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making financial sense of the future

GENERAL INSURANCE PRICING SEMINAR

13 JUNE 2008, LONDON

Application of predictive modelling in commercial lines

Ryan Warren
Watson Wyatt Limited

Agenda

- The rating process
- Generalised linear models
- A predictive modelling case study
- Investigating uncertainty

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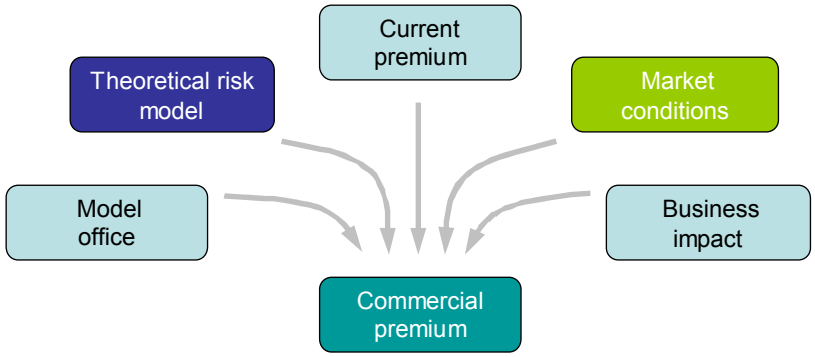
The rating process



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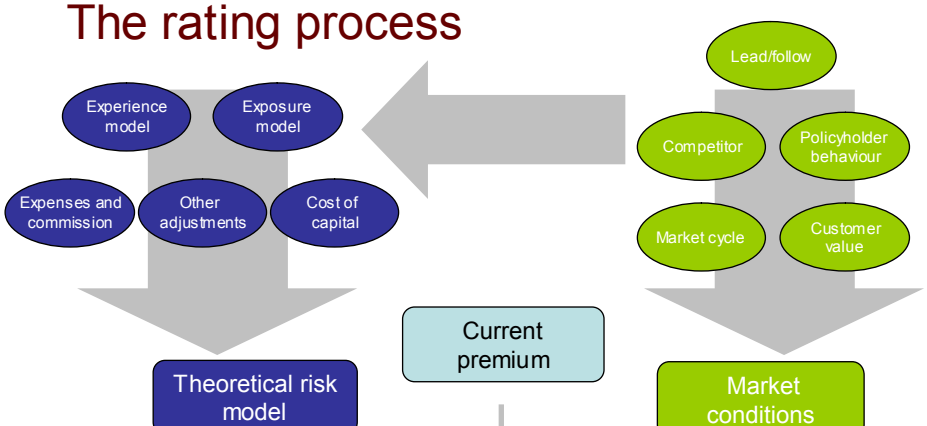
The rating process



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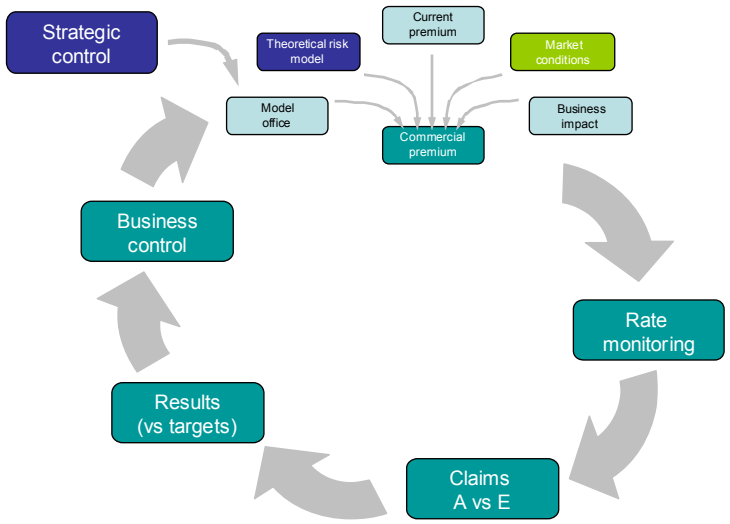

