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Setting Optimal Retention based on Freq & Sev Modeling

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EAAC

Intro

- **What is Retention**
  - Theories
  - Application
- **Modeling**
  - GLM (Generalized Linear Model)
- **Example**
  - Simulation & Evaluation

Intro

- **Korean Reinsurance Company**
  - Established in 1963
  - Top Reinsurer in Asia
  - Global Top 9th Reinsurer
  - AM Best : A, S&P : A-

(USD Million, %)

Gross written premiums	4,125.7
Net written premiums	2,617.6
Net income	111.9
RBC ratio	206.3
Combined ratio	98.4

* FY2013

Intro

- **Glossary**

  - Reinsurance

    o Treaty Vs. Facultative

  - Primary / Cedant / Retrocession

    o Written, Share, Ceded or Reinsured

  - Underwriting(U/W) / Claim

  - Type of Data

    o Individual Vs. Grouped

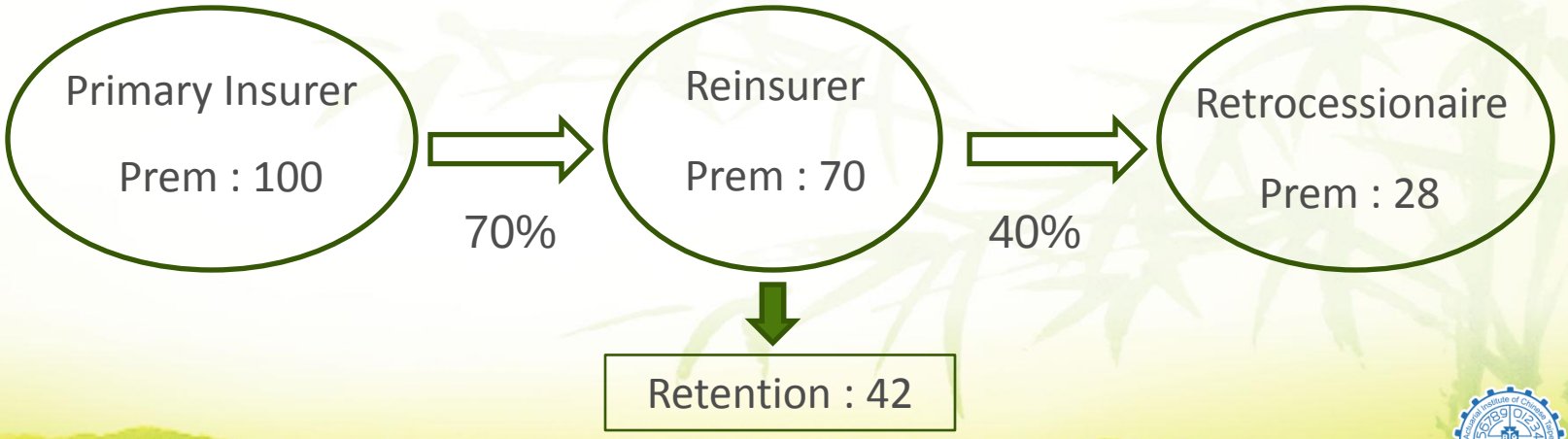
Intro

- **Retention**

  - Determine what remains for its own account after underwriting

  - Net portfolio

    = Gross Portfolio – Reinsurance/Retrocession



Retention

- **Important Factors**
  - Solvency regulations
  - Underwriting capacity
  - Financial strength
  - Large risk and catastrophe protection
  - Portfolio composition
  - Reinsurance market

*** No standard for setting retention**

Modeling

- **Simpson's paradox**

	1995		1996		Combined	
Derek Jeter	12/48	.250	183/582	.314	195/630	**.310**
David Justice	104/411	**.253**	45/140	**.321**	149/551	.270

- **One-way analysis**

  - Easy to use and analyze
  - But, sometimes correlations may not be taken into account in the case of multiple parameters in model

