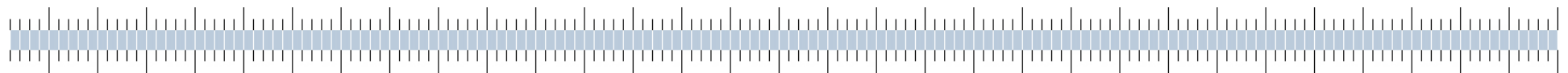


Validation

Dr. Jens Bruderhausen



2011-10-17

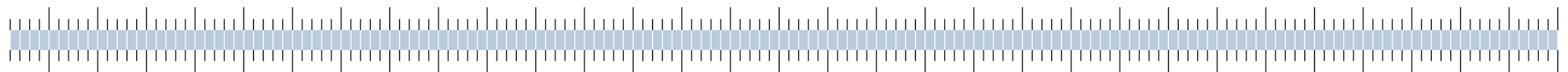
Evaluation

1

Agenda



- | **General principles**
- | **External data and 3rd party elements**
- | **Backtesting**
- | **Validation of the rating process**
- | **Q & A**

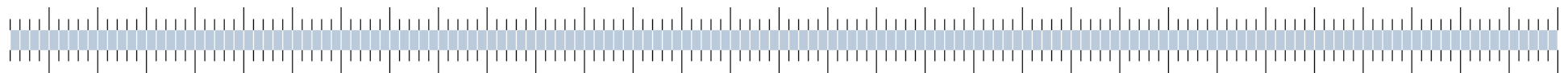


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Evaluation

2

GENERAL PRINCIPLES



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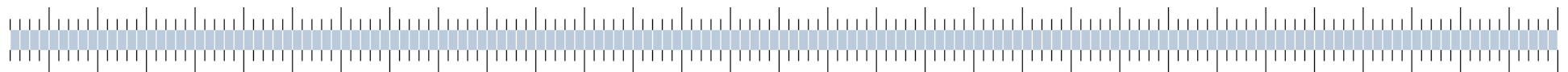
Evaluation

3

Guidelines



- | Quality of prediction and embedding of estimates in the credit process**
- | Adequate implementation**
- | There is no universal method for validation**
- | Validation is an iterative process**
- | Validation consists of quantitative and qualitative elements**



Quality of prediction

- **Broad definition of validation**

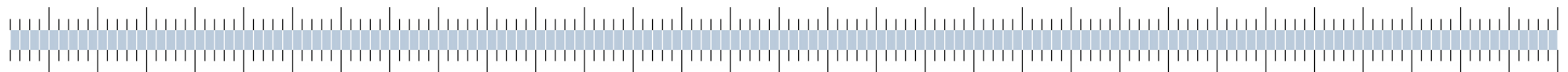
- **Stresses ability to predict**

- **Goals**

 - Quality of prediction

 - Methods and processes for measuring ability to predict

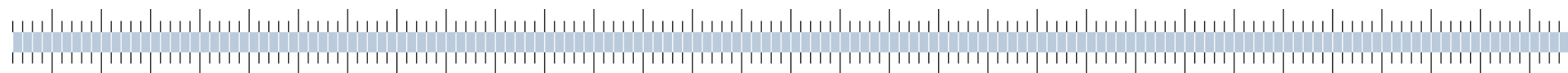
 - Embedding of validation in bank's processes



Adequate implementation

Usetest

- Assessment of bank's internal validation methods and processes is key component of acceptance by supervisory authority
- Appropriate methods and processes depend on portfolio, rating methods, defaults



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Evaluation

6

Validation process

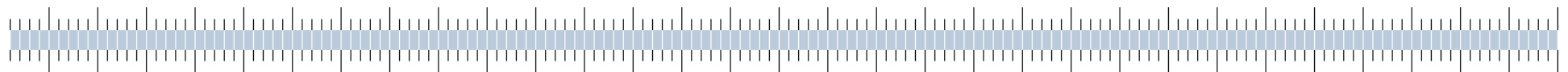
Validation of the rating method's components

