

Will Financial Markets Change The Way We Model Reinsurance?

Daniel Burren, PhD, Actuary SAA

GIC - 29 May 2015

"There are no right price of insurance; there is simply the transacted market price which is high enough to bring forth sellers, and low enough to induce buyers".

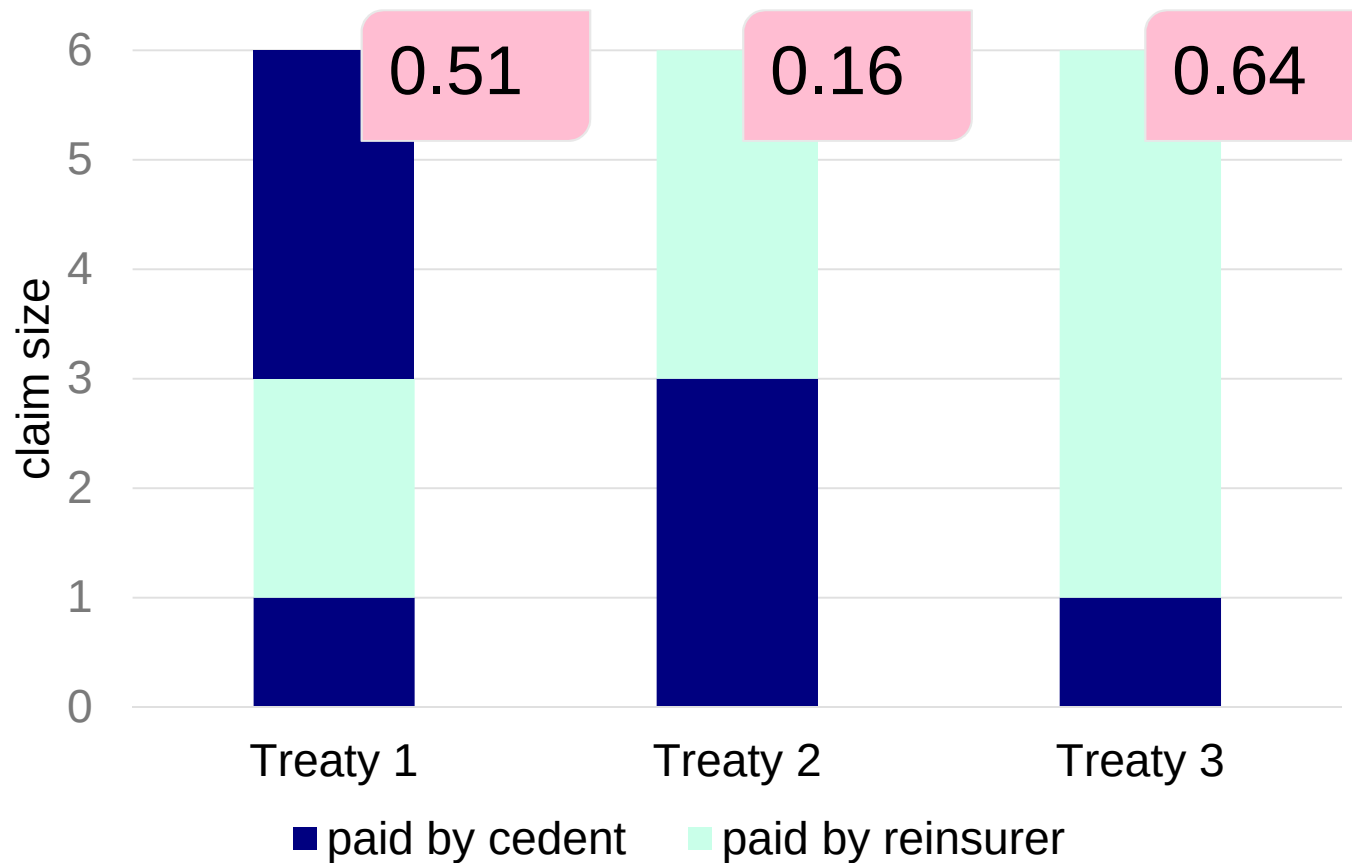
Finn and Lane (1997)

Actuarial view:

$$\text{Price} = \text{Expected Loss} + \text{Loading}$$

Actuarial pricing

Loading = 20% Standard Deviation of the Treaty



Price tags are obtained with a compound Poisson($\lambda=1.0$)-Pareto($\alpha=2.2$) for claims exceeding 0.8, assuming the excess of loss treaties cover all qualifying claims.

