



**CENTER FOR MACROECONOMIC ANALYSIS
AND SHORT-TERM FORECASTING**

Tel.: (499)129-17-22, fax: (499)129-09-22, e-mail: mail@forecast.ru, <http://www.forecast.ru>

***Stress-testing in the early warning system of
financial crises: application to stability
analysis of Russian banking sector***

*Anna Pestova, expert, CMASF
post-graduate student, HSE*

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Relevance of the topic

- Financial instability tend to repeat, number of affected countries grows, losses in economic growth rates are substantial
- Policy response: anticipate, prevent, limit, reduce risks, mitigate the effects of crises
 - Early warning system
 - Macroprudential policy

CMASF Early Warning System of financial crises

- Early warning models of systemic financial crisis and individual types of risk (credit, liquidity, currency etc.)
 - Estimate probability of financial crisis (unlikely event)
- Macro stress-testing
 - Evaluate the resilience of the financial system under stress scenarios (extreme but plausible)
- Macroeconomic and financial sector forecasts
 - Predict most likely outlook

Macro stress-test definition

- Macro stress-testing refers to a range of techniques used to assess the vulnerability of a financial system to «exceptional but plausible» macroeconomic shocks (Sorge, 2004)
- The objective of a stress test is to identify possible risks by estimating the potential losses in abnormal macroeconomic conditions and compare the size of these losses with a given regulatory minimum level.

Specification of conducted stress-test

- Type of risk
 - Credit, market, liquidity, etc.
- Type of stress-test
 - Sensitivity, scenario analysis, other (including reverse stress-test)
- Type of scenario
 - Historical, hypothetical, Monte Carlo simulation (stochastic shocks)
- Methodology
 - Integrated, piecewise approach (credit risk indicator – ratio of nonperforming loans to total loans of banking sector - NPL)
 - Top-down, bottom-up approach

Specification of aggregate credit risk model and data description

- Panel data on 38 countries suffered from «bad debt» crisis*. Yearly observations for 1997-2009. Data source – IMF (IFS, FSI)
- NPL persistence (Salas, Saurina, 2002) + fixed effects = System GMM specification

$$\begin{cases} \Delta NPL_{it} = \alpha \Delta NPL_{it-1} + \Delta x'_{it} \beta + \Delta v_{it} \\ NPL_{it} = \alpha NPL_{it-1} + x'_{it} \beta + \mu_i + v_{it} \end{cases}, \text{ where}$$

$$x_{it} = \begin{pmatrix} \textit{Credit market risks, Currency risks,} \\ \textit{Macroeconomic conditions,} \\ \textit{Financial development} \end{pmatrix}$$

* considerable increase in the share non-performing loans compared to the pre-crisis level

Model specification issues – endogeneity and feedback effects

- Level of financial development and currency market variables are exogenous
- Credit market variables – endogenous
- Macroeconomic variables – endogenous + (feedback effects -?, mechanism – financial accelerator)
- If there are feedbacks then panel VAR specification is relevant (Hoggarth et al., 2005), (Espinoza, Prasad, 2010)
- Test for feedback effects - panel Granger Causality

Results of Panel Granger Causality test : NPL does not Granger cause GDP growth

	Dependent variable: NPL		Dependent variable: GDPgrowth	
	one-step Difference GMM	two-step System GMM	one-step Difference GMM	two-step System GMM
Intercept		3.016** (1.472)		-0.445 (1.876)
NPL _{t-1}	0.672*** (0.088)	0.761*** (0.139)	0.152 (0.117)	0.131 (0.163)
NPL _{t-2}	-0.017 (0.066)	-0.080 (0.081)	-0.023 (0.071)	-0.012 (0.091)
Σ AR NPL coefficients			0.128 (0.112)	0.119 (0.114)
GDPgrowth _{t-1}	-0.239** (0.115)	-0.253** (0.127)	0.678*** (0.198)	0.731*** (0.230)
GDPgrowth _{t-2}	-0.122 (0.093)	-0.097 (0.120)	0.102 (0.129)	0.042 (0.160)
Σ AR GDPgrowth coefficients	-0.360** (0.166)	-0.350* (0.206)		
Number of observations	343	381	343	381
Number of countries	40	40	40	40
Number of instruments	22	25	22	25
p-value Wald test	0.000	0.000	0.001	0.000
p-value Hansen test	0.110	0.161	0.037	0.069
p-value Arellano-Bond test for AR(2)	0.083	0.218	0.273	0.766

