

Importance of Catastrophe Modeling in (Re)insurance Pricing

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*Prepared for
The Azerbaijan International Insurance Forum 2026, 25-25 June 2026 Baku, Azerbaijan*



Outline

- Loss modeling of natural catastrophes (NatCat) and major outputs for (re)insurance pricing
- (Re)insurance pricing approach
- Some examples
- Main takeaway

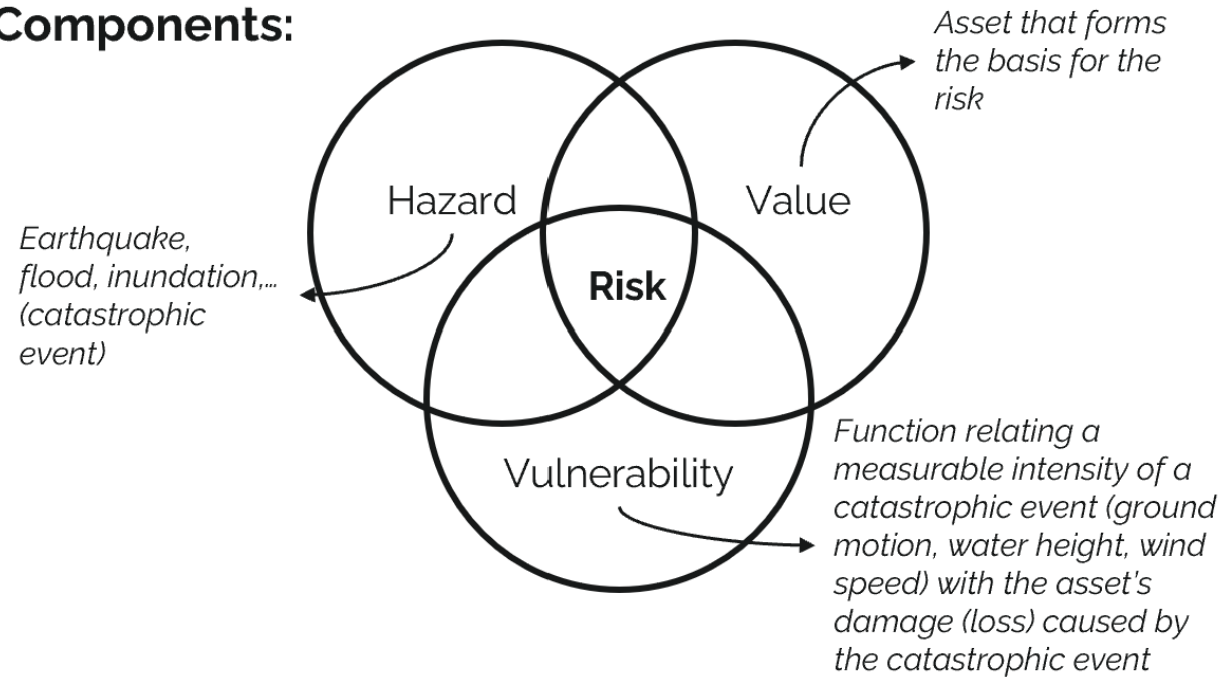


NatCat loss modeling and its major outputs for pricing

Risk: Possibility of living an *unpleasant event**

**Unpleasant event: Occurrence of critical problems after a catastrophic event (earthquake, flooding due to heavy rainfall, wild-fire)*

