Bank of Russia
The Central Bank of the Russian Federation

Stress-testing the mortgage market

1-2 March 2017

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Russian mortgage market dynamics

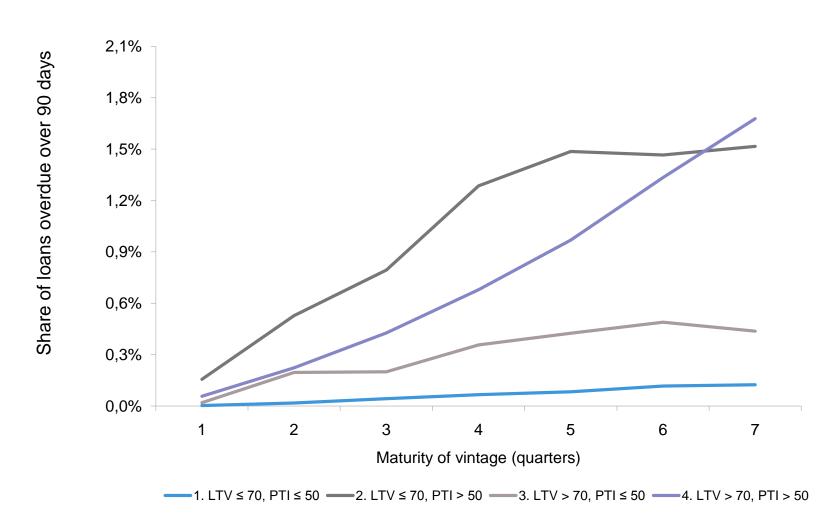Legend: NPL 90+,% • Share of overdue claims, % • Mortgage portfolio (right axis, trln. Rub.)

Mortgage market bottom-up stress-test

- Stress-test includes 4 Top Russian banks with the share of 77% in the total amount of loans for residential real estate purchase (on 1st January 2017).

- Stress-test is based on vintage analysis of quarterly loans generations grouped by loan-to-value (LTV) and payment-to-income (PTI) values and macroeconomic scenarios with 2-year forecast of unemployment and prices for crude oil (migration matrix and macroeconomic forecasts are provided by the Bank of Russia)
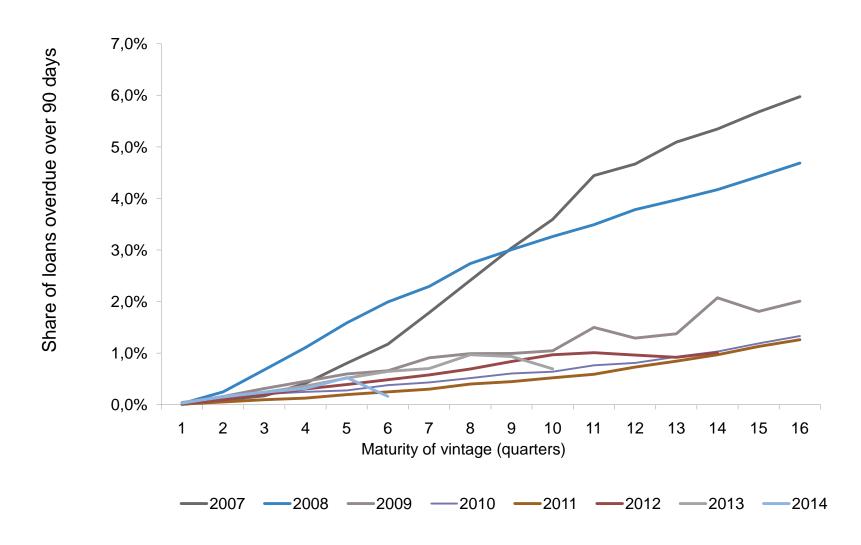
Distribution of loans for residential real estate purchase by LTV and PTI,%		LTV	
		≤70%	>70%
PTI	≤50%	28,7	34,1
	>50%	12,1	25,1

- The result of stress-test is a quarterly estimate of the share of non-performing loans, the amount of provisions formed for possible losses on loans and changes in ratio of own funds (capital) to risk weighted assets, CET1 and Tier 1 capital.

- Last stress-test (2016) showed no significant impact on any capital ratios of surveyed banks.

