

Reinsurance modeling and Dynamic Reinsurance Analysis



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The focus on (partial) internal models in the insurance industry



Dynamic Reinsurance Analysis using PillarOne gives options to answer risk specific questions



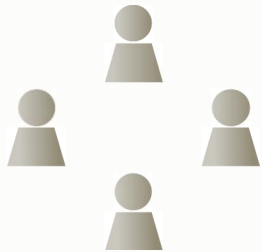
- What is my overall annual risk situation?
- What are my main risk drivers?
- What is the overall capital requirement of the assumed insurance policies?
- How can we allocate the overall capital requirements to individual policies?
- What is the capital relief of our reinsurance policy?
- What is our SCR under Solvency II regulation?



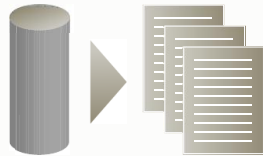
A model is needed to answer this questions: **PODRA**

The PODRA Service - Process Illustration

Modeling



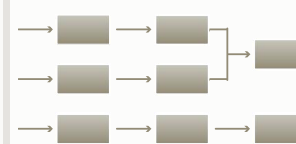
Data requirements



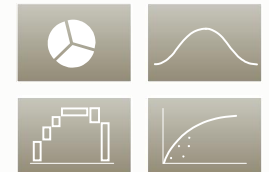
Calibration



Risk mitigation instruments



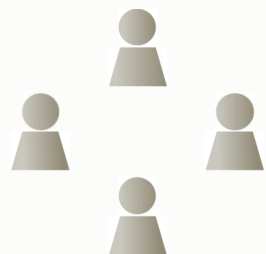
Evaluation



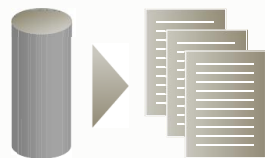
The five steps of Dynamic Reinsurance Analysis Modeling

The PODRA Service - Process Illustration

Modeling



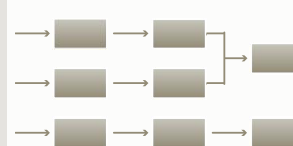
Data requirements



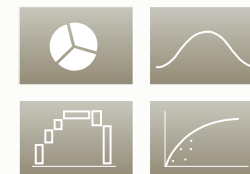
Calibration



Risk mitigation instruments

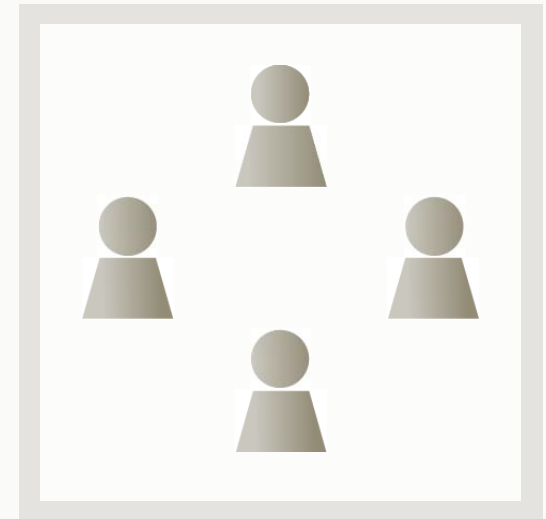


Evaluation



Modeling: based on an elaborate discussion of the business

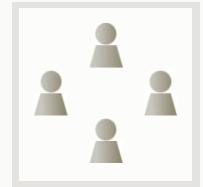
- Specify of result variables and key risk indicators
- Segmentation of the Business (Lines of Business, Perils, ...)
- Assign model components to the segments
- Consider diverse loss components for attritional, large and catastrophic losses according to different perils
- Allowance for special features of the business
- Consider dependency structures
- Define embeddable reinsurance structures



Modeling: Definition of Result Variables

What can the model be used for?

- What risk information do we require for steering purposes?
- What risk information do we use to fulfill the requirements of the regulatory regime / the regulator?
- Should the modeling reflect future developments like Solvency II?



Options for Result Variables:

- Annual aggregated loss (gross and net retained)
- Results (net premium – net losses + commissions)

Options for (Risk) Measures on Result Variables:

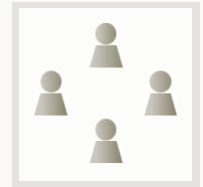
- Expected Value
- Value at Risk at the 99.5% confidence level

Agreement on possible results should be reached

Capital Eagle: The P&C insurer

Are we prepared for modeling

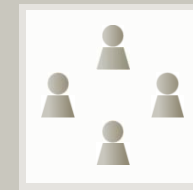
- Founded in 1998 by
 - N. Kuschel, CEO, COO and Reinsurance Manager
 - A. Majidi, CRO and Chief Actuary
- Consultants
 - J. Dittrich, Project Manager, Munich Re
 - L. Berthaut, Consultant, Munich Re
- On Capital Eagle refer to Munich Re Knowledge Series:



http://www.munichre.com/publications/302-05823_en.pdf

Capital Eagle

Definition of Result Variables



Result Variables:

- Annual aggregated loss (gross and net retained)
- Results (net premium – net losses + commissions)

Measures on Result Variables:

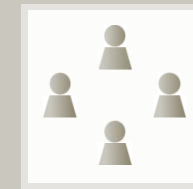
- Expected Value
- Value at Risk at the 99.5% confidence level
- Standard Deviation



Agreement on results reached

Capital Eagle

Modeling of Property Business



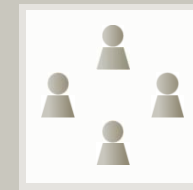
Property

Attritional Loss	
Distribution	
Mean	
Std	
Large Loss	
Household	
x0	
Frequency	
lambda	
Severity	
alpha	
Small Commercial	
x0	
Frequency	
lambda	
Severity	
alpha	
Storm	
x0	
Frequency	
lambda	
Severity	
CatLoss	
Earthquake	
x0	
Frequency	
lambda	
Severity	
CatLoss	

- Segment: Property
- Attritional Loss: Aggregate Distribution
- Large Loss separated for Household and Small Commercial losses
- Frequency / Severity approach
- Natural Perils: Storm and Earthquake
- Frequency / Severity derived from exposure based analysis

