RANEPA
THE RUSSIAN PRESIDENTIAL ACADEMY OF NATIONAL ECONOMY AND PUBLIC ADMINISTRATION

Default Forecasting in the Russian Banking Sector

The Rimini Conference in Economics and Finance 2018

Elena Sinelnikova-Muryleva
e.sinelnikova@ranepa.ru
Taisija Gorshkova
Natalja Makeeva
Russian Presidential Academy of National Economy and Public Administration

June 14, 2018

RANEPA
THE RUSSIAN PRESIDENTIAL ACADEMY OF NATIONAL ECONOMY AND PUBLIC ADMINISTRATION

RELEVANCE, NOVEL AND GOAL OF RESEARCH

RELEVANCE OF RESEARCH:

- There are few researches devoted to the study of the current situation in the Russian banking sector.
- The increase number of banks with revoked licenses leads to aggravation of problems with capital adequacy, asset quality and total debt in the economy.

NOVEL OF RESEARCH:

- The application of the machine learning algorithm "random forest" to build a model for default forecasting in the Russian banking sector.
- The applcation of a microprudential approach, using only microeconomic financial variables to build forecasting models.

GOAl OF RESEARCH:

The purpose of the research is to forecast bank defaults and compare the predicted strength of the used models to identify the better one for the Russian banking sector.

RANEPA
THE RUSSIAN PRESIDENTIAL ACADEMY OF NATIONAL ECONOMY AND PUBLIC ADMINISTRATION

LITERATURE REVIEW

Approach	Model	Specification	Inference
Classic	Diamond D.W., Dybvig P.H., 1983	Government deposit insurance	Government deposit insurance prevents bank runs. But proportions of patient and inpatient agents shouldn't be stochastic.
Stochastic modification	Chari V.V., Jagannathan R., 1988	Return of investment is stochastic	There are two equilibriums, where bank run is fulfilled.
The increase in time horizon	Engineer M., 1989	Suspension of deposit convertibility	Suspension of deposit convertibility doesn't prevent bank runs in economy with four periods.
Changes of prerequisites for depositors	Peck J., Shell K., 2003	Different utility functions	The optimal banking mechanism allows the positive probability of bank run.
Modification of the periods structure	Chao G., 2011	Split the second period into N + 1 subperiods	The line to the bank maintains information of the quality of the investment portfolio of the bank.

RANEPA
THE RUSSIAN PRESIDENTIAL ACADEMY OF NATIONAL ECONOMY AND PUBLIC ADMINISTRATION

FACTORS AND THEIR INFLUENCE ON THE PROBABILITY OF DEFAULT

Factor	Effect	Country	Reference
Equity capital/Total assets	-	USA	Hwang, et al., 997
		Russia	Fidrmuc et al., 2011
Gross charge-offs/Net operating income	+	USA	Martin, 1977
		Russia	Fidrmuc et al., 2011
Total loans/Total assets	+	Latin America and East Asia	Arena, 2005
		Russia	Fidrmuc et al., 2011
Return on assets	-	Latin America and East Asia	Arena, 2005
		Russia	Claeys et al., 2007
Return on equity (average)	+	Europe	Messai et al., 2015
		Russia	Fidrmuc et al., 2011
Bank reserves for possible losses	-	Russia	Peresetsky et al., 2011
Past-due debt	-	Russia	Zubarev, 2013

RANEPA
THE RUSSIAN PRESIDENTIAL ACADEMY OF NATIONAL ECONOMY AND PUBLIC ADMINISTRATION

CRITERIA OF DEFAULT

- Default has occurred if and only if at least two of the following events have happened:
  - The value of all capital adequacy ratios of the credit institution became below 2%;
  - The value of net assets is lower than the minimum value of the capital stock, established on the date of state registration;
  - The credit institution does not comply with the requirements of the Bank of Russia in time to adjust the amount of capital stock and capital;
  - The bank can not satisfy the claims of creditors for monetary obligations and/or fulfill the obligation to pay mandatory payments within 14 days from the onset of the date of their satisfaction/performance;
  - The Bank after 1 January 2015 for three consecutive months allows a decrease in the amount of equity(capital) below the minimum amount of equity(capital).

