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MACROECONOMIC AND BANK-SPECIFIC DETERMINANTS OF CREDIT RISK: EVIDENCE FROM RUSSIA

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Abstract

During the global financial crisis, the Russian banking system has experienced a significant increase in nonperforming loans. The Russian government has carried out massive recapitalization of major banks to maintain their stability. To evaluate the effectiveness of this policy it is necessary to identify the drivers of the credit risk increase in the affected banks. The main purpose of this research is to disentangle the influence of macroeconomic and bank-specific factors that led to the increase in the nonperforming loans of Russian banks. To address this research question we use both panel data econometrics and multivariate statistical analysis in order to mutually verify the results obtained using different methods. We find that most of the negative influence on the loan quality of the median Russian bank came from the deterioration of macroeconomic conditions. At the same time about 10 percent of banks were themselves to blame in a sharp increase in nonperforming loan ratio during the 2008 crisis. The obtained results have strong policy implications and highlight the importance of macroprudential regulation for enhancing financial stability of the Russian banking sector.

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Non-technical summary

During the global financial crisis, the Russian banking system has experienced a significant increase in nonperforming loans. The Russian government has carried out massive recapitalization of major banks (2.8% GDP in 2009) to maintain their stability. To evaluate the effectiveness of this policy it is necessary to identify the drivers of the credit risk increase in the affected banks. The main purpose of this research is to disentangle the influence of macroeconomic and bank-specific factors that led to the increase in the nonperforming loans of Russian banks.

To address this research question we apply multivariate statistical analysis (principal component analysis) to the bank level credit risk data. We extract first 3 factors (principal components) that capture 73% of the overall variance. This finding provides evidence in favor of macroeconomic factors that were the drivers of the overdue loans increase during the 2008-2010 crisis.

We estimate panel data econometric models explaining the dynamics of nonperforming loans. A wide range of independent variables that reflect macroeconomic conditions and specific business strategies of banks is used. We conduct factor decomposition of the fitted values of the dependent variable in the estimated specifications and compare the contribution of four groups of factors («macro+», «micro+», «macro-», micro-») before and at the peak of the crisis. The main result is that macroeconomic determinants were the most important for the median bank and this finding is robust to the specification of the econometric model. Thus, we point out that worsening of macroeconomic conditions in 2008-2009 made the prevailing contributions into problem loans increase of the median bank in Russia. However, this result is reversed for banks from 90-th percentile and higher, for which the role of micro-variables is predominant. Therefore, about 10 percent of banks were themselves to blame in a sharp increase in overdue loan ratio after the 2008 crisis.

The obtained results have strong policy implications and highlight the importance of macroprudential regulation for reducing procyclicality and enhancing financial stability of the Russian banking sector.

1. Introduction

During the global financial crisis, the Russian banking system experienced a significant increase in nonperforming loans. This caused a sharp rise of banks' loan loss reserves, reduced opportunities for banks to earn profits and exerted downward pressure on banks' capital adequacy ratio[1]. Under these conditions the Russian government has carried out massive recapitalization of the major banks to prevent decapitalization and maintain their stability. In 2008-2009 Vnesheconombank (Russian Development Bank), granted Russian credit institutions more than 400 billion rubles in the form of subordinated loans (tier 2 capital). Besides, the Bank of Russia provided Sberbank — the largest Russian bank — with a subordinated loan of 500 billion rubles. Together with an increase of government stake in the second largest bank VTB of the 180 billion rubles in 2009 total amount of state support came to more than 1 trillion rubles (2.8% GDP in 2009).

The question inevitably arises, how justified was the decision of Russian government to provide financial support to credit institutions? To evaluate the effectiveness of this policy it is necessary to identify the drivers of the credit risk increase in affected banks. In particular, state capital injections into banks with aggressive pre-crisis business strategies create distorting incentives for other banks and may lead to an exacerbation of the moral hazard in the middle-term perspective. On the contrary, government support is reasonable for those banks who suffered from the decrease in the quality of their loan portfolios mainly due to the worsening of macroeconomic conditions[2].

The main purpose of this research is to disentangle the influence of macroeconomic and bank-specific factors that led to an increase in nonperforming loans. To address the research question we use both panel data econometrics and multivariate statistical analysis in order to mutually verify the results obtained using different methods. Our main methodological framework involves estimation of

[1] The ratio of nonperforming loans to total loans increased from 2.4% in 2008Q2 to 9.6% in 2010Q1. Loan loss reserves to total loans ratio grew from 4.9% in 2008Q2 to13.9% in 2010Q2. Return on assets shrunk from 2.5% in 2008Q2 to 0.7% in 2010Q1.

[2] The mechanism of government support that is described above is suitable only for those cases when policymakers do not take into account consequences of individual bank failure, when the problems of one bank can spread throughout the system (via interbank market or payment system stop or as a result of bank panic in the deposit market). Under these conditions government will provide support only for those banks that are not guilty for the deterioration of their financial position. This condition is likely not satisfied in practice. That is why the model toolkit that is presented in the paper is not exhaustive in the real life decision-making (additional models are needed that test systemic importance of problem banks and calculate benefits and costs of its supporting).

panel data econometric models explaining the dynamics of nonperforming loans. A wide range of independent variables that reflect macroeconomic conditions and specific business strategies of banks is used. We divide the explained variance of the dependent variable into two parts: captured by macro- and micro- variables. In order to check robustness of the results a multivariate statistical analysis (principal component analysis) is applied to credit risk data on individual banks. We identify first 3 factors (principal components) and calculate which part of the total variance of the percentage of nonperforming loans these principal components can explain.

There are many studies considering determinants of credit risk at the level of individual banks. Most of them utilize data on the largest banks or on a representative sample of banks within one country (for example research on Italian, Indian, Greek, Spanish, Polish banks). A few papers consider cross-country data at the level of individual banks combining banking units of similar countries (geographically or economically) into one panel (GCC, MENA countries). Existing bank-level studies are aimed at identifying robust determinants of credit risk. This is important in terms of regulation design (for example, these studies found significant influence of bank competition, capitalization, diversification, regulation environment on the financial stability approximated by *ex post* credit risk). To the best of our knowledge the question of disentangling the relative importance of macro- and bank-specific factors of credit risk has not been raised yet.[3] However we believe that this question is of great importance in the context of last crisis that undermined stability of the banking system of Russia and other countries. Governments of affected countries spent considerable funds - about 5 percent of GDP on supporting the financial sector, as reported in Laeven and Valencia (2010). That is why the research is relevant in terms of fiscal cost savings arising from the bail out of troubled financial institutions in the future.

The remainder of the paper is structured as follows. Section 2 provides a literature review, Section 3 describes data set, Section 4 deals with preliminary analysis of the research question by means of the

[3] Except for Bercoff (2002) who, as reported in Dash and Kabra (2010), used survival analysis to separate influence of macroeconomic and bank specific factors of credit risk. Though, this paper was not published yet that's why it isn't publicly available now. We were not able to get acquainted with its results and methodology.

multivariate statistical analysis, Section 5 discusses econometric model specification and methodology, Section 6 presents estimation results and finally Section 7 concludes.

2. Related literature review

The accumulation of credit risk is the most important factor that may undermine stability of the financial sector in most countries (see e.g., Salas and Saurina, 2002). In developing countries, like Russia, financial system is mostly bank-based, and banks allocate the majority of assets in loans[4].

The empirical literature suggests that the excessive growth of distressed assets is a sign of an imminent banking crisis. For regulators aimed at ensuring financial stability it is important to predict and foresee the onset of a bad debt crisis and to identify its drivers. This encouraged a large number of empirical studies on the econometric analysis of the credit risk determinants.

Empirical studies on the determinants of credit risk can be divided into two main groups - studies at the level of the banking system as a whole (macroeconomic approach – see Hoggarth et al., 2005; Babihuga, 2007; Pesola, 2007), as well as studies at the level of individual banks (microeconomic approach – Jimenez and Saurina, 2005; Espinoza and Prasad, 2010; Quagliariello, 2007, etc.). Studies on macroeconomic or aggregate data are focused on exploring the relationship between aggregate measure of credit risk[5] and macroeconomic conditions using data in one country as in Hoggarth et al. (2005) or several countries – see Nkusu (2011). The resulting econometric models can be applied to top-down stress-tests[6] of the banking sector (see Hoggarth et al., 2005) or to investigate the feedback effects from aggregate credit risk to macroeconomic conditions (like Nkusu, 2011).

The other branch of empirical literature investigates the determinants of credit risk on the bank level data. These papers are of the most interest as they explain quality of loan portfolio of individual banks using microeconomic (bank level) and macroeconomic variables. This directly corresponds to the topic of our research. Bank-level studies at the level of individual banks differ in choosing the measure of

[4] The ratio of loans to assets in the Russian banking system exceeds 70 %
[5] Percentage of adversely classified loans in the consolidated loan portfolio of banking sector or aggregate default rate in the corporate sector
[6] Sorge (2004) provides a comprehensive review of stress-test methodologies

credit risk. The first indicator that is frequently used in empirical work is the ratio of loan loss provisions to total loan portfolio (see e.g. Quagliariello, 2007; Głogowski, 2008). Unfortunately, this measure has a high proportion of noise compared to the real size of the credit risk because of differences in management policies of banks over the business cycle. Another credit risk indicator is the percentage of adversely classified / nonperforming loans. This measure is most often used in empirical research on credit risk determinants (see Dash and Kabra, 2010; Louzis et al., 2011; Jimenez and Saurina, 2006; Boudriga et al., 2009; Salas and Saurina, 2002; Espinoza and Prasad, 2010). In Quagliariello (2007) the flow of new bad loans is also used instead of the commonly used stock measure. As noted by Quagliariello (2007) this indicator can be interpreted as a default rate. However the ratio of new bad loans (classified in the reference period) to the performing loans outstanding does not take into account recovery of loans that were adversely classified in the past. These drawbacks induced us to use the percentage of nonperforming loans or its' proxy as the dependent variable in our research.

The heterogeneity of both banks' borrowers (in terms of their creditworthiness) and banks' business strategies may result in different sensitivity of banks' credit risk to macroeconomic conditions. For example, the ratio of problem loans in savings and commercial banks in Spain has different sensitivity to GDP growth as pointed out in Salas and Saurina (2002). The same holds for consumer and corporate loans in Greece as recently stated by Louzis et al. (2011). However, most of the studies use a heterogeneous sample of banks controlling for banks' different strategies by means of dummy variables and taking into account the share of bank resources used in specific niches (retail, corporate lending etc.).

Most of the reviewed studies provide an empirical confirmation that bank credit risk depends on the riskiness of adopted business strategy (controlling for factors, common for all banks - systematic or macroeconomic). Indeed, even in the same macroeconomic environment banks have access to the borrowers of different credit quality depending on the bank's market power. Besides, the growth rate of loan issuance of particular bank depends on its risk appetite, quality of screening, etc. Banks' loan quality unevenness becomes evident during the periods of instability. For example, Salas and Saurina (2002) found that the dispersion of the problem loans ratio across banks rises substantially in the downward

phase of the business cycle.

The question of the importance of bank-level factors remains open because empirical research provide controversial evidence. On the one hand, Louzis et al. (2011) found that incorporation of bank-specific determinants helped to improve the explanatory power of credit risk model, which previously included only macroeconomic factors. Salas and Saurina (2002) studied whether microeconomic variables are significant in their problem loan equation by running an F-test that all these variables have coefficients equal to zero. They rejected the hypothesis and concluded that bank specific variables do matter. On the contrary, Klein (2013) when studying determinants of nonperforming loans in CESEE countries reported that bank-level factors only marginally contribute to the «within» explanatory power of the banks' loan quality model.

2.1. Macroeconomic determinants of credit risk

Most of the studies under review use GDP growth rates as the main indicator of macroeconomic conditions and debt sustainability of a wide group of borrowers. An increase in GDP growth rates translates into higher income and improves the debt servicing capacity of borrowers. This leads to lower credit risk of banks. A similar relationship holds for the unemployment rate as it reflects both households and firms income. Some papers include solvency indicators of individual economic agents: households, corporate sector (see Salas and Saurina, 2002; Głogowski, 2008) or central government (see Louzis et al., 2011).

Bank loan service cost at the level of the economy as a whole is usually approximated by the nominal or real short-term interest rates (most often – interbank rate – Hoggarth et al., 2005; Jimenez and Saurina, 2006; Głogowski, 2008). The rationale is the following: as noted in Bofondi and Ropele (2011), in most developed countries there is a large proportion of floating rate loans, interest rate on which is pegged to policy or interbank interest rate.

Some authors include asset prices (approximated by inflation rate, house price growth and stock market growth) to take into account influence of collateral inflation, asset bubbles and wealth effect on banks' credit risk – see Quagliariello (2007), Nkusu (2011).

In the studies on banking sectors of emerging markets the research stress the importance of taking into account foreign currency exposure because in these countries the confidence in the national currency can be limited in comparison to internationally recognized currencies (U.S. dollar, euro). This results in a large proportion of foreign currency loans. The credit quality of these loans is highly dependent on exchange rate dynamics. To catch this effect Głogowski (2008) and Dash and Kabra (2010) include the real or nominal exchange rate of national currency into their models of credit risk.