- Data
- Statistical modell
- Overruling
- Monitoring

Validation of result of the rating method

Process oriented validation

- Rating proceses
- Interface to other processes

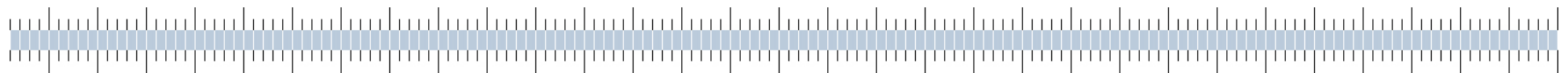


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Evaluation

7

EXTERNAL DATA



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Evaluation

8

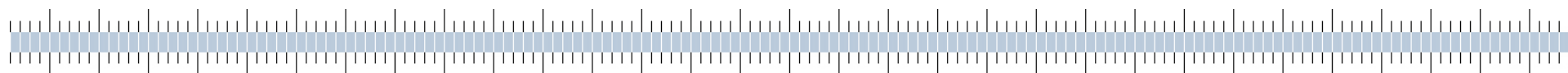
Basel rules for PD

■ Banks must meet all requirements

■ 456 Basel II:

■ A bank must record actual defaults on IRB exposure classes using this reference definition. A bank must also use the reference definition for its estimation of PDs, and (where relevant) LGDs and EADs. In arriving at these estimations, a bank may use external data available to it that is not itself consistent with that definition, subject to the requirements set out in paragraph 462. However, in such cases, banks must demonstrate to their supervisors that appropriate adjustments to the data have been made to achieve broad equivalence with the reference definition. This same condition would apply to any internal data used up to implementation of this Framework. Internal data (including that pooled by banks) used in such estimates beyond the date of implementation of this Framework must be consistent with the reference definition.

■ 462: Requirements specific to PD estimation



Basel rules for external data

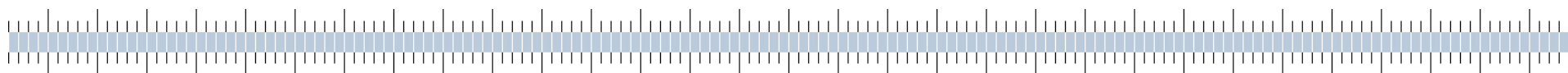
IRBA-rules allow use of external data

417 Basel II (excerpt)

- The bank must demonstrate that the data used to build the model are representative of the population of the bank's actual borrowers or facilities.

462 Basel II (excerpt)

- (...) A bank may use data on internal default experience for the estimation of PD. The use of pooled data across institutions may also be recognised. A bank must demonstrate that the internal rating systems and criteria of other banks in the pool are comparable with its own. (...)
- Banks may associate or map their internal grades to the scale used by an external credit assessment institution or similar institution and then attribute the default rate observed for the external institution's grades to the bank's grades. (...)
- The bank's analysis must include a comparison of the default definitions used, subject to the requirements in paragraph 452 to 457.

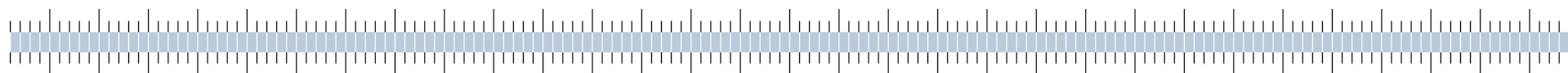


Basel rules for external models

IRBA-rules allow the use of mathematical models

417 Basel II:

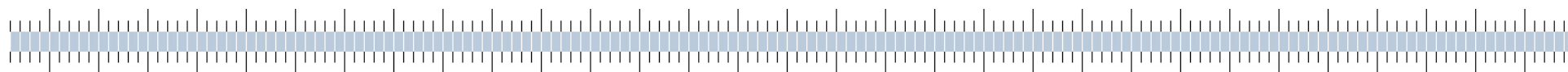
- Credit scoring models and other mechanical rating procedures generally use only a subset of available information. Although mechanical rating procedures may sometimes avoid some of the idiosyncratic errors made by rating systems in which human judgement plays a large role, mechanical use of limited information also is a source of rating errors. Credit scoring models and other mechanical procedures are permissible as the primary or partial basis of rating assignments, and may play a role in the estimation of loss characteristics. Sufficient human judgement and human oversight is necessary to ensure that all relevant and material information, including that which is outside the scope of the model, is also taken into consideration, and that the model is used appropriately.



