Provisioning and used models description

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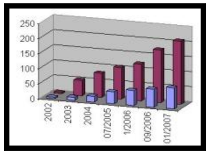

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Provisions? What is it and why should be used?

Generally, provisions (or reserves) estimates the amount of money necessary for compensation of money loss from ‘bad’ contracts. The exact moment when the money is lost is charge off (so called write off). When it really happens in finance differs from country to country (most usually it is after one year delinquency).

Reserves calculation is demanded by

Regulators (such as ČNB) – release the minimal requirements for companies which want to do a business here

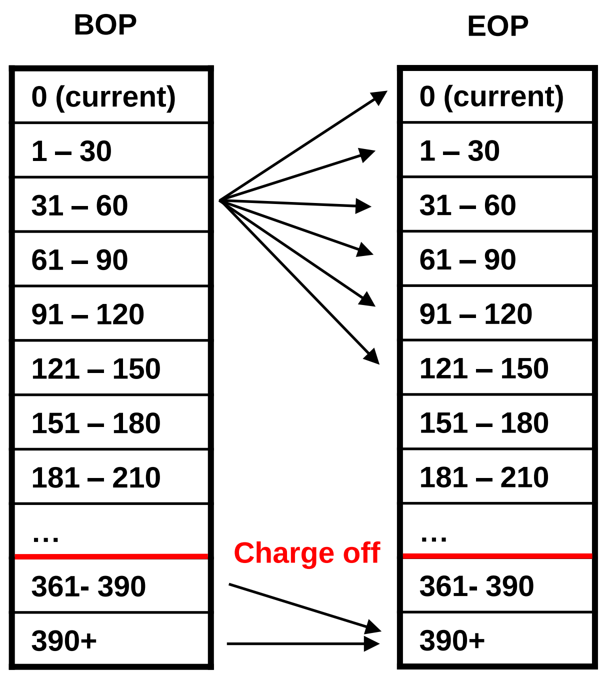
Auditors – make independent audits to confirm correct finance values and also following the requirements from regulators (correct calculation methodology,…)

Management – for the management it is a good estimation of probable losses. The results are used for risk evolution monitoring and risk analysis. Provisions also influence the profit of the company.

How do we calculate provisions?

The basic method used for provisions calculation is modelling of clients previous behaviour (in aggregated volumes – we do not track each client separately). Such analysis should give us quite good estimation of their future behaviour. The main goal is to determine how big amount of receivable will fall into charge off in future.

The behavior modeling is based on transitions between 'states' at the beginning and at the end of particular period (period length depends on methodology). States (so called buckets) are in our case DPD categories or their modifications (DPD could be combined with months on book or other predictive variables).



Depending on the length of period used for calculation, transitions between DPD categories are limited, e.g., if the period is only one month, the contract cannot (or should not) jump more then 2 buckets higher.

After the charge off (361 DPD) contracts are not allowed to return back to previous buckets. From this point of view, it is kind of 'ever' calculation.

Regardless of the type of model, the transitions are used to estimate the expected lifetime loss, i.e., the ratio of current volume that is expected to fall into charge off.

Different types of models

Since different types of products behave differently, we do not use the same models for all of them.

- ✓ all models use principal receivable for calculation
- ✓ offer the same result – estimation of current volume that will fall into charge off (lifetime). This estimation is represented by charge off coefficient for particular bucket.

For closed end loans (PoS and Cash loans) Markov models are used for the reserves estimation. These models consider all possible transitions between buckets and use so called transition matrix for each period.

For revolving loans we use simpler model – Rollrate model – which only compares the amounts of principal receivable in adjacent buckets. The problem with revolving loans and credit cards are repeated drawings that complicate the appropriate bucket assignment for particular contracts in Markov model.

Rollrate model

This model is based on so called rollrate coefficients from which resulting charge off coefficients are calculated. How to calculate these coefficients is depicted below.

16.7% = 500 / 3000

207 = 41.3% * 500

89.3% = 94.0% * 95.0%

	amounts		coefficients		gross loss
DPD	**BOP**	**EOP**	**rollrate**	**charge off**	
0	**3 000**	**3 200**	**16.7%**	**6.9%**	**220**
1 - 30	**450**	**500**	**68.9%**	**41.3%**	**207**
31 - 60	**300**	**310**	**80.0%**	**60.0%**	**186**
61 - 90	**250**	**240**	**84.0%**	**75.0%**	**180**
91 - 120	**200**	**210**	**95.0%**	**89.3%**	**187**
121 - 150	**180**	**190**	**97.2%**	**94.0%**	**179**
151 - 180	**150**	**175**	**96.7%**	**96.7%**	**169**
181 - 210	**140**	**145**	**-**	**-**	**-**
total	**-**	**4 825**	**-**	**27.5%**	**1 328**

4 825 = NEA (without 181-210)

27.5% = 1 328 / 4 825

1 328 = gross loss

The gross loss (or gross reserves) are evaluated as the scalar product of volumes at EOP and charge off coefficients. In this example, the resulted gross loss is 1 328, which is 27.5% coverage rate.

Rollrate model adjustments

Current bucket modification

Current bucket is divided into new and old based on age of loans. Charge off coefficient has to be adjusted according to IFRS requirements.

Averaging

For smoothening of the resulted figures and including seasonality effects 12 months average of the charge off coefficients is used. However, on some portfolios the history is not long enough and therefore less months could be taken.

Recoveries

To obtain net loss estimates, we have to include recoveries. Usually, recoveries are considered up to 24 months after contract is charged off

Turnover

The basic rollrate model do not estimate the loss for the lifetime of the portfolio. Therefore, adjustment based on average time portfolio needs either to get to charge off or to be paid is used.

