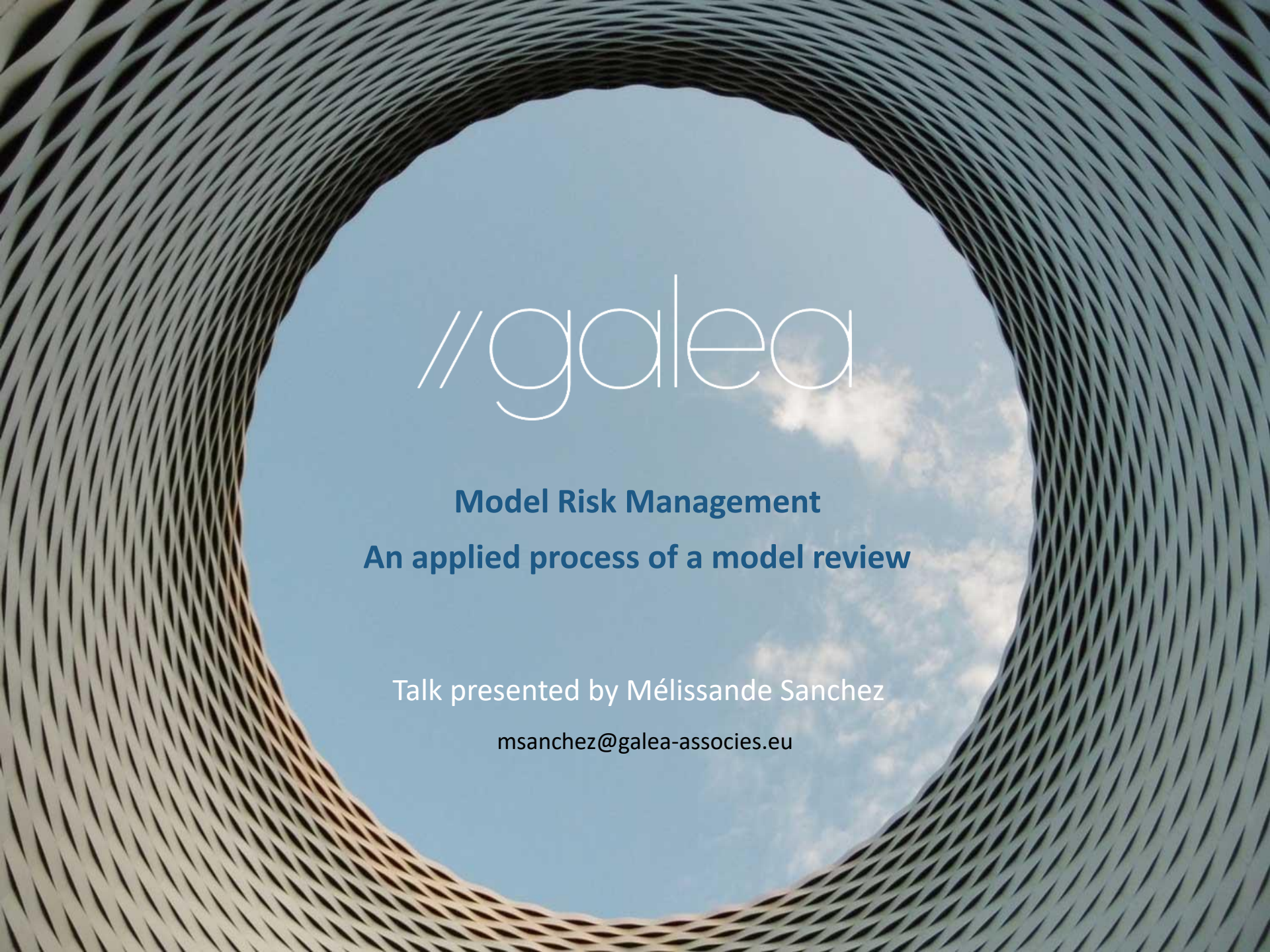

Model Risk Management

An applied process of a model review

Talk presented by Mélissande Sanchez

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Table of contents

Background and purpose of the study (1/2)

// Models are primary source of information.

// Constraints for Institutions :

- Respecting the models' theoretical properties
- Guarantying coherence
- Parameters' adequacy and justifying the hypotheses
- Optimizing the computing time
- Reglementary requirements

// Model reviews are becoming increasingly frequent, and carried out either by the regulator or by financial institutions.

// Insurance : work of the actuarial and risk management functions

Background and purpose of the study (2/2)

// Market practices have evolved, especially by developing the enforcement of models' governance system.