Basel rules for external data

417 Basel II (ctd.)

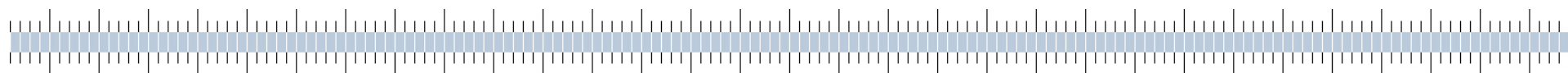
- The burden is on the bank to satisfy its supervisor that a model or procedure has good predictive power and that regulatory capital requirements will not be distorted as a result of its use. The variables that are input to the model must form a reasonable set of predictors. The model must be accurate on average across the range of borrowers or facilities to which the bank is exposed and there must be no known material biases.
- The bank must have in place a process for vetting data inputs into a statistical default or loss prediction model which includes an assessment of the accuracy, completeness and appropriateness of the data specific to the assignment of an approved rating.
- The bank must demonstrate that the data used to build the model are representative of the population of the bank's actual borrowers or facilities.
- When combining model results with human judgement, the judgement must take into account all relevant and material information not considered by the model.



Basel rules for external data

417 Basel II (ctd.)

- The bank must have procedures for human review of model-based rating assignments. Such procedures should focus on finding and limiting errors associated with known model weaknesses and must also include credible ongoing efforts to improve the model's performance.
- The bank must have a regular cycle of model validation that includes monitoring of model performance and stability; review of model relationships; and testing of model outputs against outcomes.



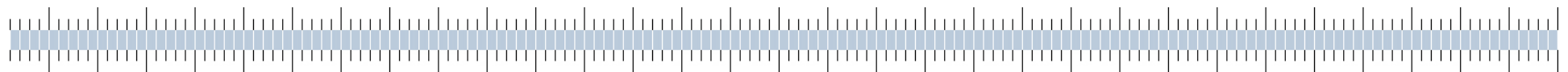
Translation of Basel rules

Internal rating models consist of two stages:

- Ranking
- Quantification of risk (internal or external)

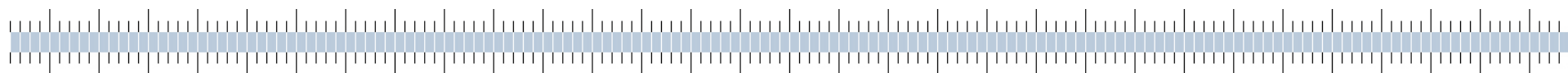
Possibly non-internal elements:

- 3rd-party data
- 3rd-party models



3rd-Party Elements

- **Verification of representativeness**
- **Analysis of discriminatory power at least yearly (internal data)**
- **Use-test**
- **Verification that all relevant data is used in the credit decision process**
- **Development sample consists of data similar to internal data (in case external data is used)**
- **Control sample consists of internal data (in case external model is used)**
- **Parameters, their weight, and their direction of action known (in case external model is used)**
- **Scope of application and limits of application known (in case external model is used)**



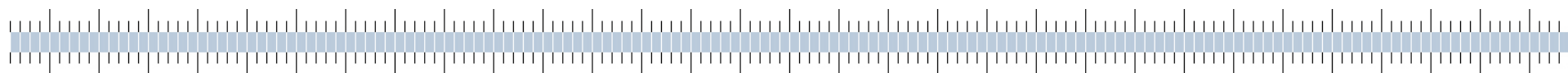
Use-test

444 Basel II

- Internal ratings and default and loss estimates must play an essential role in the credit approval, risk management, internal capital allocations, and corporate governance functions of banks using the IRB approach. (...)
- It is recognised that banks will not necessarily be using exactly the same estimates for both IRB and all internal purposes. (...)
- Where there are such differences, a bank must document them and demonstrate their reasonableness to the supervisor.

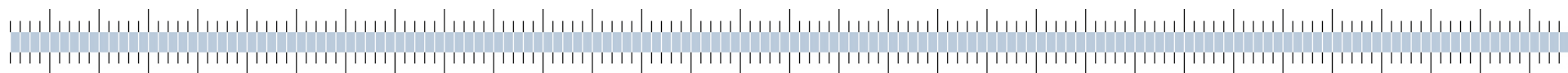
445 Basel II

- A bank must have a credible track record in the use of internal ratings information. Thus, the bank must demonstrate that it has been using a rating system that was broadly in line with the minimum requirements articulated in this document for at least the three years prior to qualification.