Modeling

- **Simple Regression**

$$E(Y) = u = \beta_0 + \sum_{j=1}^{p} \beta_j x_j$$

β_j : Vectors of regression coefficients

- **GLM(Generalized Linear Model)**

$$E(Y) = g(u) = \beta_0 + \beta_1 + \Lambda + \beta_j x_j$$

$g(u)$: Link function

* Log link is commonly used

Modeling

- **GLM(cont.)**

  - Frequency : Poisson

  - Severity : Gamma

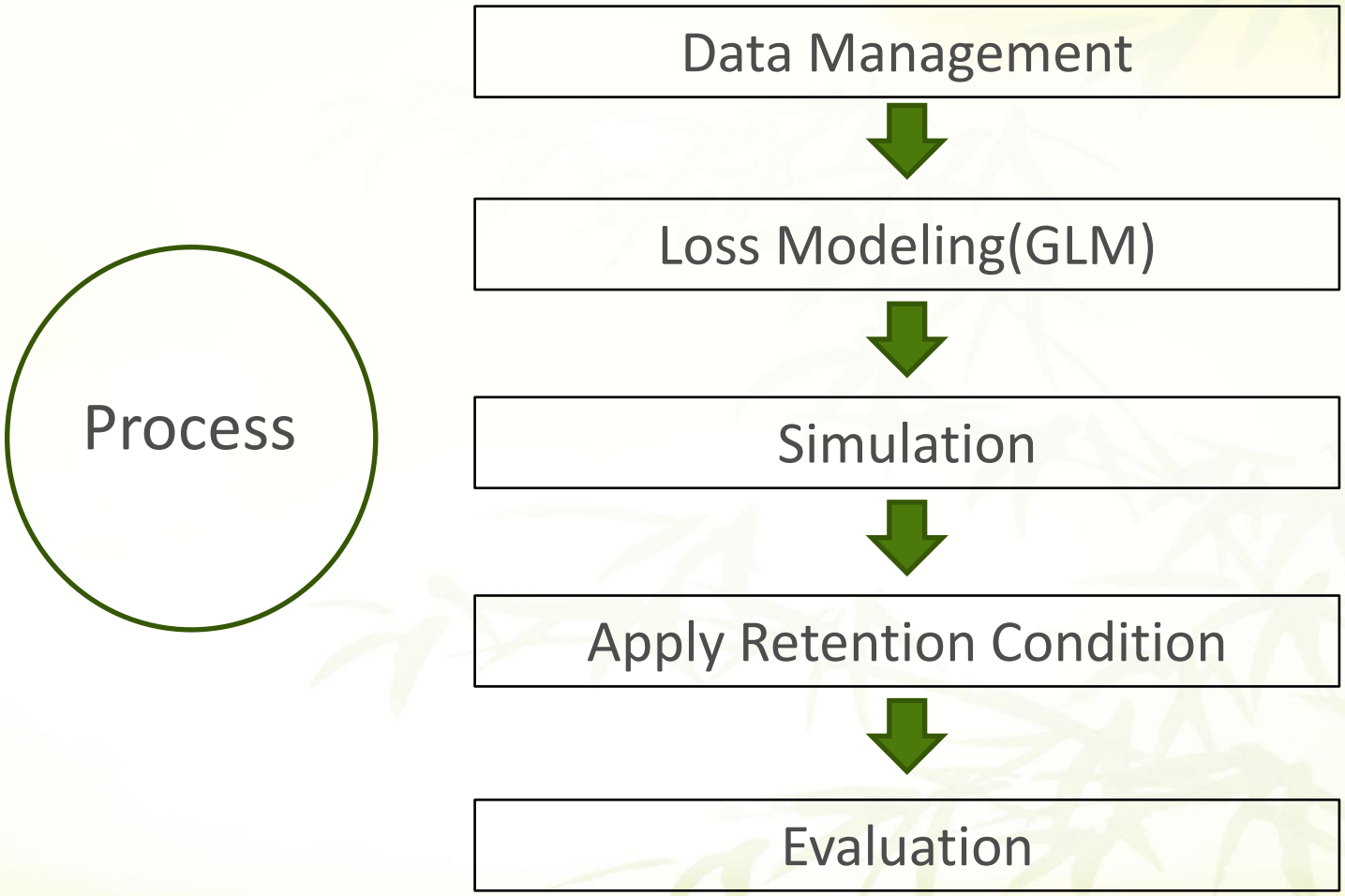
- **“Good” Model ?**

  - Simple Vs. Complex

  - How many parameters are used

  - Previous experience Vs. Future prediction

Example


Process
Data Management
Loss Modeling(GLM)
Simulation
Apply Retention Condition
Evaluation