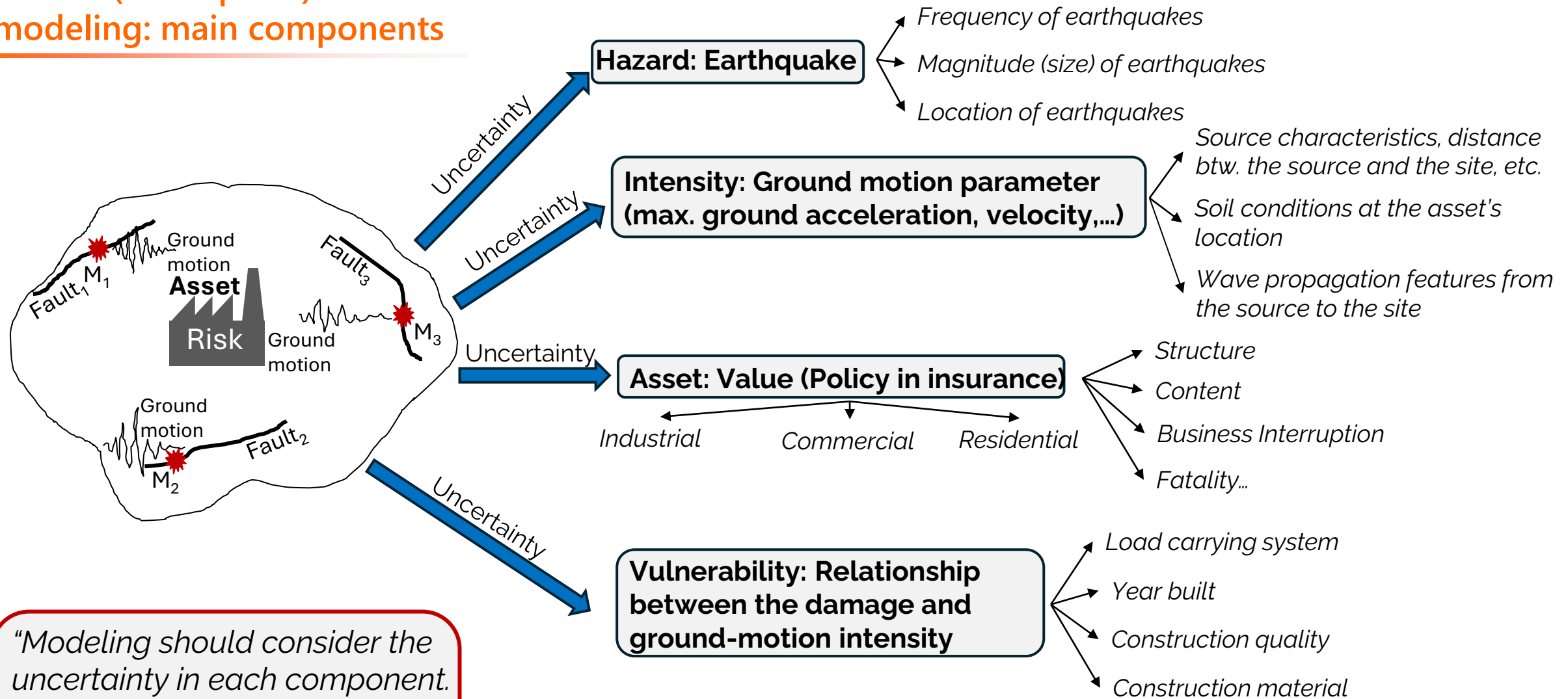
Risk Components:



Catastrophe modeling builds a mathematical model by using the three risk components to estimate the asset damage (loss) due to a catastrophic event before the risk occurs. As such, it aims to provide quality information to the property owner to take pro-actions for risk management

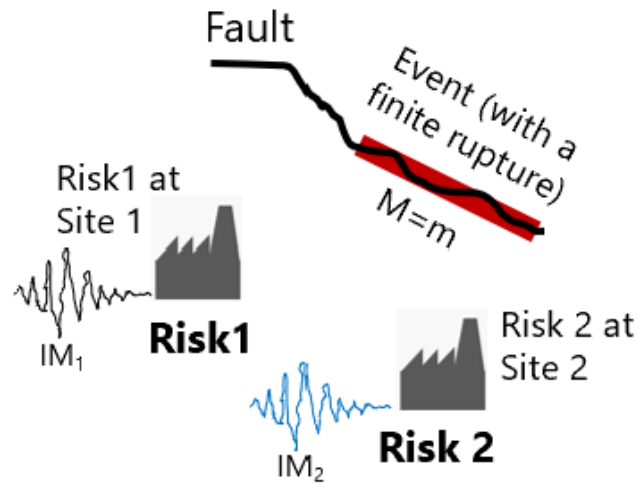
Damage (loss): Metric for risk; the higher the loss, the larger the risk

NatCat (earthquake) loss modeling: main components



"Modeling should consider the uncertainty in each component. For this reason, catastrophe model development is based on probability and statistics"