Macroeconomic variables are expected to have short-lagged influence on credit risk. For example, Salas and Saurina (2002) and Jimenez and Saurina (2006) included macro-level determinants contemporaneously as well as their one year lagged values to take into account the timing effect. Louzis et al. (2011) take macroeconomic variables with one and two quarter lags.

2.2. Microeconomic (bank-specific) determinants of credit risk

Existing studies consider the following list of bank-specific factors of credit risk: restrictiveness of banks' lending policy and risk appetite (approximated by loan or branch growth rates[7], lending rate, net interest margin, share of collateralized loans etc.), market power (approximated by market share or Lerner index), bank cost efficiency (measured by cost to income ratio or efficiency index), bank performance (profitability), loan portfolio and income diversification (measured by bank size as a proxy for loan portfolio diversification, Herfindahl or entropy indexes for revenue diversification and industry and region loan portfolio concentration), solvency ratio (capital adequacy ratio). Some papers also include bank profile and ownership structure dummy into credit risk equation.

The lending policy of bank is expected to be highly correlated with the credit risk indicators. The possible explanation of this phenomenon is the following: rapid loan growth is often accompanied by decreasing lending standards as it corresponds with the reduction in time dedicated to consideration of loan applications, decline in monitoring quality, etc. and after a time (often during an economic contraction) it may result in problem loans increase. Several empirical studies found significant influence of pre-crisis credit expansion on the size of nonperforming loans in the banking sector (see e.g.

[7] Głogowski (2008) points out that this indicator may be of limited usefulness because it may not reflect the accumulation of credit risk in case if level of financial depth was small at the starting point and economic agents rapidly increase use of financial services in an environment where access to them was limited before.

Quagliariello, 2007; Espinoza and Prasad, 2010; Jimenez and Saurina, 2005).

High level of lending rate and net interest margin can be a sign of deliberately risky credit policy (high *ex ante* credit risk, built in risk premium) that can lead to the rise of problem loans (*ex post* credit risk). Besides, an increase in interest rate raises debt service costs for borrowers thus leading to excess default rate. However, most papers didn't find significant influence of bank-level lending rate on its credit risk.

There is a large body of empirical literature that provide contradictory evidence on bank's market power – stability relationship («market power – fragility» hypothesis of Boyd and De Nicolo, 2005; «market power – stability» hypothesis of Keeley, 1990), where stability is approximated by different credit or aggregate risk measures. However, existing studies use data on different sets of countries and different measures of market power and risk. The most commonly used indicators of market power in bank-level panel studies are Lerner index and concentration ratio such as Herfindahl-Hirschman index (HHI). Individual bank risk is most often measured by the ratio of non-performing loans (NPL) to total loans, which is of primary interest in this research, and Z-scores in Roy (1952) methodology. The positive relationship between Lerner index and NPL as well as between HHI in loan (deposit) market and NPL are found in Berger et al. (2008) paper that partially confirms the «market power – fragility» view for the sample of 30 developed countries. From the opposite side, Jimenez et al. (2007) reveal the strong evidence in favor of the «market power – stability» nexus using the sample of Spanish banks.

There is no consensus in the literature on the relationship between credit risk and bank efficiency. On the one hand, high level of cost efficiency may reflect reduction of resources allocated to risk management and borrower's monitoring, thus leading to the loan quality deterioration (the «skimping» hypothesis, put forward by Berger and DeYoung , 1997). On the other hand, low cost efficiency is a sign of low quality of bank management, which is revealed in poor quality of loan portfolio (assumed that inefficient managers are unable to cope with the credit risk management – the so-called «bad management» hypothesis, Berger and DeYoung, 1997). Besides low values of this variable may induce banks to take on more risk in order to improve profitability at the expense of the quality of loan portfolio.

The investigation of causality direction between cost efficiency and nonperforming loans provide more empirical support for the «bad management» hypothesis (see Berger and DeYoung, 1997; Louzis et al., 2011; Quagliariello, 2007; Podriera and Weill, 2008).

A number of studies consider the influence of banks past performance measured by profitability (ROA – return on assets, ROE – return on equity) on future problem loans ratio. In particular, Quagliariello (2007) and Głogowski (2008) examine whether the «income smoothing» hypothesis holds. This hypothesis implies that banks earn more in time of the economic expansion in order to cushion inevitable deterioration of loans' quality during the contraction. If this proposition holds then lagged profitability should have positive influence on credit risk. Louzis et al. (2011) explain this phenomenon by «procyclical credit policy» hypothesis. The reasoning is that bank management aimed at increasing the banks' market share may inflate earnings by means of more liberal lending policy («negative NPL extension of credit») thus seeding the seeds of future problems. This hypothesis predicts positive sign of profitability influence on credit risk.

Empirical evidence suggests that diversification of both borrowers and income sources are effective means of lowering credit risk. First, involvement in the operations that are not associated with credit risk taking (payment transactions, broking, etc. – income diversification) allows banks to earn less risky income thus reducing incentives to finance speculative projects. Second, having opportunity to lend money to a diversified range of borrowers banks can successfully reduce their impaired loans (minimizing the risk of individual borrower). Salas and Saurina (2002) found empirical confirmation of the «borrower diversification» hypothesis.

It is widely accepted in the literature that low capital adequacy ratio is associated with higher probability of bank's default, because it may induce management to involve in more risky projects (the «moral hazard» hypothesis, Berger and DeYoung, 1997). The confirmation of this statement was found in Salas and Saurina (2002) and Berger and DeYoung (1997).

Głogowski (2008) puts forward the idea that the level of credit risk differs between types of loans and borrowers. It is obvious that banks' percentage of problem loans can be influenced by the

composition of its loan portfolio (weights of retail / corporate loans). Different types of borrowers have unequal debt sustainability under the same macro-environment *ceteris paribus*. For example, Louzis et al. (2011) report that the corporate loan default rates are more sensitive to the worsening of macroeconomic conditions. Głogowski (2008) outlines that in many countries mortgage loans exhibit lowest default rates. To take these differences into account Głogowski (2008) explores if bank business profile significant by introducing corresponding dummy variables (retail, corporate, universal banks, etc.) into equation.

The other important determinant of management quality and riskiness of the strategy is the type of bank ownership. Boudriga et al. (2009) found that foreign ownership has a positive impact on the loan quality as it promotes imports of human capital, management skills and technologies and provides opportunity to raise funds cheaply on international markets. State banks are reported to have more incentives to involve in risky projects since they are more prone to the «too big to fail problem». Micco (2004) investigated bank performance in 119 countries and concluded that state-owned banks in developing countries have higher ratio of nonperforming loans. However, Hu et al. (2004) found nonlinear U-relationship between problem loans and the percentage of government shareholdings in bank capital.

Głogowski (2008) proposed an idea of specific transformations of credit risk factors to improve their explanatory power. First, in this paper household income and debt sustainability characteristics were multiplied by individual bank's share of retail loans. This allowed taking into account individual bank's exposure to the particular source of risk. Second, Głogowski (2008) took bank-level loan growth and capital adequacy ratio in deviations from the sector median. These variable transformations helped to identify bank-specific type of risk excluding common for all banks effects.

Bank-level indicators are commonly included with at least one period lag to avoid endogeneity with the dependent variable. Louzis et al. (2011) include up to four quarter lags of bank-specific variables (except for the size of the bank and ownership structure dummy variables, which are taken contemporaneously). This allowed taking into account time delay between changes in management

policy and impact on the quality of loans. Salas and Saurina (2002) and Jimenez and Saurina (2006) used two, three and four year lags of bank-level credit growth. The aim was to take into consideration extended period between loan granting (which is most likely issued during the upward phase of the business cycle) and the default on loan (which often happens during the contraction). It is also noted in Salas and Saurina (2002) that if credit growth is lagged less than one year it could be spuriously correlated with the problem loans ratio through the denominator. That is why it is highly recommended to take more than one year lag of this variable.

3. Data description

3.1. Explanatory variables

Based on the overview of relevant empirical literature, we identify the following two groups of credit risk determinants (a detailed list of factors and expected sign of their influence see in the Appendix, Tables 2a-2b):

- macroeconomic factors:
    - the general state of the economy, households and firms debt burden and income;
    - price stability, collateral inflation;
    - exchange rate dynamics and balance of payment indicators;
- bank-specific factors:
    - lending policy characteristics;
    - interest rates on loans;
    - cost efficiency indicators;
    - income and customer diversification indicators;
    - market power index;
    - ownership / strategy dummy variables.

The indicators of Russian government debt sustainability were not taken into consideration in contrast to Louzis et al. (2011) study that tested whether the rise of sovereign debt of the Greek

government led to an increase in banks' nonperforming loans. One should note that Russian government has relatively low level of debt to GDP ratio in comparison with Greece and other OECD countries (Figure 1 in the Appendix). That is why risks originated from government finance deterioration were not investigated.

Russian banks issue a high proportion of foreign currency loans (before the 2008 crisis the share of foreign currency loans in total loans was about 20 percent). Borrowers' ability to repay these loans is highly sensitive to the ruble exchange rates dynamics (in particular, national currency depreciations noticeably affects debt burden and debt service costs for those borrowers that have high proportion of debt denominated in foreign currency thus increasing default rate on these loans). That is why following Głogowski (2008) nominal and real exchange rates dynamics were taken into empirical consideration. Besides, we tested the influence of the balance of payment sustainability indicators, as they could be the leading indicators of the currency market stress.

Performance indicators such as bank profitability (ROA, ROE) were not used in this study, as these measures are derivatives of cost efficiency and market power. That is why these three types of variables should be multicollinear. To avoid this statistical problem only cost efficiency and market power indicators were taken into consideration.

Following Maudos and De Guevara (2007) and Turk Ariss (2010), we use funding-adjusted Lerner index instead of conventional Lerner index to capture the effect of possible endogeneity between both market power originated from the liabilities side of banking activities and market power extracted from the assets side. Typically, dealing with the credit risk of Russian banks, we calculate funding-adjusted Lerner index only for the market of commercial loans at the bank-level for each period of time as the difference between the interest rate charged on loans and the sum of operating marginal cost with respect to loans and the average funding rate. The latter reflects our attempt to extend the approach of Maudos and De Guevara (2007) to the funding adjustments in Lerner index computation by replacing the interbank interest rate with the average funding rate. The key reason is that the interbank market doesn't

play such a crucial role in the Russian banking system (at least yet)[8] as it does in other countries, e.g. developed economies. The Lerner index can thus be written:

$$Lerner_{it} = \frac{r_{LNS,it} - AFR_{it} - MC_{LNS,it}}{r_{LNS,it}} \quad (1)$$

where $r_{LNS,it}$ is the estimated price for loans, AFR_{it} is the average funding rate and $MC_{LNS,it}$ proxies operating marginal costs with respect to loans. We estimate price for loans as the ratio of interest income on loans to total loans. Average funding rate is calculated as the ratio of total interest expense to total interest-bearing debt. We employ stochastic frontier analysis to a translog cost function in order to derive both $MC_{LNS,it}$ and bank-level efficiency scores (description of methodology is provided in the Appendix).

We use SFA index as the measure of bank total cost efficiency calculated on the basis of estimated total cost efficiency frontier (methodological details are given in the Appendix).

3.2. Dependent variable selection

As it was previously noted, the percentage of nonperforming loans[9] is supposed to be the dependent variable in the research. Unfortunately, Russian banks are not required to publish their financial accounts in line with international acoounting standards. Based on the Russian accounting standards it is impossible to estimate this indicator. Nevertheless, IMF considers the share of problem and bad loans[10] as the approximation for Russian banks' nonperforming loans for the purpose of international comparisons. However, the Bank of Russia does not disclose the so-called Form 115 that contains the information about these types of loans of individual banks. That is why we use the ratio of overdue loans[11] to total loans as the only available substitute for the share of nonperforming loans as the dependent variable in our further analysis. Figure 2 in the Appendix demonstrates that there is a close correlation between these indicators.

[8] The share of attracted interbank loans in total liabilities of Russian banks amounts to only 6% as of the end of 2012 exhibiting weak growing tendency within the last 5 years while households and corporate deposits reached 51% of total liabilities at the same time. The later is much better reflected in the average funding rate than in the interbank rate.

[9] The entire loan becomes nonperforming if payment of interest or principal is past due by 90 days or more

[10] Loans of IV and V quality categories according to the Regulation of the Bank of Russia № 254-P

[11] Percentage of overdue loans includes only the overdue payments of loan, not the entire loan as in the case of nonperforming loans

3.3. Data sources description

We exploit two types of the determinants of banks' loan portfolio quality. They are as follows:

1. bank variables:
   - at the micro level, collected from the Bank of Russia website[12];
   - at the macro level, taken as the sample averages;
2. macroeconomic variables, collected from the Federal State Statistics Service website[13].

We use monthly bank-level data from the balance sheet statistics (Form 101) and quarterly bank-level data from the profit & loss accounts (Form 102) reported by Russian commercial banks over the period 2004Q1 – 2013Q1 (Table 1 in the Appendix)[14]. All quarterly bank-specific indicators that are calculated on the basis of the Form 102 (interest income, interest and operating expenses, etc.) are taken in the annual terms (as the moving sum of each indicator values for the four previous quarters) to avoid the seasonality problem. To ensure the comparability of the Forms 101 and 102 we reorganize monthly bank-level indicators calculated on the basis of the Form 101 to the quarterly basis.

