

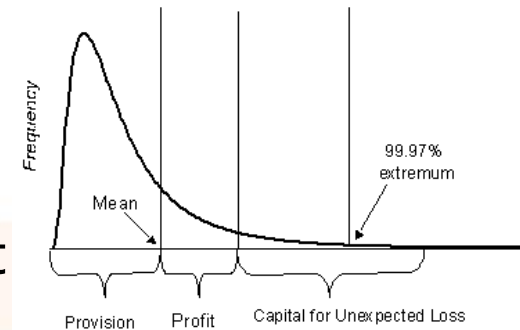
# Stress testing

One of the offered services

QUANTITATIVE

## RISK MANAGEMENT TOOL FOR EVALUATING UNEXPECTED RISKS

- Regulatory capital is set by given formula, but what event does the 99,9% quantile refer to?
- „Method for linking risks to specific events“.
- Stress testing is based on evaluating the impact of plausible scenarios.
- Can be used in all risk areas (operational, market, liquidity, credit), and should be used comprehensively in order to avoid neglecting correlations among all risk areas.
- The term “stress testing” is also used to refer not only to the mechanics of applying specific individual tests, but also to the wider environment within which the tests are developed, evaluated and used within the decision-making process.



- Basel II:

- (v) Stress tests used in assessment of capital adequacy*

434. An IRB bank must have in place sound stress testing processes for use in the assessment of capital adequacy. Stress testing must involve identifying possible events or future changes in economic conditions that could have unfavourable effects on a bank's credit exposures and assessment of the bank's ability to withstand such changes. Examples of scenarios that could be used are (i) economic or industry downturns; (ii) market-risk events; and (iii) liquidity conditions.

- ČNB, announcement 123/2007, §168 Požadavky na používání vlastních modelů, (1) f):

povinná osoba provádí stresové testování pravidelně

## FOUR ASPECTS

Sensitivity analyses

X

Scenario analyses

Historical scenarios

X

Hypothetical scenarios

Event driven

X

Portfolio driven

Macroeconomic/market  
events

X

Worst case events

### MEANINGFUL STRESS TEST

- Probability of stress scenario must be greater than zero
  - Finding such scenario can be based on statistical analysis, e.g. as a quantile of stressed parameter
  - Sometimes requires expert assessment of people involved in problem
- Developed scenarios should more or less cover all possible evolutions of events

### REVERSE STRESS TEST

- Finding scenario corresponding to given loss

### EVALUATED SCENARIOS CREATE BASIS FOR DECISIONS

- Once stress scenarios are developed and evaluated, the bank knows impact of such events
- The bank is prepared for such situations and should have developed steps to be taken

## EXAMPLES

- Historical scenario analysis for PD/LGD pools given by worst historical values:
  - Take historically worst PD for each PD pool and the worst LGD for each LGD pool
  - Assign it to all exposures
  - Evaluate the impact on capital requirement
- Hypothetical scenario with sensitivity analysis:
  - Move  $x$  % (5, 10, etc.) of clients to one class worse pool and evaluate impact on capital requirement
  - Value of  $x$  is set expertly or by study of historical data (confidence intervals of volume of exposures in particular pools or migration matrices study)
  - Sensitivity analysis on  $x$  can be performed

## STRESSING RISK PARAMETERS

- PD
- Main risk parameter for stressing – up to 2008 crisis
- Analysis of variance and quantile stressing (sd, 90%)
- Stressed transition probabilities
- LGD
- EAD
- Conditional on PD
- LGD strongly depends on economic cycle, stressing is necessary for economic downturns (also Basel roughly specifies stressing LGD)
- Stressing evaluation of collateral

## BASEL II FORMULA

- The regulatory capital formula is stress test of PD itself, based on assumption of portfolio correlation R:

- $$K = LGD * \left[ N \left( \sqrt{\frac{1}{1-R}} * N^{-1}(PD) + \sqrt{\frac{R}{1-R}} * N^{-1}(0.999) \right) - PD \right]$$

