

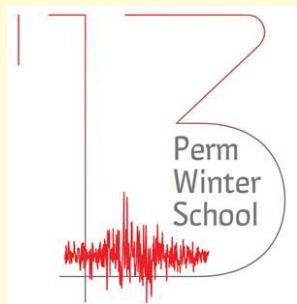
The multiplication of the credit rating agencies efforts under IRB Approach

Интегрирование деятельности рейтинговых агентств в рамках IRB-подхода

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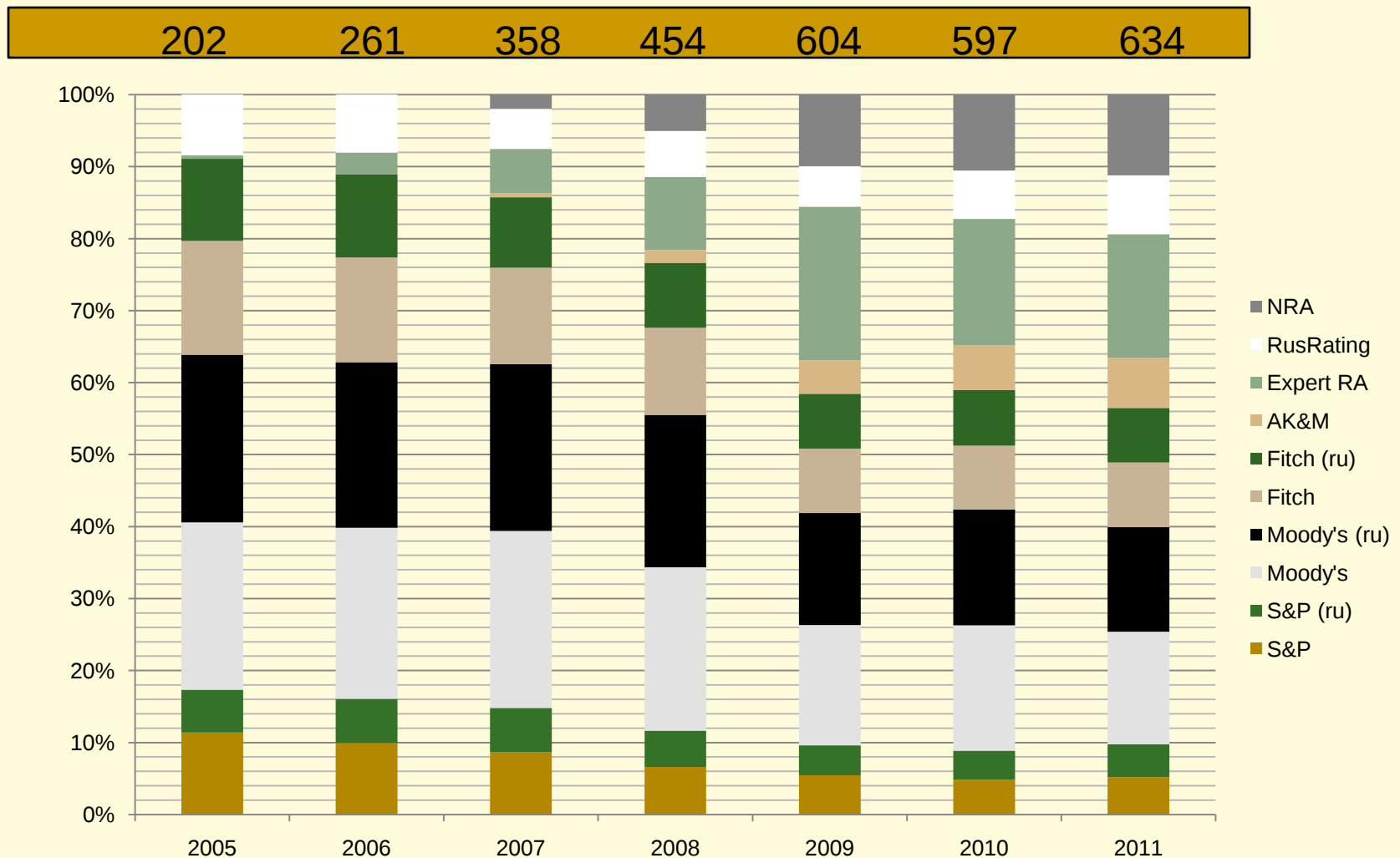
Agenda

- Credit ratings in Russia
- Multiple mapping: comparison of rating scales
- Why modeling of ratings needed?
 - Bank rating modeling
 - Corporate rating modeling
 - Sovereign rating modeling
- Probability of default model for Russian Banks
 - Research background
 - Data and model
 - Empirical model estimation
- Comparing of internal and external ratings for IRB Approach

Literature

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Rating services dynamic : Russian banks



Limitations and capabilities of ratings

Limitations of rating's efficient employment:

- Relatively small number of updated communicative ratings
- Difficulties of **estimation comparison** of different rating agencies
- No multiplicative effect from available competitive estimations
- Demand of extended usage of independent rating estimations primarily owing to **modeling** techniques

Current activities:

- ✓ achieve **comparison** capability of different estimations of rating agencies
- ✓ multiplex independent estimations with employment of **rating modeling**

Unified rating space:

- ✓ selection of base rating scale
- ✓ building of mapping system of external and internal ratings to base scale
- ✓ for every class of rating subjects (**financial institutes**, companies, etc.)
- ✓ common usage of all rating estimations