3.4. Dealing with the outliers

The reporting of financial accounts has one special feature in Russia – it is not necessary for bank to make its individual data publicly available. Accordingly, from quarter to quarter the sample size of banks, that published their accounts, can vary significantly – from 706 financial institutions at the beginning of 2004 to 940 at the end of 2012.

It is a well-known fact that in Russia there is a widespread problem of financial accounts falsification undertaken by banks to satisfy supervisory standards. Banks mask problem loans by means of restructuring, prolongation and so on. Under these conditions the econometric estimation on these data can produce biased results. To address this problem, we suggest the following procedure aimed at identifying such banks in order to exclude them from our sample.

First of all, we exclude those banks, for which lending is not the main activity. In particular, we do not consider banks with the loans to assets ratio below sample's 5th percentile. Second, we compare the

[12] Balance sheet statistics (form 101) and profit & loss accounts (form 102), http://www.cbr.ru/credit/forms.asp
[13] Data on GDP, inflation, exchange rates, unemployment, etc: http://www.gks.ru/dbscripts/Cbsd/DBInet.cgi
[14] Earlier data is not available in the open access

overdue loan ratio for each bank at the peak of the crisis (2010 Q2) with its pre-crisis (normal) level (2008 Q2). The idea is the following: if a bank did not experience an increase in the overdue loan ratio during the period 2008 Q2 - 2010 Q2 then it is suspected to falsify its accounts and thus should be excluded from the analysis. This rule is not applied to the banks whose overdue loan ratio is lower than the median value before the crisis. In this case the dynamics of overdue loan ratio is likely to be explained by specific business strategies (a number of retail banks with high pre-crisis percentage of overdue loans did not suffer an increase in overdue loan ratio during the crisis). Besides, we exclude observations of overdue loans that were abnormally low (below 1st percentile).

After excluding procedures the sample comprises between 500 and 700 banks depending on the quarter representing approximately 90% of total assets of Russian banking system.

4. Principal component analysis

We start our analysis from running principal component analysis on the bank overdue loans data. The purpose is to lower space of the overdue loans data by means of correlation matrix analysis. The basic idea is the following: if overdue loans of individual banks are highly correlated then we can extract the first factors (principal components) that can capture the variance of initial data.

We run principal components on the adjusted data. As we have previously noted the disclosure of financial statements is not obligatory for Russian banks, that is why the data on overdue loans is unbalanced. Unfortunately, principal component analysis cannot be run on the data with omissions: this method either discards those banks that have at least one missing observation in the overdue loans or fills these omissions by average values (this distorts the time-series dynamics of individual banks). Therefore, in this Section we have to analyze only those banks that do not have data omissions over the period 1Q2004-4Q2012. This sample consists of 257 banks that hold 83% of banking sector assets and is still representative.

The resulting findings suggest that the individual overdue loan ratios are highly correlated, so it is possible to extract principal components that capture most of the overall variance of overdue loans. For example, the first factor explains 53% of the total variance, the first three principal components account

for 73% (Figure 3 in the Appendix).

The principal component analysis reveals that individual overdue loan ratios are at high extent driven by the «common trends» as the first three components are able to explain most of the variance. This evidence indicates that macroeconomic factors are of crucial importance in explaining the recent «bad debt» crisis – the rise of banks' overdue loans during the 2008-2010 crisis.

We also try to identify macroeconomic factors that are correlated with the principal components. We analyze bivariate correlation coefficients between the first principal component and the macroeconomic variables (the lists of macroeconomic and bank macro-level factors are provided in Tables 2a and 2b in the Appendix).

We found that most of the macroeconomic variables are tightly correlated with the first principal component (correlation coefficients are larger than 0.5 in absolute value). We found two variables that are most closely correlated with the first principal component. They are the expenditure-income ratio at the level of the economy as a whole and the dynamics of house price (Figure 4 in the Appendix). This means that the growing debt burden of enterprises and households as well as the fall in the value of collateral for loans have played an important role in explaining common for all banks deterioration of the loan quality during the crisis.

5. Econometric model specification and estimation results

Since the main purpose of our research is to separate the relative importance of macro- and bank-specific factors of credit risk we start the econometric analysis from the investigation of the interdependence between these groups of factors. It is obvious that if we include both types of factors as the explanatory variables into the credit risk equation and if at the same time the dynamic of the bank-specific factors are explained, at least partially, by macroeconomic conditions then we will get a bias in the estimation of the relative contribution of both groups of factors. In particular, if bank-specific factors are correlated with macroeconomic ones then we will overestimate the relative importance of microeconomic factors. In this case, macro factors will have direct effect on the bank risk through their own coefficients in the credit risk equation and indirect effect through the influence on the bank factors.

The possible and the easiest solution to this problem is to avoid inclusion into the equation those bank-specific factors that are highly correlated with macro conditions. It is clear that this correlation can be maintained only by the link between dynamics common to all banks (measured as the sample mean) and the macroeconomic environment. Our correlation analysis suggests that only the average loan growth rates and the share of non-interest income in total income are those bank-specific variables that are closely correlated with macroeconomic factors approximated by GDP growth rates (Figure 5 in the Appendix). Thereby we did not include these variables into the credit risk equation in order to avoid bias in the factor decomposition. But, these bank-level factors can be included in deviations from the banking sector mean (these transformed variables are uncorrelated with macro factors due to construction) – see Table 2b in the Appendix. Other bank-specific factors (that are uncorrelated with macroeconomic factors) were included in levels. This approach allows us to address the problem of potential bias in the factor decomposition of the dependent variable and thus estimate the contribution of each group of factors consistently.

Following Salas and Saurina (2002), we assume that the share of overdue loans in the loan portfolio is closely related to its values in the previous periods, because overdue loans cannot be immediately written-down and may remain on banks' balance sheets up to several years. In other words, overdue loan ratio shows a tendency to persist over time. It necessitates the use of the dynamic specification of the econometric equations describing the relation between overdue loans and its bank specific and macroeconomic determinants instead of common static equations. Dynamic specifications were also estimated in Jimenez and Saurina (2005), Quagliariello (2007) and Espinoza and Prasad (2010). Nonetheless, we used both static and dynamic approaches to ensure robustness of our conclusions concerning the contribution of micro- and macroeconomic factors to the overdue loan ratio.

5.1. Static model specification

The static approach implies the estimation of the following overdue loan ratio equation:

$$OL_{i,t} = \xi + \sum_{j=1}^{N_1} \beta^{(j)} \cdot M_{t-k}^{(j)} + \sum_{s=1}^{N_2} \gamma^{(s)} \cdot BM_{t-k}^{(s)} + \sum_{h=1}^{N_3} \theta^{(h)} \cdot B_{i,t-k}^{(h)} + \sum_{m=1}^{N_4} \delta^{(m)} \cdot \left(B_{i,t-k}^{(m)} - BM_{t-k}^{(m)}\right) + \mu_i + \nu_{i,t} \quad (2)$$

where

lower-case letters refer to the bank *i* at quarter *t* ($t = Q1\ 2004 ... Q1\ 2013$) and quarter time lag *k* ($k = 0, 1, ..., 8$). The number of banks varies significantly in different specifications (between 500 and 700 banks after excluding outliers - see Section 3) depending on the choice of covariates and due to the unbalanced structure of the bank panel.

$OL_{i,t}$ – overdue loan ratio of bank *i* at quarter *t*;

upper-case letters j, s, h and *m* refer to the different sets of macroeconomic (*M*), banking sector determinants (at the macro level - *BM*) and bank-specific determinants at the micro level (*B*) as well as their deviations from the banking sector averaged variables (*B–BM*). N_1, N_2, N_3 and N_4 are their respective quantities, which vary in different specifications.

$\mu_i + \nu_{i,t}$ – composite error term, μ_i represents the individual effect of the bank *i* and $\nu_{i,t}$ is the idiosyncratic component, which is assumed to be $i.i.d.\left(0, \sigma_\nu^2\right)$;

$\xi, \beta, \gamma, \theta, \delta$ – vectors of parameters to be estimated.

To estimate the static version of the model we apply the fixed effects estimator as the sample selection procedure suggests that sample constructing was not random (see Section 3.4).

5.2. Static model estimation results

In this Section we present the parameter estimates of the fixed effects regressions (static specification of the credit risk equation). The results are provided in the four panels of Table 5a in the Appendix (descriptive statistics of the variables are provided in Table 3 in the Appendix[15]). Most coefficients are of high significance and are robust to changes in specification. In the absence of dependent variable lag in the right hand side of equations, we have from 50% to 70% of the goodness of fit calculated by the least squares dummy variables (LSDV) approach. There is strong evidence in favor of the presence of bank individual effects in our sample according to F-test.

The econometric estimation of fixed effects models has shown that the quality of loan portfolios of

[15] We excluded the outliers, which were found in several variables by means of imposing additional restrictions on the sample, see note to the Table 3 in the Appendix

all banks is tightly correlated with the macroeconomic conditions.

First, the rate of unemployment demonstrates significant and robust to different specifications positive influence on the percentage of overdue loans. During the periods of economic expansions associated with low unemployment rate the credit risk tends to be lower. On the contrary, during the contraction periods firms are forced to lay off employees in response to a deterioration in their financial position, that is why many workers lose their jobs followed by corporate and retail loan quality deterioration.

Second, the sustainability of balance of payment that we proxy by the current account balance to GDP ratio significantly affects the overdue loans of banks in all fixed effects models. The explanation of this relation is the following. Reduction in the current account of Russian economy can be a sign of upcoming ruble downward correction that could substantially influence the quality of loans denominated in foreign currency.

Third, both reduction in the inflation rate and disinflation indicate the sudden stop of income and asset price growth that can reduce borrowers' debt sustainability.

Fourth, the deterioration of corporate profit to debt indicator leads to an increase in loan default rate.

Fifth, the quality of loans is significantly linked to the collateral price index approximated by the house price dynamics. The obtained negative effect is likely to reflect credit squeeze due to banks' reduction in the risk tolerance as a result of collateral price drop during economic contractions. As our estimates show, resulting credit rationing only exacerbates the problem of defaults on loans.

Sixth, we found detrimental effect of high loans interest rate on the loan quality of bank both at the banking sector level and bank level.

As for the other bank-specific variables, we found that bank efficiency, market power as well as bank risk strategy indicators have significant effect on the loan quality.

We found strong empirical evidence in favor of the «bad management» hypothesis as the coefficient of SFA index, which stand for bank cost efficiency, was negative in all specifications. This

means that if bank management is efficient in its operating and funding activities then it also carries out competent policy on credit risk control.

Next, banks with considerable share of retail loans in their loan portfolio were found to be more risky and to have higher level of overdue loan ratio. This phenomenon can be explained by the high share of unsecured loans in total loans to households (about 75%) because of underdeveloped mortgage loan market in Russia. These non-mortgage loans are even more risky than corporate ones.

Our results also reveal the negative effect of banks' market power (approximated by the Lerner index) on its loan quality. A bank with strong position on the market can at the same time set interest rate on loans above its marginal costs and average funding rate. In this case the credit risk will be lower because this bank has no stimulus to involve into risky projects in order to earn more profit. In order to protect its accumulated charter value bank will filter out low quality borrowers. To sum it up, our results confirm the «market power-stability» view of Keeley (1990) for Russian banks that was previously revealed in Mamonov (2012) and Fungacova and Weill (2013).

We found significant negative influence of the loans to assets ratio on the overdue loan ratio. This can be explained by the scale effect coming from the prevailing part of the bank operations focused on the lending activities. This reduces average costs on borrower screening and monitoring.

We next verify the robustness of our fixed effects estimation results. We add some variables to our «best» fixed effects model (FE4 model has the largest adjusted R-squared – Table 5a in the Appendix) and impose the restrictions on the sample. In the majority of these additional models all variables that entered in the FE4 model preserved their significance and sign after adding controls or modifying the sample (Table 5b, 5c).

First of all, we add three dummy variables to account for differences in the bank ownership structure (state-owned, foreign-owned or private) and their geographical location (metropolitan[16] or regional[17]). We found that foreign banks have on average larger overdue loans ratio (model RE4.1, Table 5b in the Appendix). This phenomenon can be explained by the fact that a large number of foreign banks

[16] Banks with head office located in Moscow or Saint Petersburg

[17] Regional banks is a basic category, all the coefficients of the ownership and location dummy variables are estimated with respect to the regional banks

entered Russian market just before the crisis that is why they were not able to cope with rising risks and deteriorating macroeconomic conditions. Metropolitan banks tend to have higher overdue loan ratio than the regional ones. The dummy variable coefficient of state-controlled banks is not significant.

Bank level loans to deposits ratio as a proxy for the riskiness of its credit policy is not significant in our robustness check (model FE4.2 in Table 5b in the Appendix). Bank size does not influence the credit risk indicator (model FE4.3, Table 5b). Adding time effects does not bias the initial results. Bringing back falsified banks to the sample does not change the results (see estimates of the FE4.4 model, Table 5b). Running FE4 model on the different subsamples of banks in accordance with their ranking (top-200, out of top-200) results in the loss of the significance of some bank level variables for the top-200 model (Table 5c in the Appendix). This may be due to stronger influence of the macro factors on large banks in comparison with small.