- Stressing merely PD is not sufficient, since PD and LGD are correlated



**QC stress test case study  
N°1**

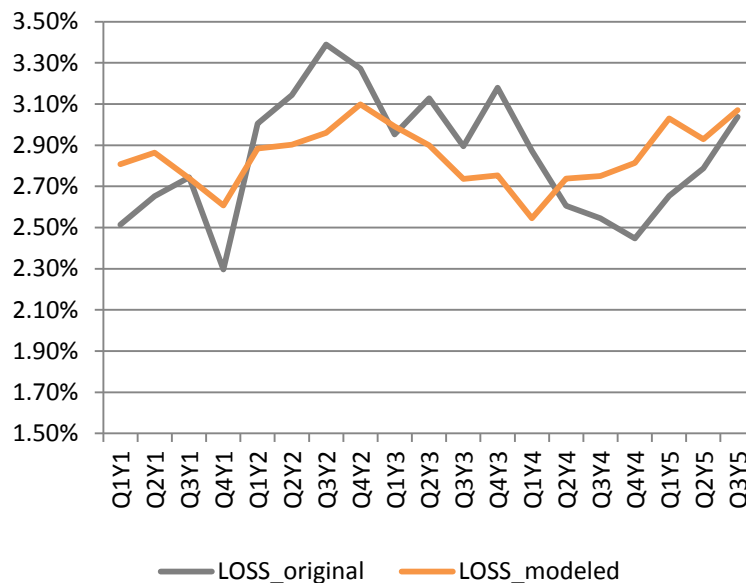
## STRESSING TOTAL LOSS (IN %)

- Let us study the impact of macroeconomic variables on LGD and PD jointly, i.e. the modeled variable will be  $LOSS_t = LGD_t * PD_t$
- Assume hypothetical retail portfolio, quarterly observed (same methodology as ČNB uses for stress testing)
- The model which satisfactorily describes the LOSS progress is

$$LOSS_t = 0.125 - 0.089 * GDP(YoY)_t,$$

where  $GDP(YoY)$  is the GDP growth,  
i.e.  $GDP(YoY)_t = \frac{GDP_t}{GDP_{t-4}}$

LOSS (LGD\*PD)



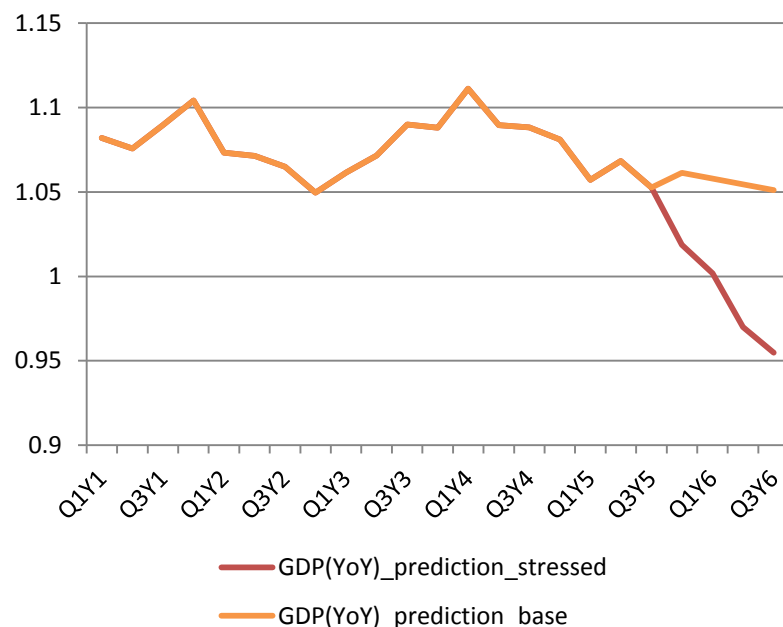
$$R^2 = 0,24$$

$$F \text{ test } p\text{-val} = 0,0317$$

## POSSIBLE SCENARIOS

- 1) Base: GDP growth will slowly continue in slight decrease, but still over 1
- 2) Stress: GDP will rapidly decrease, even under 1
- Scenario 1 was obtained from linear prediction from last 10 observations of GDP
- Scenario 2 can be obtained from CNB annual prediction of stressed GDP development