Dependence of the level of the risk on initial LTV and PTI

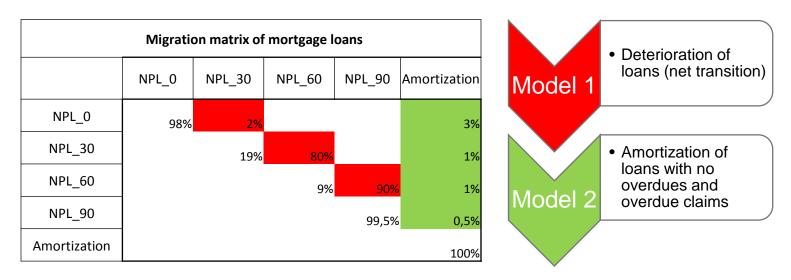# Dependence of the level of the risk on macroeconomic environment

Example of requested data

Vintage	Loans issued, bln. rub.	Loans	Maturity of vintage								
			Distribution on stress-test date	1Q	2Q	3Q	4Q	5Q	6Q	7Q	...
1Q2015		with no overdues									
		with overdues 1-30 days									
		with overdues 31-90 days									
		with overdues over 90 days									
		V_0/V_{90-}									
		V_{1-30}/V_{90-}									
		V_{31-90}/V_{90-}									
		Total due left									
		Total due less 90 days left									

For each cohort (vintage at the specified interval of LTV and PTI) banks report the amount of loans issued, as well as loans with no overdues, loans with overdues 1-30 days, loans with overdues 31-90 days and loans with overdues over 90 days.

Restoration of the migration matrix of loans

Migration matrix of mortgage loans					
	NPL_0	NPL_30	NPL_60	NPL_90	Amortization
NPL_0	98%	2%			3%
NPL_30		19%	80%		1%
NPL_60			9%	90%	1%
NPL_90				99,5%	0,5%
Amortization					100%

Model 1 • Deterioration of loans (net transition)

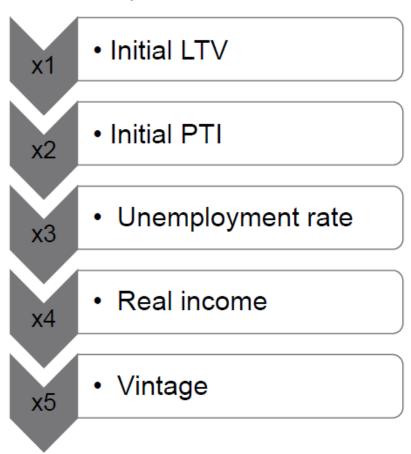**Model 2** • Amortization of loans with no overdues and overdue claims

On the basis of initial data the Bank of Russia complies a diagonalized matrix of net transition of quality categories of loans which covers 2 types of migration:
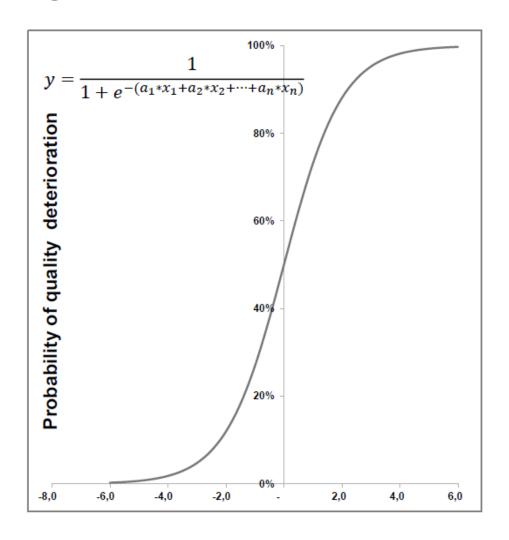- Deterioration by 1 grade;
- Redemption (amortization).

Cells of these types are predicted by 2 different models.