Financial pricing

- No arbitrage
- Find a new probability measure Q by changing the real world probabilities in order to give more weight to unfavourable events

Price = Expected Loss (with new probabilities Q)

How can we find a probability measure Q for insurance risks?

A martingale approach to premium calculation principles in an arbitrage free market (Article)

Delbaen, F.^a, Haezendonck, J.^b 

^a University of Brussels (VUB), 1050 Brussels, Belgium

^b University of Antwerp (UIA), 2610 Antwerp, Belgium

Abstract

 [View references \(8\)](#)

An arbitrage free model is used to study martingale equivalent probability distributions on the basic probability space of a compound Poisson process. It is shown how this new approach is related to premium calculation principles. © 1989.

Key assumption: “**At each time t the company can sell the remaining risk of the period $[t, T]$ for a given premium.**”

➤ Claims up to time t + premium to resell risk is a martingale

Reinsurance in arbitrage-free markets (Article)

Sondermann, D. 

University of Bonn, D-5300 Bonn 1, Germany

Abstract

[View references \(24\)](#)

The paper studies dynamic **reinsurance** policies in the continuous Lundberg model, where claims, premiums and interest rates are stochastic processes. The main purpose of the paper is to study the consequences of **arbitrage-free markets** for the premium calculation of arbitrary **reinsurance** contracts like stop loss or excess loss. An explicit formula is derived for the stop-loss contract when the claim process is Compound Poisson. Conditions are given when Pareto-optimal allocations of the total risk in an economy can be achieved through **markets** for proportional risk sharing. © 1991.

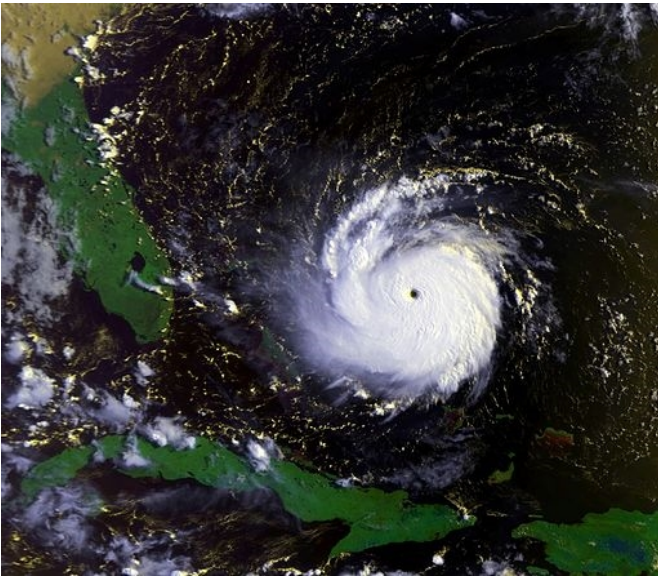
Key assumption: “*We assume that **at any time a market** for proportional reinsurance contracts exists.*”

- Present values of claims minus present values of premiums paid is a martingale

“Insurance markets are very far from the fiction of continuous trading...arbitrage opportunities are quite natural in insurance markets”.

Albrecht (1991)

1992



Hurricane Andrew by NOAA / Satellite and Information Service [Public domain], via Wikimedia Commons

1994



Northridge Earthquake by Gedstrom at en.wikipedia [Public domain], from Wikimedia Commons

1996

Michael Millette (Goldman Sachs) sets out to develop a new generation of reinsurance treaties...