Capital Eagle

The Model in PillarOne



```
package models.capitalEagle

import org.pillarone.modelling.domain.lob.ExampleLob
import org.pillarone.modelling.simulation.Model
import org.pillarone.modelling.domain.lob.PropertyLob
import org.pillarone.modelling.domain.aggregators.ClaimsAggregator

class CapitalEagleModel extends Model {
  ExampleLob mtpl
  ExampleLob motorHull
  ExampleLob personalAccident
  PropertyLob property
  ClaimsAggregator claimsAggregator

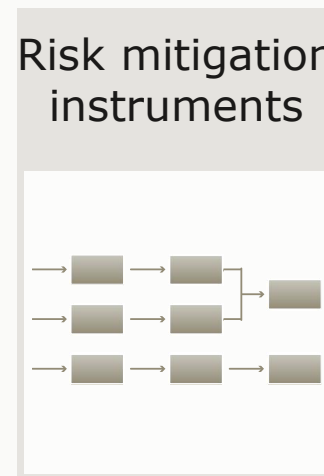
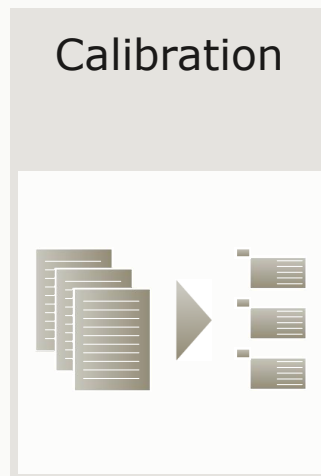
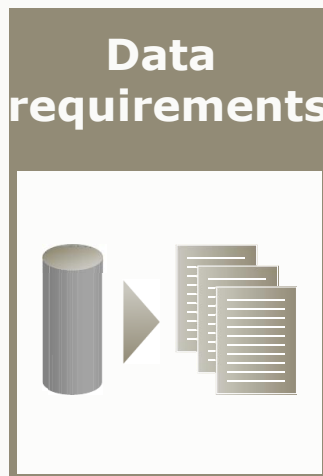
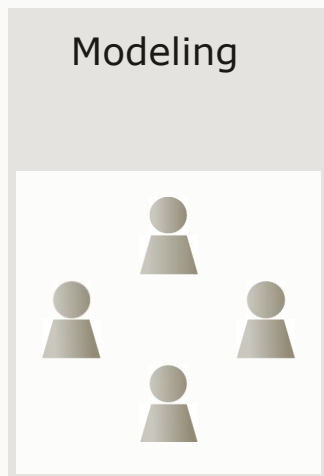
  ...

  public void wireComponents() {
    claimsAggregator.inClaimsGross = mtpl.subRiProgram.outClaimsGross
    claimsAggregator.inClaimsGross = motorHull.subRiProgram.outClaimsGross
    claimsAggregator.inClaimsGross = personalAccident.subRiProgram.outClaimsGross
    claimsAggregator.inClaimsGross = property.subRiProgram.outClaimsGross
    claimsAggregator.inClaimsCeded = mtpl.subRiProgram.outClaimsCeded
    claimsAggregator.inClaimsCeded = motorHull.subRiProgram.outClaimsCeded
    claimsAggregator.inClaimsCeded = personalAccident.subRiProgram.outClaimsCeded
    claimsAggregator.inClaimsCeded = property.subRiProgram.outClaimsCeded
  }
}
```

The five steps of Dynamic Reinsurance Analysis

Data requirements

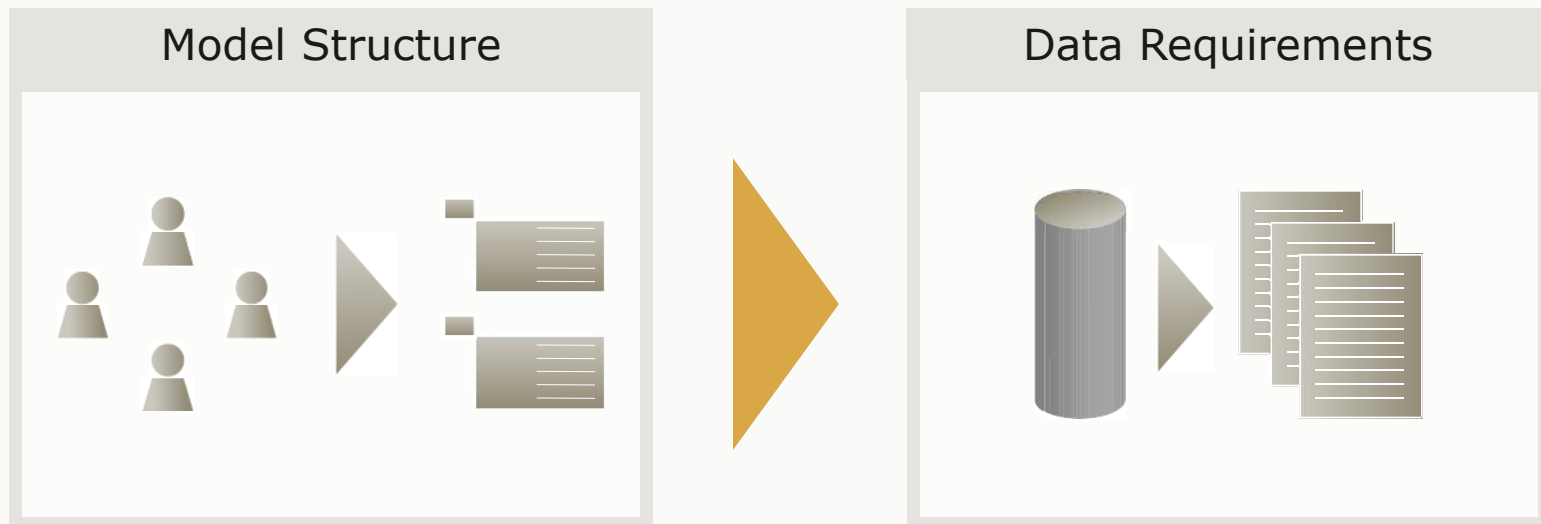
The PODRA Service - Process Illustration



Data requirements

What is necessary to get the model running?

- Model structure defined and proposed
- What parameter set can be derived from the model structure?
- Are parameter fitting and calibration methods identified?
- What data requirements do the fitting and calibration methods have?



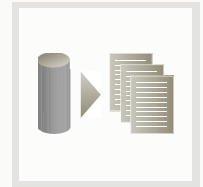
Data requirements

Detailed specification

The following data are required for a PODRA:

- completed QIS4 Sheet*
- Definition of segments to be analysed (lines of business, LoBs)
- Segment specific information (see next slide)
- Reinsurance structure in place
- Risks usually ceded facultatively

- Known alternative reinsurance structures



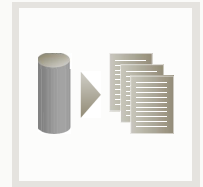
* optional: for calculation of Solvency II key figures

