www.ICA2014.org

LEARN
INTERACT
GROW

Non-pandemic catastrophe risk modelling: Application to a loan insurance portfolio

Esther MALKA – April 4th, 2014

Plan

Introduction

I. Building a model based on a simulation approach

II. Calibrating severity distribution with Extreme Value Theory

III. Bicentenary scenario assessment

Conclusion

ICA 2014 CIA WASHINGTON DC

This work was carried out from the model proposed from 2011 by:
Bruno Massonnet, AS-Consultant

Introduction

Introduction

- Distinction between 2 components:
  - Pandemic catastrophes
  - Non-pandemic catastrophes

- Goals:
  - Deliver a modelization of non-pandemic catastrophe risk adapted to the portfolio specifications
    - Loan insurance contracts
    - French population
    - Borrowers population

  - Deliver a capital requirement amount adjusted to the non-pandemic catastrophe risk related to the loan insurance activity of the company

Building a model based on a simulation approach

Building a model based on a simulation approach

Iteration on simulated years

Random selection of the number of catastrophes

- Poisson distribution

Iteration on catastrophes

Random selection of the type of catastrophe

- Multinomial distribution

Random selection of the number of dead victims

- Pareto, Gumbel, Lognormal, Weibull or Gamma distribution

Random selection of the number of disabled victims

- Poisson distribution

Random selection of the catastrophe area

- Uniform distribution (except the case of industrial catastrophe: Multinomial distribution)

Distribution of the victims over the partners according to their market penetration rate

- Binomial distribution

Iteration on partners

Iteration on dead victims

Random selection of the outstanding capital tier, based on the partner’s historical claim distribution

- Multinomial distribution

Selection of the historical average cost for the tier selected, as the simulated claim amount

Iteration on disabled victims

Random selection of the claim amount tier, based on the partner’s historical claim distribution

- Multinomial distribution

Selection of the historical average cost for the tier selected, as the simulated claim amount

Calibrating severity distribution with Extreme Value Theory

Calibration specifications

Our study takes into account:

- Industrial catastrophes
- Catastrophes related to concentration of population
- Transportation catastrophes (Air, Maritime, Rail, Road)
- Natural catastrophes

Which severity distribution for each type of catastrophe?

- Low frequency ⇨ Little data available
- Extreme severity ⇨ Tail distribution issue

ICA 2014 CIA WASHINGTON DC

Accident database: ***EM-DAT: The OFDA/CRED International Disaster Database – www.emdat.net – Université catholique de Louvain – Brussels – Belgium***

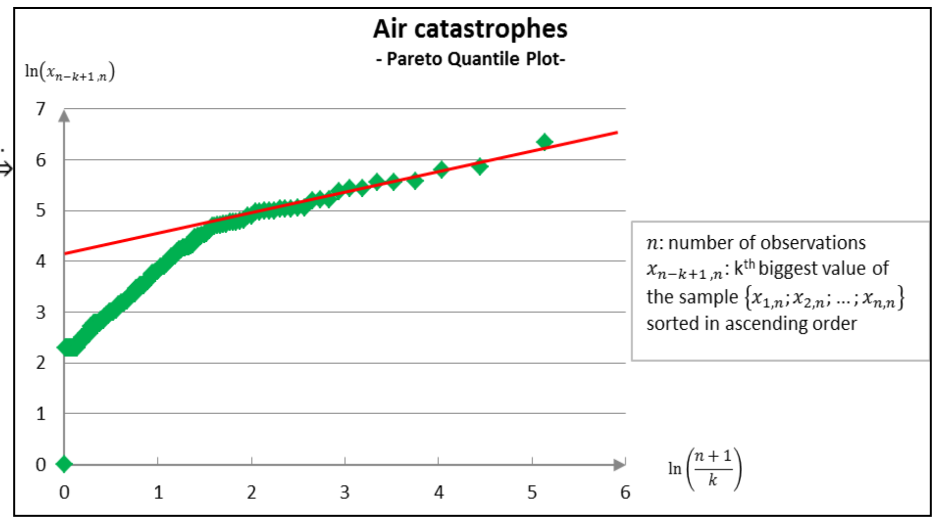
Main results of Extreme Value Theory (EVT)

2 main theorems

- Maximum distribution
- Peaks-over-threshold (POT) distribution

In practice, 3 graphic tools are used to check if these theorems are applicable

- Mean Excess Plot
- Pareto Quantile Plot (PQP) $\stackrel{e.g.}{\Longrightarrow}$
- Hill Plot



