"Approach to recalibrating undertaking-specific parameters for incapacity and disability risks within Solvency II framework" Jean-Samuel, my 13 years old son

Approach to recalibrating undertaking-specific shocks parameters for the risks of incidence, recovery or non-recovery in health insurance within the framework of Solvency II

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AGENDA

- Context
- Theorical aspects
  - Main components and models
  - Notion of credibility
- Case study : application on a loan insurance portfolio
  - Studied portfolio : guarantees, specificities and data
  - Undertaking Specific Parameters estimation
  - Solvency Capital Requirement calculation : USP vs Standard Formula
- Conclusion

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Context

What problems do we face?

- **Parameters proposed by Standard Formula (Solvency 2) are limited and inadequate…** :

  - Problems of heterogeneousness of the risks in the module Health module similar to life (Health SLT) :

    - Problems of anti selection in insurance
    (Group / Individual contracts)

    - Impact of medical selection on the quality/severity of the risks
    (with selection / without selection on entry)

    - Difference of the duration of the liabilities of insurance
    (Incapacity and disability risks of loan insurance / Entreprise Healthcare contracts …)

    - …

- **Consequence :**
  "Fixed" shocks proposed by Standard Formula seem unsuitable to take into account the heterogeneousness of the underlying risks in the calculation of the economic capital.

Context

What framework of case study do we propose?

- **Partial Internal Model and ORSA implementation within Solvency 2 framework**

- **Case study : loan insurance portfolio**

  - Main guarantees ➔ Death (mortality risk) and Incapacity and Disability (incidence and recovery risks)

  - To avoid Standard Formula parameters ➔ because too severe and inadequate in this case !

    - Standard Formula shocks levels are :
      - ✓ Incidence shocks : **+35%** (first year) vs **+25%** (following years)
      - ✓ Recovery (or non recovery) shocks : **+20%** (2 cases : on rate of non recovery if **level < 50%**, on rate of recovery if not)

    - Application of the multiplicative shocks jointly on incidence rates and recovery (or non recovery) rates

- **Consequence :**

  We developed methods and approaches of recalibration Undertaking Specific Parameters (USP) for incapacity and disability risks.

Context

What preliminary questions?

- **Focus on incapacity/disablity garantees**
  - Which risks ?

  Incidence and recovery (non recorvery)

- **Focus on data**
  - How to use company experience ?

  To use avalaible data to quantifiy entity specifics shocks (portfolio, business unit, business line…)

- **Focus on economic values**
  - For which economic values ?

  To calculate Solvency Capital Requirement (SCR), ORSA capital…

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Theorical aspects

Main components and models

Main components	• Two main sources of errors ✓ Error of estimation ✓ Process variance or error of process
Error of estimation	• Error of estimation : ✓ Difference between the estimated law and the intrinsic law (to reflect sampling fluctuations)
Process variance or error of process	• Process variance or error of process : ✓ Fluctuation of claims rates over time due to endogenous or exogenous conditions… ✓ Examples : ▪ Changes in internal underwriting, medical selection, claims compensation… **conditions**, ▪ Changes in the general state of health, ▪ Changes in external and statutory rules, ▪ Changes in the structure of the insured population…

Theorical aspects

Main components and models

Error of estimation calculation

- **Incidence rates calibration : actuarial (vs Hoem) estimator**
  - ✓ Number of incidence follows a binomial law ➔ **Variance of Binomial law**
- **Non recovery rates : Kaplan-Meier**
  - ✓ Non parametric estimator ➔ **Variance of Greenwood**

$\sigma_{estimation}$

Error process models

- **Two predictive models are proposed to measure temporal evolution :**
  - ✓ **Time series approach : autoregressive process AR(1)**

$$W_{(s',t)} = \alpha_{(s')} + \beta_{(s')} \times W_{(s',t-1)} + \sigma_{(s')} \times \varepsilon_{(s',t)}$$

$$i_{(s',t_{\max}+1)} = i_{(s',t_{\max})} \times \left(1 + \alpha_{(s')} + \beta_{(s')} \times W_{(s',t_{\max}-1)} + \sigma_{(s')} \times \varepsilon_{(s',t_{\max})}\right)$$

  - ✓ **Log-Normal model :** $\ln\left(\frac{i_{(s',t)}}{i_{(s',t-1)}}\right) = \alpha_{(s')} + \sigma_{(s')} \times \varepsilon_{(s',t)}$

$$i_{(s',t_{\max}+1)} = i_{(s',t_{\max})} \times \exp(\alpha_{(s')} + \sigma_{(s')} \times \varepsilon_{(s',t_{\max})})$$