Example

Step 1 : Data Management

□ Generating source data for Underwriting and Claim separately

□ Check Accuracy

- Compare Total premium, Claim(paid loss, O/S etc) with B/S

- Divide data into Available vs. Not available

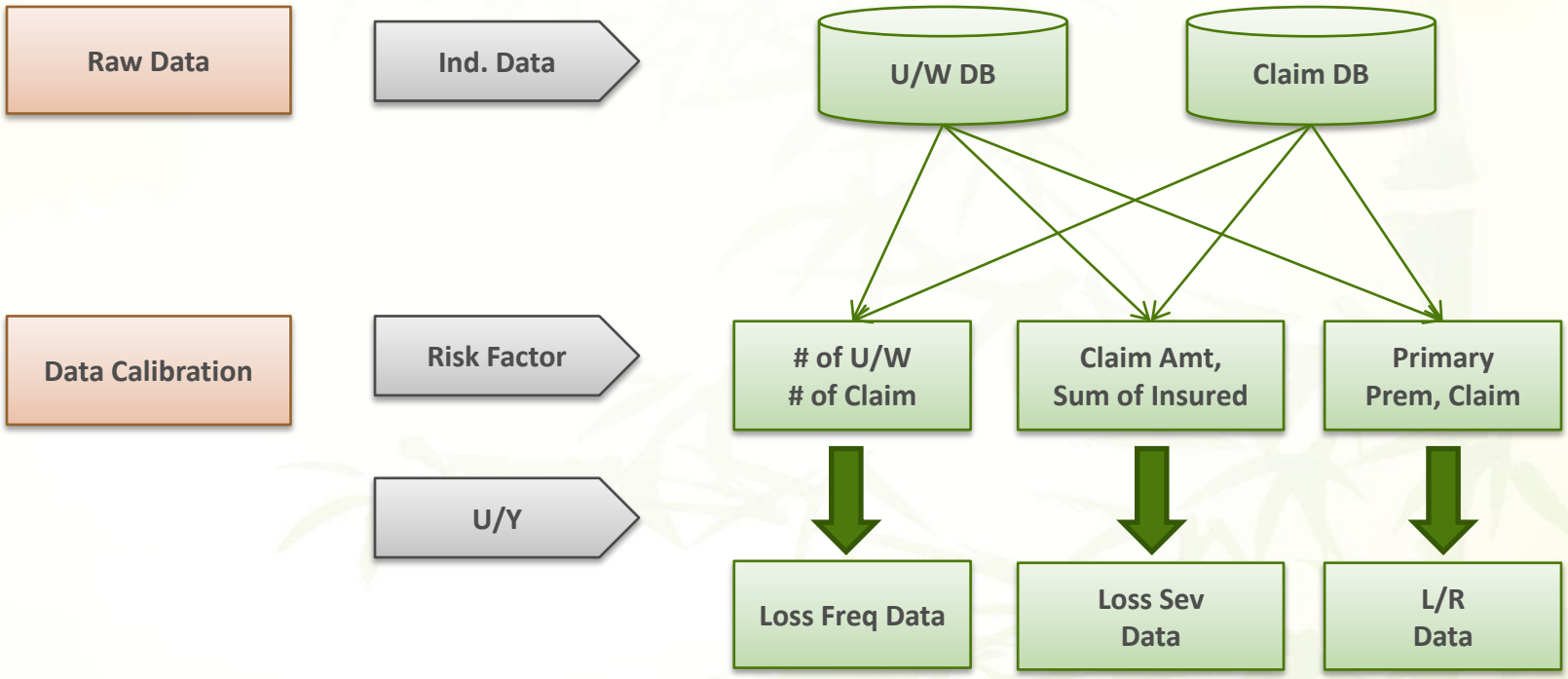
※ Bordereaux Vs. Non-bordereaux (or Individual Vs. Grouped)

□ Adjust Claim data by applying LDF

□ Combine Underwriting and Claim

Example

Step 1 : Data Management



Example

Step 1 : Data Management

LOB	Policy #	U/Y	Risk Factor				Sum of Insured	Premium	Loss	
			1	2	3	4			# of claims	Paid (Inc. O/S)
Car	FA00124	2008	A	50	1	D	3,000,000,000	1,000,000		
Fire	CRD937	2013	A	30	1	D	85,000,000	52,784	3	56,000,000
Ship	A104583	2009	C	30	3	D	500,000,000	965,200		
BBB	HH02	2011	D	30	2	O	1,000,000	5,843	1	800,000
Eng	HD03	2011	A	50	1	D	5,950,000	100,000	1	
D&O	419DDR	2002	B	100	1	D	15,000,000,000	8,000,000	5	3,365,840,000
Fire	T012582	2006	B	90	5	O	2,800,000,000	500,000		
Eng	UAH082	2008	C	84	4	O	97,000,000	45,000	3	15,000,000
BI	BBB913	2006	A	76	1	D	5,000,000	3,000		

Example

Step 2 : Loss Modeling(GLM)

□ Risk Grouping

- Combination of Risk Factors

□ Using Statistical Package(SAS)

- PROC GENMOD

- Find the appropriate parameter for each variable

- Reasonable P-value

Example

Step 2 : Loss Modeling(GLM)