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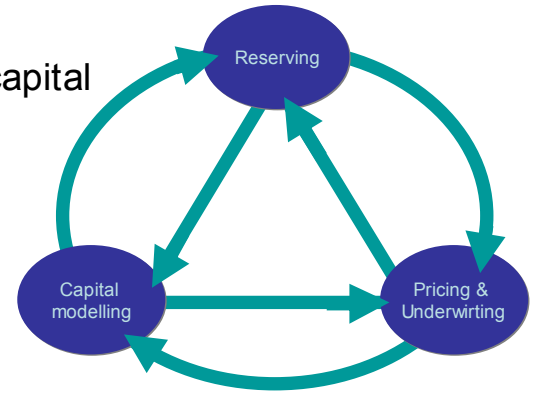
Integrated business processes

- Rate monitoring
- Allocating cost of capital
  - Line of business
  - Policy
- Communication
  - Reserving
  - Underwriting
  - Capital modelling



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Processes and controls

- Managing operational risk is increasingly seen as an important aspect of the business
- Rigorous controls are the norm for claims
- Pricing has had less attention but arguably more important to the profitability of the business
- How do you protect your business against:
  - Loss of key staff
  - Accusations of unfairness in pricing
  - Errors in key calculations

Processes and controls

- Key is to have:
  - Clear and persistent records of analysis
  - Documentation of decisions
  - Standard methods to allow task sharing
- To be effective these should be:
  - Automatic and embedded within systems
  - Universal: Actuaries, Underwriters, Claims Managers
  - Regularly reviewed to check compliance
  - Not too onerous

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Modelling in non-traditional areas

- Predictive modelling widely used:
  - Excel, @Risk, …
- GLMs:
  - Commercial property
  - Commercial motor and Fleet
  - Marine
  - Mortality/Morbidity
  - Accident and Health
  - Aviation
  - D&O
- Used for:
  - Underwriting
  - Fraud detection
  - Marketing

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Modelling in non-traditional areas

- Types of models used:
  - GLM
  - Clustering (eg CHAID)
  - Simulation and Bayesian models (MCMC)
- Complex models can be blended with simpler models where appropriate

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Generalised linear models

$$E[\underline{Y}] = \underline{\mu} = g^{-1}(\mathbf{X}.\underline{\beta} + \underline{\xi})$$

$$Var[\underline{Y}] = \phi.V(\underline{\mu}) / \underline{\omega}$$

- Consider all factors simultaneously
- Allow for nature of random process
- Robust and transparent
- EU industry standard for personal lines

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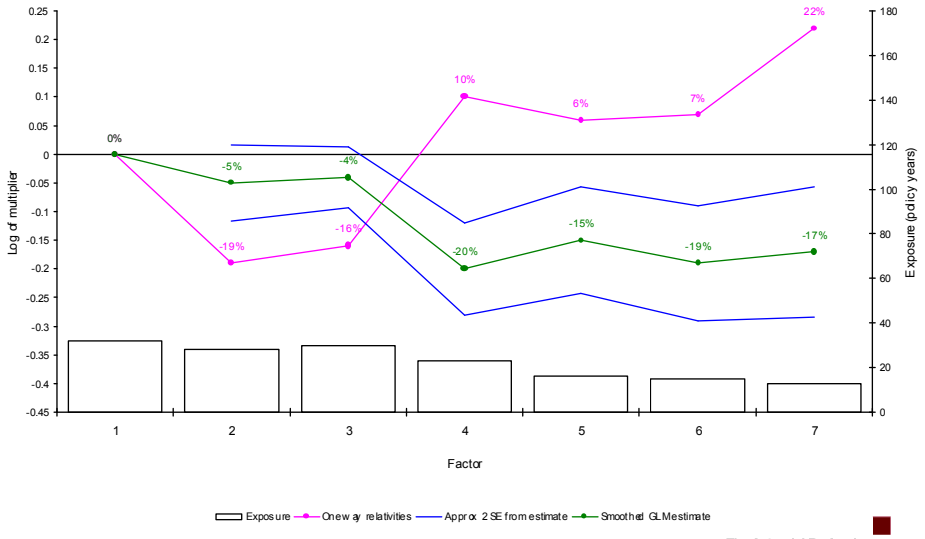
Example of GLM output (real UK data)



