shocks has a greater impact on the Czech Republic compared to Germany.

Generally, the studies examined confirm the hypothesis that the key macroeconomic factors influence the level of the credit risk (loan loss provisions and the share of non-performing loans). First of all, most studies show that GDP growth rates, interest rates and the level of debt load are the key factors in the credit risk.

2. Methodology and model results

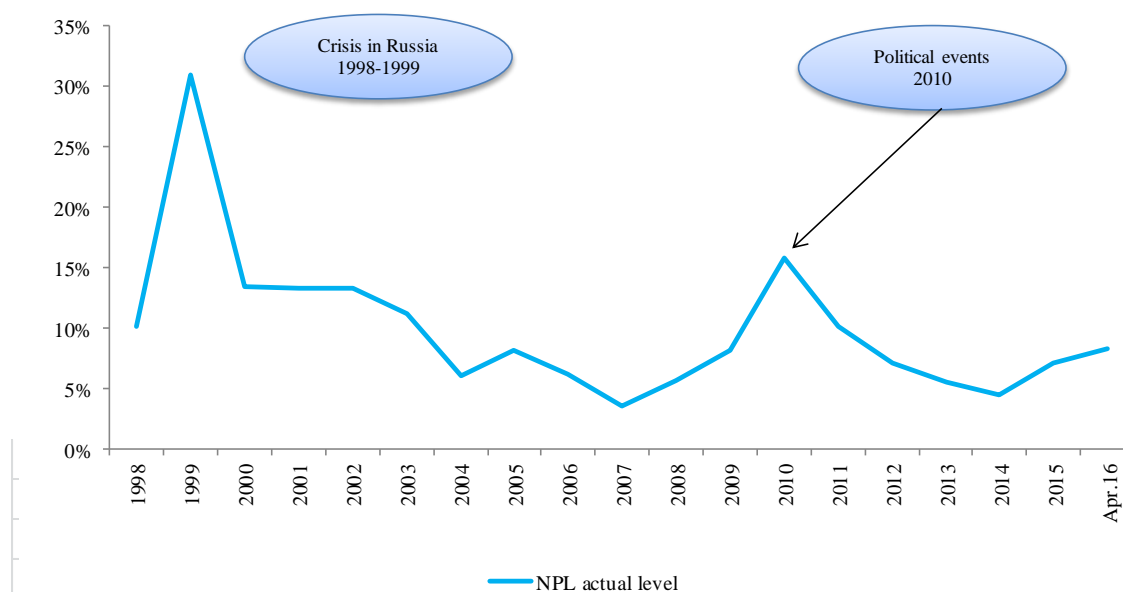
2.1. Data description

The quarterly data of the commercial banks of the Kyrgyz Republic for the period from 2003 to 2015 were used in order to conduct the analysis and to construct the regression. Statistical data of the commercial banks (on the bank (endogenous) variables), as well as data of the National Statistics Committee of the Kyrgyz Republic and the National Bank of the Kyrgyz Republic (according to the macroeconomic (exogenous) indicators) are the information base of the study.

Change in the trend of the share of non-performing loans in the aggregate loan portfolio of the banks from downward to upward will be considered as the identifiable event that reflects the implementation of the systemic credit risks of the banking sector. Meanwhile, we will consider an increase in the share of non-performing loans by more than one percentage point throughout the year (Chart 1) as the stable positive trend.

It should be emphasized that improving the borrower's creditworthiness and writing off bad loans can cause a decrease in the share of non-performing loans. Therefore, in order to obtain more accurate estimates, not absolute values were used, and the share of non-performing loans in the aggregate loan portfolio of the banks was expressed in percent.

Chart 1. Dynamics of the share of non-performing loans in the banking sector of the Kyrgyz Republic



Source: Bulletin of the National Bank of the Kyrgyz Republic

Real GDP growth, interest rates on loans, inflation and exchange rates were used as explanatory macroeconomic variables.