*, **, *** denote an estimate significantly different from zero at the 10%, 5%, 1% level. Standard errors are in parentheses

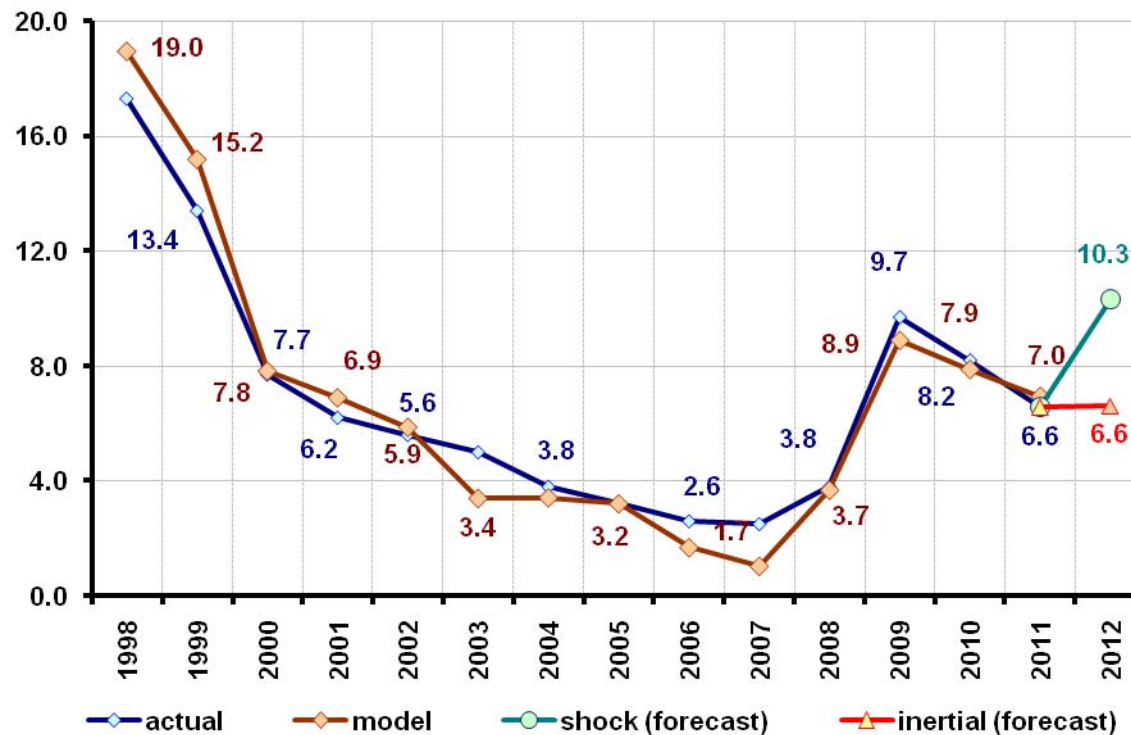
Aggregate credit risk model: estimation results