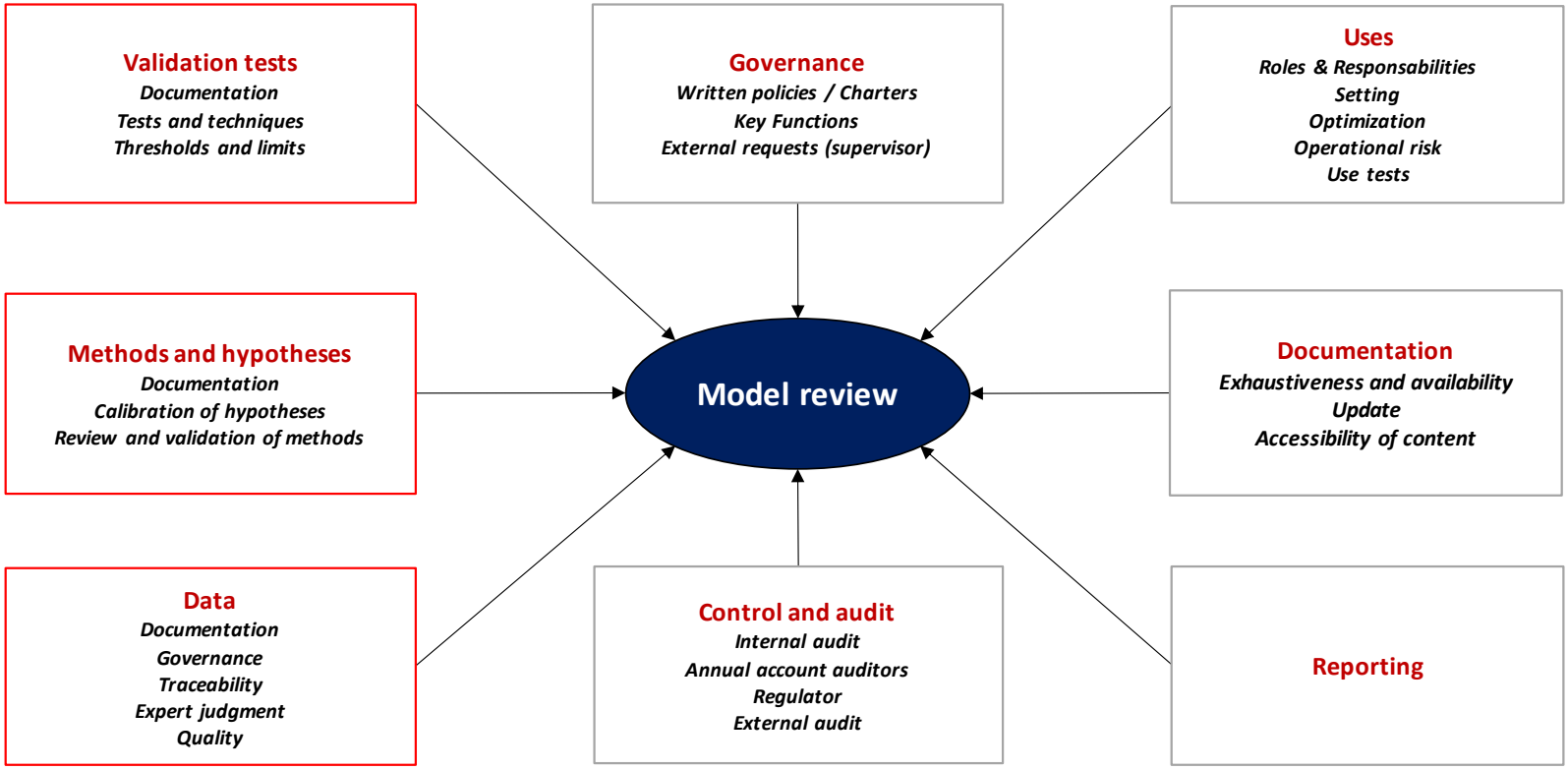
// The model review is an essential and value-added measure that allows :

- More informed decision-making
- Understanding of statistical uncertainties
- Anticipation of the impact of future reglementary changes
- Better global efficiency

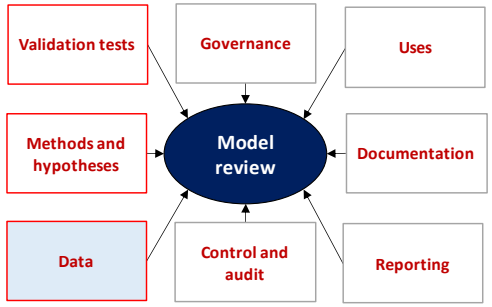
// Models is at the root of multiple strategic activities :

- production of financial statements
- product launching
- forecasting the business activities
- Etc.

