Operational Risk:

EVT **Models**

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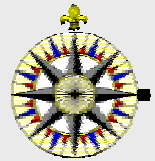
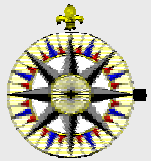
Presentation Outline



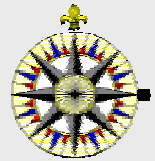
- Introduction (The Problem)
- Methodology Survey
- Extreme Value Theory
- Example
- Assumptions and Issues
- Summary

The Problem



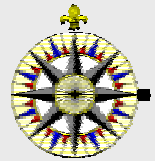
- What is the maximum amount of loss due to operational risk that can be expected in a specific business unit over a period of one year at a very high confidence level (e.g. 99%) ?

The Environment



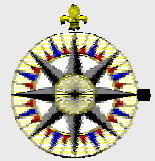
- Business unit with no market or credit risk.
- Processes composed of people, systems, and infrastructure.
- Business model is based on earning fees for services.
- Value is added to individual transactions.

Approach to Methodology



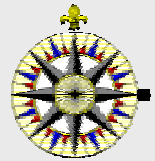
- Factor approach
  - Identify key indicators and relationships to losses.
  - Use a factor model to calculate the capital requirement directly, (e.g. 12% of income).
- Delta approach
  - Calculate volatility of profits using error propagation technique that relates volatility of profits to volatility of key indicators using sensitivities.
  - Choose a factor on profit volatility based on distributional assumption (normal or lognormal) and required confidence interval, plus a ‘fudge’ factor.

Approach to Methodology



- Loss model
  - Record losses made and fit a parametric distribution to their severity and one to their frequency.
  - Use simulation to create cumulative loss distribution for the period based on frequency and severity.
  - Choose quantile of resulting distribution, plus a ‘fudge’ factor

Delta Method



- Factor model that is predictive.
  - Uses measure at hand and linear relationship to predicts measure not at hand.

$$\Delta p = \frac{\partial p}{\partial f} \Delta f$$

- Theory
  - Partial differential equations (PDE's).
- Example
  - Change in interest rate used to predict change in bond price.

Delta Method

- Assumption
  - Causal relationship between measured indicator and predicted measure.
  - Linear relationship (approximated)
- Advantages
  - Predictive
  - Understandable
- Disadvantages
  - Factor interactions
  - Non-linear relationships
  - Unknown factors

Loss Models

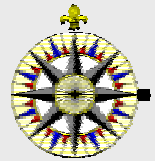
- Use historical results to predict future values of a measurement based on an intrinsic regularity and symmetry of underlying system.

- Theory

$$x_{t+1} = \Phi\{x_{t-n}, \ldots x_t\}$$

  - Statistical distributions
- Example
  - Yearly claims loss of automobile insurance business for defined set of policy characteristics.

