Reevaluation of the capital charge in insurance after a large shock: empirical and theoretical views

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Contents

Context & problems

Solvency II framework

- Based on historical data
- Adding a large actual shock (Non-Life or Life) in the firm historical database can have a huge effect on quantiles
- LACs
- Cat NAT inspiration

Stress test and SCR reestimation

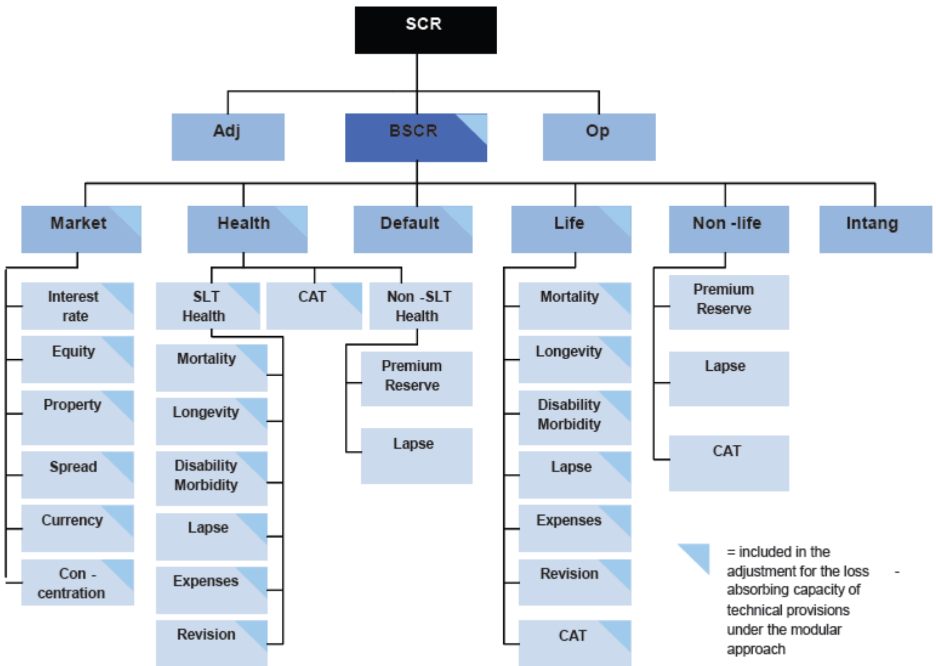
- No-reestimation of SCR has always been considered conservative in stress testing or impact studies
- Some empirical data contradicts this consensus

Extreme value theory

- Can help performing a stress testing exercise allowing with SCR reestimation
- Gives an interpretation of the data collected
- Theoretical orders of magnitude can be backtested to actual parameters

Solvency Framework : a quick reminder

❑ Solvency II capital charge: views on the Market Risk (ST EIOPA 2014)



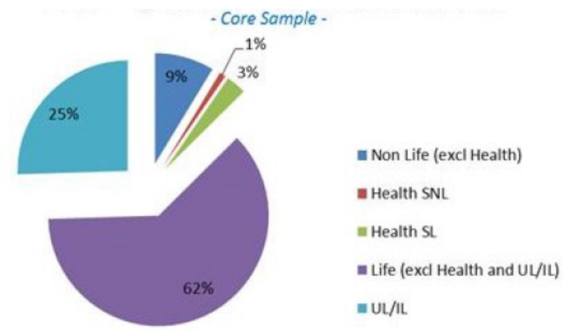


Figure 4: Technical provisions breakdown (source: EIOPA Insurance Stress test)