3rd-Party Data

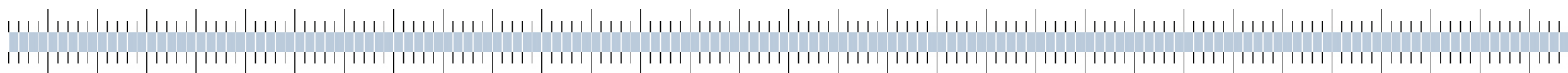
- **Verification of representativeness of external data**
- **External data includes observed rates of default as well as non-modelled PDs**
- **Existing internal data on observed rates of default can be accounted for**
- **Validation based on internal data at least yearly**
- **Appropriate mapping of the definition of default to Basel II definition of default, in case external data does not conform with this definition. Mapping has to be based on internal data.**



Basel II Definition of default

456 Basel II

- A bank must record actual defaults on IRB exposure classes using this reference definition. A bank must also use the reference definition for its estimation of PDs, and (where relevant) LGDs and EADs.
- In arriving at these estimations, a bank may use external data
- available to it that is not itself consistent with that definition, subject to the requirements set out in paragraph 462. However, in such cases, banks must demonstrate to their supervisors that appropriate adjustments to the data have been made to achieve broad equivalence with the reference definition.
- This same condition would apply to any internal data used up to implementation of this Framework. Internal data (including that pooled by banks) used in such estimates beyond the date of implementation of this Framework must be consistent with the reference definition.

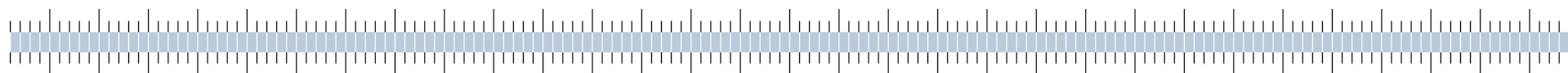


3rd-Party Risk Quantification

■ Not acceptable in case of unknown external model

■ Use of external data acceptable, provided

- Rating classes / rating segments, on which the external model was built, are compatible with the risk content of internal data
- External data used for building the model consists of observed default rates and not on PDs calculated with a model
- Use of internal data on observed default rates
- Validation based on internal data at least yearly
- Appropriate mapping of the definition of default to Basel II definition of default, in case external data does not conform with this definition. Mapping has to be based on internal data.



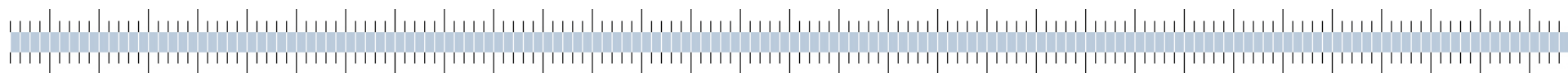
3rd-Party Rating

Adoption of 3rd-party ratings comprises:

- Fundamentals: Data, risk parameters, methods etc., or
- Results: e.g. subsidiary company adopts rating issued by parent company

Requirements

- No curtailing with internal risk measurement and risk control
- All relevant internal data is used in the external rating to full extent
- Internal validation methods are able to detect misjudged external ratings
- Validation can be externalised (e.g. pool projects)
- Defined set of rules for adopted external elements

