



Management Risk

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Prime Re

*This presentation has been prepared for the Actuaries Institute 2015 ASTIN and AFIR/ERM Colloquium.
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Models

Reserves

Different models depending on

- data availability / quality
- line of business / market
- processes / products
- ...
- actuarial judgment

→ 1st moment of a distribution

 standard reserving model

Capital

Different models depending on

- data availability / quality
- line of business / market
- processes / products
- ...
- actuarial judgment

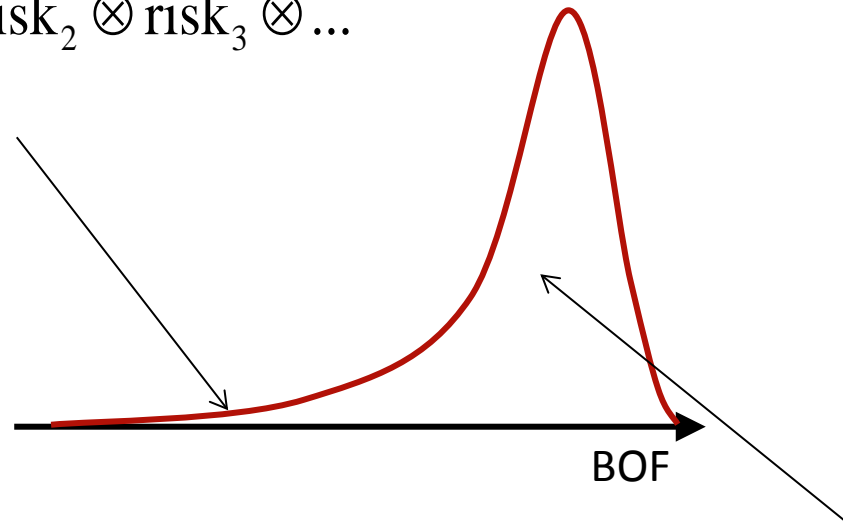
→ nth moment of a distribution

 standard solvency formula

Determine the BOF distribution

Internal model

- Numerical aggregation of realistic distributions
 $SCR \leftarrow \text{risk}_1 \otimes \text{risk}_2 \otimes \text{risk}_3 \otimes \dots$
- Probe the true tail



Standard Solvency II formula

- Analytic linear approximation
 $SCR \leftarrow \sigma^2 = \sum \rho_{ij} \sigma_i \sigma_j$
- Probe the tail with 2nd moments

All Europe uses the standard formula.



All Europe uses the standard formula. All?



All Europe uses the standard formula. All? No!



Except for one small country of indomitable insurers that still holds out against the lure!



Except for one small country of indomitable insurers that still holds out against the lure!

FINMA presentation, 22 March 2007

- **Internal models should be used.** If the SST standard model is not applicable, then a partial or full internal model must be used.

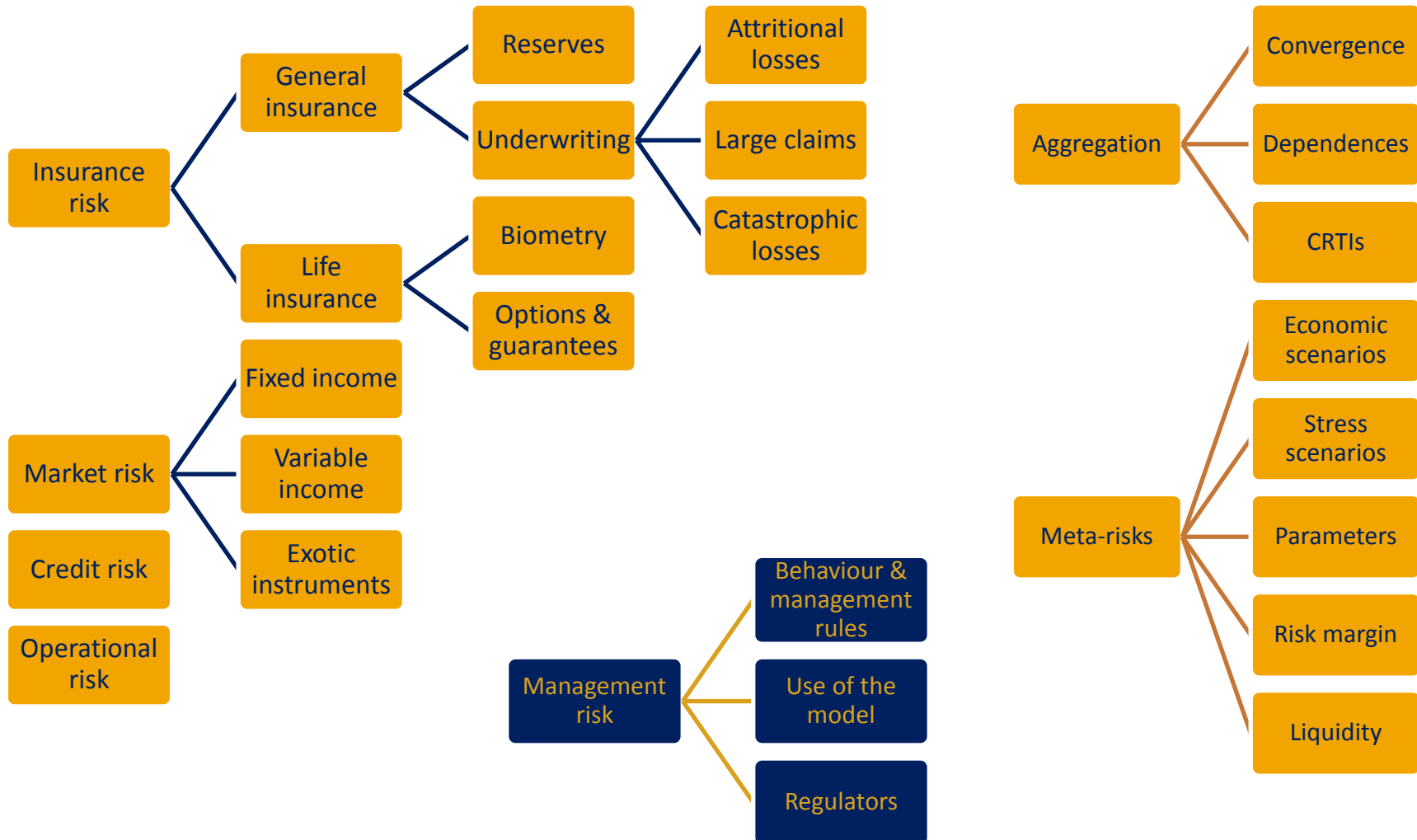
FINMA Circular 2008/44

- Groups and reinsurers **must develop an internal model.**

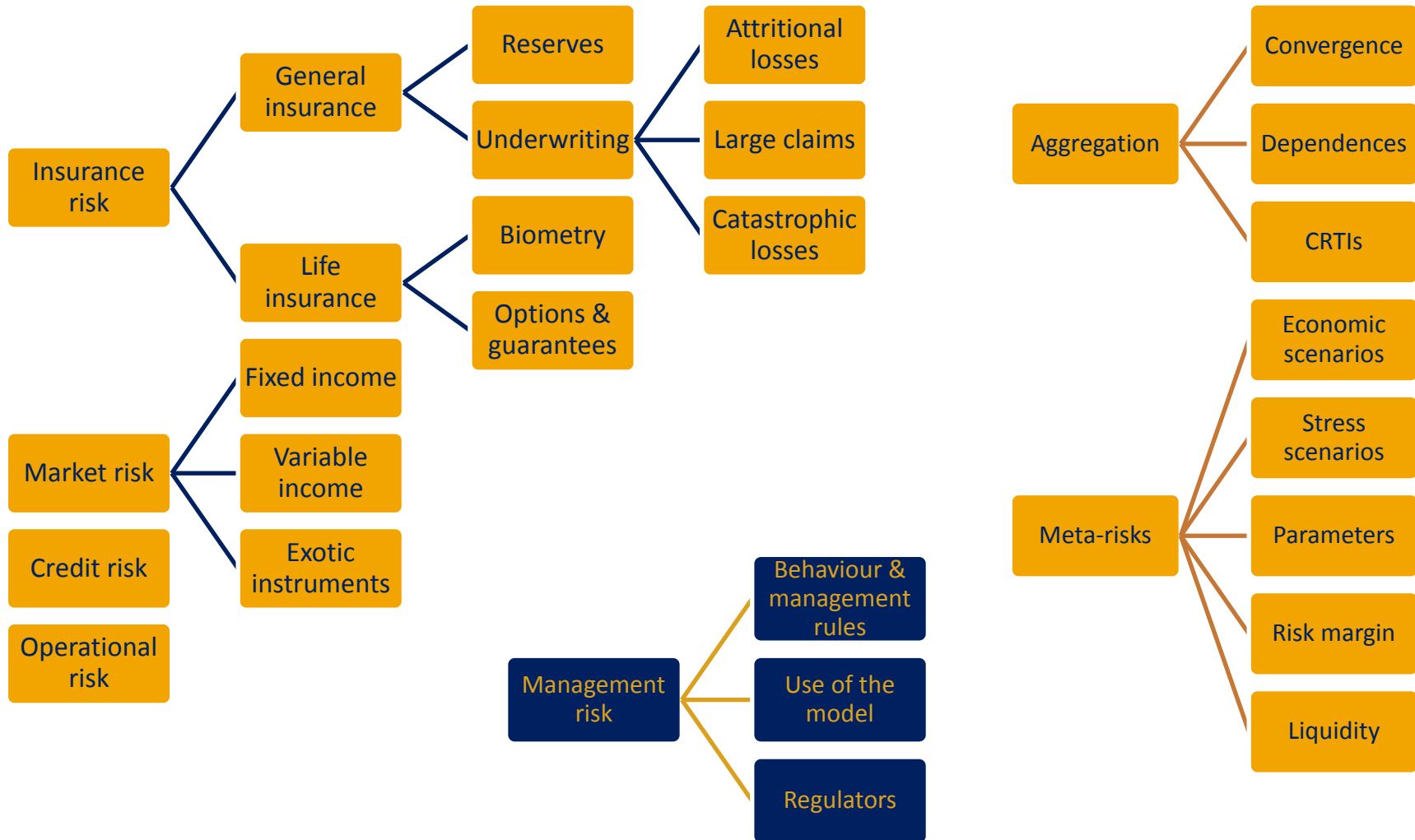
FINMA presentation, 10 March 2014

- **Rules based risk assessment means**
 - Focusing on compliance rather than on understanding underlying risks
 - Incentives to arbitrage
 - **Systemic risk**