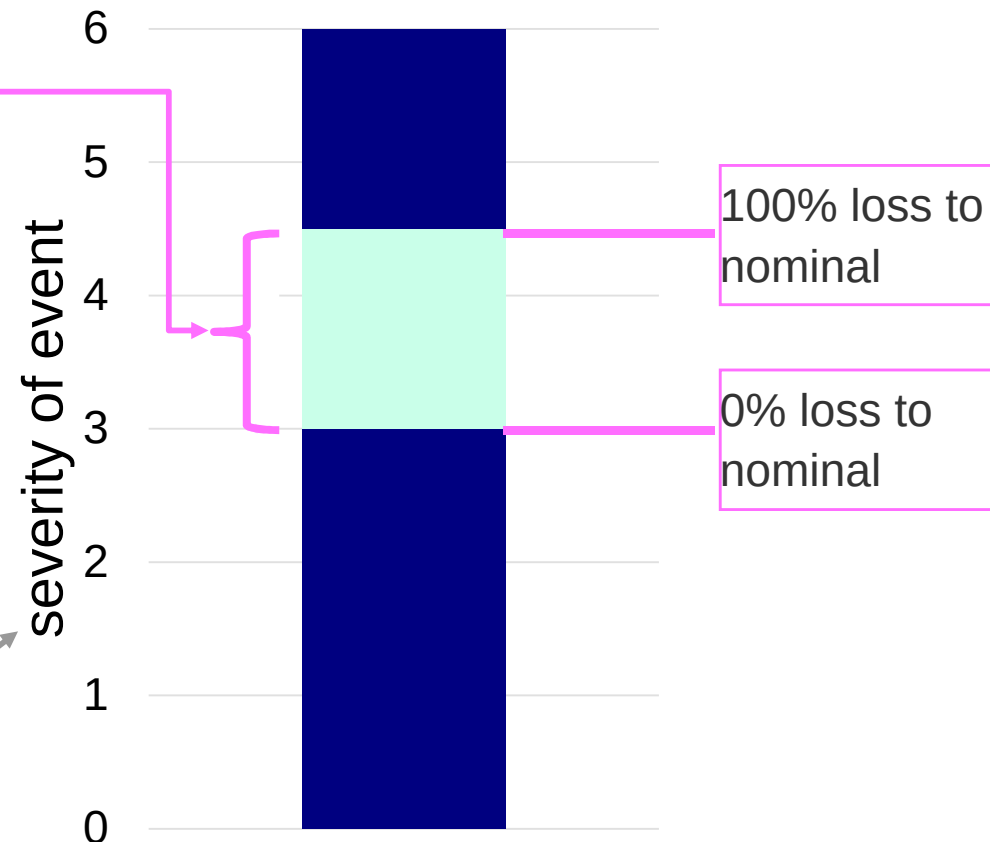
Insurance-linked securities are born

Insurance-linked security (abbrev. ILS)

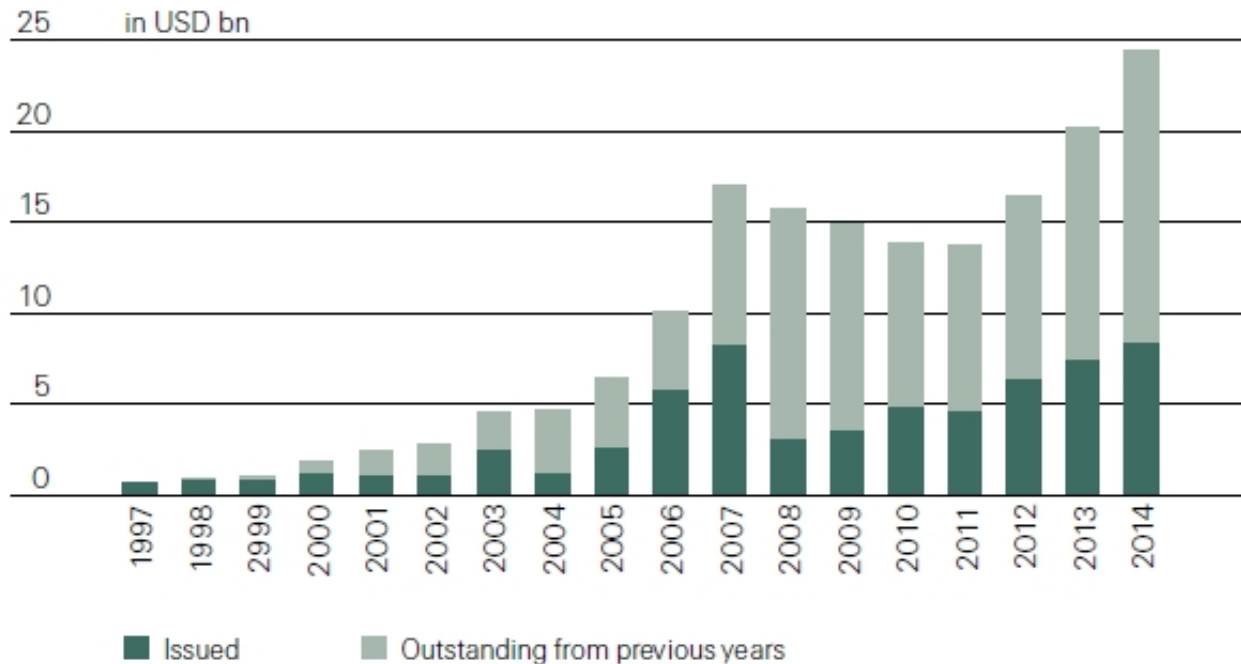
- covered perils/region
- covered period
- coupon
- nominal
- ...