□ Definition

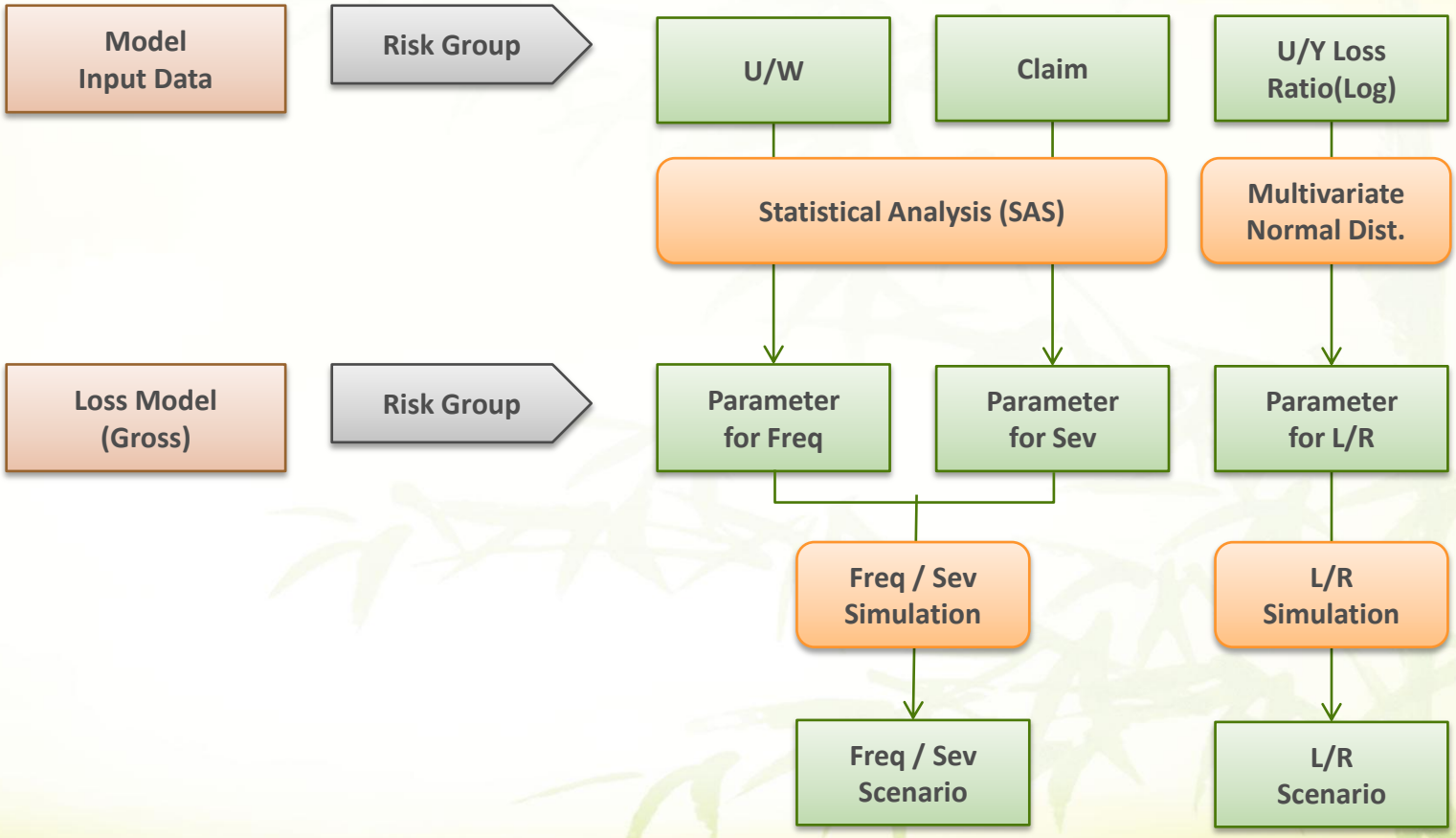
- Frequency : for each grouping, the number of accidents that occurred in a given year
- Severity : for each individual policy, the amount of claims paid

□ Risk grouping is repeated until satisfied

- Select optimized risk grouping by appropriate P-value

Example

Step 2 : Loss Modeling (GLM)



Example

Step 2 : Loss Modeling(GLM)

□ SAS Coding

```
TITLE 'Freq GLM Analysis – LOB1';
PROC GENMOD DATA = QDM_ANAL_FREQ_CF01 ORDER = FREQ;
        CLASS   FREQ_ID1 FREQ_ID2 FREQ_ID3 FREQ_ID4 / DESC ;
        MODEL  ACDT_CNT = FREQ_ID1 FREQ_ID2 FREQ_ID3 FREQ_ID4 / DIST = POI   LINK = LOG OFFSET = LOG_CNT;
        OUTPUT OUT = QDM_RSLT_FREQ_CF01   P=P_ACC   XBETA=X_BETA;
        ODS OUTPUT PARAMETERESTIMATES = PARA_FREQ_CF01;
RUN;

TITLE 'Sev GLM Analysis – LOB2';
PROC GENMOD DATA = QDM_ANAL_SEVR_E02;
        CLASS  SEVR_ID1 SEVR_ID2 SEVR_ID3 SEVR_ID4 / DESC ;
        MODEL LOSS_DEGREE = SEVR_ID_1 SEVR_ID_2 SEVR_ID_3 SEVR_ID_4 / DIST = GAMMA LINK = LOG;
        OUTPUT OUT = QDM_RSLT_SEVR_CF01   P=P_ACC    XBETA=X_BETA  ;
        ODS OUTPUT PARAMETERESTIMATES = PARA_SEVR_E02;
RUN;
```

Example

Step 2 : Loss Modeling(GLM)

□ SAS Result

The GENMOD Procedure

Model Information

Data Set	QDM_ANAL_SEVR_CF03
Distribution	Gamma
Link Function	Log
Dependent Variable	LOSS_DEGREE
Number of Observations Read	8080
Number of Observations Used	8080

Class Level Information

Class	Levels	Values
SEVR_ID_1	2	A02 A01
SEVR_ID_2	2	CB04 CB01
SEVR_ID_3	5	ZG15 ZG04 ZG01 ZG10 ZG05
SEVR_ID_4	1	*

Example

Step 2 : Loss Modeling(GLM)

□ SAS Result (Cont.)

