Credit Risk Modelling and Analysis in Practice

Abbreviated Handout Version

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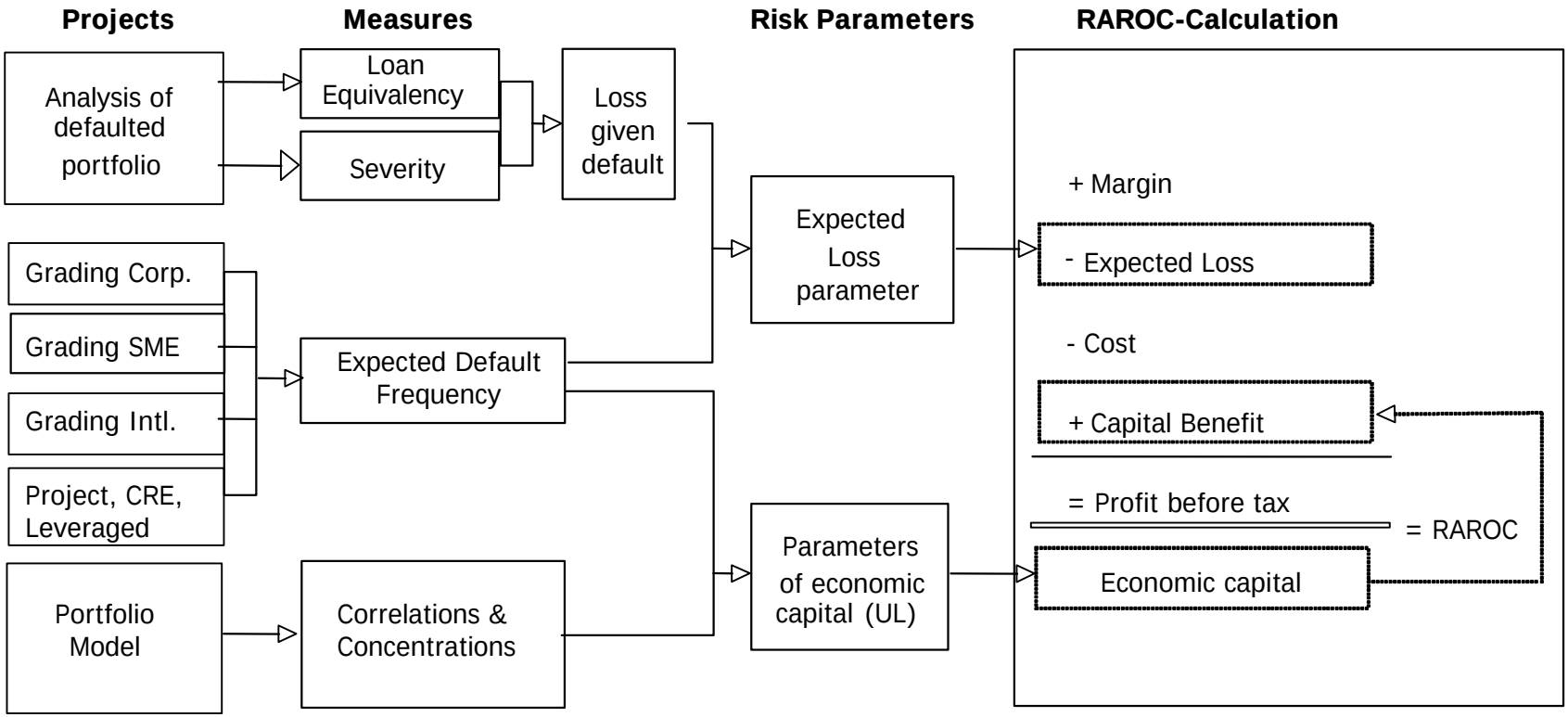
Overview

- Basic concepts
- Level 1: The rating model
- Level 2: The portfolio model
  - Sidestep: Using simulation models
  - Parameter effects
- Portfolio management

Basic concepts: Risk vs. Return

TO APPLY RAROC ACROSS THE CREDIT BOOK WE NEED TO KNOW THE PARAMETERS



Level 1 - The rating model: Major steps

1) Analysis of portfolio / Requirements

2) Building of model

3) Implementation / Institutionalization

Level 1 - The rating model: Requirements

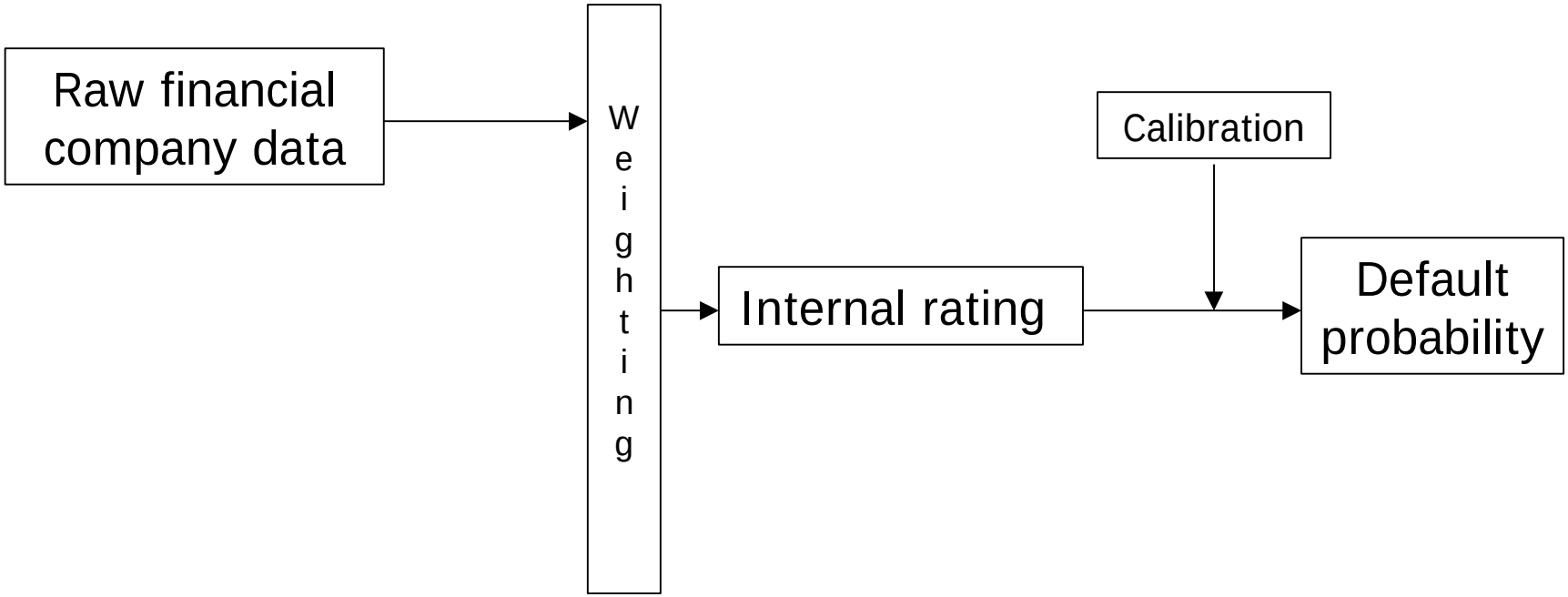
- Analysis of portfolio structure

		Region			
		Domestic	**Developed Markets**	**Emerging Markets**	**Eastern Europe**
Client	**Private**	**x**			**x**
	SME	**x**			**x**
	Corporates	**x**	**x**	**x**	**x**
	Leveraged	**x**			
	Financials	**x**			
	Project & R. Estate	**x**			
	Countries		**x**		

- Determine level of detail / seperate modelling

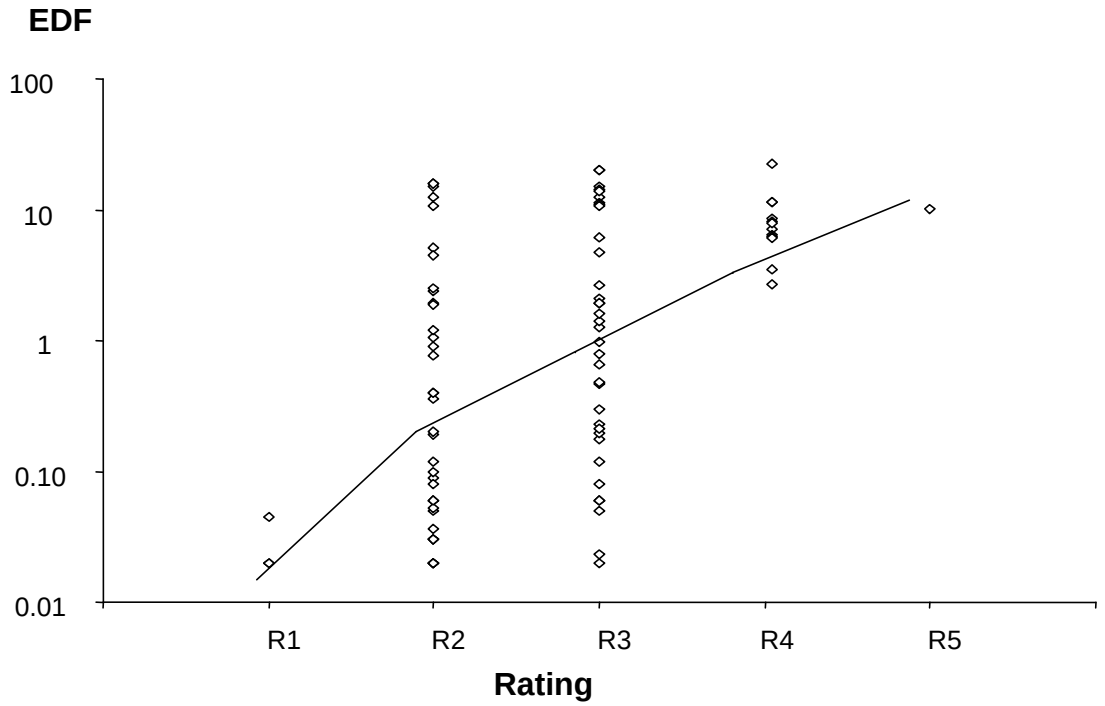
Level 1 - The rating model: Building of model