Assessment of ratios of migration matrix of loans on the basis of logistic regression

Input variables:

x1
- Initial LTV

x2
- Initial PTI

x3
- Unemployment rate

x4
- Real income

x5
- Vintage

$$y = \frac{1}{1 + e^{-(a_1 * x_1 + a_2 * x_2 + \cdots + a_n * x_n)}}$$

Probability of quality deterioration

100%	
80%	
60%	
40%	
20%	
0%	

-8,0   -6,0   -4,0   -2,0   -   2,0   4,0   6,0

The Bank of Russia is using in its regulatory practice differentiated risk weights for mortgage loans depending on the levels of LTV and PTI.
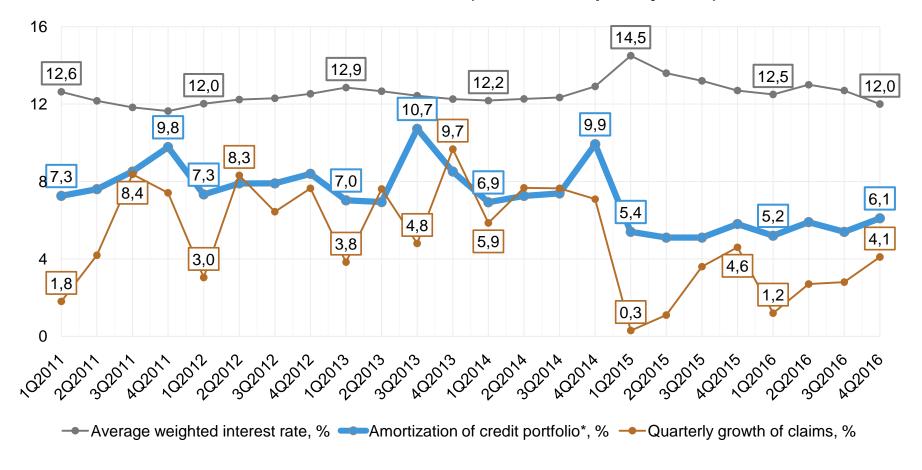
Type of loans	Mortgage loans with relatively low risk			Mortgage loans with high risk	Foreign-currency mortgage loans
Risk weights	0.35	0.5	0.7	1.5	3.0 (for loans issued after April 1, 2015)
Size of loans	< 50 million rubles (approx. 830 000 USD)			> 50 million rubles (approx. 830 000 USD)	–
LTV	< 50% (January 2016)	< 50% (December 2014)	< 70% (May 2009)	> 80% (October 2011) > 90% (December 2014)	–
PTI	< 33⅓% (January 2016)	< 40% (December 2014)	< 33⅓% (May 2009) < 50% (May 2014)	–	–

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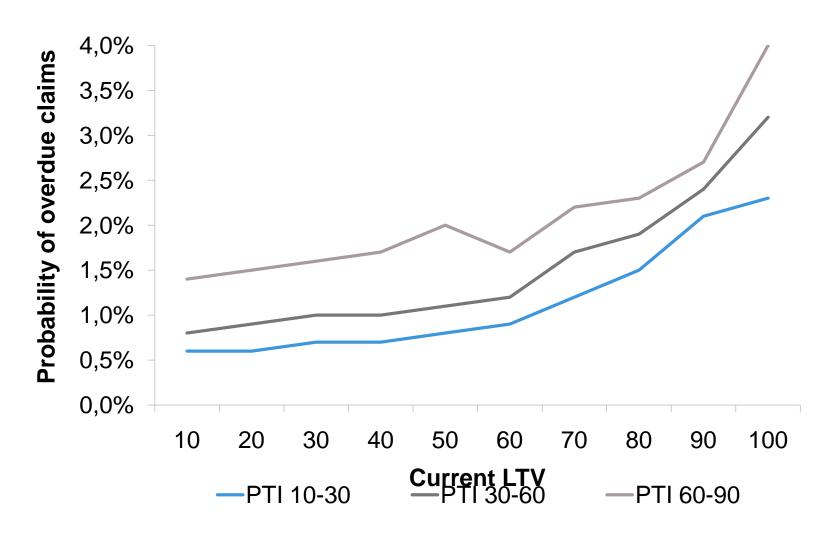The Central Bank of the Russian Federation

Further development of the stress-testing methodology

Mortgage market is characterized by high pace of amortization of loans and claims (20-25% per year)

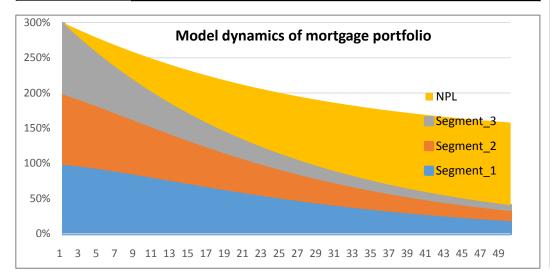Average weighted interest rate, %   Amortization of credit portfolio*, %   Quarterly growth of claims, %

The amount of paid claims in accordance with debt during the quarter, % of debt in the beginning of the quarter.