Criteria For Assessing Goodness Of Fit

Criterion	DF	Value	Value/DF
Deviance	8073	23728.017	2.9392
Scaled Deviance	8073	10468.368	1.2967
Pearson Chi-Square	8073	385716.2108	47.7785
Scaled Pearson X2	8073	170170.9521	21.079
Log Likelihood		62397.3913	
Full Log Likelihood		62397.3913	
AIC (smaller is better)		-124778.7826	
AICC (smaller is better)		-124778.7647	
BIC (smaller is better)		-124722.8054	

Example

Step 2 : Loss Modeling(GLM)

□ SAS Result (Cont.)

Parameter		DF	Estimate	Standard Error	Wald 95% Confidence Limits		Wald Chi-Square	Pr > ChiSq
Intercept		1	-5.9703	0.1118	-6.1895	-5.7512	2850.05	<.0001
SEVR_ID_1	A02	1	0.1402	0.0664	0.0101	0.2703	4.46	0.0347
SEVR_ID_1	A01	0	0	0	0	0	.	.
SEVR_ID_2	CB04	1	-0.0964	0.04	-0.1748	-0.0181	5.82	0.0159
SEVR_ID_2	CB01	0	0	0	0	0	.	.
SEVR_ID_3	ZG15	1	-3.3273	0.1128	-3.5484	-3.1062	870.32	<.0001
SEVR_ID_3	ZG04	1	2.0575	0.1411	1.7809	2.3341	212.53	<.0001
SEVR_ID_3	ZG01	1	-1.9482	0.1155	-2.1746	-1.7217	284.35	<.0001
SEVR_ID_3	ZG10	1	-1.218	0.1184	-1.4501	-0.986	105.83	<.0001
SEVR_ID_3	ZG05	0	0	0	0	0	.	.
SEVR_ID_4	*	0	0	0	0	0	.	.
Scale		1	0.4412	0.0057	0.4302	0.4524		

Example

Step 3 : Simulation

□ Using the results of SAS

- Apply the Estimate to each underwriting policy

- Random Numbers of Poisson or Gamma etc.

□ Do analysis repeatedly until satisfied

- Reasonable Loss Distribution

- 10% buffer in conservative view

Example

Step 3 : Simulation

□ Illustration

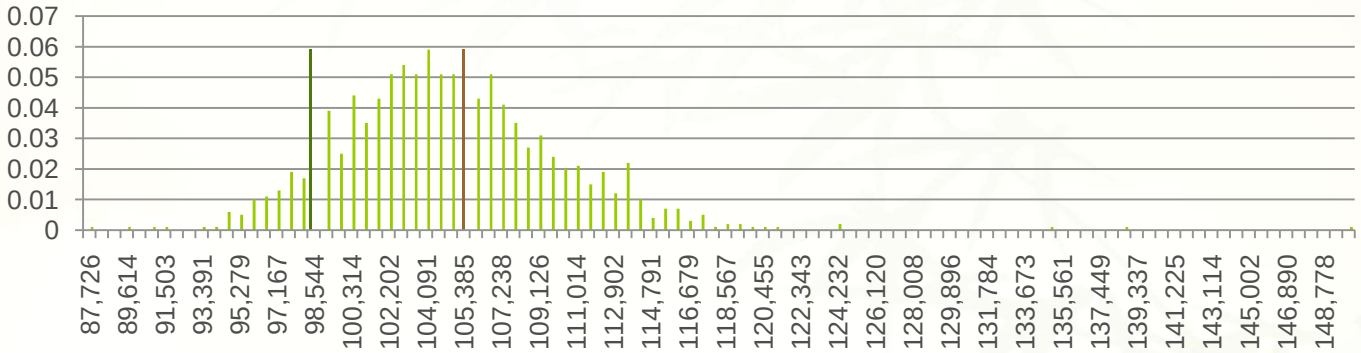
LOB	Policy #	U/Y	Risk Factor			
			SEVR_ID_1	SEVR_ID_2	SEVR_ID_3	SEVR_ID_4
XXX	FCTW004566	2012	A02	CB04	ZG04	*
Estimate			0.1402	-0.0964	2.0575	0

- Generate Gamma random variable by using average
  - Exp(0.1402 - 0.0964 + 2.0575)

