Macroeconomic and bank-specific determinants of credit risk: evidence from Russia

Anna Pestova, CMASF, NRU-HSE
Mikhail Mamonov, CMASF, NRU-HSE

Rethymnon, Greece
2013
Outline

1. Introduction
2. Literature review
3. Data description
4. Principal component analysis
5. Econometric model specification and methodology
6. Econometric model estimation results
7. Conclusion
Outline

1. Introduction
2. Literature review
3. Data description
4. Principal component analysis
5. Econometric model specification and methodology
6. Econometric model estimation results
7. Conclusion
Motivation of the study

- During the global financial crisis the Russian banking system was faced with a significant increase in nonperforming loans (four times growth over the period 2008-2010).
- Under these conditions Russian government carried out sizable recapitalization of the major Russian banks (18 banks, most of them were in the top-30 of largest banks; about trillion rubles) to prevent their bankruptcies.
- The question inevitably arises, how justified was the decision of Russian government to provide financial support to the credit institutions?
The objective of the study

- to disentangle the influence of macro- and microeconomic factors on the credit risk increase of Russian banks
- assess to what extent the growth of nonperforming loans in the banking system was due to the common for all banks shock (macroeconomic crisis) – principal component analysis;
- explain the dynamics of nonperforming loans on the panel data of Russian banks using independent variables that reflect macroeconomic conditions and bank-specific business strategies, implement factor decomposition of the dependent variable – panel data econometric analysis.
Contribution

- There are many studies considering determinants of the credit risk at the level of individual banks on the different countries data sets. These studies provide valuable empirical basis for the regulation design in the analyzed countries.

- To the best of our knowledge the question of disentangling the relative importance of macro- and bank-specific factors of the credit risk has not been raised yet. We propose the specification of the credit risk econometric model that is aimed at unbiased assessment of macro- and bank-level determinants contribution to the credit risk increase during the crisis.

- This is the first comprehensive research on the credit risk determinants in Russia, only bank «competition – stability» nexus was investigated – *Mamonov (2012).*

- Different data sets: all banks are considered in this paper *vs* banks reported their balance sheets during the entire analyzed period in *Mamonov (2012).*
Outline

1. Introduction
2. Literature review
3. Data description
4. Principal component analysis
5. Econometric model specification and methodology
6. Econometric model estimation results
7. Conclusion
Literature review

Determinants of the credit risk in the empirical literature

- **Macroeconomic factors**
  - GDP growth rates / unemployment rate / corporate profit to debt ratio (phase of the business cycle) – most of the studies
  - Asset prices – *Quagliariello (2007); (Nkusu 2011)*
  - Exchange rates dynamics – *Głogowski (2008); Dash, Kabra (2010)*

- **Bank-specific factors**
  - Lending policy – *Quagliariello (2007); Espinoza, Prasad (2010); Jimenez et al. (2005)*
  - Interest rates on loans – *Pesola (2005)*
  - Banks’ market power – *Berger et al. (2008); Jimenez (2007)*
  - Banks’ efficiency and performance – *Berger, DeYoung (1997); Louzis et al. (2011), etc.*
  - Income and borrowers diversification – *Salas, Saurina (2002)*
Outline

1. Introduction
2. Literature review
3. Data description
4. Principal component analysis
5. Econometric model specification and methodology
6. Econometric model estimation results
7. Conclusion
Data description 1/3

Data sources

- bank-specific factors – Bank of Russia website (www.cbr.ru)

<table>
<thead>
<tr>
<th>Data Sources</th>
<th>Balance sheet statistics (form 101)</th>
<th>Income statement data (form 102)</th>
</tr>
</thead>
</table>
| Variables    | Assets: retail and corporate loans including overdue loans, total assets, etc.  
|              | Liabilities: attracted funds, deposits, 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                         |
The dependent variable – choosing available indicator of bank loan quality

- the percentage of nonperforming loans - available on a small number of banks;
  - Note: Russian banks are not required to publish their financial accounts in line with the International Financial Reporting Standards;
- the share of problem and bad loans (IV and V quality categories according to the Regulation of the Bank of Russia № 254-P) - data on individual banks are not available;
  - Published only for the whole sector, approximation for the share of nonperforming loans (IMF);
- the percentage of overdue loans – the only available substitute for the share of nonperforming loans on individual banks
  - In line with the Russian Accounting Standards, published by all banks

Ratio of overdue loans to total loans reflects only the outstanding tranches of loan
The entire loan becomes nonperforming if any payment is past due by 90 days or more

nonperforming loans to total loans
overdue loans to total loans
Sample description