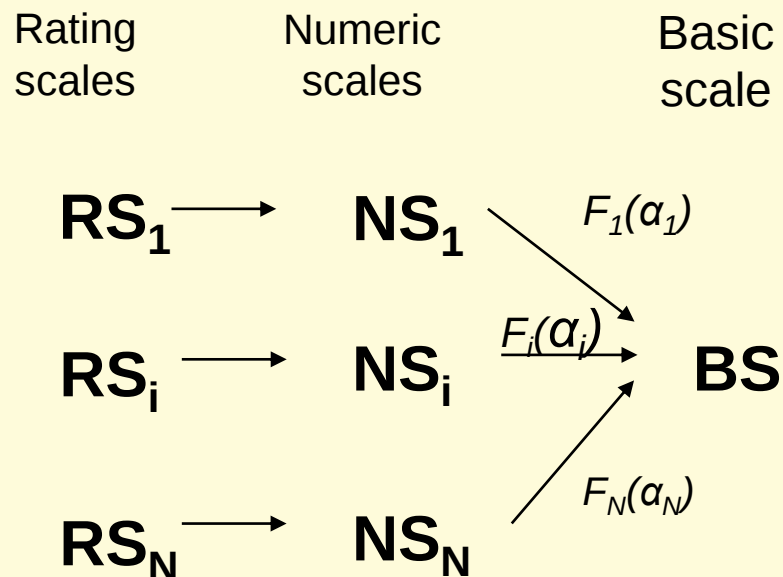
Comparison methods for rating scales

■ Comparison methods include:

- ✓ Methodology of agency-scales mapping
- ✓ Principles and criteria for comparison of rating scales
- Econometric models of scale comparison
- ✓ Audit of the “conformity table” and the coordination of its structure
- ✓ Possibility of duplicated software usage

■ Rating agencies :

- ✓ International: Fitch, Moody's и S&P – 2 scales for everyone
- ✓ Russian: AK&M, NRA, RusRating, Expert RA



$$\min_{\{\alpha_i, i=1, \dots, N\}} \sum_Q (F_{i1}(R_{i1jt}, \alpha_{i1}) - F_{i2}(R_{i2jt}, \alpha_{i2}))^2$$

Q – combination set {quarter t , bank j , rating of basic agency R_{i1jt} , rating of other agency R_{i2jt} }; $F_{i1} : R_i \rightarrow R_{\text{баз}}$; $F_i = \alpha_{i1} \cdot f_i(R_i) + \alpha_{i2}$
 f_i – linear, power or logarithmic function

Data and models: Russian banks ratings

■ Ratings

- International agencies:
3 agency & 6 scales
- 4 Russian agencies
- **Time span:** 1Q 2006 – 4Q 2010 (20 quarters)
- 370 Russian banks with any rating during this time span
- 7400 different estimations

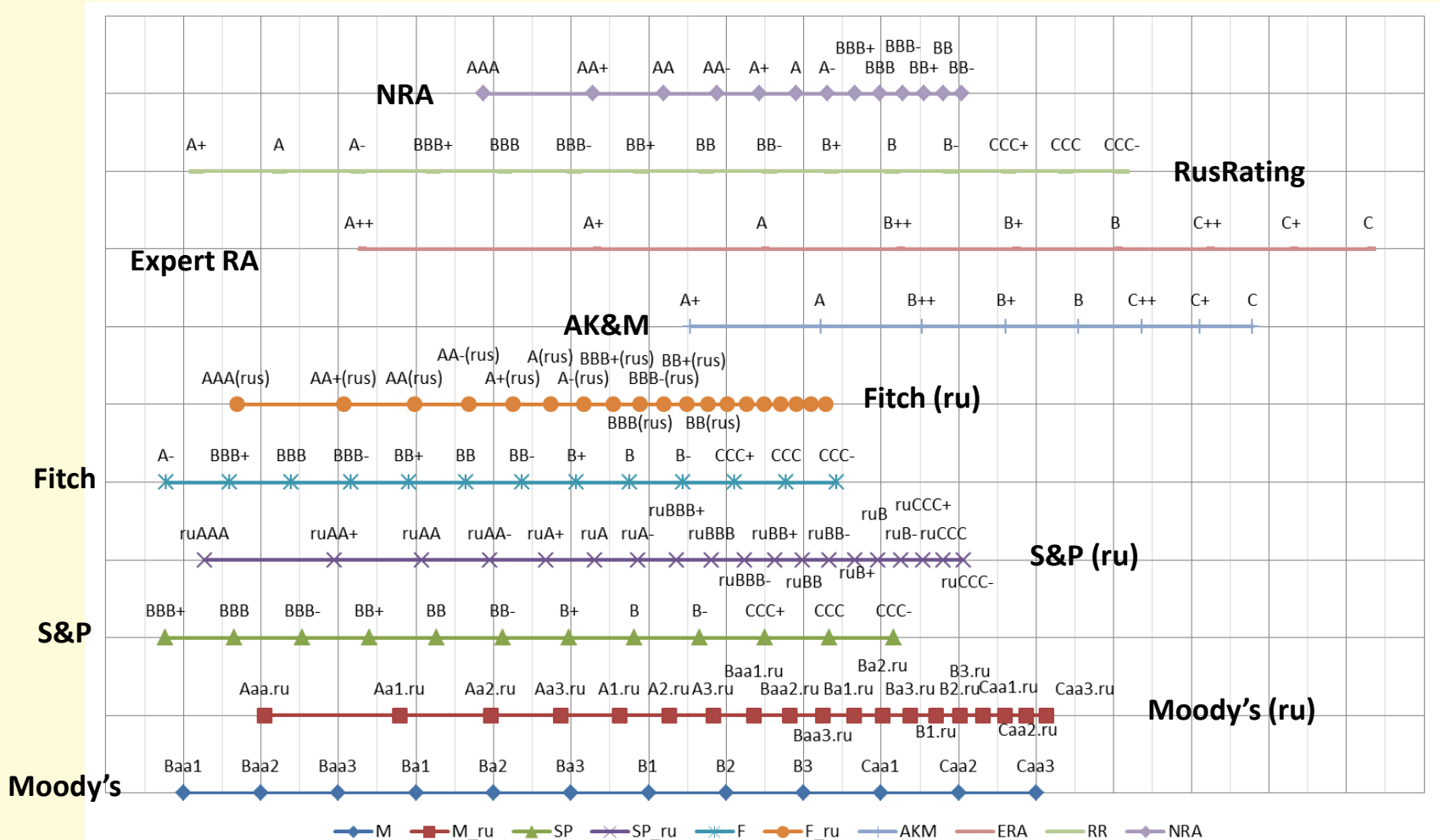
Logarithmic model:

2006-2010 years data

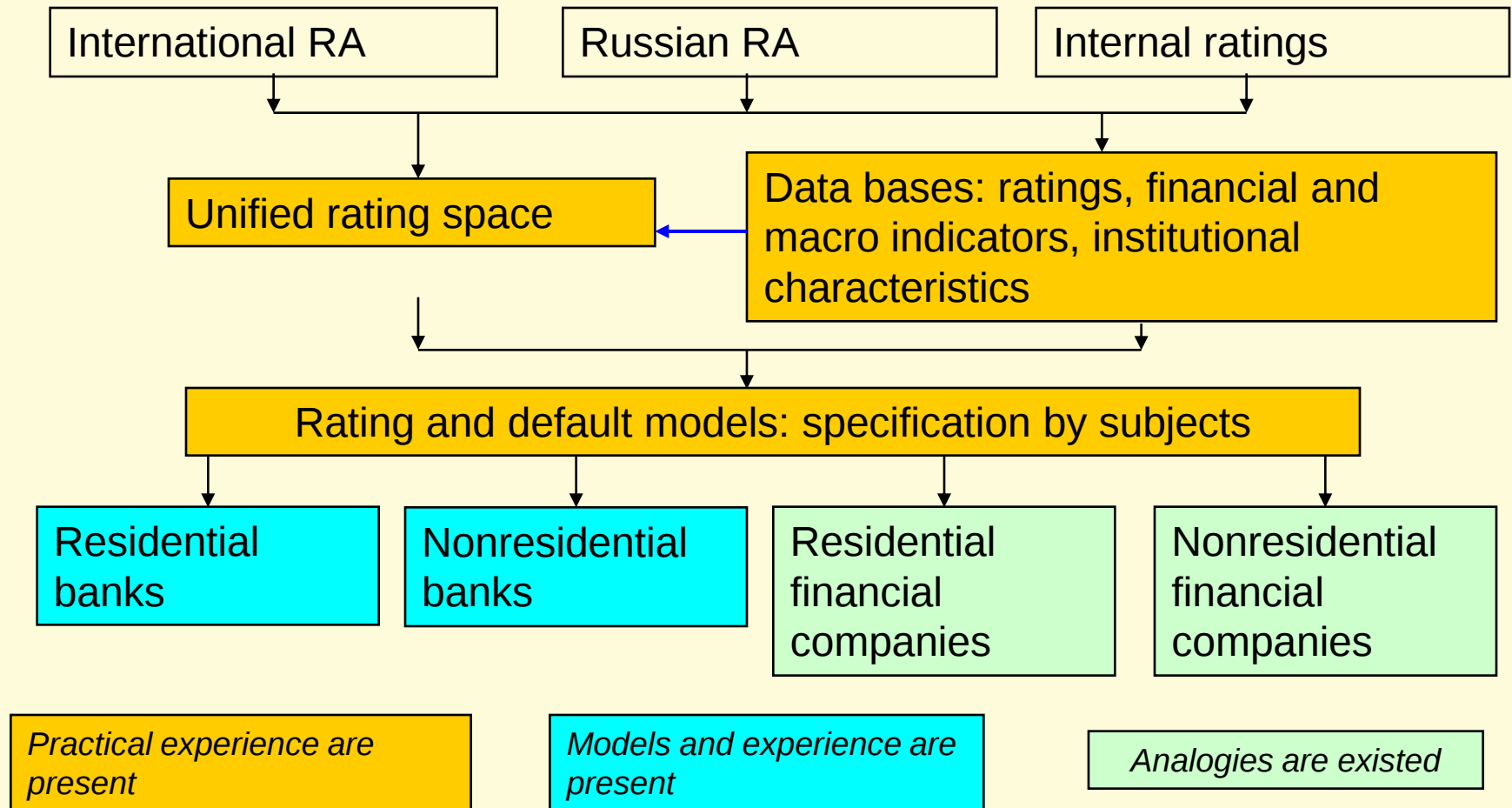
$$M = \text{const} \cdot R^a \quad \Leftrightarrow \quad \ln(M) = a \cdot \ln(R) + b$$

Rating scale	a	b
Moody's (Russian scale)	0,254	2,202
Standard & Poor's	0,916	0,146
Standard & Poor's (Russian scale)	0,265	2,113
Fitch Ratings	0,749	0,594
Fitch Ratings (Russian scale)	0,213	2,162
AK&M	0,269	2,491
Expert RA	0,373	2,329
RusRating	0,674	1,016
National rating agency	0,163	2,474
<i>Number of estimations</i>	3432	
<i>Pseudo-R²</i>	0,902	

Comparison of rating scales: 2006-2010 (logarithmic specification)