The short way: calibrating the old model



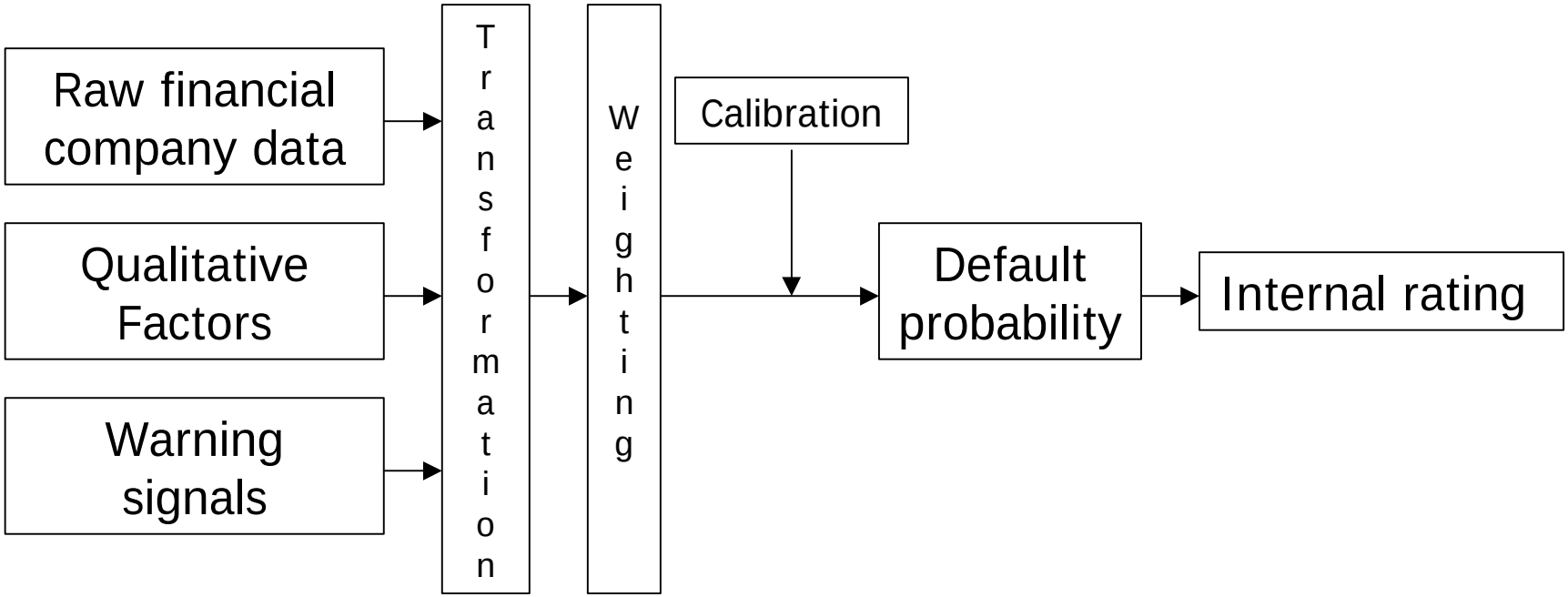
Level 1 - The rating model: Building of model

But: Usually large overlaps can be observed



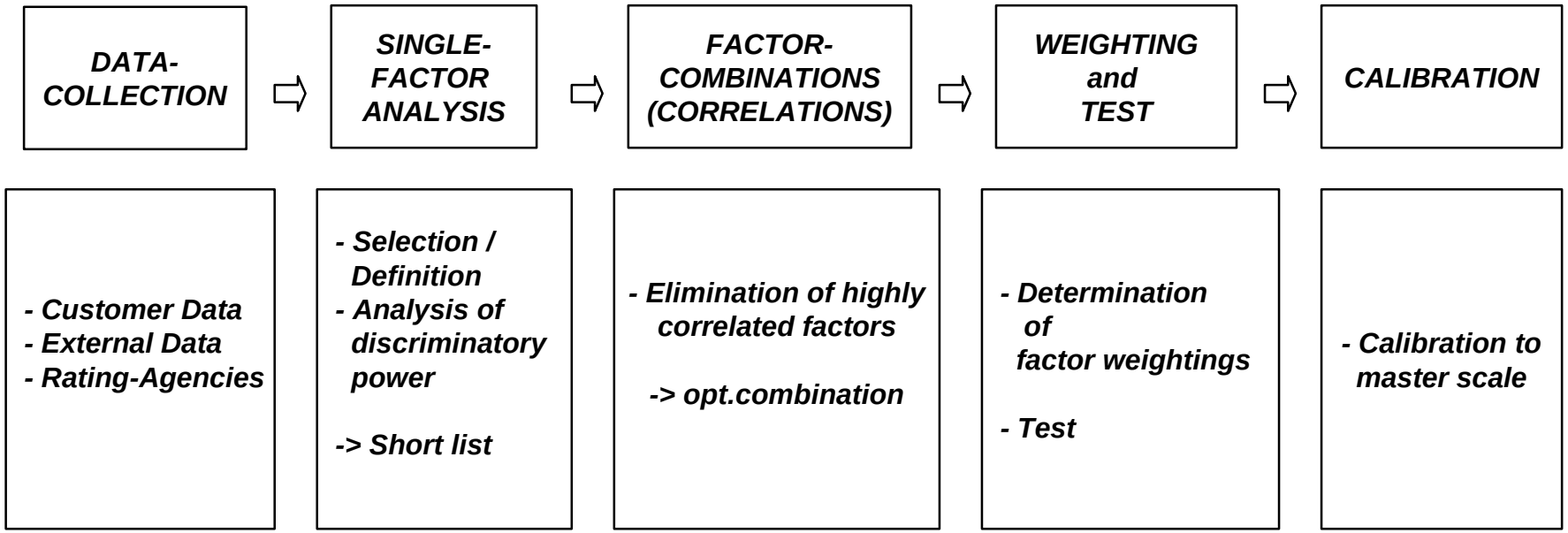
Level 1 - The rating model: Building of model

Building a new model



Level 1 - The rating model: Building process

The necessary steps for building a statistical rating model are:



Level 1 - The rating model: Theory

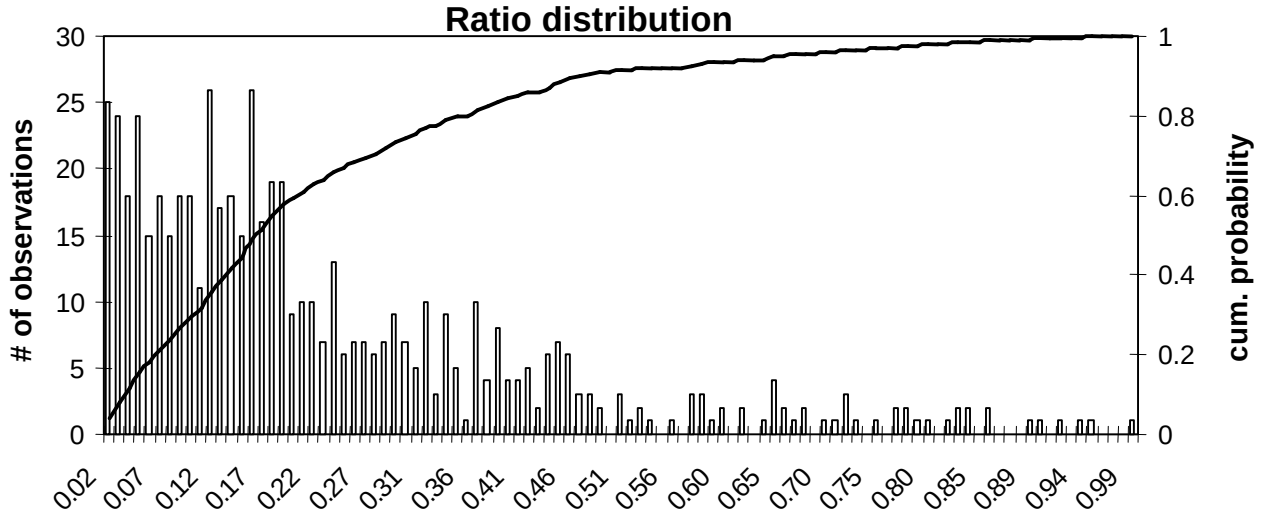
$P_k = f_k(R_k) \; \forall k \in [1..K]$ - Determine transformation function for each ratio

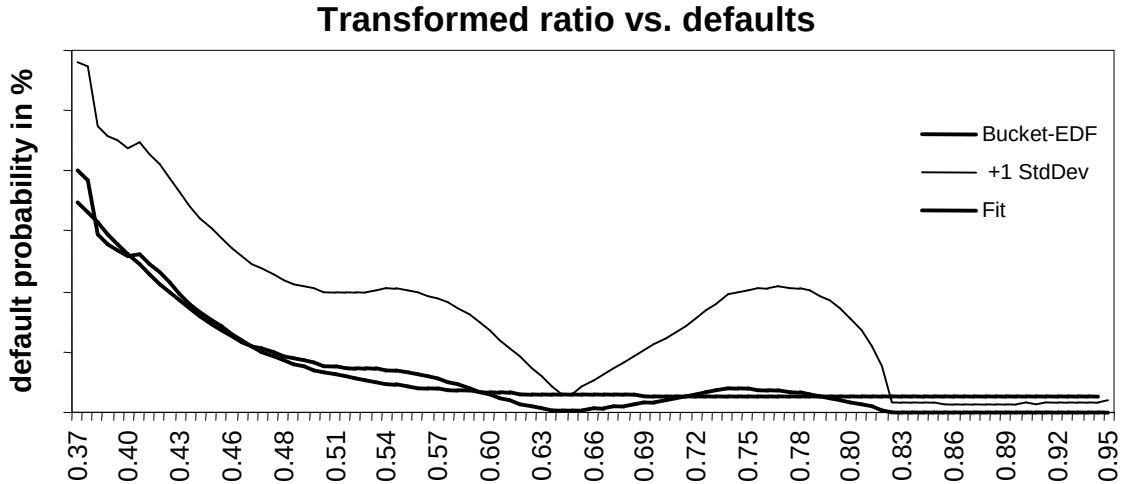
with R_k financial / economic ratio
K total number of ratios

$P = \tilde{f}(P_k)$ - Find optimal parametrization for the sample space

$p_i = f_P(P_i)$ - Calibrate to get default probabilities for each company *i*

Level 1-The rating model: Practice





Level 1 - The rating model: Building process

The rating system should be the result of a combination of statistical analysis and expert discussions ...