Major Risk Models



Major Risk Models

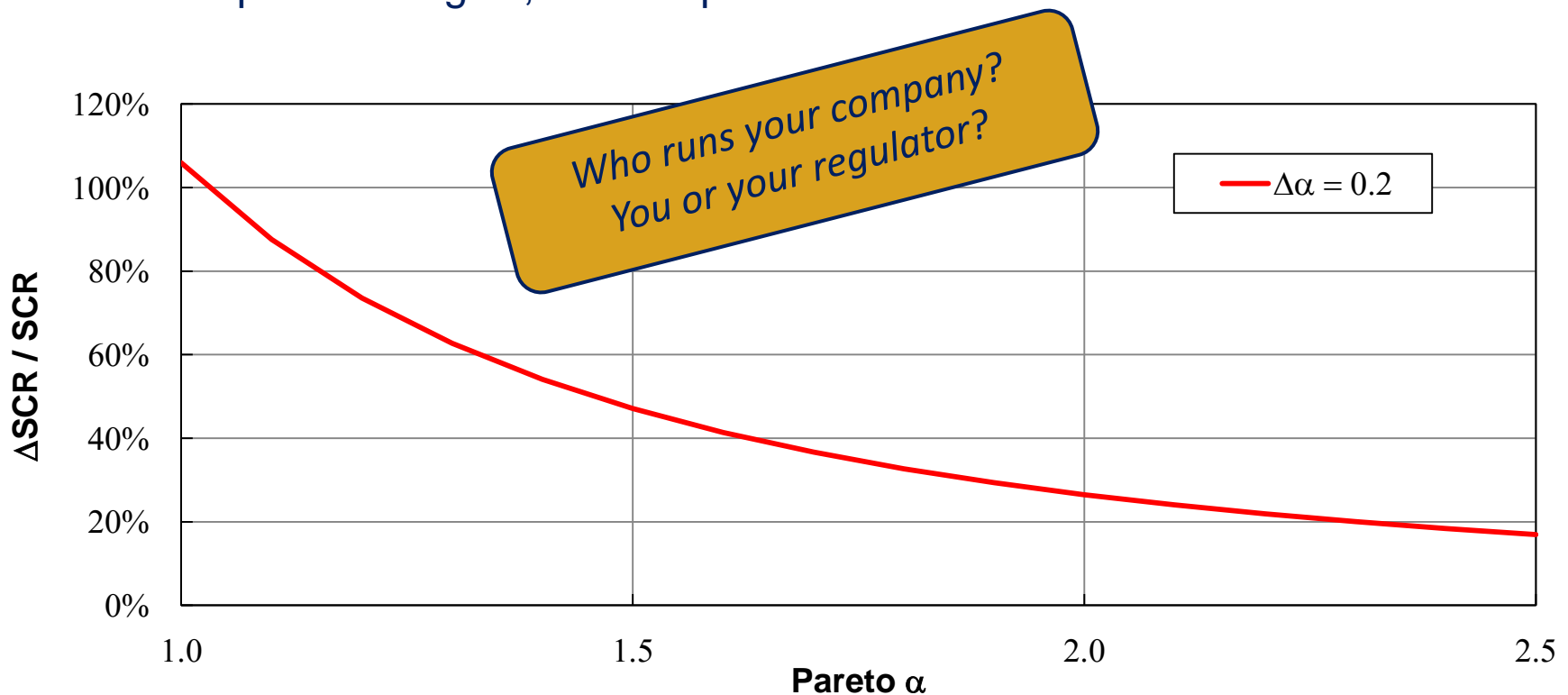


Regulatory Risk

- VaR
 - super-additivity
 - 99.5% percentile \Rightarrow absurd SCR confidence intervals
 - stubborn sticking to percentile \rightarrow interest rates mumbo-jumbo

Solvency ratio to compare companies

- Can't summarize a company in one figure
- 99.5% percentile \Rightarrow meaningless SCR confidence intervals
- Pillar 3 generates absurd beauty contest
 \Rightarrow compare strategies, not companies



What is Solvency for?

- Satisfy the regulator
- Impress analysts
- Save capital
- ...
- Portfolio management
- Capital allocation
- Risk optimisation
- ...
- Development
- M&A
- Incentives & remuneration
- ...

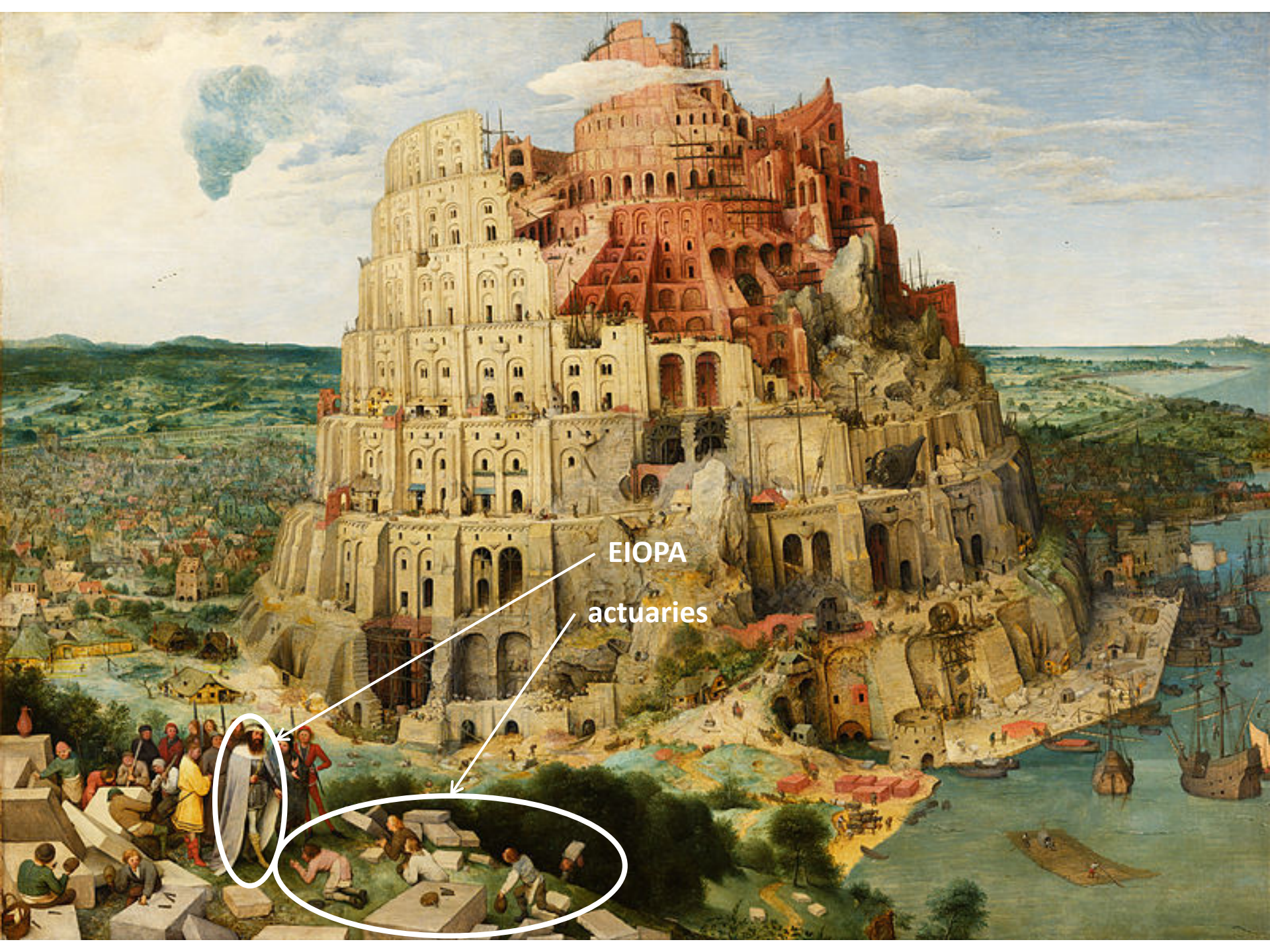
Do you want to extract your competitive advantage
by saving some regulatory capital costs
or
by making the right decisions?