RANEPA
THE RUSSIAN PRESIDENTIAL ACADEMY OF NATIONAL ECONOMY AND PUBLIC ADMINISTRATION

DATA USED

- Time period: 1q 2015 – 1q 2017:
  - Training sample: 1q 2015 – 4q 2016.
  - Control sample: 1q 2017.
- Microdata on 661 banks have been taken from financial statements.
- Removal of outliers and omissions.
- 28 variables have been checked for their possible predicting power.
- ANOVA- test has shown that 14 variables should be included into "structural" the model:
  - $\mathrm{F} = \frac{MSG}{MSE}$,
    - MSG – variance between groups,
    - MSE – variance within groups.

RANEPA
THE RUSSIAN PRESIDENTIAL ACADEMY OF NATIONAL ECONOMY AND PUBLIC ADMINISTRATION

METHODOLOGY: LOGIT-MODEL

$$P(Prob_{it} = 1) = \Lambda\left(x_{it}^T \beta\right),$$

$$G(z) = \Lambda(z) = \frac{e^z}{1 + e^z}$$

- Hausman specification test has shown that both model can be estimated:
  - RE-model (random effects),

$$Prob_{it}^* = x_{it}^T \beta + \alpha_i + \varepsilon_{it}$$

  - PA-model (pool).

$$Prob_{it}^* = x_{it}^T \beta + \varepsilon_{it}$$

$$Prob_{it} = \begin{cases} 0, 0 < Prob_{it}^* \leq \gamma, \\ 1, \gamma < Prob_{it}^* \leq 1 \end{cases}$$

RANEPA
THE RUSSIAN PRESIDENTIAL ACADEMY OF NATIONAL ECONOMY AND PUBLIC ADMINISTRATION

LOGIT-MODEL

Factor	Coef. (pa)	P>|z|	Coef. (re)	P>|z|
Net income/Total assets	-3.58	0.001	—	—
Credit portfolio/Total assets	.88	0.011	—	—
Commercial credit/Credit portfolio	-1.98	0.000	-6.76	0.000
Industrial credit/Credit portfolio	—	—	3.18	0.000
Commercial credit/Total assets	-4.56	0.000	-10.69	0.000
Return on assets	-.00015	0.002	-.0006	0.000
Past-due debt/Credit portfolio	-.029	0.000	-.0501	0.000
Level of collateral for the credit portfolio with property pledge	-.0027	0.002	—	—
Capital adequacy ratio H1	-.033	0.000	-.0655	0.000
Log of deposits of enterprises and organizations	-.629	0.000	-1.516	0.000

RANEPA
THE RUSSIAN PRESIDENTIAL ACADEMY OF NATIONAL ECONOMY AND PUBLIC ADMINISTRATION

LOGIT-MODEL

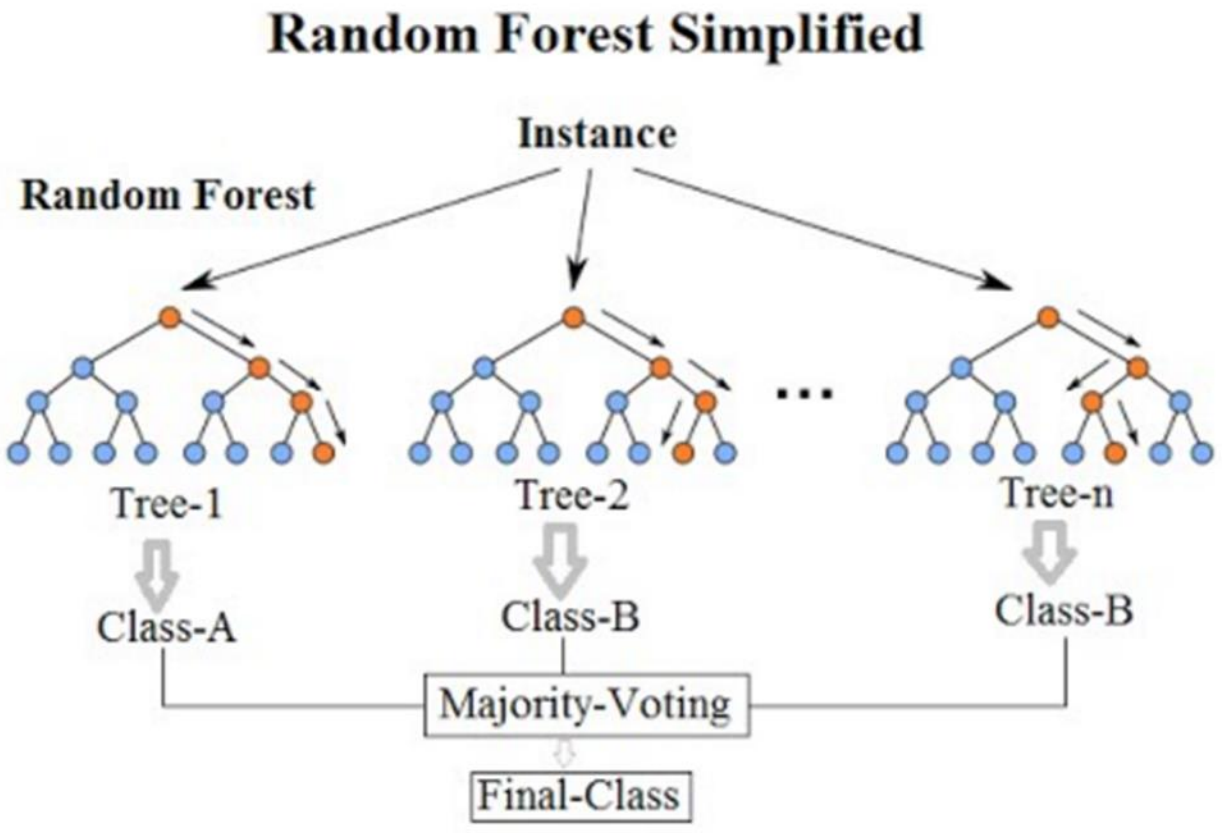
Factor	Expected sign	Sign (PA)	Sign (RE)
Net income/Total assets	-	-	
Credit portfolio/Total assets	+/-	+	
Commercial credit/Credit portfolio	-	-	-
Industrial credit/Credit portfolio	+		+
Commercial credit/Total assets	-	-	-
Return on assets	-	-	-
Past-due debt/Credit portfolio	+	-	-
Level of collateral for the credit portfolio with property pledge	-	-	
Capital adequacy ratio H1	-	-	-
Log of deposits of enterprises and organizations	-	-	-