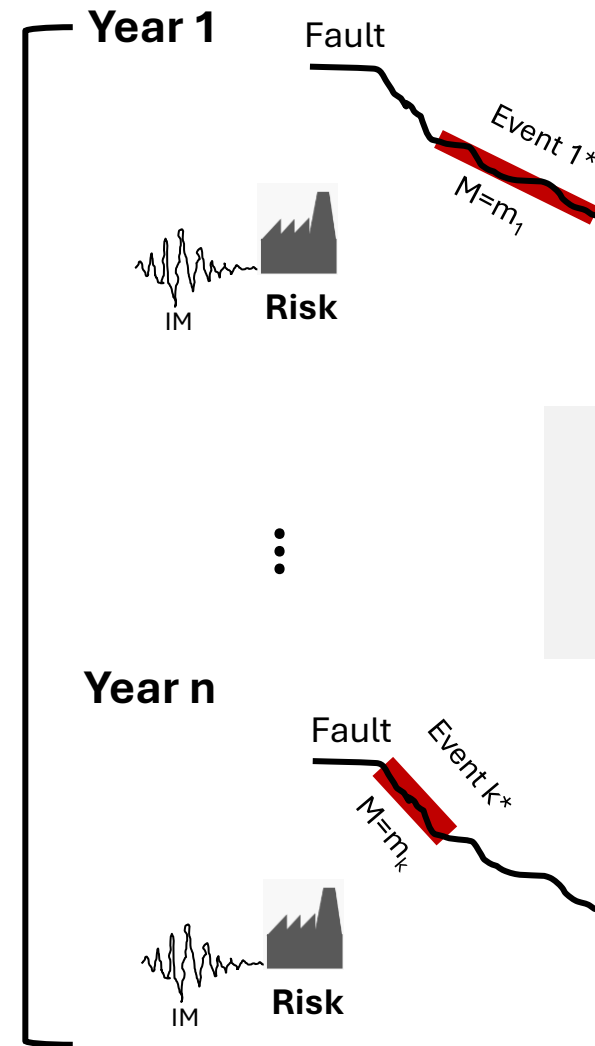
Scenario-based loss analysis



Exposure loss is computed for a "target" earthquake scenario

Stochastic loss analysis

Stochastic Earthquake Catalog
(Representative of yearly seismic activity)



Exposure loss is computed for the entire stochastic earthquake catalog

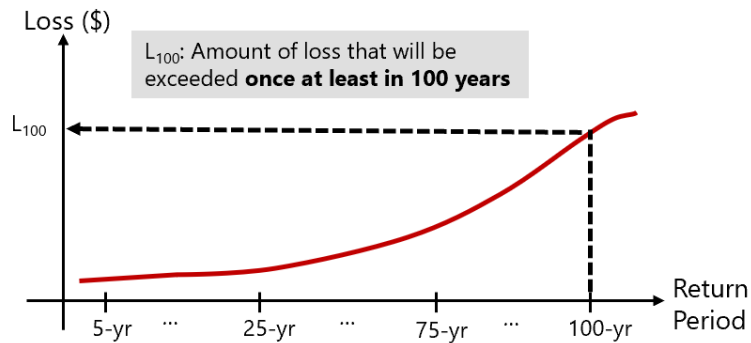
**Each event has a specific annual occurrence probability*

Main output for scenario-based loss analysis

Expected (mean) loss, which is a reasonably large loss, determined from the loss distribution of a given portfolio for the plausible catastrophe scenario. It can be used for determining the event loss limit for a given treaty or excess of loss agreement.

Main outputs of stochastic loss analysis (for pricing)

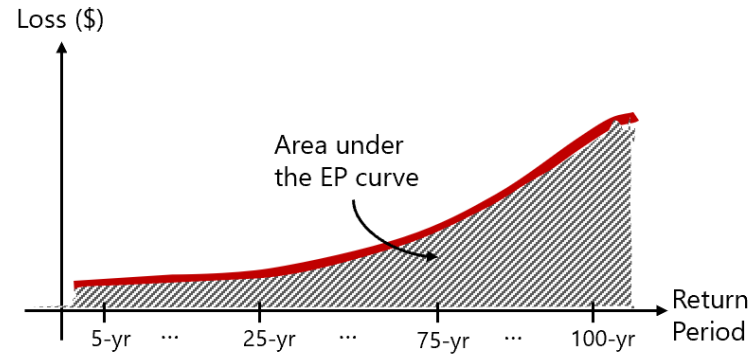
1 Loss exceedance probability (EP) curves