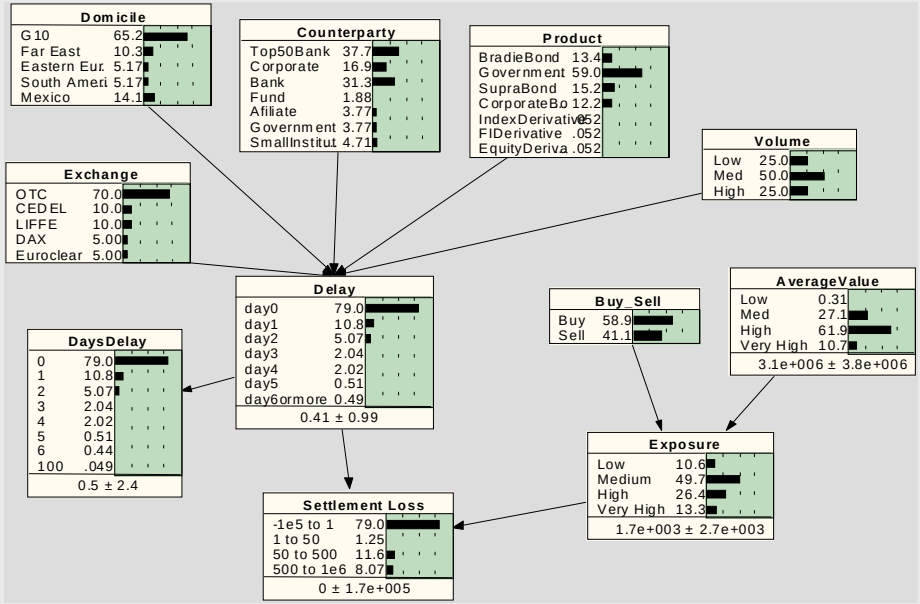
Loss Models



- Assumptions
  - Underlying regularity and symmetry are known and stable.
- Advantages
  - Allows prediction without understanding causes.
  - Large samples tend toward a regularity and symmetry.
- Disadvantages
  - Irregularity and shocks to the system.
  - Not easily influenced because no known causes.
  - ‘Post-predictor’ that is insensitive to outliers.

Advanced Models -- Causal Models

- Causal Models
  - Advantages of factor model
  - Non-linear relationships
  - Mitigates interrelationships of factors

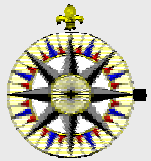


Extreme Value Theory Approach

- Loss Model
  - Uses one of the extreme value distributions for severity distribution.
  - Fits distribution based on extreme events only.
- Generalized Pareto Distribution (GPD)
  - Fits the excess losses above a threshold.

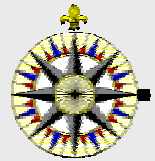
$$GPD(x) = \left((1+\xi)\frac{x - threshold}{\beta} \right)^{-1/\xi}$$

Advantages of EVT Loss Models



Data:	Only need large losses (not all losses).
Analysis:	Not influenced by volume of small losses.
Theory:	Well-founded theory beginning with Fisher-Tippet.
Application:	Widely applied in physical sciences (damns, dykes, reliability).

