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Modelling Credit Risk
Croatian Quants Day

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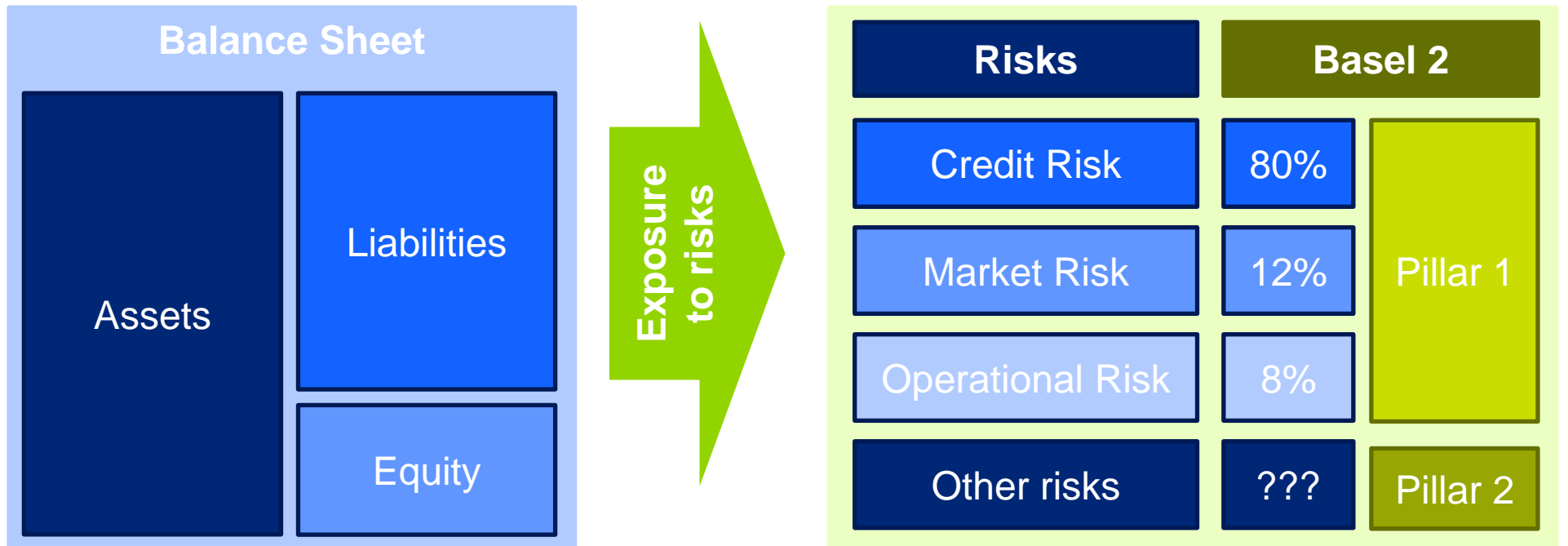
Zagreb, 9 April 2010

Agenda

1. Risk management in banking

2. What is Credit Risk?

3. Modelling Probability of Default (PD)

4. Conclusion

Risk Management in banking

Business case of the banks:
- intermediaries between lenders and borrowers
- financial instruments transactions
- other services

Balance Sheet		Exposure to risks	Risks		Basel 2	
Assets	Liabilities		Credit Risk	80%	Pillar 1	
	Equity		Market Risk	12%		
			Operational Risk	8%		
			Other risks	???	Pillar 2	

Need for regulation

Managing risks

Quantitative aspects (measurement)	Qualitative aspects (governance)

What is Credit Risk?
… and how to describe it analytically…

Definition: Credit risk can be defined as **risk of loss** arising from inability of the contractual party to **partially or fully fulfil** its contractual obligations

Process: 1. Payment of contractual obligations – risk of non-payment

2. In case of non-payment legal prosecution – recovered amount

Uncertainty

Loss

Probability of Default (PD)

- assumes concept of **Default**
  - simplified definition: borrower stops to pay its obligations
  - in practice: 90 DPD or Unlikely to Pay
- binomial event (0/1)
- customer oriented
- focus on credit quality, that is ability to repay

Loss Given Default (LGD)

- recovery rate
- models percentage of exposure that will be lost under assumption that default has occurred
- based on facility

Exposure at Default (EAD)