Compare companies ☹️

Compare strategies 😊

Regulatory Risk

- VaR
 - super-additivity
 - 99.5% percentile \Rightarrow absurd SCR confidence intervals
 - stubborn sticking to percentile \rightarrow interest rates mumbo-jumbo
- Terrified by monster they created
 - principles-base \rightarrow rules-based
 - avoiding validation by all means
 - coercing market towards a ramshackle standard model
 - non-proportional reinsurance misrepresented
 - ...
 - systemic risk
 - blind trust in standard vendor software

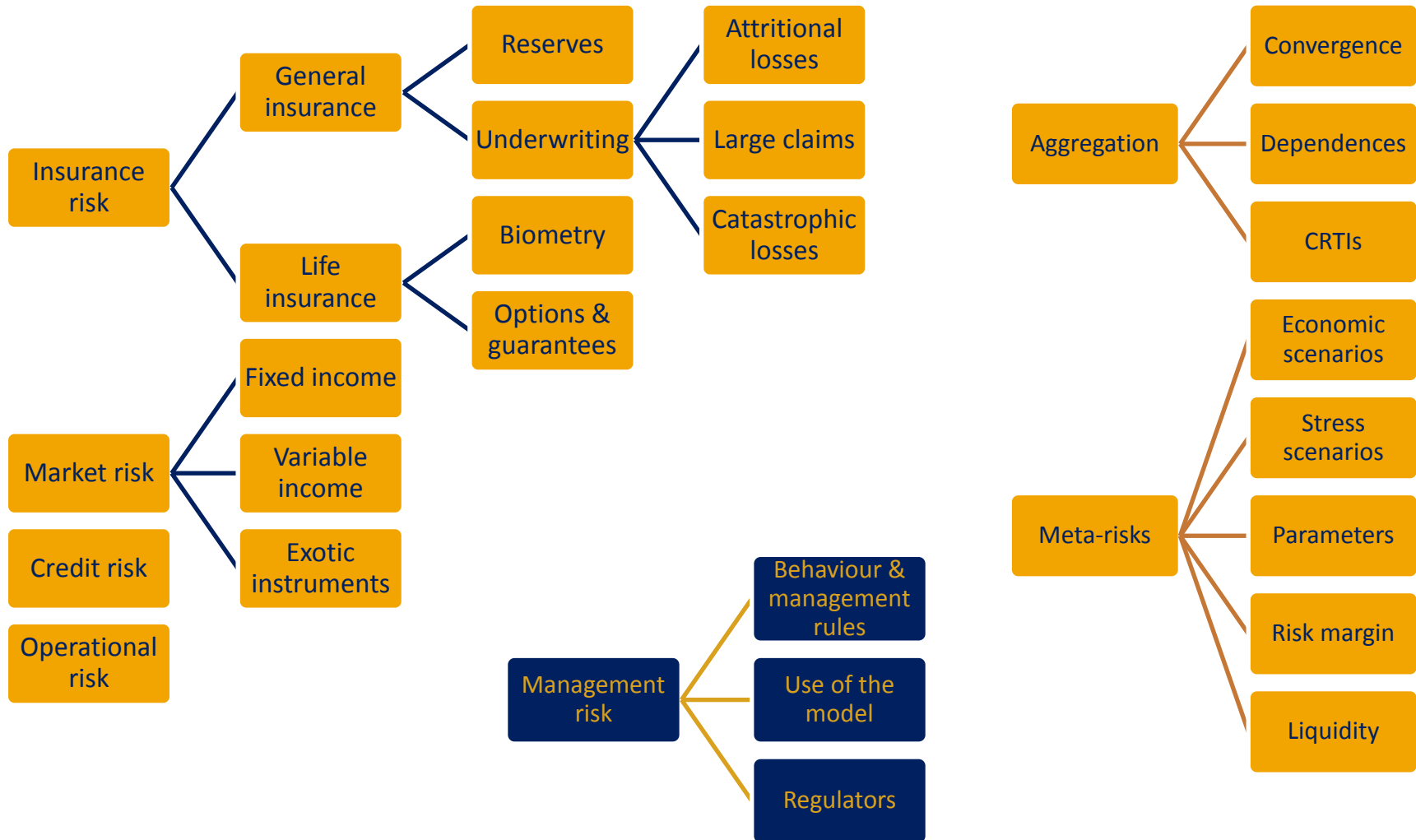


EIOPA

actuaries








Major Risk Models



Management Risk

Fallacies

-  There is a perfect model
-  Models must be complex
-  All details must be modeled
-  Models are expensive
-  Models are static