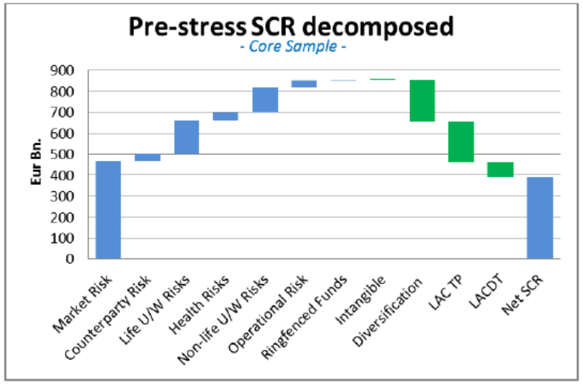


Figure 5: SCR Decomposition

Framework of the article

Loss absorbing capacities

- First thought as proportional (up to QIS3): therefore SCR constant is prudent.
- 3 steps approach (per risk) module:
  - 1/ net SCR: $nSCR_{Mod}$
  - 2/ gross SCR (without risk absorption) : $gSCR_{Mod}$
  - 3/ And then the risk absorbing capacities as a difference: $KC_{Mod} = gSCR_{Mod} - nSCR_{Mod}$
- With such a mechanism, possible to have SCR post shock larger than baseline one.

A simplified model for post-stress SCR:

$$SCR = [VaR_{99.5\%}(X) - E(X) - b]_+$$

- After the shock, b transformed in b' and X becomes $X' = a\tilde{X}$, with $\tilde{X}$ is the revised version of X taking into account the last shock.

Change in tail estimators after a record

- We note $X_1, X_2, \ldots, X_n$ random variables corresponding to observations of X, the underlying random loss used for the SCR calibration. We also use the orders statistics $X_{n:i}$
- We assume the record occurs at time n and that $X_n > X_{n-1}$
- The point is to measure the difference between, eg, a Tail quantile estimator T_n and its conditional expectation regarding $\{X_{n+1} > X_{n:i}\}$ noted:

$$[T_n \mid X_{n+1} > X_{n:n}]$$

- Which is *a priori* different from T_n

Theoretical estimation of the “new large recorded shock effect”

Tail probability error estimation

- The error can be asymptotically approximated with $p \sim \frac{\tau}{n}$ is the tail probability.

$$\frac{1}{p}E[T_n \,|X_{n:n} < X_{n+1}] - 1 \;\rightarrow\; -\frac{1-e^{-\tau}}{\tau}$$

- The larger the number of exceedances (“τ“) the more the tail probability is underestimated.

Tail quantile error estimation

- Some additional hypotheses used here for the X_i (random losses with a Fréchet distribution) with shape parameter α and the $\log(X_i)$) are iid and have expectations equal to γ.
- After some straightforward calculations the relative error on the quantile is given by:

$$\{Q(1-p)\}^{-a_k} = \left(\frac{1}{p}\right)^{a_k \cdot \gamma}$$

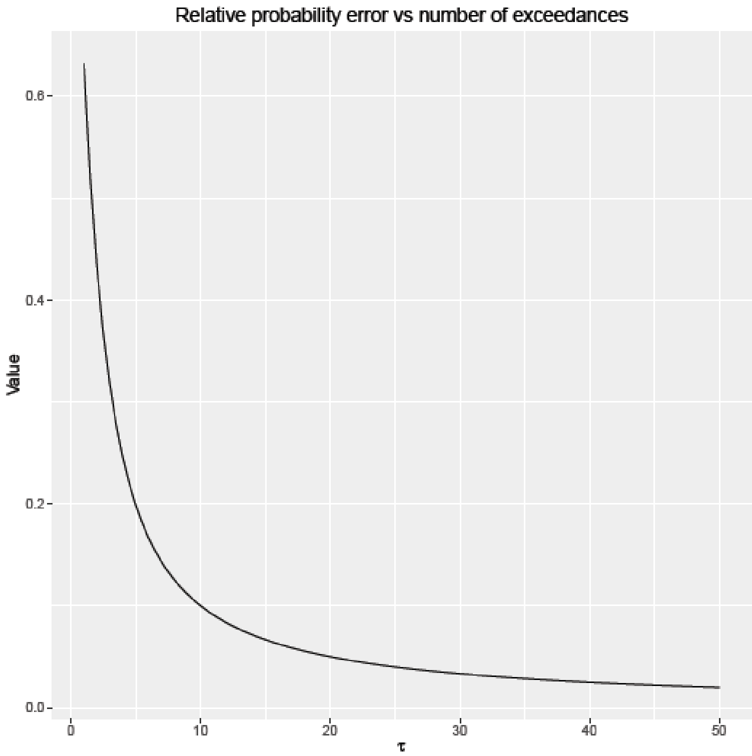
Coefficient k is chosen such that $p < k/n$