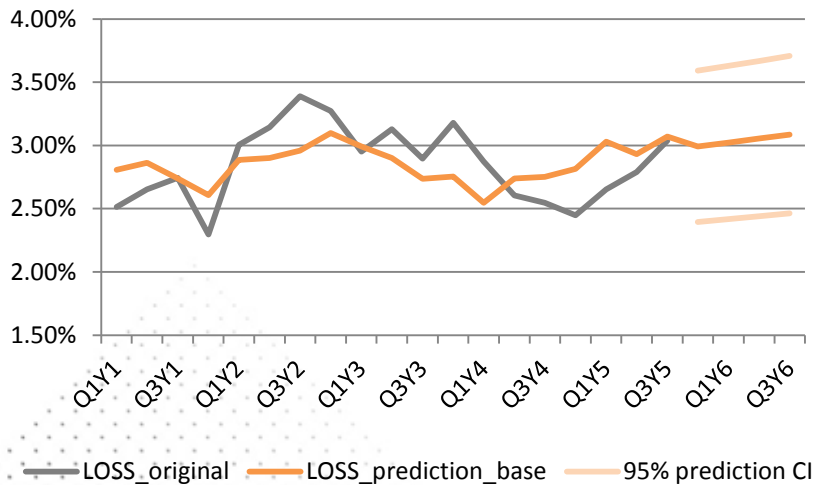
**GDP growth scenarios**



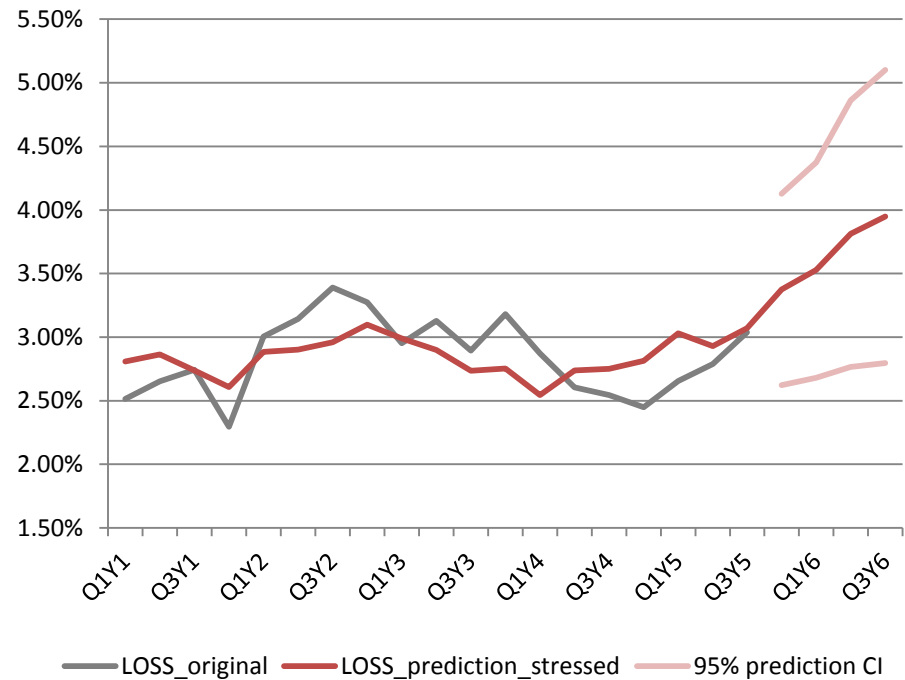
## RESULTS IN LOSS

- Prediction of LOSS development from computed regression model

**Baseline scenario**



**Stress scenario**



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**QC stress test case study  
№2**