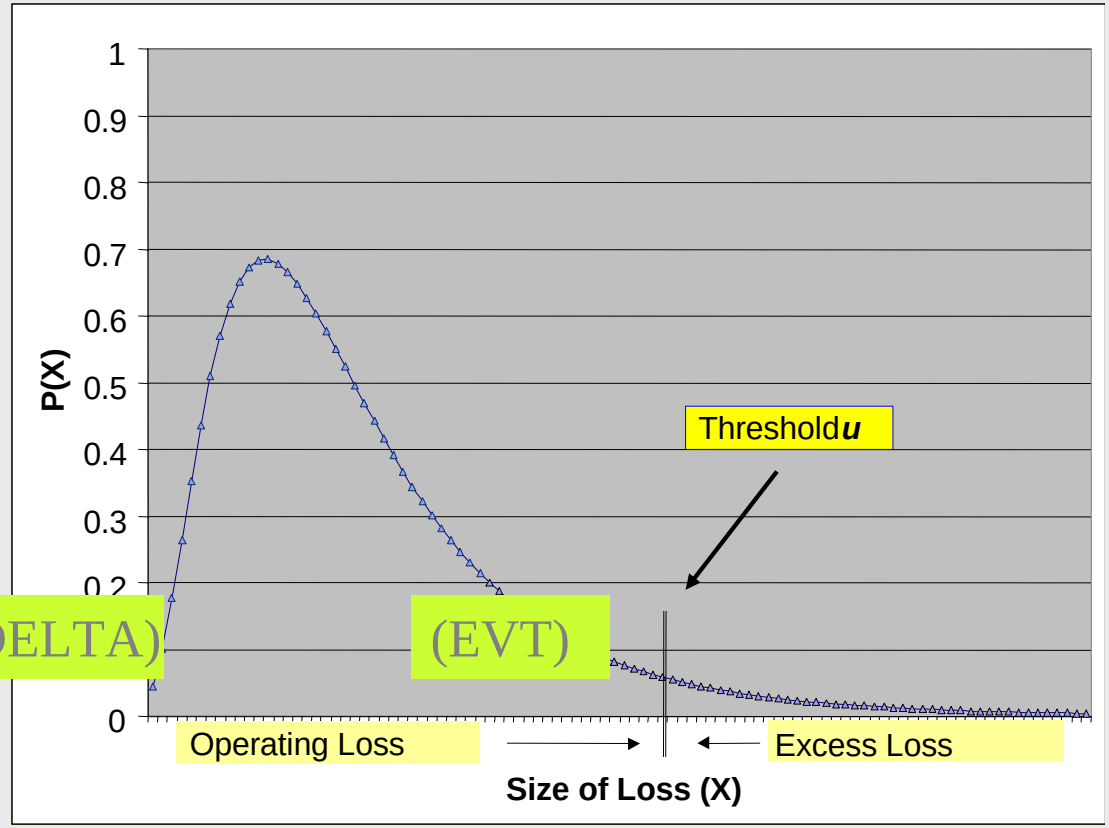
Advanced Model -- Delta-EVT™



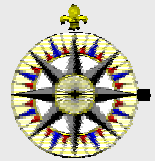
- Uses the Delta factor model for high frequency, low severity losses.
- Uses EVT loss model for low frequency, high severity losses.
- Combines the two approaches using the threshold value for large losses.

Delta-EVT™ Combination Methodology

- Combines Delta and EVT to link performance of the business to the losses and provide a built-in validation of capital charges.



Example (Genoa Bank)



- Business Unit Description
  - Profit center in financial services
  - No market or credit risk
- Problem
  - What is the maximum amount of loss due to operational risk that can be expected in a this business unit over a period of one year at a very high confidence level (e.g. 99%) ?