STATISTICAL ANALYSIS:

Measure predictive power of ***single factors***

Identify optimal weights for ***combining*** highly predictive and economically important factors (multi-linear regressions)

Compare various ***models*** with high discriminatory power, according to economic criteria

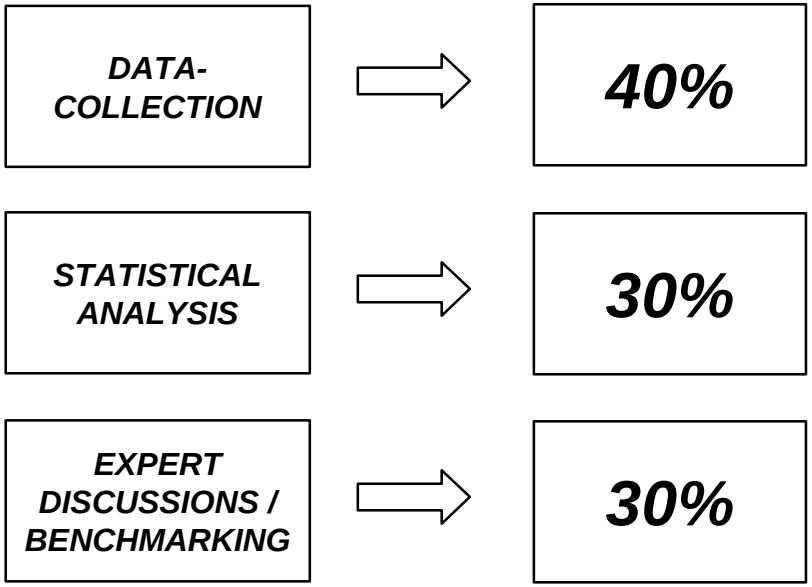
EXPERT DISCUSSIONS:

- Accounting Experts
- Research Group
- Risk Management
- External benchmarks
- Experience

. . . SINCE THERE EXISTS LIMITED DATA, EXPERT DISCUSSIONS PLAY AN ESSENTIAL ROLE

Level 1 - The rating model: Time consumption

Building several rating models has shown a common profile:



Level 1 - The rating model: Implementation

A) Building of IT-application:
- centralized data warehouse in uniform format
- modular system
- usage throughout the whole bank

B) Definition of "Rating Rules" (guideline)

C) Installation of rating-process

Time Horizon: 7 - 9 months

Level 2 - The portfolio model: Major steps

1) Specification of portfolio-model

2) Data collection

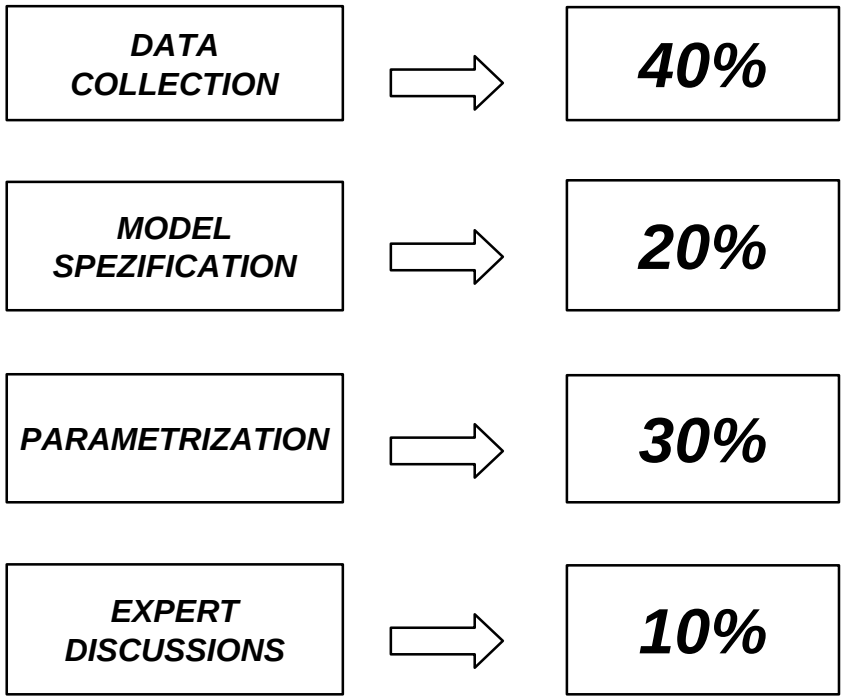
3) Parametrization

4) Prototype for reconciliation and structuring

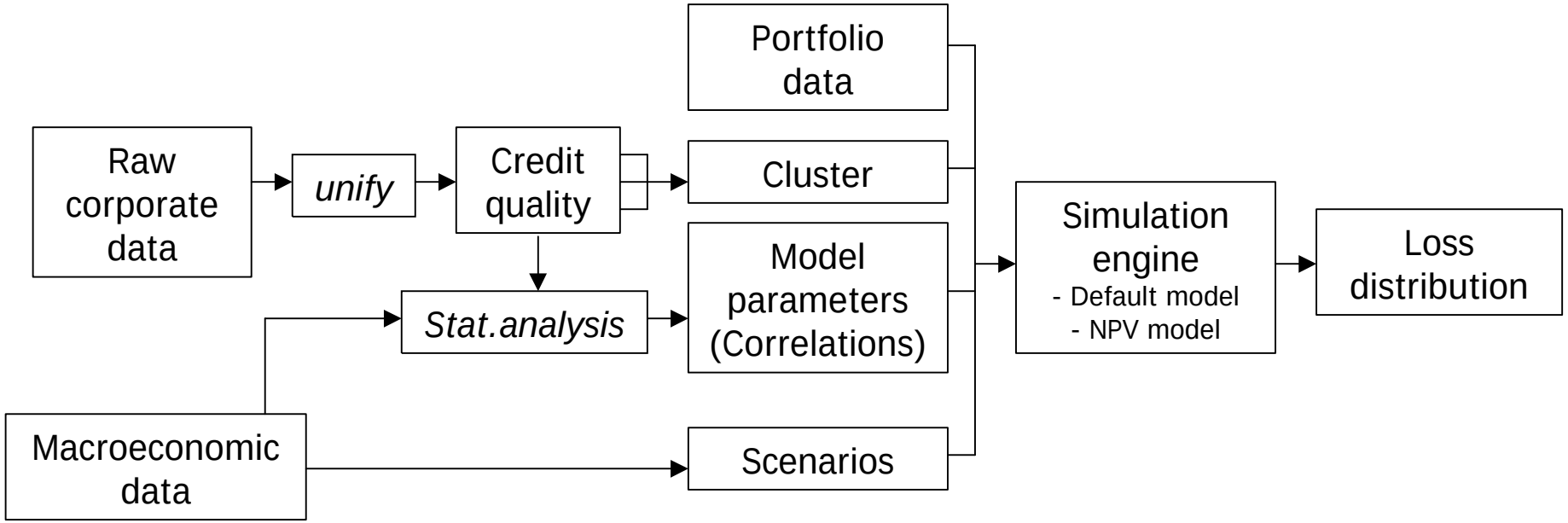
5) Implementation and reporting

Level 2 - The portfolio model: Time consumption

Data collection and parametrization are the most important steps



Level 2 - The portfolio model: The process



Level 2 - The portfolio model: Theory part 1

- Start with the unconditional default probability of obligor *i* ...

$$p_i(t) = \Pr\{t_i \le t\} \quad \text{, with } t_i \text{ time of default}$$

... and transform it into an unconditional credit quality

$$c_i = \Phi^{-1}(p_i)$$

- A change in orthogonal economic factor returns m_j results in a change in credit quality ...

$$d_i(t \mid m(t)) = \sum_{j=1}^{M} b_{ij} \cdot m_j(t) + s_i \cdot e_i \quad ; \; m, e \sim iid\ N[0,1]$$

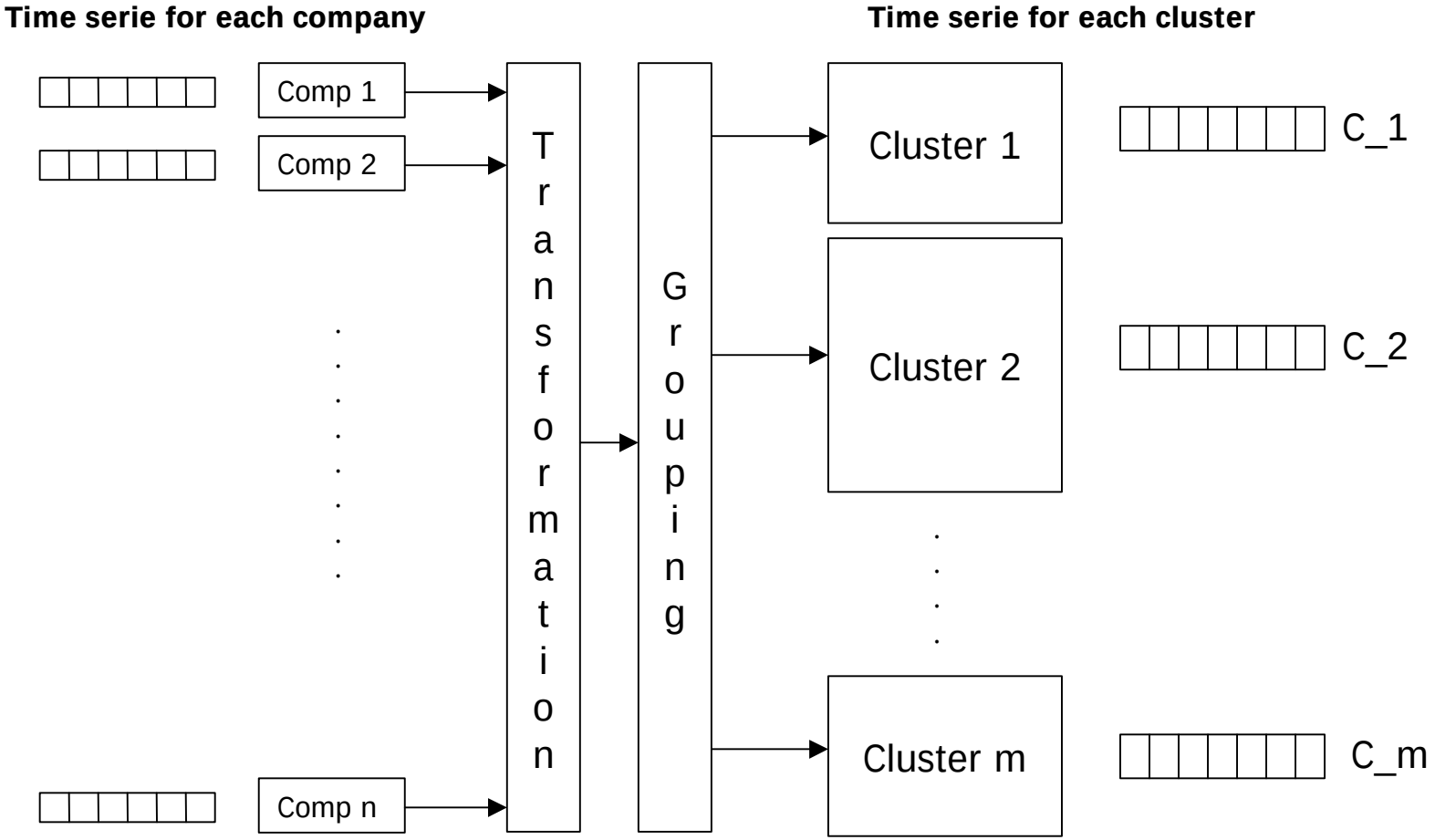
$$s_i = \sqrt{1 - \sum b_{ij}^2}$$

... which leads to a conditional default probability for each scenario

$$p_i(t \mid m(t)) = \Pr\{t_i \le t \mid m(t)\} = \Phi\left(\frac{c_i - \sum b_i \cdot m(t)}{s_i}\right)$$