Real GDP growth and interest rates on loans are the most significant explanatory indicators in this model, while the exchange rate and inflation have a relatively weak effect on the share of non-performing loans. GDP is one of the important indicators of the economic activity in the country. As a rule, an increase or decrease in the GDP growth rate has an impact on the credit risk. For example, the profitability of the corporate sector and the household sector decreases, unemployment increases as a result of lower economic activity, which, in turn, leads to deterioration in the quality of the bank's loan portfolio. The growth of interest rates on loans affects the quality of the loan portfolio in a similar way, increasing the costs of the corporate sector and the households for servicing the loan.

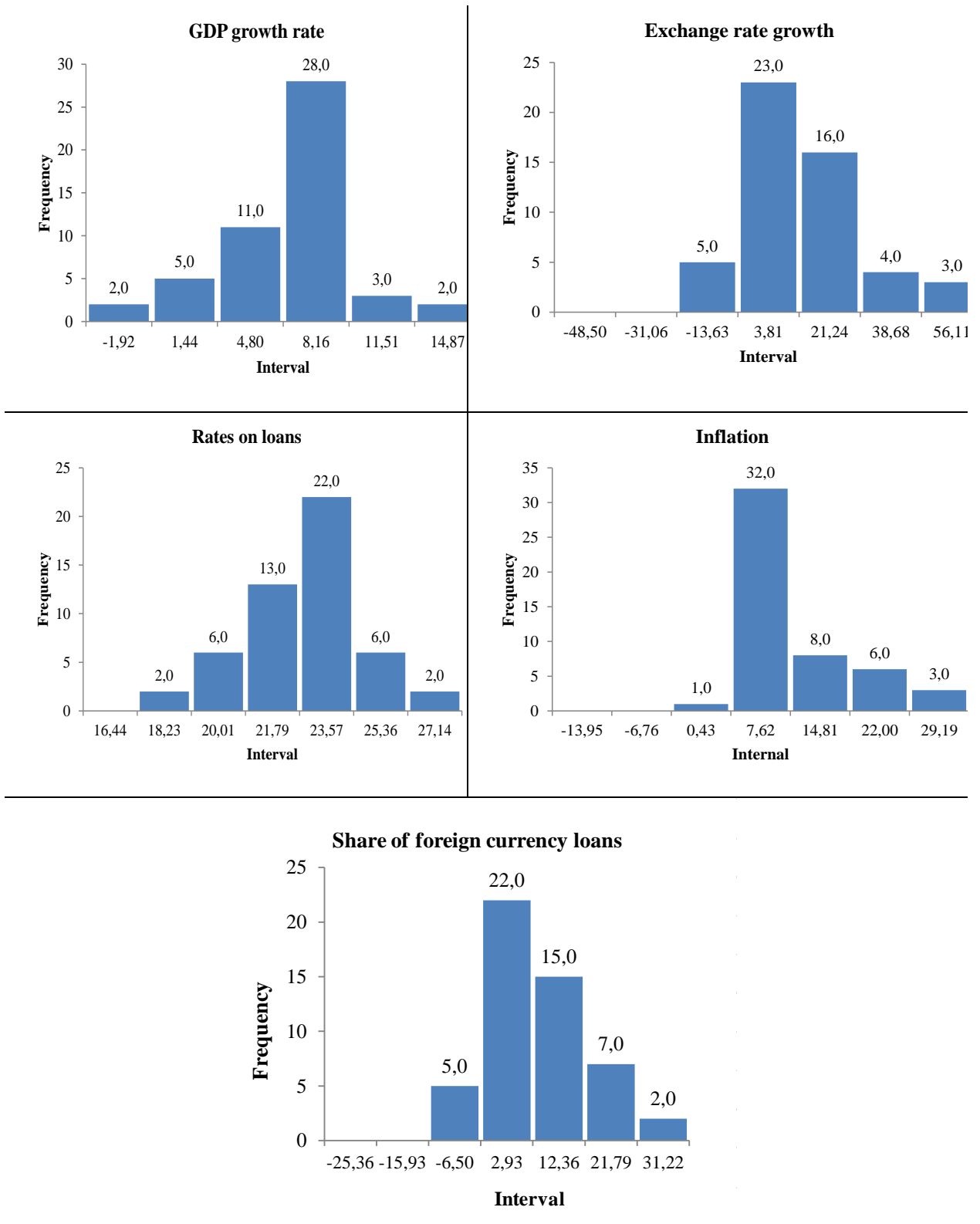
The lags of some of variables used are also included in the model of credit risk on the example of the commercial banks of the Kyrgyz Republic. The lags in the explanatory variables take into account the degree of possible delay with which macroeconomic shocks affect the banks. In other words, changes in the values of macroeconomic factors do not have an immediate impact on the position of the banks, however they are manifested after some time. It is necessary to identify such lags and take into account in order to form a more precise and complete picture of the impact of macroeconomic fluctuations on the banking sector.

