GENERIC FIRE RISK ASSESSMENT FOR RESIDENTIAL AND INDUSTRIAL BUILDINGS

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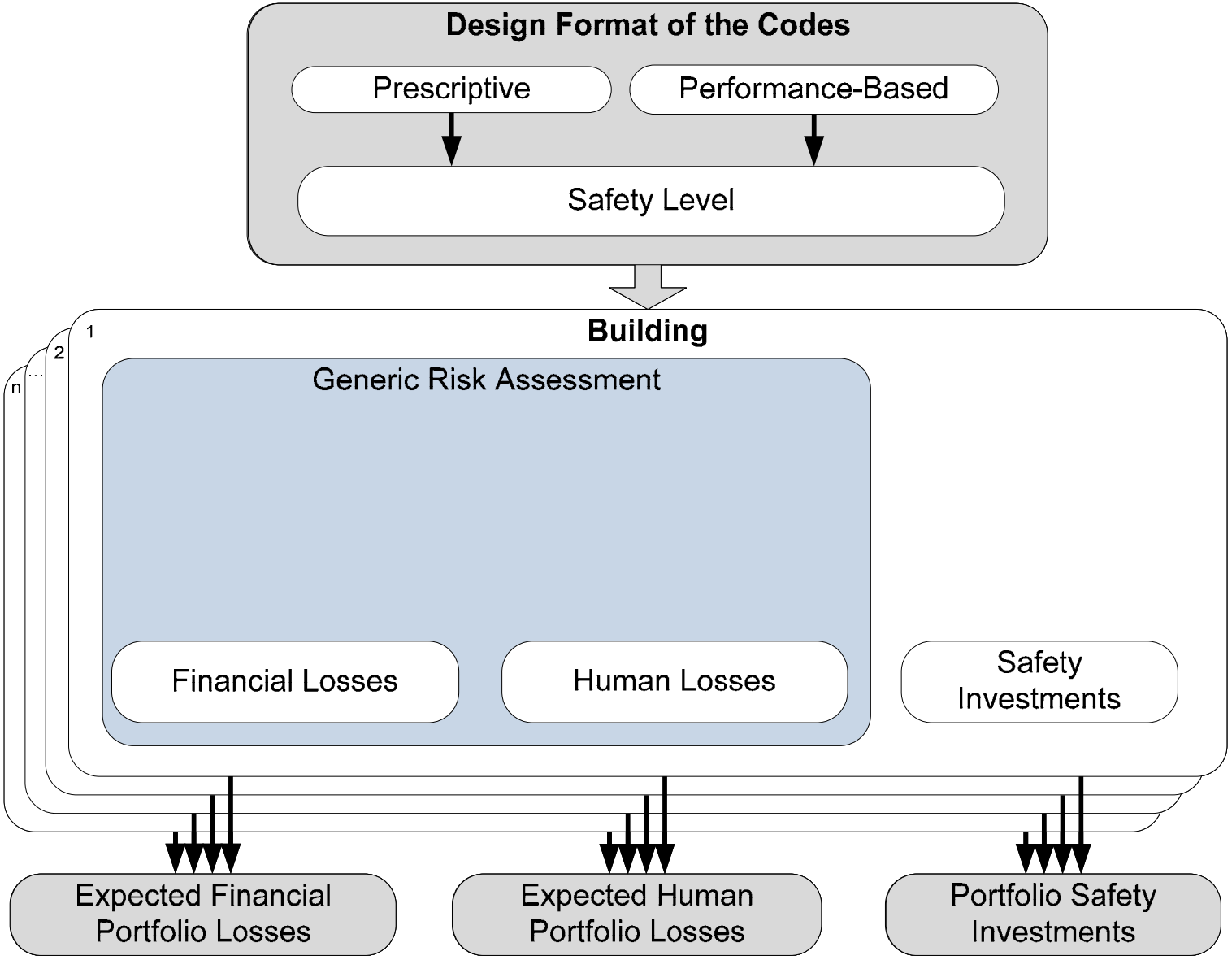
EFFICIENT SAFETY REQUIREMENTS FOR THE CODES