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Applying GLMs in commercial lines

- Market databases vs own claims experience
- Standard rates for risk considered
- Adjust using typical experience rating methods
- Combine with / consider alongside other "traditional" methods

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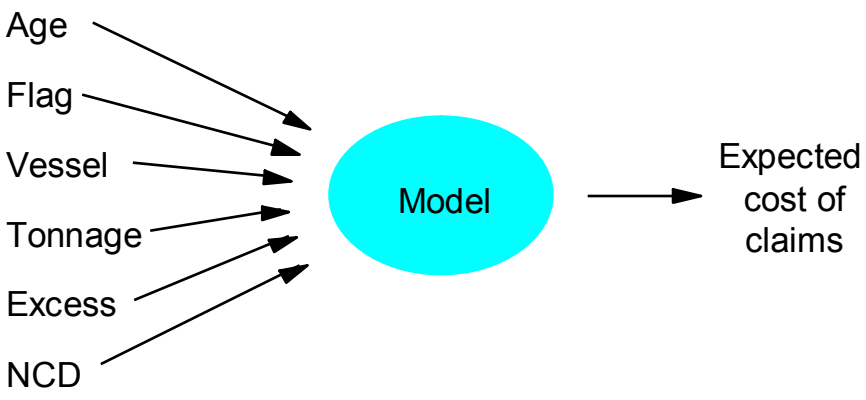
Marine liability example - objective



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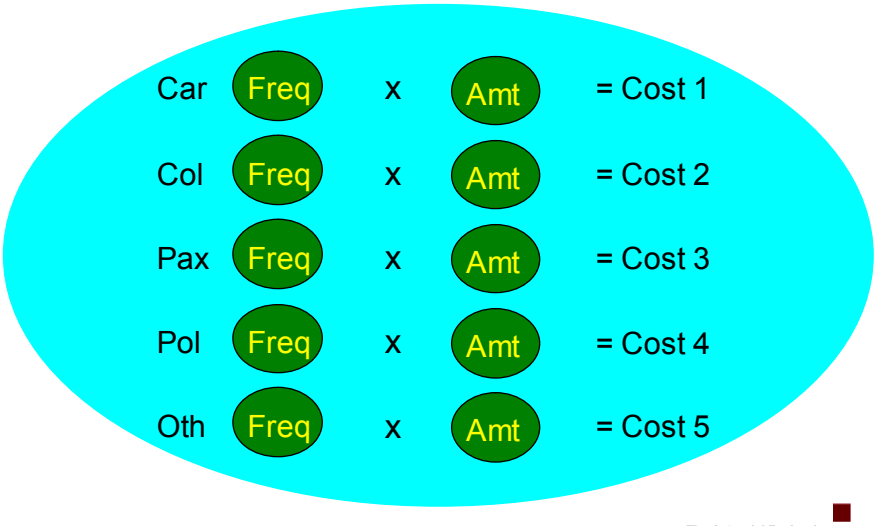
Modelling the cost of claims



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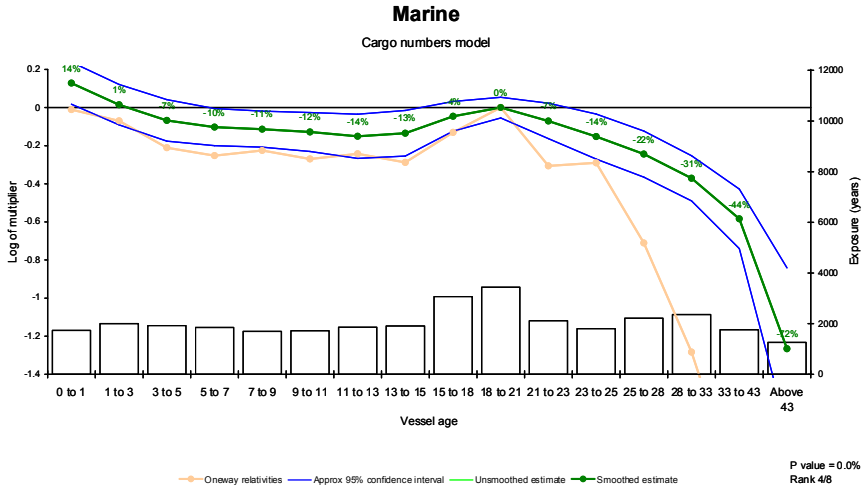
Some marine examples