Data requirements: Detailed specification

Segment specific information

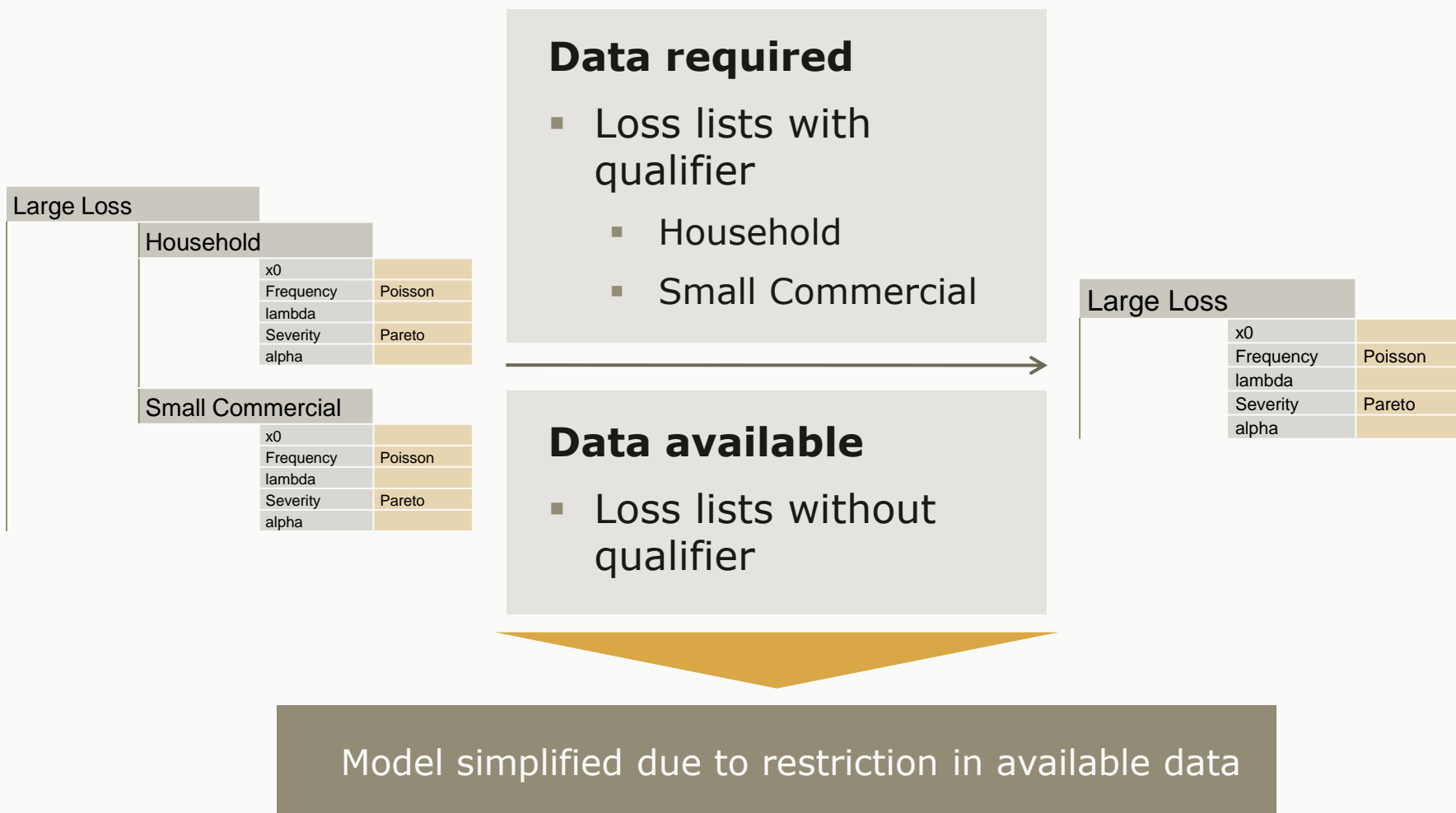
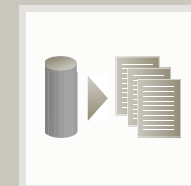
Data requirements for a segment to be modelled in PODRA

- Segment information in line with QIS4 Sheet *
- Premium statistics (calendar year or underwriting year with run-off)
- Aggregate loss amounts per LoB (run-off triangles/ calendar year losses)
- Individual loss amounts per LoB and occurrence year (incl. run-off/calendar year)
- Accumulation loss amounts per LoB and accident year (incl. run-off/calendar year) allocated on hazard
- Accumulation exposures as per e.g. CRESTA/Results of an accumulation risk analysis



* optional: for calculation of Solvency II key figures

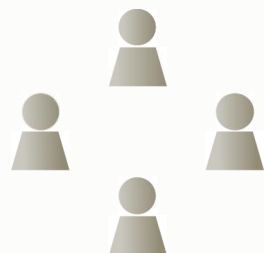
Capital Eagle: Drawbacks from data requirements on the model



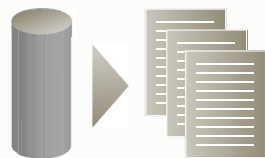
The five steps of Dynamic Reinsurance Analysis Calibration

The PODRA Service - Process Illustration

Modeling



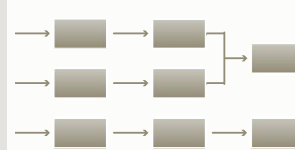
Data requirements



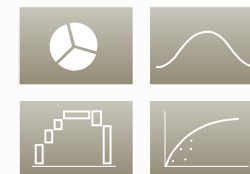
Calibration



Risk mitigation instruments



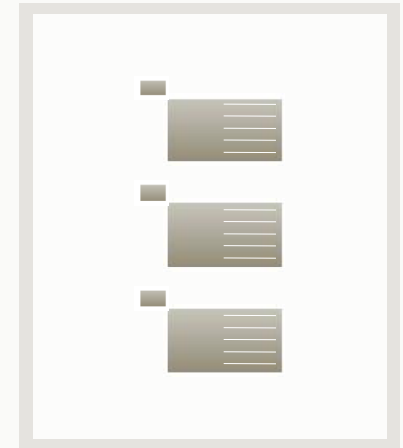
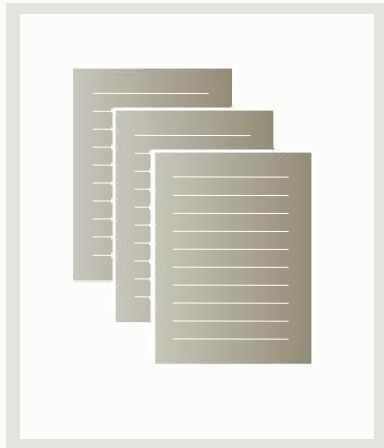
Evaluation



Calibration: Which is the best parametrization for our model?

