

Validating Inputs and Outputs of the Regulatory and Economic Capital Allocation Process

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Overview

Validating Inputs and Outputs of the Capital Allocation Process

1. Validating Inputs

2. Validating Parameters

- Probability of Default (PD) / Rating class
- Rating Details
- Loss Given Default (LGD)
- Exposure at Default (EAD)
- Encountering Problems: Sampling Period, Small Sample Sizes, Correlations etc.

3. Validating Outputs

- Basel II Capital
- Internal Credit Portfolio Models
 - Volatility of Losses (UL)
 - Internal Economic Capital (EC)

Framework for Validation

Dual requirement

- Methodological considerations
- Adherence to Basel II

Data

Definition and storage of the default event

Availability of sufficient data

Rating-, default-, loss-relevant information

Unique identifier for customer, facility ...

Unique marking of rating changes

Time series of non-static data

Input Data : Basel II Requirements

Basel 2: Overall validation - CP3

463. Banks must have a robust system in place to validate the accuracy and consistency of rating systems, processes, and the estimation of all relevant risk components. A bank must demonstrate to its supervisor that the internal validation process enables it to assess the performance of internal rating and risk estimation systems consistently and meaningfully.

... (464-468)

Under the Advanced Approach

■ Minimum length for the period of underlying historical observations used

- PD : 5 years for a least one data source (Retail : at least 3 years)
- LGD & EAD : one economic cycle, and at least 7 years (Retail: at least 3 years)
- correlations? Open issue

■ If a longer period of data is available, it must be used

- though
“A bank need not give equal importance to historic data if it can demonstrate to its supervisor that more recent data are a better predictor of [drawdowns/loss rates]”.

■ “The less data a bank has, the more conservative it must be in its estimation”

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Validation of Estimators : Motivation

Basel II Requirements under the Advanced Approach

- Currently no specifications as to which method must be used

Constant monitoring

- Upper management
- Auditors (Audit Trail)
- Regulators

Analytical tool

- Measuring the business cycle (albeit subjectively)
- Detection of deterioration in quality of estimators
 - systematic changes in input parameters (eg: payment by electronic transfer instead of cheque)
 - changes in the structure of the portfolio (eg: inhomogeneity compared to the original)
- Enhancement of the predictive power of estimators

Validation : Some Considerations

Choice of Segment

- Segment (separation by country or industry or rating methodology used) must be large enough for the analysis to be statistically significant

Choice of Timeframe

- Within a given time frame, can perform validation using ODFs :
 - for each one year period within the timeframe
 - for the ODF over the entire timeframe
 - for different multiyear periods within the timeframe

Conclusion

- Validation does not provide a fixed decision, but rather an input and the suggestion that action or further study is necessary

Aspects of Estimator Validation

Frequency of Validation

- Depending on the impact and stage of the business cycle (different ratios may become important)
- Dependent on the turnover frequency of assets in the portfolio
- Dependent on the significance of a given segment relative to the whole portfolio

Different Levels of Validation

1. Portfolio-Level: Expected Loss vs. write-offs or external benchmarks
2. By Rating Class: Variation in Default-Rates / LGD-Rates / EAD Parameters
3. On continuous Probability of Default (PD)-curves / Collateral Evaluation Routines / EAD Profiles:
binning / fitting / high resolution
4. On submodules / input ratios / etc.

Documentation

2. Validating Parameters

Validation on Portfolio Level : EL Validation

Time-Series of Expected Loss vs. Write-Offs

Expected Loss (EL) Components

On Counterparty level:

$$EI_i = PD_i \times LGD_i \times EAD_i$$

Probability of Default (PD)
of counterparty to horizon

Expected Loss Given
Default (LGD) ($0 < LGD < 1$)

Expected Exposure
at Default

On Portfolio level:

$$EL = \sum EI_i$$

2. Validating Parameters

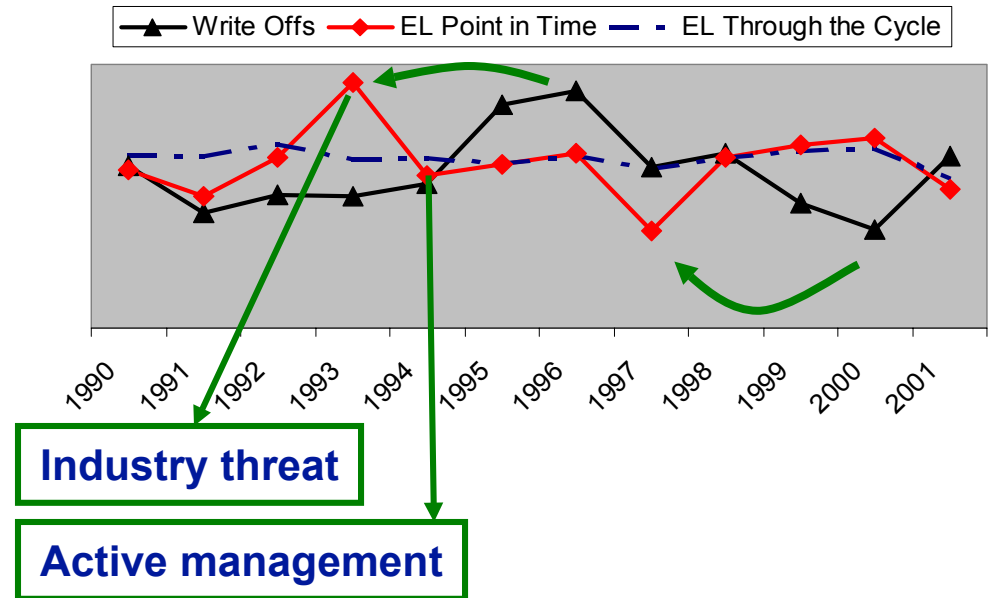
EL Validation : Time-Series of Expected Loss vs. Write-Offs

Approach:

- By segment:
Product vs. Customer type
- Match:
Close to event vs. average

Concerns:

- Reasons for changes
- Time lag of write-offs
- Which parameter is to blame ?
(Default Probability, Loss Given Default, Exposure at Default ?)
- Write-offs incorporate unexpected loss features



Validation of the Probability of Default (PD)

Driving factors :

- Creditworthiness of counterparty (Rating)
- Tenor of Loan
- Migration Pattern of Counterparty
- Documentation, if it helps to avoid default or to cancel an exposure prior to default
- Risk enhancing or decreasing features
(eg: Holding structure, letter of comfort, etc...)

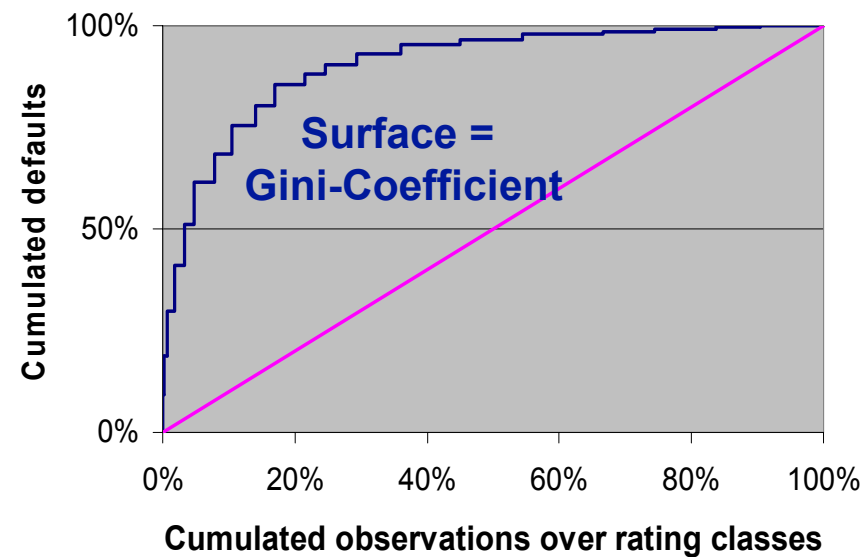
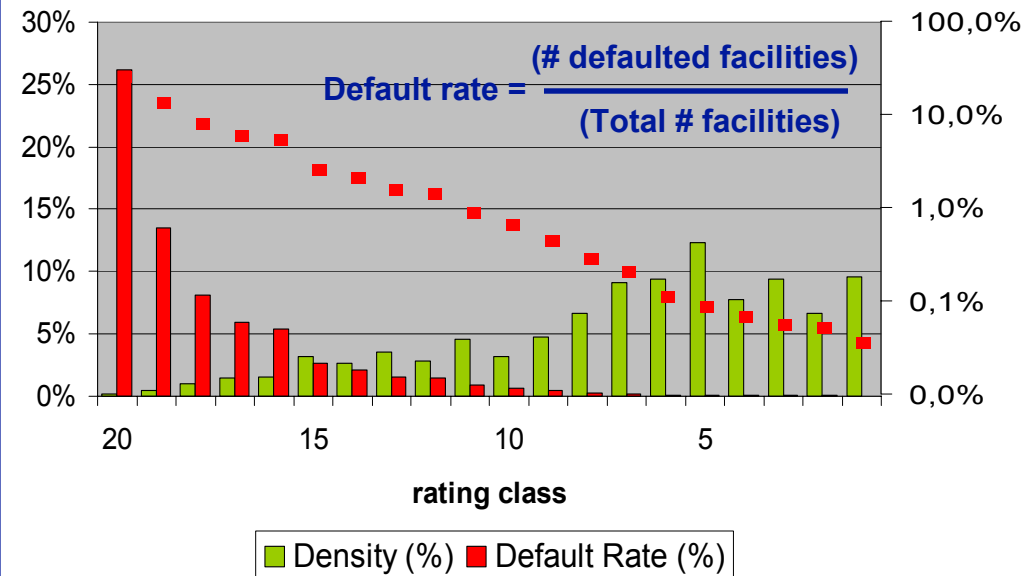

$$EL = PD \times LGD \times EAD$$

Approaches

- Quality of separation (Statistical measures)
- Comparing observed PDs to estimated PDs across segments of the portfolio
(eg across rating class, countries, industries, business divisions)
- Comparison with previous PD estimates
- Benchmarking:
 - External rating agencies
 - KMV
 - Credit spreads

2. Validating Parameters

PD Validation : Quality of Separation



■ Is the default rate monotonous ?