We estimate how much adjusted R-squared decreases when excluding macro and bank-level variables from the FE4 model. If the macro variables are excluded then the adjusted R-squared falls from 0.691 to 0.625, and if microeconomic determinants are dropped then we get the value of 0.680. Thus, this analysis suggests that macro variables add more to the explanatory power of the model than the micro ones.

We conduct the factor decomposition of the fitted values of dependent variable in the estimated static specifications and compute the contributions of four groups of factors («macro+», «micro+», «macro-», «micro-»). The criterion for a macro (micro) variable X to be attributed to a «macro+» («micro+») group of factors is that its product with the corresponding coefficient β, i.e. βX, is positive. Note that the sign of this product can vary over time depending on the sign of variable X, which can be positive or negative (e.g. GDP growth rate is positive before the 2008 crisis and negative during the 2009 recession). Such variables can move from «positive» to «negative» group and vice versa.

We developed a special application that allowed us to perform factor decomposition for any bank in our sample. In this Section we do that only for the median bank (Figures 6a and 6b in the Appendix). One can see that the overdue loans increase in this bank was mainly driven by the deterioration of

macroeconomic factors (increase in "macro +" bars, reduction of "macro -" bars in 2009-2010 on the charts). Below we present factor decomposition of the dependent variable for different percentiles of banks.

5.3. Dynamic model specification

Next, we turn to the dynamic specification of our empirical credit risk model. We rewrite our static equation (2) in the following way. We add one-quarter lag of the dependent variable to the right hand side of the equation in order to account for the persistency of overdue loan ratio:

$$OL_{i,t} = \xi + \alpha\, OL_{i,t-1} + \sum_{j=1}^{N_1} \beta^{(j)} M_{t-k}^{(j)} + \sum_{s=1}^{N_2} \gamma^{(s)} BI_{t-k}^{(s)} + \sum_{h=1}^{N_3} \theta^{(h)} BS_{i,t-k}^{(h)} + \sum_{m=1}^{N_4} \delta^{(m)} \left(BS_{i,t-k}^{(m)} - BI_{t-k}^{(m)} \right) + \mu_i + \nu_{i,t} \quad (3)$$

We estimate equation (3) using one-step difference GMM estimator developed by Arellano and Bond (1991) as the introduction of the lagged dependent variable into the set of covariates leads to inconsistency of the fixed effects estimator. We do not apply System GMM estimator developed by Blundell and Bond (1998) to equation (3) as it produces unsatisfactory results in terms of economic interpretation of the coefficient of the lagged dependent variable. The System GMM estimator includes equation in levels together with the differentiated form of (3). Thus, coefficient of the lagged dependent variable would be biased in this case towards the inertial dynamics of the levels of the overdue loan ratio. During the investigated period, the dependent variable had positive upward trend that is why when running System GMM regressions its coefficient exceeds one. This could hardly be interpreted economically especially when applying these results to the future.

5.4. Dynamic model estimation results

We next describe the estimation results obtained in the dynamic version of the overdue loans equation (Table 6 in the Appendix).

When estimating dynamic panel data model we specify instrumental variables set. First, lagged dependent variable is treated as predetermined. The same holds for the lagged Lerner index (it could be influenced by the past values of overdue loans: e.g. banks with low loan portfolio quality can gradually lose its market share). We instrument these variables by its previous lags by means of «GMM-style»

instrumental variables, see Roodman (2006). Second, we treat macroeconomic variables as strictly exogenous to the dependent variable so we include them into «IV-style» instruments. In addition, the share of bank non-interest income in total income is considered to be exogenous to the dependent variable as it reflects bank long-run strategy on non-credit markets and thus is not affected by the credit risk.

We apply two different methods to limit the size of instrumental variables matrix. First, we use the «collapse» option in Stata xtabond2 command as described in Roodman (2006) – see GMM0 and GMM1 models in Table 6. Second, we limit the depth of lags in the «GMM-style» instruments from one to four quarters – GMM2 model.

Estimation of the dynamic GMM model with the same set of macro- and bank-specific variables as in the static FE4 specification produces unsatisfactory results as most of the micro variables became insignificant. That is why we next try to find GMM specifications that contain a bit different set of controls compared to the previously obtained FE results in order to achieve significant estimates.

In all GMM specifications we found strong inertia in the dependent variable. One-quarter lag of the overdue loan ratio is significant in all GMM specifications. Since GMM estimates are highly sensitive to the set of instrumental variables, we observe differences in the lagged dependent variable coefficients between GMM1 and GMM2 models.

In dynamic models weakening of ruble exchange rates demonstrates upward pressure on the overdue loans. This is because ruble devaluation undermines debt sustainability of borrowers that have foreign currency loans.

Under the GMM methodology we found positive effect of bank income sources diversification on the loan portfolio quality (or, in other words, negative impact on the overdue loan ratio). This is explained by the lowering pressure to involve in risky projects due to the increased role of other non-credit market for banking activities. Lerner index demonstrates the same negative influence on the dependent variable as in the static version providing us with one more argument in favor of the «market power – stability» view.

Next, we again turn to the factor decomposition of the fitted values of the dependent variable obtained in the GMM models for the median bank in our sample (Figure 6c in the Appendix)

The conclusion of the FE models that the macroeconomic determinants were the most important in explaining overdue loans increase in Russia during the recent crisis holds for two different GMM models (GMM1 and GMM2). Thus, this finding is robust to the specification of the econometric model and the chosen set of instrumental variables.

Now we are able to aggregate factor decomposition results from all of the estimated equations. We calculate the increases in all groups of factors («macro+», «micro+», «macro-», «micro-») over the period of overdue loans growth, namely 2008Q2 – 2010Q2. As depicted in Figure 7 in the Appendix, macroeconomic factors were of highest influence on loan quality deterioration in all estimated equations (FE and GMM).

Finally, we provide comparison of the factor decomposition of overdue loan ratio increase over the crisis period for different percentiles of banks (for baseline model – FE4, see Figure 8 in the Appendix). The results suggest that for banks that are above the 50-th percentile of our sample the role of micro-variables becomes much higher than for the median bank. For the 90-th percentile and higher the role of micro-variables is predominant. So, about 10 percent of banks were themselves to blame in a sharp increase in the overdue loan ratio after the 2008 crisis. We claim that for more risky banks the role of micro factors becomes more important compared to the macro ones.

6. Conclusions and policy implications

Our study investigates the relative importance of macroeconomic and bank-specific factors in explaining problem loans increase in the Russian banking sector during the global financial crisis. To address the research question we employ both multivariate statistical analysis and econometric estimation of static and dynamic specifications of overdue loans equation on the panel data of Russian banks.

First, we extract three first principal components from the bank-level overdue loans data and uncovered that they capture 73% of the overall variance. This finding provides preliminary evidence in favor of macroeconomic factors that were the main drivers of the overdue loans increase during the

2008-2010 crisis.

Second, we estimate static and dynamic panel data econometric models explaining the dynamics of bank overdue loan ratio using macroeconomic and bank-specific factors as the explanatory variables. We conduct the factor decomposition of fitted values of dependent variable in the estimated specifications and compared the contribution of four groups of factors («macro+», «micro+», «macro-», micro-») to the overdue loan ratio before and at the peak of the crisis. The main result is that macroeconomic determinants were the most important in explaining the increase in overdue loan ratio of the median bank and this finding is robust to the specification of the econometric model. Thus, we claim that worsening of macroeconomic conditions in 2008-2009 made the prevailing contributions into problem loans increase of the median bank in Russia. However, this result is reversed for banks from 90-th percentile and higher, for which the role of micro-variables is predominant. Therefore, about 10 percent of banks were themselves to blame in a sharp increase in overdue loan ratio after the 2008 crisis.

These findings are of great importance for the regulators and policymakers. Our study suggests that in order to lower credit risk of the majority of Russian banks it is necessary to reduce procyclicality of financial intermediation. Regulators should limit the size of adopted risks during the cyclical upturns by means of macroprudential policy and other applicable measures. For example, as noted in Moiseev (2009), current regulations of the loan loss reserves in the Russian banking sector only exacerbates the problem of its procyclicality. In accordance with the current prudential norms, banks should build up large amount of reserves only during the crisis as it corresponds with the borrowers' credit quality deterioration. Large reserves accumulation leads to sharp drop in profit and negatively affects banks' capital. On the contrary, during the expansionary phase of the business cycle banks are not required to accumulate reserves in such large amounts as existing regulation do not take into account future risks of borrowers (only current financial condition matters, which is always better during the boom periods). One of possible solutions to this problem is an introduction of dynamic prudential norms (applied to reserves, capital, loan-to-value ratio, etc.). The most well-known countercyclical instrument is dynamic (statistical) provisions introduced in Spain in 2000. The main feature of this regulation is that it

necessitates banks to build up more reserves during the expansion in comparison with the visible level of risks thus reducing their costs during the crisis. This approach is aimed at provision smoothing over the business cycle as it takes into account future loan losses and hidden risks. The main shortcoming of dynamic reserves is that they reduce banks' profit during the upturns as the expenses on provisioning are made before profit is calculated. This negative feature can be overcome in other dynamic prudential norm – the dynamic capital regulation when countercyclical reserves are allocated from the after-tax profit and are treated as a part of bank's capital.

The other important macroeconomic factor that contributed to the problem loans increase is the foreign exchange market conditions. Decrease in the current account balance of Russian economy as well as the increased volatility of ruble exchange rate can be the sign of upcoming ruble devaluation. This can undermine debt sustainability of those borrowers that have sizable debt denominated in the foreign currency. In order to limit the negative effect coming from currency market instability the Bank of Russia should reduce the attractiveness of foreign currency loans both for banks and for borrowers (especially with low share of income denominated in the foreign currency). For example, the Bank of Russia can introduce additional reserve requirements on foreign currency loans. Actually, the regulator has already made some steps in that direction (in terms of reducing the attractiveness of foreign currency loans), as it has reduced its interference on the foreign exchange market in comparison to the pre-crisis period thus promoting more flexible ruble exchange rate. The resulting increase in the exchange rate uncertainty has already led to the reduction in the share of foreign currency loans, as the Bank of Russia no longer guarantees exchange rate peg.

The regulator should also limit banks' interest rates charged on loans during the instability periods. It was found in this study, that the increase in interest rate on loans during the 2008-2009 crisis was the important push-up factor of the overdue loans increase both at the macro- and micro-level. The recommendation is to increase the availability of liquidity provisioning to banks.

Our additional results are as follows. First, we found empirical confirmation to the «bad management» hypothesis of Berger and DeYoung (1997) on the Russian banks data. An increase in the

total cost efficiency leads to reduction in the overdue loan ratio. This means that the Bank of Russia should facilitate reduction in the funding costs of banks by regulating the maximum level of deposit interest rate and reducing the price of refinancing instruments for banks.

Second, banks with considerable share of retail loans in their loan portfolio were found to be more risky and to have higher levels of overdue loan ratio. The Bank of Russia can discourage bank excessive involvement into retail lending by imposing additional reserve requirements on the loans to households (especially for unsecured ones – introduced in 2012).

Third, our results confirm the «market power – stability» hypothesis of Keeley (1990) for Russian banks. This means that banks with higher market power tend to have lower overdue loan ratio. This is the rationale for the Bank of Russia to encourage mergers and acquisitions of small banks (since they are not likely to have market power). The possible stimulus could be the deduction of costs associated with the purchase of significant amount of shares of other banks from the taxable profits.

Fourth, we also found that the greater participation of a bank in the operations that are not associated with the credit risk taking (payment transactions, broking, asset management services, etc.) allowed banks to decrease their overdue loan ratio. Earning larger share of noninterest income reduces incentives for banks to involve in the speculative projects. As for the regulator, it should promote the demand for the non-cash transactions and for the financial services provided by banks. For this purpose, the program of improving financial literacy of the population should be implemented.