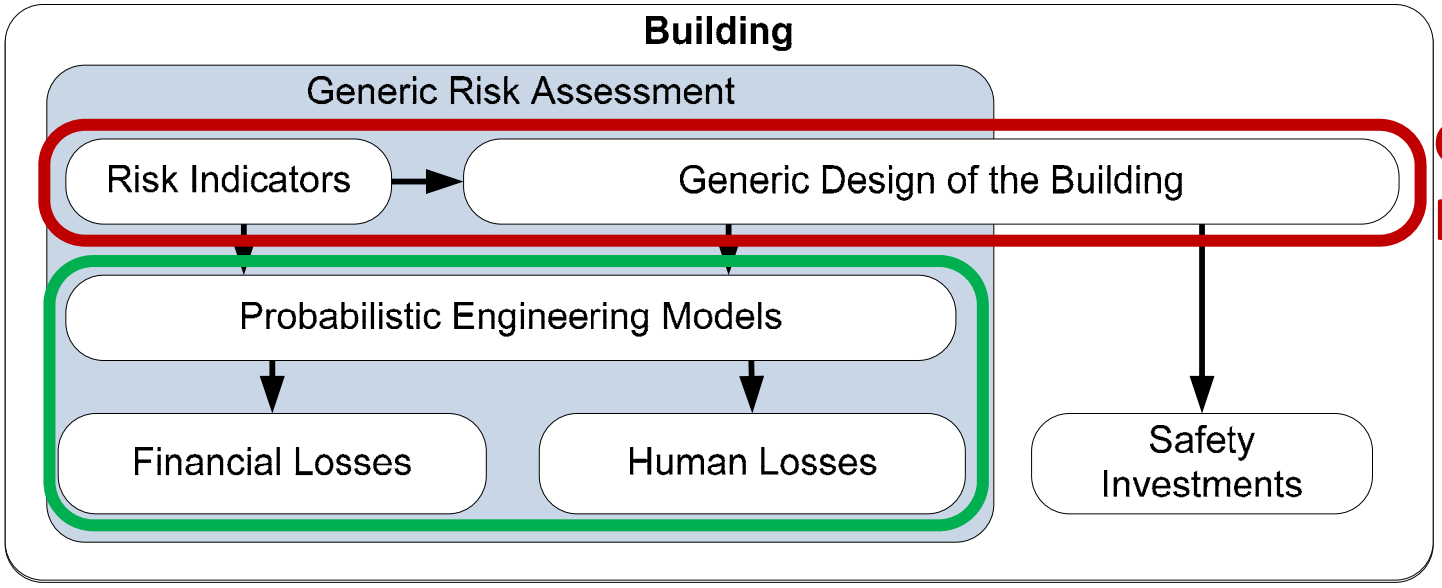


GENERIC RISK ASSESSMENT

Requirements for a generic risk model

- Applicable for most buildings in a portfolio
- Quantitative assessment of the risk

  → Physical effects of the required fire safety measures
- Unbiased assessment of the portfolio risk