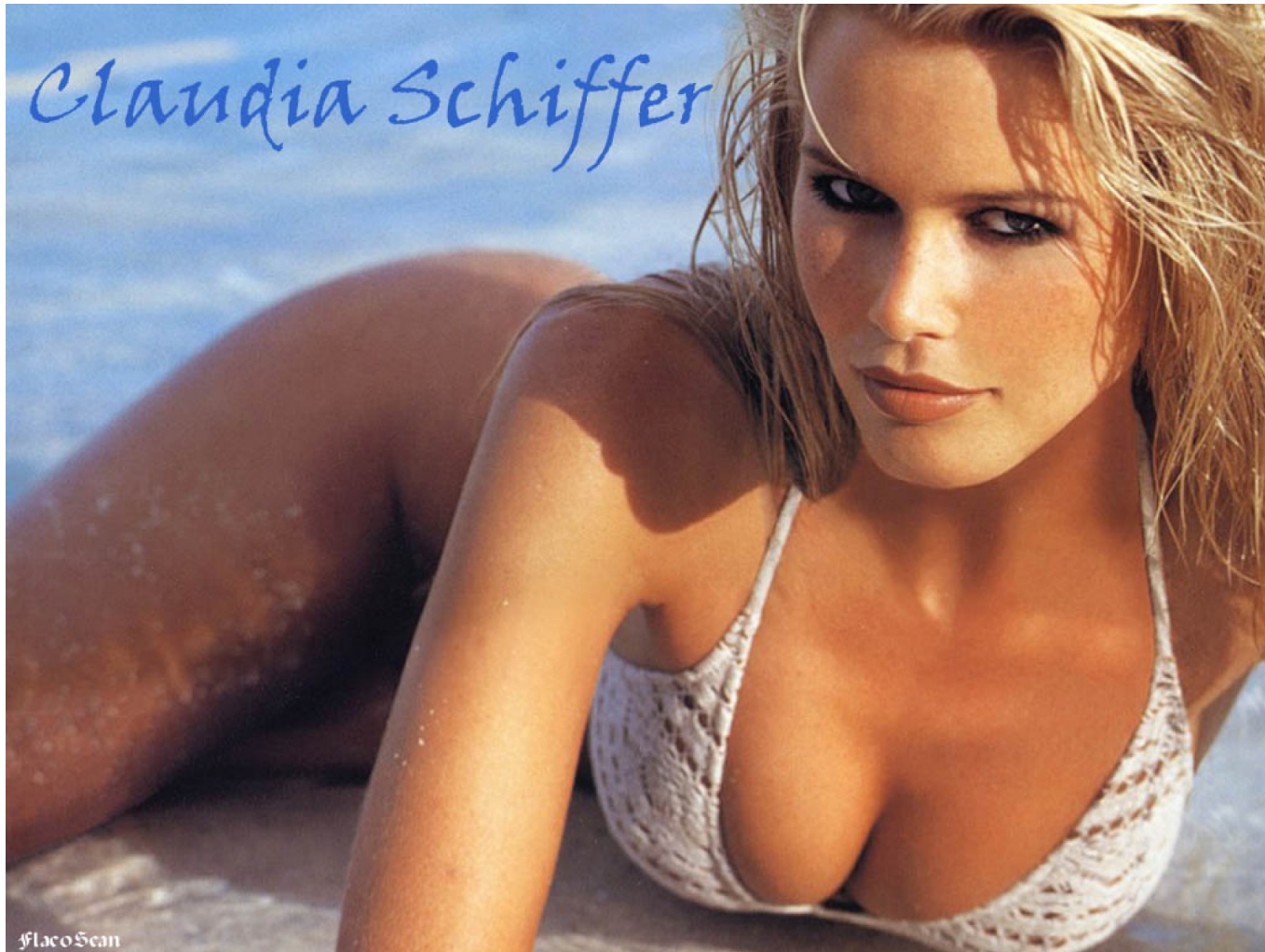


There is a perfect model

- One size does not fit all
- There is no TOE

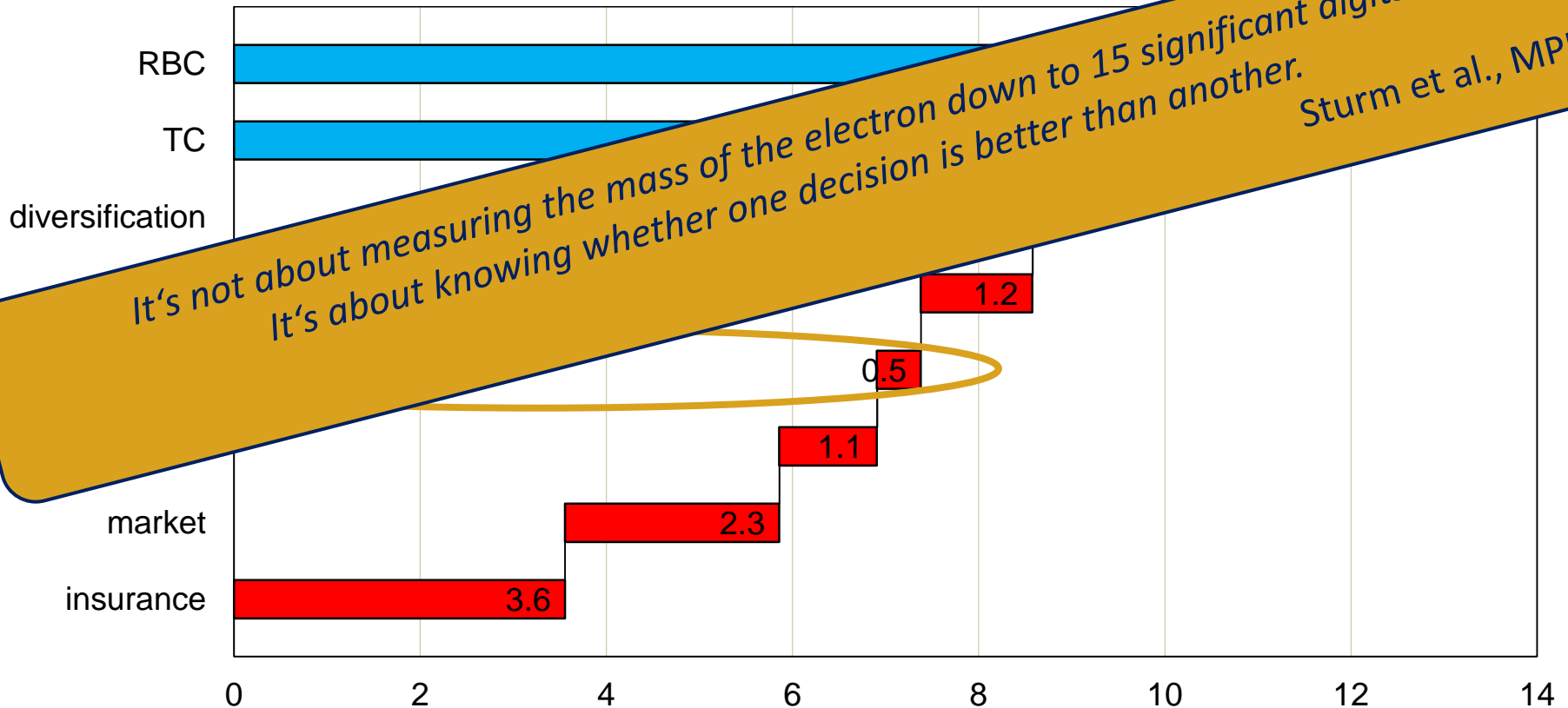


Don't fall in love with you model



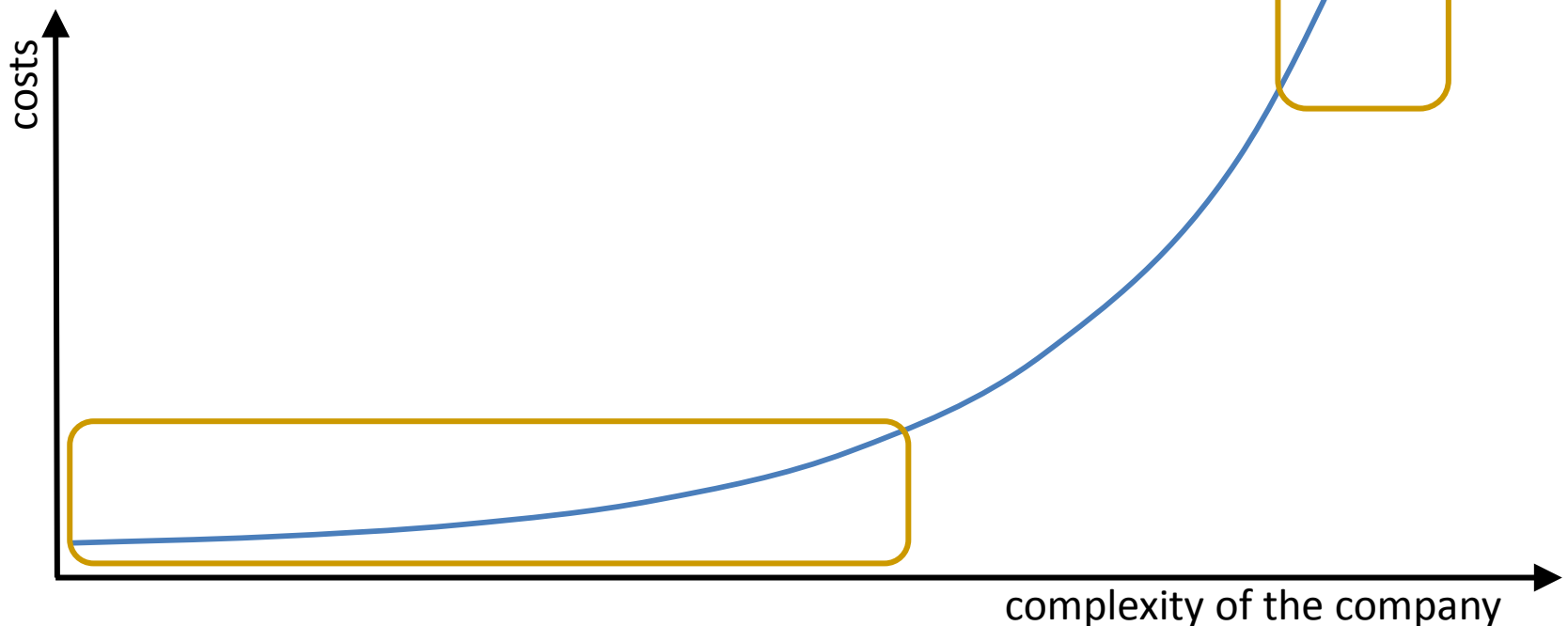
All details must be modeled

- Eventually start modeling noise
- 80% solution \Rightarrow keep the overview



Models are expensive

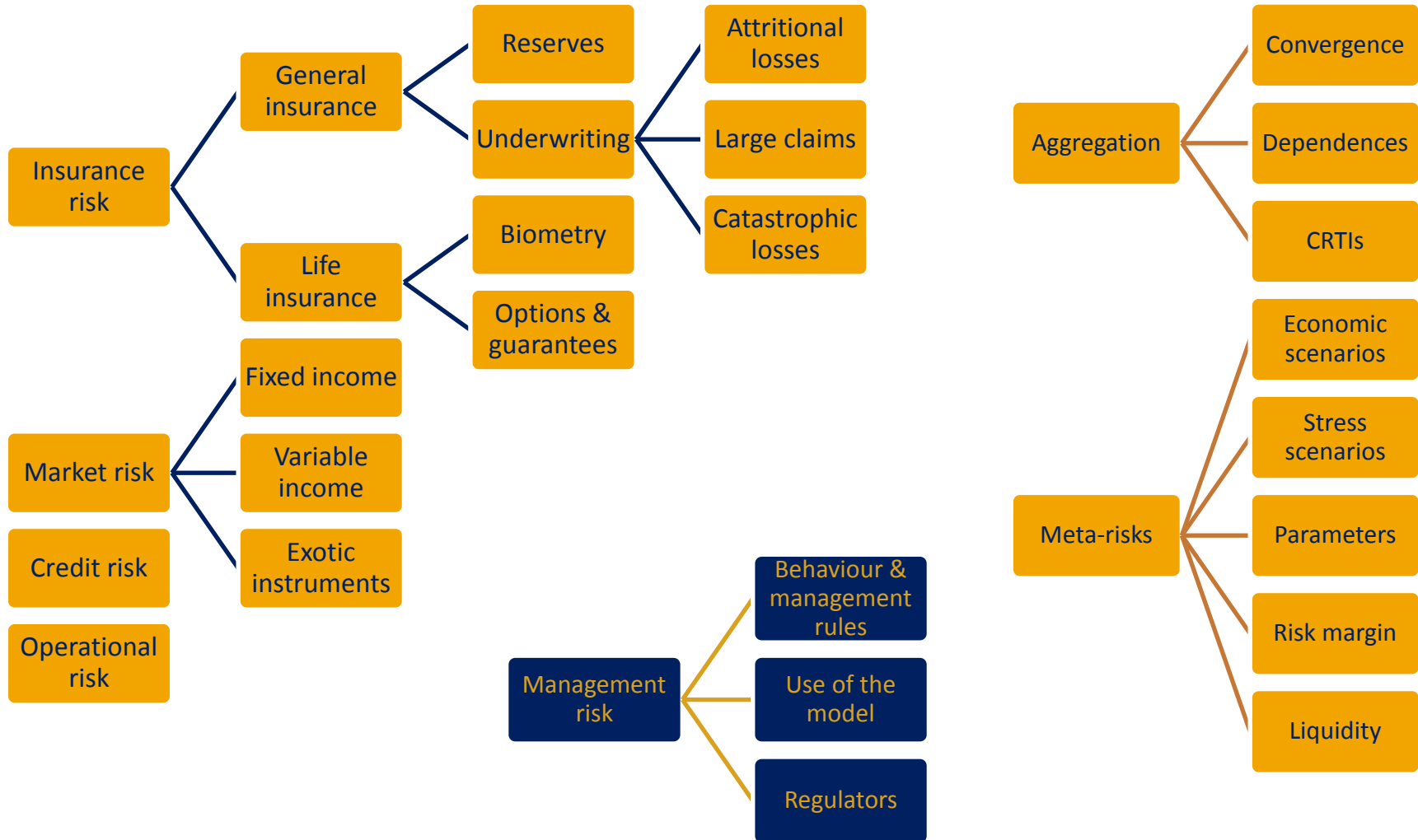
- Costs increase exponentially with complexity
- Costs decrease exponentially with simplicity
 - Internal solvency models can be modeled with Excel
 - Internal solvency can be developed within 3 months



Models are static

- Must give opportunity to experiment
- Must adapt to changes
 - Internal
 - External
 - SoA
- Why do actuaries still use 20th century techniques?