Rating models system: financial institutions



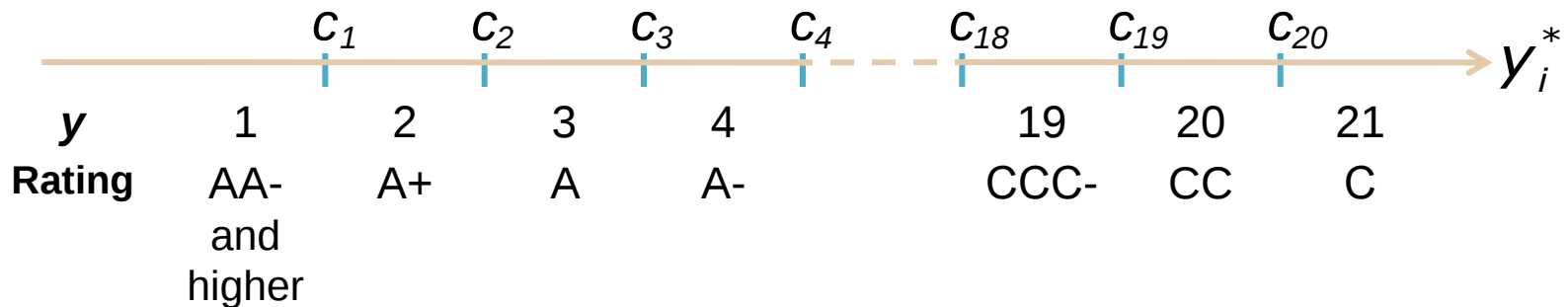
Research questions

Are credit ratings of international agencies differed or are estimated models for all three agencies similar?	A little differ
Do credit ratings depend on bank affiliation to group of countries (developed, emerging markets, CEE, etc.)?	OECD BRIC CEE CIS
Which financial indicators of banks have influence on their credit ratings?	At the tables
Which macroeconomic indicators are meaningful for bank credit ratings?	At the tables
What time lag is necessary for rating agencies to perform the analysis of bank creditworthiness and assign credit ratings?	0.5-1.5 years
Are bank credit ratings degraded in time?	Partly Moody's

Econometrical rating models

(Ordered probit/logit models)

$$y_i^* = x_i' \beta + \varepsilon_i$$



$$\begin{cases} P(y_i = 0) = F(c_1 - x_i' \beta), \\ P(y_i = r) = F(c_{r-1} - x_i' \beta) - F(c_r - x_i' \beta), \quad 2 \leq r \leq k-1, \\ P(y_i = k) = 1 - F(c_{k-1} - x_i' \beta). \end{cases} \quad \begin{cases} y_i = 1, \text{ если } y_i^* < c_1 \\ y_i = r, \text{ если } c_{r-1} \leq y_i^* < c_r, \quad 2 \leq r \leq 20 \\ y_i = 21, \text{ если } y_i^* \geq c_{20} \end{cases}$$

y^* – latent variable

y – order variable

x – regression vector

β – vector of coefficients

ε – mistake

c – threshold values

Data bases: Russian and International Financial Reporting

Russian Financial Data: Interfax and HSE

2645 estimations by 370 banks

Financial data : 23 quarters from 1Q 2006 till 3Q 2010

Institutional Indicators: ownership (35 state и 34 international banks) and Banks age

International Financial Data: Bloomberg and GMID

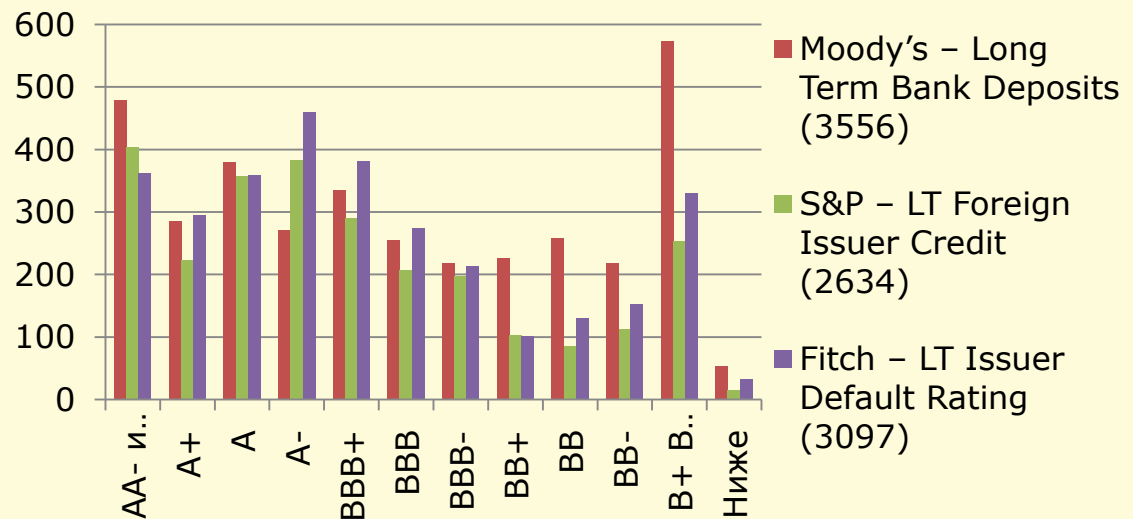
■ 5629 estimations

- Developed countries - 50%
- Developing countries - 30%
- CEE - 5%
- CIS - 4%

■ 86 countries

■ 551 banks

■ 1995-2009 years



Basic models for nonresidential banks

Variable	Influence	S&P – Issuer Credit	Fitch – Issuer Default	Moody's – Bank Deposits	Moody's – BFSR
Ln (Assets)	+	-0,523***	-0,561***	-0,545***	-0,383***
Equity Capital/ Total Assets	+	-3,012***	-1,945***	-2,758***	-1,607***
Loan loss provision/ Average Assets	-	42,763***	37,284***	19,188***	12,245***
Long Term Debt/ Total Assets	-	0,008*	0,017**	0,023***	0,020***
Interest Expenses/ Interest Income	-	0,353***	0,277***	0,294***	0,171***
Retained Earnings/ Total Assets	+	-9,841***	-5,063***	-1,404*	-2,345***
Cash&Near Cash Items/ Total Liabilities	-	2,303***	1,814***	1,985***	1,917***
Corruption Index	-	-0,408***	-0,356***	-0,383***	-0,316***
Annual Rate of Inflation	-	0,038***	0,020**	0,028***	-0,009*
Exports/Imports	+	-0,584***	-0,400***	-0,559***	-0,017
GDP	+	-4,40***	-4,40***	-12,20***	-15,80***
Pseudo R²		0,293	0,266	0,295	0,192
Number of estimations		1804	1985	1787	1897

