Insurance
Data
Science

Insurance Data Science Conference 2023

A Practitioner Guide to Marginal Pricing – Pricing with Portfolio Impact in Mind

Shirley Ng

Why Marginal Pricing?

Line of Business – Energy

Coverage – Physical Damage

Existing Portfolio – Perdido in the Gulf of Mexico

Option A – Olympus in the Gulf of Mexico

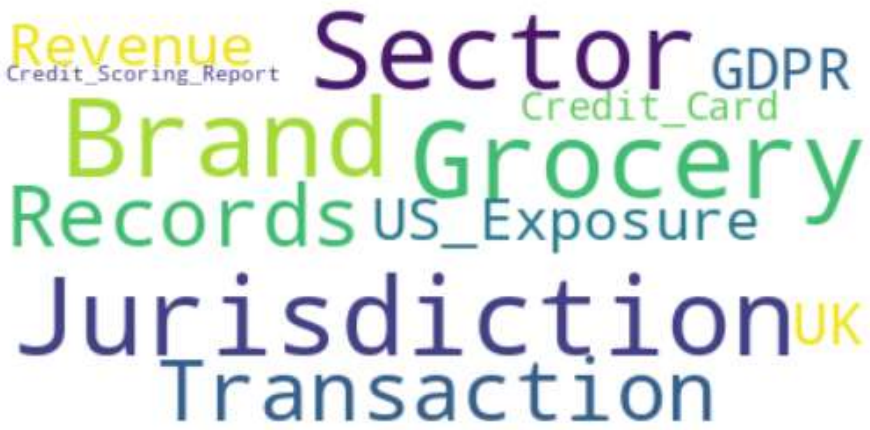
Option B – Maui in New Zealand

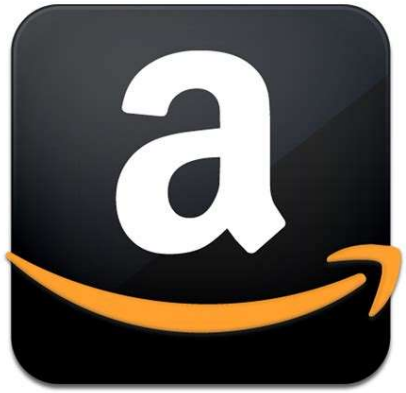
- **Assume both options have the same Expected Loss**
- **Which one do you choose?**

Why Marginal Pricing?

Line of Business – Cyber Liability

Coverage – Data Breach





➢ **Assume both options have the same Expected Loss**

Considerations: Single Risk Pricing vs Marginal Pricing

Individual Risk Pricing

- Expected Annual Average Loss
- Compound Loss Distribution from Frequency & Severity Monte Carlo Simulation

Marginal Pricing

- Model the whole portfolio with and without the new risk
- Calculate the difference between the portfolio distribution

Factors to Consider – Risk Aggregation

Property and Specialty

- Coverage
- Region
- Peril
  - Man Made, e.g. Terrorism, Derailment, Shipping Route Blockage
  - Natural Catastrophe – Hurricane, Earthquake, Wildfire, Severe Convective Storm
- Asset Type

Casualty

- Coverage
- Jurisdiction
- Industry
- Catastrophe
- Size
- # Records

Risk Aggregation – Reinsurance Data Format

Property and Specialty

1. AIR / RMS Exposure Data Model
2. Insured listing with risk characteristics, e.g. IMO for ship, Rig Name, Coordinates and Sum Insured
3. Event Loss Table (ELT)
4. Exposure Description by Location
5. Top 10 Aggregated Risk Location
6. Top 10 Asset by Sum Insured
7. Lloyd's RDS

Casualty

1. Individual Insured Listing with Coverage, Jurisdiction, Industry, Revenue, #Records, #Employee
2. Limit Profile and Industry Split
3. Exposure Description by Location
4. Lloyd's RDS

Note – Refer to this paper when converting ELT into frequency severity
https://www.casact.org/sites/default/files/2021-02/2017_most-practical-paper_homer-li.pdf

Marginal Pricing - Options

From Ground Up Approach

- Design a risk matrix and correlation matrix / copula
- Model the portfolio by risk matrix with and without a new submission
- Calculate the difference

✗ Impractical – takes a long time to run, spurious accuracy

Approximation

- Create a portfolio aggregate distribution every quarter
- Run the portfolio aggregate distribution and new submission together by risk matrix and correlation matrix
- Assume claims frequency and severity do not correlate.

✓ Quick to run. Can run it in Excel, R and Python

Conclusion

- Enables decisions to be based on the impact on the portfolio.
- Optimise capital and aggregation utilisation.
- Enables better outwards reinsurance protection and improve overall underwriting result.
- The approximation methods allow analysts to calculate the marginal impact of writing a new risk without running a full capital model.

- BUT it relies on all the risks to be captured consistently across the whole company

Appendices

Approximation Method 1 – Monte Carlo

R

- https://cran.r-project.org/web/packages/NonNorMvtDist/index.html
- https://cran.r-project.org/web/packages/compositions/index.html
- https://cran.r-project.org/web/packages/copula/index.html
- https://rdrr.io/cran/MASS/man/mvrnorm.html

Python

- https://numpy.org/doc/stable/reference/random/generated/numpy.random.multivariate_normal.html
- https://pypi.org/project/pycop/
- https://sdv.dev/Copulas/

Paper

- S.S.Wang, *Aggregation of Correlated Risk Portfolios: Methods and Algorithms (2008*), CAS
- R.Shaw, G. Spivak, *Correlations and Dependencies in Economic Capital Models, Section 3 (2009),* IFoA

https://www.actuaries.org.uk/system/files/documents/pdf/c05shaw.pdf

Approximation Method 2 – Non-Parametric

Iman-Conover Method

- Python package aggregate https://pypi.org/project/aggregate/
- https://aggregate.readthedocs.io/en/latest/5_technical_guides/5_x_working_with_samples.html
- R package mc2d https://search.r-project.org/CRAN/refmans/mc2d/html/cornode.html
- Excel Add-In Palisade @Risk https://kb.palisade.com/index.php?pg=kb.page&id=71