The level of risk depends substantially on the current LTV and PTI

Methodology of stress-testing the mortgage market on the basis of dynamic parameters of PTI, LTV

Model matrix migration of mortgage loans

	Segment_1	Segment_2	Segment_3	NPL	Amortization
Segment_1	94%	2%	1%	1%	3%
Segment_2	2%	93%	2%	2%	2%
Segment_3	3%	3%	90%	3%	1%
NPL	0	0	0	100%	0
Amortization	0	0	0	0	100%

Model dynamics of mortgage portfolio

- NPL
- Segment_3
- Segment_2
- Segment_1

The proposed methodology of stress-testing is based on portfolio segmentation and grouping of loans in the cohort not by **the initial client's PTI and LTV,** but by **the current level** of these indicators.

The current levels of PTI and LTV are calculated using scenario of dynamics of the population income and real estate prices.

$$PTI_{curr} = PTI_{start} * \frac{Income_t}{Income_{start}};$$

$$LTV_{curr} = LTV_{start} * \frac{Mortag\_index_t}{Mortag\_index_{start}};$$

Neural network is used to assess values in the migration matrix. To calibrate the model banks' data on loans migration are used, in the context of combinations **of the current LTV and PTI of the client.**

Extended migration matrix of loans

Migration matrix			Segment_1 — Loans and Claims					Segment_2 — NPL from 1 to 30 days					Segment_3 — NPL from 31 to 60 days				
			LTV ≤ 10 PTI ≤ 10	LTV ≤ 10 PTI (10; 20]	...	LTV (10; 20] PTI ≤ 10	LTV (10; 20] PTI (10; 20]	...	LTV ≤ 10 PTI ≤ 10	LTV ≤ 10 PTI (10; 20]	...	LTV (10; 20] PTI ≤ 10	LTV (10; 20] PTI (10; 20]	...	LTV ≤ 10 PTI ≤ 10	LTV ≤ 10 PTI (10; 20]	...	LTV (10; 20] PTI ≤ 10	LTV (10; 20] PTI (10; 20]	...
Segment_1	Loans and claims	LTV ≤ 10 PTI ≤ 10																	
		LTV ≤ 10 PTI (10; 20]																	
		...																	
		LTV [10; 20) PTI < 10																	
		LTV [10; 20) PTI [10; 20)																	
		...																	
Segment_2	NPL from 1 to 30 days	LTV < 10 PTI < 10																	
		LTV < 10 PTI [10; 20)																	
		...																	
		LTV [10; 20) PTI < 10																	
		LTV [10; 20) PTI [10; 20)																	
		...																	
Segment_3	NPLfromr 31 to 60 days	LTV < 10 PTI < 10																	
		LTV < 10 PTI [10; 20)																	
		...																	
		LTV [10; 20) PTI < 10																	
		LTV [10; 20) PTI [10; 20)																	
		...																	

Assessment of ratios of migration matrix of loans on the basis of multilayer neural network

Input variables:
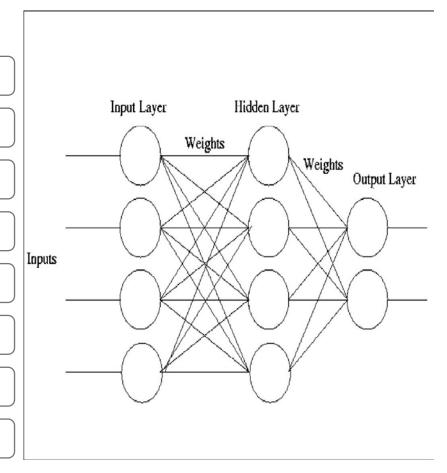
- Current LTV — x1
- Current PTI — x2
- LTV in the next period — x3
- PTI in the next period — x4
- Unemployment rate — x5
- Real income of the population — x6
- Real estate prices — x7
- Vintage — x8

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THANK YOU FOR YOUR ATTENTION!