Markov model

Is more precise in tracking the contracts behaviour. We use real transitions between all states that form the transition matrix for particular period. Contrary to the rollrate model, we are able to include also backward transitions (to lower buckets) and therefore avoid possible misinterpretation of the rollrate coefficients.

The transition matrix consists of percentages of volume that move from particular state (bucket) at BOP to some state at EOP. Beside the ordinal (transient) states, there are two more called absorbing states (charge off and paid).

The matrix fulfils several rules:

- the sum of each row is 100%
- it is not possible to get to another state from absorbing state (therefore the name absorbing)
- depending on the length of period, some of the cells above the diagonal are empty

	0	1 - 30	31 - 60	61 - 90	91 - 120	121 - 150	151 - 180	charge off	paid
0	70.0%	10.0%	1.0%	0.0%	0.0%	0.0%	0.0%	0.0%	19.0%
1 - 30	30.0%	35.0%	20.0%	1.0%	0.0%	0.0%	0.0%	0.0%	14.0%
31 - 60	5.0%	11.0%	16.0%	55.0%	1.0%	0.0%	0.0%	0.0%	12.0%
61 - 90	2.0%	5.0%	7.0%	12.0%	65.0%	2.0%	0.0%	0.0%	7.0%
91 - 120	1.0%	1.0%	2.0%	4.0%	10.0%	75.0%	3.0%	0.0%	4.0%
121 - 150	0.0%	0.0%	1.0%	1.0%	2.0%	7.0%	85.0%	1.0%	3.0%
151 - 180	0.0%	0.0%	0.0%	1.0%	1.0%	2.0%	10.0%	85.0%	1.0%

Markov model – coefficients calculation

The transition matrix T gives us the information about the behavior during one period. But we need to find out how it ends, i.e., the lifetime estimate. This can be done by multiplying the transition matrix by itself.
From now on we will denote the transient part of transition matrix as $\mathbf{T_T}$ and the absorbing states as $\mathbf{T_A}$.

If we make $\mathbf{T_T} * \mathbf{T_T}$ we get the transition matrix T^2_T which estimates the transitions after two periods ($\mathbf{T_A}$ stays the same). Infinitely, we get the matrix T^n_T of lifetime transitions. From the absorbing states definition, the contracts cannot get back to transition ones and at the end the whole volume will be in these states. Therefore we will get the estimation of the percentage of volume that will be charged off or paid (the sum for each row will be still 100%).

By multiplying the volumes in each bucket and the matrix T^x_T we get the estimate of volumes in buckets after x periods. Since we will use the infinite multiplication, no adjustment is needed to estimate lifetime reserves contrary to rollrate model.

We use MS Excel for the calculation where the infinite multiplication is simplified to matrix operations. The resulting values in absorbing states after infinite number of transitions are calculated as

$$(E - \mathbf{T_T})^{-1} * \mathbf{T_A}$$

where E stays for identity matrix.

The explanation of this formula is on the next slide.

Markov model – excel formula

The desired result is the volumes divided into absorbing states after the infinite number of transitions. The initial vector of volumes in buckets is denoted as v and v_{ch} stays for the final vector of charged off volume (lifetime).

After one transition the volumes will be $v*\mathbf{T}$, after second transition $v*\mathbf{T}^2$, after third transition $v*\mathbf{T}^3$, etc. Since we care only about volumes in the absorbing state (particularly the charge off), we can sum the volumes in this state produced in each transitions. This sum can be written as

$$v_{ch} = v*\mathbf{T}_A + v*\mathbf{T}_T*\mathbf{T}_A + v*\mathbf{T}^2_T*\mathbf{T}_A + v*\mathbf{T}^3_T*\mathbf{T}_A + \ldots$$

$$v_{ch} = v*(E+\mathbf{T}_T+\mathbf{T}^2_T+ \mathbf{T}^3_T + \ldots)*\mathbf{T}_A$$

We can also use the equation

$$(E-\mathbf{T}_T)*(E+\mathbf{T}_T+\mathbf{T}^2_T+ \mathbf{T}^3_T + \ldots) = E$$ where E is identity matrix

and from these two follows

$$v_{ch} = v * (E-\mathbf{T}_T)^{-1} * \mathbf{T}_A$$

So for the computation of the part of volume that will in future move into one of absorbing states, we need to calculate only the inverse matrix of $(E-\mathbf{T}_T)$ and multiply it by the absorbing states $\mathbf{T}_A$ and by the initial volume in each bucket.

Markov model adjustments

As in rollrate model, we use for the calculation of real provisions few settings/adjustments.

Period

three month transitions are taken as the period for calculation (e.g., transition from January to April)

Current bucket modification

current bucket is divided into new and old

- new current forms a new state in transition matrix. It holds that no contract can get to this state from any other and each contract is in this state only once
- the reserves are calculated separately for the new and old current, since these behave differently
- for both buckets, the final charge off coefficients are adjusted according to IFRS requirements

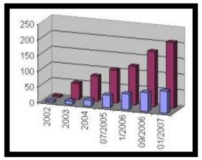
Averaging

as in rollrate model, the resulting coefficients are averaged over past twelve months (if possible)

Recoveries

calculated as in rollrate model and included to obtain net reserves

Model outputs & problems



As a result from both types of model, we obtain the development of coverage rates that should correspond to risk parameters for the portfolio and show the development of the overall risk from month to month.

The basic output from the models we calculate includes (for particular balance sheet date):

- principal receivable split into DPD buckets
- coverage rate (and corresponding provisions)
- charge off coefficients for individual buckets

Practical problems:

- Uneven number of days in months

  not corresponding to DPD buckets, instalment due day, number of working days

- Weekends and public holidays, non-banking days

  influence collection dept.

- Complexity of transition matrices for prediction purposes