Calibration

- Distribution
 - Type assumption
- Parameter estimation
 - Mean
 - Standard deviation
 - Skewness
- Confidence ranges
 - Mean in Intervall $[a,b]$ at 95% probability cannot be rejected

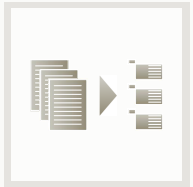


Calibration

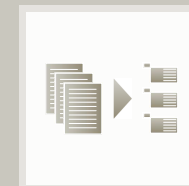
Detailed specification

Data are linked with models

- Parameter estimates of models based on statistics
- Simulations with external nat cat tools
- Parameter estimates of models from nat cat simulations
- Adjustment of dependencies (optional)
- Simulation and plausibility test



Capital Eagle: Estimation of parameters by moment matching



Premium	Loss Ratio
35.515	50,15%
39.482	56,49%
42.822	58,89%
42.402	60,15%
32.315	51,30%
31.509	52,54%
26.200	45,47%
29.358	51,20%
30.322	53,61%
30.401	54,24%
29.967	53,93%
26.380	48,57%
24.064	46,04%

Calibration

$$\hat{\mu} = \frac{1}{n} \sum_{i=1}^n x_i$$

$$\hat{\sigma} = \frac{1}{n-1} \sum_{i=1}^n (x_i - \hat{\mu})^2$$

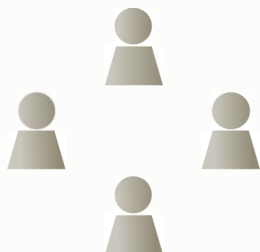
Property	Attritional Loss	
	Distribution	LogNorm
	Mean	0,5251
	Std	0,0444

The five steps of Dynamic Reinsurance Analysis

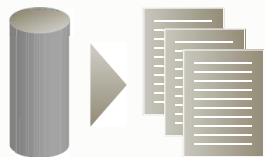
Risk mitigation instruments

The PODRA Service - Process Illustration

Modeling



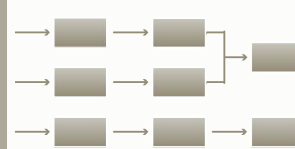
Data requirements



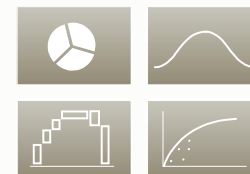
Calibration



Risk mitigation instruments



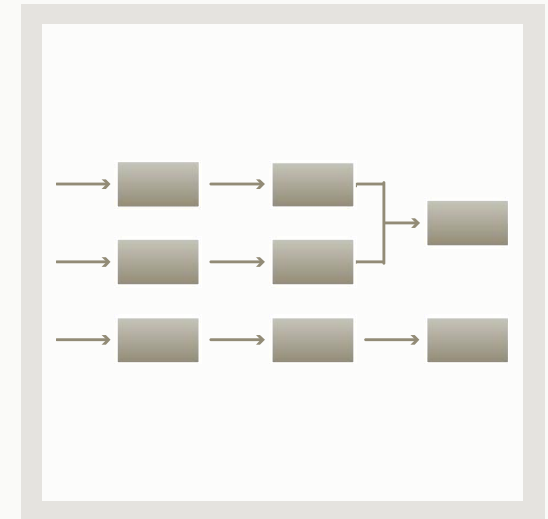
Evaluation



Risk Mitigation

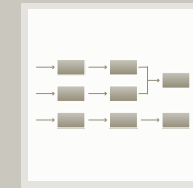
Representation of reinsurance

- Representation of current reinsurance program structure (LoBs, treaty reins. structures)
- Parametrisation of treaties
- Consideration of reinsurance premiums and determination of a premium calculation principle
- Optional: Definition of alternative reinsurance structures and parameters
- Calculation of reinsurance premiums equivalent to those used for current reinsurance structure



Capital Eagle

Reinsurance program alternatives



PeakRisk (Peak risk cover)

Motor liability	ML WXL 95 xs 5	
Motor own damage	MOD CXL 10 xs 10	
Personal accident	PA WXL 1 xs 2	PA CXL 10 xs 2
Property	Prop. CXL 170 xs 10	

NP (Pure non-proportional cover)

Motor liability	ML WXL 99 xs 1	
Motor own damage	MOD CXL 19,5 xs 0,5	
Personal accident	PA WXL 2.8 xs 0.2	PA CXL 1.4 xs 0.2
Property	Prop. CXL 14 xs 1	Prop. SL 300% xs 100%

ML50+NP (ML quota share and NP cover)

Motor liability	ML 50% quota share cession	ML WXL 99 xs 1	
Motor own damage		MOD CXL 19.5 xs 0.5	
Personal accident		PA WXL 2.8 xs 0.2	PA CXL 1.4 xs 0.2
Property		Prop. CXL 14 xs 1	Prop. SL 300% xs 100%

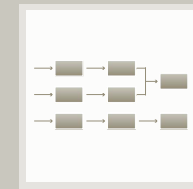
ALL 50+NP (Quota share and NP cover)

Motor liability	ML 50% quota share	ML - WXL 99 xs 1	
Motor own damage	MOD 50% quota share	MOD CXL 19.5 xs 0.5	
Personal accident	PA 50% quota share	PA WXL 2.8 xs 0.2	PA CXL 1.4 xs 0.2
Property	Prop. CXL 14 xs 1	Prop. 50% quota share	Prop. SL 300% xs 100%

The solvency capital is calculated based on four different reinsurance programmes.

Capital Eagle

Property Reinsurance in PillarOne

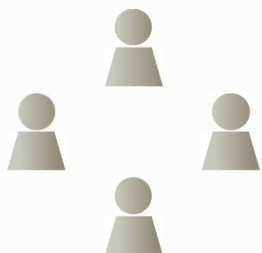


```
...
subRiProgram {
  subContract1 {
    parmContractStrategy[0]=...getContractStrategy (...ReinsuranceContractType.WXL,
      ["premiumBase"...PremiumBase.ABSOLUTE, "premium":800000.0, "reinstatementPremiums":new
      ...TableMultiDimensionalParameter ([0.5], ["Reinstatement
      Premium"]), "attachmentPoint":1000000.0, "limit":4.2E7, "aggregateLimit":5.0E7, "coveredByReinsurer":1.0,])
    parmInuringPriority[0]=0
  }
  subContract2 {
    parmContractStrategy[0]=...ReinsuranceContractStrategyFactory.getContractStrategy (...ReinsuranceContractType.QUOTASHARE,
      ["quotaShare":0.5, "commission":0.0, "coveredByReinsurer":0.0,])
    parmInuringPriority[0]=1
  }
  subContract3 {
    parmContractStrategy[0]=...ReinsuranceContractStrategyFactory.getContractStrategy (...ReinsuranceContractType.STOPLOSS,
      ["premiumBase"...PremiumBase.ABSOLUTE, "premium":100000.0, "attachmentPoint":3.3960398
      E7, "limit":1.01881194E8, "coveredByReinsurer":1.0,])
    parmInuringPriority[0]=2
  }
}
...
```

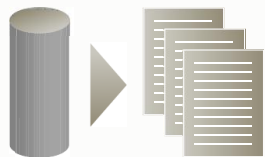
The five steps of Dynamic Reinsurance Analysis Evaluation

The PODRA Service - Process Illustration

Modeling



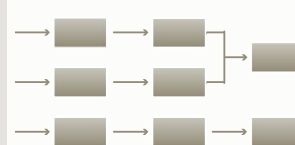
Data requirements



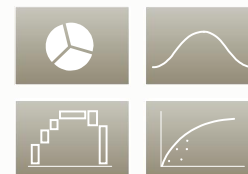
Calibration



Risk mitigation instruments



Evaluation



Result presentation

Detailed specification

- Preparation of information on the risk situation of the gross portfolio
- Description of risk situation under current reinsurance cession
- Details on the risk situation under alternative reinsurance structures
- Cost-benefit analysis of reinsurance structures
- Optional: Representation of results in line with Solvency II (QIS4)