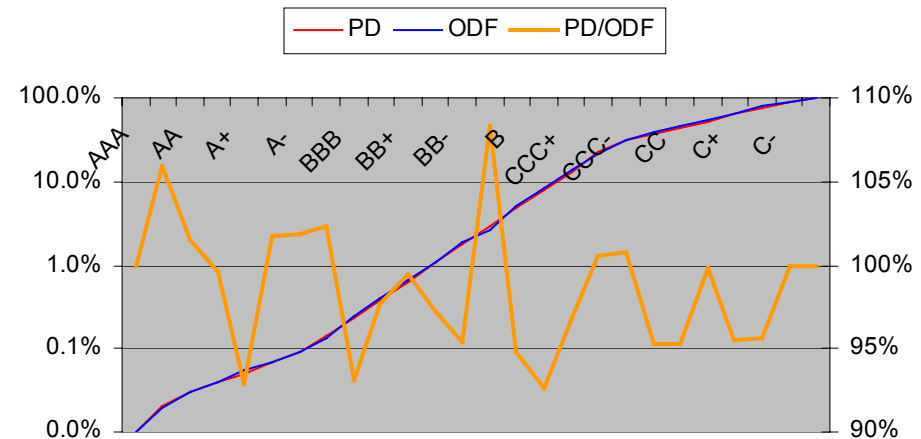
■ Is the Gini coefficient acceptable ?

2. Validating Parameters

PD Validation : Observed PD (ODF) vs PD

Quality of PD estimates

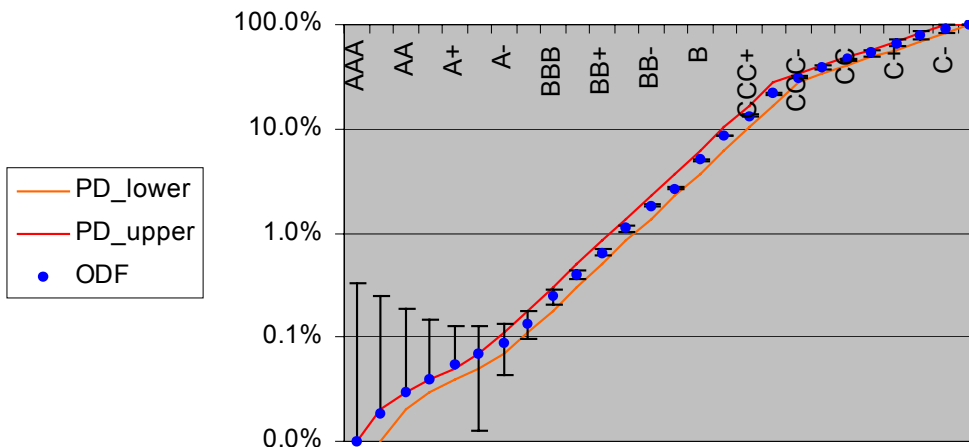
- Ratio ODF / PD should be close to 1
 - If not, are deviations due to :
Statistical fluctuations ? Incorrect rating proces:
Correlated events ? Macroeconomic changes?



- Statistical error

$$err_ODF_k = N^{-1} \left[\frac{1 + confidence_level}{2} \right] \sqrt{\frac{ODF_k (1 - ODF_k)}{\# \text{ defaults in class } k}}$$

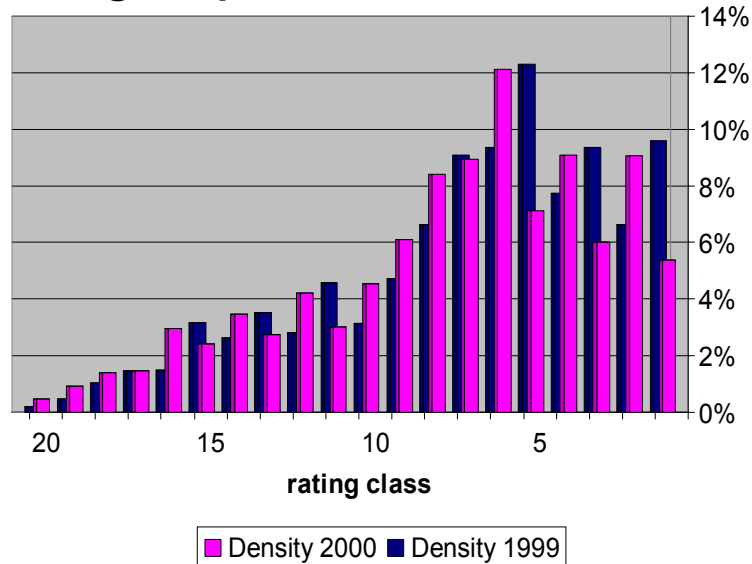
- For each class k , is PD in the interval $[ODF - err_ODF ; ODF + err_ODF]$?



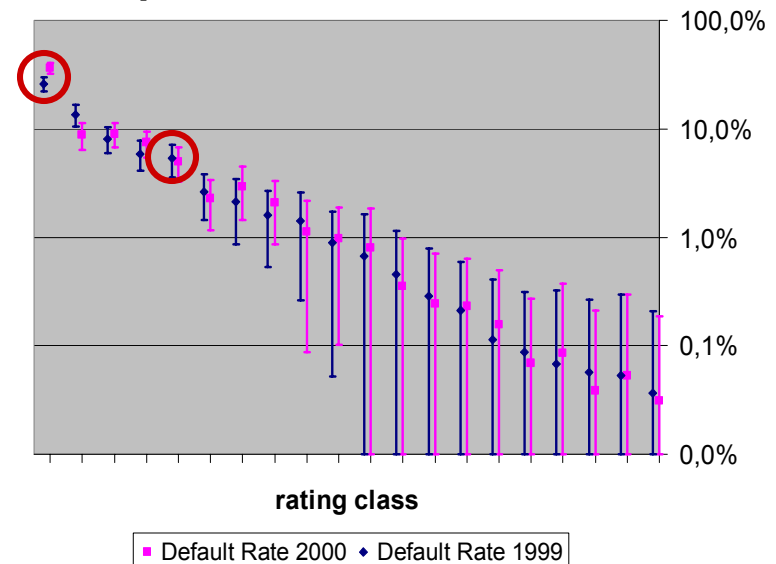
- Is the ODF within the lower and upper bounds of PD for its rating class?

PD Validation: Comparison with Previous Estimates

Change in portfolio distribution of PDs



Comparison of default rates



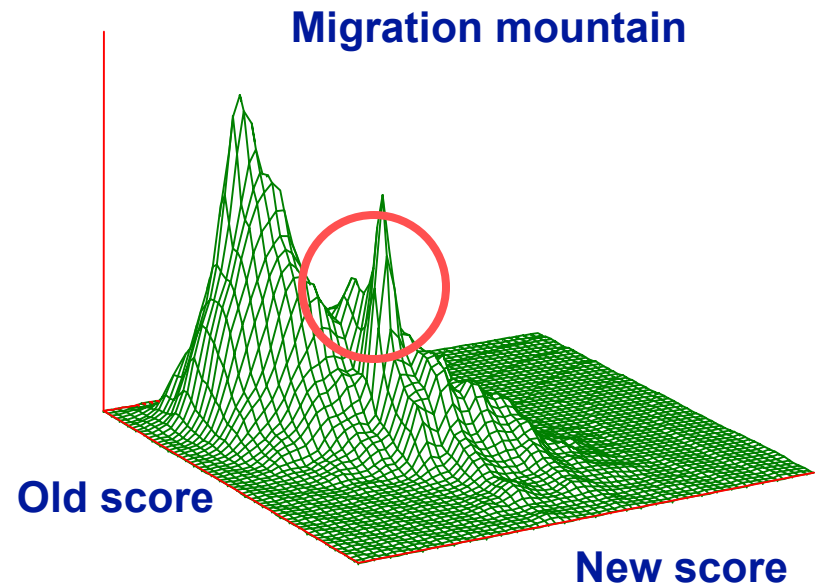
- **Is the shift in the distribution due to**
 - the business cycle (Point-in-Time - Rating)?
 - systematic changes in the input variables on the scorecard?

- **Are deviations**
 - within the confidence interval?
 - systematic or unsystematic?
 - still acceptable, or should action be taken?

PD Validation : Comparison with Previous Estimates

Rating migration

- Markov assumption for monitoring portfolios (not necessarily true for initial request scorings)
- Based on rating classes or scores
- Are structural breaks visible?