- credit conversion factor is modelled - percentage of usage of credit limits (e.g. revolving, overdrafts, unused credit lines etc.)
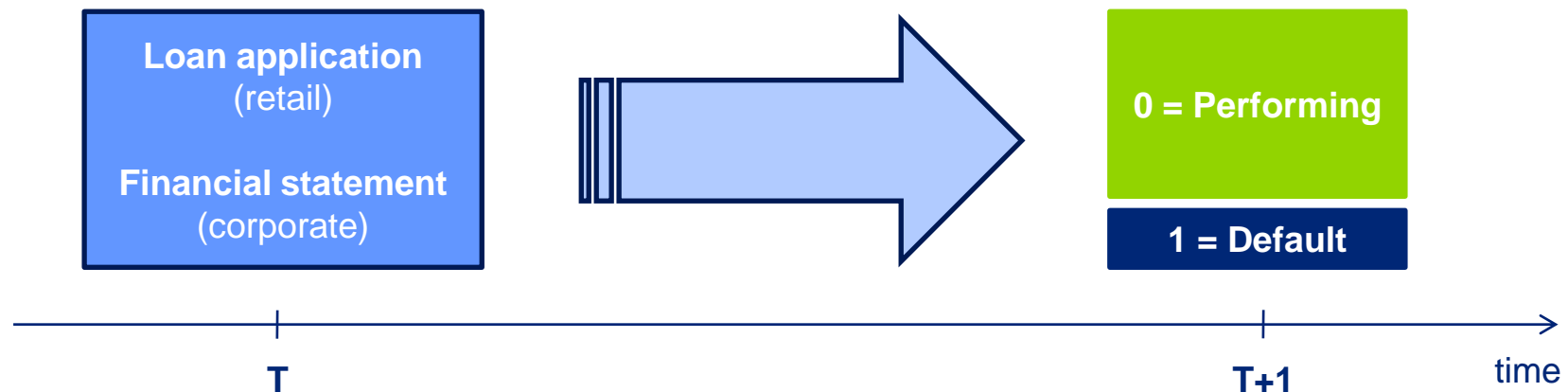
Expected loss (EL) = **PD** X **LGD** X **EAD**

Modelling Probability of Default (PD)
Introduction

<u>Definition:</u> Probability that counterparty will satisfy **default definition** within predefined **time horizon** (e.g. 1 year)

- **Binomial event**: Default flag (0/1) is target (dependent) variable

- We do not model **which client** will default, but rather **what is probability** that observed client (with certain characteristics) will default!
  - **client's characteristics** = independent variables that predict probability of default (i.e. dependent variable)
  - **idea**: $PD_i = f(X_{1,i}, ..., X_{k,i})$
  - **task:** to estimate functional relationship **f**

- **What characteristics we expect from the model**:
  - good **predictive power** - to separate good from bad clients
  - good **calibration** - to estimate "level of risk" with adequate precision

Modelling Probability of Default (PD)
Example of client's characteristics that influence credit quality

Retail	Corporate

Retail

Financial statements (i.e. financial indicators):
- Size (Total assets, Total Sales, …)
- Profitability (EBIT/Assets, ROE, Profit margins,…)
- Liquidity (Current ratio, Quick ratio, …)
- Growth (1 year Sales growth, …)
- Leverage (Debt to Equity, …)

Qualitative questionnaires (i.e. qualitative information about company):
- Quality of financial statement
- Quality of management
- Market position
- Relationship with the bank

Corporate

Socio-Demographic variables:
- Age
- Number of children
- Marital status

Economic variables:
- Level of education
- Occupation
- Years of employment

Financial variables:
- Monthly salary
- Salary averages

Stability variables:
- Number of years:
  - At current address
  - On current job

Behavioural variables

- Number of sent payment notices
- Days of delay
- Average monthly inflow on giro account (in last quarter, year, etc)
- Utilization of approved credit lines etc.