7. Appendix

Methodology: translog cost function specification

We specify translog cost function (*C*) by combining the commonly used sets of inputs (*p*) and outputs (*Y*) with the set of netputs (*N*) to control for off-balance sheet activities and managers preferences to hold equity capital, see, for example, Schaeck and Cihak (2008), Turk Ariss (2010), Fiordelisi et al. (2011), among others. Besides, we add time trend and its squared term to account for possible nonlinear character of technical change. Moreover, we include product terms of time trend with each input, output and netput measures to explore possible non-neutral nature of technical progress. More specifically, we use the following form of translog cost function to estimate both the operating marginal cost and efficiency frontier:

$$\begin{aligned}\ln C_{it} = {} & \beta_0 + \sum_{j=1}^{2}\beta_j \cdot \ln Y_{j,it} + \frac{1}{2}\sum_{k=1}^{2}\sum_{l=1}^{2}\beta_{kl} \cdot \ln Y_{k,it} \cdot \ln Y_{l,it} + \sum_{m=1}^{3}\gamma_m \cdot \ln p_{m,it} + \frac{1}{2}\sum_{r=1}^{3}\sum_{q=1}^{3}\gamma_{rq} \cdot \ln p_{r,it} \cdot \ln p_{q,it} \\ & + \sum_{g=1}^{2}\delta_g \cdot \ln N_{g,it} + \frac{1}{2}\sum_{k=1}^{2}\sum_{l=1}^{2}\delta_{kl} \cdot \ln N_{k,it} \cdot \ln N_{l,it} + \sum_{s=1}^{2}\sum_{u=1}^{3}\eta_{su} \cdot \ln Y_{s,it} \cdot \ln p_{u,it} \\ & + \sum_{k=1}^{2}\sum_{g=1}^{2}\xi_{kg} \cdot \ln Y_{k,it} \cdot \ln N_{g,it} + \sum_{r=1}^{3}\sum_{g=1}^{2}\theta_{rg} \cdot \ln p_{r,it} \cdot \ln N_{g,it} + \alpha_1 \cdot TREND + \alpha_2 \cdot TREND^2 \\ & + \sum_{j=1}^{2}\varphi_j \cdot \ln Y_{j,it} \cdot TREND + \sum_{m=1}^{3}\psi_m \cdot \ln p_{p,it} \cdot TREND + \sum_{j=1}^{2}\varphi_g \cdot \ln N_{g,it} \cdot TREND + v_{it} + u_{it} \qquad (A1)\end{aligned}$$

where C_{it} is operating costs[18] (when we estimate Lerner index) or total costs (for computation of efficiency scores) of bank *i* in time period *t*. $Y_{j,it}$ is *j-th* output measure: $Y_{1,it}$ for loans to households and non-financial firms, $Y_{2,it}$ for deposits of the same types of clients. $p_{m,it}$ is *m-th* input measure: $p_{1,it}$ is the price of attracted funds (average funding rate), $p_{2,it}$ is the price of labor (the ratio of personnel expenses to total assets), $p_{3,it}$ is the price of other expenses as a proxy for the price of capital (the ratio of non-interest and non-personnel expenses to total assets). *TREND* is time trend.

[18] We compute operating costs as total costs minus sum of interest expenses, expenses due to loan loss provisioning, and positive revaluation of assets denominated in foreign currency. While interest expenses may in fact reflect market power, the latter two components mirror pro-cyclical behavior of credit risk and bank involvement into foreign exchange market, respectively, regardless of operating efficiency nature. Eliminating of foreign currency revaluation is especially important for the Russian banking sector given that this component reaches approx. 50% (and even more during the 2008-2009 crisis) of total income/losses accounts. For robustness check we also exclude only interest expenses from total costs. Our main results qualitatively remain unchanged.

$v_{it} + u_{it}$ is an error term composed of idiosyncratic shock $v_{it} \sim N\left(0, \sigma^2_{v,it}\right)$ and inefficiency term $u_{it} \sim N^{+}\left(0, \sigma^2_{u,it}\right)$, which is assumed to be half-normal distributed. The heteroscedastic components of both v_{it} and v_{it} are treated as a linear functional form of bank ownership dummies (state-, foreign-, Moscow- and St. Petersburg-controlled financial institutions) and the following three risk profile measures: overdue loans to total loans ratio, liquid assets to total assets ratio and equity capital to total assets ratio as proxies for credit risk, liquidity risk, and financial leverage, respectively. We suppose that the more risky business strategy the more unstable or volatile bank efficiency level within different types of ownership. In this way we partially follow Karas et al. (2008) and their approach to incorporate risk and ownership measures into the translog cost function[19].

We impose standard linear homogeneity conditions in input prices:

$$\sum_{m=1}^{3} \gamma_m = 1, \sum_{r=1}^{3} \gamma_{rq} = 0 \,\forall\, q = 1...3, \sum_{u=1}^{3} \eta_{su} = 0 \,\forall\, s = 1,2, \sum_{r=1}^{3} \theta_{rg} = 0 \,\forall\, g = 1,2, \sum_{m=1}^{3} \psi_m = 0 \qquad (A2)$$

We estimate parameters of Eq. (A1) using maximum likelihood estimator (MLE) under the above-mentioned homogeneity conditions. We compute SFA-scores on the basis of estimated cost function as:

$$SFA_{it} = E\left[\exp\left\{-\hat{u}_{it} \mid \hat{v}_{it} + \hat{u}_{it}\right\}\right] \qquad (A3)$$

[19] We also assumed the homoscedastic form of composite error term. The basic results remain the same

Tables

Table 1. The sources and structure of the data on Russian commercial banks

Data Sources:	Balance sheet data (Form 101)	Income statement data (Form 102)
Variables	*Assets*: retail and corporate loans, granted inter-bank loans, purchased securities, total assets, etc. *Liabilities*: retail and corporate deposits, attracted inter-bank loans, foreign liabilities, total funds, etc. *Capital and performance*: total equity, loan loss provision, profit	*Income*: interest income, operating income, etc. *Expense*: interest expenses, operating expenses, etc.
Frequency	monthly	quarterly
Availability	from 2004M1	from 2004Q1

Table 2a. Description of the macroeconomic factors

Variable	Notation	Expected sign
Consumption plus investment expenditure to disposable income, per year, %	M-C+I-Y-T	+
Gross profit to the corporate sector debt ratio, %	M-GrosProfit-Debt	-
Inflation, growth rate, per year, %	M-Inflat-y	+/-
Disinflation (reduction of the inflation rate), percentage points	M-Desinflat-y	-
Unemployment rate, %	M-Unempl	+
House price, growth rate, per year, %	M-Housing-y	-
Weakening of the nominal exchange rate (ruble to US dollar), %	M-Weakening	+
Current account balance to GDP ratio, %	M-CAB-GDP	-

Table 2b. Description of the bank-specific factors (at the level of individual bank and banking system level indicators)

Variable	Notation		Expected sign	Comment
	Banking system level	The level of individual banks		
Loans to deposits ratio, %	BM-LTD	B-LTD	+	Lagged more than a year
Real loans growth rate, per year (%)	BM-Rloans-y	B-dev-Rloans-y	+	Lagged more than a year, bank-level indicator is in the deviations from the sector mean
Loans to total assets, %		B-Lns-TA	-	
Real lending rate, %	BM-RIR	B-RIR	+	Lagged
Non-interest income to total income[20], %	BM-NII-to-TI	B-dev-NII-to-TI	-	Lagged, bank-level indicator is in the deviations from the sector mean. Diversification hypothesis
Market power (Lerner index)	-	B-Lerner	+/-	Lagged, market power – fragility / stability hypotheses
Total cost efficiency index (SFA)	-	B-SFA	+/-	Lagged, skimping / bad management hypotheses
Retail loans to total loans, %		B-Retail	+	
Capital to assets ratio, %	–	B-EQ-to-TA	-	Moral hazard hypothesis
Bank's share in the total assets of the banking sector, %	–	B-d-TA	-/+	Diversification, Too-big-to-fail hypothesis
Ownership structure dummy variables	–	B-State, B-Foreign, B-Metropol, B-Region	+/-	

[20] Excluding income coming from loan loss provision recovery and currency market expenses

Table 3. Descriptive statistics of the dependent variable and its determinants included into the static and dynamic specifications of the overdue loans equation

Variable	Obs	Mean	Std. Dev.	Min	Max	Percentiles		
						P1	P50	P99
Macroeconomic variables								
Unemployment rate, %	44820	7.06	1.04	5.27	9.17	5.27	7.07	9.17
Inflation rate, per year, %	44820	9.84	2.89	3.76	15.15	3.76	9.58	15.15
Disinflation (reduction of the inflation rate), percentage points	44820	-1.95	2.20	-7.65	0.00	-7.65	-0.77	0.00
Gross profit to the corporate sector debt ratio, %	44820	64.49	15.38	42.35	92.03	42.35	58.36	92.03
House price, growth rate, per year, %	44820	16.26	14.97	-9.53	51.30	-9.53	17.82	51.30
Weakening of the nominal exchange rate (ruble to US dollar), %	44820	-1.99	4.07	-14.07	0	-14.07	0	0
Current account balance to GDP ratio, %	44820	6.93	3.34	1.45	14.70	1.45	6.14	14.70
Loans to deposits ratio, %	44820	108.45	9.55	93.95	131.60	93.95	105.40	131.60
Real lending rate, %	39840	2.38	2.72	-2.62	7.22	-2.62	2.31	7.22
Microeconomic variables								
Overdue loan ratio, %	27155	3.75	6.89	0.00	100.00	0.01	1.76	29.56
Overdue loan ratio, % (excluding falsifiers)	23093	3.66	6.02	0.00	100.00	0.01	1.82	26.53
Loans to total assets, %	31837	51.68	19.97	0.00	98.33	2.17	54.48	88.34
Loans to deposits ratio, %	31800	515.35	29951.33	0.00	5000000	6.98	91.30	2456.68
Real lending rate, %	25819	6.01	9.32	-11.83	477.14	-4.69	5.45	23.01
Total cost efficiency index (SFA)	24680	80.44	13.43	11.51	99.28	34.42	83.60	97.16
Deviation from the sector mean of the share of non-interest income in the total income	27599	-9.47	21.83	-49.57	72.11	-43.24	-13.84	57.26
Market power (Lerner index)	15248	48.49	22.26	-59.78	99.25	-24.45	50.28	91.97
Bank's share in the total assets of the banking sector, %	32728	0.11	1.02	0.00	33.38	0.00	0.01	1.68
Dummy for state ownership	34056	0.01	0.10	0	1			
Dummy for foreign ownership	34056	0.08	0.27	0	1			
Dummy for metropolitan banks (Moscow and S.Petersburg)	34056	0.48	0.50	0	1			
Retail loans to total loans, %	31209	31.16	25.71	0.00	100.00	0.21	24.24	100.00

Note: the model estimation took place with the imposition of the following conditions on the microeconomic variables (depending on the list of variables included into particular equation): lns_ta>2.17; lns_ta<88.34; lnsretail_to_lns>0.21; ltd<2456.68; ltd>6.98; rir_lns<23.01

Table 4. Translog cost function estimation results

	Dependent variable	
	Operating cost	Total cost
Loans (Y_1)	–0.001 (0.041)	0.364*** (0.008)
Deposits (Y_2)	0.250*** (0.026)	0.240*** (0.007)
Price of funds (p_1)	0.160*** (0.024)	0.122*** (0.006)
Price of labor (p_2)	0.440*** (0.027)	0.356*** (0.007)
Price of capital (p_3)	0.400*** (0.022)	0.522*** (0.007)
Fee income (N_1)	0.342*** (0.025)	0.064*** (0.006)
Equity capital (N_2)	0.359*** (0.034)	0.370*** (0.008)
Loans × Loans	0.180*** (0.010)	0.023*** (0.001)
Loans × Deposits	–0.155*** (0.010)	–0.032*** (0.002)
Deposits × Deposits	0.112*** (0.004)	0.089*** (0.001)
Price of funds × Price of funds	0.020*** (0.002)	0.012*** (0.001)
Price of funds × Price of labor	–0.045*** (0.006)	0.008*** (0.002)
Price of funds × Price of capital	0.005 (0.004)	–0.032*** (0.002)
Price of labor × Price of labor	0.037*** (0.004)	0.055*** (0.001)
Price of labor × Price of capital	–0.030*** (0.006)	–0.118*** (0.002)
Price of capital × Price of capital	0.012*** (0.003)	0.075*** (0.001)
Fee income × Fee income	0.042*** (0.003)	0.007*** (0.001)
Fee income × Equity capital	–0.004 (0.007)	0.006*** (0.002)
Equity capital × Equity capital	0.072*** (0.007)	0.077*** (0.002)
Loans × Price of funds	–0.038*** (0.008)	0.014*** (0.001)
Loans × Price of labor	0.130*** (0.011)	0.012*** (0.002)
Loans × Price of capital	–0.092*** (0.008)	–0.026*** (0.002)
Deposits × Price of funds	0.001 (0.006)	0.001 (0.001)
Deposits × Price of labor	–0.010 (0.008)	–0.018*** (0.002)
Deposits × Price of capital	0.009 (0.006)	0.017*** (0.002)

Loans × Fee income	–0.067*** (0.008)	0.007*** (0.001)
Loans × Equity capital	–0.102*** (0.015)	0.005** (0.002)
Deposits × Fee income	–0.022*** (0.005)	–0.023*** (0.001)
Deposits × Equity capital	–0.054*** (0.010)	–0.162*** (0.002)
Price of funds × Fee income	0.015*** (0.005)	0.000 (0.001)
Price of funds × Equity capital	0.022*** (0.007)	–0.002 (0.002)
Price of labor × Fee income	–0.022*** (0.006)	–0.001 (0.002)
Price of labor × Equity capital	–0.162*** (0.008)	–0.011*** (0.002)
Price of capital × Fee income	0.007 (0.005)	0.001 (0.001)
Price of capital × Equity capital	0.140*** (0.007)	0.014*** (0.002)
Trend	–0.01811*** (0.00249)	0.00243*** (0.00080)
$Trend^2$	0.00042*** (0.00004)	–0.00002* (0.00001)
Trend × Loans	–0.005*** (0.001)	–0.005*** (0.002)
Trend × Deposits	0.003*** (0.001)	0.002*** (0.000)
Trend × Price of funds	0.000 (0.000)	0.001*** (0.000)
Trend × Price of labor	0.000 (0.000)	–0.001*** (0.000)
Trend × Price of capital	0.000 (0.000)	0.000 (0.000)
Trend × Fee income	0.000 (0.000)	0.000 (0.000)
Trend × Equity capital	0.003*** (0.001)	0.003*** (0.001)
Intercept	–2.842*** (0.069)	–2.871*** (0.019)
Number of observations	16692	24675
Log Likelihood	–7586.919	7266.054
Convergence achieved	yes	yes
P-value of Wald statistics	0.000	0.000