Thus, the following factors were selected for modeling of the credit risk on the example of the commercial banks of the Kyrgyz Republic, taking into account the studied international experience:

1. Indicator of the level of economic activity in the country is the real GDP annual growth rate (excluding enterprises for the development of the Kumtor Mine).
2. The level of weighted average interest rates on loans in the national currency (from 1 to 3 years).
3. Consumer price index.
4. Growth of the national currency exchange rate against the US dollar.
5. Share of foreign currency loans in the aggregate loan portfolio of the commercial banks.

Let's consider the histograms of the macroeconomic variables distribution (absolute frequencies are given above the columns).

Chart 2. Histograms of the macroeconomic variables distribution



The histograms show that the distribution of the values of almost all macroeconomic variables, with the exception of the loan rates, is unsustainable. Therefore, we will use robust statistics instead of the traditional average and standard deviations for descriptive analysis. The descriptive table of robust statistics is given in Table 1.

Table 1. Descriptive statistics of explanatory variables

Factors	Designation	Median	Interquartile range	Minimum	Maximum
Real GDP	gdp_growth	5.582	3.032	-6.001	12.609
Exchange rate	exch_growth	2.682	14.734	-27.575	51.177
Interest rates on loans	ir_loans	22.236	2.156	17.611	25.63
Inflation rate	infl	5.73	5.332	-0.178	29.221

Based on the results of reviewing the literature on the issues of non-performing loans modeling, we made the following assumptions regarding the impact of macroeconomic factors on the share of non-performing loans (Table 2).

Table 2. Factors affecting the share of non-performing loans of the banks

<i>Factors</i>	<i>Expected sign (+/-)</i>
Real GDP growth	-
Growth of interest rates on loans	+
Exchange rate	+
Inflation rate	+

2.2. Model specification

The analysis of scientific literature on the subject showed that the overwhelming majority of experts develop a model based on the panel data when estimating the influence of macroeconomic factors on the credit risk. The final model used for estimating and forecasting the quality of the loan portfolio (level of credit risk) of the banking sector is as follows:

$$Y_{i,t} = \beta_0 + \beta_1 Y_{i,t-2} + \beta_2 gdp_growth_t + \beta_3 exch_growth_{t-1} + \beta_4 ir_loans_{t-1} + \beta_5 fx_loans_{i,t-2} + \beta_6 infl_t \quad (1)$$

where

$Y_{i,t}$ – the share of non-performing loans in the total volume of the loan portfolio, subjected to a logistic transformation in percent;

$Y_{i,t-2}$ – dependent variable with lag, in percent;

gdp_growth_t – real GDP growth excluding enterprises developing the Kumtor Mine, in percent;

$exch_growth_t$ – increase of the exchange rate (KGS / USD) in annual terms, in percent;
 ir_loans_t – interest rates on loans in the national currency (from 1 to 3 years), in percent;
 $fx_loans_{i,t}$ – the share of foreign currency loans in the total volume of the loan portfolio of the banks, in percent;

$infl_t$ – inflation rate, in percent;

i – bank;

t – quarter.