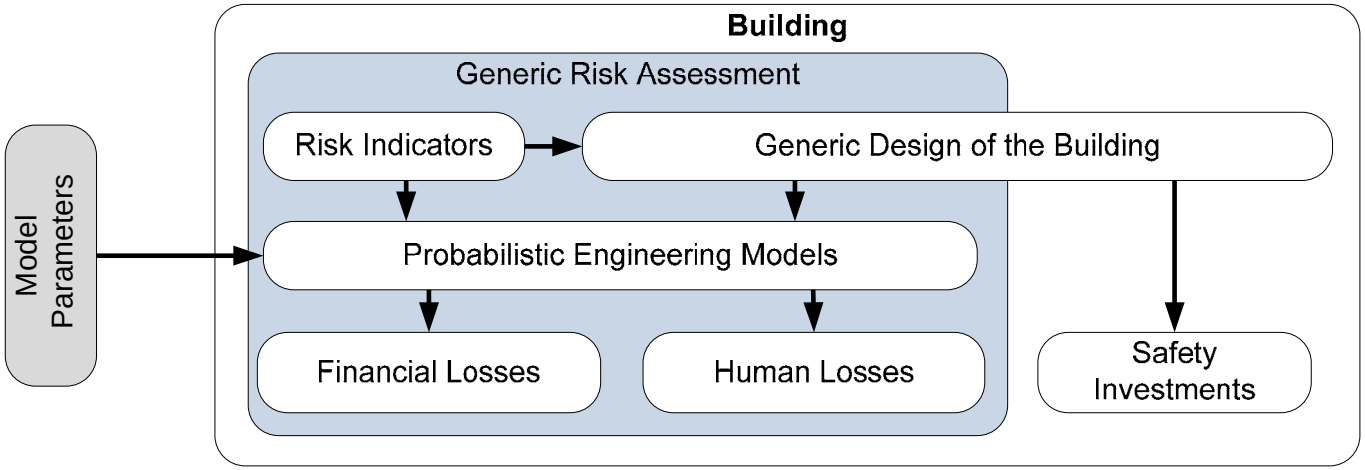


Generic System Representation

Risk Analysis

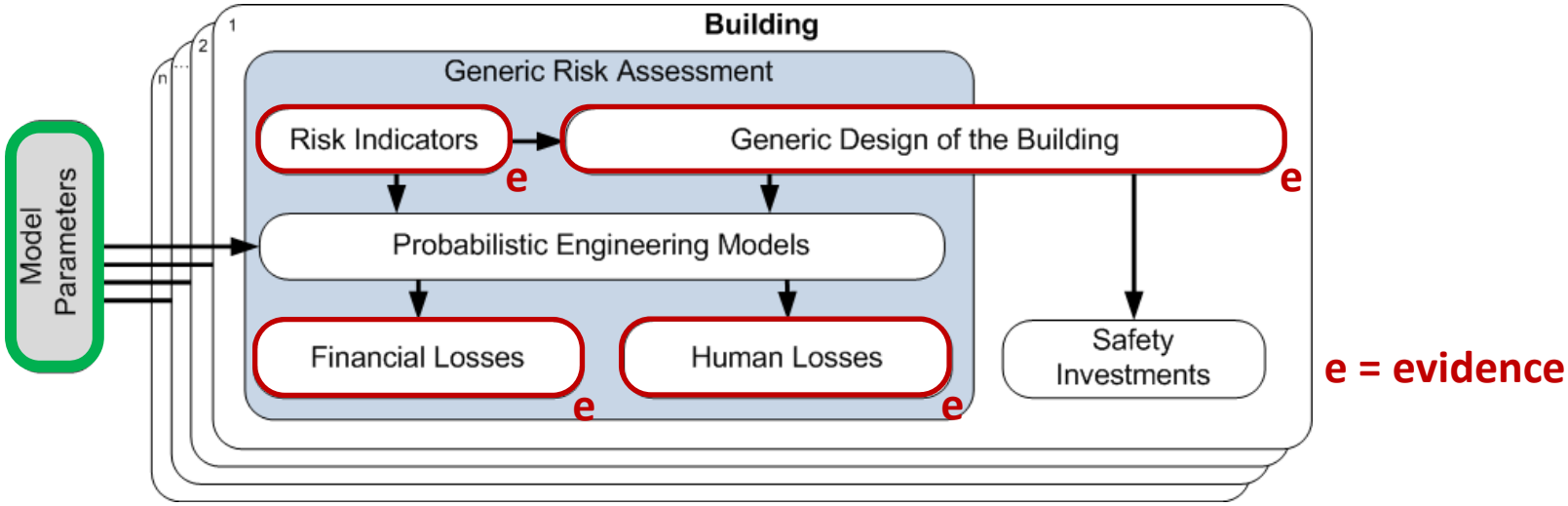
RISK ANALYSIS

- Engineering models are able to quantify the losses based on the risk indicators and physical or empirical understanding of the problem
- Probabilistic engineering models allow to consider the uncertainties of the risk indicators consistently
- Due to simplification and approximations, engineering models will never predict the real behaviour of a system exactly. The resulting loss estimation will be biased.
- This lack of fit could be considered by model parameters