* optional: only when QIS4 sheet completed

Capital Eagle

Risk measures

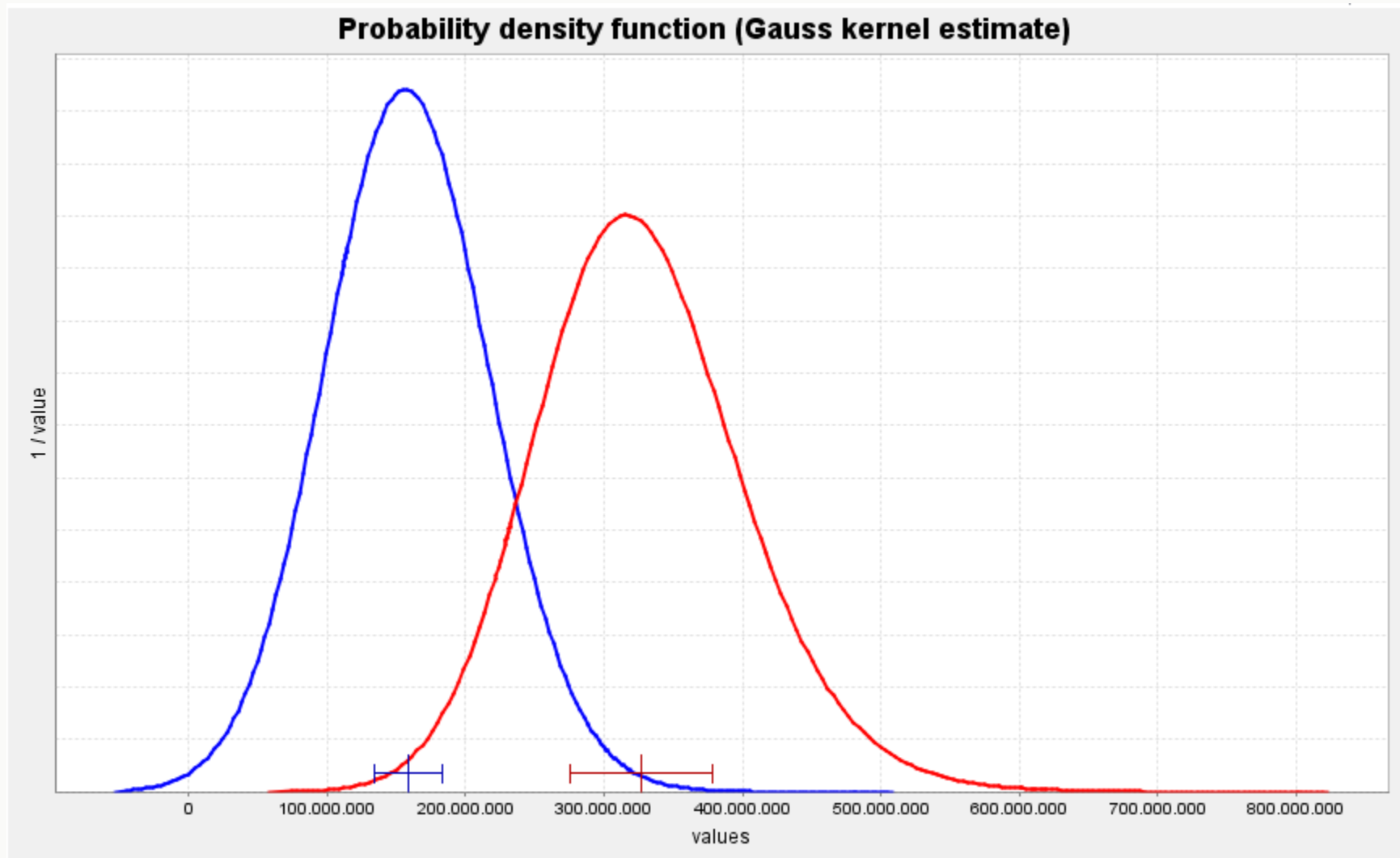


CapitalEagle	gross		RBC			
	premium	loss	expectation	st-deviation	(VaR99,5)	RBC/expectedRBC/P Quote
Total	386.627.763	326.690.042	51.499.084	183.230.288	56,1%	47,4%
Diversification	0	0	-27.526.946	-127.772.278	-39,1%	
Property	72.939.000	52.126.131	46.721.917	173.654.847	333,1%	238,1%
Personal Accident	27.432.763	22.956.967	5.008.889	16.268.881	70,9%	59,3%
MotorLiability	189.242.000	170.891.940	20.246.051	96.463.404	56,4%	51,0%
MotorHull	97.014.000	80.715.004	7.049.173	24.615.435	30,5%	25,4%

CapitalEagle	net		RBC			
	premium -commission	loss	expectation	st-deviation	(VaR99,5)	RBC/expectedRBC/P Quote
Total	242.368.717	158.341.441	24.641.012	88.585.220	55,9%	36,5%
Diversification	0	0	-10.677.672	-33.005.251	-20,8%	
Property	44.524.335	26.063.066	23.360.959	86.827.423	333,1%	195,0%
Personal Accident	37.254.437	11.135.698	2.434.813	8.029.456	72,1%	21,6%
MotorLiability	105.000.924	81.852.320	6.869.067	19.432.286	23,7%	18,5%
MotorHull	55.589.022	39.290.357	2.653.846	7.301.305	18,6%	13,1%

