Interest Rate Risk Management Using Economic Value Sensitivity Model

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Abstract: The article discusses the practical aspects of measuring and managing the interest rate risk by scenario analysis and sensitivity model. The model is constructed on already made an income gap or duration gap analysis. The basis of such model is forecasting, calculation and measurement of changes in the present value of bank assets, liabilities and off-balance sheet positions in various interest rate scenarios. The ultimate goal in modeling is the calculation of the expected economic value of the bank in different scenarios.

Keywords: interest rate risk, scenario analysis, sensitivity model, banks

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Introduction

The scenario and simulation models are among the most commonly used approaches in measurement and management of bank interest risk. They are based on already made an income gap or duration gap analysis. The simulation models analyze interest rate risk in dynamic aspect i.e. they estimate the current exposure subject to interest rate risk and as well as the future scenarios for a financial institution. They are an important tool for bank strategic planning, as measured and compared the effects of different future scenarios on the financial results of the bank and its economic value.

When the bank risk managers construct such scenario models they try to forecast how and when exactly interest rates on assets and liabilities will change if the base interest rate indices change. Furthermore, the additional variables such as expected changes in the macroeconomic parameters, changes in the competitive environment, new product lines planned innovation, optimization of operational processes are included in model.

The core of simulation models are probabilistic assumptions about future changes in the key variables on financial markets and macroeconomic framework. The financial analysts usually include the following assumptions in the model framework about:

- the type of curve yield to maturity and correlation between different interest rate indexes used in pricing of banking services;
- future levels and direction of change of base interest rates;
- future values of macroeconomic parameters and their correlation with base interest rates;
- planned future growth and changes in balance sheet items;
- introducing new product lines, market share and competitive environment;
- pricing strategies, entering into new markets.

Once interest curves are projected and the direction and amount of the expected changes in interest rates are determined, the bank manager needs the precise answers to the following questions:

- How will this change the economic value of the bank?
- How will banking income and expenditures for individual financial instruments change?
- What changes would occur in the value of bank assets and liabilities?

The scenario modelling most often measures the interest rate risk by calculating the financial impact of interest rates and bank strategies on net interest income, total income (interest and non-interest),

the economic value of the bank, its duration gap or certain balance sheet items[1].

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All bank simulation models are computer-based and carried out a series of calculations according to specified scenarios, forecasts and assumptions. As a starting point, i.e. a baseline scenario is used the values of bank balance sheet items. Based on these actual data and interest rates forecasts the scenario models calculate under different scenarios the expected future cash flows, changes in the balance sheet and off-balance sheet items, revenue s, expenses, etc. A special attention is paid to the modeling of different scenarios for loan portfolios and deposit resource base.

First a simplified method of scenario analysis will be presented. It serves as a quick assessment of the impact of interest rate risk on the income of the bank. The model framework includes a significant number of simplifying assumptions, such as:

- The interest rates vary in the same magnitude and the same direction;
- The changes in interest rates is sudden and abrupt to a new fixed rate. Financial practice rarely observed such abrupt changes,
- The financial instruments with fixed interest rates would not be changed until maturity despite the change in market interest rates
- The bank management will not take advantage of changes in interest rates and interest rate risk mitigation actions are not intended;
- The liabilities and assets will be reassessed simultaneously in the middle of the time interval;
- The changes in the bank policy as the introduction of new product lines, dumping, advertising campaigns and etc. are not envisaged.

Table 1 shows a simple example of a sensitivity scenario model of bank income gap under different interest rate scenarios. It is assumed that the interest rate curves vary in parallel way i.e. all rates vary in the same direction at the same time. Simulated six different scenarios of change in interest rates and calculated their impact on bank revenue.

The bank has a negative gap (-39.3 million lev) in the time interval up to 1 month, which means that more liabilities than assets will be revalued or their maturity will occur in this time period. This means that the remaining 11.5 months (the period during which the gap is effective) bank will have a 39.3 million lev liabilities over assets available and they will be revaluate at a different rate.