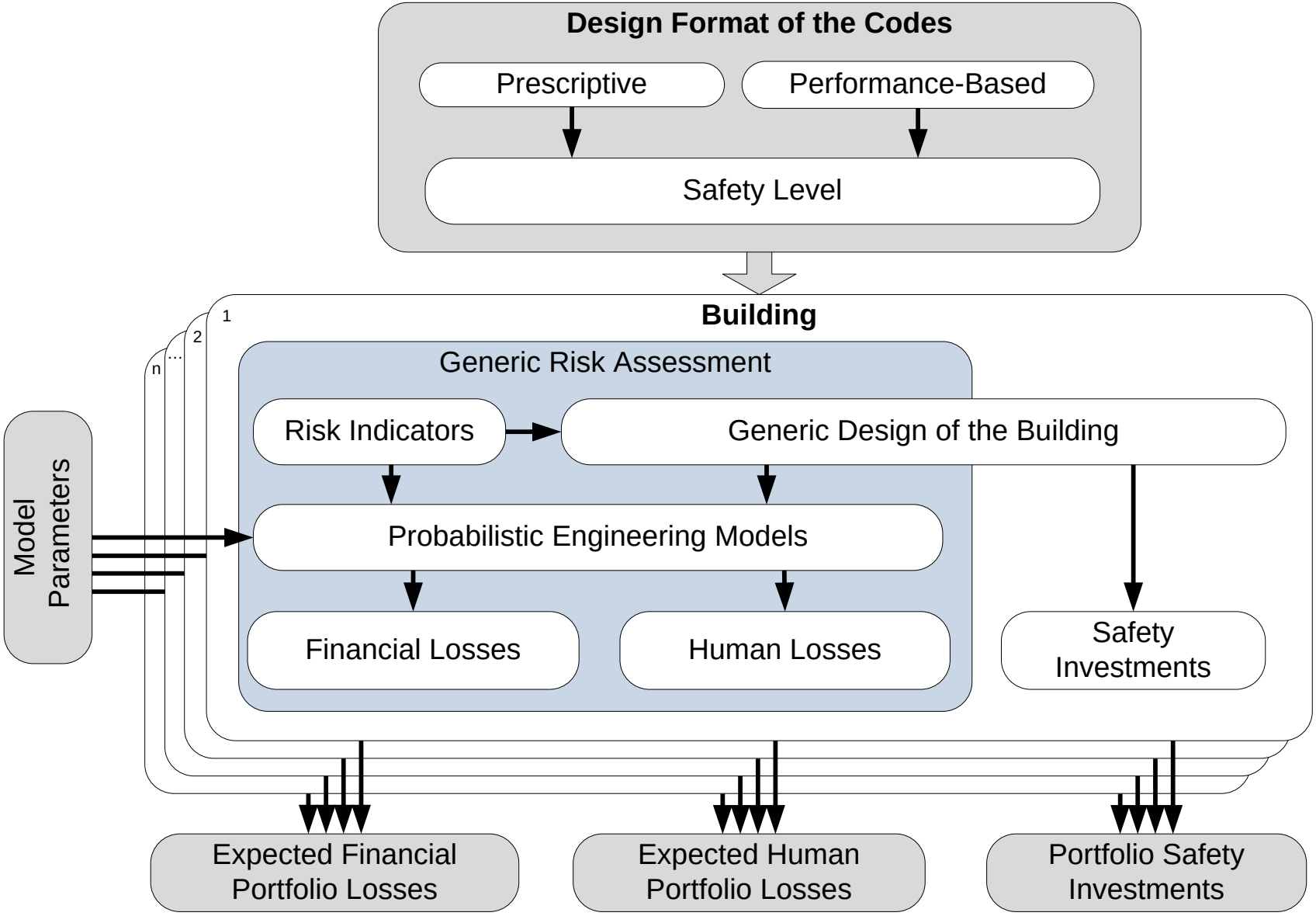


COMBINING AN ENGINEERING APPROACH WITH DATA

- A calibration of the model with observed data leads to an unbiased estimation of the expected losses on **portfolio level**
- The aim is to quantify the model parameters through the available data
- Methods:
  - Maximum Likelihood Method → select model parameters such that the observed values obtain the greatest probability
  - Bayesian Updating → for involving prior information