Dependent variable - NPL	OLS	FE	2-Step System GMM
NPL (lag = one year , %)	0,779*** (0,032)	0,650*** (0,056)	0,678*** (0,053)
GDP growth (%)	-0,402*** (0,047)	-0,408*** (0,066)	-0,367*** (0,060)
Loan to deposit ratio (lag = one year , %)	0,009* (0,005)	0,020* (0,011)	0,034* (0,020)
Weakening of national currency nominal exchange rate against U.S. dollar (%)	-0,078*** (0,021)	-0,079** (0,034)	-0,067* (0,038)
Fixed exchange rate dummy variable (lag = one year)	1,242** (0,600)	0,856 (0,695)	1,206 (0,953)
GDP per capita (lag = one year, thousand dollars)	-0,055*** (0,010)	-0,062* (0,033)	-0,077** (0,036)
Real lending rate (lag = one year, %)	-0,006 (0,014)	0,052 (0,035)	0,062** (0,031)
Intercept	1,653* (0,932)	1,117 (1,698)	-1,131 (2,023)
Number of observations	364		
Number of countries	39		
R-squared	0,831	0,868	
Number of instruments			52
p-value Hansen test			0,910
p-value Arellano-Bond test for AR(2)			0,537

*, **, *** denote an estimate significantly different from zero at the 10%, 5%, 1% level. Standard errors are in parentheses

Application of estimated credit risk model to the analysis of Russian banking system stability - I

- forecast time required to reach the pre-crisis ratio of NPL



In 2012 stabilization of NPL is expected.

Slow decline of this indicator leads to the fact that more than 3 years will require to release bank balances from nonperforming loans

Application of estimated credit risk model to the analysis of Russian banking system stability - II

- Sensitivity analysis of the NPL ratio to changes of the econometric model factors
- Factor decomposition of 2012 NPL forecast

Dependent variable - NPL	Growth of indicator = 1 std. dev. (2000-2010)	Increase in NPL fraction in 2012 in response to an indicator growth per 1 std. dev., compared to the inertial scenario	Contribution to NPL growth (reduction) in 2012, %	
			inertial scenario	shock scenario
NPL (lag = one year , %)	3.4	2.3	-129%	-54%
GDP growth (%)	-4.4	1.6	22%	94%
Real lending rate (lag = one year, %)	7.7	0.5	-28%	-12%
Loan to deposit ratio (lag = one year , %)	9.8	0.3	18%	8%
Weakening of national currency nominal exchange rate against U.S. dollar (%)	-4.9	0.3	30%	69%
GDP per capita (lag = one year, thousand dollars)	-3.4	0.3	-14%	-6%
Fixed exchange rate dummy variable (lag = one year)	0.0	0.0	0%	0%
Total effect			- 100%	100%

Application of estimated credit risk model to the analysis of Russian banking system stability - III

- banks' capital losses calculation* under different scenarios and possible bank request for government support
 - inertial scenario (growth rate of oil prices = - 10%, GDP growth = 3,9%), 100 vulnerable banks, capital deficit = 100 bn rubles, demand for government recapitalization = 50 bn rubles;
 - shock scenario (growth rate of oil prices = - 40%, GDP growth = -1 %), 150 vulnerable banks, capital deficit = 250 bn rubles, demand for government recapitalization = 130 bn rubles;

Note: NPL forecast for the banking system is projected on individual banks assuming constancy of individual shares in total assets and total nonperforming loans

*Calculations are based on (Mamonov, Solntsev, 2011) «Stress Test of the Russian banking system: cut before it's too late», Vedomosti №245 (2011)

Conclusion

- Aggregate credit risk model on country panel data is highly significant and provides good explanatory power for nonperforming loans ratio
 - Persistence in NPL is found (coefficient of the lagged dependent variable = 0.7)
 - Currency market conditions affect debt policy of real sector companies and thus their solvency
 - Credit market overheating leads to reduced quality requirements to borrowers and future expansion of NPL
 - Credit and business cycle are coincident, recession on average precedes «bad» debt crisis. Feedback effects influence macroeconomic conditions not more than a year
- As a result of the stress test exercise we identified sufficiently broad group of vulnerable banks. This finding suggests the possibility of crisis in the credit market in 2012, even under the inertial scenario, i.e. under a rather moderate decline in world oil prices

Thank you for your attention!



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*Anna Pestova,
apestova (at) forecast.ru*

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