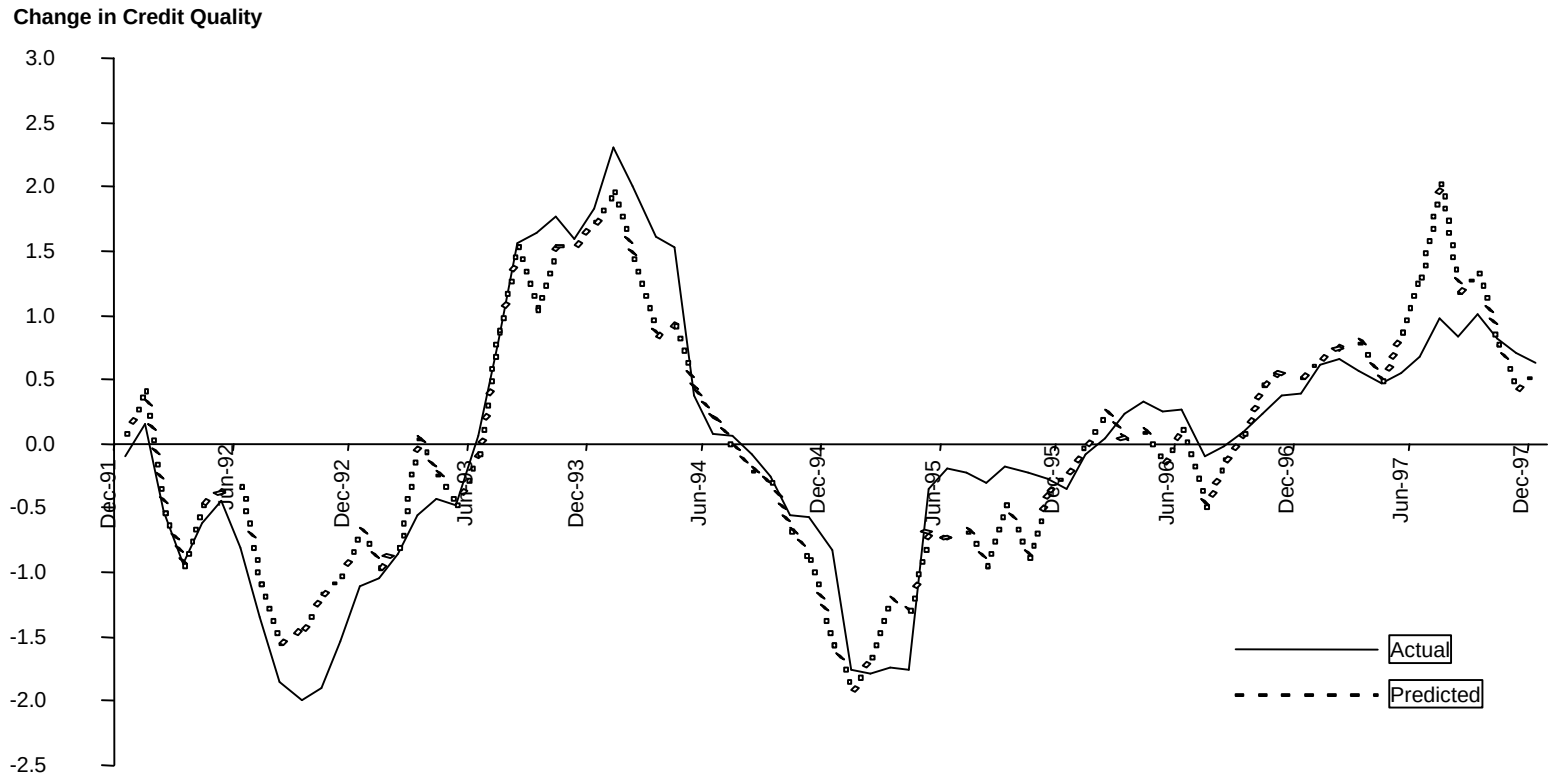
Level 2 - The portfolio model: Clustering

- Grouping companies into clusters reduces complexity dramatically



Level 2 - The portfolio model: Macroeconomic factors

Clusters responded well to the macro-economy



Level 2 - The portfolio model: Theory part 2

- After modelling default probabilities we need to focus on exposure

$$LGD_i(m(t)) = X_i(m(t)) \cdot [1 - h_i(m(t))]$$

with X_i conditional exposure of obligor *i*
h_i conditional recovery rate

- Now we can calculate conditional loss distributions for each obligor resp. for the whole portfolio

$$\Pr\{x < Loss_i < y \mid m\} = L_{i|m}(y) - L_{i|m}(x)$$
$$\Pr\{x < Loss_{PF} < y \mid m\} = L_{PF|m}(y) - L_{PF|m}(x)$$

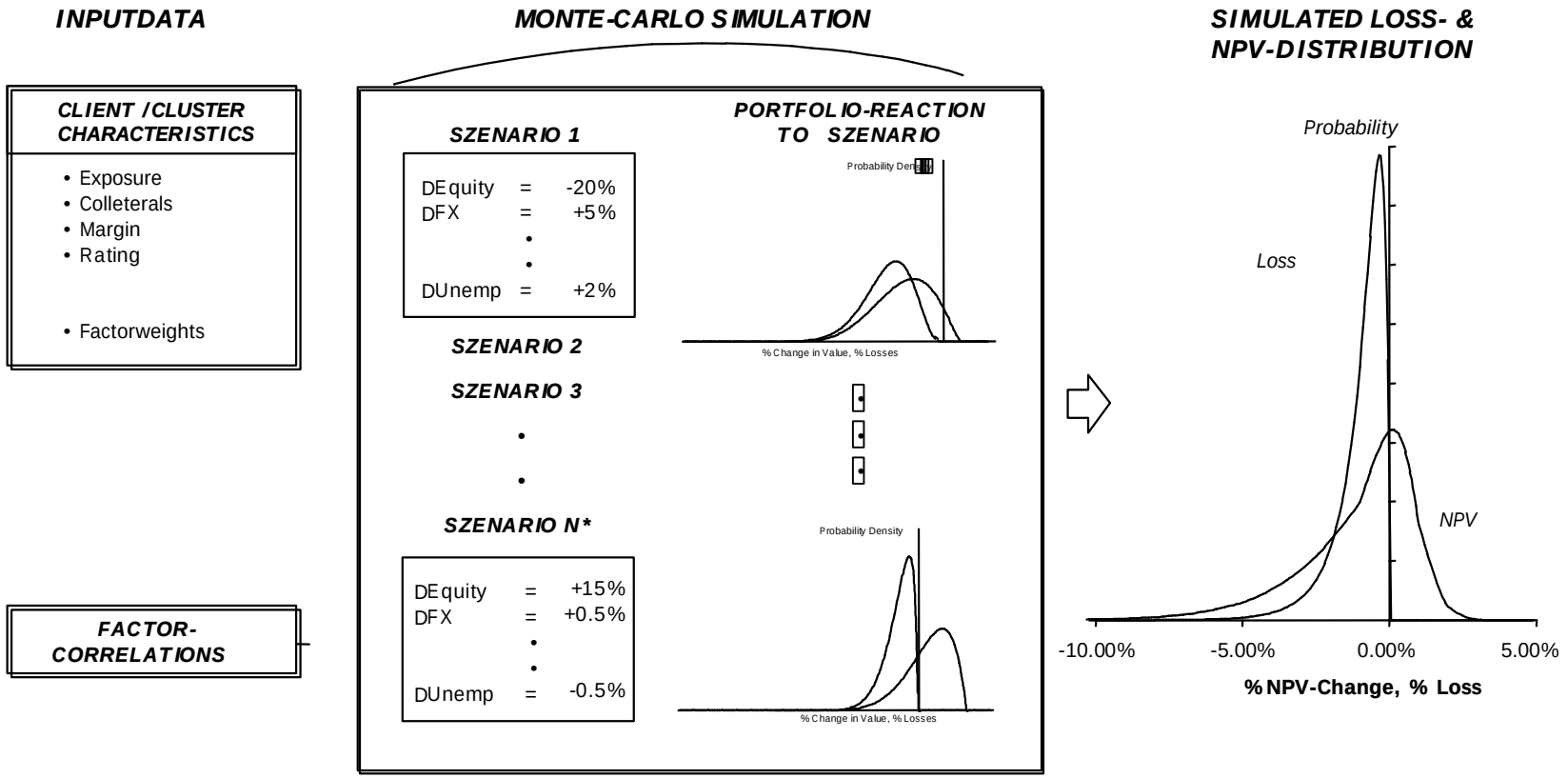
Full monte carlo simulation leads finally to the portfolio loss distribution

$$\Pr\{x < Loss_{PF} < y\} = \int_m \Pr\{x < Loss_{PF} < y \mid m\} dq(m)$$

with *q(m)* pdf of scenarios

Level 2 - The portfolio model: Simulation Framework

The loss distribution is generated with a Monte-Carlo-Simulation of the underlying macro factors



Sidestep - Using simulation models

To determine complete loss distribution:

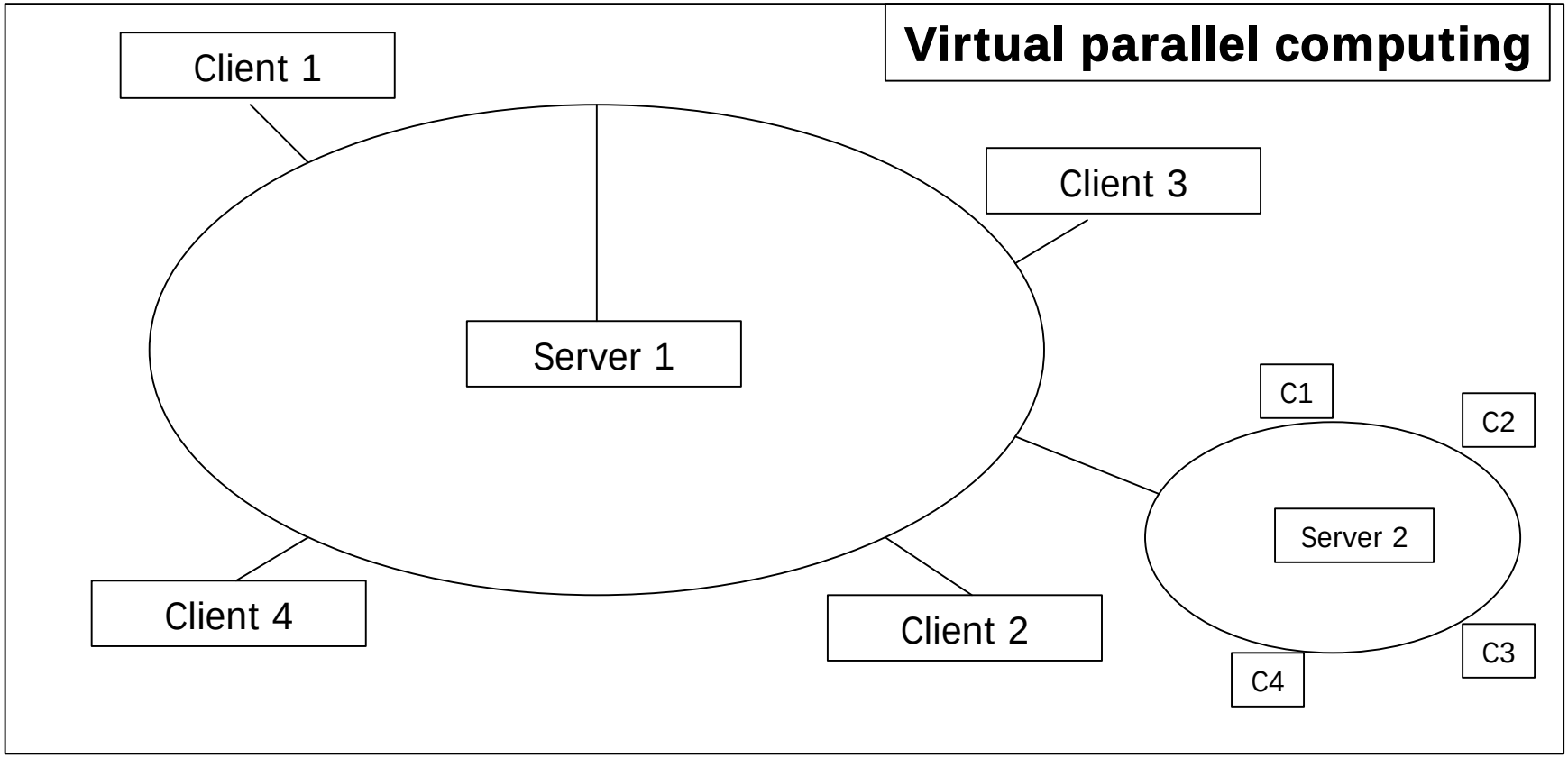
- Usually calculation of 10.000s scenarios necessary (even with sophisticated sampling techniques)