- Model parameter and its associated uncertainties can be assessed for the hole portfolio



PORTFOLIO RISK ASSESSMENT



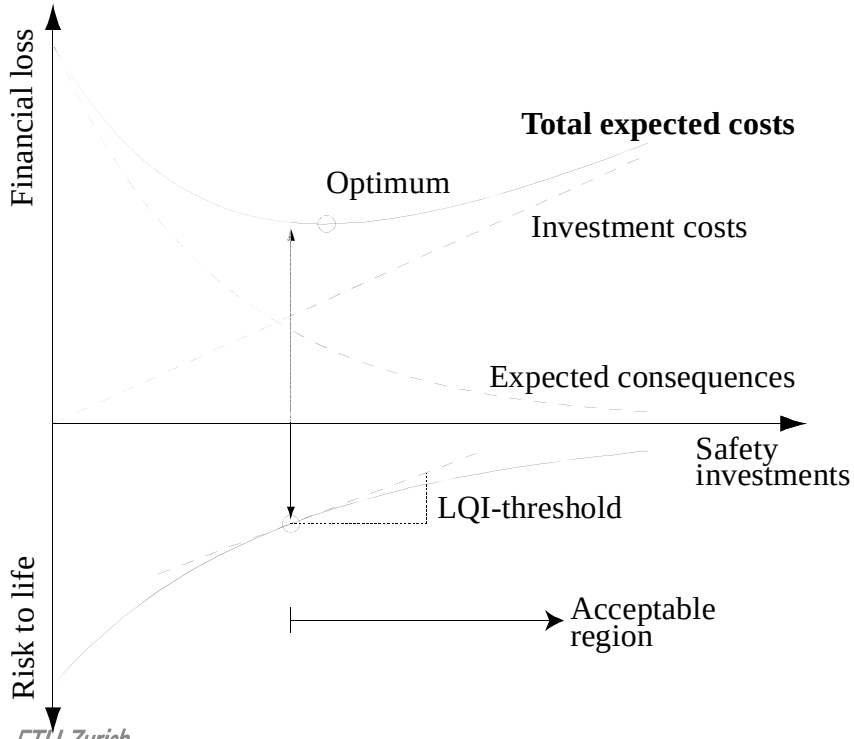
EFFICIENT FIRE SAFETY MEASURES

Life Safety

- A rational acceptance criterion for decisions regarding life safety can be derived based on the Life Quality Index (LQI)
- The LQI define a threshold for the societal willingness to pay for a marginal increase in life safety