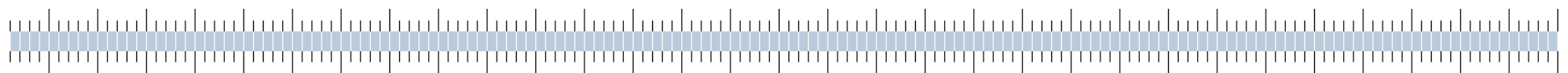


2011-10-17

Evaluation

20

BACKTESTING



2011-10-17

Evaluation

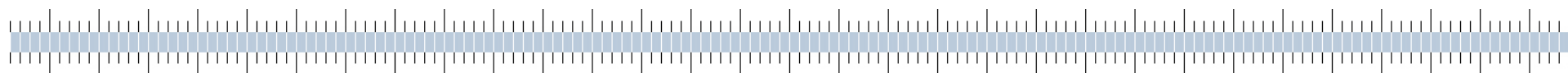
21

Backtesting

Compare predicted performance with observed performance

501 Basel II

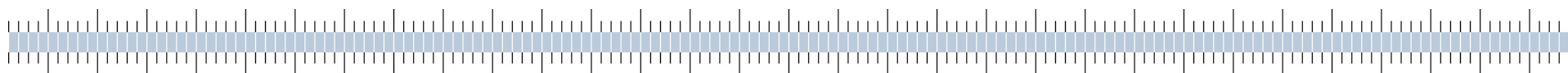
- Banks must regularly compare realised default rates with estimated PDs for each grade and be able to demonstrate that the realised default rates are within the expected range for that grade. Banks using the advanced IRB approach must complete such analysis for their estimates of LGDs and EADs.
- Such comparisons must make use of historical data that are over as long a period as possible.
- The methods and data used in such comparisons by the bank must be clearly documented by the bank. This analysis and documentation must be updated at least annually.



Backtesting

Comparison between internal market risk models and internal rating based models of default risk

	Market risk	IRB
Prediction	VaR	PD, EL
Observed data	Clean P&L	Default rate, loss
Frequency	250 times a year	Once a year
Pre-requisite	Evaluation of clean P&L, time series of VaR and clean P&L	Time series of default and migration events
Backtest method	Binominal	??? (Confidence level > 99.0 %)



Backtesting

Measuring default rate

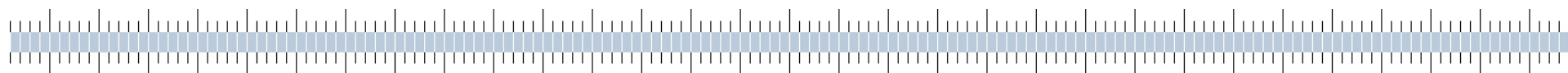
$$\text{(observed) default rate} = \frac{\text{number of defaulted loans per period per rating class}}{\text{total number of loans per rating class}}$$

Define!

- Period of time and number of defaulted loans
- Total number

Competing definitions (forthcoming):

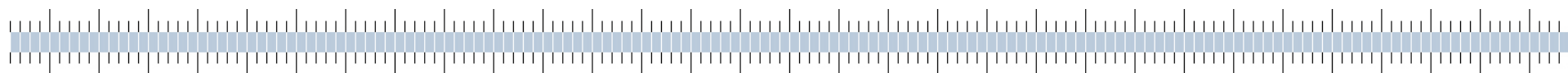
- Static pools vs. dynamic pools
- Showing that observed default rates are subject to
 - Method of detection of default
 - Susceptible to manipulation



Backtesting

Static pools

- All ratings frozen in at a given point in time.
- Nominator: Number of defaulted loans within a 1-year period beginning with the fixed point in time
- Denominator: Fixed by frozen ratings
- Disadvantages
 - (Cf. forthcoming example)
 - Data on defaulted loans may be lost
 - Assignment of defaulted loans may be incorrect
 - Susceptible to manipulation



2011-10-17

Evaluation

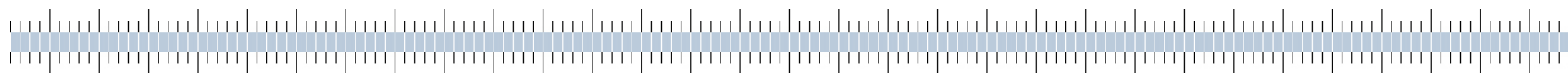
25

Backtesting

Static pool (ctd.)