## STRESSING PD MATRIX

- Consider mortgage portfolio with 5 PD pools and default state. The observed transition matrix (unstressed) is

	1	2	3	4	5	Default
1	0.92	0.01	0.01	0.04	0.01	0.00
2	0.11	0.78	0.01	0.07	0.02	0.01
3	0.47	0.17	0.65	0.03	0.09	0.01
4	0.22	0.20	0.05	0.37	0.14	0.02
5	0.04	0.06	0.11	0.13	0.51	0.14
Default	0.00	0.00	0.00	0.00	0.00	1.00

- We can stress the probabilities using generalized Vasicek model<sup>1)</sup> with stressing correlation factor  $\rho = 15\%$  and obtain following matrix

	1	2	3	4	5	Default
1	0.60	0.04	0.04	0.19	0.09	0.05
2	0.00	0.52	0.02	0.24	0.15	0.08
3	0.00	0.02	0.46	0.08	0.34	0.11
4	0.02	0.05	0.02	0.33	0.40	0.18
5	0.00	0.00	0.01	0.03	0.41	0.55
Default	0.00	0.00	0.00	0.00	0.00	1.00

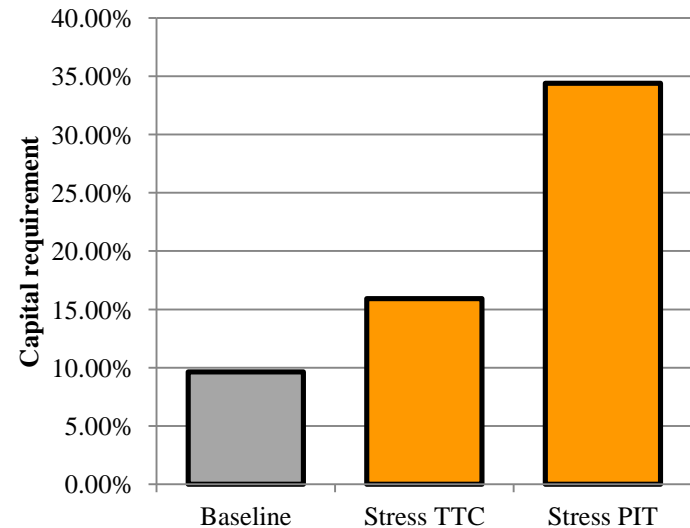
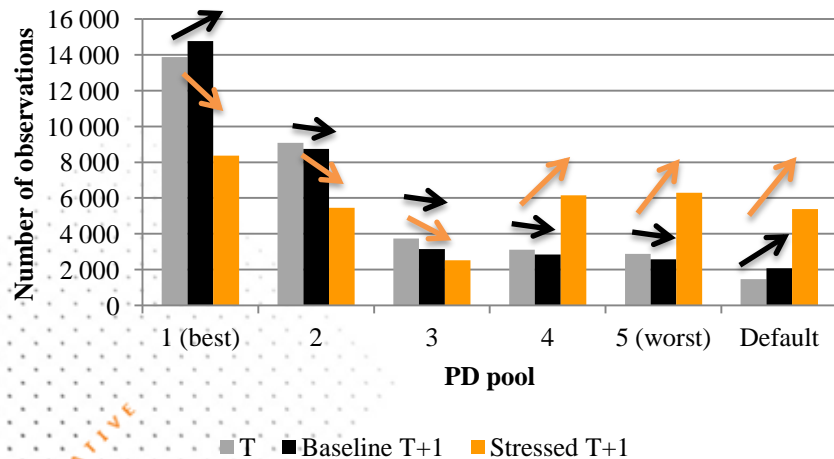
1) Properties, description of model and detailed example can be found in the Stress testing case study material

## STRESSING PD MATRIX

- Stressing will result in change of the distribution of clients among pools, i.e. increasing the number of clients in bad pools and decreasing in good pools

- At the end we can use stressed counts in pools to calculation of stressed capital requirement (in terms of PIT or TTC method)

**Distribution of observations**



# A Step Ahead

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