Themes around model that requiring a review



Issues and works



Data (1/2)

// Documentation :
- Centralization of expert judgments
- Written policies with details about the data management process

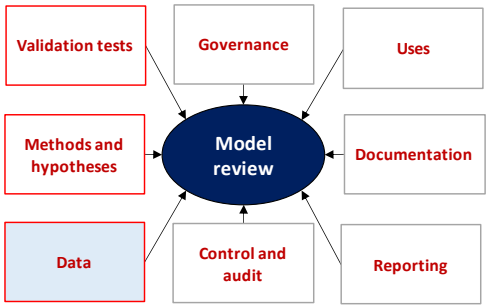
// Data governance :
- Defining roles and responsibilities according to their fields of activity, in particular that of the DQO (Data Quality Officer)
- Management of external data
- Compliance of the data

// Data accessibility :
- Sustainability and robustness of the Information Technology

// Full traceability :
- Data dictionary
- Data flow
- IT tools

Issues and works

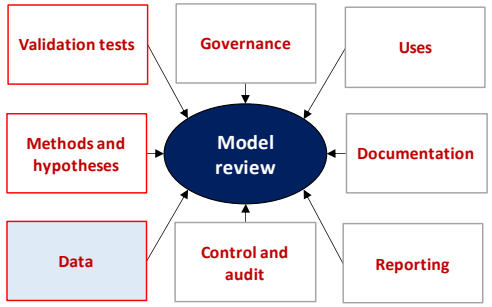
Data (2/2)



// Expert judgments :
- Documentation
- Update
- Reviewing of the techniques for incomplete data
- Thresholds and limits for data validation
- Data validation and understanding

// Data quality :
- Insurance : criteria of quality from Solvency 2
  - Accuracy
  - Completeness
  - Appropriateness
- Temporal consistency / data reconciliation from a year to another

Issues and works



Data

Application

// Statistical tests

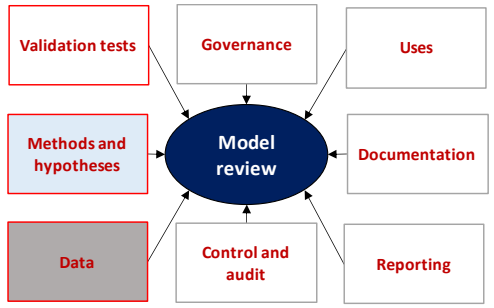
- Significance tests
  - Student test
  - Fisher test

$$z = \sqrt{n} \times \frac{\bar{x} - \mu_0}{s_n^*} \; where \; s_n^* = \sqrt{\frac{1}{n-1}\sum_i^n (x_i - \bar{x}_n)^2}$$

- Correlation between 2 variables (Pearson)

$$t = (n-2)^{\frac{1}{2}} \frac{\left|r_p(x^1, x^2)\right|}{\sqrt{1 - r_p(x^1, x^2)}} \; where \; r_p(x^1, x^2) = \frac{\sum_i \left(x_i^1 - \overline{x^1}\right)\left(x_i^2 - \overline{x^2}\right)}{\sqrt{\sum_i \left(x_i^1 - \overline{x^1}\right)^2 \sum_i \left(x_i^2 - \overline{x^2}\right)^2}}$$

Issues and works



Methods and hypotheses

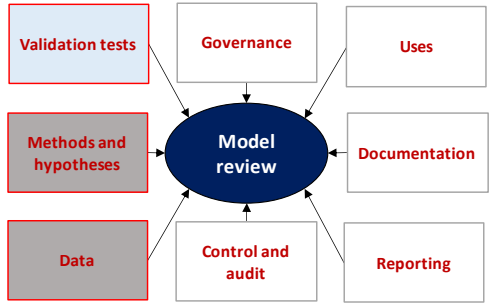
// Documentation :

- Comprehensive and understandable technical sheets and user manuals.