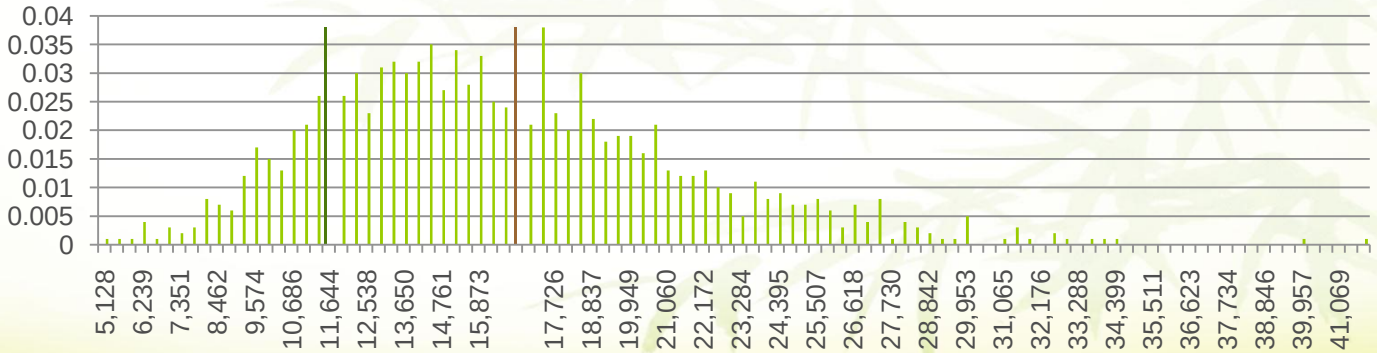
Example

- Simulation result

  - LOB1



  - LOB2



Example

Step 4 : Apply Retention Condition

□ Retention Conditions

- Retention structure (Scheme)

  o Automatically calculate the portion of retention

  o Remaining goes to retrocession

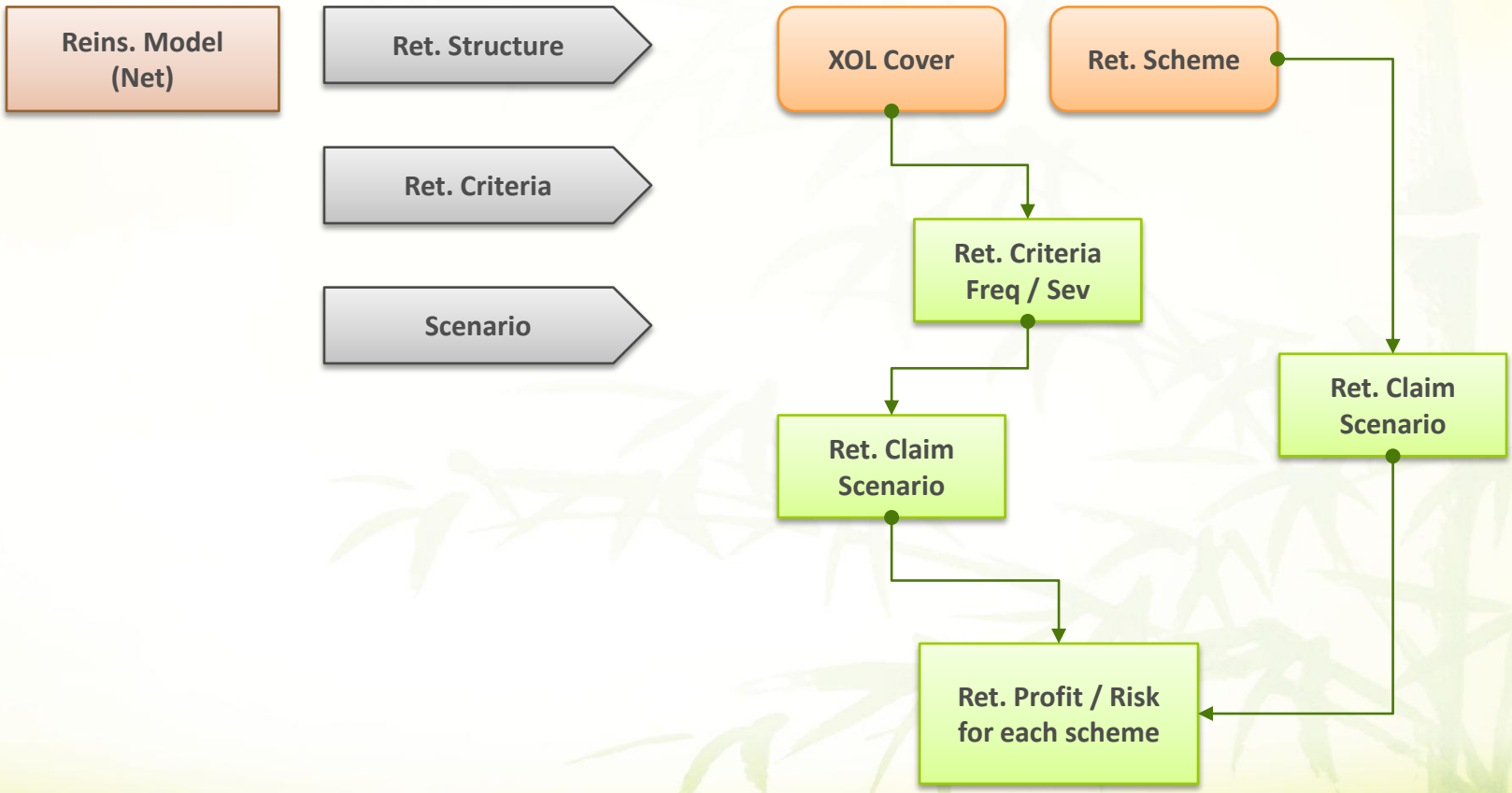
- XOL(Excess of Loss)