➔ Allows to simulate différent value of incidence or recorvery rates over one year (at date t_{max} +1)…

Theorical aspects

Main components and models

Error process calculation and Global shock calibration

- **Steps of calculation of the error process:**
  - ✓ **Estimation** of models parameters by Least Square Error method
  - ✓ **Projection** of the time tendency of incidence (non-recovery or recovery) rates over one year (t_{max} +1)
  - ✓ **Deduce** variance and coefficient of variation associated with the distribution
  - ✓ **Calculate** the marginal shock for the error of process by multiplying the coefficient of variation estimated at t_{max} +1 by the incidence (non-recovery or recovery) rate calculated at t_{max}

$$\sigma_{process} = CV_{(s')} i(x, s, t_{max})$$

- **Calculation of global shock by aggregating process error and estimation error :**
  - ✓ Assuming that the estimation errors are de-correlated from one another and from any other contingency

$$\sigma_{global}{}^2 = \sigma_{estimation}{}^2 + \sigma_{process}{}^2$$

Theorical aspects

Notion of credibility and adaptation

Why to introduce this notion ?

- **Taking into account limits of the data (of experience) of the entity :**

  ✓ Experience data constraints :

  - Bad quality ➔ Quality
  - Absence or little history available ➔ History
  - Small-size of data available ➔ Volume
  - New business ➔ No data

  ✓ Alternative approach to include that “harsh” reality… :

  - **Define the criteria of full credibility**

    ➔ criteria allowing to assure a total credibility of specifics parameters

  - **Deduct the criteria of partial credibility on the basis of the available data**

    ➔ integrate into the evaluation of the specifics parameters part of the parameters proposed by Standard Formula (chosen as reference parameters of the industry)

Theorical aspects

Notion of credibility and adaptation

Notion of credibility

- **Two main theories** :
  - ✓ Theorie of the credibility based on the biggest accuracy (Théorie de la crédibilité fondée sur la plus grande exactitude ➔ TCGE)
    - **Method of Buhlmann** (vs Buhlmann-Straub)
  - ✓ Theory of the credibility with limited variation (Théorie de la crédibilité à variation limitée ➔TCVL)
    - American credibility
    - **Standardized method** (*see note éducative of ICA*)

Theorical aspects

Notion of credibility and adaptation

Notion of credibility

- **Adaptation we propose is ➔ TCVL standardized method**

  ✓ **Criterion of full credibility**

  ➔ use only specifics parameters estimate with experience base on available data set (without integration of Standard Formula parameters)

  ➔ Validate the following conditions :

  - **Minimal size of data**
    ➔ Cochran criterion (vs minimal exposition)

  - **Minimal depth of data history**
    ➔ Be sure that the parameter is stable (when we add one year of additional history)

  ✓ **Criterion of partial credibility**

  ➔ Undertaking specific parameter (USP) is the **weighted sum** of the specific parameter and of the Standard Formula parameter (reference of the industry)

Theorical aspects

Principle of TCVL and limits

How to estimate credibility factor?

- **Limit of TCVL** :

$$X_E = z\overline{X} + (1 - z)\mu$$

X_E number or amount of claims expected
z credibiliy factor
$X = \{X_1, X_2, \ldots, X_m\}$ experience data
m number of years of experience (available history)
μ expected value of the underlying distribution of X (unknown law?) of claims
$\overline{X}$ observed average calculated on experience data

✓ **No constraint :**

➔ TCVL doesn't propose underlying theoretical model for the distribution of X_i (i=1,2,…,m) which is in compliance with the proposed formula

✓ **Observation** :

➔ calculate X_E by choosing a parameter of margin error *r* (*r* > 0) and a level of probability *p* (0< p <1) such as the difference between X_E and μ is low.

$$Prob\{|X - \mu| \leq -r\delta\} \geq p$$

Theorical aspects

Choice of « reasonable » hypotheses

How to estimate credibility factor?