Tabular format →

Return Period	Loss (\$)
2	L_2
4	L_4
...	...
100	L_{100}
200	L_{200}
250	L_{250}
...	...
1000	L_{1000}

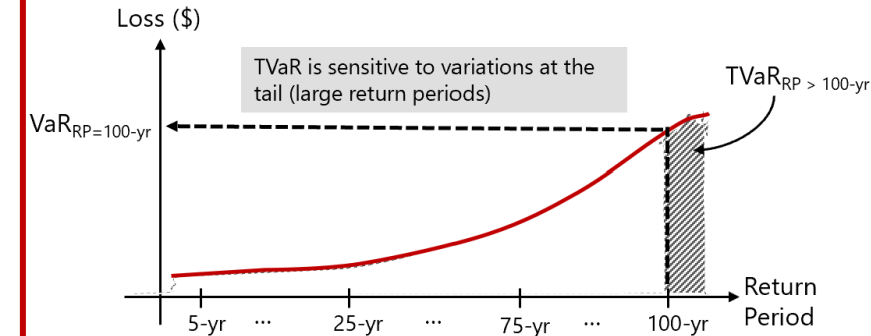
2 Average annual loss (AAL)



AAL is the average loss (the “expected loss amount”) per year. (Area under the probability loss exceedance curve).

AAL represents a long-term average. It is referred to as “Technical Premium” or “Pure Risk Premium” and controlled by low annual exceedance probabilities (losses caused by frequent small magnitude events)

3 Value at risk (VaR) and tail value at risk (TVaR)



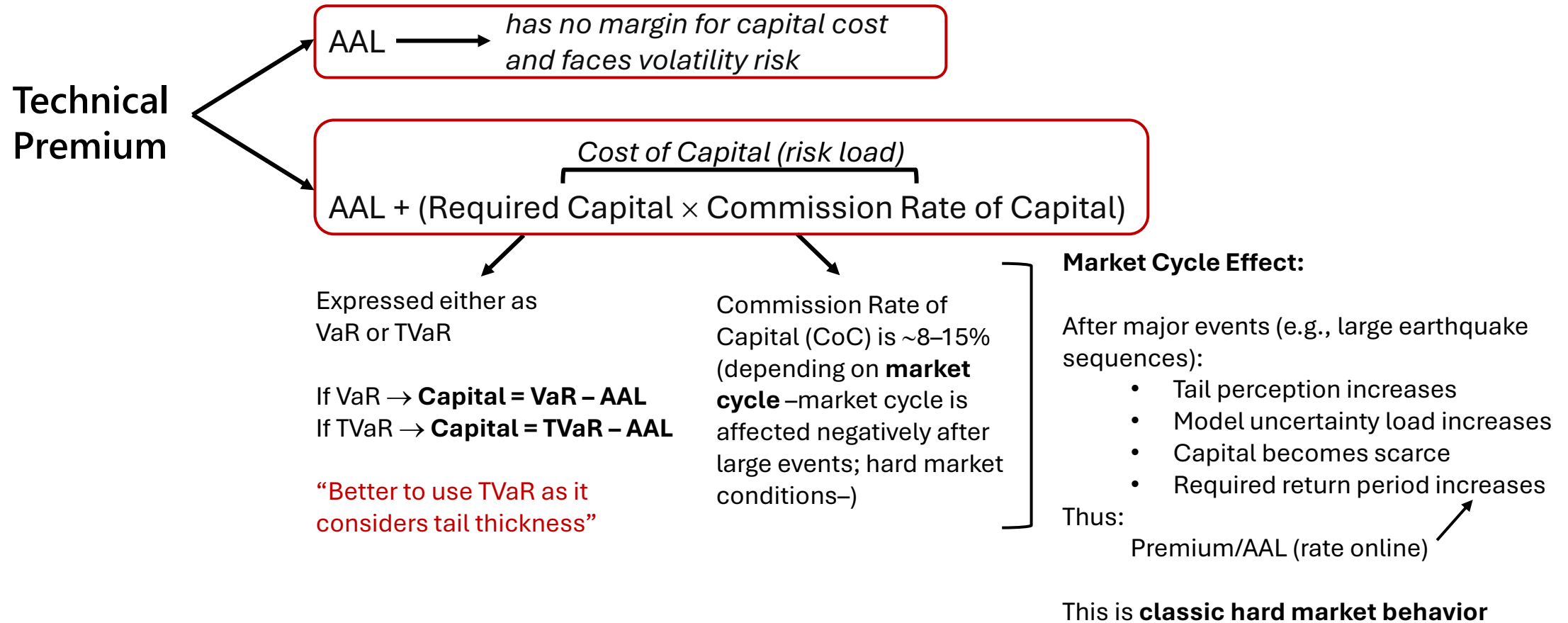
VaR is the loss *threshold* corresponding to a given return period. **VaR tells you “how bad things get up to a return period”** but it does **NOT** tell you how bad losses are beyond that return period.