  o Apply XOL recovery for net retained claim

□ Various types of retention structures

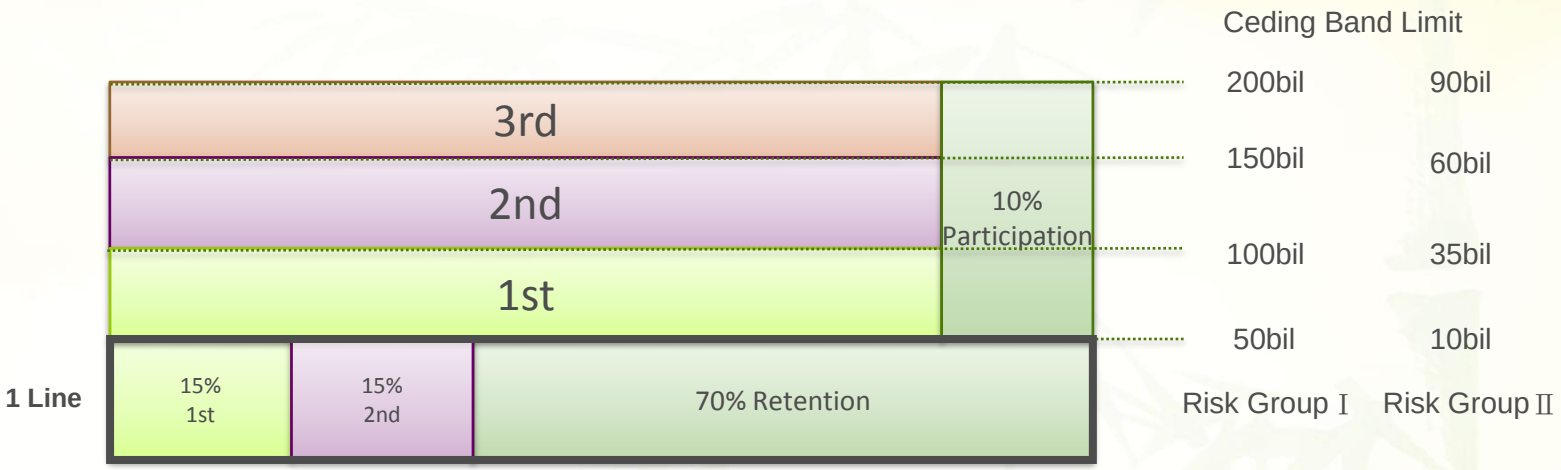
Example

Step 4 : Apply Retention Condition



Example

- Retention Structure (Complex case)



(Unit : Bil KRW)

	Risk Group I		Risk Group II		EPI	Event Limit
	TTY Limit	Line Limit	TTY Limit	Line Limit		
3rd	45	1	27	3	16	100
2nd	52.5	1	24	2.5	58	265
1st	52.5	1	24	2.5	77	265

Example

- Retention Structure (Simple)

Level	Code	Age	Ret %	Ret Limit
A1	B1	0 ~ 10	85%	35,000,000
		11 ~ 15	80%	35,000,000
		16 ~	60%	35,000,000
	B2	0 ~ 10	70%	40,000,000
		11 ~	60%	35,000,000
	B3	0 ~ 25	55%	35,000,000
		25 ~	35%	10,000,000
	B4	-	70%	15,000,000
	B5	-	70%	20,000,000
A2	-	-	70%	15,000,000
A3	-	-	70%	10,000,000