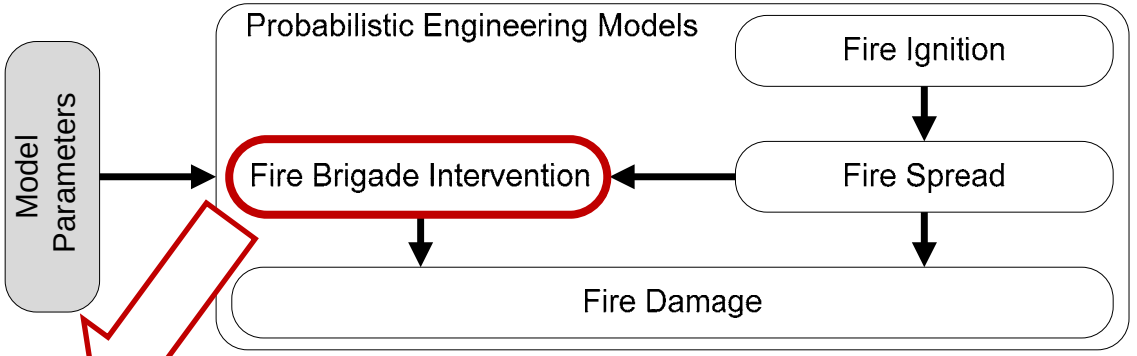
Financial Losses

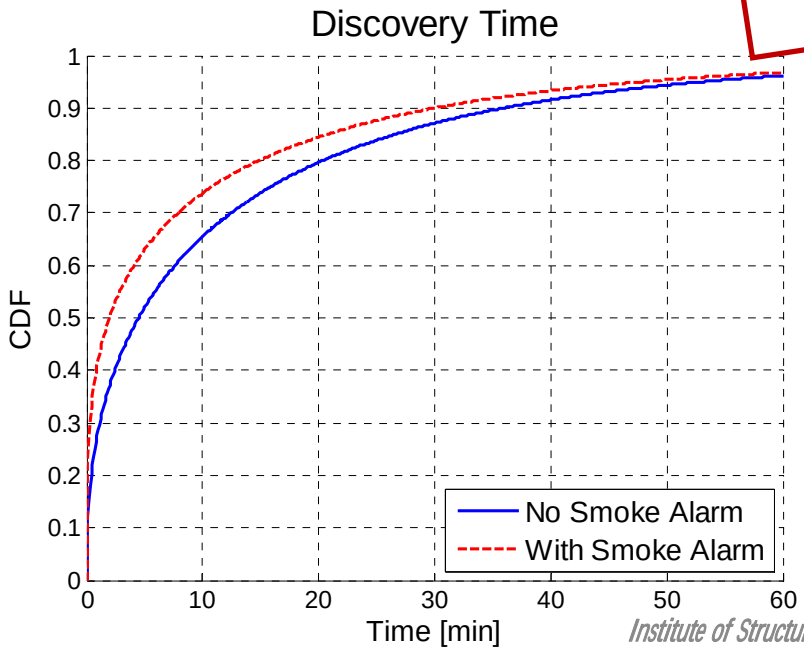
- Minimizing the total expected costs while the fire safety measures fulfil the Life Safety conditions derived from the LQI principle



SINGLE FAMILY HOUSES

An economical examination: should smoke alarms be required for single family houses?





Smoke Alarm:

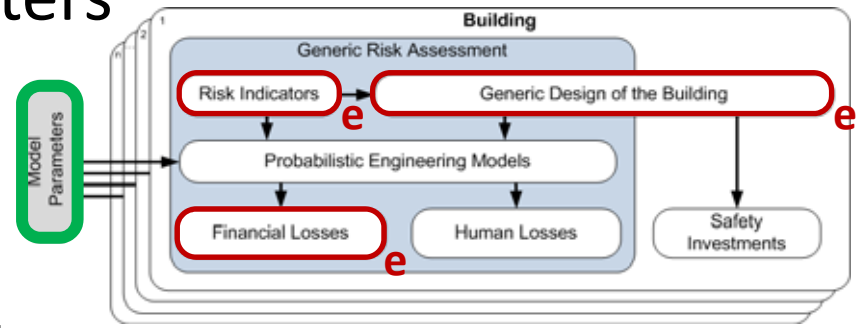
- Increasing probability of fire discovery (derived from statistical data[1][2])
- Increasing probability that the fire brigade will arrive sooner