↓

Migration matrix (%)

class	1	2	3	4	5	sum
1	56	24	9	7	4	100
2	29	44	23	3	1	100
3	16	23	27	22	13	100
4	5	9	22	35	30	100
5	1	0	23	28	48	100

New score

Deutsche Bank



PD Validation : Benchmarking

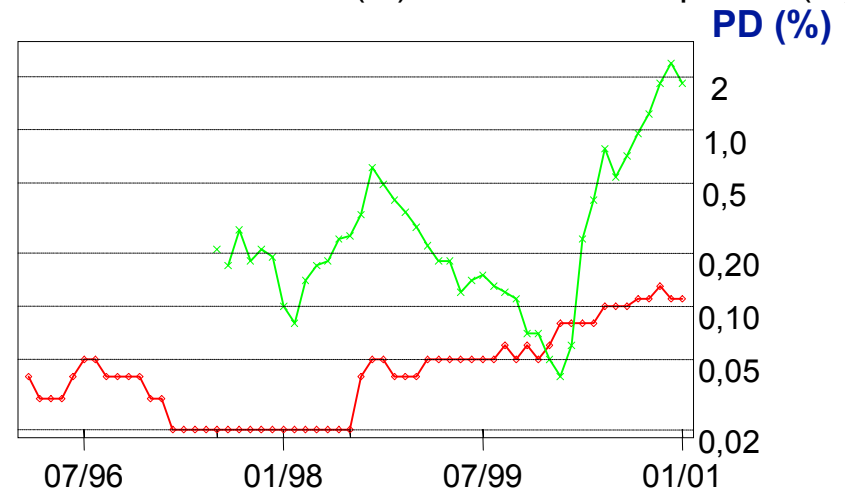
Benchmarking to external sources :

- rating agencies
- market models

Problems :

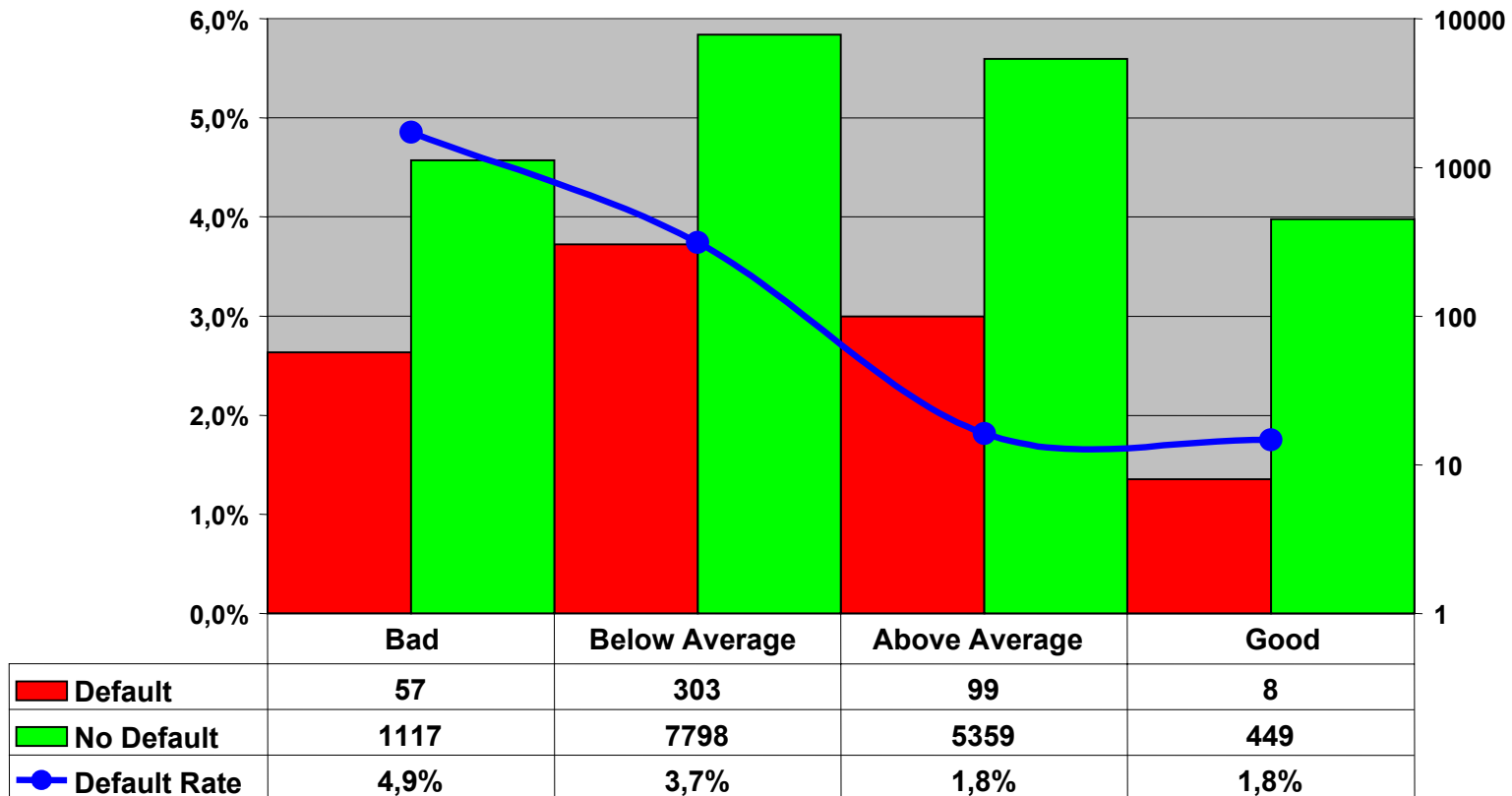
- Type of Rating!
- Quality of Benchmark is unknown
- Endogeneity of credit risk(?)
 - Dependence on credit culture / credit process

Credit Monitor - A-rated (◻) vs. B-rated companies (x)



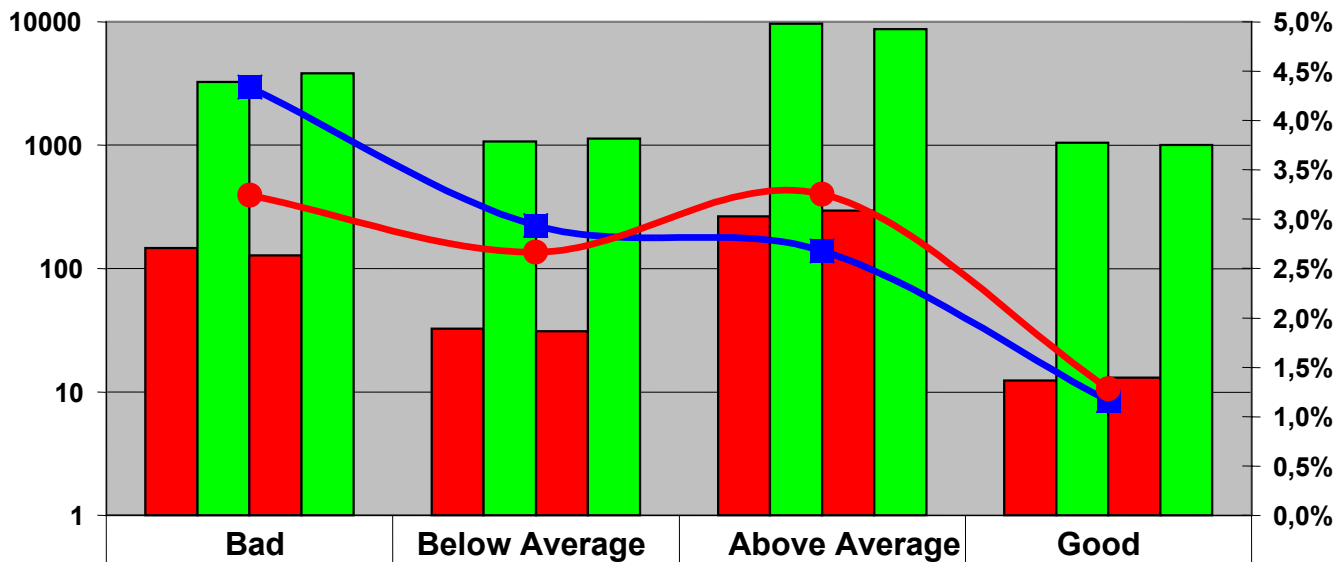
Validation of Rating Details

Future Prospects of Industry



Validation of Rating Details over Time

Dependency on Suppliers




	Bad	Below Average	Above Average	Good
Default Year 1	147	33	266	12
No Default Year 1	3248	1075	9646	1051
Default Year 2	128	31	295	13
No Default Year 2	3821	1132	8769	1001
Default Rate Year 1	4,3%	2,9%	2,7%	1,2%
Default Rate Year 2	3,2%	2,7%	3,3%	1,3%

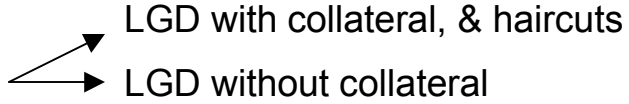
Validation of Loss Given Default

Driving factors:

- Impersonal collateral
- Guarantees
- Documentation, if it reduces loss in case of default
- Nature of the product


$$EL = PD \times LGD \times EAD$$

Approach

- Usual approach applied to 
 - LGD with collateral, & haircuts
 - LGD without collateral
- Type of collateral instrument taken into account
- In a given timeframe
- Calculate averages and errors for observed LGDs and haircuts across a segment
- Check whether estimator values are within bounds provided by observation

2. Validating Parameters

Validation of Loss Given Default

On transaction level:

- With collateral

$$LGD_{sec_obs} = \max \left(0\% , 100\% - \frac{rec_{sec}}{\min(val_{nominal}, val_{liquidation})} \right)$$

amount generated by liquidation of collateral or payments of guarantors

$$haircut_{obs} = \frac{rec_{sec}}{val_{mkt}}$$

collateral's estimated market value 1Y before default

fixed amount of claims to the collateral if expressed in the contract

collateral's estimated liquidation value 1Y before default

- Without collateral

$$LGD_{unsec_obs} = \max \left(0\% , 100\% - \frac{rec_{unsec}}{EAD - rec_{sec}} \right)$$

(Note : amounts are valued at time of default)

amount generated by workout excluding liquidation of collateral

On counterparty or segment level:

- Calculate average and error in observed LGDs and haircuts

Validation

- Are the estimated LGDs within the required intervals ?

$$[LGD_{obs} - LGD_{error} , LGD_{obs} + LGD_{error}]$$

Validation of Exposure at Default (EAD)

$EAD = \text{current outstanding} + \lambda (\text{limit} - \text{current outstanding})$
with $0 < \lambda < 1$

$$EL = PD \times LGD \times EAD$$



Driving factors:

- product type
- time to maturity

Approach

- Similar to that of comparing ODFs to PDs
- For each transactions i that defaulted within a chosen timeframe, calculate

$$\lambda_{obs(i)} = \max \left(0 ; \frac{\text{outstanding_at_default} - \text{outstanding_1Y_before_default}}{\text{limit} - \text{outstanding_1Y_before_default}} \right)$$

- Calculate across segments of the portfolio :
 - the average observed λ_{obs}
 - the error λ_{err}
- Is the estimator λ in the interval $[\lambda_{obs} - \lambda_{err}, \lambda_{obs} + \lambda_{err}]$?



Small Samples - Sparse Defaults

Statistical Validation methodologies need on large portfolios with many defaults.