Major Risk Models



Models for Reserves Risk

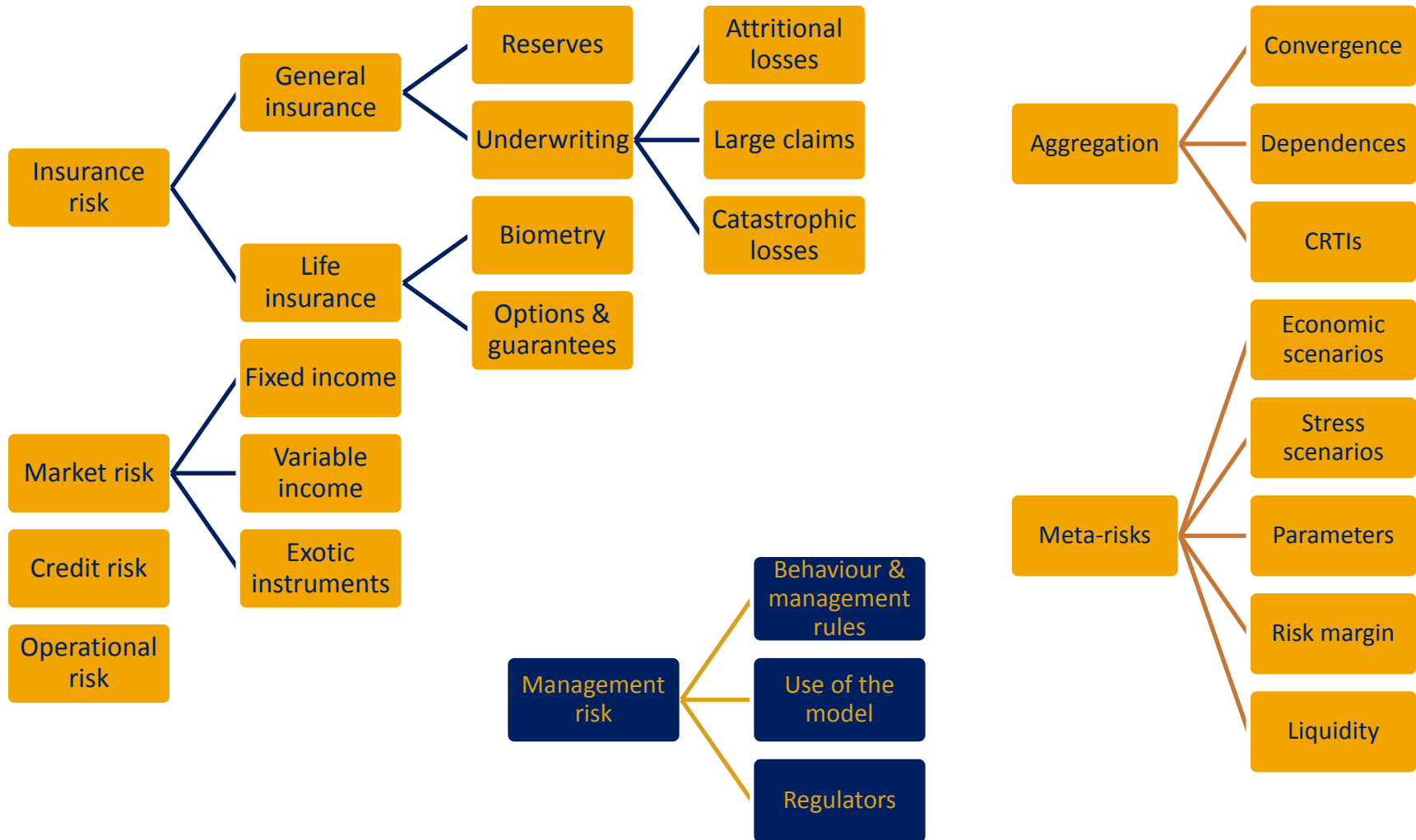
Classic methods

- Aggregate claims into accident-development year cells
- Squander information
- Mix frequency (IBNYR) & severity (IBNER) effects

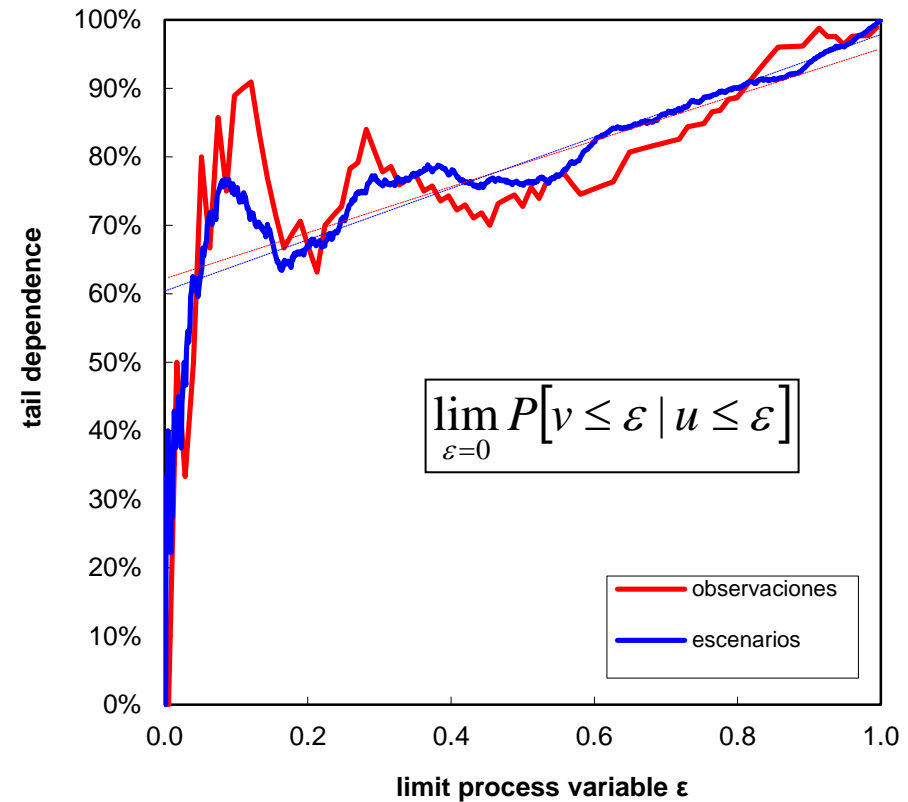
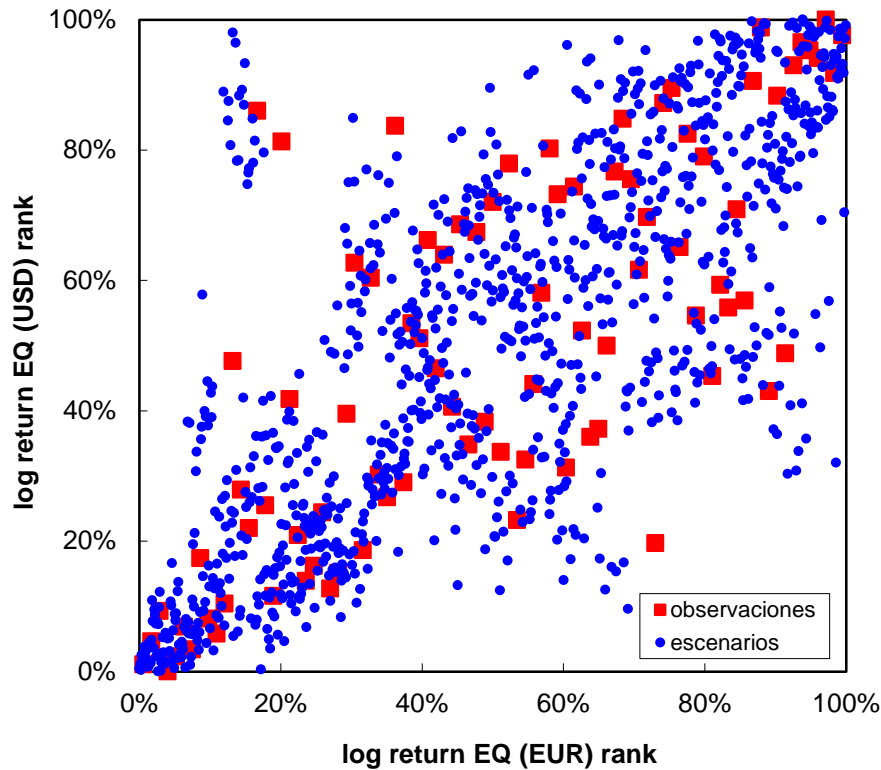
Individual claims development (ICD)

- Use pattern recognition techniques (e.g. neural networks)
- Use all available information
- Separate frequency (IBNYR) & severity (IBNER) effects