- The PQP sets as evident a linearity in extreme values
  - This points to a distribution in the Fréchet domain ⇨ GDP adjustment

Results obtained with EVT and limitations of theory

- EVT provides indication whether an adjustment with a GPD distribution is relevant or not
- It does not indicate the GPD parameters for the relevant cases
- Visualization of EVT's graphic tools is not always conclusive

⇨ Need for second calibration method when EVT does not seem appropriate, based on:
  - Anderson-Darling statistical test
  - P-P Plot visualization

Results obtained with alternative calibration method

- Several distributions (and thresholds) tested: Gamma, Gumbel, Weibull, GPD,…

- Obtained results with 2nd method don't always point to the same direction than with EVT

	Graphic arguments for a GPD ajustment (EVT)			Alternative method
Catastrophe type	Mean Excess Plot	Pareto Quantile Plot	Hill Plot	Anderson-Darling test
Air	+	+	≈	GPD
Maritime	+	++	+	Lognormal
Rail	-	+	+	Weibull
Road	≈	++	+	GPD

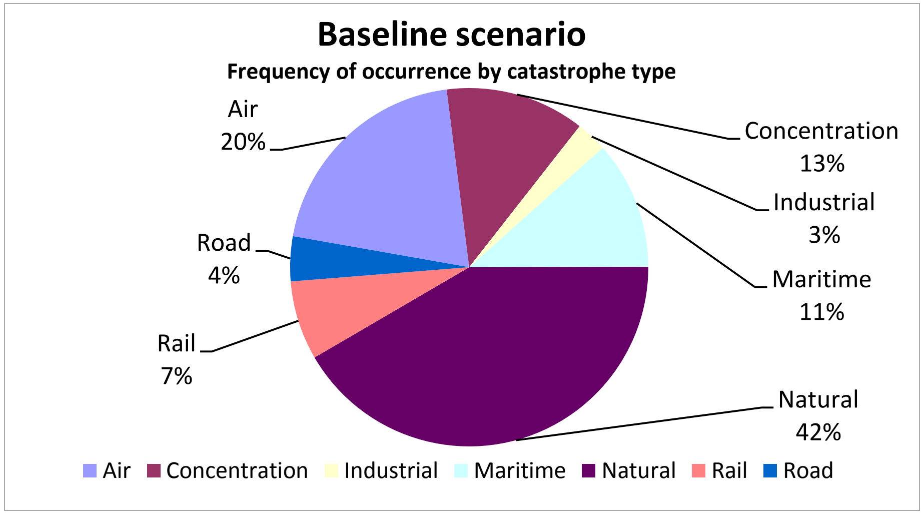
- Need to remain vigilant regarding to the reliability of the developed methods

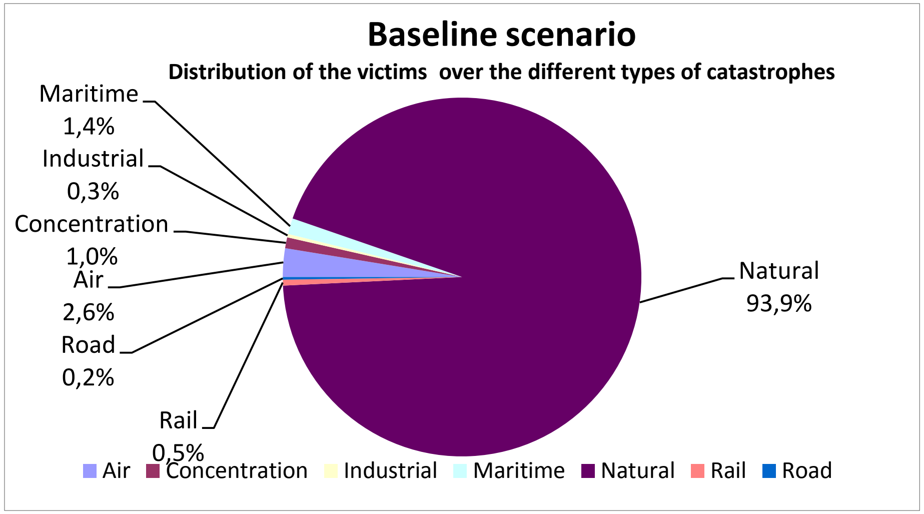
Bicentenary scenario assessment

Introduction
Calibrating severity distribution with Extreme Value Theory
Building a model based on a simulation approach
Bicentenary scenario assessment