Not true for all Basel 2 Segments (Banks, Sovereigns)

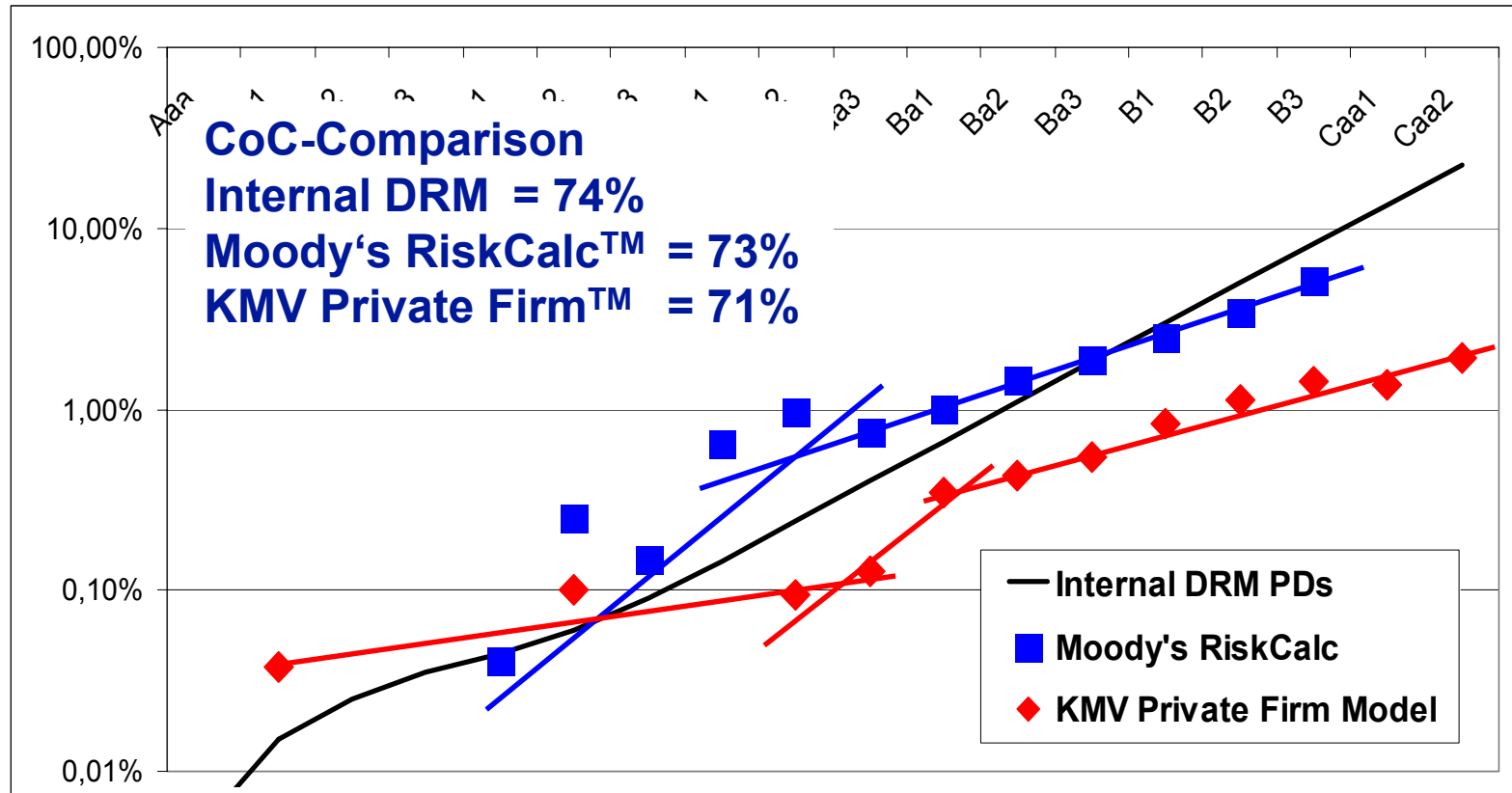
→ alternative Validation methods needed

Data Pooling ist problematic

- different default definition,
- different Processes und Portfolio compositions.
- Legal constraints (eg banking secrecy)
- Potential increase of systemic Risk
Same Data → Same Methods → Same Decisions
- Those Segments are significant for many banks but their validation has not been covered yet in the consultative process.

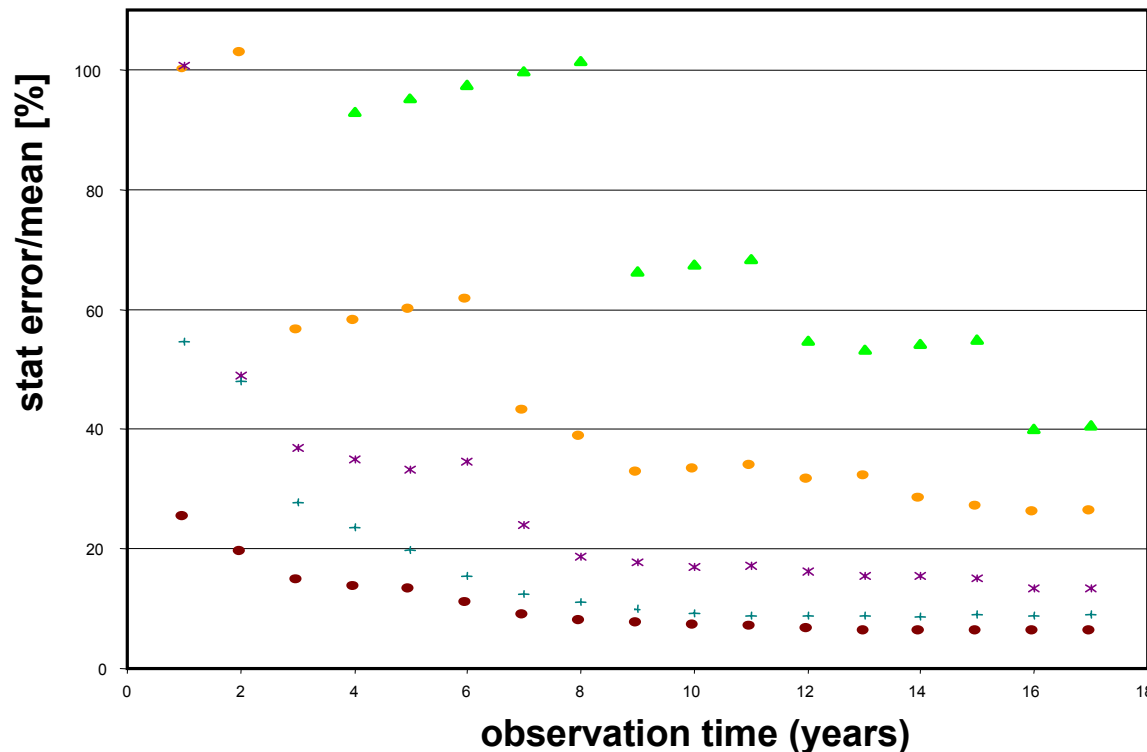
2. Validating Parameters

Comparison with External Ratings - Example



Impact of the Length of the Sampling Period

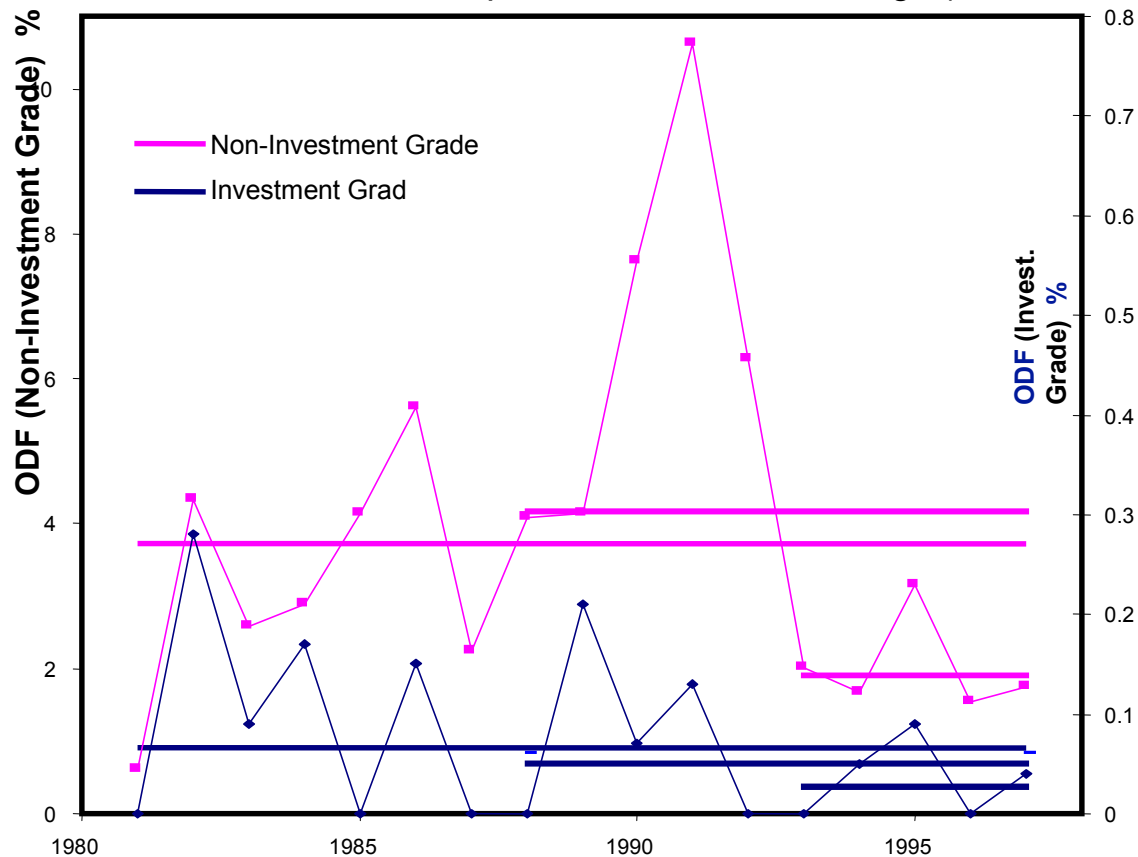
Relative statistical Error (dispersion of yearly distribution around average) for a time series of increasing length



- **Statistical point of view:**
one should use as long a time series as possible
- **But...older data may not describe the current portfolio correctly, due to changes in**
 - client base
 - rating methodology
 - economic climate

Impact of the Length of the Sampling Period

Observed Default Frequencies from S&P Ratings (1981 - 1997)



■ Choice of sampling period (somewhat subjective) has a significant influence on the PD calibration

- Full cycle?
- Outliers ?
- Data Cleansing ?