// Calibration of hypotheses and choice of methods :

- Comparing expert judgment
- *Benchmark*
- Limits of the hypotheses
- Regular update
- Hypotheses stability
- Complexity and difficulty of implemented methods
- Validation of proxies

Issues and works



Validation tests

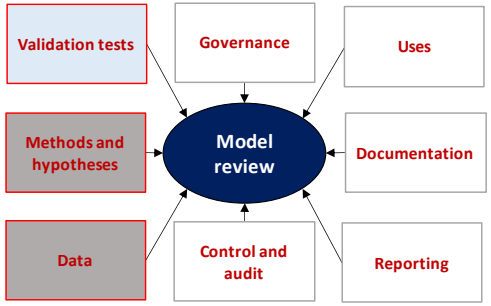
// Documentation :
- Process/Check-list of the tests

// Techniques and tests :
- Back testing, change of experience measurement
- Sampling / test cases
- Stress tests
- Movement analysis
- *Benchmarks*
- Managing the convergence gap (for stochastic models)
- Discriminant analysis/Cross validation methods

// Thresholds and limits :
- Defining tolerance thresholds and review of their good application.

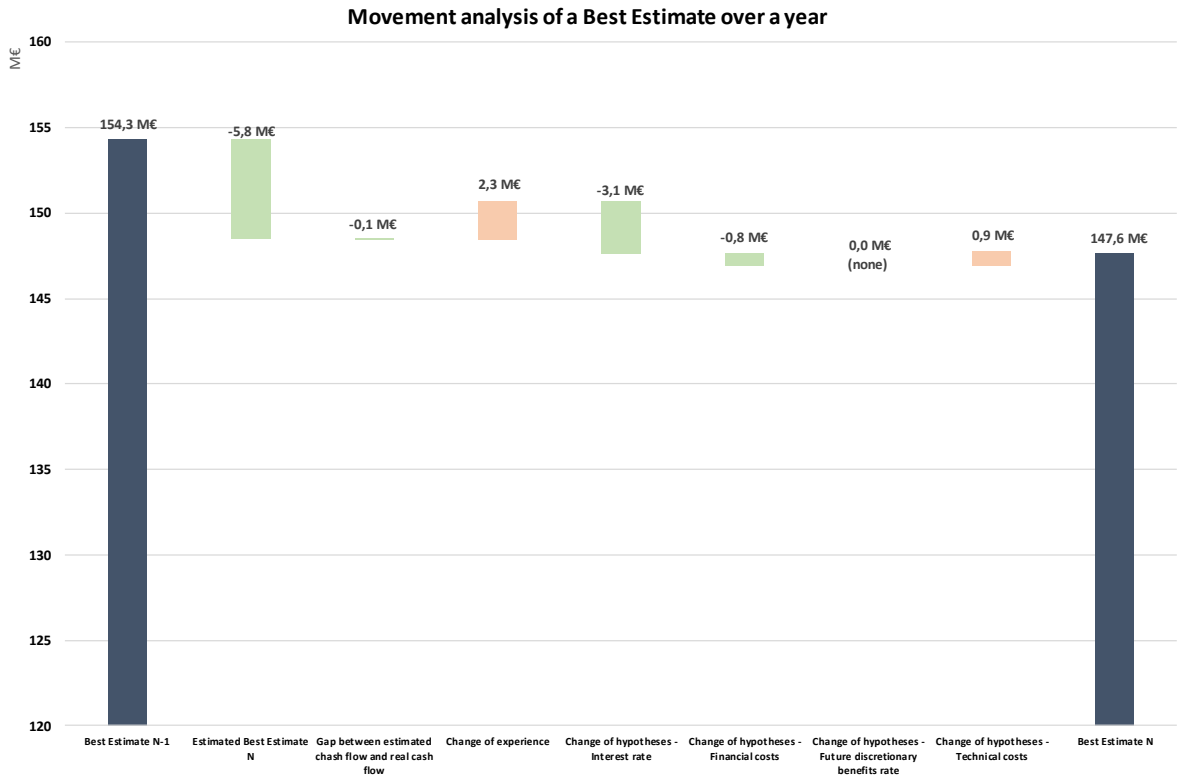
Issues and works

Validation tests



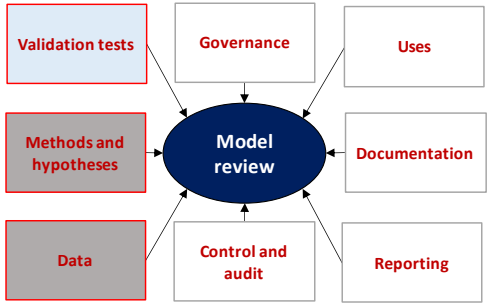
Application

// Movement analysis



Issues and works

Validation tests



Application

// Stochastic ALM model/Convergence gap

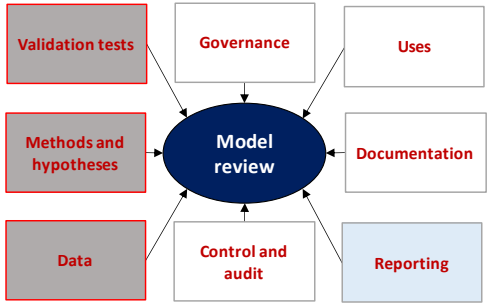
$$\Delta = Asset\ market\ value + other\ assets - (PVFP + Best\ stimate + others\ liabilities)$$