- Time period: 2004 Q1 – 2013 Q1;
- From quarter to quarter sample size of banks, who published their accounts, varies from 706 financial institutions at the beginning of 2004 to 940 at the end of 2012.
- We excluded banks for whom lending is not the main activity: whose ratio of loans to total assets was below the 5th percentile (less than 10%);
- We identified and excluded from the sample banks suspected of financial accounts falsification.
  - Basic idea: if a bank does not face an increase in overdue loans ratio during the crisis (2008 Q2 - 2010 Q2) and also its overdue loans ratio was lower than the median value before the crisis, than it is highly expected that its managers do falsify financial accounts.
- Besides, we excluded observations on overdue loans below the 1st percentile (abnormally low level).
- 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.
Outline

1. Introduction
2. Literature review
3. Data description
4. Principal component analysis
5. Econometric model specification and methodology
6. Econometric model estimation results
7. Conclusion
Principal component analysis

- The purpose is to lower space of the individual bank overdue loans data by means of the 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.

The first factor explains 53% of the total variance, the first three principal components account for 73%;

- Individual bank overdue loans ratios are at high extent driven by the "common trends";
- Evidence in favor of macroeconomic factors predominance.
Outline

1. Introduction
2. Literature review
3. Data description
4. Principal component analysis
5. Econometric model specification and methodology
6. Econometric model estimation results
7. Conclusion
Econometric model specification and methodology 1/3

- Naive specification of the overdue loans model:

\[
OL_{i,t} = \xi + \sum_{j=1}^{N_1} \beta^{(j)} \cdot M_{t-k}^{(j)} + \sum_{h=1}^{N_2} \theta^{(h)} \cdot B_{i,t-k}^{(h)} + \mu_i + \nu_{i,t}
\]

where \( OL \) is the percentage of overdue loans, \( M \) – macroeconomic determinants, \( B \) – bank-specific factors

- If bank-specific factors are correlated with the macroeconomic ones we can overestimate the relative importance of microeconomic factors.

- In this case macro factors would have direct influence through their own coefficients and \textit{indirect} impact on the overdue loans through the influence on bank actions → bias in factor decomposition

- The possible solution is to avoid to include into equation those bank-specific factors that are closely correlated with macroeconomic conditions
Econometric model specification and methodology 2/3

Correlation between sample mean of banking factors and macroeconomic conditions approximated by GDP growth

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

Non interest income to total income (%) and GDP growth rate, per year (%) - right scale
Econometric model specification and methodology 3/3

Static specification of the overdue loans (OL) ratio equation – FE model

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

- \( M \) – macroeconomic factors;
- \( BM \) – banking sector macro-factors;
- \( B \) – bank-specific microeconomic determinants;
- \((B - MB)\) - deviations of the bank-specific determinants from the banking sector averaged variables
- \( \mu_i + \nu_{i,t} \) – composite error term, that includes individual effect of bank \( i \) and idiosyncratic component which assumed to be \( i.i.d. (0, \sigma_v^2) \)

Dynamic specification (OL cannot be immediately written-down) – system GMM: difference + levels equation

\[
\begin{align*}
OL_{t,i} &= \xi + \alpha_i OL_{t-1,i} + \sum_{j=1}^{N_1} \beta^{(j)} M_{t-k}^{(j)} + \sum_{s=1}^{N_2} \gamma^{(s)} BM_{t-k}^{(s)} + \sum_{h=1}^{N_3} \theta^{(h)} B_{i,t-k}^{(h)} + \sum_{m=1}^{N_4} \delta^{(m)} (B_{i,t-k}^{(m)} - BM_{t-k}^{(m)}) + \mu_i + \nu_{i,t} \\
\Delta OL_{t,i} &= \alpha_i \Delta OL_{t-1,i} + \sum_{j=1}^{N_1} \beta^{(j)} \Delta M_{t-k}^{(j)} + \sum_{s=1}^{N_2} \gamma^{(s)} \Delta BM_{t-k}^{(s)} + \sum_{h=1}^{N_3} \theta^{(h)} \Delta B_{i,t-k}^{(h)} + \sum_{m=1}^{N_4} \delta^{(m)} \Delta (B_{i,t-k}^{(m)} - BM_{t-k}^{(m)}) + \Delta \nu_{i,t}
\end{align*}
\]
Outline

1. Introduction
2. Literature review
3. Data description
4. Principal component analysis
5. Econometric model specification and methodology
6. Econometric model estimation results
7. Conclusion
### Static model - FE estimator