$\Rightarrow$ compared to analytical solutions a little more time consuming

But:
- Calculation can easily be "distributed"
- Results are much more transparent
- Illiquid portfolios can be modelled
- Much higher flexibility

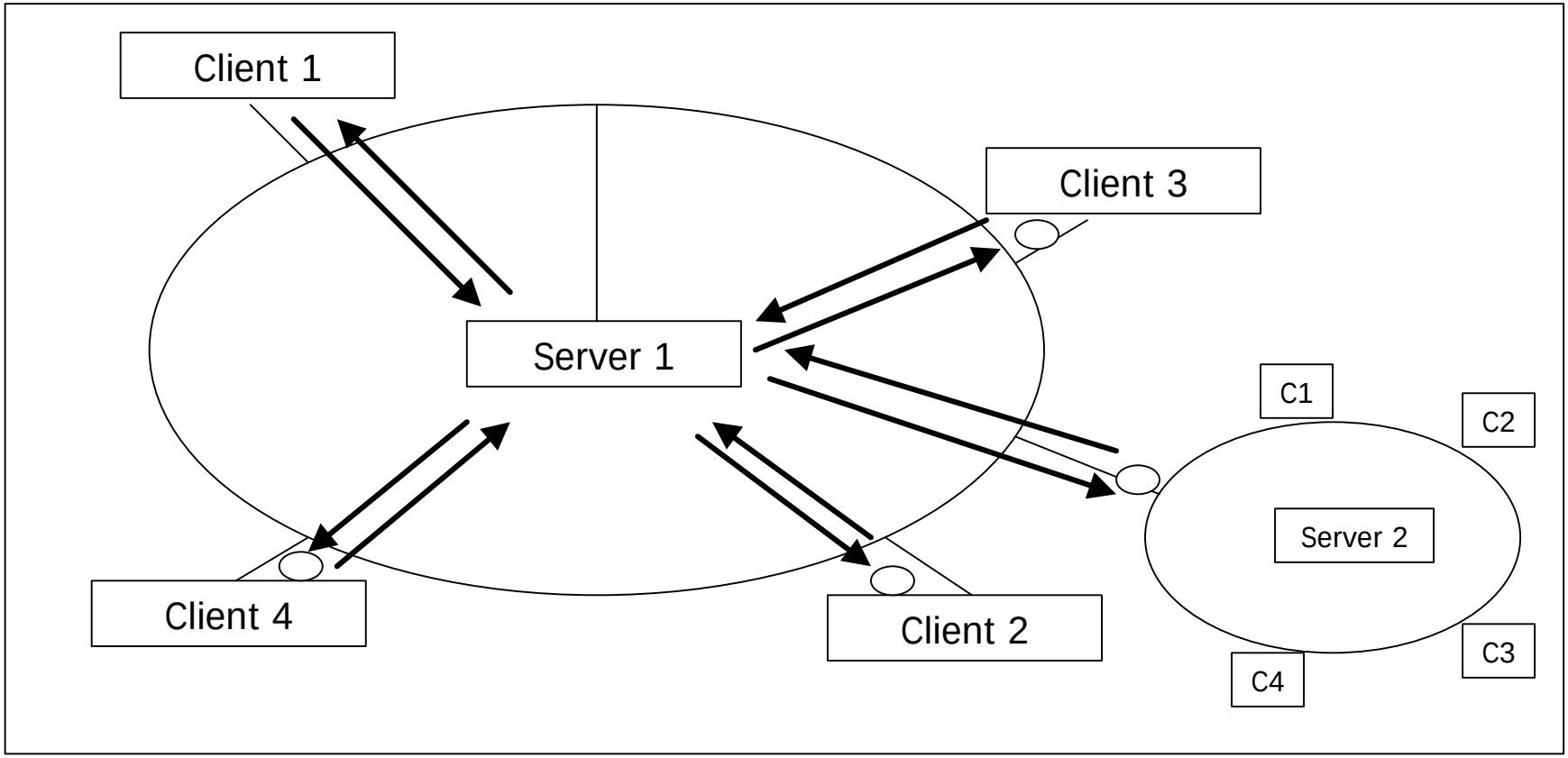
Sidestep - Using simulation models

Using intranet-technology increases speed enormously...



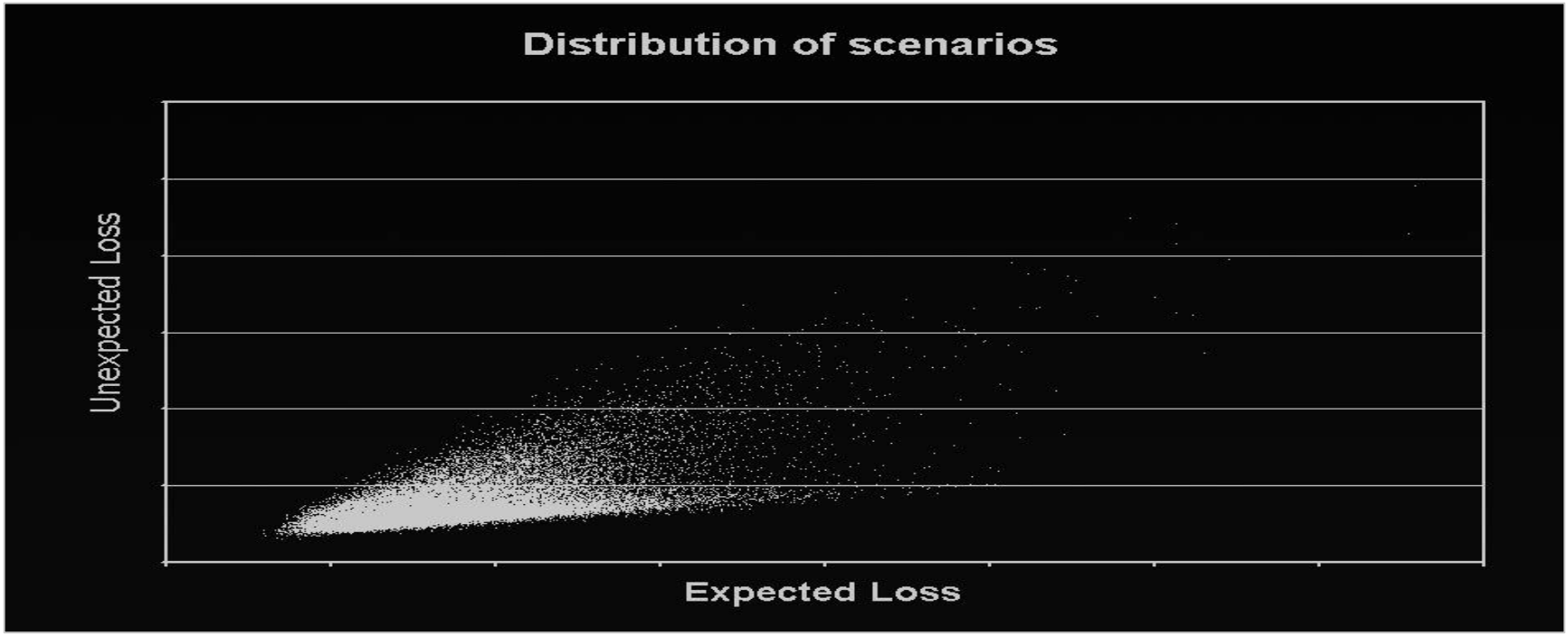
Sidestep - Using simulation models

- A **C**lient-**S**erver-**C**lient concept coordinates calculations throughout the whole network