// Proportional hazards assumption (Cox Model)

$$\frac{\lambda(t/Z_i)}{\lambda(t/Z_j)} = \frac{exp(\beta'.Z_i)}{\exp(\beta'.Z_j)}$$

Appendix 1 : Issues and works

Reporting



Application

// An insurance company's dashboard to the AMSB

Accounting result

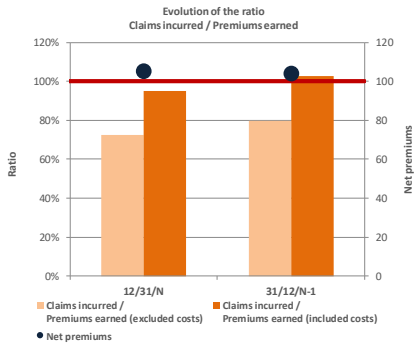
M€

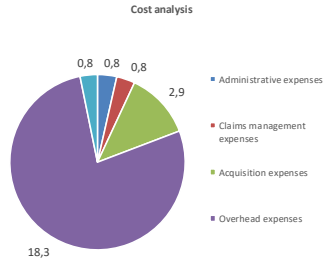
Technical result of insurance activities

	12/31/N			12/31/N-1			
	Gross	Reinsurers' share	Net	Gross	Reinsurers' share	Net	Evolution
Premiums	121	16	105	121	17	104	1%
Claims incurred	-85	-9	-76	-93	-10	-83	-8%
Changes in other technical provisions	0	1	0	0	0	0	-250%
Expenses incurred	-27	-4	-24	-25	-1	-24	-3%
Administrative expenses	*-1*	*0*	*-1*	*-1*	*0*	*-1*	-6%
Claims management expenses	*-2*	*-1*	*-1*	*-1*	*-1*	*-1*	20%
Acquisition expenses	*-6*	*-3*	*-3*	*-7*	*0*	*-7*	-58%
Overhead expenses	*-18*	*0*	*-18*	*-15*	*0*	*-15*	22%
Other expenses	*-1*		*-1*	*-1*		*-1*	-9%
TOTAL	9	3	5	3	6	-3	-276%

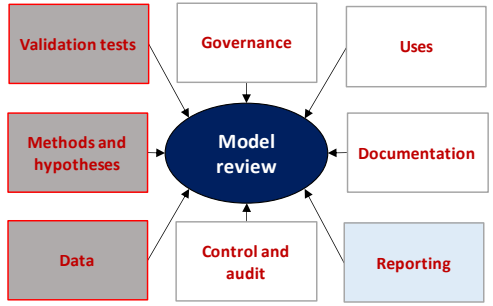
Indicateurs :

Claims incurred / Premiums earned (excluded costs)	73%	80%
Claims incurred / Premiums earned (included costs)	95%	103%
Claims management expenses / Claims incurred	1,0%	0,8%





Appendix 2 : Issues and works



Reporting

Application

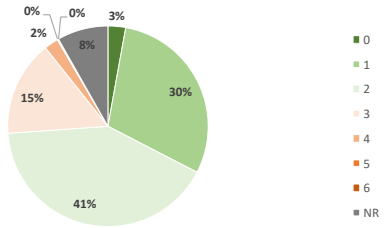
// An insurance company's dashboard to the AMSB

Rating of financial instrument

Rating	Market value 12/31/N	*Weight*
0	4 M€	***3%***
1	40 M€	***30%***
2	55 M€	***41%***
3	21 M€	***15%***
4	3 M€	***2%***
5	0 M€	***0%***
6	0 M€	***0%***
NR	11 M€	***8%***

Rating	Market value 12/31/N-1	*Weight*	*Evolution*
0	4 M€	*3%*	*-0%*
1	42 M€	*28%*	*-6%*
2	63 M€	*42%*	*-12%*
3	24 M€	*16%*	*-14%*
4	3 M€	*2%*	*+2%*
5	0 M€	*0%*	*0%*
6	0 M€	*0%*	*0%*
NR	13 M€	*9%*	*-15%*

Distribution by rating of the financial assets - 12/31/N



Distribution by rating of the financial assets - 12/31/N-1