Severity measurements

- losses paid by cedent
- industry loss
- parametric (for example strength of earthquake or storm)
- ...



Yearly issuance and outstanding ILS



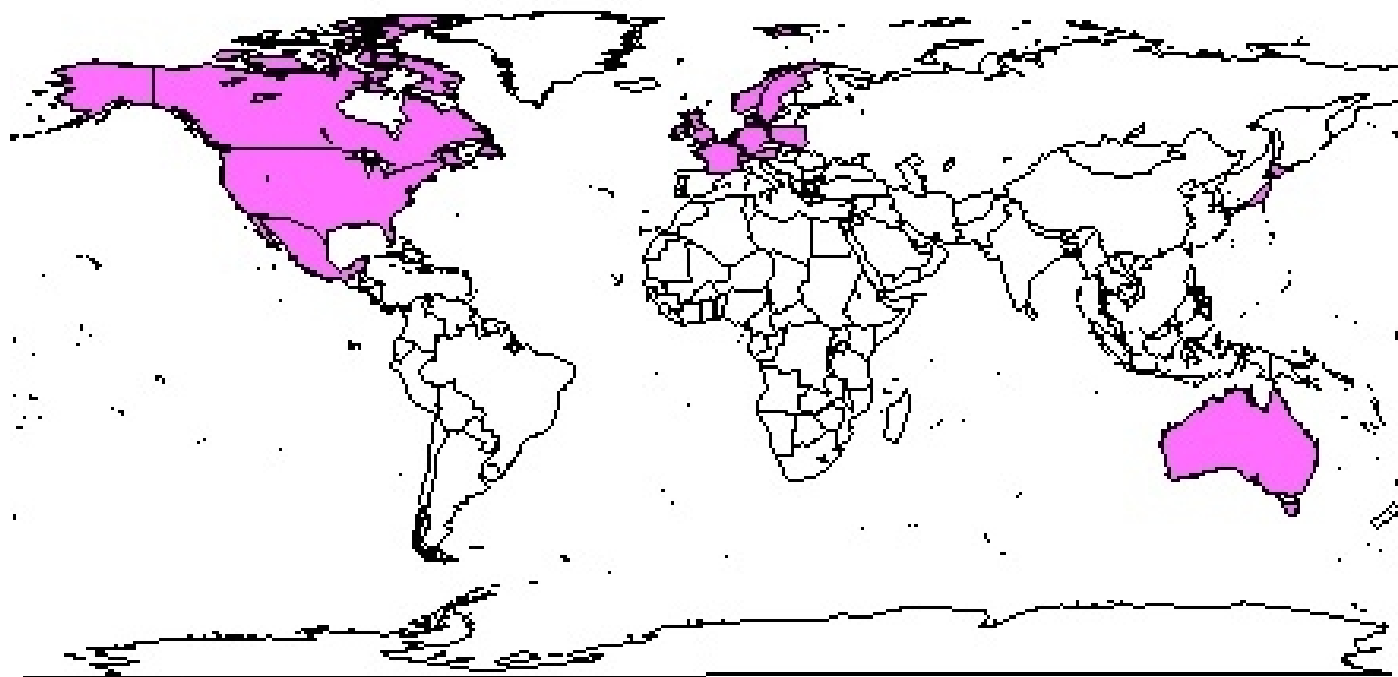
*“As of December 31, 2014 the overall outstanding ILS market had grown to USD 24.1bn, approximately **20%** larger than the market size at year end 2013.”*

Swiss Re (2015)

Source: Swiss Re Capital Markets; As of December 31 2014

In comparison, growth of global reinsurance capital was **6%** in 2014 according to AON Benfield (2015).