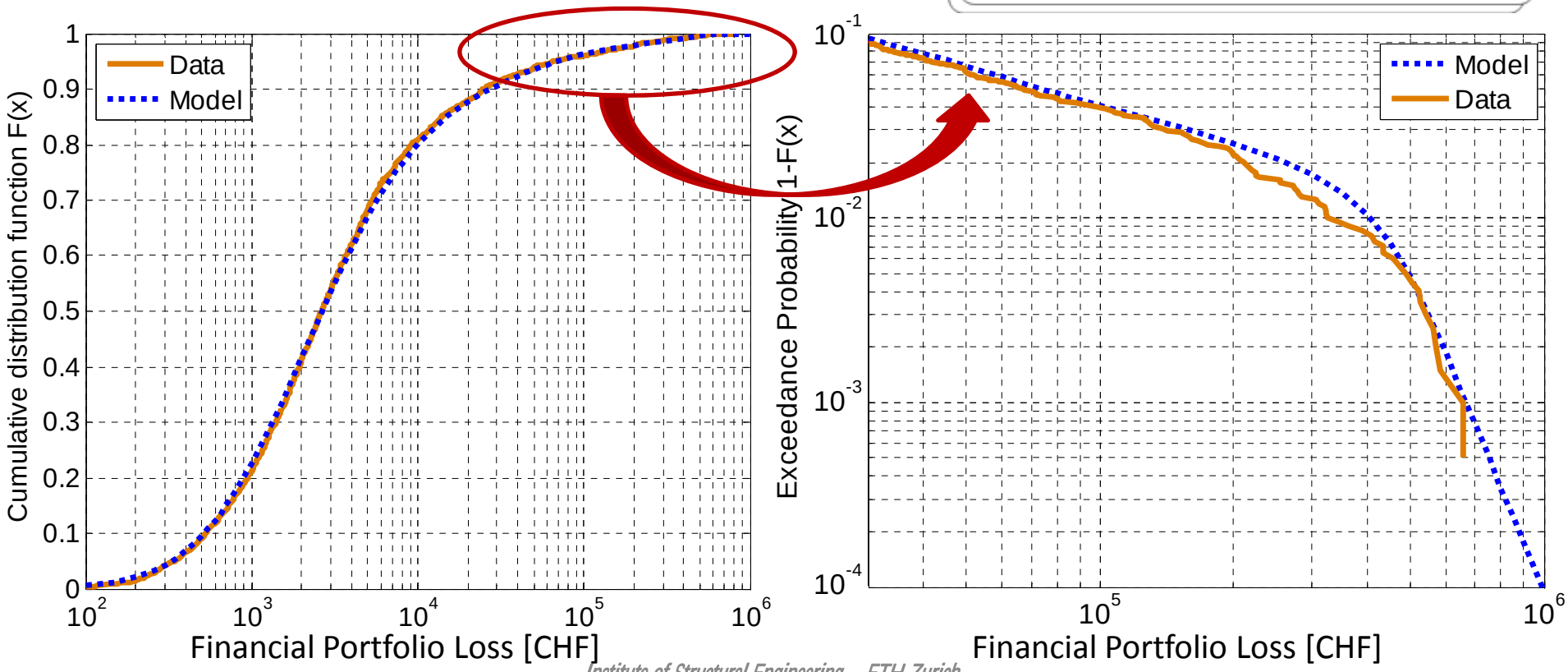
[1] Holborn, Nolan & Golt (2004)
[2] Department for Communities and Local Government (2006)