#### Dependent variable: overdue loans to total loans ratio

<table>
<thead>
<tr>
<th></th>
<th>FE1</th>
<th>FE2</th>
<th>FE3</th>
<th>FE4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unemployment rate, %</td>
<td>1.268***</td>
<td>0.473***</td>
<td>0.588***</td>
<td>0.486***</td>
</tr>
<tr>
<td></td>
<td>(0.081)</td>
<td>(0.085)</td>
<td>(0.075)</td>
<td>(0.063)</td>
</tr>
<tr>
<td>Current account balance to GDP ratio, %</td>
<td>–0.260***</td>
<td>–0.045***</td>
<td>–0.238***</td>
<td>–0.196***</td>
</tr>
<tr>
<td></td>
<td>(0.017)</td>
<td>(0.013)</td>
<td>(0.017)</td>
<td>(0.015)</td>
</tr>
<tr>
<td>Inflation, per year, %</td>
<td>–0.344***</td>
<td></td>
<td>–0.460***</td>
<td>–0.288***</td>
</tr>
<tr>
<td></td>
<td>(0.028)</td>
<td></td>
<td>(0.036)</td>
<td>(0.028)</td>
</tr>
<tr>
<td>Disinflation, p. p.</td>
<td></td>
<td></td>
<td>–0.106***</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.009)</td>
<td></td>
</tr>
<tr>
<td>Corporate profit to debt, %</td>
<td></td>
<td>–0.050***</td>
<td>–0.040***</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.004)</td>
<td>(0.004)</td>
<td></td>
</tr>
<tr>
<td>House price, growth rate, per year, %</td>
<td></td>
<td>–0.260***</td>
<td>–0.045***</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.017)</td>
<td>(0.013)</td>
<td></td>
</tr>
<tr>
<td>Real lending rate, lag = 4 quarters %</td>
<td>0.041***</td>
<td>0.032***</td>
<td>0.019*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.010)</td>
<td>(0.009)</td>
<td>(0.010)</td>
<td></td>
</tr>
<tr>
<td>Efficiency index (SFA)(^a), Total sum of 4 lags</td>
<td>–0.068***</td>
<td>–0.080***</td>
<td>–0.075***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.023)</td>
<td>(0.024)</td>
<td>(0.023)</td>
<td></td>
</tr>
<tr>
<td>Retail loans to total loans ratio, % Total sum of 4 lags</td>
<td>0.041***</td>
<td>0.032***</td>
<td>0.019*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.010)</td>
<td>(0.009)</td>
<td>(0.010)</td>
<td></td>
</tr>
<tr>
<td>Real lending rate, % Total sum of 4 lags</td>
<td></td>
<td></td>
<td>0.184***</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.032)</td>
<td></td>
</tr>
<tr>
<td>Market power (Lerner index)(^b), % Total sum of 4 lags</td>
<td></td>
<td></td>
<td>–0.025**</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.011)</td>
<td></td>
</tr>
<tr>
<td>Loans to total assets ratio, % Total sum of 4 lags</td>
<td></td>
<td></td>
<td>–0.062***</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.017)</td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>3.691*</td>
<td>12.565***</td>
<td>5.152**</td>
<td>5.112***</td>
</tr>
<tr>
<td></td>
<td>(2.023)</td>
<td>(2.632)</td>
<td>(2.072)</td>
<td>(1.662)</td>
</tr>
<tr>
<td>Number of observations (banks)</td>
<td>15181 (880)</td>
<td>15018 (869)</td>
<td>15181 (880)</td>
<td>8578 (672)</td>
</tr>
<tr>
<td>R(^2) (LSDV)</td>
<td>0.537</td>
<td>0.517</td>
<td>0.554</td>
<td>0.691</td>
</tr>
<tr>
<td>P-value of F statistic</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
</tbody>
</table>

**Notes:** *, **, *** - an estimate is significantly different from zero at 1%, 5% and 10% level, respectively. Robust standard errors are in parentheses.
Factor decomposition of the dependent variable for the median bank – model FE4 («baseline»)

Estimation results 2/6
We added control variables to the baseline fixed effects model (FE4 model which had the largest adjusted R-squared):

- dummy variables for ownership structure and geographical location: metropolitan, foreign banks dummies were significant;
- individual bank loans to deposits ratio – insignificant;
- bank size – insignificant;
- time effects – partly significant;

and imposed the restrictions on the sample:

- added falsified banks to the sample;
- estimated separate models for the subsample of top-200 banks and banks that are out of top-200.

In the majority of these additional models all variables that were included in the baseline model preserved their significance and sign after adding controls or modifying sample.