Validation of Correlations - Some Comments

Similar approaches could be applied to the correlations

■ Correlations between LGD & PD

- a non-deterministic LGD that is correlated with PD

■ Correlations between EAD & PD

- in particular :
 - when EAD depends on market prices (eg: for traded products)
 - possibility of wrong way exposures

■ Correlations between counterparties

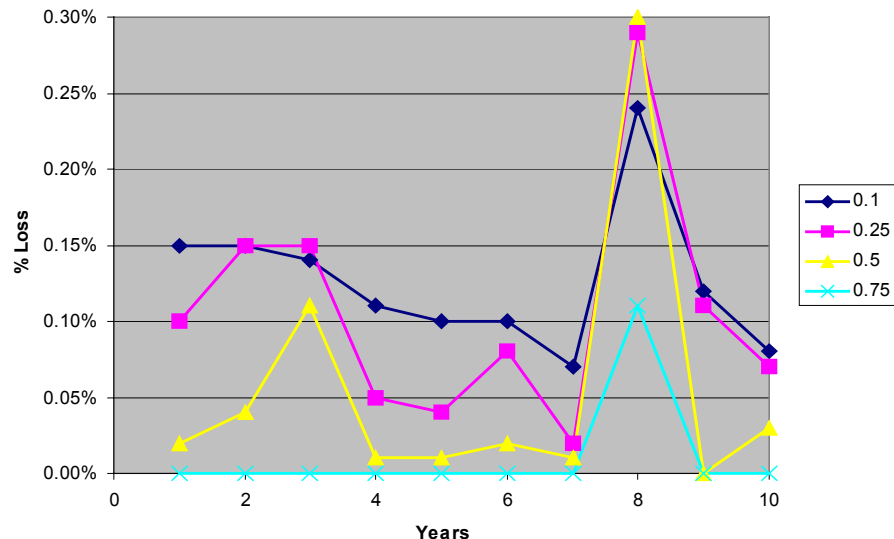
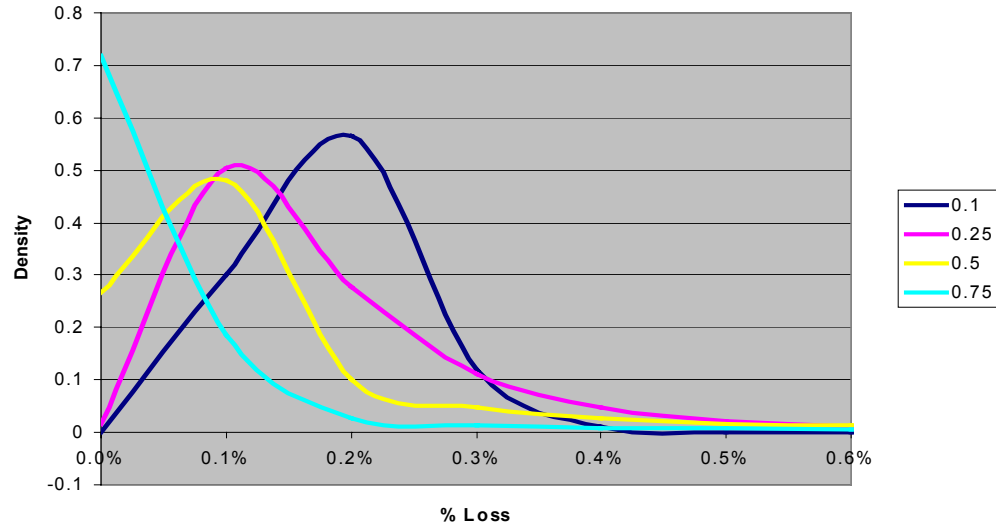
- correlations and PDs can be estimated and validated simultaneously
- problem : achieving a sufficient level of sensitivity in the validation tests

2. Validating Parameters

Impact of Correlations

Example Calculation

- Portfolio of 10,000 facilities, rated BBB+
- EL = 0.14%
- Distribution of losses depends on correlations between counterparties

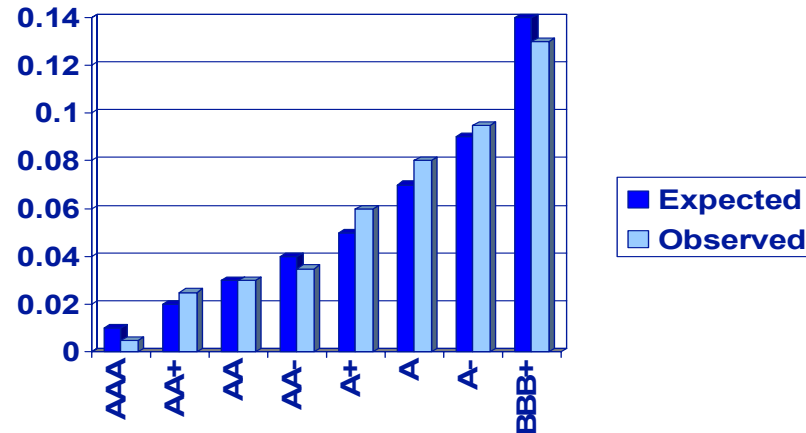


- Based on 10 years of observations

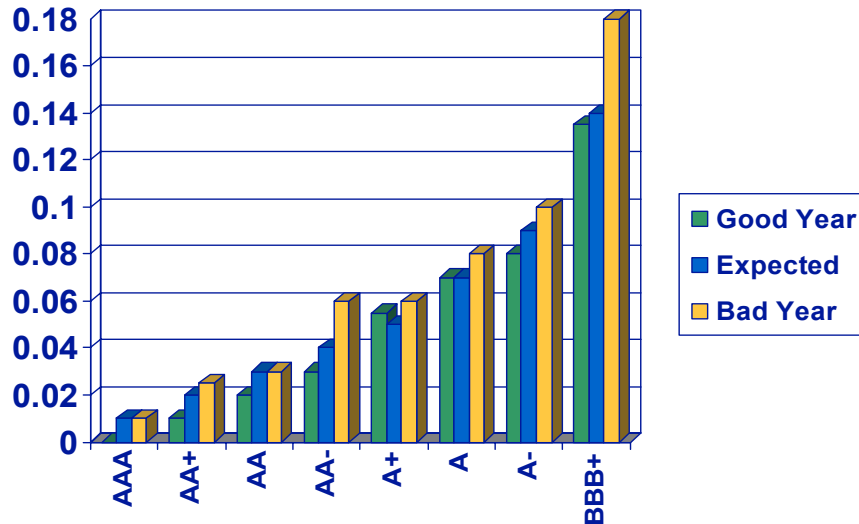
	0.1	0.25	0.5	0.75
Expected Loss	0.14%	0.14%	0.14%	0.14%
Observed Loss	0.13%	0.11%	0.06%	0.01%
% Difference	-10%	-24%	-61%	-92%

2. Validating Parameters

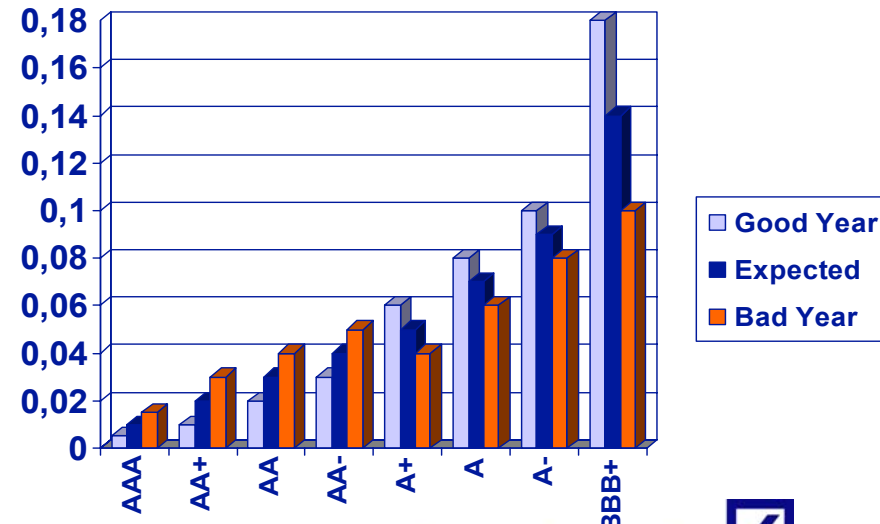
Impact of Correlations between counterparties on Rating calibrations