- **TCVL standardized method** :

  ✓ **Reasonable choice of hypotheses:**

  ➔ Assume that $\bar{X}$ follows a normal distribution allows to use the table of standard normal law (with parameters *r* and *p*)

  ➔ Approximation of the number of claims (binomial distribution) by a Poisson distribution when the probability of emergence are low

  ✓ **Definition of the partial credibility factor** :

$$z = min\left\{\sqrt{\frac{n}{Seuil}}; 1\right\}$$

n : number of claims observed in the available experience data
Seuil : required number of claims corresponding to the parameters r and p in the table of standard normal law

  ✓ **Standardized principe :**

  ➔ Taken into account by the various segmentations retained in the calibration of the rates

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Case study
Application on loan insurance portfolio

► Scope

- The study concern a protfolio of loan insurance contracts which is **representative of french market** and mainly composed of property loans

- **Some figures about this Portfolio :**

  - Number of contracts : > 12 millions
  - Age of subscription (average) : 40 years
  - Insured Capital (average) : 48 000 €
  - Claim cost (average) : 12 000 €

► Guarantees

- **Main guarantees** :

  - « Death » : refund of remaining capital in case of death
  - « Incapacity/disability» : payment of loan terms in case of sick leave

- **Same specificities of guarantees on all the scope** :

  - Conditions of sale, legal framework, waiting period, exclusions, insurance selection…

Case study
Application on loan insurance portfolio

► Data bases

- **3 data bases with different structures and records depth :**
  - The « Individual » base : personnal informations about each insured people still covered by his contracts
  - The « Class » base : global informations about class of insured people still covered by their contracts
  - The « Claims » base : personnal informations for each accident

- **Data bases with different structures and level of details** :

Data bases \ use	Incidence – rates	Incidence – USP	Recovery– rates	recovery – USP
« Individual » base *2 to 5 years of history*	✓			
« Class » base *16 years of history*		✓		
« Claims » base *23 years of history*	✓	✓	✓	✓

  - **Limit** : No key variable to link « claims » and « individual » data bases

► Data quality validation criteria

- **Relevance, accuracy and exhaustiveness**

Case study

Undertaking Specific Parameters estimation

- **Credibility factors calibration** :

  - **Parameters** : **p = 99%** (confidence interval) and **r = 3%** (error margin)

  - **Extract of Table of standard normal law** :

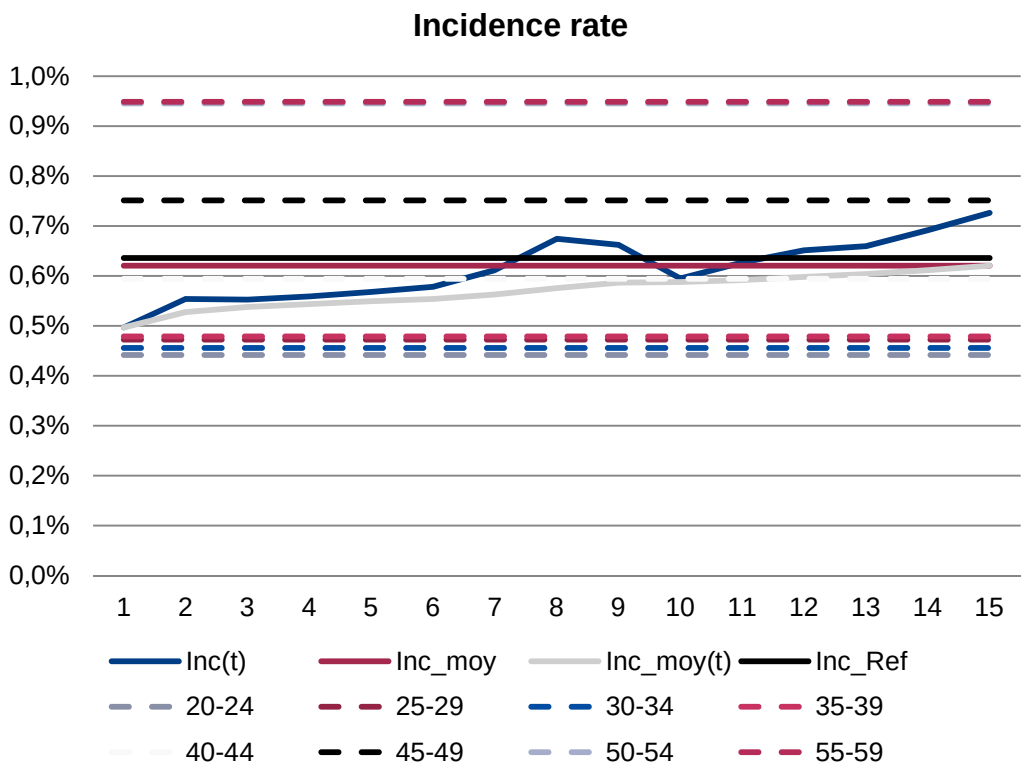
Table of standard normal law					
Number of claims required for full credibility					
Probability parameter (p)	**Error margin parameter (r)**				
	5%	4%	3%	2%	1%
90%	1 082	1 691	3 007	6 765	27 060
95%	1 537	2 401	4 268	9 604	38 416
99%	2 654	4 147	**7 373**	16 589	66 538
99,9%	4 331	6 767	12 030	27 068	108 274