Modelling Probability of Default (PD)
Methodological approach

Task: to estimate functional relationship $PD_i = f(X_{1,i}, ..., X_{k,i})$
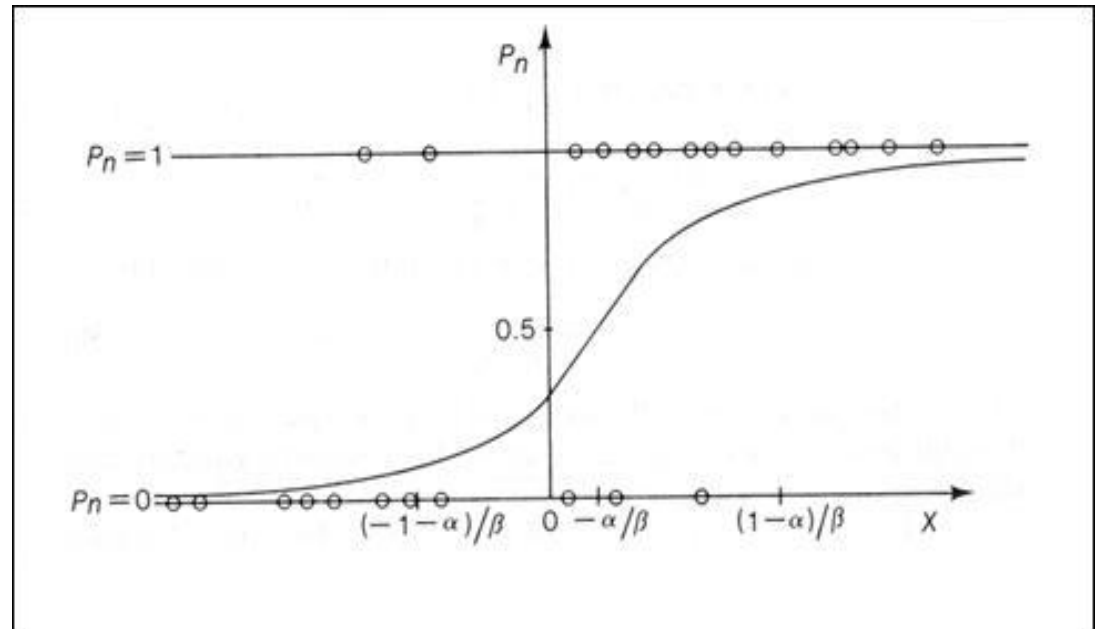
- **Regression models** - most common used apporach in practice
  - academic example: **linear reggresion** – can't work (binomial event!)
  - **logit** and **probit** models

- **Logit model** (used in practice):

$$score = \ln\left(\frac{PD_i}{1-PD_i}\right) = \beta_0 + \beta_1 x_{1i} + \cdots + \beta_k x_{ki}$$

$$\ln\left(\frac{PD_i}{1-PD_i}\right) = score \iff PD_i = \frac{1}{1+e^{-score}}$$
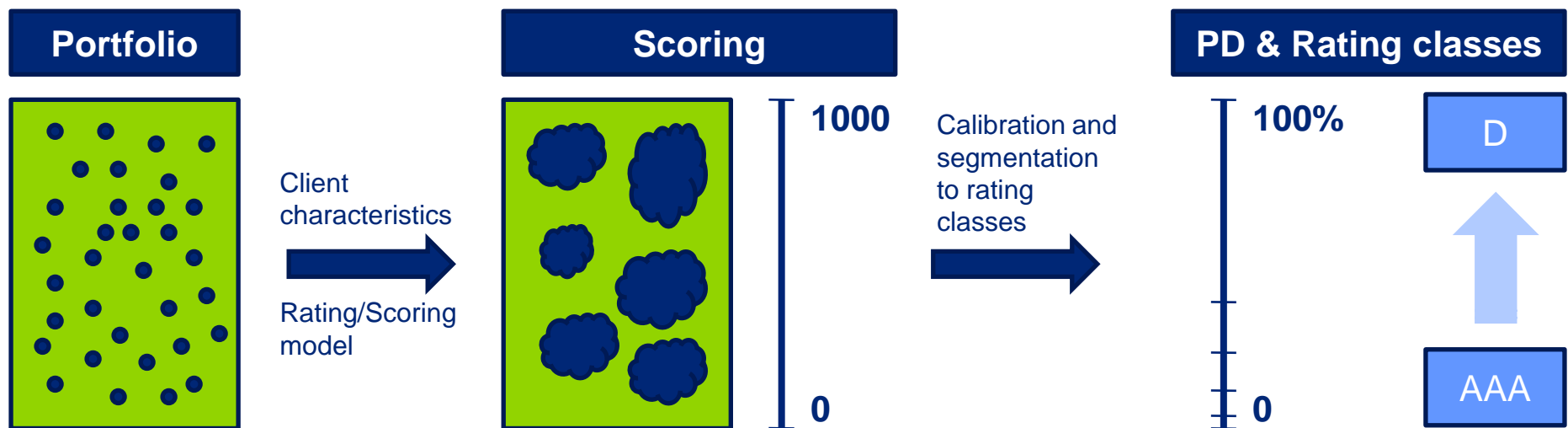
odds - ratio of bad and good