RANEPA
THE RUSSIAN PRESIDENTIAL ACADEMY OF NATIONAL ECONOMY AND PUBLIC ADMINISTRATION

METHODOLOGY: RANDOM FOREST

- Selection of basic parameters
- Model
- Prediction

- Type of random forest: classification
- Number of trees: 5000
- Number of variables in random subset: N/3
- Number of variables tried at each split: 5



RANEPA
THE RUSSIAN PRESIDENTIAL ACADEMY OF NATIONAL ECONOMY AND PUBLIC ADMINISTRATION

COMPARISON OF MODELS

Model	Probability	Predicted classification		Total
		0	1	
RE-model	0	519	9	528
	1	1	3	4
PA-model	0	524	4	528
	1	1	3	4
Random forest	0	528	0	528
	1	2	2	4

RANEPA
THE RUSSIAN PRESIDENTIAL ACADEMY OF NATIONAL ECONOMY AND PUBLIC ADMINISTRATION

CRITERIA FOR COMPARING

- $MAE = \frac{1}{n}\sum_{i=1}^{n} |\widehat{Prob}_i - Prob_i|$
- $1 - MAE = 1 - \frac{1}{n}\sum_{i=1}^{n} |\widehat{Prob}_i - Prob_i|$
- $MAE \times 100\% = \left(\frac{1}{n}\sum_{i=1}^{n} |\widehat{Prob}_i - Prob_i|\right) \times 100\%$
- $(1 - MAE) \times 100\% = \left(1 - \frac{1}{n}\sum_{i=1}^{n} |\widehat{Prob}_i - Prob_i|\right) \times 100\%$

RANEPA
THE RUSSIAN PRESIDENTIAL ACADEMY OF NATIONAL ECONOMY AND PUBLIC ADMINISTRATION

COMPARISON OF MODELS

Model	MAE × 100%	(1 - MAE)× 100%
RE-model	1.88	98.12
PA-model	0.94	99.06
Random forest	0.38	99.62

RANEPA
THE RUSSIAN PRESIDENTIAL ACADEMY OF NATIONAL ECONOMY AND PUBLIC ADMINISTRATION

RESULTS OF RESEARCH

RESULT:

The best forecast is given by a model, which is built on the basis of the random forest.

FINDINGS:

- PA-model is fitting Russian banking sector data better than RE-model.
- The obtained assessment of the factors influence on probability of default either agrees with previous empirical work or characterizes the features of the Russian economy.
- Identification random forest model as the best model agrees quite well with previous empirical studies.

RANEPA
THE RUSSIAN PRESIDENTIAL ACADEMY
OF NATIONAL ECONOMY
AND PUBLIC ADMINISTRATION

Thank you for your attention!