*, **, *** – 10%, 5%, 1% levels of significant respectively

Basic models for residential banks

Variable	<i>SP</i>	<i>SP_ru</i>	<i>M</i>	<i>M_ru</i>	<i>F</i>	<i>F_ru</i>
Assets (log)	-1,170***	-1,350***	-0,735***	-0,874***	- 0,588***	-0,832***
Equity Capital/ Assets	-4,859***	-7,912***	-9,122***	-9,676***	- 1,233***	-8,629***
Square of variable			17,808***	18,544***		10,528***
Loans to economy/ (Deposits, Debt, capital)		-0,708**	-0,255***	-0,264***	- 0,620***	-0,669***
Loans to economy/ Assets	-1,401**				1,047**	1,138**
Number of estimations	380	285	1162	1079	622	482
Pseudo R²	0,313	0,393	0,245	0,213	0,214	0,208
Acurity forecasts ($\Delta=0$)	44,5%	41,4%	45,4%	42,4%	44,5%	38,4%
Forecasts with less than 1 grade mistake ($ \Delta \leq 1$)	91%	92%	90%	90%	89%	90%

*, **, *** – 10%, 5%, 1% levels of significant respectively

Non- financial companies data

Corporate financial indicators:

- ❑ 30+ countries
- ❑ 2000 – 2009 years
- ❑ 211 corporate
- ❑ Nearly 1800 estimations (non - balance panel)
- S&P, Fitch and Moody's ratings
- Macro indicators
- Market indicators
- Industry types classification

Number of ratings by agencies

S&P - LT FC Issuer Credit	1522
Fitch - LT Issuer Default	481
Moody's - LT Issuer Rating	377

Important financial variables

Financial Variables Group

Total Asset's (USD mln)	
Market capitalization (USD mln)	Size (log)
Equity Capital/Total Assets	Capitalization
Total Risk-Based Capital Ratio	
Long Term Debt/ Total Assets	Assets, Management
Loan loss provision / Total Assets	
Interest Expenses/Interest Income	Efficiency
Retained Earnings/Total Assets	
Cash and Near Cash Items/ Total Liabilities	Liquidity