Note: ***, ** and * - an estimate is significantly different from zero at 1%, 5% and 10% level, respectively. Standard errors of estimated coefficients are reported in parentheses. Estimated coefficients of heteroscedastic error terms are not reported to preserve space and are available upon request

Table 5a. Estimation results of the static specification of the overdue loans equation

	Dependent variable: overdue loans to total loans ratio			
	FE1	FE2	FE3	FE4
Macroeconomic determinants				
Unemployment rate, %	1.268***	0.473***	0.588***	0.486***
	(0.081)	(0.085)	(0.075)	(0.063)
Current account balance to GDP ratio, %	–0.260***	–0.045***	–0.238***	–0.196***
	(0.017)	(0.013)	(0.017)	(0.015)
Inflation, growth rate, per year, %	–0.344***			
	(0.028)			
Disinflation (reduction of inflation), percentage points			–0.460***	–0.288***
			(0.036)	(0.028)
Gross profit to the corporate sector debt ratio, %		–0.106***		
		(0.009)		
House price, growth rate, per year, %			–0.050***	–0.040***
			(0.004)	(0.004)
Real lending rate, lag = 4 quarters %			0.444***	0.232***
			(0.041)	(0.031)
Microeconomic determinants				
Efficiency index (SFA)[a]				
lag = 1 quarter	–0.062***	–0.065***	–0.065***	
	(0.019)	(0.019)	(0.019)	
lag = 2 quarters	–0.015**	–0.016**	–0.014**	
	(0.007)	(0.007)	(0.007)	
lag = 3 quarters	0.002	0.002	0.003	
	(0.007)	(0.006)	(0.007)	
lag = 4 quarters	0.006	–0.001	0.002	
	(0.008)	(0.008)	(0.008)	
Total sum of 4 lags	–0.068***	–0.080***	–0.075***	
	(0.023)	(0.024)	(0.023)	
Retail loans to total loans ratio, %				
lag = 1 quarter	0.007		0.019	0.026**
	(0.016)		(0.016)	(0.011)
lag = 2 quarters	–0.011*		–0.014**	–0.029***
	(0.006)		(0.006)	(0.010)
lag = 3 quarters	0.015***		0.010*	0.013
	(0.006)		(0.005)	(0.009)
lag = 4 quarters	0.031*		0.017	0.009
	(0.017)		(0.016)	(0.009)
Total sum of 4 lags	0.041***		0.032***	0.019*
	(0.010)		(0.009)	(0.010)
Real lending rate, %				
lag = 1 quarter		0.051**		
		(0.024)		
lag = 2 quarters		0.085***		
		(0.026)		
lag = 3 quarters		0.076***		
		(0.022)		
lag = 4 quarters		–0.028		
		(0.019)		
Total sum of 4 lags		0.184***		
		(0.032)		
Market power (Lerner index)[b], %				
lag = 1 quarter				–0.017*
				(0.009)
lag = 2 quarters				0.006
				(0.006)
lag = 3 quarters				0.000
				(0.007)

	Dependent variable: overdue loans to total loans ratio			
	FE1	FE2	FE3	FE4
lag = 4 quarters				–0.013*
				(0.007)
Total sum of 4 lags				–0.025**
				(0.011)
Loans to total assets ratio, %				
lag = 1 quarter				–0.051***
				(0.011)
lag = 2 quarters				–0.006
				(0.005)
lag = 3 quarters				–0.003
				(0.005)
lag = 4 quarters				–0.003
				(0.006)
Total sum of 4 lags				–0.062***
				(0.017)
Intercept	3.691*	12.565***	5.152**	5.112***
	(2.023)	(2.632)	(2.072)	(1.662)
Number of observations	15181	15018	15181	8578
(banks)	(880)	(869)	(880)	(672)
R^2 (LSDV)	0.537	0.517	0.554	0.691
P-value of F statistics	0.000	0.000	0.000	0.000

Note: ***, ** and * - an estimate is significantly different from zero at 1%, 5% and 10% level, respectively. Robust standard errors of estimated coefficients are reported in parentheses.

[a] SFA index is based on estimated total cost efficiency frontier

[b] Lerner index is calculated using operating marginal costs, which is based on estimated operating efficiency frontier

Table 5b. Estimation results of the static specification of the overdue loans equation: robustness check №1

	Dependent variable: Overdue loans to total loans ratio				
	RE 4.1	FE 4.2	FE 4.3	FE 4.4	FE 4.5 (unadjusted)[a]
Macroeconomic determinants					
Unemployment rate, %	0.468***	0.488***	0.486***	0.306***	0.421***
	(0.068)	(0.064)	(0.062)	(0.067)	(0.060)
Current account balance to GDP ratio, %	–0.191***	–0.196***	–0.195***	–0.138***	–0.184***
	(0.016)	(0.015)	(0.015)	(0.024)	(0.015)
Disinflation (reduction of inflation), percentage points	–0.289***	–0.286***	–0.287***	–0.189***	–0.249***
	(0.028)	(0.026)	(0.028)	(0.031)	(0.026)
House price, growth rate, per year, %	–0.038***	–0.041***	–0.040***	–0.034***	–0.037***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.003)
Real lending rate, lag = 4 quarters, %	0.231***	0.242***	0.231***	0.047	0.196***
	(0.032)	(0.030)	(0.031)	(0.046)	(0.029)
Microeconomic determinants					
Market power (Lerner index)[b], %					
lag = 1 quarter	–0.010	–0.012	–0.016*	–0.019**	–0.019**
	(0.009)	(0.009)	(0.009)	(0.009)	(0.008)
lag = 2 quarters	0.000	0.006	0.006	0.007	0.012
	(0.006)	(0.008)	(0.007)	(0.007)	(0.007)
lag = 3 quarters	0.004	–0.002	0.000	–0.002	–0.003
	(0.008)	(0.007)	(0.007)	(0.007)	(0.009)
lag = 4 quarters	–0.016**	–0.008	–0.014**	–0.012*	–0.012*
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Total sum of 4 lags	–0.023**	–0.016*	–0.024**	–0.026**	–0.022**
	(0.010)	(0.009)	(0.010)	(0.011)	(0.010)
Retail loans to total loans ratio, %					
lag = 1 quarter	0.030**	0.030***	0.026**	0.023**	0.016
	(0.012)	(0.010)	(0.011)	(0.011)	(0.010)
lag = 2 quarters	–0.030**	–0.026**	–0.029***	–0.025**	–0.017
	(0.012)	(0.007)	(0.010)	(0.011)	(0.012)
lag = 3 quarters	0.012	0.002	0.012	0.013	0.018*
	(0.011)	(0.008)	(0.009)	(0.009)	(0.010)
lag = 4 quarters	0.014	0.018**	0.010	0.011	–0.003
	(0.010)	(0.009)	(0.009)	(0.009)	(0.014)
Total sum of 4 lags	0.027***	0.024***	0.019*	0.023**	0.014
	(0.009)	(0.007)	(0.010)	(0.010)	(0.009)
Loans to total assets ratio, %					
lag = 1 quarter	–0.048***	–0.043***	–0.051***	–0.051***	–0.054***
	(0.012)	(0.010)	(0.011)	(0.011)	(0.010)
lag = 2 quarters	–0.007	–0.007	–0.006	–0.007	0.001
	(0.005)	(0.005)	(0.005)	(0.005)	(0.007)
lag = 3 quarters	0.000	–0.005	–0.003	–0.002	–0.003
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
lag = 4 quarters	–0.001	–0.005	–0.002	0.002	–0.001
	(0.006)	(0.007)	(0.006)	(0.006)	(0.006)
Total sum of 4 lags	–0.056***	–0.059***	–0.062***	–0.058***	–0.057***
	(0.016)	(0.015)	(0.017)	(0.017)	(0.016)
Loans to deposits ratio, %					
lag = 4 quarters		0.002			
		(0.002)			
lag = 5 quarters		0.000			
		(0.001)			
lag = 6 quarters		0.001			

	Dependent variable: Overdue loans to total loans ratio				
	RE 4.1	FE 4.2	FE 4.3	FE 4.4	FE 4.5 (unadjusted)[a]
		(0.001)			
lag = 7 quarters		0.000			
		(0.001)			
lag = 8 quarters		0.000			
		(0.001)			
Total sum of 5 lags		0.001			
		(0.001)			
Bank's share in the total assets of the banking sector, %					
lag = 1 quarter			–0.222		
			(0.707)		
lag = 2 quarters			–0.102		
			(0.264)		
lag = 3 quarters			–0.187		
			(0.225)		
lag = 4 quarters			0.873**		
			(0.401)		
Total sum of 4 lags			0.361		
			(0.720)		
Ownership dummies					
State-controlled banks	–0.153				
	(0.901)				
Metropolitan banks (Moscow and S.Petersburg)	1.000***				
	(0.381)				
Foreign-controlled banks	2.557**				
	(1.090)				
Time effects[c]					
2006				–1.237***	
				(0.410)	
2007				–1.200***	
				(0.331)	
2008				–1.470***	
				(0.286)	
2009				–1.064***	
				(0.272)	
2010				–0.643**	
				(0.274)	
2011				0.114	
				(0.193)	
2012				–0.428***	
				(0.132)	
Intercept	3.976***	4.100***	4.982***	7.004***	5.177***
	(1.680)	(1.403)	(1.627)	(1.691)	(1.520)
Number of observations (banks)	7516	8221	8578	8578	9580
	(549)	(664)	(672)	(672)	(753)
R^2 (LSDV)	0.654	0.678	0.691	0.694	0.664
P-value of F statistics	0.000	0.000	0.000	0.000	0.000

Note: ***, ** and * - an estimate is significantly different from zero at 1%, 5% and 10% level, respectively. Robust standard errors of estimated coefficients are reported in parentheses.

[a] In FE 4.5 we replace our adjusted-to-falsifiers overdue loan ratio to its unadjusted analogue

[b] Lerner index is calculated using operating marginal costs, which is based on estimated operating efficiency frontier

[c] 2004 and 2005 dummies were omitted due to collinearity

Table 5c. Estimation results of the static specification of the overdue loans equation: robustness check №2

	Dependent variable: Overdue loans to total loans ratio	
	FE 4.6 Top-200 banks	FE 4.6 Out of the Top-200 banks
Macroeconomic determinants		
Unemployment rate, %	0.486***	0.454***
	(0.148)	(0.065)
Current account balance to GDP ratio, %	–0.254***	–0.165***
	(0.028)	(0.017)
Disinflation (reduction of inflation),	–0.345***	–0.243***
percentage points	(0.048)	(0.032)
House price, growth rate, per year,	–0.053***	–0.034***
%	(0.007)	(0.004)
Real lending rate, lag = 4 quarters, %	0.245***	0.207***
	(0.060)	(0.035)
Microeconomic determinants		
Market power (Lerner index)[b], %		
lag = 1 quarter	–0.001	–0.031***
	(0.014)	(0.011)
lag = 2 quarters	–0.008	0.016
	(0.006)	(0.011)
lag = 3 quarters	–0.001	0.001
	(0.009)	(0.011)
lag = 4 quarters	–0.005	–0.017
	(0.008)	(0.011)
Total sum of 4 lags	–0.015	–0.031*
	(0.015)	(0.016)
Retail loans to total loans ratio, %		
lag = 1 quarter	0.016	0.032***
	(0.028)	(0.011)
lag = 2 quarters	–0.032**	–0.026**
	(0.013)	(0.012)
lag = 3 quarters	–0.012	0.016
	(0.015)	(0.011)
lag = 4 quarters	0.033**	0.003
	(0.016)	(0.010)
Total sum of 4 lags	0.005	0.026***
	(0.019)	(0.010)
Loans to total assets ratio, %		
lag = 1 quarter	–0.074***	–0.044***
	(0.024)	(0.013)
lag = 2 quarters	–0.008	0.000
	(0.010)	(0.006)
lag = 3 quarters	–0.014*	0.003
	(0.008)	(0.006)
lag = 4 quarters	–0.002	–0.001
	(0.009)	(0.009)
Total sum of 4 lags	–0.097***	–0.042**
	(0.031)	(0.021)
Intercept	7.700**	3.902*
	(2.977)	(2.127)
Number of observations (banks)	2663	5915
	(157)	(515)
R^2 (LSDV)	0.683	0.697
P-value of F statistics	0.000	0.000

Note: ***, ** and * - an estimate is significantly different from zero at 1%, 5% and 10% level, respectively. Robust standard errors of estimated coefficients are reported in parentheses.