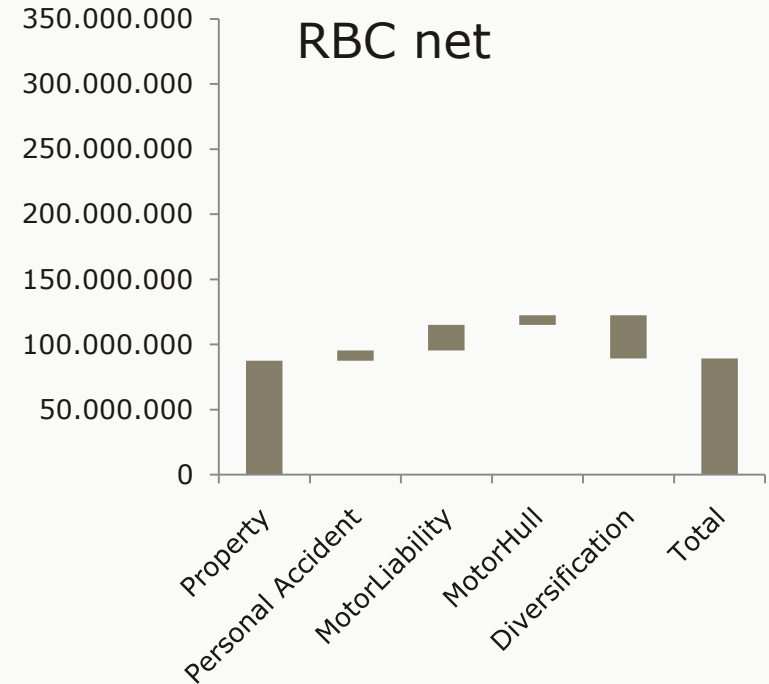
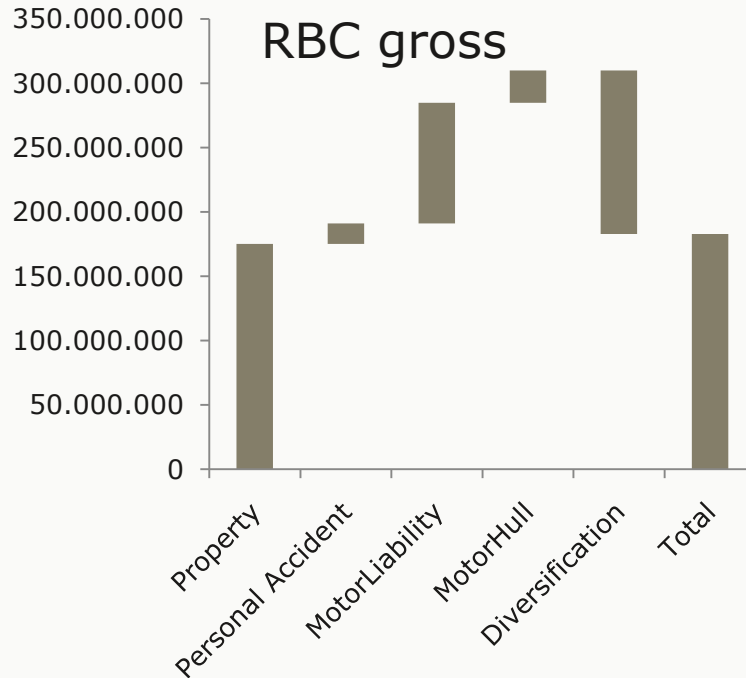
Capital Eagle

Loss distributions: gross vs. net



Capital Eagle: Risk situation

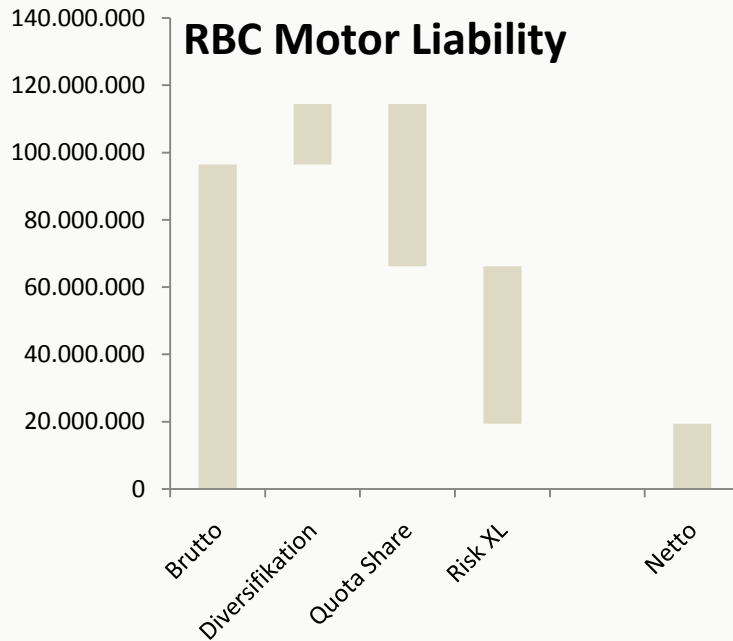
RBC gross vs. net



The effects of reinsurance are made obvious

Capital Eagle

Motor Liability gross vs. net

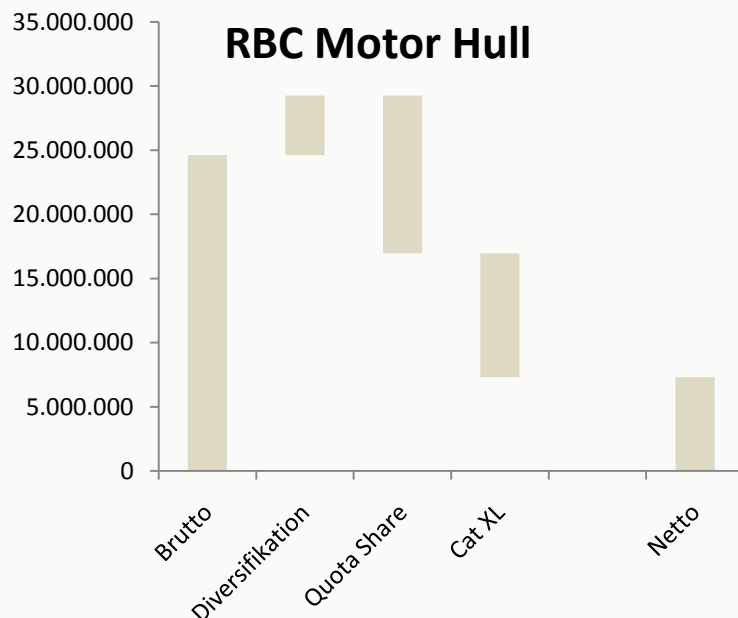


- Risk mitigation reached by program structure
 - Attritional loss ratio fluctuation reduced by quota share
 - Large loss fluctuation reduced by Risk Excess of Loss

CapitalEagle	Motor Liability					
	premium -commission	loss expectation	st-deviation	RBC (VaR99,5)	RBC/expected	RBC/P Quote
Gross	189.242.000	170.891.940	20.246.051	96.463.404	56%	51,0%
Diversifikation	0	0	-3.840.567	-17.978.856		
Net	105.000.924	81.852.320	6.869.067	19.432.286	24%	18,5%
Quota Share	78.819.293	85.445.970	10.123.026	48.231.702	56%	61,2%
Risk XL	5.421.783	3.593.650	7.094.526	46.778.271	1302%	862,8%

Capital Eagle

Motor Hull gross vs. net



- Risk mitigation reached by program structure
 - Attritional loss ratio fluctuation reduced by quota share
 - Large loss fluctuation reduced by Catastrophe Excess of Loss