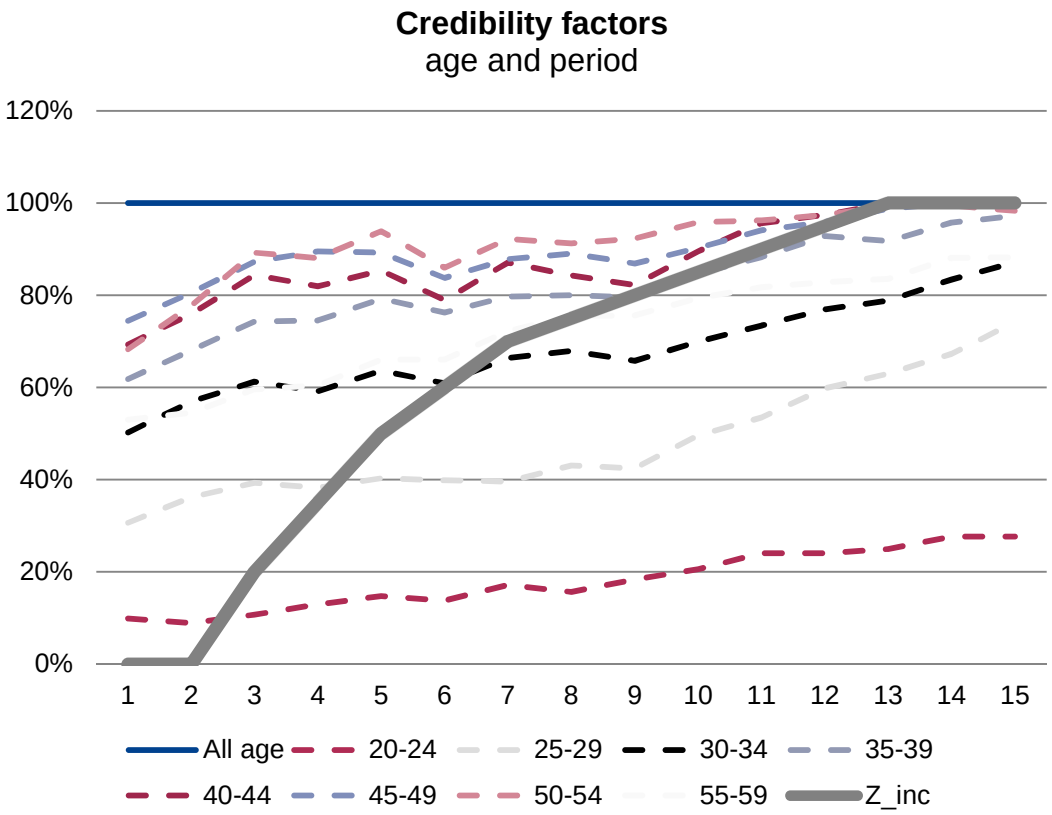
    - If p = 99% and r = 3% ➔ **7373** claims required to get full credibility

Case study

Undertaking Specific Parameters estimation

► Credibility factor for incidence risk





■ **Comments** :

- **Incidence rates** increase with age
- **Credibility factors** also increase with age ➔ history and volume effects on parameters
- Standardization ➔ to obtain **final credibility factors** by taking into account segmentations (exposure)

Case study

Undertaking Specific Parameters estimation

- **Credibility factors for incidence rates** :

Credibility factors for years of available history: shocks of incidence											
Year	3	4	5	6	7	8	9	10	11	12	13 and +
C	20%	35%	50%	60%	70%	75%	80%	85%	90%	95%	100%

- **Remarks :**
  - Depth of history smaller than **3 years ➔ Standard Formula parameters**
  - Credibility factors growing with **depth of history**
  - History for full credibility : more than **13 years**

- **Credibility factors for (non) recovery rates** :