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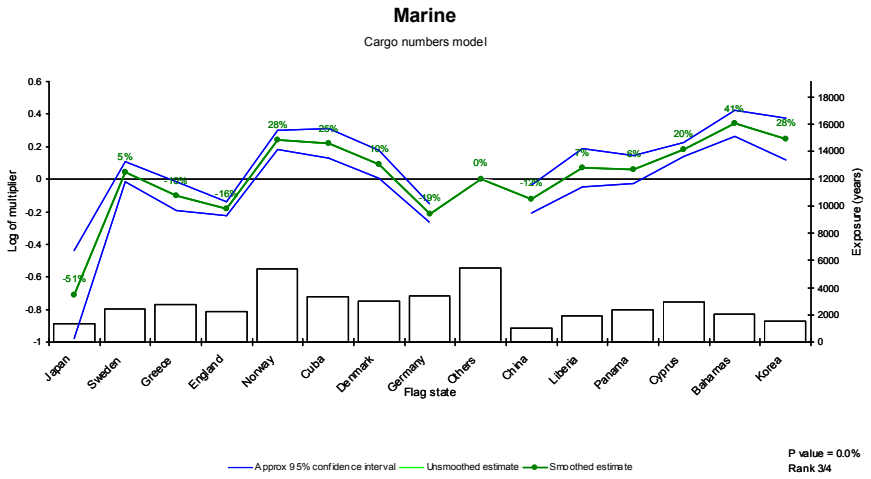

P value = 0.0%
Rank 3/4

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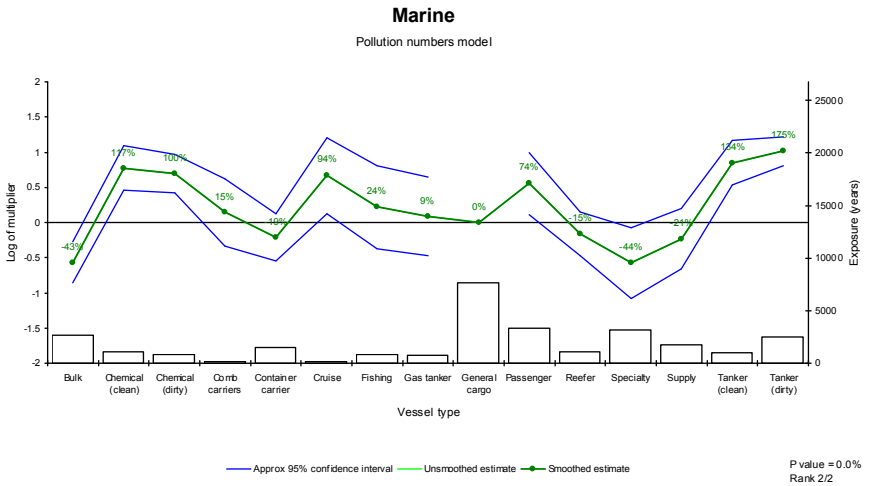
Some marine examples