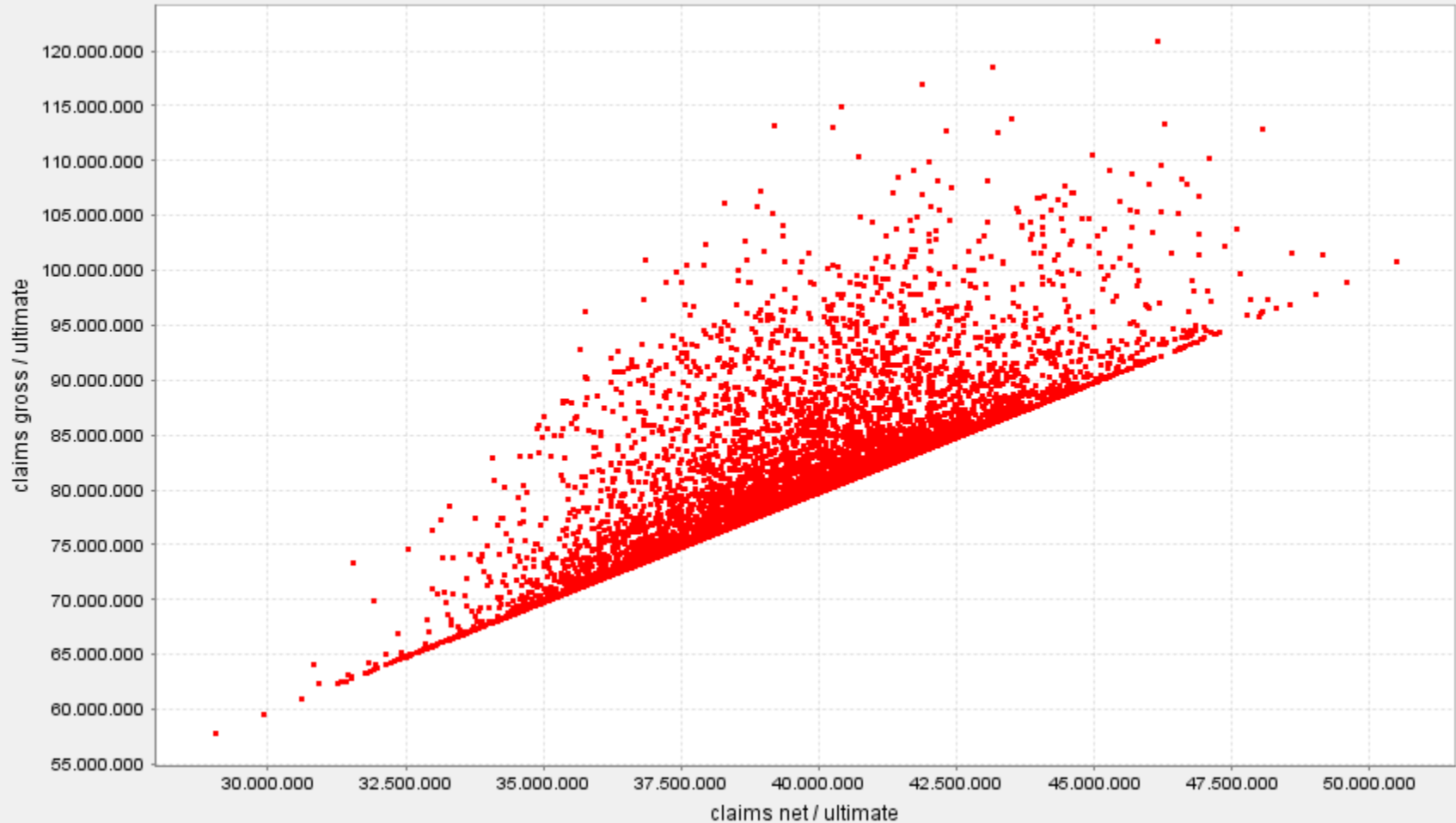
CapitalEagle	Motor Hull					
	premium -commission	loss expectation	st-deviation	RBC (VaR99,5)	RBC/expected	RBC/P Quote
Gross	97.014.000	80.715.004	7.049.173	24.615.435	30%	25,4%
Diversification	0	0	-1.234.875	-4.654.614		
Net	55.589.022	39.290.357	2.653.846	7.301.305	19%	13,1%
Quota Share	39.339.177	40.357.502	3.524.587	12.307.718	30%	31,3%
Risk XL	2.085.801	1.067.145	2.105.616	9.661.026	905%	463,2%