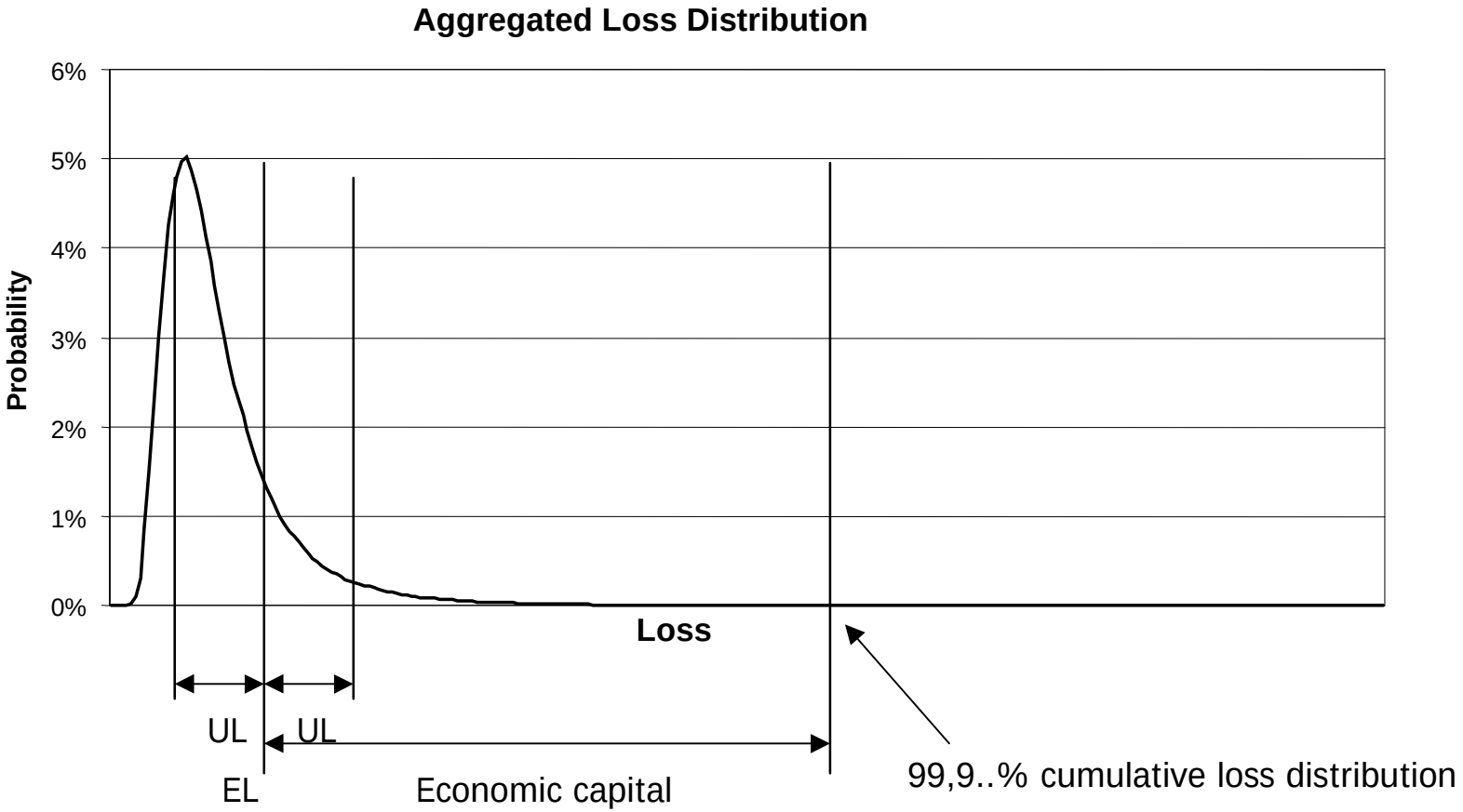
Sidestep - Using simulation models

Each scenario leads to a conditional expected and unexpected loss



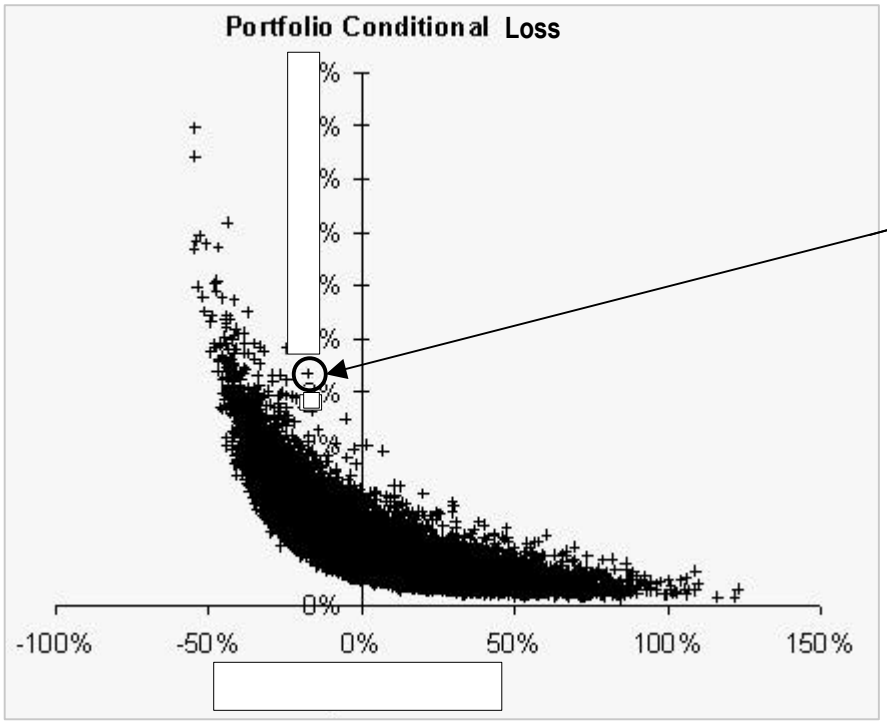
Level 2 - The portfolio model: Loss Distribution

To determine the discrete loss distribution all scenarios are aggregated



Level 2 - The portfolio model: Sensitivity Analysis

Dramatic changes in macro-economic factors can result in extremely high losses.

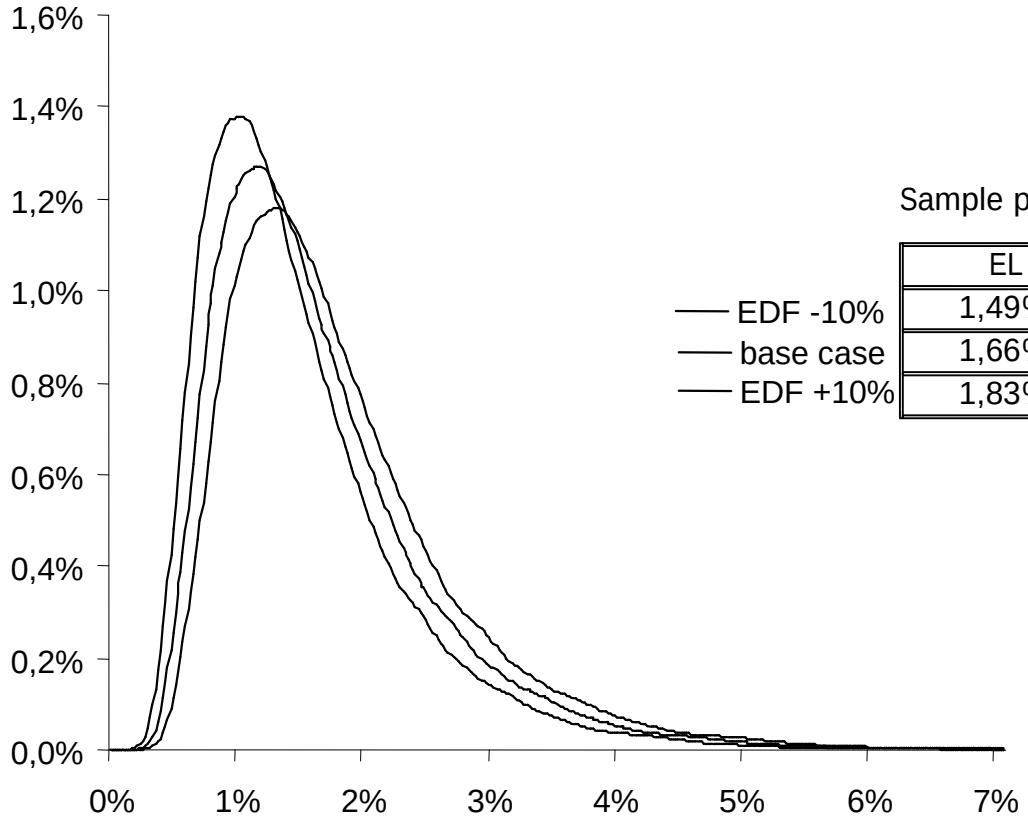


S&P	+xx%
Trade-weighted EURO	+xx%
Raw materials index	-xx%
EURO ST-IR	+x,x% absolut

Conditional Loss x.x%
Probability 0.25% (1x all 400 years)

Parameter effects: EDF

Sample calculations help to point out influences of parametrization...



Sample portfolio size: 300 Mrd ATS

	EL	UL	Capital AA
EDF -10%	1,49%	0,82%	6,08%
base case	1,66%	0,88%	6,39%
EDF +10%	1,83%	0,93%	6,66%

Parameter effects: Correlation vs. stochastic severity

Changes in correlation also have high impact on UL and capital ...

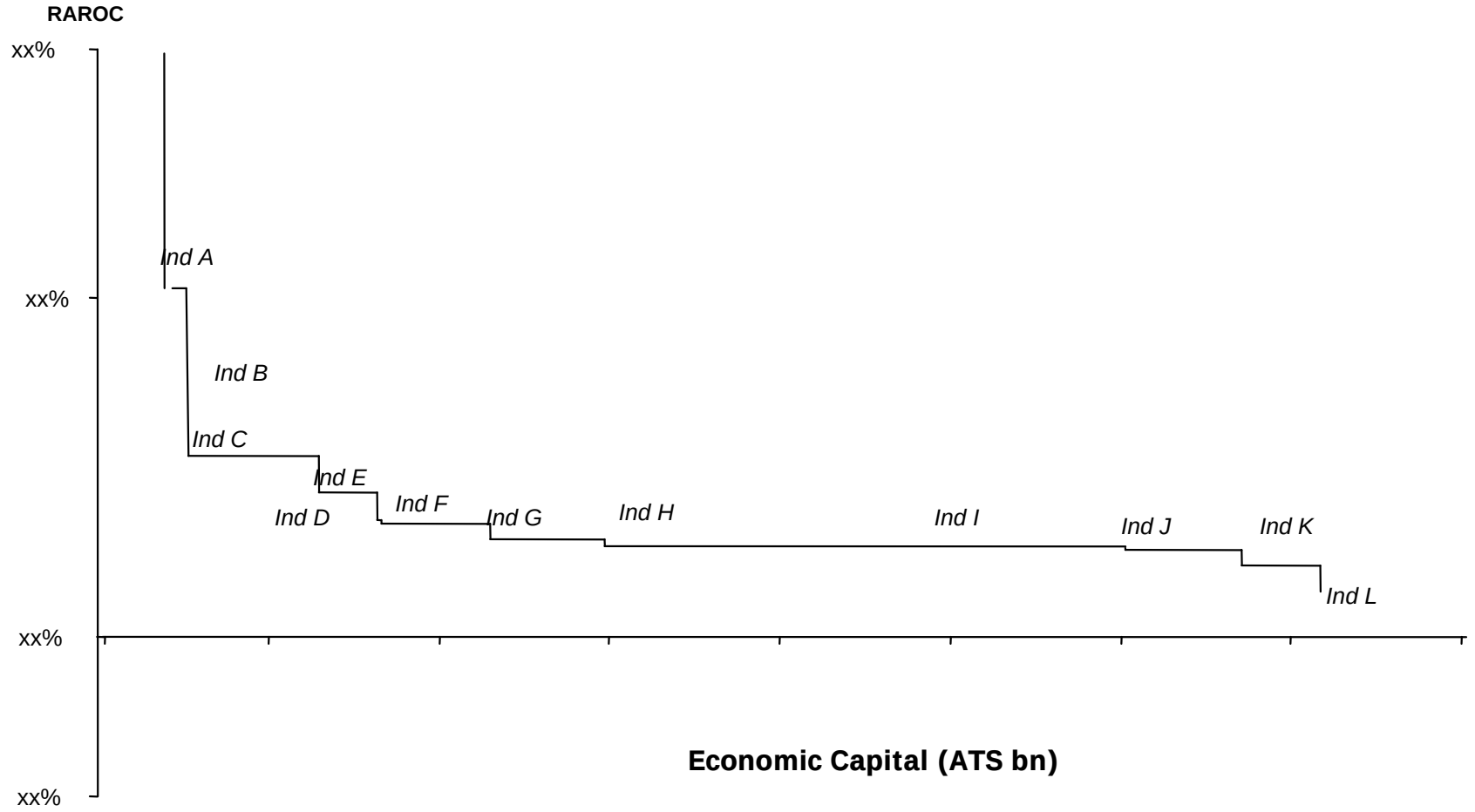
	avg rho asset	UL	AA
-10% rel.chg	17%	0,83%	5,85%
base case	19%	0,88%	6,39%
+10% rel.chg	21%	0,93%	6,93%
high level	50%	2,68%	26,63%
even higher level	80%	4,03%	42,65%