Due to the fact that the dependent variable is a *share* and all its values are within the range from 0 to 1, it must be stretched to the actual axis. To do this, we used a logistic transformation to establish a correspondence between the real axis and the segment [0, 1], and set by the formula:

$$Y_{it} = \ln\left[\frac{R_{it}}{1-R_{it}}\right] \quad (2)$$

where,

R_{it} – the share of non-performing loans in the total volume of the loan portfolio of a bank i at the time t .

2.3. Assessment results

Table 3 shows the results of the assessed model.

Table 3. Results of assessing the credit risk macroeconomic model of the Kyrgyz Republic

Factors	Designation	Lags	Coefficient	Standard mistake
Constant	C		-3.140***	0.481
Non-performing loans	Y	2	0.599***	0.026
Real GDP	gdp_growth		-0.024**	0.009
Exchange rate	exch_growth	1	0.004**	0.001
Interest rates on loans	ir_loans	1	0.078***	0.018
Inflation rate	infl		0.009**	0.004
Foreign currency loans	fx_loans	1	0.004***	0.002
R ²	0.716			
Standard mistakes of balances	0.708			
Darbyne-Watson's statistics	0.985			
Number of observations	739			
Number of cross-sections (banks)	16			

Note:

- a) The formula was assessed using the Panel Least Squares with Fixed Effects method based on quarterly data for the period from III quarter 2003 to the fourth quarter of 2015.
- b) Before the model was assessed, the data were cleared of seasonality using the CensusX12 algorithm and verified for stationarity using ADF and KPSS tests.
- c) ***, **, and * represent significance at 1, 5 and 10 percent, respectively.

Thus, the results of the econometric model indicate that the quality of the loan portfolio (credit risk) of the banks has sensitivity to the macroeconomic shocks. Growth of real GDP, exchange rate, inflation, interest rates on loans and foreign currency loans are statistically significant, and the signs of the coefficients of macro-parameters coincide with our proposed assumptions and are economically justified.

Conclusion

Review of existing literature has shown that in most studies of the central banks and international financial institutions dealing with problems of the financial stability in the banking sector, a panel approach to the construction of econometric models is used. Indeed, a panel combining the virtues of time series and spatial selections allows us to reveal more information about the interrelationships between modeled variables. Due to the panel regression it becomes possible to take into account the individual features of modeled banks, while revealing a general reaction to external shocks. According to the results of many studies, such macroeconomic factors as the level of interest rates, inflation, indicators of economic activity (GDP, production, unemployment, investment) and the exchange rate have a significant effect on the stability of the banking sector. Based on the review of literature and economic expectations, we believed that as a result of carried out modeling, a negative correlation would be found between an indicator of the share of non-performing loans and economic growth and the positive relationship between the share of non-performing loans and the exchange rate, inflation and interest rates.

In constructing the model of macroeconomic impact on the stability of the financial sector, we used an approach known as “panel regression with fixed effects”. This method allows analyzing the influence of time-varying factors (GDP, exchange rate, etc.) on the dependent variable. With panel regression with fixed effects, each cross-section object (in our case these are banks) is assumed to have some individual characteristics, a feature that does not change in time and unique to a particular bank. Using panel regression with fixed effects in our analysis allows us to divide the effect of macroeconomic variables on the share of non-performing loans of each bank into two components: one part is a general reaction of the entire banking system, and the second part is the individual reaction of the bank to shock, which takes into account its features, and is called an individual effect. One of the weaknesses of panel regression with fixed effects is the risk of receiving less reliable estimates in the event that the individual effects of the banks are somehow correlated with each other. However, the analysis of the structure of the banks included in the panel did not reveal a correlation sufficient to cause a decrease in the reliability of the estimates.

The results of panel regression estimation with fixed effects confirm our expectations. According to the estimated model, GDP growth has a statistically significant effect on the decline in the share of non-performing loans, while the growth of interest rates, inflation and exchange rate leads to an increase in the investigated indicator.