2014 ILS issuances – covered areas



Map created in R based on www.artemis.bm/deal_directory/ and www.perils.org – map might not be accurate, for more accurate information about covered areas consult the mentioned sources and other sources.

Trading

Slower cat bond trading last week, again focused on higher coupons

by ARTEMIS on FEBRUARY 23, 2015

Active December secondary cat bond trading sees risk spreads widen

by ARTEMIS on JANUARY 21, 2015

Strong secondary cat bond trading in November due to impending maturities

by ARTEMIS on DECEMBER 17, 2014

Headlines from www.artemis.bm/blog/



The Eurekahedge ILS Advisers Index



Insurance Linked Securities

Impact on...

...Market discipline / insurance cycle?

...Duration of reinsurance treaties?

...Lines of business?

...Actuarial work?

...Reinsurer's business model?

Let's do a pricing

Example: securities with binary trigger based on industry loss in USA

Security	Covered Events	Trigger	Price / Coupon
A	All natural perils	USD 50bn	10.0%
B	HU	USD 50bn	7.5%
C	EQ	USD 50bn	???

Prices/coupons are fictitious.

Thank you for your attention.

Solution of “Let’s do a pricing”

Assuming HU and EQ are the only natural catastrophe events which can cause a USD 50bn loss and assuming that they are stochastically independent, we get the following two equations for the risk neutral Q probabilities of triggering events (Q probabilities are introduced on slide 4):

Coupon A = 10.0% = $1 \cdot \text{Prob}(\text{A triggers}) = \text{Prob}(\text{HU or EQ}) = \text{Prob}(\text{HU}) + \text{Prob}(\text{EQ}) - \text{Prob}(\text{HU and EQ})$

Coupon B = 7.5% = $1 \cdot \text{Prob}(\text{B triggers}) = \text{Prob}(\text{HU})$.

Solving these two equations gives $\text{Prob}(\text{EQ}) = \text{Prob}(\text{C triggers}) = 2.7\% = \text{coupon C}$ (assuming an arbitrage free market).

Selected resources online

- Directory/news of insurance-linked securities
 - www.artemis.bm
- News and analysis
 - www.insurancelinked.com
- Article “What every prudent investor should consider”
 - www.promasta.com/reflections-on-insurance-linked-securities

References

Albrecht P. (1991) Financial Approach to Actuarial Risks? AFIR Colloquium 4, 227-247.

AON Benfield Analytics (2015) Reinsurance Market Outlook January 2015

Delbaen F. and Haezendonck J. (1989) A martingale approach to premium calculation principles in an arbitrage free market. Insurance: Mathematics and Economics 8, 269 – 277.

Embrechts P. (2000) Actuarial versus financial pricing of insurance. Risk Finance 1, no. 4, 17-26. (can be downloaded on <https://people.math.ethz.ch/~embrecht/ftp/wharton.pdf>)

Finn J. and Lane M (1997) The Perfume of the Premium. Proceedings of the 1995 Bowles Symposium on Securitization of Risk, 27 – 35. Georgia State University, Atlanta. Society of Actuaries, Monograph MFI97-1, 27-35.

Sedgwick Lane Financial LLC (1998). The Perfume of the Premium II 12-21-98

Sondermann D. (1991) Reinsurance in arbitrage-free markets. Insurance: Mathematics and Economics 10, 191–202.
<http://nottheaverageactuary.com/2015/04/07/the-rise-of-insurance-linked-securities-and-their-impact-on-the-reinsurance-industry/>

Swiss Re (2015) Insurance Linked Securities market update, Volume XXII, January 2015.

With you, for you



Daniel is the director of ProMaSta Pte Ltd, has a MSc in mathematical statistics, a PhD in economics and is a fully qualified actuary of the Swiss Association of Actuaries.



Prior to founding ProMaSta, Daniel worked in a reinsurance company and was responsible for the evaluation of reinsurance treaties and insurance-linked securities (catbonds) as well as for the development, maintenance and improvement of the pricing tools.

Besides, Daniel has published in several peer reviewed research journals and acts as a reviewer.

ProMaSta offers solutions based on up-to-date methods in probability, mathematics and statistics - see www.promasta.com/our-services.

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