Example Business Process

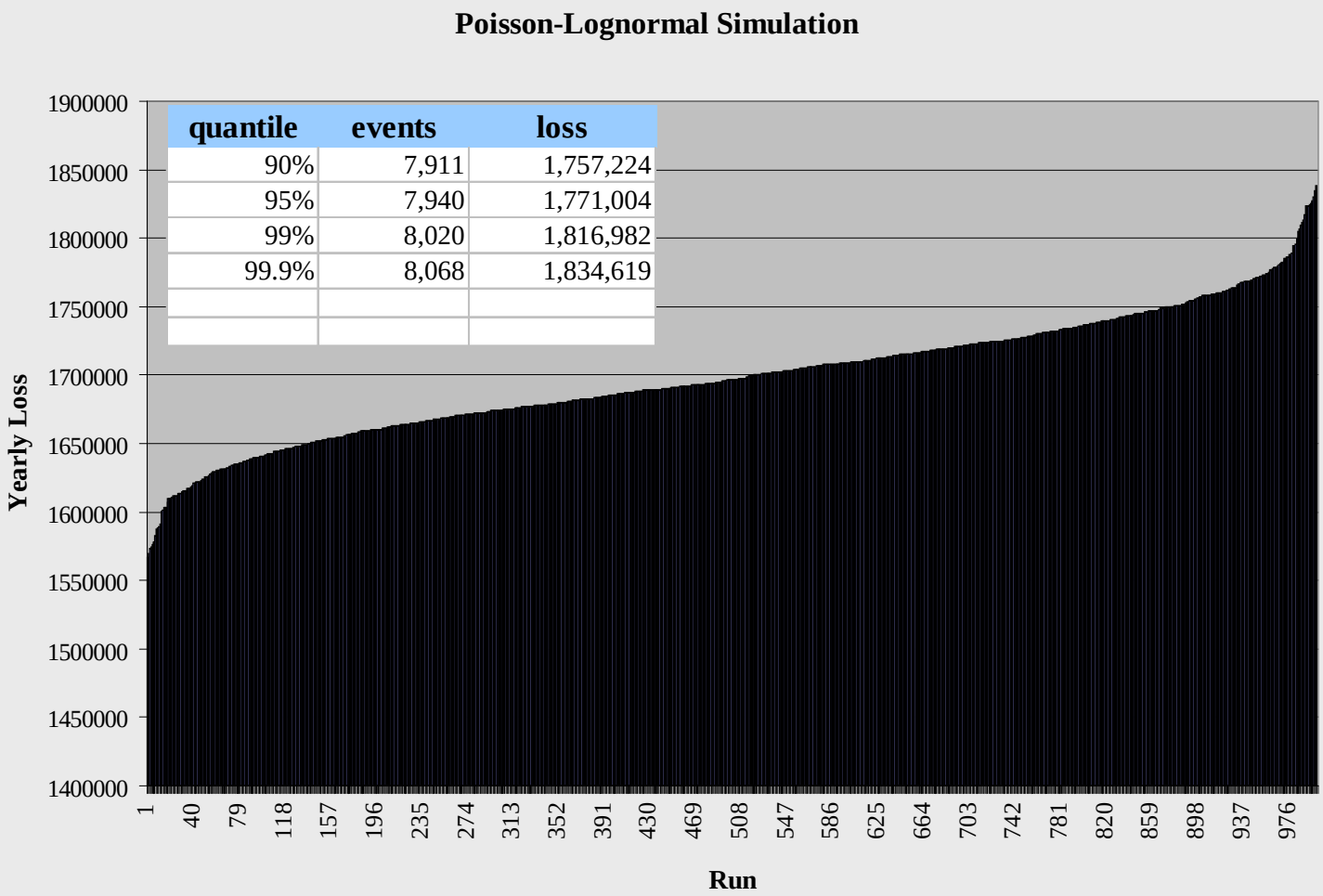
Business Process		
Transactions/day	1,000	
Transactions/year (1)	260,000	
Average transaction value	200,000	€
Transaction margin	100	bp
Transaction net value	200	€
Net per year	52,000,000	€
Proposed capital ratio	12%	
Capital Required	6,240,000	€