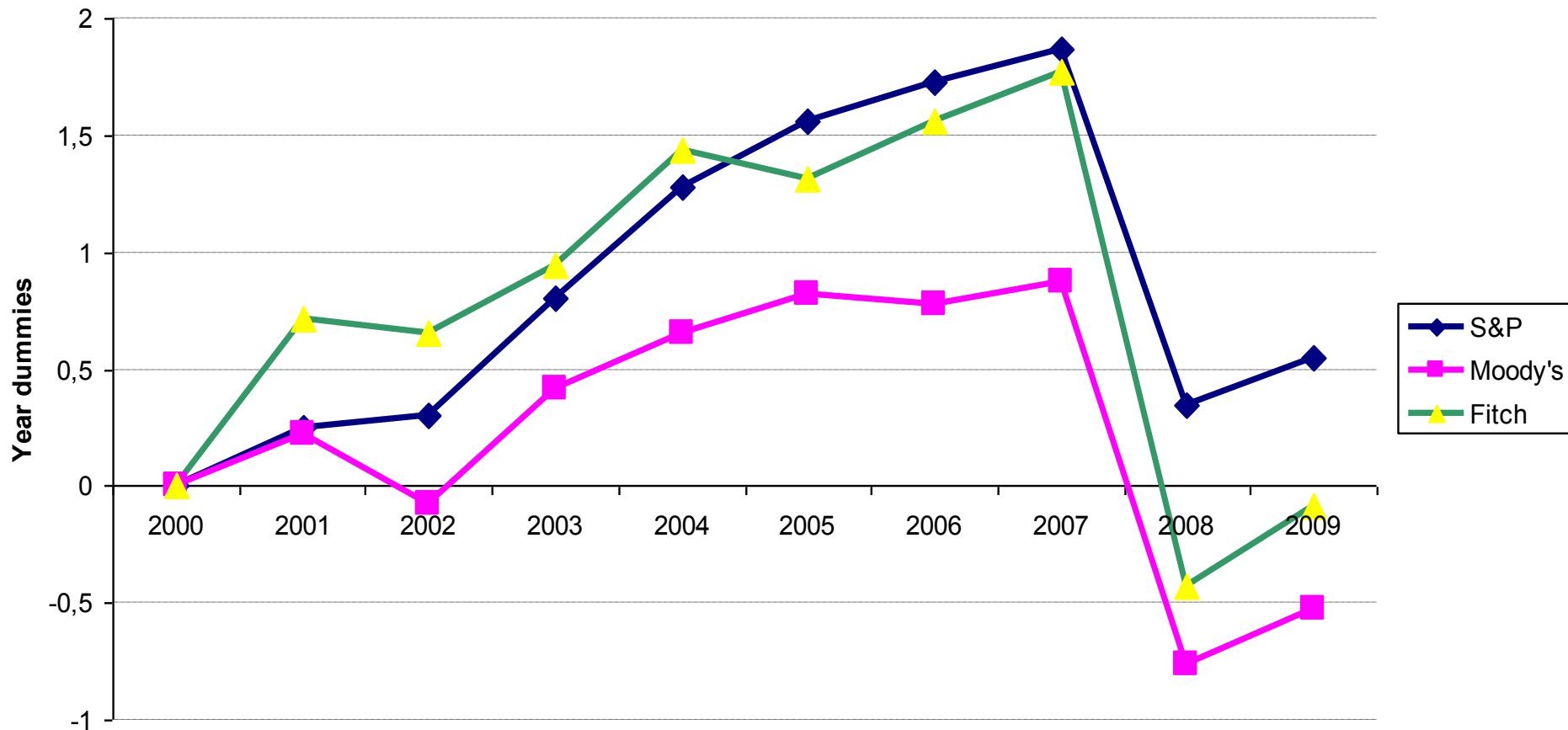
Dummies and macro variables

- Macro characteristics
 - Corruption Perception Index (Transparency International)
 - Annual rate of inflation
 - GDP to PPP
 - Export / Import
- Group of countries
 - Developed countries (OECD)
 - CEE
 - CIS
 - BRIC
 - Russian banks
- Market indicators

Corporate rating models

Variable	S&P	Fitch	Moody's
LN (Market Capital)	-0,692*** (0,028)	-0,806*** (0,052)	-0,691*** (0,050)
Sales/ Cash	0,00004*** (0,00001)	-0,00051 (0,00032)	-0,00049 (0,00056)
EBIT/ Interest Expenses	-0,0017*** (0,0004)	0,0006 (0,0006)	-0,0054*** (0,001)
LT Debt/ Capital	0,006*** (0,002)	0,011*** (0,004)	0,019*** (0,003)
Retained Earnings/ Capital	-1,107*** (0,128)	-0,581** (0,248)	-1,230*** (0,269)
Volatility (360d)	0,012*** (0,001)	0,013*** (0,002)	0,016*** (0,002)
Corruption Perception Index	-0,217*** (0,022)	-0,088*** (0,033)	-0,088 (0,054)
Chemicals	-0,235*** (0,061)	0,381*** (0,126)	-0,182 (0,129)
Metal & Mining	0,322*** (0,084)	1,317*** (0,153)	0,947*** (0,198)
Pseudo-R2	0,215	0,220	0,276
Number of Observations	1362	423	339
$ \Delta =0$	40,6%	34,3%	42,5%
$ \Delta =1$	87,7%	87,7%	87,0%

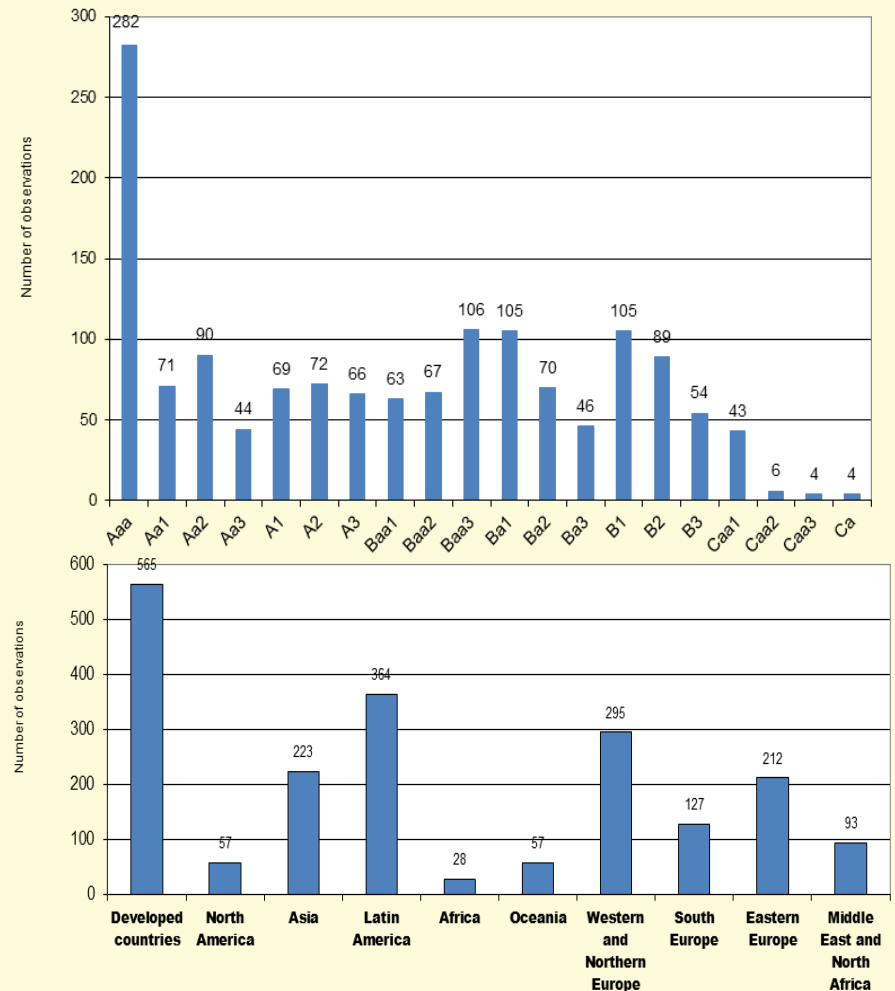
Procyclicality of corporate ratings: Year dummies dynamics



Sovereign rating models: data

- Bank ratings ceilings - Moody's
- 111 countries
- 1991-2010 years
- 1456 estimations
- **Quantitative variables**
 - Banks (8 variables)
 - Economic growth (7 variables)
 - International finance (7 variables)
 - Monetary characteristics (5 variables)
 - Public finances (2 variables)
 - Stock market (2 variables)
- **Qualitative variables**
 - Financial crisis type
 - Regional (geographical, PIIGS, BRICS)
 - Corruption