A small example: Two periods (p1, p2), two rating classes for performing loans (a1,a2), one rating class for defaulted loans (d). Pool is created at time T, where $t1 < t2 < T < t3 < t4 < T + 1 < t5 < t3 + 1 < T + 2$

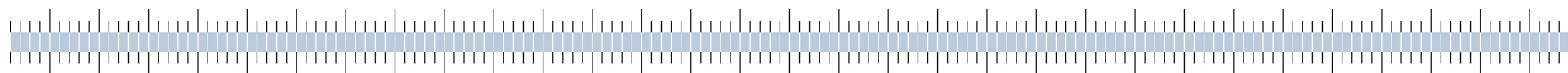
Loan			p1		p2
	t1	t2	t3	t4	t5
1	a1	a1	a1	a1	d
2	a1	a1	a1	d	
3	a1	a2	a1	a1	a1
4	a1	a2	a1	d	
5	a1	a2	a1	a1	d
6			a1	d	



Backtesting

Dynamic pool

- A new period starts every new day
- Numerator: Number of every loan defaulted in one of the 250 (static) pools
- Denominator: Number of loans present in at least one of the 250 (static) pools
- Advantage:
 - No loss of default data
- Disadvantages
 - At least 2 years of data needed for measuring a one-year default rate
 - (Weighted) mean of default rates is not the prior default rate



2011-10-17

Evaluation

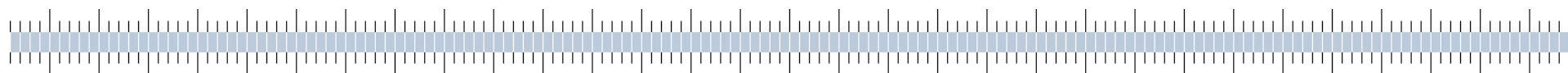
27

Backtesting

Dynamic pools (ctd.)

Above example re-considered

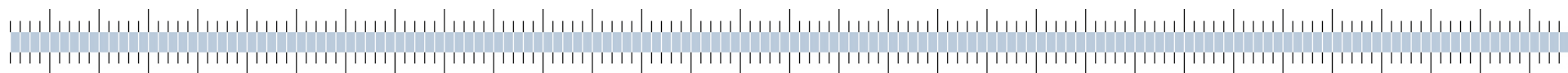
Loan			p1		p2
	t1	t2	t3	t4	t5
1	a1	a1	a1	a1	d
2	a1	a1	a1	d	
3	a1	a2	a1	a1	a1
4	a1	a2	a1	d	
5	a1	a2	a1	a1	d
6			a1	d	



Backtesting

Binomial test: Results

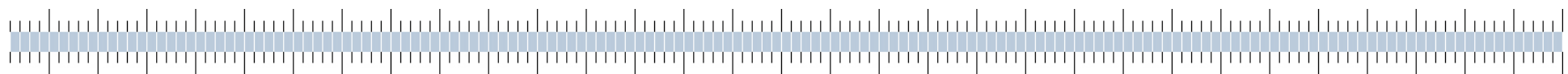
- Unrealistic, because in real lifeTM correlation between defaults exists and is far too influential to be ignored
- Correlation between defaults suggests, that the number of defaults will be higher than predicted by the binomial model. This effect will grow with PD, pool size and confidence level
- Models incorporating default correlation
 - Creid Risk+ (JP Morgan)
 - Credit Metrics (Credit Suisse)
- Special case: One-factor model (Gory model)
- Test can only be part of a bottom-up-approach



Backtesting

Asset correlation

- Single risk factor in Gordy's (Basel) model
- Factors chosen for Basel II are politically influenced (no loss of capital in the banking system)
- Divergent values across econometric studies, depending on analytical method used, period evaluated, sector evaluated etc.

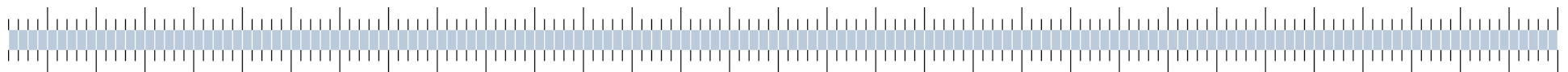


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Evaluation

30

VALIDATION OF THE RATING PROCESS



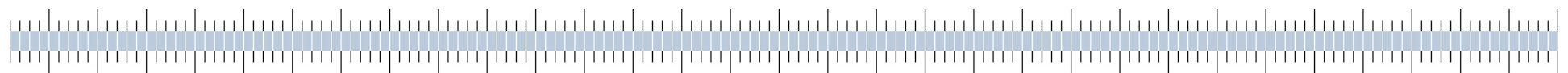
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Evaluation