P value = 0.0%
Rank 2/2

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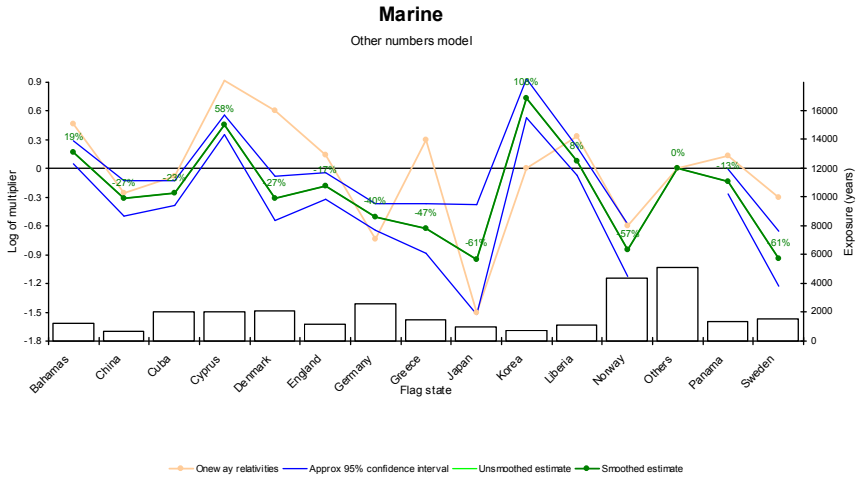
Some marine examples



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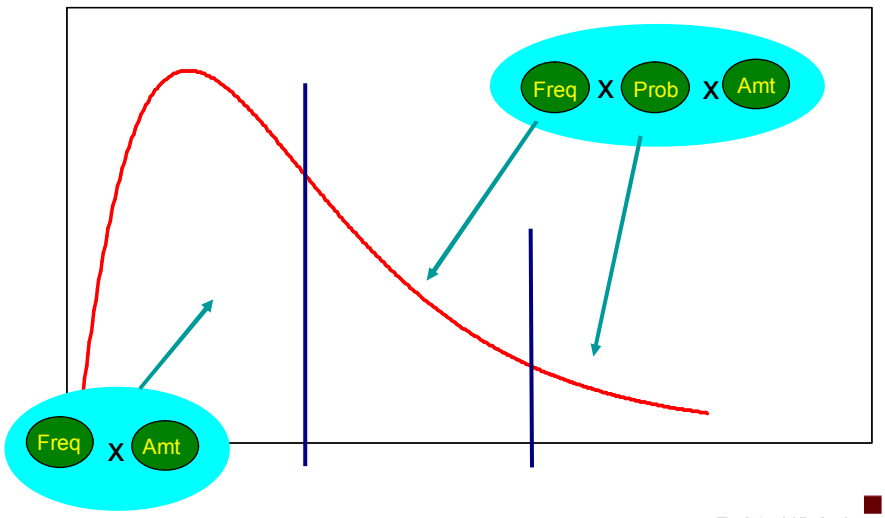
Dealing with large claims



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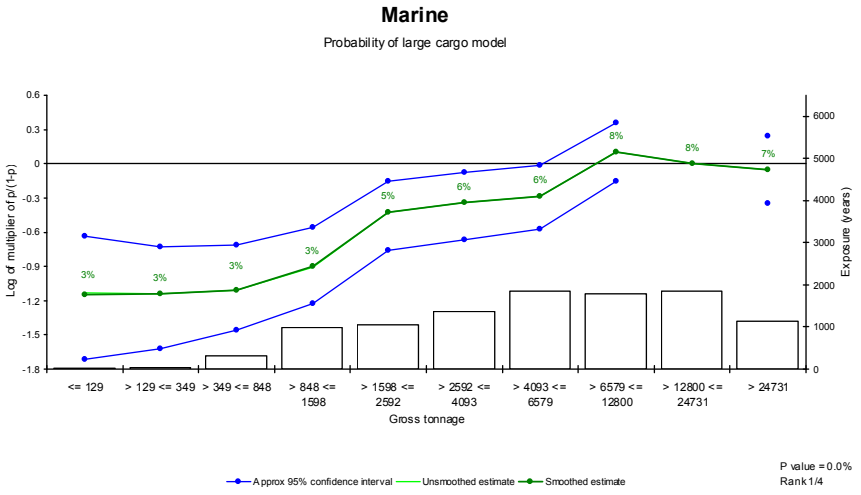
Some marine examples