Distributions



Sovereign rating models

Variables	Model 5	Model 6	Model 7
Domestic credits to private sector / GDP	-0.026***	-0.024***	
Domestic credits to private sector / GDP (t-1 period)			-0.019***
Log (GDP per capita)	-1.859***	-1.661***	-1.547***
Inflation growth rate	0.073***	0.073***	0.079***
Government budget deficit (% from GDP)	-0.041	-0.073**	-0.082***
Export to import ratio (one year time lag)	-3.527**	-0.890	-1.657
Square of export to import ratio, i.e. [export/imports]^2	0.79	0.072	0.4002
Stock market value to GDP ratio (% for t-1 period)	0.0022	0.0094***	0.008***
Sovereign debt crises occurrence (previous year)	2.98**	1.66	
Develop countries group	-0.974**	-0.853*	-1.049***
Latin America region	3.379***	3.280***	3.212***
Asia region	1.333***	1.479***	1.388***
Oil exporters	0.794***	1.192***	1.195***
BRICS	0.159	1.403***	1.356***
PIIGS	-1.957***	-1.548***	-1.759***
Middle East and North Africa region	2.171***	2.133***	2.235***
South Europe region	2.196***	1.956***	1.956***
Log(GDP)		-0.690***	-0.741***
GDP growth rate (t-1 period)		-0.133***	-0.136***
Corruption perception index	-0.560***	-0.775***	-0.86***
Pseudo R ²	0.421	0.444	0.439
$\Delta = 0$	48.7	50.6	49.1
$ \Delta \leq 1$	76.1	78.4	76.4

Research background: Default definition

There is no common opinion in literature what default is. In our research, the signals to register default are

- a bank's capital sufficiency level falls below 2%.
- the value of bank's internal resources drops lower than the minimum established at the date of registration.
- a bank fails to reconcile the size of the charter capital and the amount of internal resources.
- a bank is unable to satisfy creditors' claims and make compulsory payments.
- a bank is subject to sanitation by the Deposit Insurance Agency or another bank.

So, the aim of this research is to propose an adequate forward-looking model, which rests on the relationship between banks' default rates and public information.

Data and model (1/2)

We constructed the quarterly bank-specific financial database on the basis of Mobile's information from 1998 to 2011: data in accordance with Russian Financial Reporting Standards, taken from bank Balance sheets and Profit & Loss statements

A typical observation from the database

Bank's license number_period	Bank performance	A set of explanatory variables with lag				
				Variable names		
507_1/4/2005	default (1) or alive (0)			values		

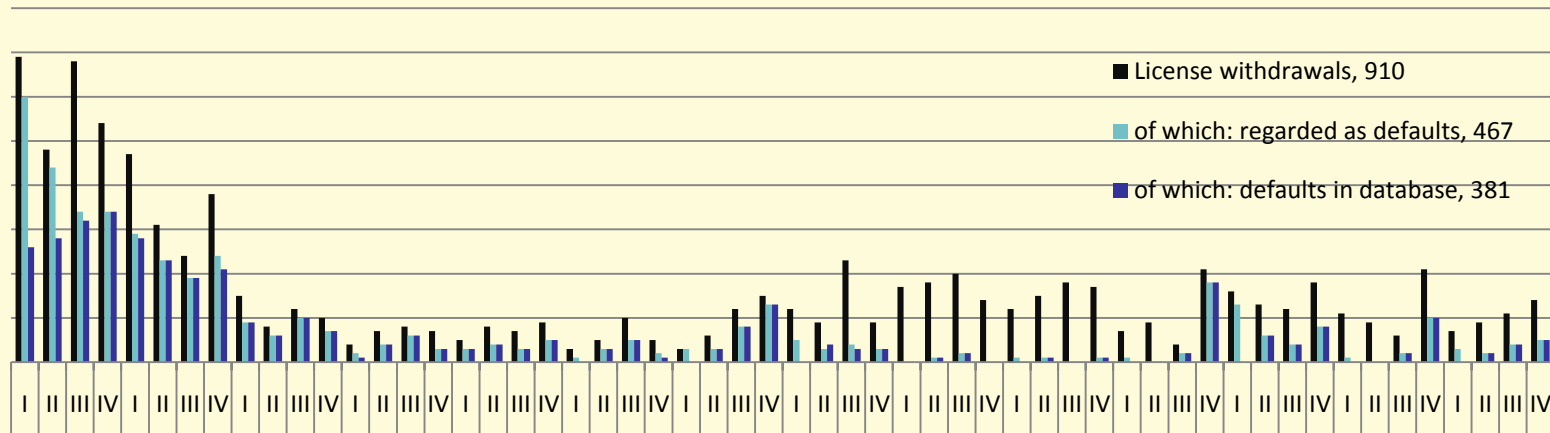
Problems with data revealed and solved:

1. The database is highly unbalanced
2. Raw bank-specific statistics in Mobile's base contains missing values, outliers and measurement errors
3. No information about structure of Russian banks' ownership

Over the considered 14-year period there were 467 defaults in compliance with our definition as well as 37 bank sanitations

Data and model (2/2)

The created quarterly database has a good coverage of default events and the banking sector



We have applied a binary choice logistic model to forecast default probability

$$P(\text{default} = 1) = \Lambda(x * \beta), \quad \Lambda(x * \beta) = \frac{\exp(x * \beta)}{1 + \exp(x * \beta)}$$

The maximum likelihood approach is used to estimate the model.