Capital Eagle

Motor Hull gross vs. net

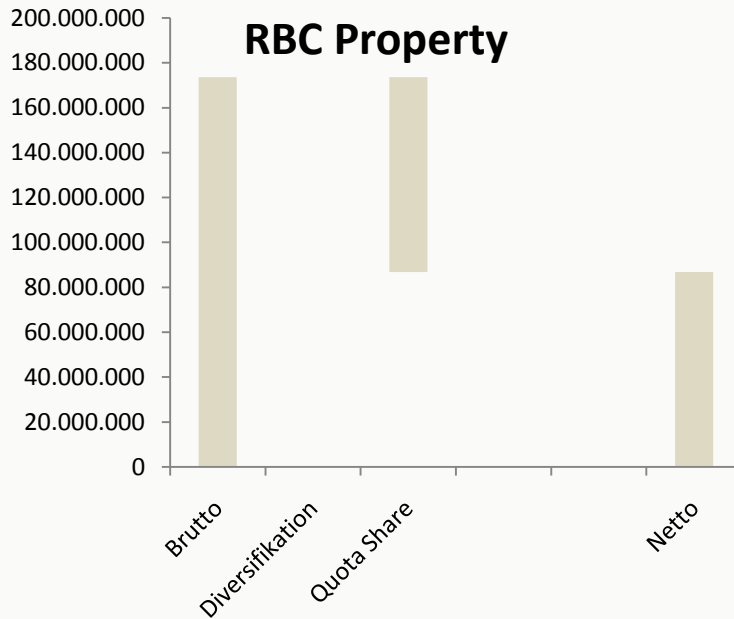


Scatter Plot



Capital Eagle

Property gross vs. net

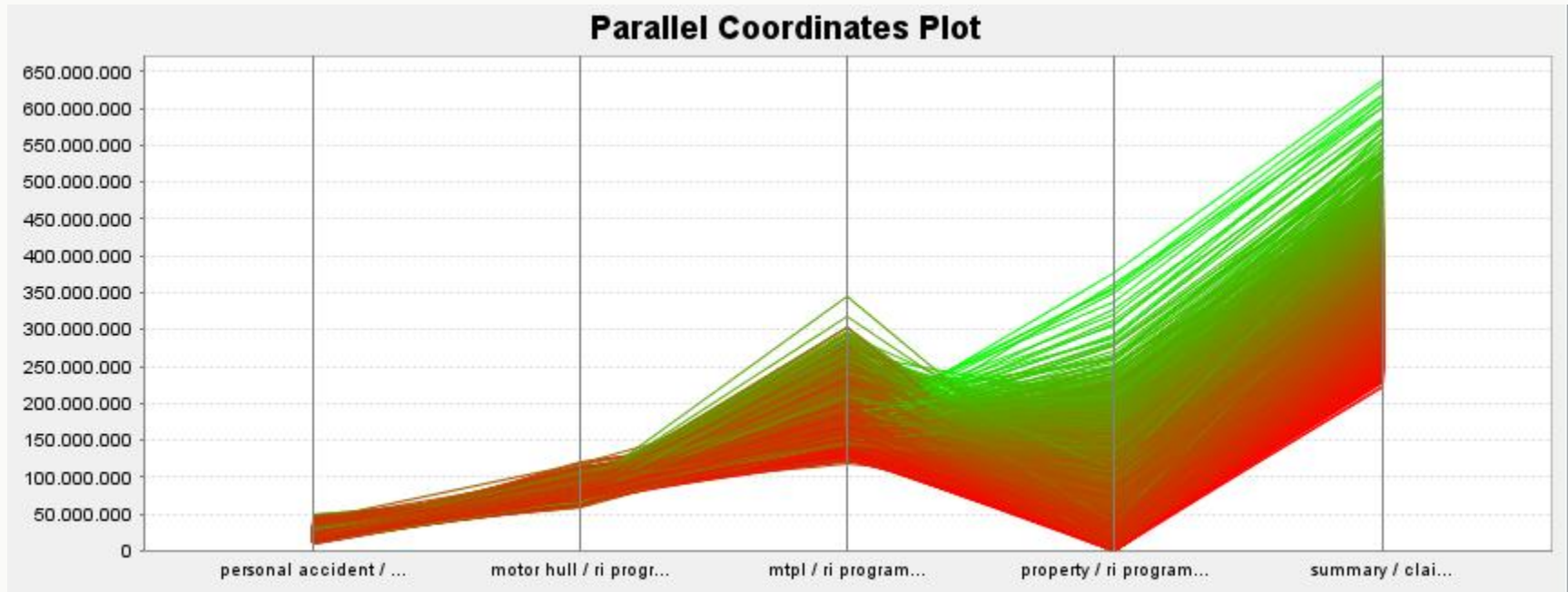


- Quota Share not sufficient in Property (compared to other Lines of business)
- Further discussion required

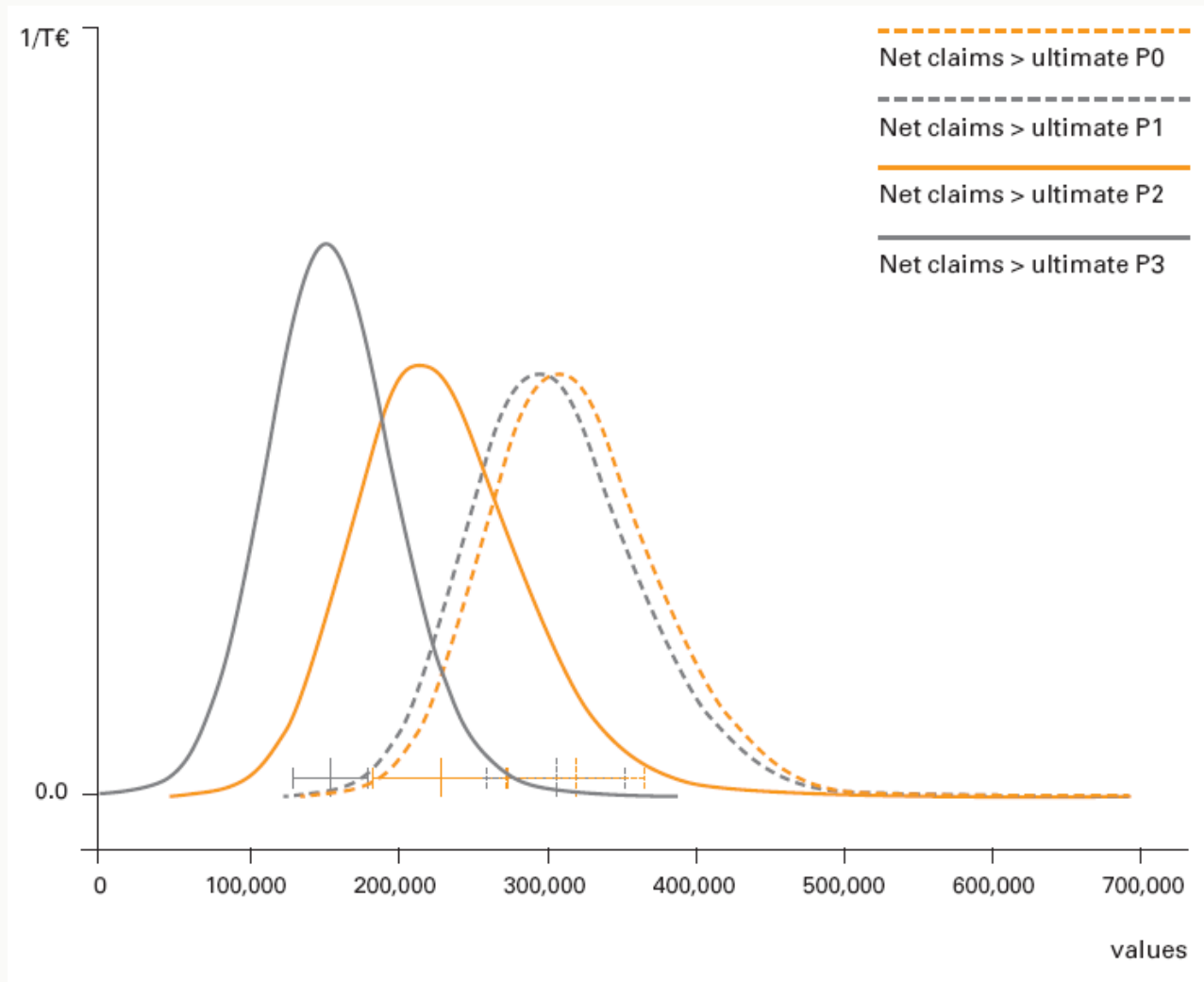
CapitalEagle	Property					
	Prämie + Provisionen	Schaden Erwartung	St-Abweichung	RBC (VaR99,5)	RBC/EW Quote	RBC/P Quote
Gross	72.939.000	52.126.131	46.721.917	173.654.847	333%	238,1%
Diversification	0	0	0	0		
Net	48.623.355	26.063.066	23.360.959	86.827.423	333%	178,6%
Quota Share	24.315.645	26.063.066	23.360.959	86.827.423	333%	357,1%

Capital Eagle

Gross loss in parallel coordinates chart



Capital Eagle: retained losses of reinsurance alternatives



Decision support of PODRA

Answers provided



overall annual risk situation?
capital requirement of the
assumed insurance policies?

- Expected value of annual aggregated loss
- Value at Risk at 99.5% confidence level

main risk drivers?

- LoB Property standalone VaR 99.5%

allocation of the overall capital
requirements to individual
policies?

- LoB Property contributes x% to the overall VaR 99.5%

capital relief of our reinsurance
policy?

- Expected Value of annual aggregated loss
- Net Value at Risk at 99.5% confidence level

Summary: Munich Re provides support in preparation of the PODRA service

PODRA – Powered by PillarOne

PODRA (PillarOne Dynamic Reinsurance Analysis) is a service developed by Munich Re to describe and measure underwriting risk in property and casualty insurance.

The method is based on the PillarOne.RiskAnalytics software platform, an open-source software project initiated and sponsored by Munich Re. Project set-up, roadmap, features, software downloads, and other information can be found on the community website www.pillarone.org. All PillarOne applications include an open source software licence (GPL) which provides usage free of charge.