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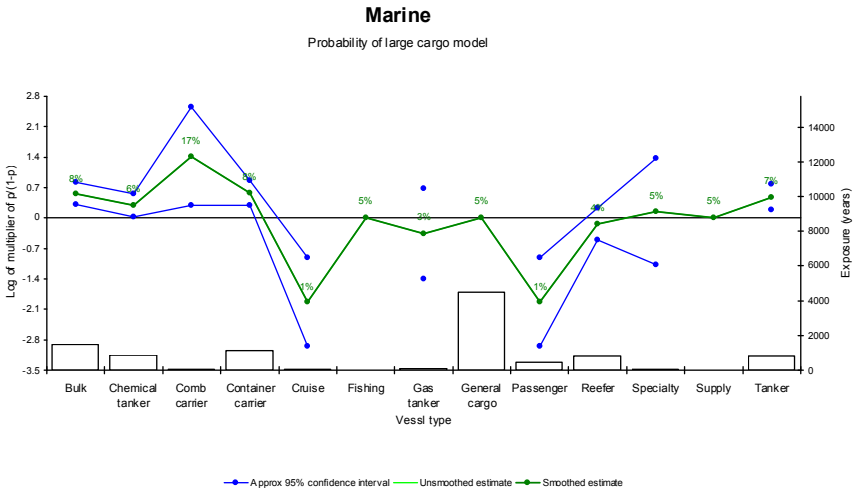

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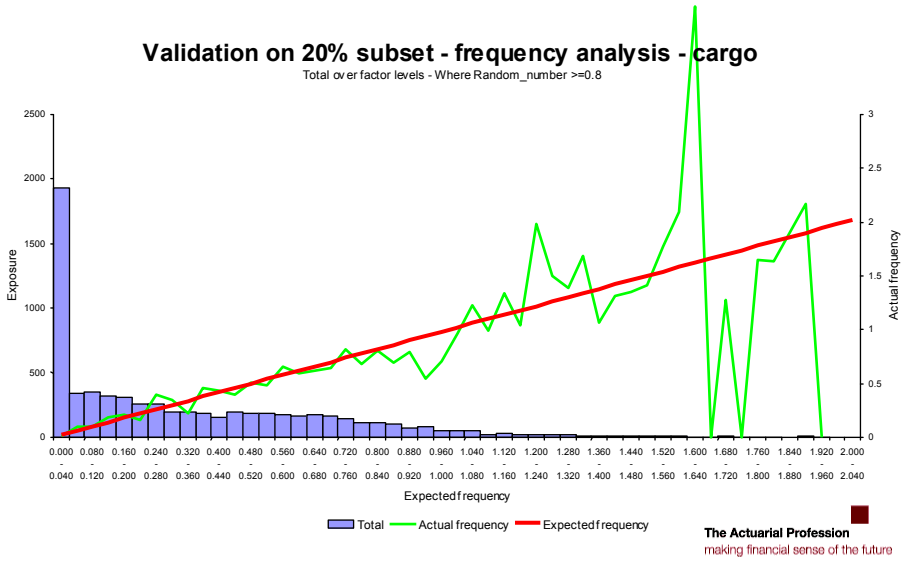
Predictive power of models



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Investigating uncertainty

- Simulation from GLM possible
- Monte Carlo type simulation using current or desired portfolio
- Allows for stochastic features
- Combine other methods or models

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Generalised linear models

Linear Models	Generalised Linear Models
$E[Y_i] = \mu_i = \Sigma X_{ij}\beta_j$	$E[Y_i] = \mu_i = g^{-1}(\Sigma X_{ij}\beta_j + \xi_i)$
$Var[Y_i] = \sigma^2$	$Var[Y_i] = \sigma^2 = \phi V(\mu_i)/\omega_i$
$Y_i \sim N(\mu_i, \sigma^2)$	Y from a distribution from the exponential family

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Typical GLM model forms

Y	Claim frequency	Claim number	Average claim amount	Probability (eg lapses)
g(x)	ln(x)	ln(x)	ln(x)	ln(x/(1-x))
Error	Poisson	Poisson	Gamma	Binomial
ϕ **V(x)**	1 x	1 x	estimate x^2	1 x(1-x)
ω	exposure	1	# claims	1
ξ	0	ln(exposure)	0	0