Systematic Shifts



Unsystematic Shifts



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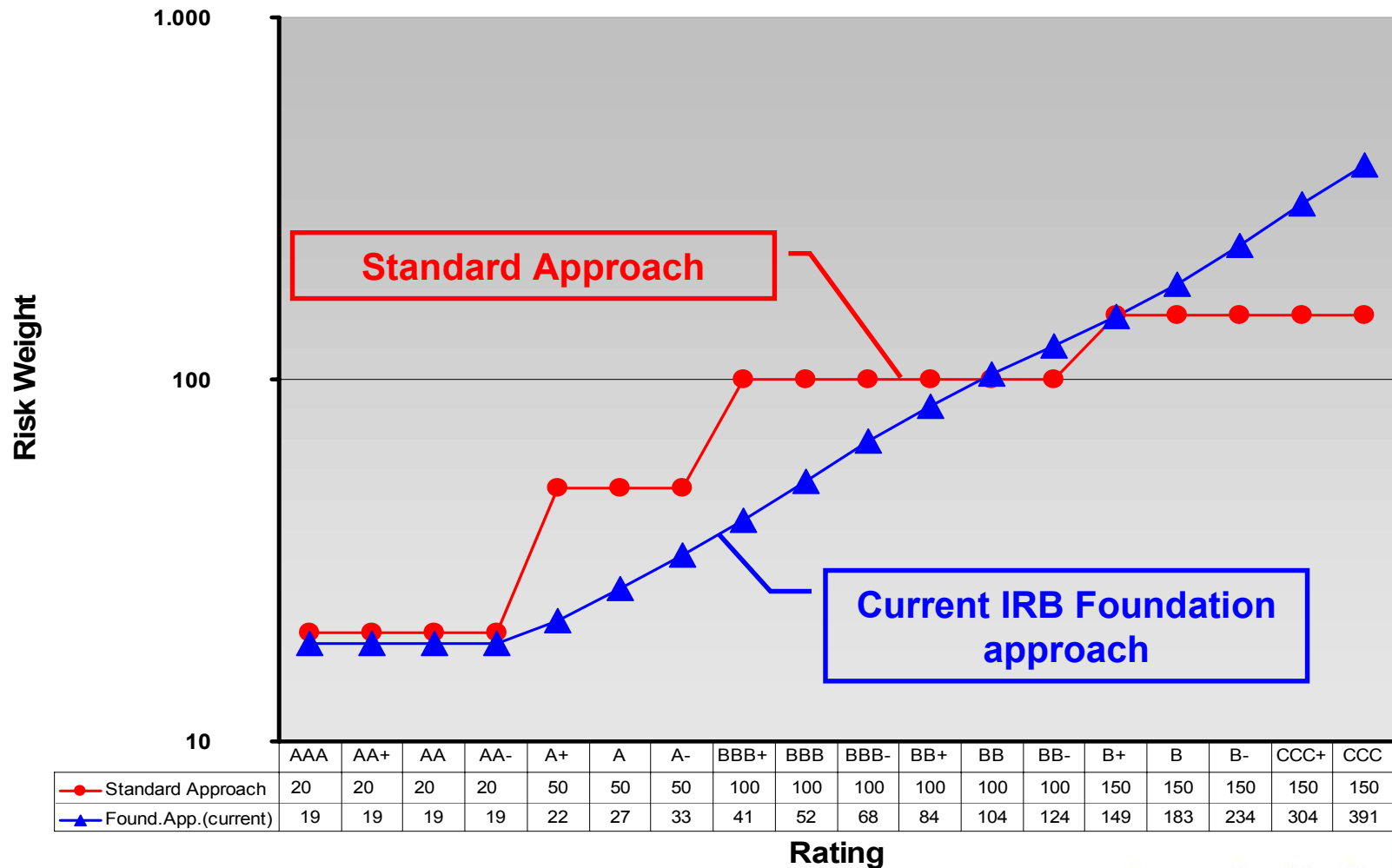
Comparing Basel II & Internal Capital Allocation Models

- Single factor
- “Once size fits all” model
- Capital allocated to each facility in isolation
- Capital allocation is given by a function of :
 - PD, LGD, EAD, Maturity
 - Customer type (-> asset correlation)
- ⇒ **Easier to implement**
- ⇒ **Easier to oversee**
- Multi - factor
- Competition of different modeling approaches
- Capital allocated to each facility reflects risks across the whole portfolio
- Capital allocation is the result of a simulation based on :
 - PD, LGD, EAD, Maturity
 - Correlation with country & industry factors
- ⇒ **Flexibility**
- ⇒ **Rewards diversification**



3. Validating Outputs

Basel Internal Ratings-based Approach: Comparison of risk weights for different approaches



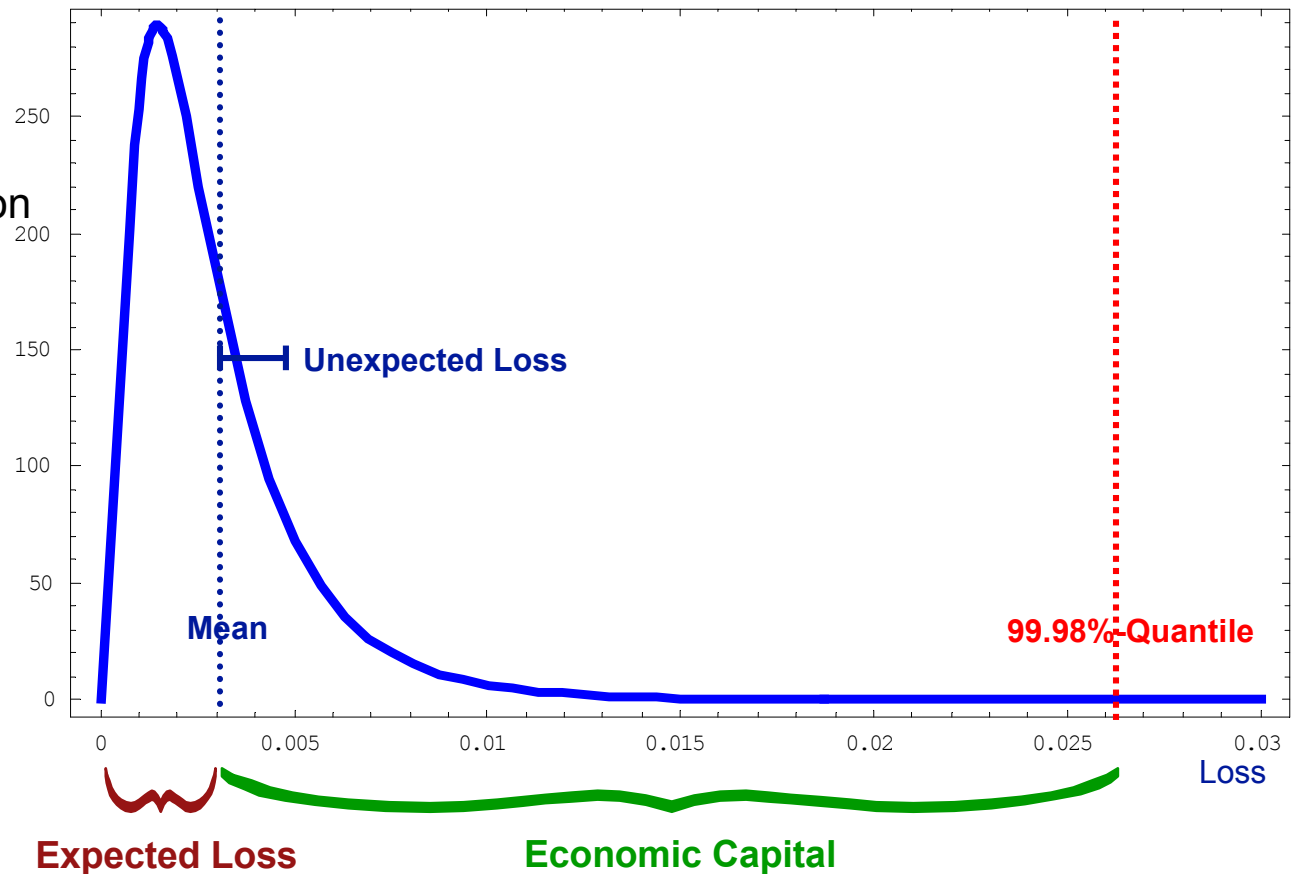
3. Validating Outputs

Internal Model Approach: Loss Distribution of a Credit Portfolio

Probability Density or Frequency of Losses

- Set Time Horizon
- Obtain Loss Distribution
- Set Confidence Level, eg: 99.98% quantile

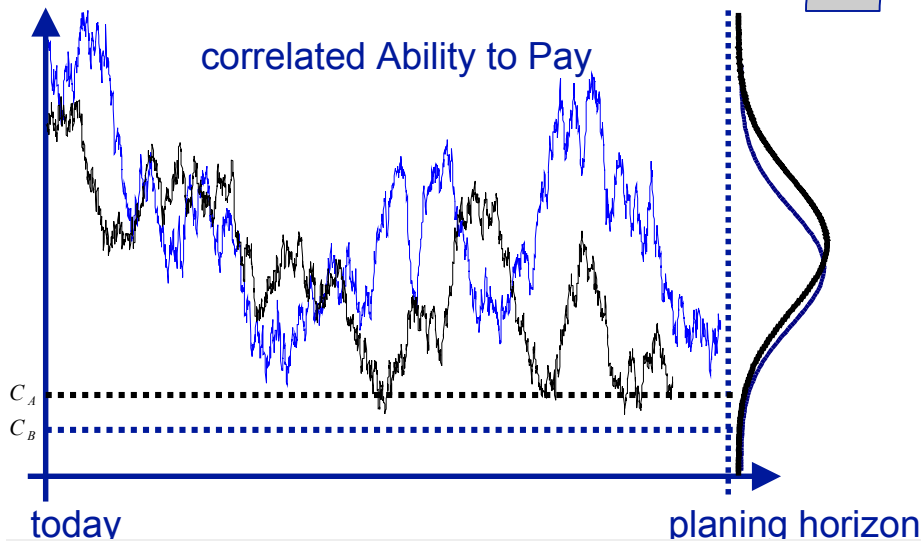
⇒ Read off Economic Capital



3. Validating Outputs

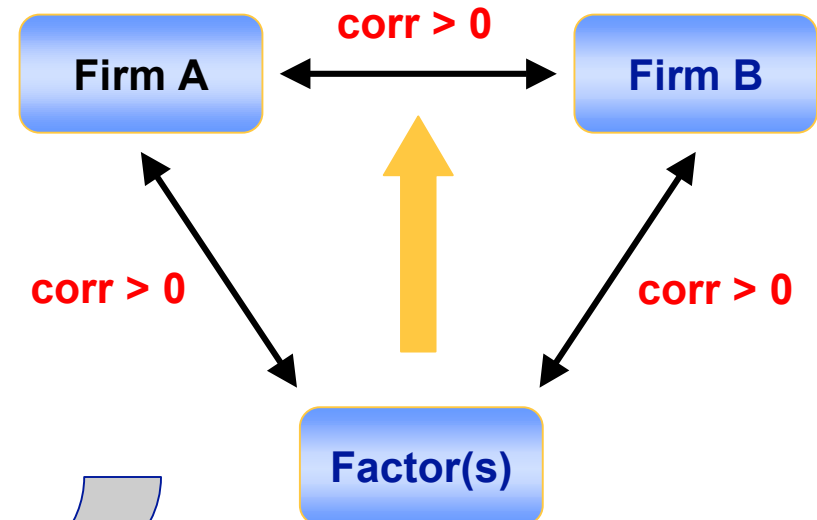
Internal Model Approach: Correlated Defaults → Calculation via Multi-Factor-Model

Defaults happen if an “ability-to-pay” of a firm falls below a threshold



Firm A and Firm B are correlated.