Example

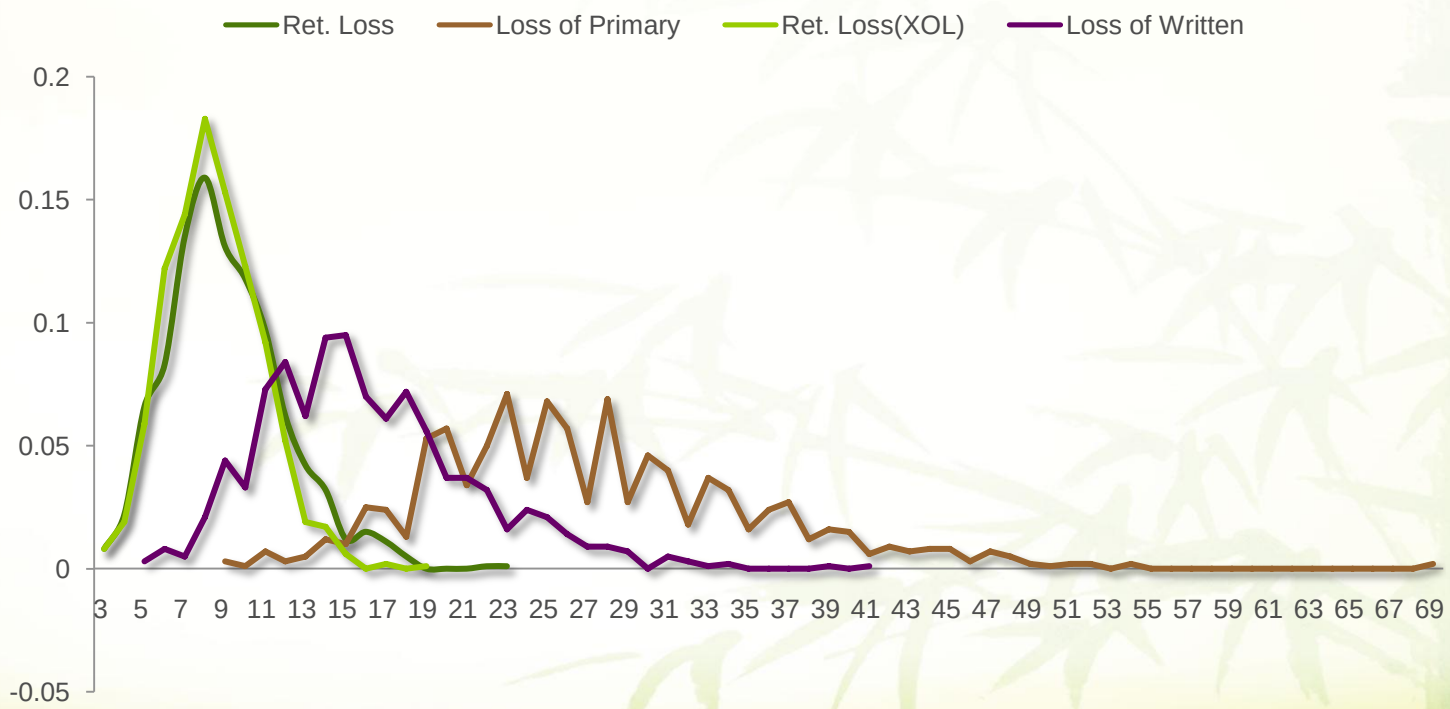
- XOL Structure

Layer	Limit	Attachment	Reinstatement
1	500,000	500,000	5
2	1,000,000	1,000,000	3
3	5,000,000	2,000,000	3
4	13,000,000	7,000,000	2
5	30,000,000	20,000,000	1
6	50,000,000	50,000,000	1

- Risk / CAT XOL

Example

- Change of Loss Distribution
  - After applying reinsurance condition



Example

Step 5 : Evaluation

□ Calculate Profit/Loss for each retention structure

- Premium, Claim and Commission
- XOL cost(incl. reinstatement) and recovery

□ KEY : ROC (Return on Capital)

- Measure of profitability
- Retained profit divided by VaR@99%

□ Choose a retention structure that maximizes ROC

Example

Step 5 : Evaluation

Ret. Structure	Premium	+/-	Claim	+/-	Profit	+/-	VaR 99%	ROC 99%
A	**136**		**87**		**21**		**56**	**0.38**
B	142	6	95	8	18	-3	59	0.31
C	136	0	91	4	17	-4	57	0.30
D	161	25	106	19	22	1	65	0.34
E	**177**	**41**	**115**	**28**	**25**	**4**	**69**	**0.37**

Further Considerations

- Capital allocation
  - Needed for optimization : Adjustment of Portfolio
  - Using RBC standard risk coefficient

Category	Coverage	Pricing risk coefficients
General	Fire, Engineering	26.8
	Package	31.2
	Marine	41.4
	Accident	30.7
	WC, Liability	12.0
	Others	39.8

Further Considerations

□ Capital allocation

Coverage	Ret Prem	Coeff (A)	Risk Amt	Profit Ratio(B)	B/A	Rank
Fire	1,859	26.8	497	12.4	46.3	③
Package	1,073	32.0	343	36.3	113.4	①
Marine	2,822	40.8	1,151	4.6	11.3	⑤
Accident	380	38.2	145	△8.9	△23.3	
Liability	1,871	14.4	270	9.6	66.69	②
WC	1,845	31.0	573	7.2	23.25	④
Guarantee	5,732	42.2	2,418	△2.9	△6.9	
Auto	7,504	17.3	1,295	2.8	16.2	
Life	10,592	18.2	1,923	△1.0	△5.5	

Further Considerations

- Modeling & Simulation using individual data
  - Vs. Grouping method
  - Due to computing hardware development
  - Can calculate the following :
    - Retained premium for each structure
    - XOL recovery
  - Diagnosis for high risk group

Thanks !

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