TVaR is the average annual loss above a given return period. **TVaR tells more about the shape of the loss EP curve for the most extreme events. It captures severity of extreme events.**



Pricing approach

Fundamental concepts in pricing



Link between insurance and reinsurance premiums

Insurance Premium, P_{gross} (Premium from policy holder)

$$P_{\text{gross}} = AAL_{\text{gross}} + c_I \cdot K_I^{\text{gross}}$$

Expected annual loss before "reinsurance"

Insurer CoC

Insurer capital – *Capital required to be allocated to mitigate the risk against negative consequences of Market Cycle Effect before reinsurance*

Reinsurance Premium, P_{RI} (Paid by insurer)

$$P_{\text{RI}} = AAL_{\text{ceded}} + c_R \cdot K_R$$

Expected annual loss transferred to reinsurer

Reinsurer CoC

Reinsurer capital – *Capital required for ceded loss to mitigate the risk against negative consequences of Market Cycle Effect before reinsurance such as loaded payouts–*

Critical Link: Capital Relief (ΔK_I)

(Economic value of reinsurance to insurance)

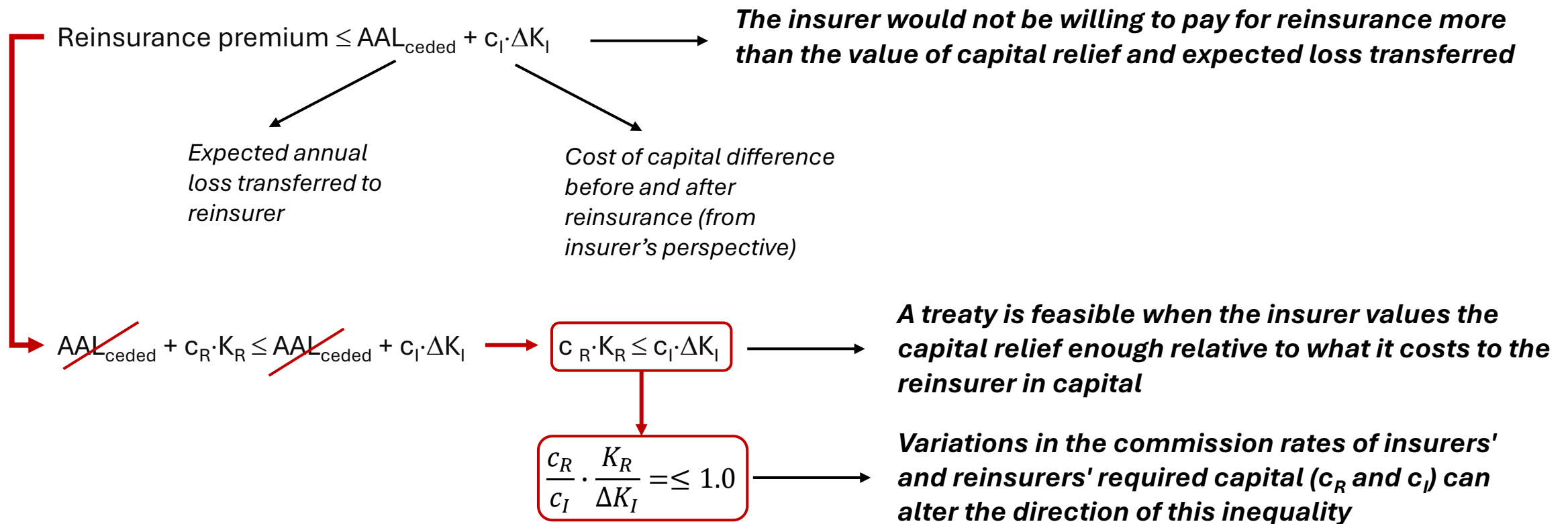
$$\Delta K_I = K_I^{\text{gross}} - K_I^{\text{net}}$$