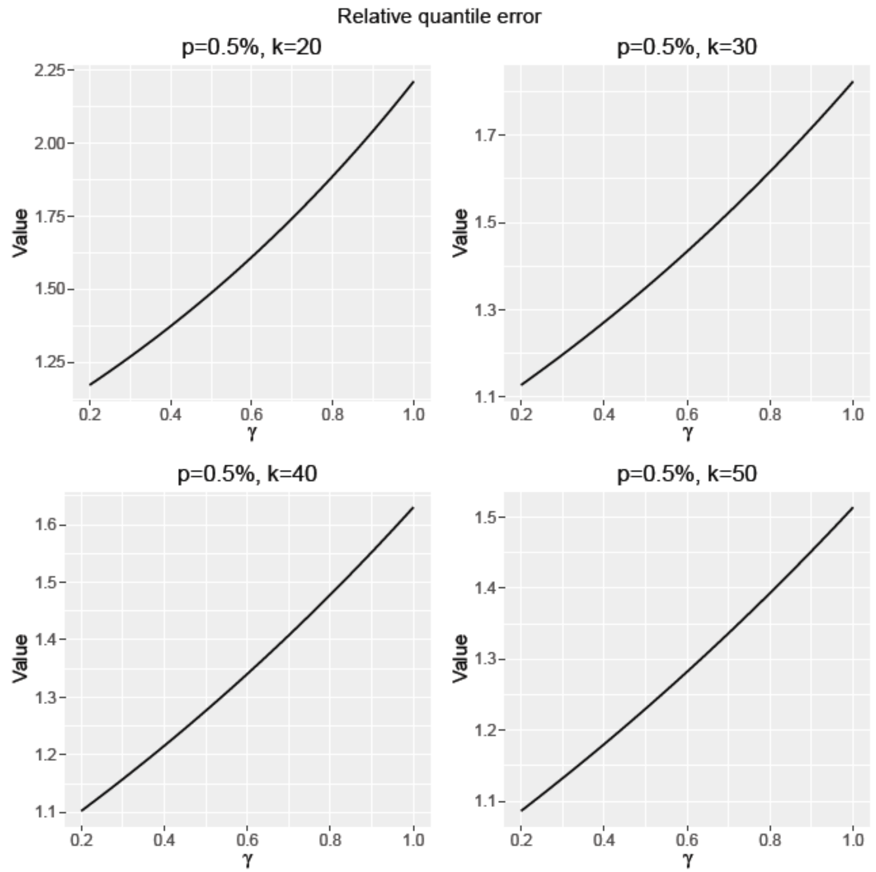
With $a_k = \frac{1}{k}\sum_{j=1}^{k}\frac{1}{j+1} \sim \frac{\log(k)}{k}$

Use of the effect's theoretical estimation on actual situations

❑ Tail probability and quantile error estimation

- Tail probability estimated with $\tau = \frac{1}{200}$
- Relative quantile error for $a < 1$





Analysis of the effect on the financial shocks (2014 ST EIOPA data)

Reestimation during the ST 2014 exercise

- Scale the value to anonymize the data
- Average the different figures to get an order of magnitude
- Scope of 30 companies reassessing out of 163 on each scenario (best-effort basis & optional)
- Here a is within a range of 0.8 to 0.9
- The gross BSCR is homogenous to a quantile and will only depend on the underlying distribution (to calibrate the volatility):

in $M€$	CA1	CA2
Liabilities	100	100
gBSCR	7.78	8.39
b	4.51	2.99
Net SCR	3.26	5.39