[b] Lerner index is calculated using operating marginal costs, which is based on estimated operating efficiency frontier

Table 6. Estimation results of the dynamic specification of the overdue loans equation (one-step difference GMM estimator)

	Dependent variable: overdue loans to total loans ratio		
	GMM 0 (FE 4)	GMM 1	GMM 2
Inertia			
Overdue loans to total loans ratio, lag = 1 quarter, %	0.963***	0.961***	0.722***
	(0.147)	(0.066)	(0.149)
Macroeconomic determinants			
Unemployment rate, %	0.204***	0.168***	0.230***
	(0.047)	(0.043)	(0.057)
Weakening of the nominal exchange rate (ruble to US dollar)		–0.010*	
		(0.005)	
Current account balance to GDP ratio, %	–0.032		
	(0.025)		
Disinflation (reduction of inflation), percentage points	–0.043		–0.045*
	(0.038)		(0.027)
House price, growth rate, per year, %	–0.007		
	(0.007)		
Real lending rate, lag = 4 quarters, %	0.027		
	(0.049)		
Microeconomic determinants			
Non-interest income to total income ratio[a] (in the deviations from the banking system average), %			
lag = 1 quarter		–0.028***	–0.025***
		(0.011)	(0.010)
lag = 2 quarters		0.012	0.012
		(0.013)	(0.013)
lag = 3 quarters		0.008	0.019
		(0.015)	(0.018)
lag = 4 quarters		–0.018*	–0.029**
		(0.010)	(0.013)
Total sum of 4 lags		–0.025***	–0.022**
		(0.009)	(0.009)
Market power (Lerner index)[b], %			
lag = 1 quarter	–0.016	–0.047***	–0.072**
	(0.029)	(0.015)	(0.031)
lag = 2 quarters	0.012	0.009	0.011*
	(0.008)	(0.006)	(0.006)
lag = 3 quarters	–0.003	–0.001	0.038*
	(0.006)	(0.005)	(0.022)
lag = 4 quarters	0.002	–0.002	–0.034
	(0.006)	(0.005)	(0.025)
Total sum of 4 lags	–0.006	–0.041***	–0.056**
	(0.028)	(0.013)	(0.023)
Retail loans to total loans ratio, %			
lag = 1 quarter	–0.003		
	(0.011)		
lag = 2 quarters	–0.023*		
	(0.014)		
lag = 3 quarters	0.020		
	(0.016)		
lag = 4 quarters	0.004		
	(0.013)		
Total sum of 4 lags	–0.002		
	(0.010)		
Loans to total assets ratio, %			
lag = 1 quarter	0.025		

	Dependent variable: overdue loans to total loans ratio		
	GMM 0 (FE 4)	GMM 1	GMM 2
	(0.021)		
lag = 2 quarters	0.016**		
	(0.006)		
lag = 3 quarters	0.009*		
	(0.005)		
lag = 4 quarters	0.009		
	(0.006)		
Total sum of 4 lags	0.058**		
	(0.029)		
Number of observations	7626	7696	7696
(banks)	(629)	(630)	(630)
Number of instruments	77	70	114
Goodness of fit	0.832	0.829	0.767
P-value of AR(1) / AR(2) tests	0.000 / 0.392	0.000 / 0.448	0.000 / 0.692
P-value of Hansen test	0.001	0.038	0.064
P-value of Wald statistics	0.000	0.000	0.000

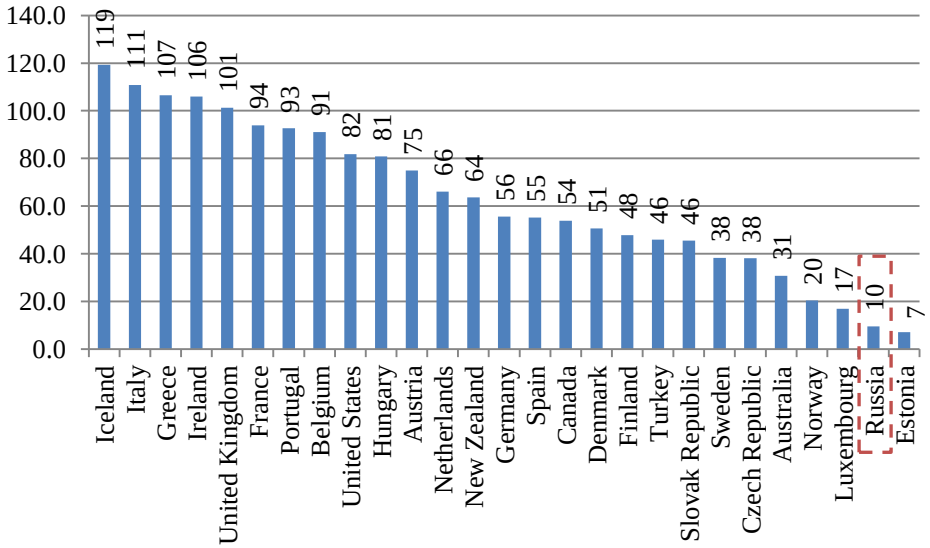
Note: ***, ** and * - an estimate is significantly different from zero at 1%, 5% and 10% level, respectively. Robust (collapsed) standard errors of estimated coefficients are reported in parentheses.

[a] Income coming from loan loss provision recovery and negative revaluation of assets denominated in foreign currency are excluded from both the numerator and the denominator of the ratio

[b] Lerner index is calculated using operating marginal costs obtained from estimated efficiency frontier

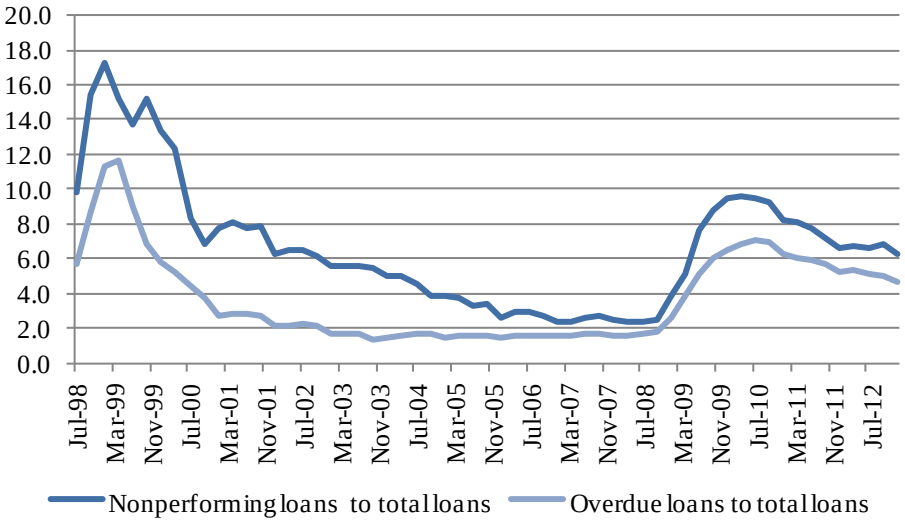
Figures

Figure 1. Central government debt to GDP in 2011, %.



Source: World Bank

Figure 2. The percentage of nonperforming loans and overdue loans in the total loan portfolio of Russian banking sector



Source: the Bank of Russia, authors' calculations

Figure 3. The share of explained by the first 10 principal components variance

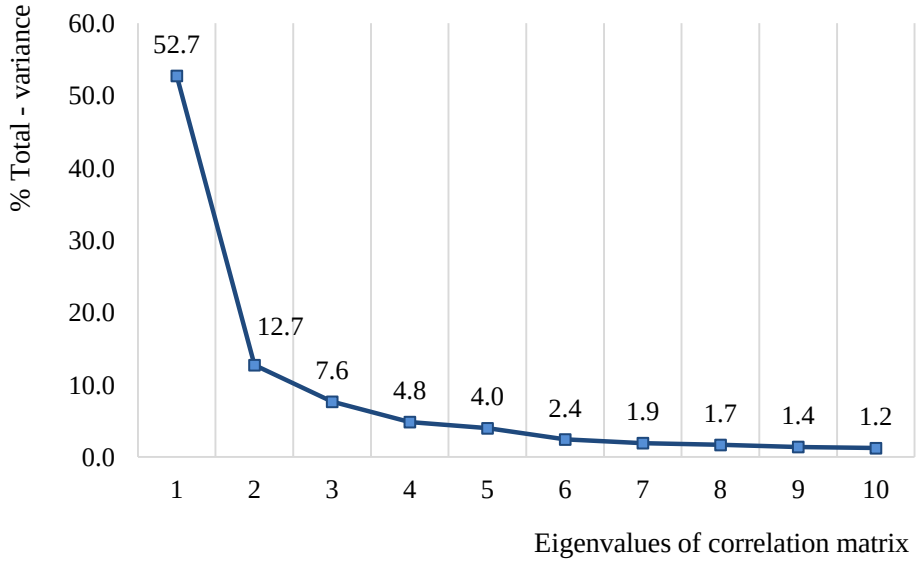
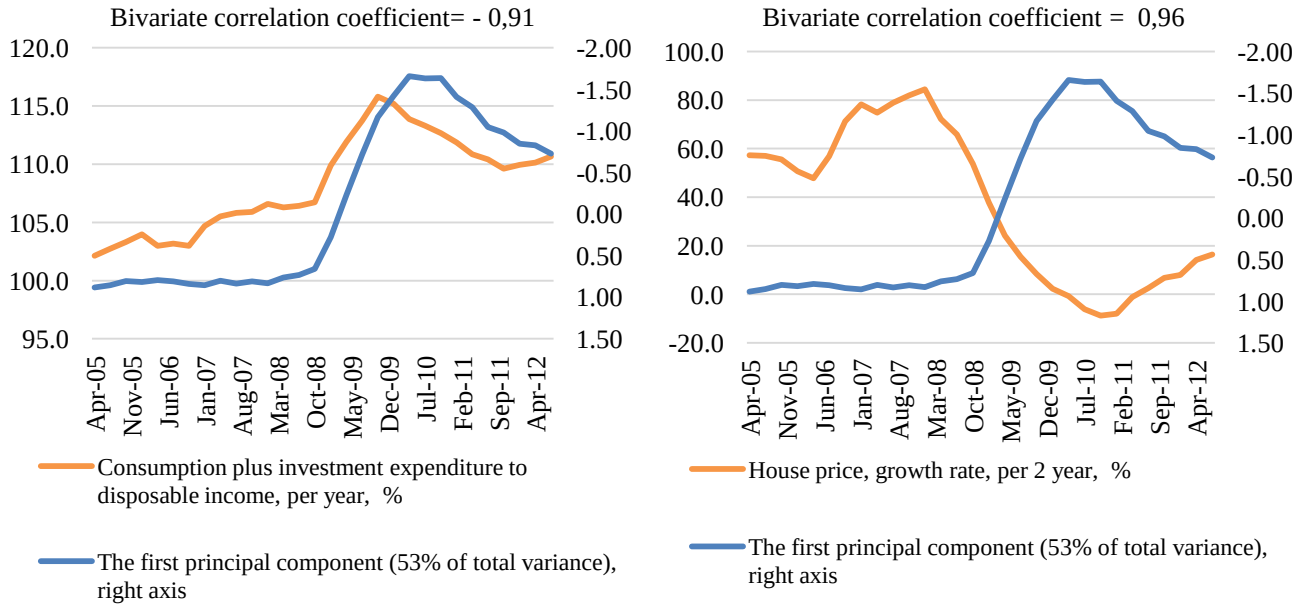


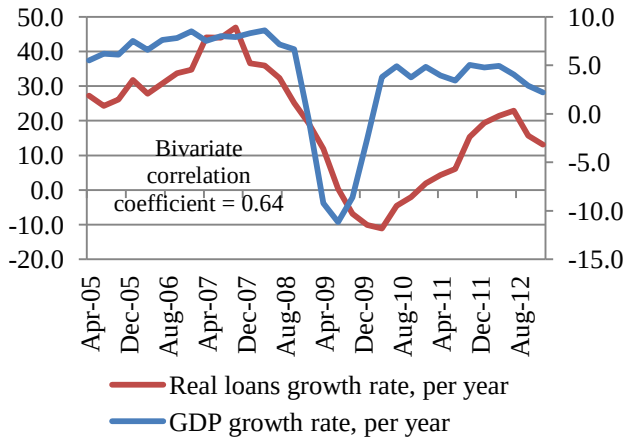
Figure 4. Analysis of the relationship between the first principal component and the macroeconomic conditions



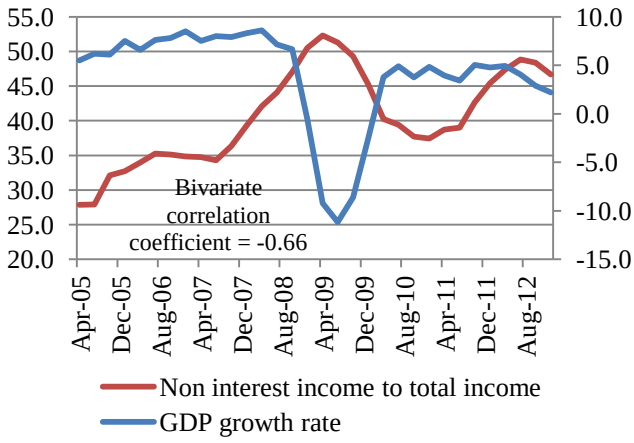
Source: the Bank of Russia, Federal State Statistic Service, authors' calculations

Figure 5. Correlation between selected banking factors (measured as sample average) and macroeconomic conditions (approximated by GDP growth rates)

Real loans growth rate, per year (%) and GDP growth rate, per year (%) - right scale