Baseline scenario

- Natural catastrophes make a dominant effect compared to the other types of catastrophe
- Natural catastrophes represent 42% of simulated catastrophes but 93,9% of the total number of simulated victims
- 1 on 200 years catastrophe scenario matches with a natural catastrophe

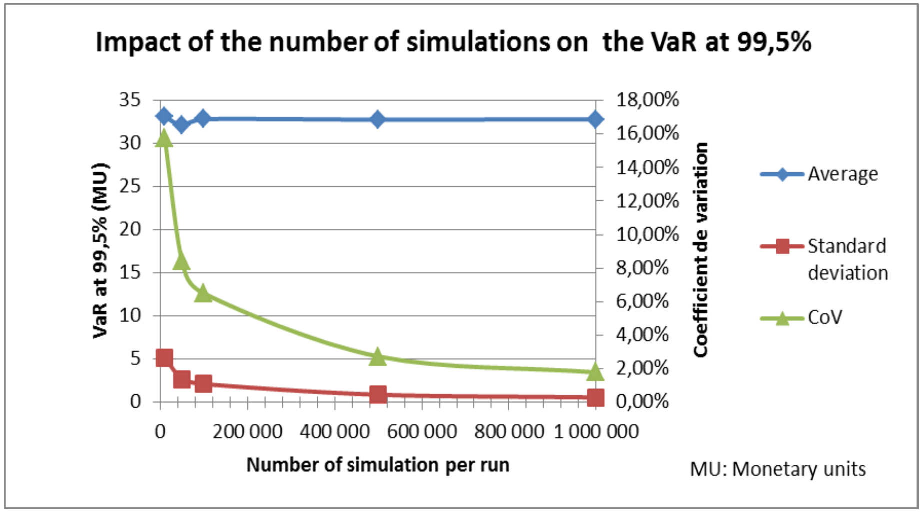


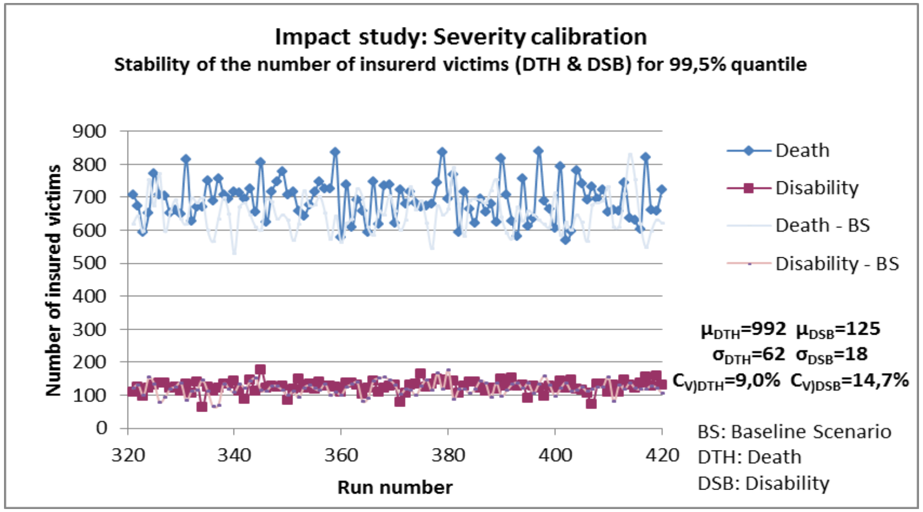


ICA 2014 CIA WASHINGTON DC

Impact studies

- Main impact studies
  - VaR 99,5% variabilty decreasing with the number of simulations
  - Choosing 100 000 simulations for the baseline scenario corresponds to the best arbitration between calculation time and results stability
  - Testing a 2nd option for calibration of severity distribution points to a severity and variability slightly higher





ICA 2014 CIA WASHINGTON DC

Conclusion

ICA 2014 CIA WASHINGTON DC

Conclusion

- Consistent and encouraging results, taking into account the retained assumptions and the reliability of the calibration statistic methods
- Natural catastrophes make a dominant effect compared to the other types of catastrophe, for a 1 on 200 years event
- Interesting results in terms of SCR gain (vs standard formula use)
- Further study to be made to develop accurate reinsurance solutions

Thanks for your attention!