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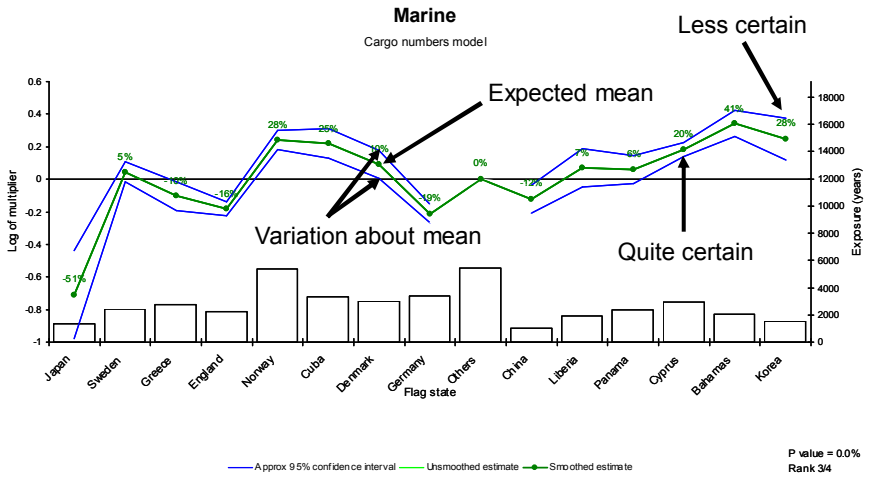
Interpreting the GLM



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Simulating from the GLM

- To determine a sample number of claims, for each record first:
  - Calculate η_i as
    - $\Sigma X_{ij}\beta_j$
  - Calculate σ_i^2 as
    - $\Sigma\Sigma X_{ij}\sigma_{jk}X_{ik}$
- Where
  - β_j is the vector of parameter estimates
  - σ_{jk} is the covariance matrix

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Simulating from the GLM

- Simulate a value for the linear predictor η^s_i from $N(\eta_i, \sigma_i^2)$
- Convert into Poisson mean $\lambda_i = \exp(\eta^s_i)$
- Sample number of claims from Poisson distribution

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Simulating from the GLM

- To determine the sample total cost of claims, for each record:
  - For each record, calculate η_i and σ_i^2 from the amounts model
  - For each sampled claim, simulate a value for the linear predictor η^s_i from $N(\eta_i, \sigma_i^2)$
  - Convert into Gamma mean $\lambda_i = \exp(\eta^s_i)$
  - Sample each claim from Gamma distribution
- Add all the sampled claims together

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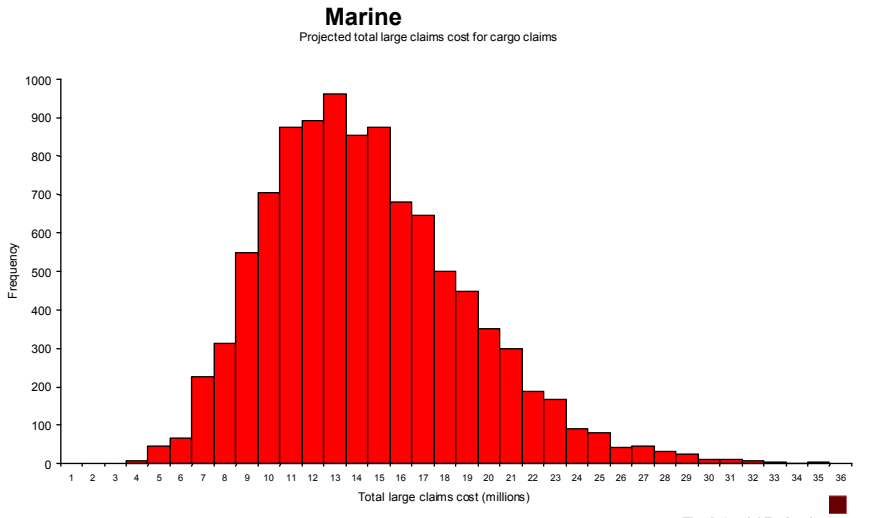

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Conclusions

- GLMs perform well in non-traditional areas
- Results appear to be very predictive of future experience
- Fits with ideal general pricing process
- Can be combined with other methods
- Robust framework for assessing uncertainty

Contact details

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