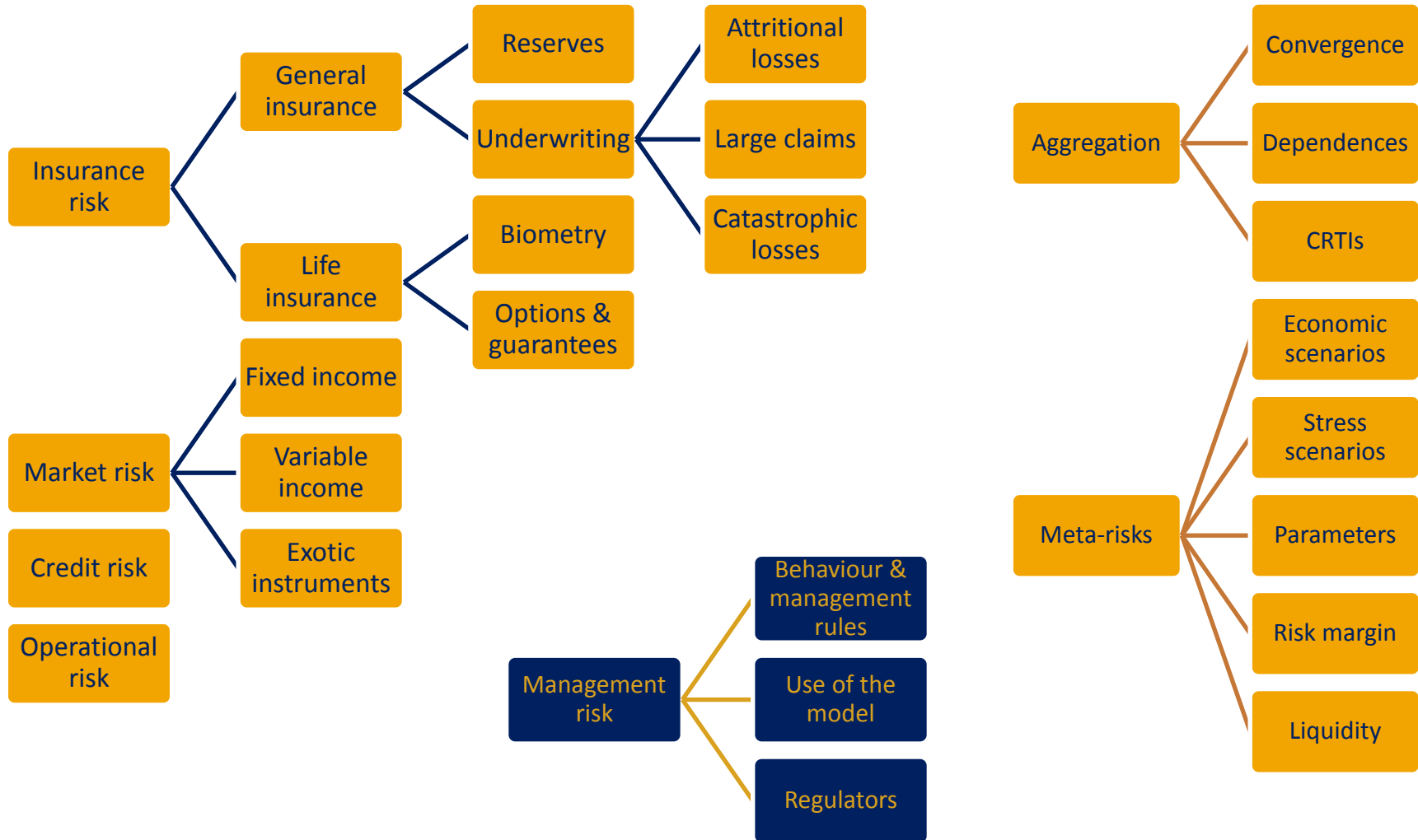
Major Risk Models



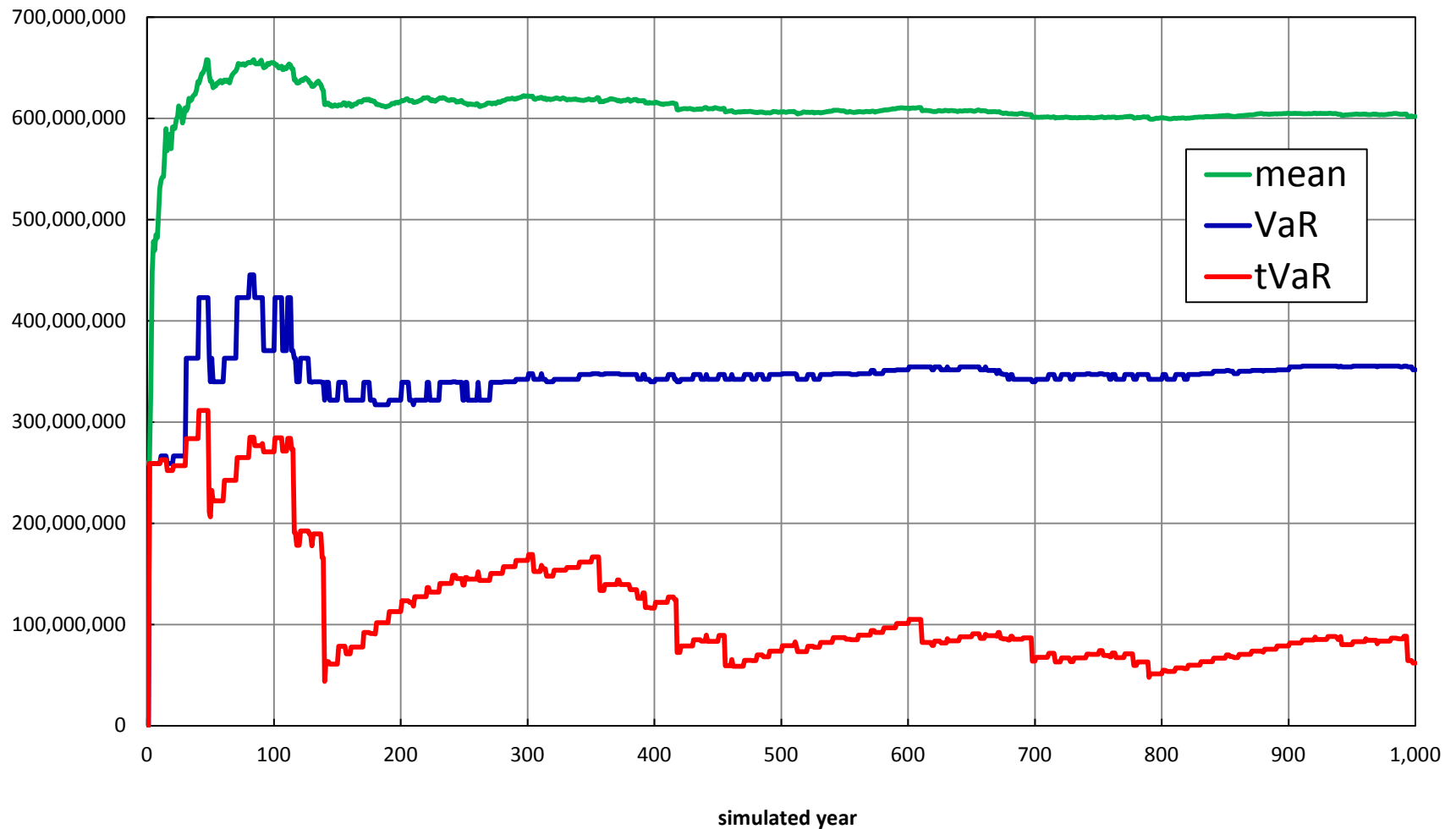
Economy's Complex Phenomenology



Major Risk Models



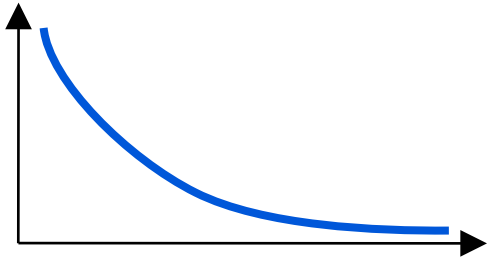
Convergence



Monte Carlo efficiency

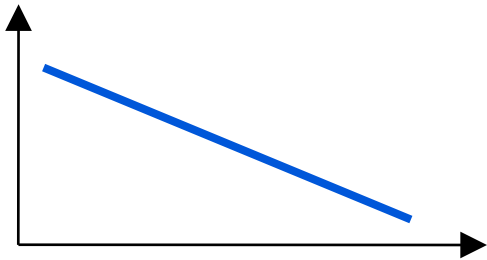
- Most actuarial modellers still driven by number of simulations
 - Ignore Monte Carlo error
 - Ignore Monte Carlo variance reduction techniques