SINGLE FAMILY HOUSES

Estimation of the model parameters

using a dataset of 1996 fires incidents

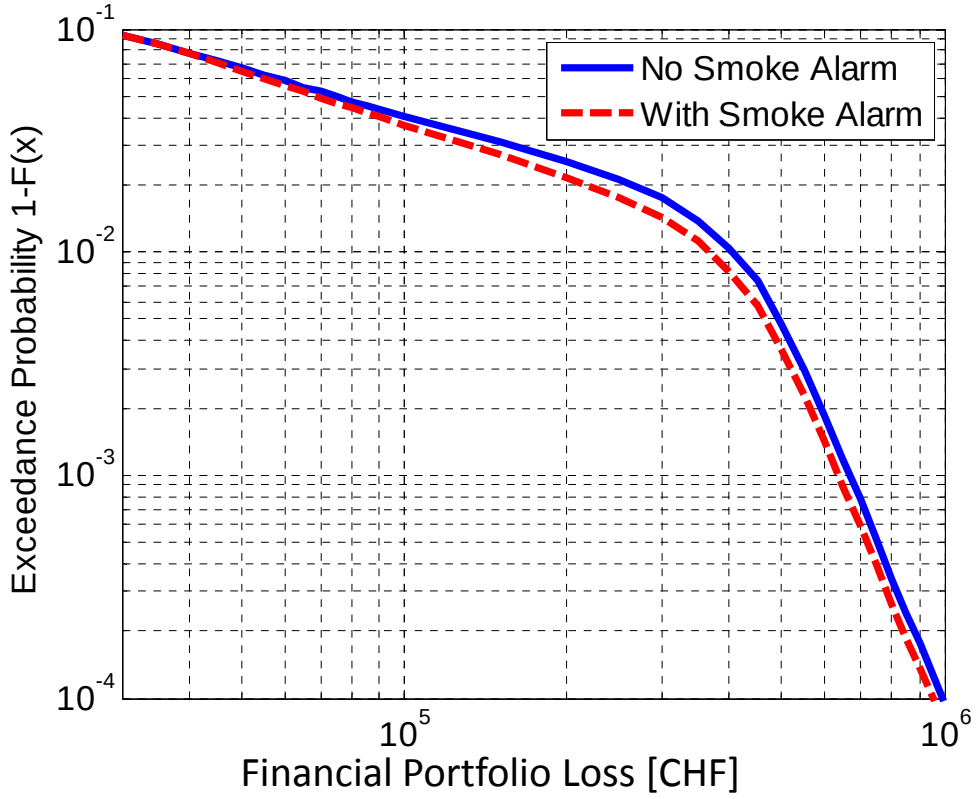




SINGLE FAMILY HOUSES

Risk reduction by demanding Smoke Alarms for single family houses:

$$r = \frac{E\left[L_{\text{no Smoke Alarm}}\right] - E\left[L_{\text{Smoke Alarm}}\right]}{E\left[L_{\text{no Smoke Alarm}}\right]} = \frac{4.8\,{}^{CHF}/_{a \cdot SFH}}{64.5\,{}^{CHF}/_{a \cdot SFH}} = 7.4\%$$



NEXT STEPS

Ongoing research at ETH

- Risk based review of the Swiss Fire Safety Regulations
- Quantitative influence of fire protection measures on the risk
- Efficiency of fire safety measures

Future research possibilities

- Application of the concept to performance based codes
- Calibration of the Fire Safety Code for a portfolio

$$\beta_{\text{target}}$$

PROBLEMS

Generic System Representation and Available Data:

- Available data does not correspond to the needed input / output for the engineering models

  → Error in the estimation of input parameters based on the available data

  → Data (Switzerland) does not classify the damage according the fire spread in the building

Probabilistic Engineering Models

- Missing “simple” engineering models for natural fire conditions, i.e. charring rate for timber, fire resistance of fire barriers (EI), fire spread in multi-compartment buildings etc.

Investments cost

- Generic assessment of safety investment costs dependent on the code format

THANK YOU FOR YOUR ATTENTION

YOUR QUESTIONS PLEASE!

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GENERIC RISK MODEL

Single Family House