This is modelled by a **Multi-Factor Model**



Decompose Ability to Pay

- systematic Part (driven by **Factor Model**)
- specific Part

Decompose systematic Part / **Factor Model** in

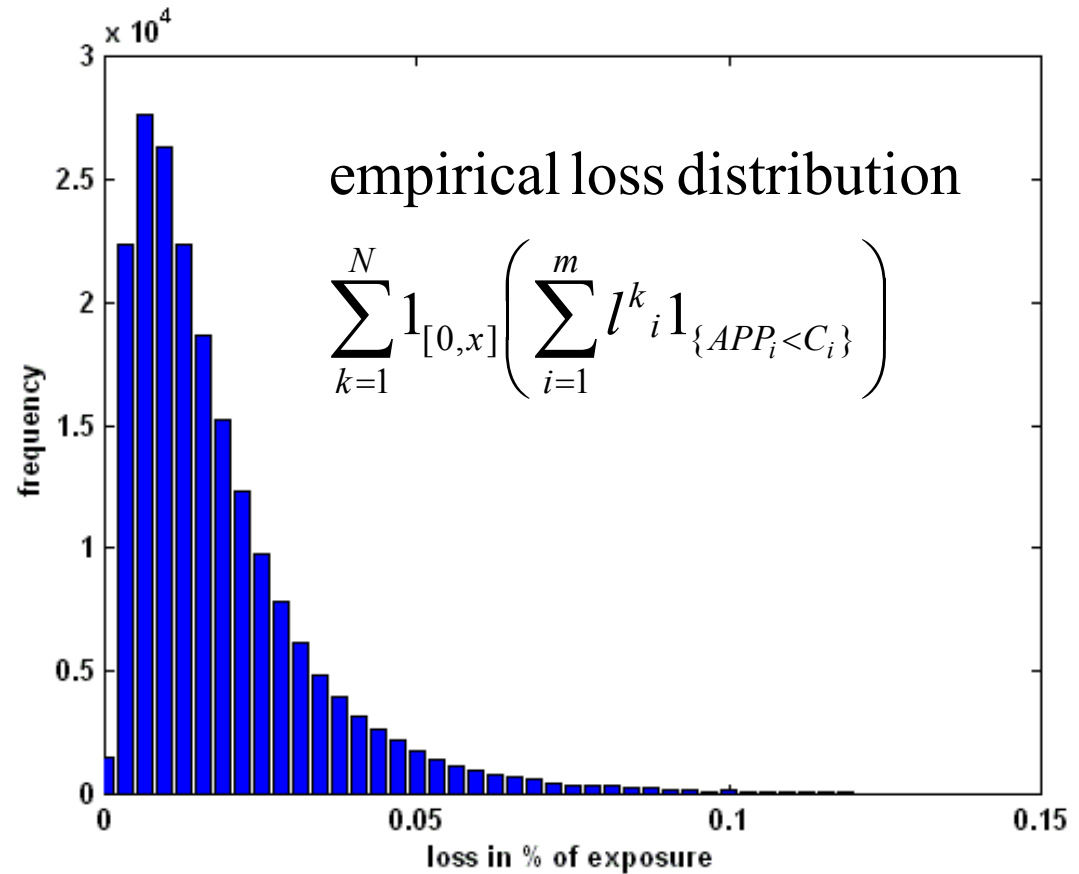
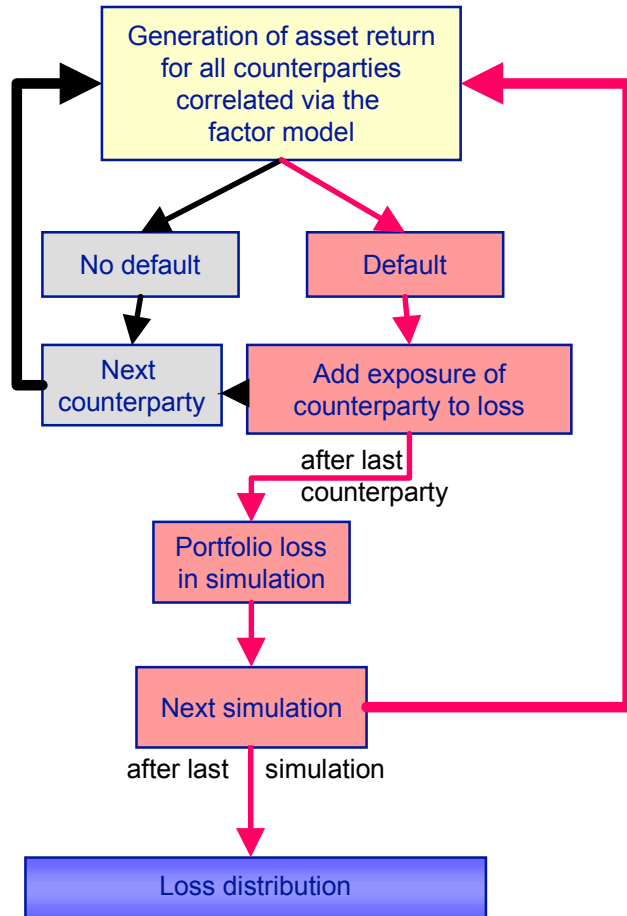
- Country Part
- Industry Part



3. Validating Outputs

Loss Distribution of a Credit Portfolio

Example of Loss Distribution from a Monte-Carlo Simulation



Example: Portfolio of 2,000 middle market loans

3. Validating Outputs

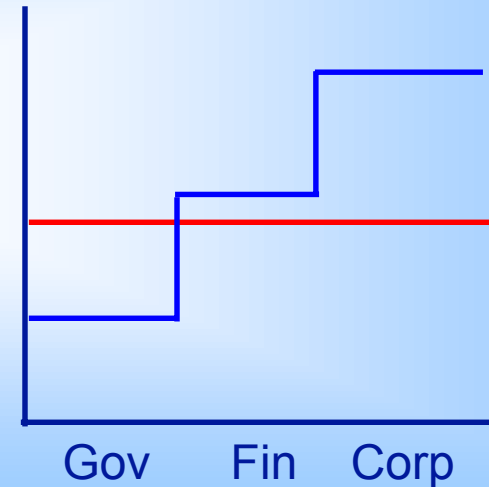
Comparison of Economic Capital and Regulatory Capital