After stress

in $M€$	ST $(a \approx 0.93)$	$a = 0.9$	$a = 0.8$
Liabilities'	95.1	92	81.8
gBSCR'	7.39	6.65	5.91
b'	3.6	2.86	2.12
Net SCR'	3.79	3.79	3.79

in $M€$	ST $(a \approx 0.95)$	$a = 0.9$	$a = 0.8$
Liabilities'	93.4	90.4	80.3
gBSCR'	7.83	7.05	6.26
b'	1.83	1.05	0.27
Net SCR'	6.00	6.00	6.00

Analysis of the effect on the financial shocks (2014 ST EIOPA data)

Value of the LAC post stress

- For example, with our setup, we find $b' = 0.63 \cdot b$, for $a = 0.9$
- Actually, if diversification is assumed constant, FDB and DT can be inferred and deduced from the model

	CA1	CA2
b' / b	79.8%	61.2%
$\mathrm{FDB}' / \mathrm{FDB}$	8.5%	13.9%
$\mathrm{DT}' / \mathrm{DT}$	310%	286%

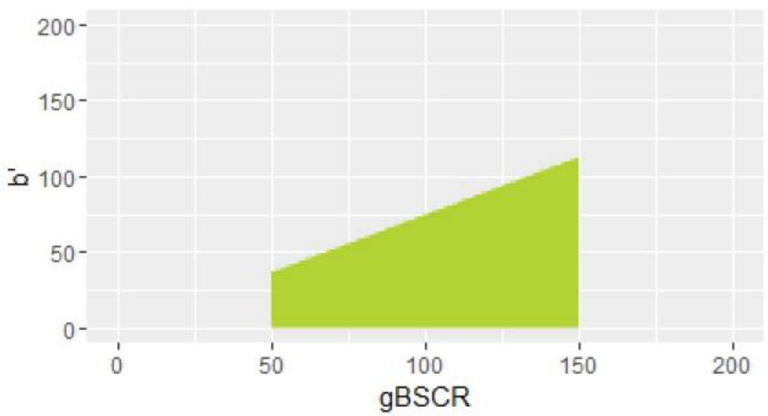
Estimation of the absorbing capacities

Case $a > 1$, estimation on actual data

- In this case the risk exposure increases so that intuitively we would expect the SCR to increase.
- Values of the absorption capacity are provided both in the French and EU ST report.

$$b = 38\% \cdot gBSCR\ (EU) \text{ or } b = 61\% \cdot gBSCR\ (FR)$$

- To estimate b', on can asses $a = 1{,}2$, and make the range vary between 50% and 150% of the market average gross SCR
- In fact, the admissible value of b' allowing for a reestimated net SCR larger than the initial one belongs to a trapezoid.



Risk margin effect

❑ Potential scissors effect on SCR coverage ratio

- Levels of own fund is taken with very great care in current financial supervision, even in insurance, now.
- But the positive surve in SCR might trigger an increase in the risk margin (CoC = Cost of Capital), using one of the simplification option:

$$RM' = CoC \cdot \sum_{t \geq 0} SCR'(t)$$

- The SCR can be deduce with the following approximation:

$$SCR(t) = SCR(0) \cdot \frac{BE(t)}{BE(0)}$$

- if we assume a constant ratio for the BE's, then $SCR'(t) > SCR(t)$ for all times t which means:

$$RM' > RM$$

- And in this context, the technical provisions would be even higher and decrease the own funds post stress.

Conclusions

On the effect

- Can be very important both in theory and empirically
- Importance of the LACs in the Solvency II framework
- Have consequences on the Enterprise risk management point of view for insurance, reinsurers and for captives

Further research

- Encouragement to better study LAC dynamics
- Using micro-founded approach for prudential balance sheet (lapses?)
- Improve the framework to take into account multi-dimension risks/shocks

On the regulatory implications

- Encourage supervisors to have a close look to historical data and to window adjustment (the longer the better)
- Always assess the credibility of hypotheses used in the best estimate simulation (effectivity of the absorbing capacities)
- Recommend the evaluation of the SCR after shocks to check the actual solvency for all kinds of prospective exercises (ORSA, ST…)

References & Questions

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