(1) 260 days/year

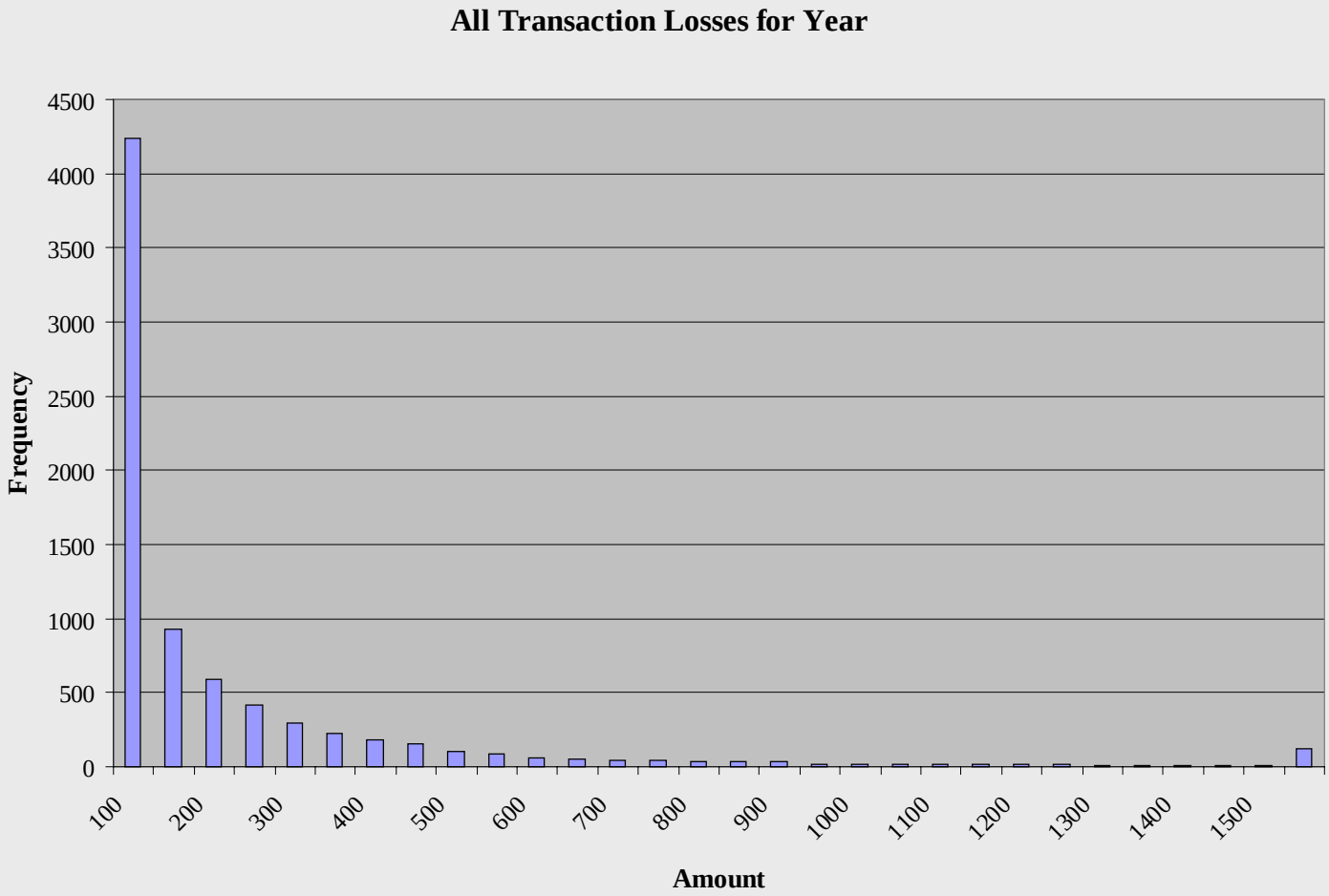
Example Delta Loss

Delta Loss			
Loss rate	3%		
Loss transactions/day	30		
Loss transactions/year	7,800		
Average loss/loss transaction	200	€	
Average total loss/year	1,560,000	€	
But:	$\sigma = 500$	€	(~lognormal)
And actual year's loss is:	5,529,860	€	