Table 1. A simplified scenario model for analyzing the sensitivity of net interest income

time interval		to 1 month	1 to 3 months	3 to 6 months	6 to 12 months	sum per year
gap period		0,9583 (11,5/12)	0,8333 (10/12)	0,625 (7,5/12)	0,25 (3/12)	
Net interest income change in mln. levs	300 BP	-1,12988	-0,03250	-0,07313	0,06375	-1,17175
	200 BP	-0,75325	-0,02167	-0,04875	0,04250	-0,78117
	100 BP	-0,37663	-0,01083	-0,02438	0,02125	-0,39058
	current gap	-39,3	-1,3	-3,9	8,5	-36
	-100 BP	0,37663	0,01083	0,02438	-0,02125	0,39058
	-200 BP	0,75325	0,02167	0,04875	-0,04250	0,78117
	-300 BP	1,12988	0,03250	0,07313	-0,06375	1,17175

[1] Maes, K., Interest Rate Risk in the Belgian Banking Sector, 2004.

We use the following formula to calculate how changes in market interest rates affect banking income for a given time horizon:

$$\Delta NII = \sum_{i=1}^{t} GAP_i * \Delta R_i * t_{ef\,i}$$, където:

GAP_i - gap for time interval i;

ΔR - changes in interest rates;

$t_{ef\,i}$ – time during which the gap is effective.

The change in net interest income up to 1 month in a scenario of increasing interest rates by 100 BP is equal to ΔNII1m = -39.3 * 0.01 * 0.9583 = - 0.37663 million lev

The next time interval (1 to 3 months) in raising interest rates by 100 BP is equal to:

ΔNII1-3 m = -1.3 * 0.01 * 0.8333 = - 0.010833 million lev

For the interval from 3 to 6 months will be:

ΔNII3-6 m = -3.9 * 0.01 * 0.625 = - 0.02438 million lev

Respectively from 3 to 6 months is:

ΔNII6-12 m = 8.5 * 0.01 * 0.25 = 0.02125 million lev.

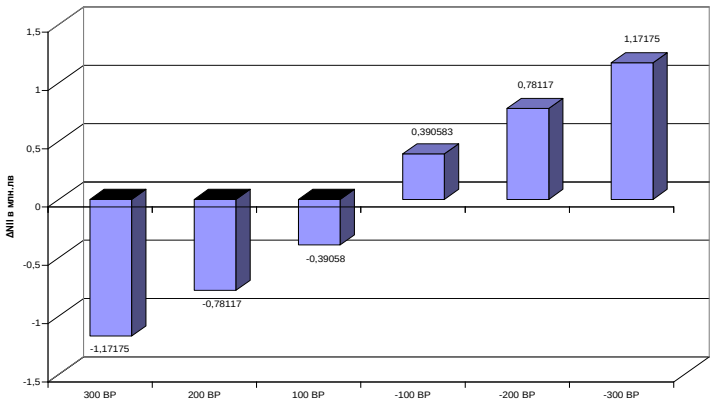
The last column of Table 1 gives an idea of the expected cumulative change in the banking net interest income for one year. It is obtained by summing the individual changes in time intervals. It can be seen that when interest rates increase by 100 basis points bank net interest income for one year will be reduced by - 0.39058 million lev and if the rates increase by 200 BP with -0.78117 million lev and etc.

Graphic 1 is built using part of the data from table 1 and gives a visual idea for the net interest income sensitivity for the different scenarios of change in interest rates. The interest rates shifts here are inverse symmetrical because of the simplicity of the assumptions in the model framework (that interest rates will change in the same magnitude, in the same direction at the same time).

As could be seen on the graphic the most significant change of net interest income is for the first interval (up to 1 month) i.e. the shortest term balance items are highly exposed to interest rate risk. This puts the bank in a dangerous perspective and should be taken into account by the manager responsible for managing interest rate risk. The changes in bank exposures for other periods is relatively low and consequently they will be less affected by the volatility of interest rates.

The illustrated simplified method of scenario analysis is easy to calculate, but rough and inaccurate. Despite its shortcomings, it indicates the basic principles and mathematical concepts of interest rate risk modern modeling. The aspiration and tendency in model design in banking practice is to be used more complex and realistic model frameworks that incorporate the main factors causing changes in interest rate and economic environment.

The impact of interest rate risk on the economic value of the bank will be represented by a more complex and realistic сценарио model that is close to those used in модерн bank management. The core of such models is forecasting, calculation and measurement of changes in the present value of bank assets, liabilities and off-balance sheet positions in various interest rate scenarios. The ultimate goal in modeling here is the calculation of the expected economic value of the bank for given scenario. In all scenarios, the economic value of the bank is equal to the present value of expected cash flows of all bank assets less the present value of expected cash flows from all liabilities plus or minus the present value of expected cash flows from off-balance sheet positions. The first step is calculation of "basic interest scenario." where we use the actual current interest rates. As discount rates in the other alternative scenarios we use the predicted future interest rates curve.