... but modelling volatility of severity has only small effects

σ_{SEV}	UL	AA
0%	0.880%	6.39%
30%	0.882%	6.39%
50%	0.885%	6.41%

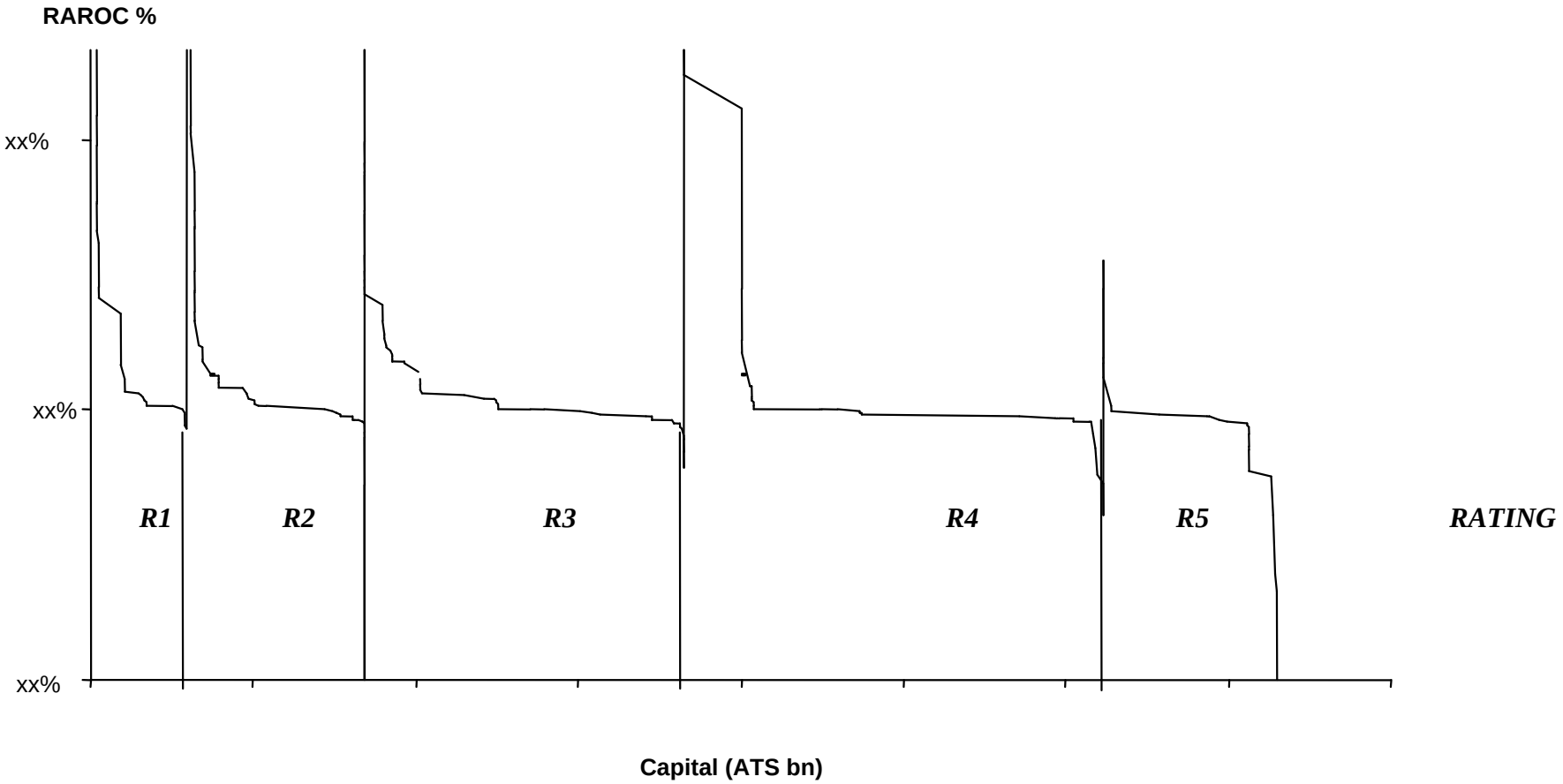
Portfolio Management: RAROC I

Analysis of different industry-segments shows us clearly the loss leaders.



Portfolio Management: RAROC II

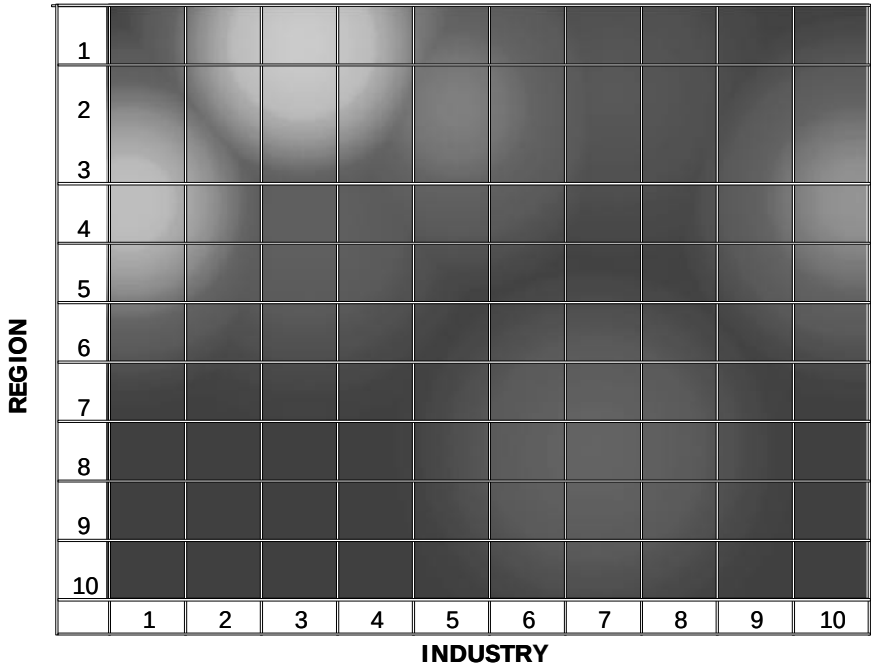
Risk adjusted profitability looks similar across and within rating classes.



Portfolio Management: Risk contributions

Systematic analysis of risk contributions helps to find concetrations and to optimize the portfolio