Credibility factors for years of available history: shocks de non-recovery vs. recovery											
Year	5	6	7	8	9	10	11	12	13	14	15 and +
C	30%	40%	50%	60%	70%	75%	80%	85%	90%	95%	100%

- **Remarks**
  - Depth of history smaller than **5 years ➔ Standard Formula parameters**
  - Credibility factors growing with **depth of history**
  - History for full credibility : more than **15 years**

Case study

Undertaking Specific Parameters estimation

► Estimation of USP for incidence rates :

- History of 16 years

	SHOCKS – MODELING OF ERROR PROCESS WITH AUTO REGRESSIVE MODEL		
	USP without credibility factors	USP with credibility factors (year 1)	USP with credibility factors (year > 1)
20	68%	68%	68%
38	12%	12%	12%
59	18%	18%	18%

	SHOCKS – MODELING OF ERROR PROCESS WITH LOG NORMAL MODEL		
	USP without credibility factors	USP with credibility factors (year 1)	USP with credibility factors (year > 1)
20	111%	111%	111%
38	17%	17%	17%
59	22%	22%	22%

- Comments

  - With both models (AR(1) or log-Normal), USP are higlhy related to age
    ➔ Exposure effect : age with high exposure lead to USP lower than Standard Formula parameters

  - In our example, the log-normal approach leads to USP higher than the time series’

Case study

Undertaking Specific Parameters estimation

► Estimation of USP for incidence rates :

- **History of 5 years : AR(1) approach**

	SHOCKS - MODELING THE ERROR PROCESS WITH AUTO REGRESSIVE MODEL		
	USP without credibility factors	USP with credibility factors (year 1)	USP with credibility factors (year > 1)
20	49%	42%	37%
38	9%	22%	17%
59	7%	21%	16%

- **Comments**

  - Calibration of USP parameters on experience data and introduction of Standard Formula by using the credibility factors (history of 5 years)

    ➔ Using the factor credibility enables to take in consideration the alea linked to the lack of the history

  - In this exemple, even when the use of credibility factor is required (short history), the USP remain lower than Standard Formula parameters

Case study

Undertaking Specific Parameters estimation

► Estimation of USP for recovery rates :

- History of 23 years

	SHOCKS – RECOVERY RISK – 3rd YEAR OF INCAPACITY		
	Non recovery rates	USP without credibility factors	USP with credibility factors
20-30	< 50%	+ 15 % on non recovery rates	+ 15 % on non recovery rates
45-50	> 50%	- 10 % on recovery rates	- 10 % on recovery rates
55-65	> 50%	- 13 % on recovery rates	- 13 % on recovery rates

- History of 7 years

	SHOCKS – RECOVERY RISK – 3rd YEAR OF INCAPACITY		
	Non recovery rates	USP without credibility factors	USP with credibility factors
20-30	< 50%	+ 14 % on non recovery rates	+ 17 % on non recovery rates
45-50	> 50%	- 9 % on recovery rates	- 15 % on recovery rates
55-65	> 50%	- 12 % on recovery rates	- 16 % on recovery rates

- Comments

  - Use of credibility factors for USP with an history of 7 years
    ➔ adjust USP to a more acceptable level in comparaison with USP with a long history of data (23 years)

  - For this example, USP are a much lower than Standard Formula parameters

Case study

Solvency Capital Requirement calculation

- **USP impacts on SCR calculation** :

  - **Long history of data : 16 years**

	SCR impact – long history of data			
	BE	SCR - USP	SCR - FS	Evolution
	1000	261	856	- 60 %

  - **Short history of data : 5 ans**

	SCR impact – short history of data			
	BE	SCR - USP	SCR - FS	Evolution
	1000	510	856	- 30 %

  - **Comments**

    - The depth of history has a significant impact on the SCR level.
      ➔ The SCR saving is growing with the depth of history and the volume of data

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Conclusions

- Key points of available data :
  - Quality ➔ impact the estimation of error process
  - Deep history ➔ history effect
  - Large size ➔ volume effect
- Credibility approach is a good alternatives to remedy the lack of a long history and produces satisfactory results
- Provide an approach to calibrate USP for Health module similar to life (Health SLT) within Solvency 2 framework (see non-life USP)
- Possibility to use these methods :
  - Calibrate parameters for ORSA capital
  - Produce sensibilities parameters to business plan and to price new products
  - Estimate risk exposure and test reinsurance program…

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THANKS FOR YOUR ATTENTION !