Graph 1. Net interest income sensitivity under the scenario from -300 BP to +300 BP

The forecasting future interest rate is a key factor that includes modeling of:

- shape of the term structure of interest rates;
- direction of interest rates change over different time horizonts;
- correlation between the major market indices, which are used in the pricing of bank instruments.

The presented below scenario models calculate the changes in the expected values of bank balance sheet and off balance sheet items under different interest rate scenarios. Tables 2 and 3 shows a more complex and realistic interest rate sensitivity scenario model. The scenario is played out in a +100 BP parallel increase in interest rates of bank assets and liabilities.

The market value (present value) of each positions is calculated, as discount rates are used interest rates raised by +100 BP.

Table 2. Scenario model +100 BP

ASSETS (in mln. levs)	**book value**	**maturity (in years)**	**base scenario**	**+ 100 BP**	**market value**
cash	4,8	0			4,8
consumer credits	13,7	3,5	0,165 %	0,175%	13,48284
mortgage credits	13,8	15	0,182 %	0,192%	13,20935
corporate credits	15,5	3	0,125 %	0,135%	15,28
corporate credits	18,2	5	0,129 %	0,139%	17,79665
T-bonds (1 y. coupon)	12,4	10	0,085 %	0,095%	11,62143
bonds (6 м. coupon)	8,3	7	0,095 %	0,105%	7,895695
overdrafts	12,4	1	0,195 %	0,205%	10,29046
other assets	0,9	0			0,9
Total	100				95,27642

Table 3

LIABILITIES and EQUITY	book value	maturity (in years)	base scenario	+ 100 BP	market value
equity	4,6	0			
reserves	3,3	0			
total equity	7,9				4,016432
bank credits	4,2	3	0,042%	0,052%	4,137443
bank credits	8,3	5	0,0485%	0,0585 %	8,101564
term deposits	12,2	1	0,06%	0,07%	12,08598
term deposits	24,3	2	0,07%	0,08%	23,86667
term deposits	13,1	0,25	0,045%	0,055%	13,06833
current accounts	7,2	0	0,005%	0,015%	7,2
demand deposits	18,1	0	0,02%	0,03%	18,1
other liabilities	4,7	0			4,7
total	92,1				91,25999
Total	100				95,27642

Table 4 . Results from a sensitivity scenario model (interest rate changes from -300 BP to 300 BP)

interest scenario	PV assets	change	PV liabilities	change	economic value	change
300 BP	90,3	-9,7	89,6	-2,5	0,7	-7,2
200 BP	92,7	-7,3	90,4	-1,7	2,3	-5,6
100 BP	95,3	-4,7	91,3	-0,8	4	-3,9
base scenario	100	0	92,1	0	7,9	0
-100 BP	100,8	0,8	92,9	0,8	7,9	0
-200 BP	103,9	3,9	93,8	1,7	10,1	2,2
-300 BP	107,2	7,2	94,8	2,7	12,4	4,5

As could be seen from table 2 and 3 if the interest rates on assets and liabilities are increased by +100 BP the economic value of the bank will be reduced by approximately 50% i.e. 3.88 million lev (7,9 – 4,016432 = 3.88). This is a serious reduction in equity and if bank mangers will take no actions the bank will not have enough capital adequacy. The current situation requires the bank manager to implement an appropriate strategy to protect the economic value of the bank from the impact of interest rate risk.

If the interest rates are getting higher and no actions from the manager the bank would in a situation of insolvency (its economic value will be negative - table 4).

Table 4 shows the final results for a sensitivity scenario model with six acted out scenarios in interest rates. The changes in the market value of bank assets, liabilities and economic value of the bank could be seen. It could be seen that if the bank keep the existing structure of its assets and liabilities, its economic value in the short term will increased with any future reduction in interest rates. But if the interest rates rised, the bank will lose a mach more and may even be threatened by insolvency . Interest rate risk is higher, the greater income gap is.

Conclusion

By constructing computer scenario simulations the bank managers may to gain an idea in advance about the coming changes in key variables and bank be able to take adequate decisions. Usually must be simulated increases in interest rates, reduction and most likely scenario.

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