31

Validation of the rating process

- **Most important issue for supervision**
- **Examination comprises**
 - Examination of the rating process
 - Interdependency with other processes



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Evaluation

32

Validation of the rating process

438 Basel II

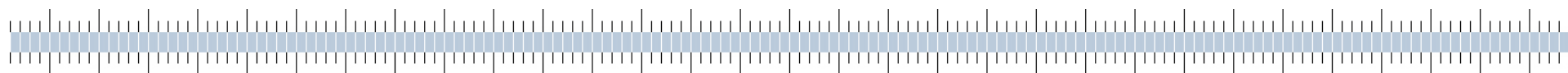
- All material aspects of the rating and estimation processes must be approved by the bank's board of directors

444 Basel II

- Internal ratings and default and loss estimates must play an essential role in the credit approval, risk management, internal capital allocations, and corporate governance functions of banks using the IRB approach. Ratings systems and estimates designed and implemented exclusively for the purpose of qualifying for the IRB approach and used only to provide IRB inputs are not acceptable.

445 Basel II

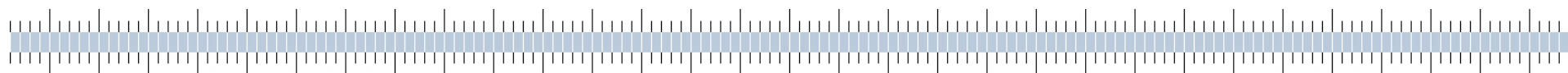
- A bank must have a credible track record in the use of internal ratings information. Thus, the bank must demonstrate that it has been using a rating system that was broadly in line with the minimum requirements articulated in this document for at least the three years prior to qualification.



Validation of the rating process

■ Suggested issues for examination

- Rating takes place before credit approval?
- Can the bank assign a rating to all creditors the rating system is designed for?
- Is bank's staff aware of the mode of operation and the limits of the rating system?
- Updating of ratings takes place in a timely manner and at least yearly?
- How does the bank conform to the timely manner?
- How do staff and rating system collaborate?
- When does the rating system have to be re-calibrated?
- Comparison between default rate derived from the rating class suggested by the system (clean default rate) and the rating class assigned by staff (dirty default rate). A working system should give evidence that staff is able to detect adverse loans.
- rating-dependent pricing of loans



Credit portfolio

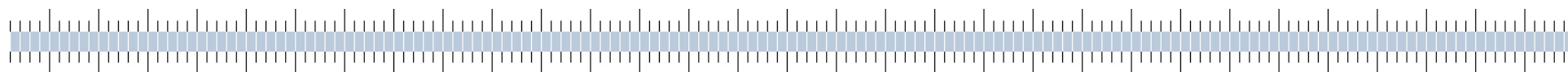
Use of credit risk models is mandatory (de factor) and the exmansion should be part of the supervisory review process (SRP)

733 (691) Basel II

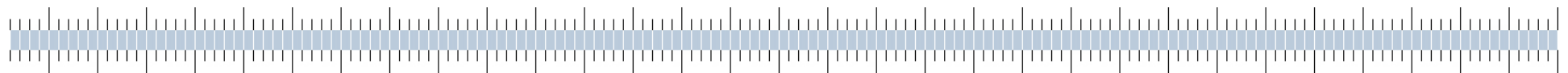
- Banks should have methodologies that enable them to assess the credit risk involved in exposures to individual borrowers or counterparties as well as at the portfolio level.**
- For more sophisticated banks, the credit review assessment of capital adequacy, at a minimum, should cover four areas: risk rating systems, portfolio analysis/aggregation, securitisation/complex credit derivatives, and large exposures and risk concentrations.**

735 (693) Basel II

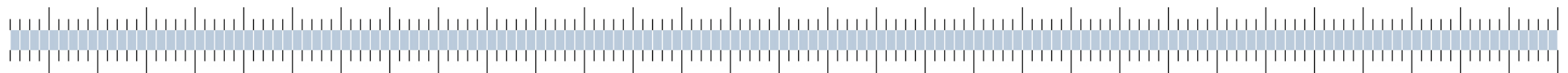
- The analysis of credit risk should adequately identify any weaknesses at the portfolio level, including any concentrations of risk.**
- It should also adequately take into consideration the risks involved in managing credit concentrations and other portfolio issues through such mechanisms as securitisation programmes and complex credit derivatives.**