Poisson-Lognormal Simulation

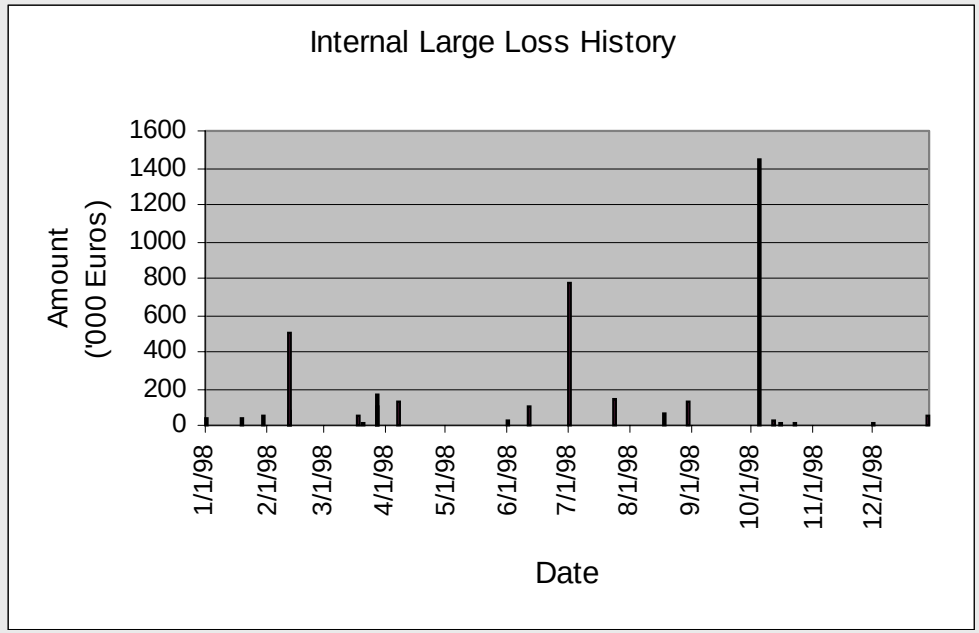


Example Loss History



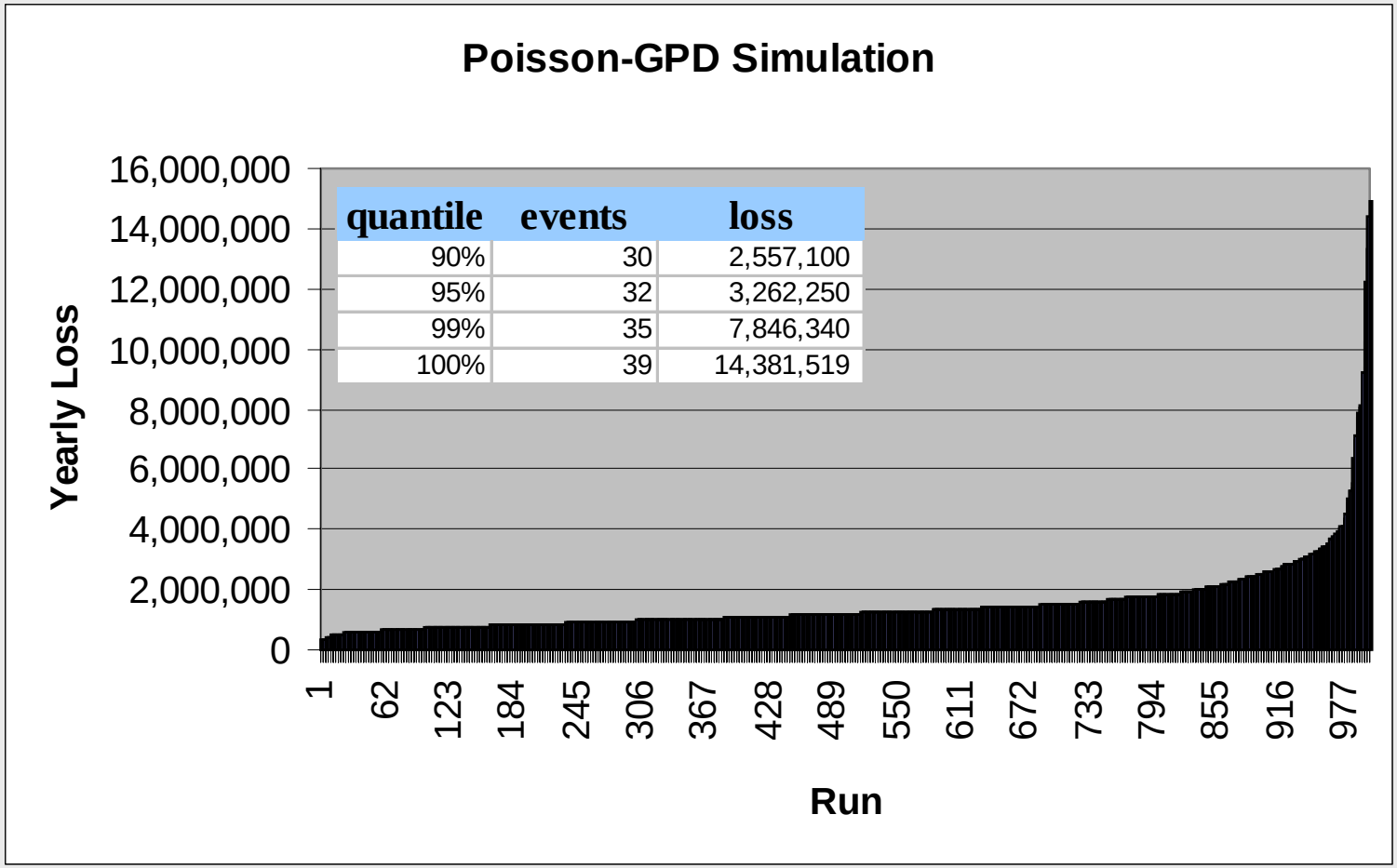
Large Losses

ID	Date	Amount ('000)	Loss
1	01/01/98	-35.1	35
2	01/19/98	-40.0	40
3	01/30/98	-55.0	55
4	02/11/98	-80.9	81
5	02/12/98	-508.0	508
6	02/17/98	-3.5	4
7	03/18/98	-48.8	49
8	03/20/98	-12.0	12
9	03/27/98	-168.9	169
10	03/27/98	-98.0	98
11	04/07/98	-128.0	128
12	06/01/98	-21.6	22
13	06/11/98	-100.0	100
14	07/01/98	-770.0	770
15	07/24/98	-142.0	142
16	08/18/98	-61.5	62
17	08/30/98	-129.4	129
18	10/05/98	-1450.0	1450
19	10/12/98	-30.0	30
20	10/15/98	-17.0	17
21	10/22/98	-8.0	8
22	11/30/98	-12.0	12
23	12/28/98	-50.0	50



Total of large losses is € 3,969,700

Poisson-GPD Simulation Results



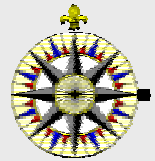
quantile	events	loss
90%	30	2,557,100
95%	32	3,262,250
99%	35	7,846,340
100%	39	14,381,519

Summary Results

Summary of Yearly Losses in Business Unit at High Confidence Levels						
	In Control (Poisson-Lognormal)		Out of Control (Poisson-GPD)		Total	
Quantile	events	loss	events	loss	events	loss
90%	7,911	1,757,224	30	2,557,100	7,941	4,314,324
95%	7,940	1,771,004	32	3,262,250	7,972	5,033,254
99%	8,020	1,816,982	35	7,846,340	8,055	9,663,322
99.9%	8,068	1,834,619	39	14,381,519	8,107	16,216,138

(Factor model using 12% of income was € 6,240,000)

Assumptions and Issues

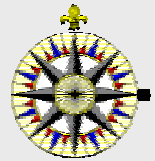


- Delta Model
  - There is little affect from the mean loss figure. Most of the information is found in the volatility (sigma). The calculation of the volatility of the losses does not need large losses (or any losses), but needs to be validated using a sample of losses.
  - Is not affected by large losses (or any previous losses for that matter).

Assumptions and Issues

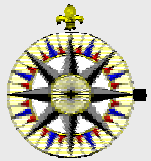
- Lognormal Loss Model
  - Contributes little to the delta methodology when there is a large sample of losses available, since most of the information is present in the volatility of the losses.
  - Could be used for validation of delta method, or reduced to a small sample size.
  - Is not affected by the inclusion of large losses when the sample size is large.

Assumptions and Issues

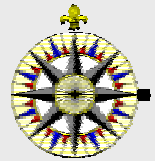


- EVT Loss Model
  - Captures the effect of large losses and shows an order of magnitude difference in the use of a delta or lognormal loss model when large losses are present.
  - Has little affect on the average loss or loss volatility, and does not account for losses below the threshold.

Summary



- A complete loss database is not required to develop a delta model or parametric loss model when a large number of losses are available and large losses are excluded from the model.
- EVT models are needed to handle situations where large losses are present (e.g. losses that lie outside any reasonable confidence limit of the delta or parametric loss model).



Operational Risk:

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