Variance reduction

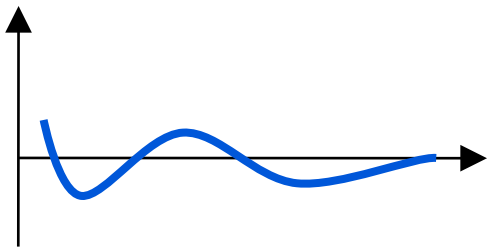


$$I = \int dx f(x) = ?$$

Monte Carlo ☹️



$$\tilde{I} = \int dx \tilde{f}(x) = \text{known}$$



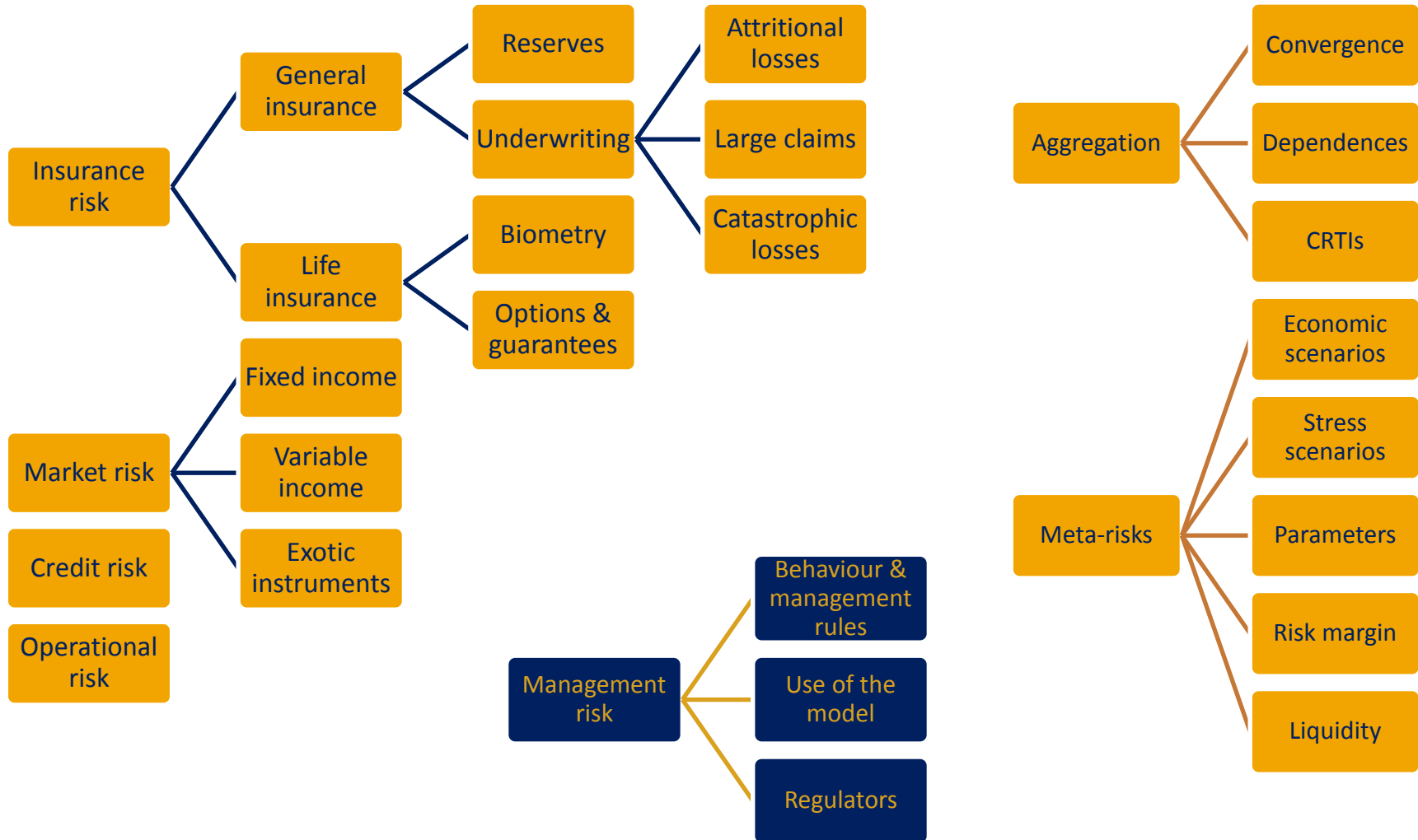
$$I = \int dx [f(x) - \tilde{f}(x)] + \int dx \tilde{f}(x)$$

$$= \int dx \Delta f + \tilde{I}$$

Monte Carlo 😊



Major Risk Models

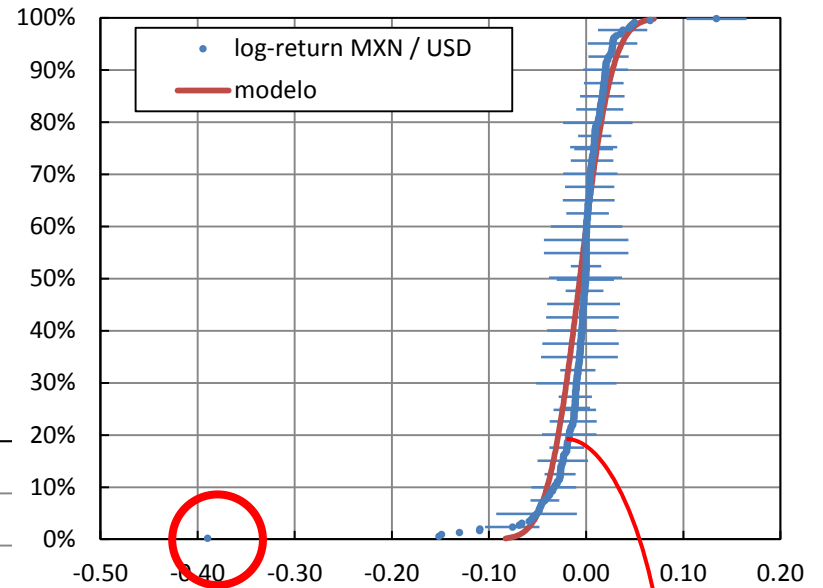
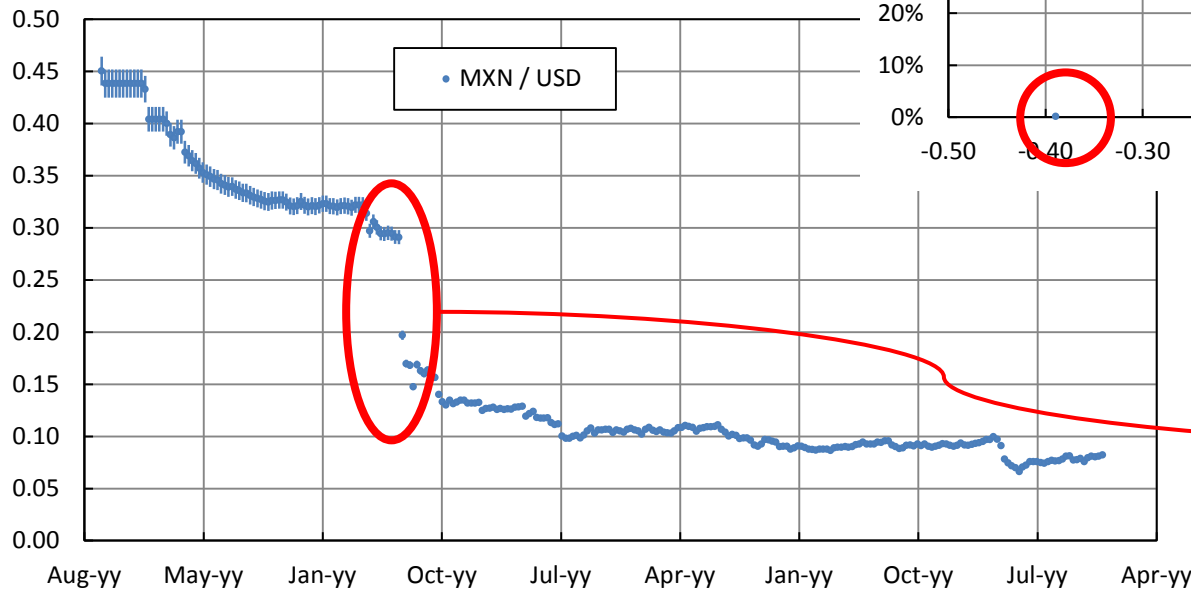


A Model for Variable Income Risk

- Value of the asset S_t
- Return of the asset $\frac{S_t}{S_{t-1}}$
- Wiener process $\ln \frac{S_t}{S_{t-1}} \sim N(\mu, \sigma)$

Model Risk

normal Models 



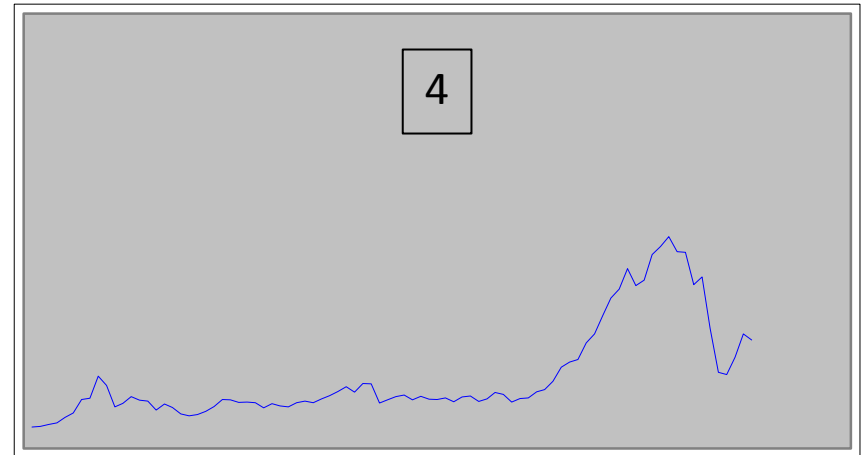
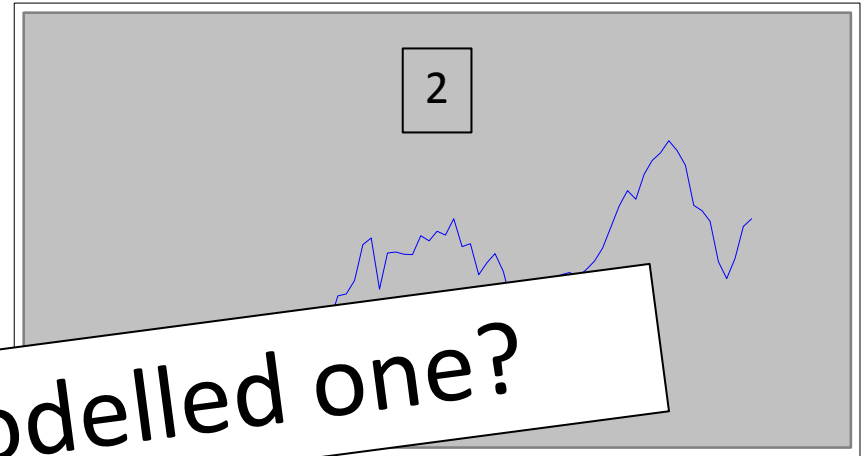
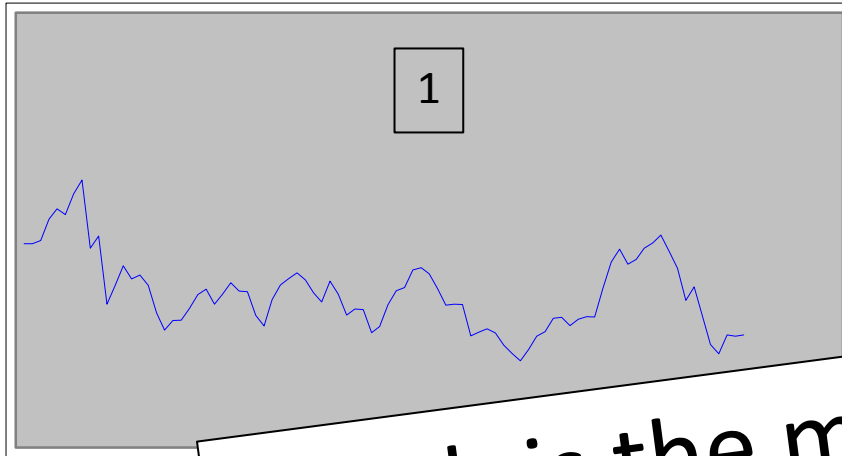
$\chi^2 / \text{dof} = 0.6$