Thus, the results of the credit risk macroeconomic model suggested in this scientific study can be used in stress testing of the banking sector of the Kyrgyz Republic, in particular, to estimate the amount of potential losses (increase / decrease in the share of non-performing loans) and the

possible shortage of capital⁴ of the commercial banks and the banking sector as a whole in the case of implementation of certain stressful events.

⁴ Capital shortage means the amount of funds needed by the commercial banks to meet capital adequacy standards.

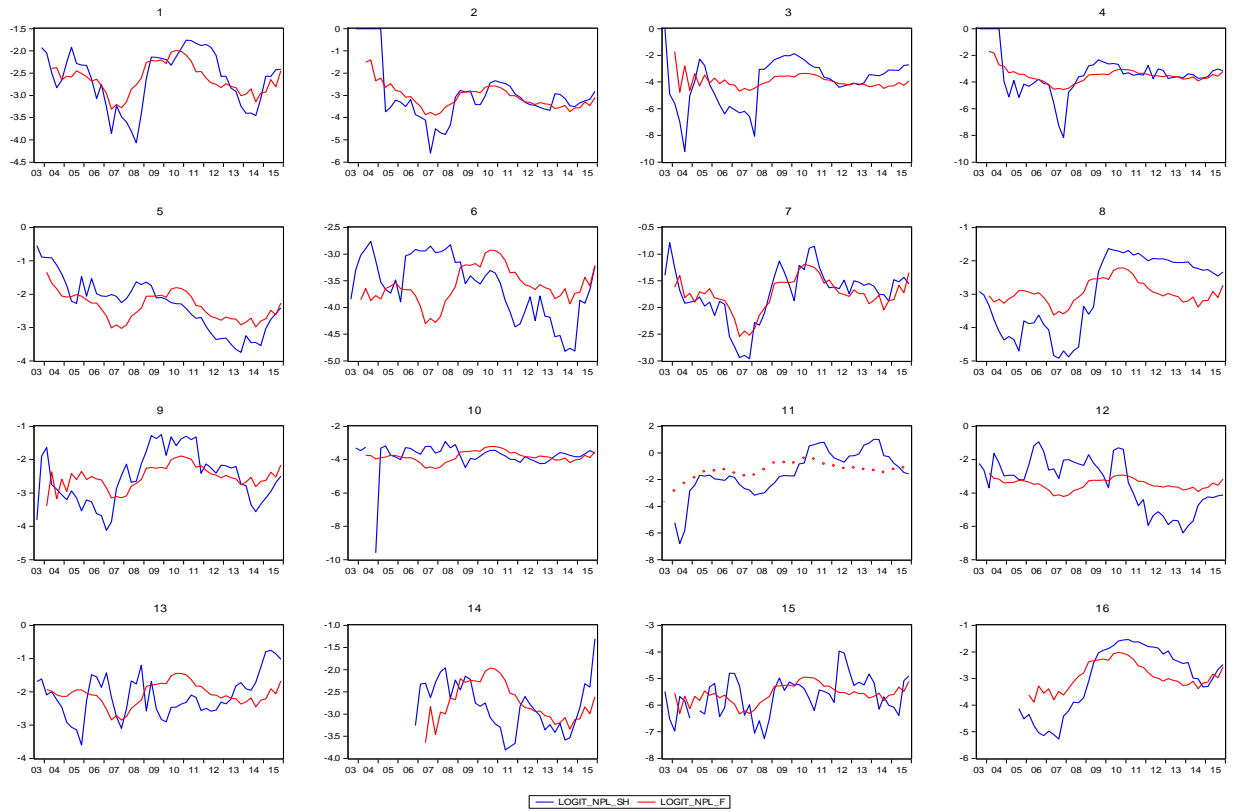
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Appendix

Appendix 1. Results of in-sample test



Appendix 2. Results of out-of-sample test