The sample was split into two parts: “1998 – 2009” – to estimate models and “2010 – 2011” – to test prediction power of models

Explanatory variables: Financial ratios

Firstly, we constructed financial ratios which seem to be significant to determine bank's PD as provided by the literature review and a common sense

Secondly, we tested the separating power of that ratios between classes of bankrupt and healthy banks

Thirdly, prominent variables were divided into blocks according to CAMELS methodology

Block	Ratio / Variable	Reason to include
Capital	Capital to Total assets ratio	Financial troubles immediately result in a sharp decline in bank's capital
Assets	Non-performing loans to Total loans to the economy	Asset quality is a dominant factor of future profits and losses
	Logarithm of Total assets	
Management	Turnover on correspondent accounts to Total assets ratio	This variable reflects the level of economic activity in a bank
Earnings	Balance profit to Total assets ratio	Profitability creates the economic value of a bank
Liquidity Sensitivity	Non-government securities to Total assets ratio	This variable reflects vulnerability of business to market risks

We have also employed nonlinearities in our model and found the optimal lag on financial ratios

Explanatory variables: macro & institutional

Macroeconomic environment

Basically, we went through the same steps as for financial ratios, but the macroeconomic variables are highly correlated. That is why only two variables were used in order to account for the effect of macroeconomic environment on bank performance: quarterly GDP growth rates and Consumer price index.

Institutional environment

We controlled for the impact of:

- monopoly power of a bank on the market (with Lerner index);
 - its participation in a Deposit insurance system (with dummy variable);
 - and territorial location of bank's operational activity (Moscow or regional)
- on bank's default probabilities.

Estimation results

$$P(\text{default} = 1) = \Lambda(sk_ca_{lag2}; (sk_ca_{lag2})^2; \ln_ca_{lag2}; (\ln_ca_{lag2})^2; pzs_ke_{lag2}; \ln_oks_ca_{lag2}; bp_ca_{lag2}; (bp_ca_{lag2})^2; ncb_ca_{lag2}; d_{2009}; d_{q1}; gdp_gr_{lag2}; cpi_{lag2}; l_{index}; \text{region}).$$

sk_ca – Capital to Total assets ratio

ln_ca – Logarithm of Total assets

pzs_ke – Non-performing loans to Total loans ratio;

bp_ca – Balance profit to Total assets ratio

ncb_ca – Non-government securities to Total assets ratio

cpi – Consumer price index

gdp_qr – quarterly GDP growth rates

dq1 – dummy variable on first quarter

d2009 – Lerner index2009

index – Lerner index

region – dummy variable on Moscow location

Our general findings are:

- 2 quarters is an optimal lag size for financial and macroeconomic variables
- Including squared capital – to – assets and profit – to – asset ratios improved the model quality
- Bank size is an insignificant factor to determine default probability without nonlinearity

Our key findings(1)

Banks with extremely high and low profitability have higher default rates.

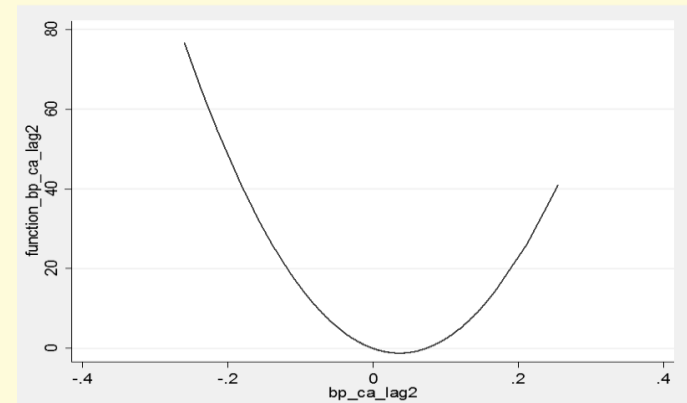
Impact of profit – to – assets ratio on default probability:

Reasoning: —→

- poor banks lack funds to pay the bills.
- banks with really high earnings take excessive risk: at the efficient markets it is impossible to claim to an outstanding profitability without bearing appropriate financial risks.

Banks with a higher proportion of corporate securities in assets carry higher risk of a price slump at the market.

Lower Turnover on correspondent accounts in comparison with Total assets increases the probability of default: the ratio indicates a bank's inability to proceed payments and incentives of managers to curtail business.



Our key findings (2)

Bank with considerable amount of bad debts are less stable.

A growing consumer price index increases bank's default probability:

- inflation reduces the real returns on loans.
- depositors are able to withdraw money and put it into the bank again at a higher interest rate or spend it.

Banks with higher monopoly power are financially stable.

The Moscow-based banks have higher PDs on the average:

- banking market competition is sharper in Moscow.
- the Bank of Russia is reluctant to withdraw licenses out of Moscow region.

We found no evidence that bank participation in the Deposit insurance system influence its PD. The explanation is that the set of System participants is too diversified.

Our key findings(3)

The out-of-sample prediction performance of the model (for 2010 – 2011) is prominent: over 60% of bank failures were correctly classified with a moderate size of a risk group.

Condition: a bank with PD over x is a candidate to fail	Quarterly average size of a risk group	Number of correctly predicted defaults, of 19. (Proportion)
$x = 10\%$	54	16 (84%)
$x = 20\%$	34	12 (63%)
$x = 30\%$	30	12 (63%)
$x = 40\%$	28	10 (52%)

At the same time, the developed model underestimates default probabilities for the year 2009. This result reveals some unrecorded channels that significantly increased risks in the period of the recent financial crisis

What system of models bring to IRB Approach?

- Basis established for development and practical usage of econometrical rating models within IRB-approach for Russian and international rating agencies
- Rating scale comparison methods defined for different agencies including external and internal rating reconciliation
- Rating estimation forecasting approach and banking risk measurement depending internal and external factors
- Rating forecasting for financial and nonfinancial companies which have no rating
- Implementation of econometrical modeling system requires:
 - ❑ Structured databases (data warehouse)
 - ❑ Support for all life cycle stages of models
 - ❑ Monitoring, data gathering and integration problem solution

Q & A

Thanks for your attention

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