- **Parameters estimation** – e.g. MLE method; In practice usage of statistical tools (e.g. SAS, Matlab)

Modelling Probability of Default (PD)
Summary

- **End result**: Rating model which based on client's characteristics estimates probability of default (PD). Final step is aggregation of counterparties with similar PD levels in rating classes (example: S&P, Moody's,…)
- Rating class is characterized by assigned PD (e.g. S&P's AAA - PD from 0% to 0,03%)
- **Example:** from 10000 counterparties with AAA rating not more than 3 are expected to default in the given time horizon (e.g. 1 year)

Portfolio	Scoring	PD & Rating classes

Client characteristics

Rating/Scoring model

1000

0

Calibration and segmentation to rating classes

100%

0

D

AAA

**Biggest challenge in practice – data:**

- IT architecture design, record keeping, data management and data quality
- experience shows that many problems emerge from unsatisfactory quality and availability of data
- models are as good and accurate as are the data on which they are developed
- preparation of raw data are extremely time consuming

Conclusion
Beyond mathematics

Usage of models:

- **loan pricing**
- loan underwriting
- regulatory capital calculation
- loan loss provisions calculation

Margin	3%
Credit risk	**2%**
Borrowing cost	5%

10%
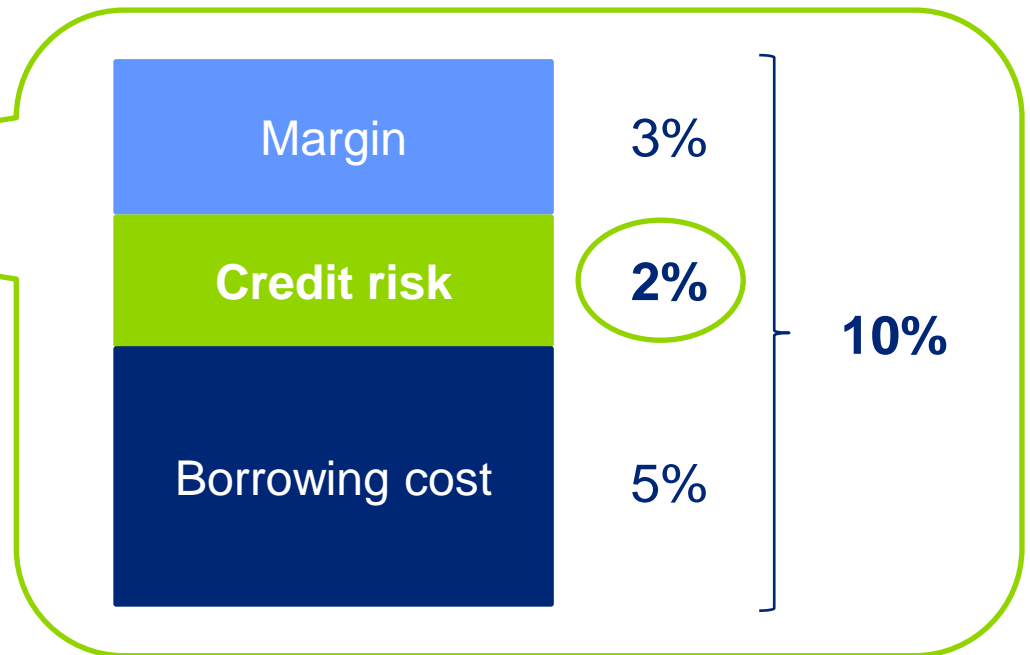
How to become good Credit Risk modeller – wide range of skills and expertise needed:

- **Mathematical** and statistical knowledge
- **Programming** skill set (SAS, Matlab, SQL, ...)
- General **IT knowledge** (DW, data management, …)
- **Economics** and **Finance**
- Understanding of **Regulation**
- **Banking processes**
- **Soft skills**