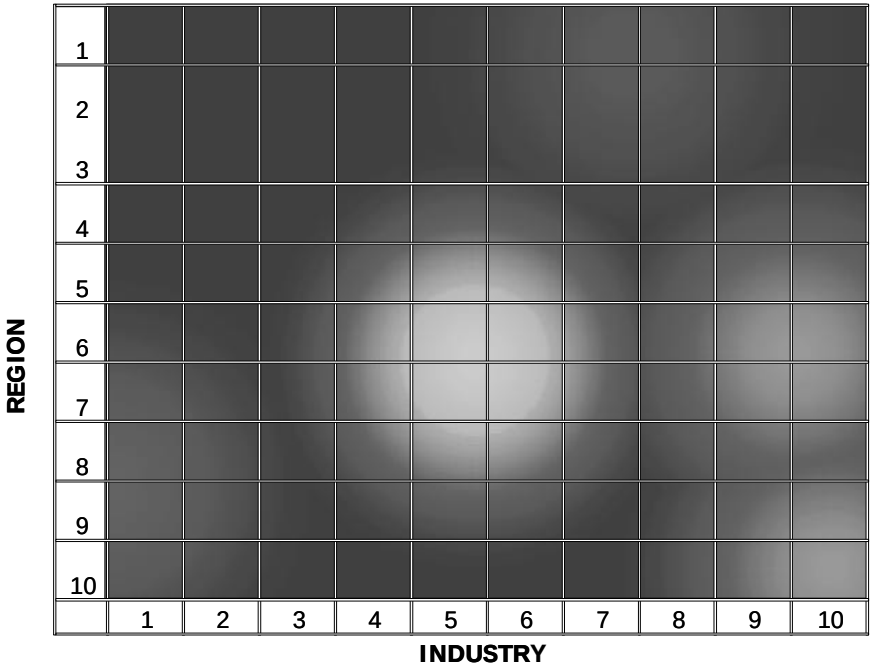
ECONOMIC CAPITAL



High capital consumption

Low capital consumption

RAROC

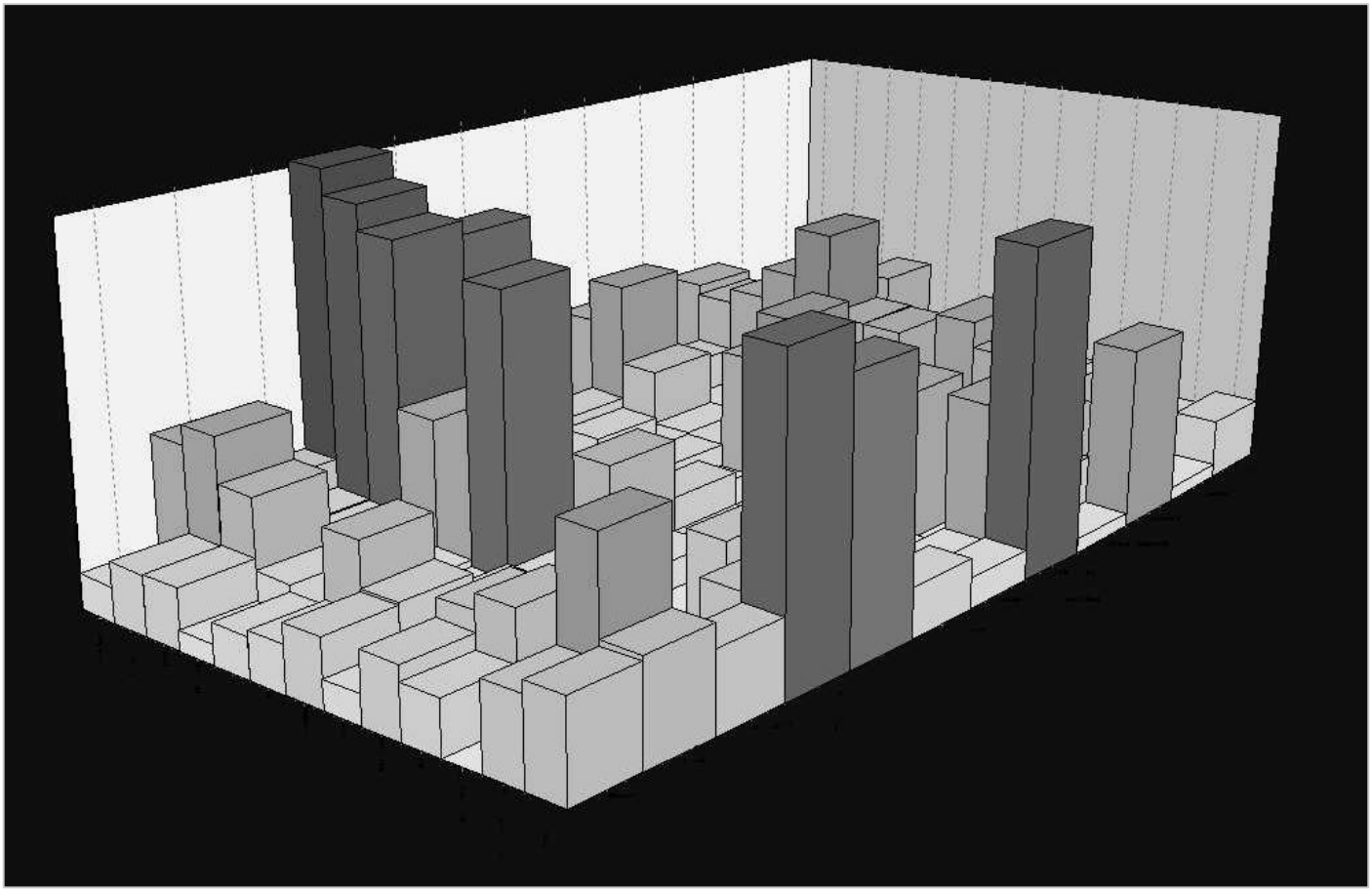


Low RAROC

High RAROC

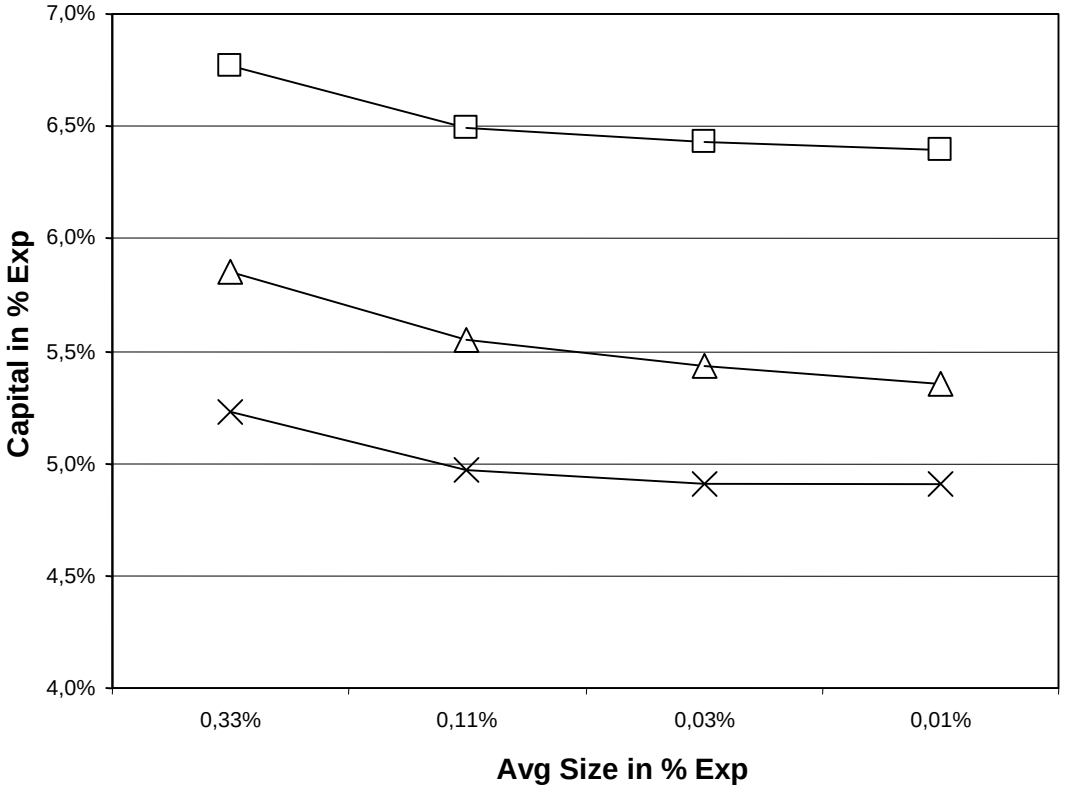
Portfolio Management: A „real“ sample picture

Sample snapshot of BA - credit risk portfolio application



Portfolio Management: Risk concentration

A sample calculation illustrates the impact of concentration on capital requirements



Portfolio size: 22 bn Euro

	Economic capital in million Euro		
Avg size % exp	AA	A	BBB
0,333%	1.476	1.275	1.140
0,111%	1.415	1.210	1.084
0,033%	1.402	1.184	1.071
0,011%	1.393	1.166	1.071

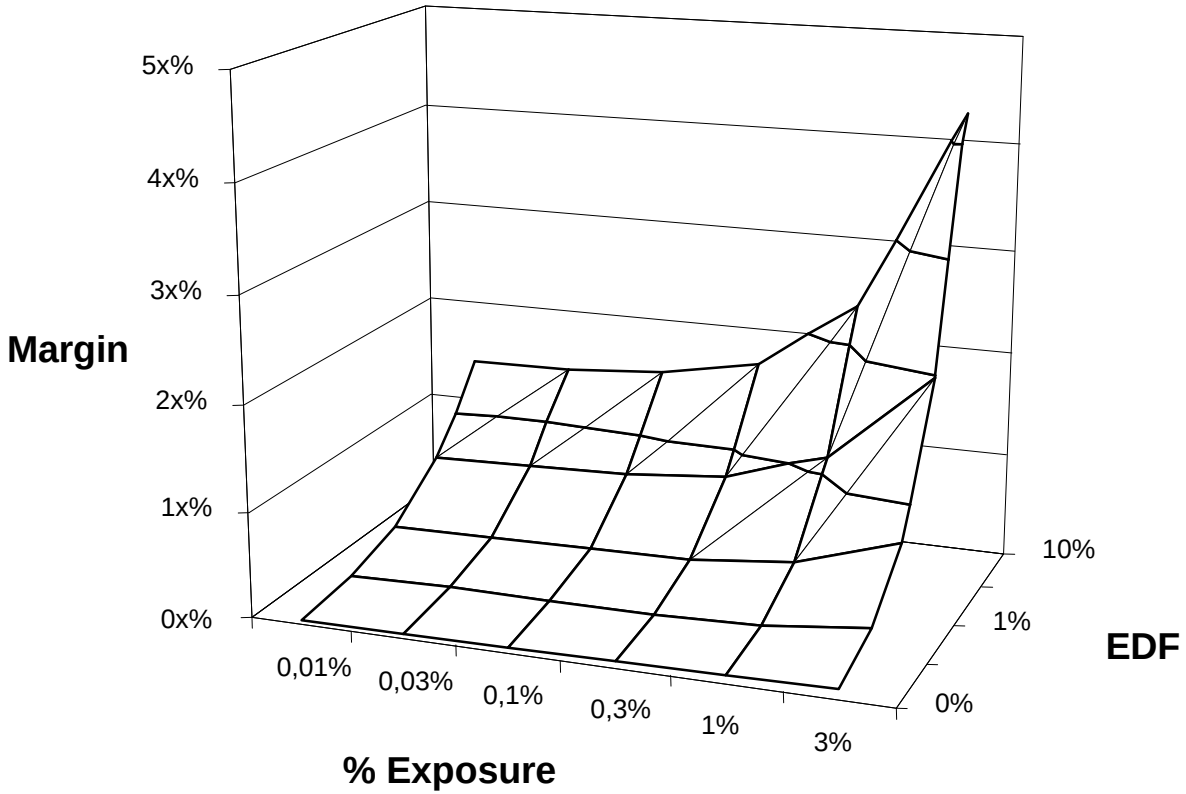
AA

A

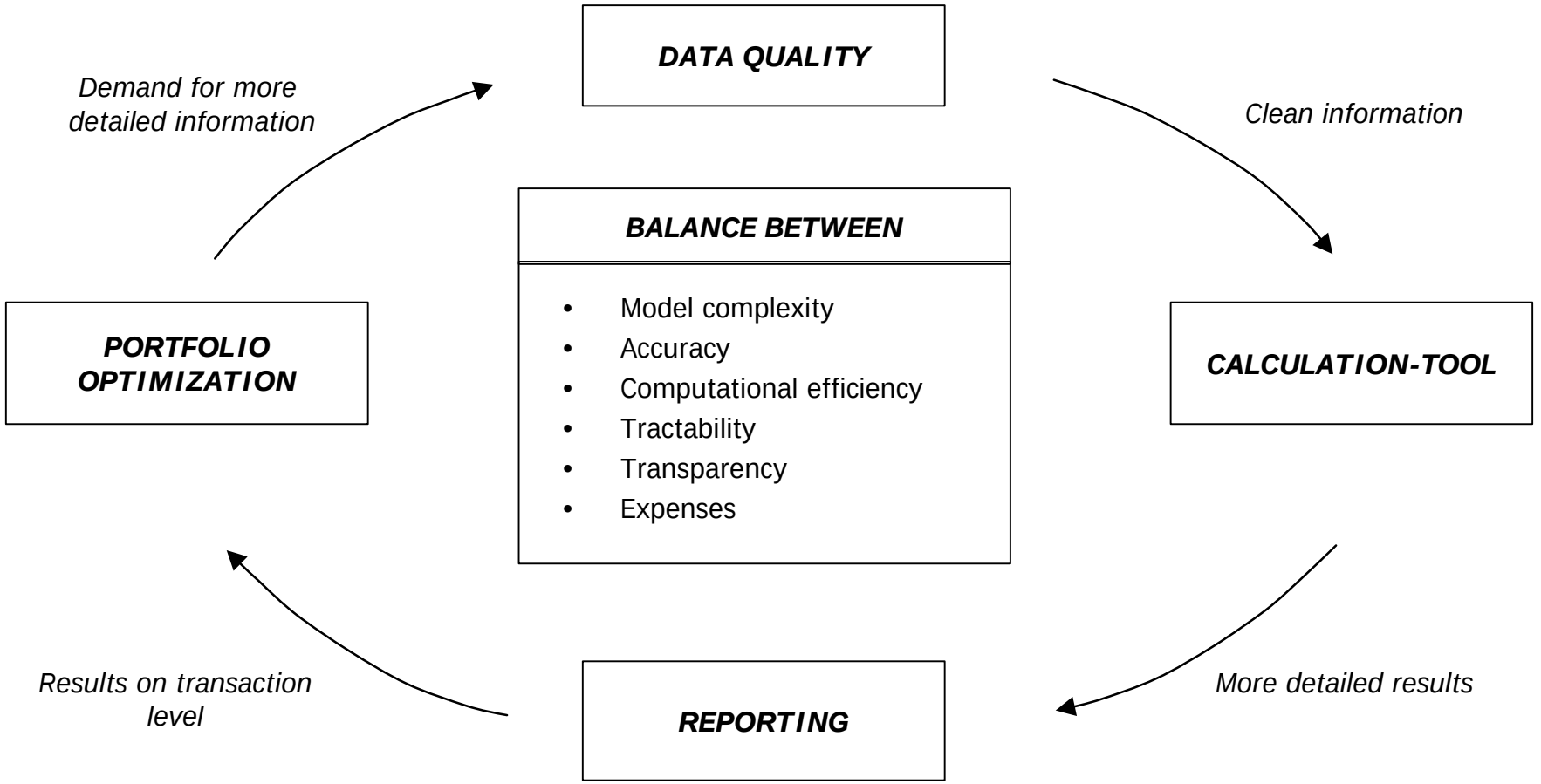
BBB

Portfolio Management: Pricing

To reach the same level of RAROC concentration effects need to be considered in pricing



The modelling circle: Possible steps



Concluding remarks

Rating Models

- Usually one year period for complete re-rating
- Risk mitigation / transfer

Portfolio Models

- Homogenity in clusters
- Benchmarks / use of analogues
- Don t trust the stats blindly

And generally...

- New BIZ requires high flexibility in models
- Right balance between theory and practice