— RC — EC

Diversification

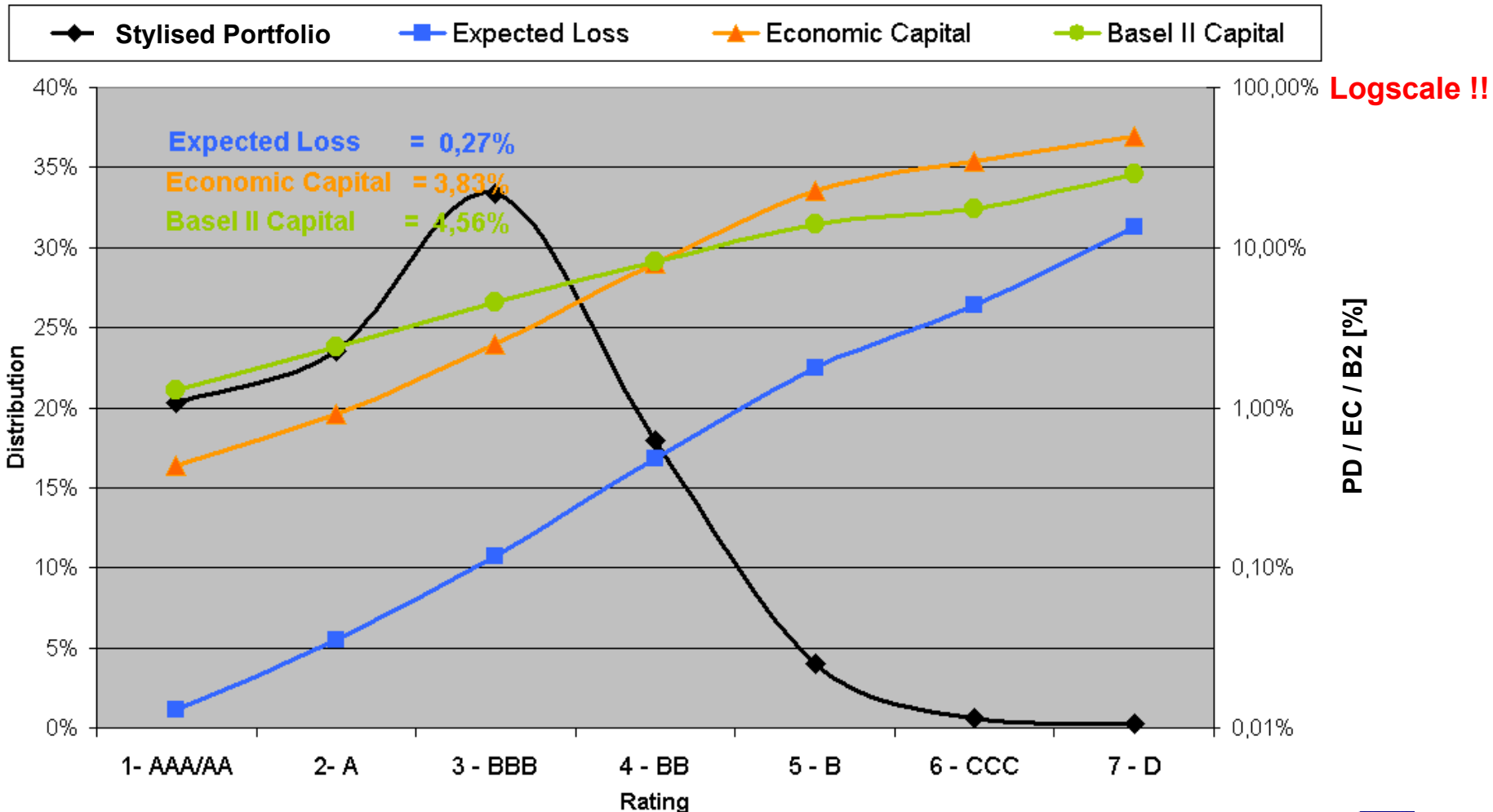


Industry Segments



3. Validating Outputs

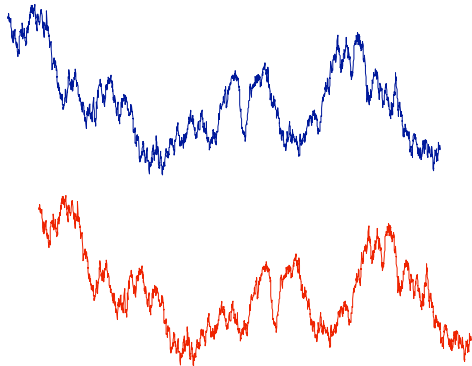
Comparison of Expected Loss, Economic Capital and Basel II Capital



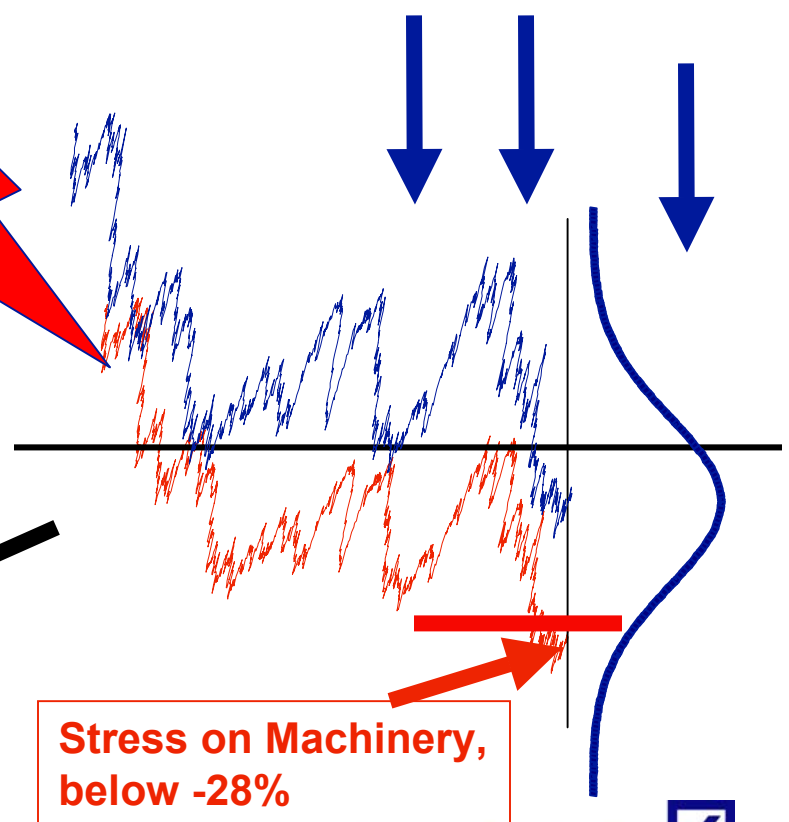
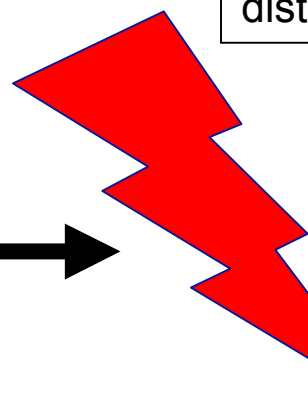
3. Validating Outputs

In a Nutshell: Stress Tests → Effect on Credit Loss Distribution

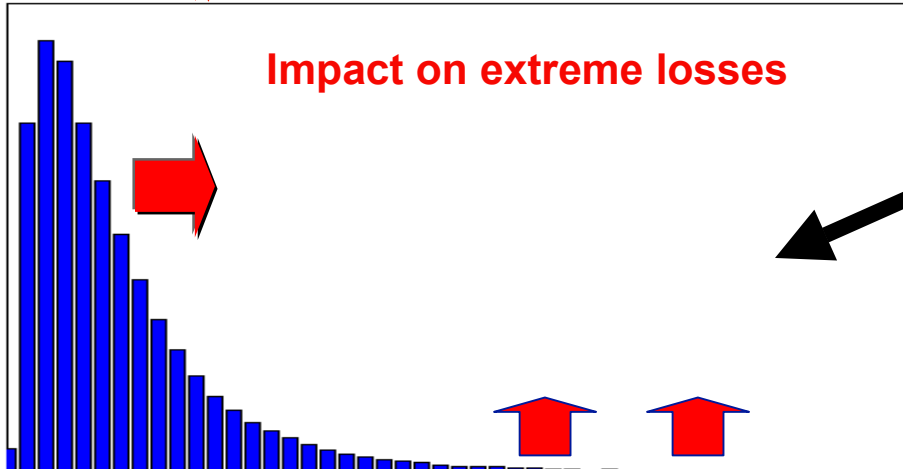
Machinery and **Automotive** move more or less in parallel under normal conditions



Stress on Machinery influences **Automotive** negatively. Its distribution is also pushed down



Impact on extreme losses

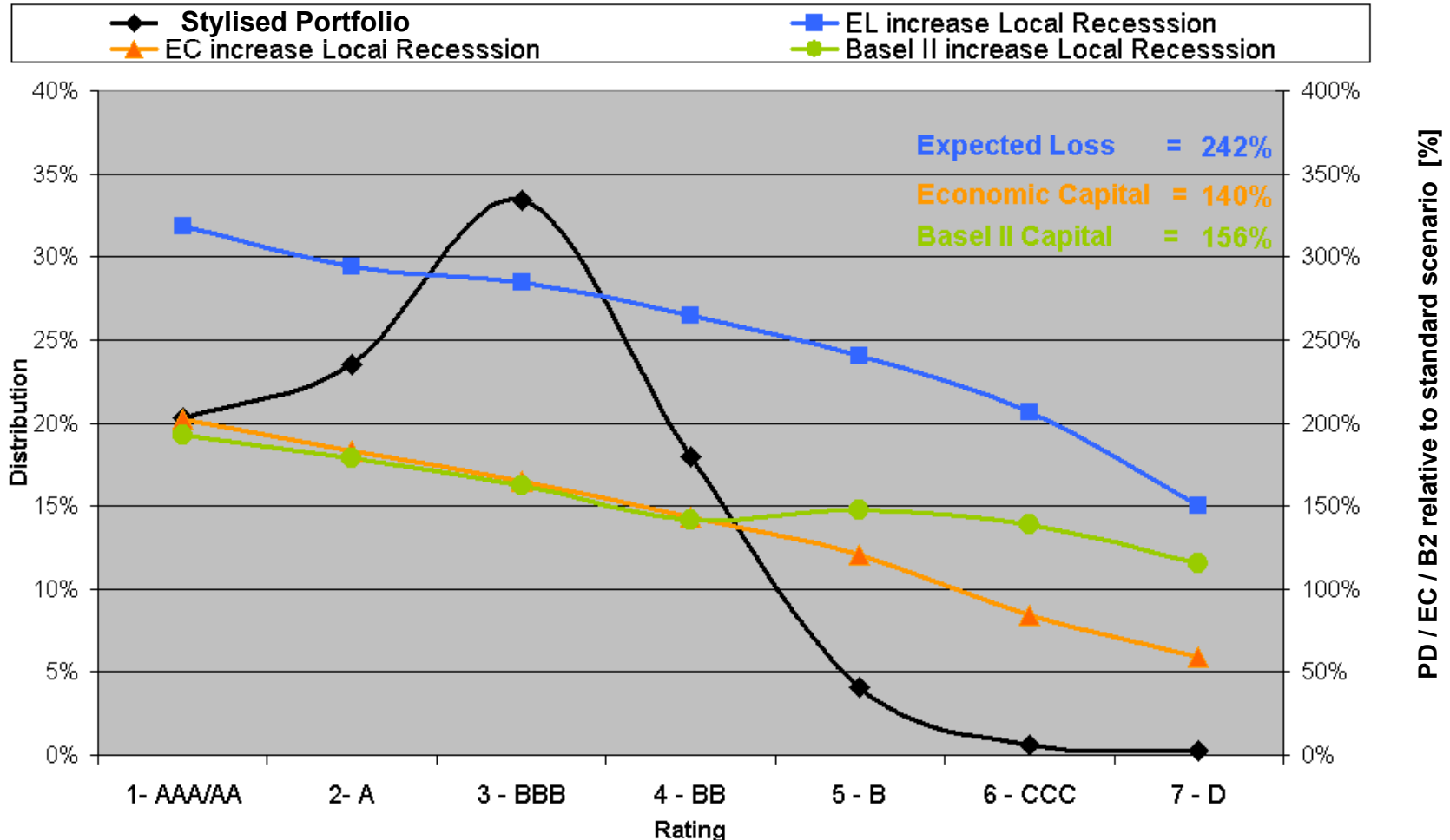


Stress on Machinery, below -28%



3. Validating Outputs

Comparison of Expected Loss, Economic Capital and Basel II Capital - Local Recession



3. Validating Outputs

Comparison of Expected Loss, Economic Capital and Basel II Capital - Global Recession