Q & A



SUGGESTED READING



2011-10-17

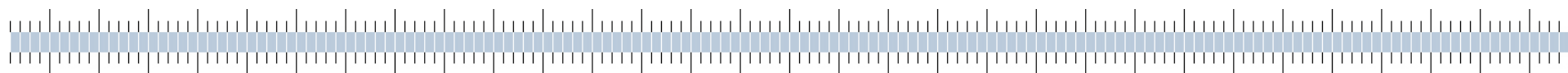
Evaluation

37

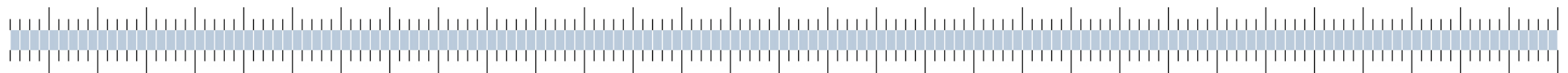
Suggested reading



- Blochwitz / Hohl, Reconciling Ratings, Risk Magazine, 2001 (June), pp. 87ff.
- Huschens / Stahl, A General Framework for IRBA Backtesting, Dresdner Beiträge zu quantitativen Verfahren 39/04, 2004
- Gordy, A Comparative Anatomy of Credit Risk Models, Journal of Banking and Finance, 24 (2000), pp. 119ff.



APPENDIX



2011-10-17

Evaluation

39

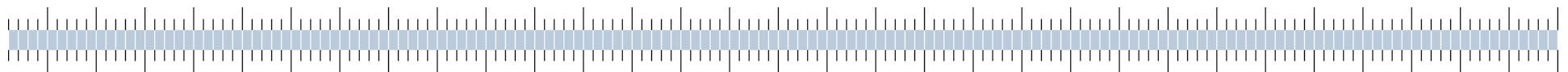
Monte Carlo simulation

■ Szenario: Rating agencies' default studies

- Static pool
- Insufficient quantity of data
- High degree of variation in the data

■ Assumptions related to PDs

- There exists a (unique) relationship between individual probability of default and rating class
- Individual probability of default is observable (with low error)
- No correlation between defaults
 - within each static pool as well as
 - between each static pool



2011-10-17

Evaluation

40

Binomial test

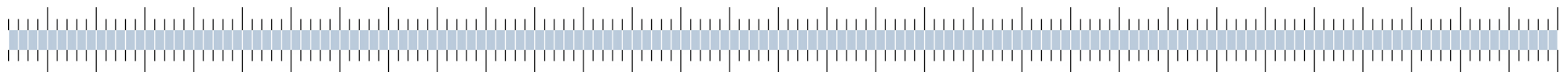
Calculation of defaults per rating class

No. of objects in rating class: N_{tot}

PD identical: p

Default indicator $D_i = \begin{cases} 1 & i \text{ defaults} \\ 0 & \text{else} \end{cases}$

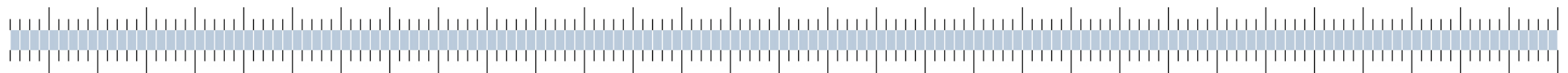
Estimated default rate: $\hat{p} = \frac{1}{N_{tot}} \sum_{i=1}^{N_{tot}} D_i$



Binomial test



Application of central limit theorem



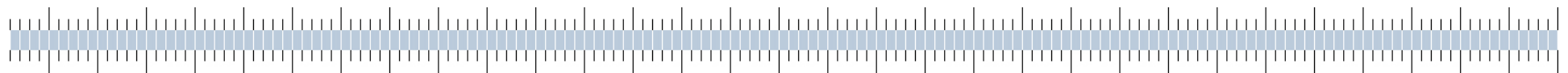
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Evaluation

42

One Factor Model

- Simulate predicted default rate via one factor model
- One factor model s.t. different talk



2011-10-17

Evaluation

43