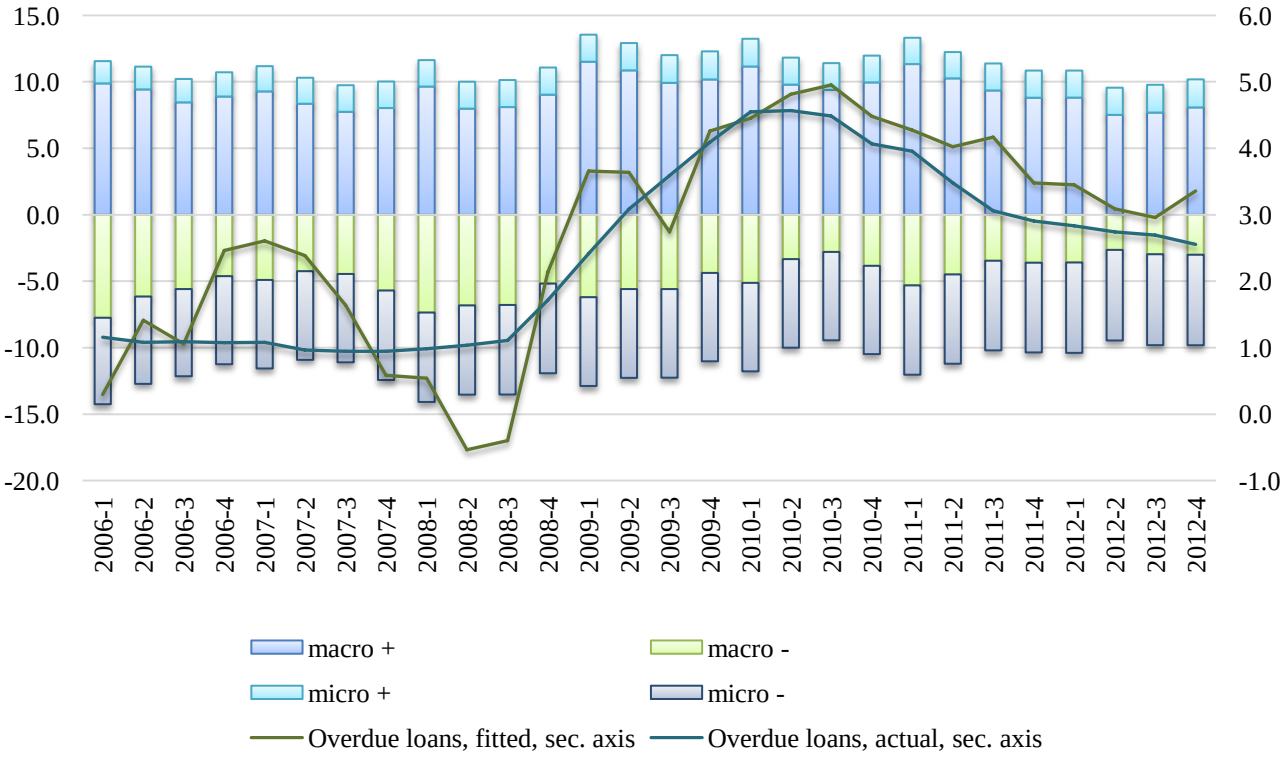


Non interest income[21] to total income (%) and GDP growth rate, per year (%) - right scale



Source: the Bank of Russia, Federal State Statistic Service, authors' calculations

Figure 6a. Factors decomposition of the overdue loan ratio (excluding intercept) of the median bank, model FE1



[21] excluding income from currency revaluation and from loan loss reserves recovery

Figure 6b Factors decomposition of the overdue loan ratio (excluding intercept) of the median bank, model FE4

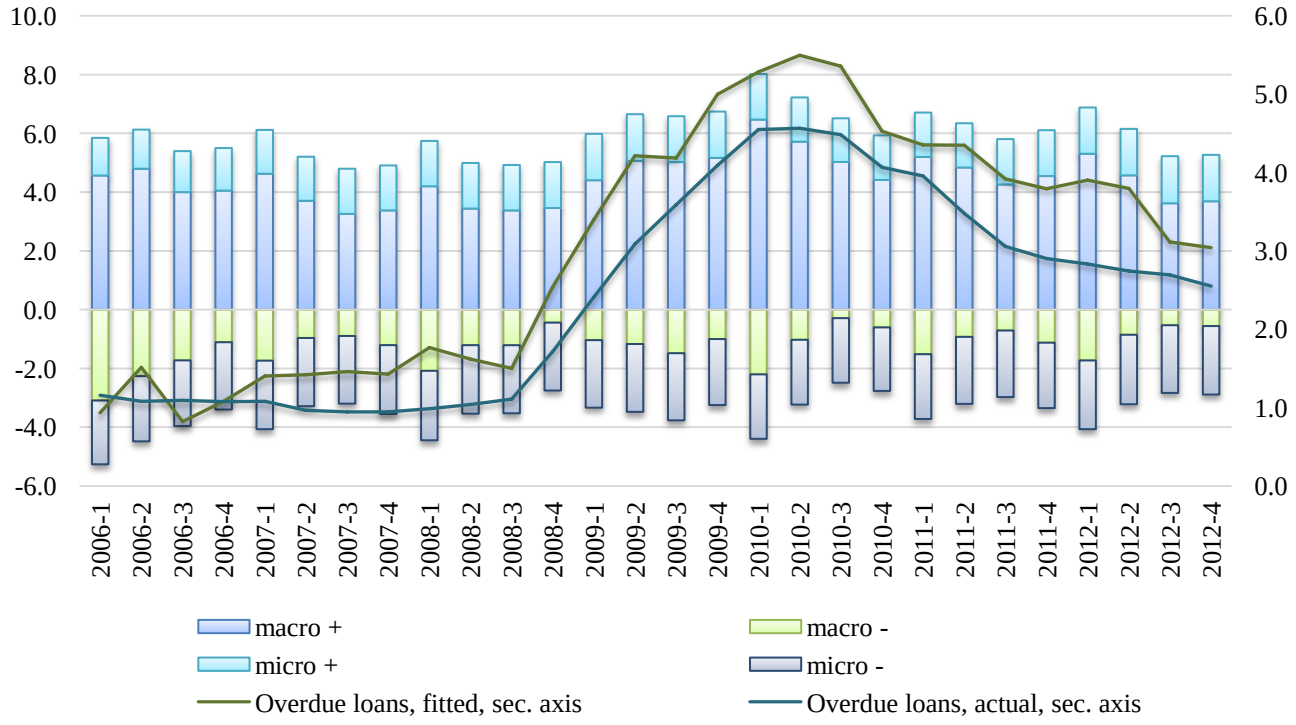


Figure 6c. Factors decomposition of the overdue loan ratio (excluding intercept and inertia) of the median bank, model GMM1

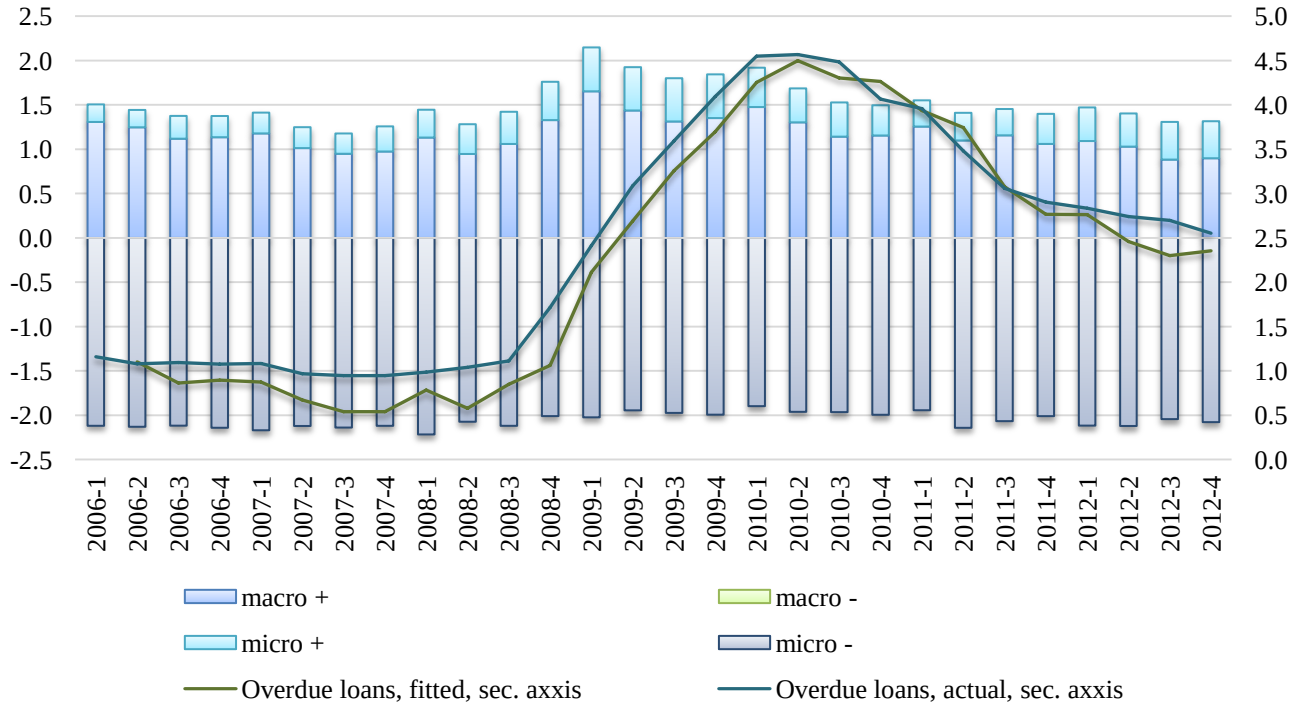
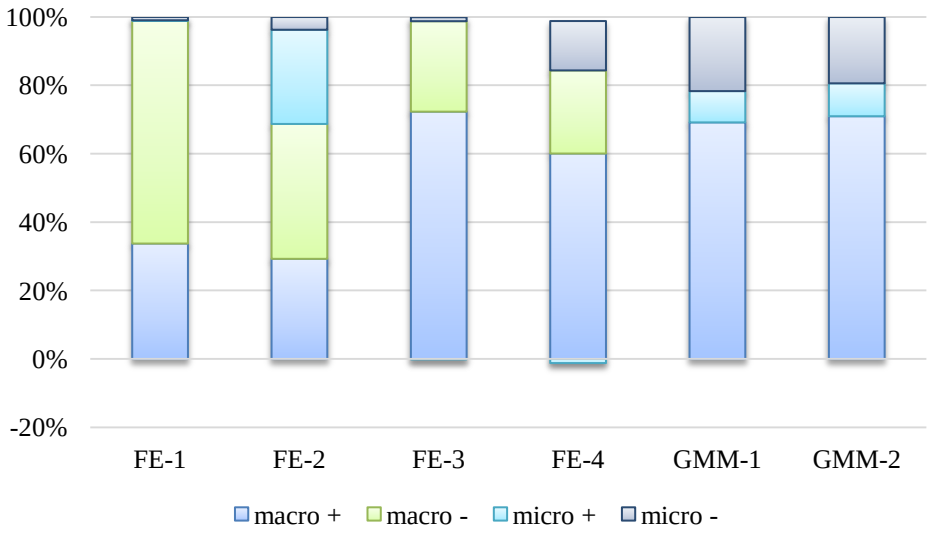
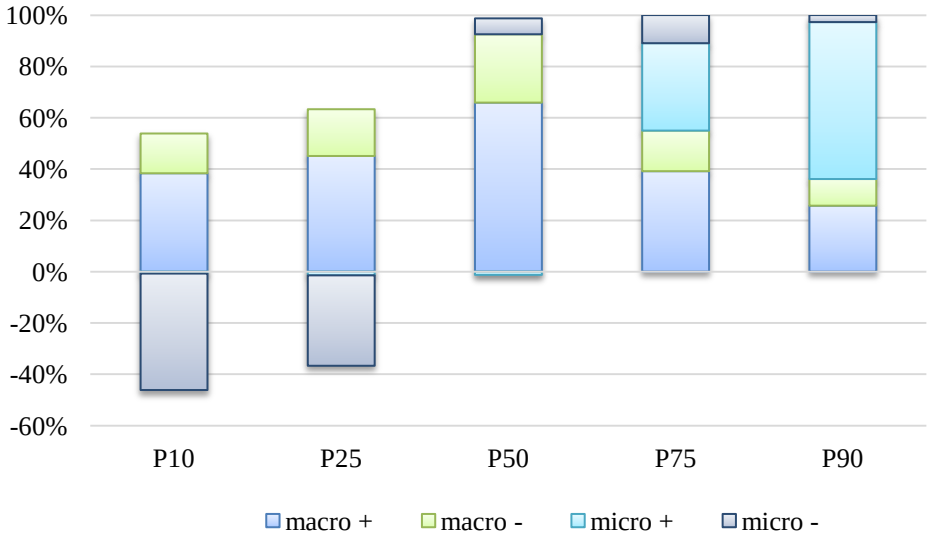


Figure 7. The contribution of increases in different factors to the fitted values of overdue loan ratio of the median bank in different model specifications over the period 2008Q2 – 2010Q2



Note: FE (fixed effects) equations are presented in the Table 5a; GMM equations are presented in the Table 6

Figure 8. Comparison of factor decomposition of overdue loan ratio increase over the crisis period (2008Q2 – 2010Q2) for different percentiles of banks (baseline model – FE4)



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