Running dynamic GMM on the baseline FE specification produces unsatisfactory results (most of the micro variables became insignificant). That is why GMM specifications could not be directly compared with the previously obtained FE models.
## Estimation results 4/6

### Dynamic model – system GMM estimator

<table>
<thead>
<tr>
<th></th>
<th>Dependent variable: overdue loans to total loans ratio</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>GMM1</td>
<td>GMM2</td>
</tr>
<tr>
<td><strong>Inertia</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overdue loans to total loans ratio, lag = 1 quarter, %</td>
<td>1.049***</td>
<td>1.067***</td>
</tr>
<tr>
<td></td>
<td>(0.030)</td>
<td>(0.032)</td>
</tr>
<tr>
<td><strong>MACRO</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unemployment rate, %</td>
<td>0.237***</td>
<td>0.223***</td>
</tr>
<tr>
<td></td>
<td>(0.040)</td>
<td>(0.025)</td>
</tr>
<tr>
<td>GDP growth rate, per year, %</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard deviation of the nominal exchange rate of ruble to US dollar, %</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Real lending rate, lag = 4 quarters, %</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loans to deposits ratio, lag = 4 quarters, %</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>MICRO</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-interest income to total income ratio (in deviations from the banking system average), %</td>
<td>–0.017*</td>
<td>–0.004***</td>
</tr>
<tr>
<td></td>
<td>(0.009)</td>
<td>(0.001)</td>
</tr>
<tr>
<td>Retail loans to total loans ratio, %</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Intercept</strong></td>
<td>–6.392**</td>
<td>–1.707***</td>
</tr>
<tr>
<td></td>
<td>(2.809)</td>
<td>(0.137)</td>
</tr>
<tr>
<td><strong>Number of observations (banks)</strong></td>
<td>16077</td>
<td>16203</td>
</tr>
<tr>
<td></td>
<td>(889)</td>
<td>(896)</td>
</tr>
<tr>
<td><strong>Number of instruments</strong></td>
<td>41</td>
<td>41</td>
</tr>
<tr>
<td><strong>Goodness of fit</strong></td>
<td>0.695</td>
<td>1.000</td>
</tr>
<tr>
<td><strong>P-value of AR(1) / AR(2) tests</strong></td>
<td>0.000 / 0.513</td>
<td>0.000 / 0.719</td>
</tr>
<tr>
<td><strong>P-value of Hansen test</strong></td>
<td>0.359</td>
<td>0.059</td>
</tr>
<tr>
<td><strong>P-value of Wald statistics</strong></td>
<td>0.000</td>
<td>0.000</td>
</tr>
</tbody>
</table>

*Notes:*, **, *** - an estimate is significantly different from zero at 1%, 5% and 10% level, respectively. Robust standard errors are in parentheses.
Estimation results 5/6

Factor decomposition of the dependent variable for the median bank – GMM2 model
Model comparison - the contribution of increases in different factors to the fitted values of overdue loan ratio of the median bank in different models over the crisis period (2008Q2 – 2010Q2)
Conclusion 1/2

- Worsening of macroeconomic conditions in 2008-2009 made the prevailing contribution to the overdue loans increase of the median bank in Russia. This finding is robust to the method of analysis and the specification of econometric model.

- Regulator should limit the size of adopted risks during the cyclical upturns by means of macroprudential policy and other applicable measures
  - introduction of dynamic prudential norms (reserves, capital, loan-to-value ratio, etc.) - smoothing over the business cycle
  - reduce attractiveness of foreign currency loans issuance.
    - introduce additional reserve requirement on FX loans. Bank of Russia has already refused to guarantee the exchange rate peg → increased exchange rate uncertainty

- During the instability periods the Bank of Russia should take interest rate on loans under control through expanding liquidity provisioning and more targeted interest rate policy
Confirmation of the «bad management» hypothesis on the Russian banks data is found (an increase in the total cost efficiency leads to the reduction in overdue loans ratio).

- The Bank of Russia should reduce the funding costs of banks by means of regulating the maximum deposit interest rate and reduction of the price of refinancing instruments for banks.

- The larger the share of retail loans in the loan portfolio the higher the overdue loans ratio.

  - The Bank of Russia should discourage excessive involvement into retail lending by means of additional reserve requirements on the loans to households (especially for unsecured ones – introduced in 2012).

“Competition-fragility” nexus on the Russian banks data is confirmed: banks with higher market power tend to have lower overdue loans ratio – in line with Mamonov, (2012).

  - This is the rationale for the Bank of Russia to encourage mergers and acquisitions of small banks. 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.

- Participation in the operations not associated with the credit risk taking (payment transactions, broking, asset management services, etc.) decreases overdue loans ratio.

  - As for the regulator, it should promote the demand for the non-cash transactions and for financial services provided by banks. For this purpose, the program of improving financial literacy of the population should be implemented.
Thank you for your attention!

Anna Pestova – apestova@forecast.ru
Mikhail Mamonov – mmamonov@forecast.ru