Capital required after reinsurance (via VaR or TVaR)

Capital required before reinsurance (via VaR or TVaR)

Financial gain by insurer after transferring the risk to reinsurer

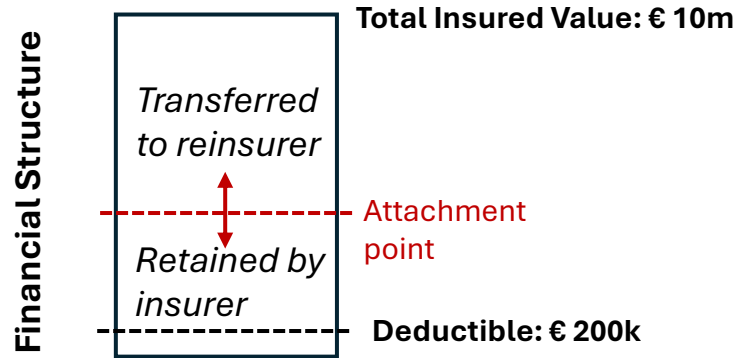
Efficient pricing condition





Explanatory examples

A heavy industrial facility
Total Insured Value (TIV) = 10m Euros
Deductible = 200k Euros



Question posed:
How would the insurance and reinsurance pricing change with the change in attachment point?

	Gross Loss (Before Reinsurance)
AAL_{gross}	€ 59,000.00
$K_I^{gross} (TVaR_{RP>100yrs}) - AAL_{gross}$	€ 4,454,000.00

Average annual loss (AAL_{gross}) and the required capital (K_I^{gross}), if the risk is retained by insurer (K_I^{gross} is computed from TVaR by assuming that 100-year RP loss and beyond are critical)

If attachment point is determined as 2,000,000 Euros

Attachment: 20% of TIV (2,000,000 Euros)					
Net Loss (After Reinsurance)		Capital Relief (Difference between gross and net capital requirements)		Ceded (Reinsurer's) Loss	
AAL_{net}	€ 35,000.00	$\Delta K_I = K_I^{gross} - K_I^{net}$	€ 2,489,000.00	AAL_{ceded}	€ 25,000.00
$K_I^{net} (TVaR_{RP>100yrs}) - AAL_{net}$	€ 1,965,000.00			$K_R (TVaR_{RP>100yrs}) - AAL_{ceded}$	€ 2,429,000.00

Capital required by insurer for the retained risk when attachment point is € 2million

Net economical relief by insurer if attachment point is € 2 million

Capital required by reinsurer for the transferred risk when attachment point is € 2 million

$$\frac{c_R}{c_I} \cdot \frac{K_R}{\Delta K_I} = \frac{c_R}{c_I} \cdot \frac{2,429,000}{2,489,000} = 0.976 \cdot \frac{c_R}{c_I} \leq 1.0$$



This inequality will not hold when C_R is 3% /or more) larger than C_I



If attachment point is increased to € 4 million, the above inequality will only hold if $C_R \approx C_I$

“This case advocates that attachment points above € 2 million might be costly if hard market conditions arise.”

Such what if scenarios will help the underwriter to write the policy more efficiently!

Main Takeaway

- Catastrophe loss modeling for (re)insurance is the unique tool to quantify mitigating the unpleasant experience (risk)
- If NatCat models are used consciously and cautiously, they can provide a good guidance to the underwriter for designing feasible agreement conditions with broader perspective



Thank you