A Model for Variable Income

- Value of the asset S_t
- Return of the asset $\frac{S_t}{S_{t-1}}$
- Wiener process $\ln \frac{S_t}{S_{t-1}} \sim N(\mu, \sigma)$
- SST deterministic stress scenarios ☺
- Lévy processes & Lévy copulas ☺
- Other ideas?...

Equity Indices 1988 - 2010



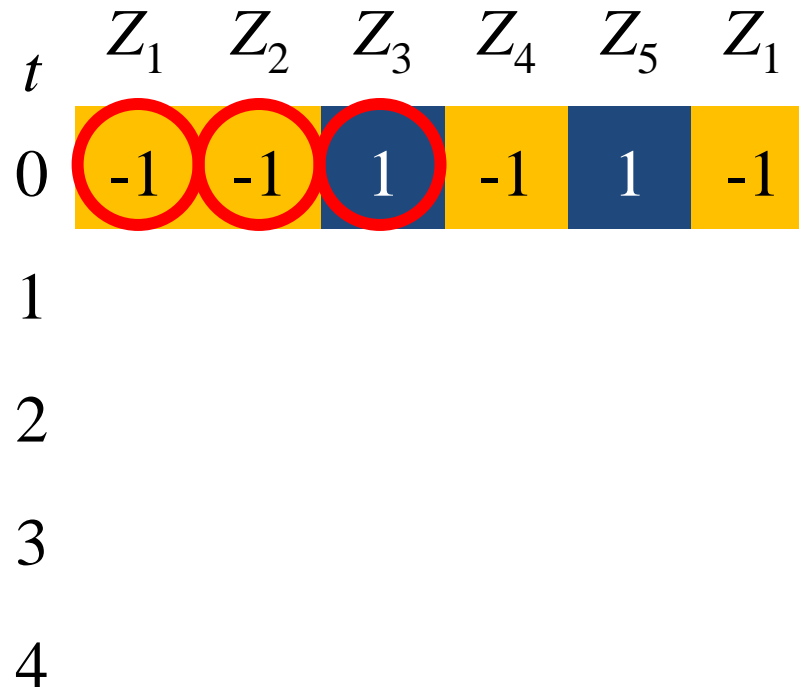
Which is the modelled one?

Cellular Automaton

C_n nearest neighbour 2 states XOR automaton:

$$Z_i(t) = Z_{i-1}(t-1) \oplus Z_{i+1}(t-1)$$

\oplus	-1	1
-1	-1	1
1	1	-1

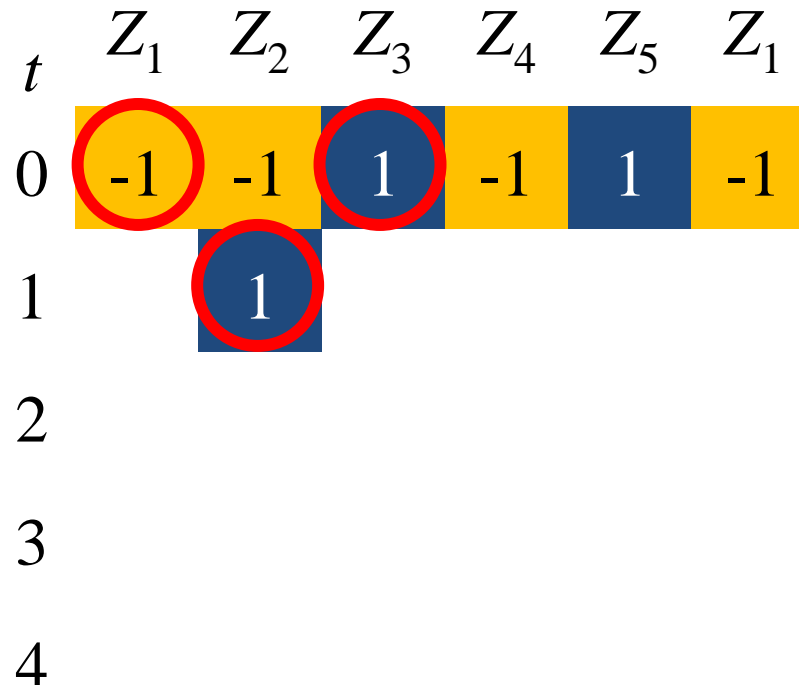


Cellular Automaton

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\oplus	-1	1
-1	-1	1
1	1	-1

t	Z_1	Z_2	Z_3	Z_4	Z_5	Z_1
0	-1	-1	1	-1	1	-1
1	-1	1	-1	-1	-1	-1
2						
3						
4						

Cellular Automaton

C_n nearest neighbour 2 states XOR automaton:

$$Z_i(t) = Z_{i-1}(t-1) \oplus Z_{i+1}(t-1)$$

\oplus	-1	1
-1	-1	1
1	1	-1

t	Z_1	Z_2	Z_3	Z_4	Z_5	Z_1
0	-1	-1	1	-1	1	-1
1	-1	1	-1	-1	-1	-1
2	1	-1	1	-1	-1	1
3	1	-1	-1	1	1	1
4	1	1	1	1	-1	1

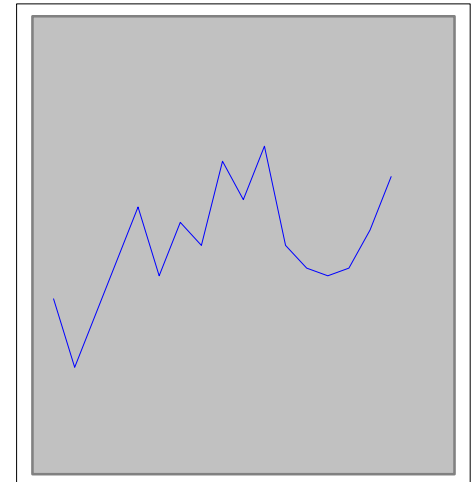
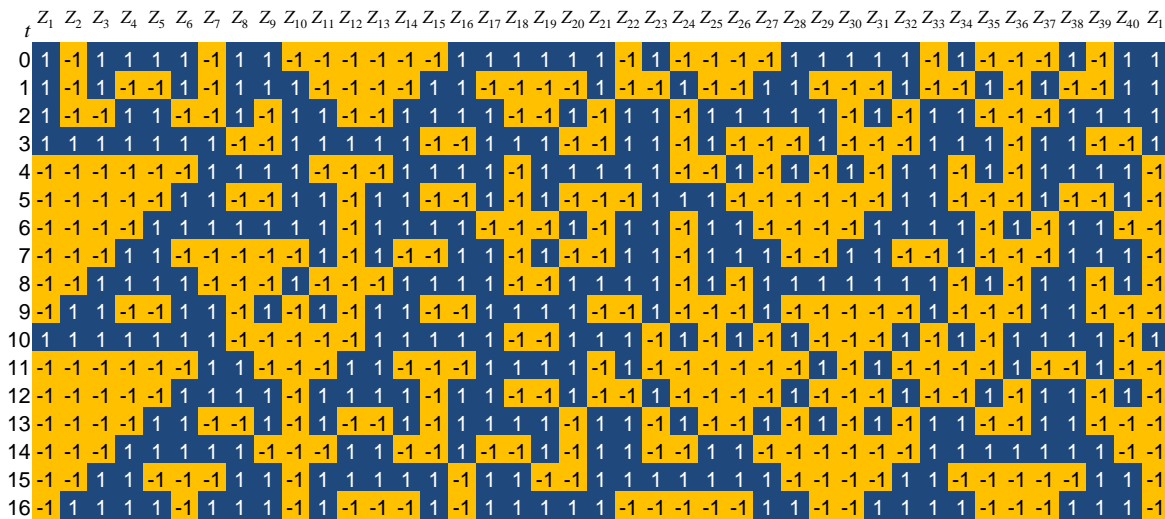
Cellular Automaton

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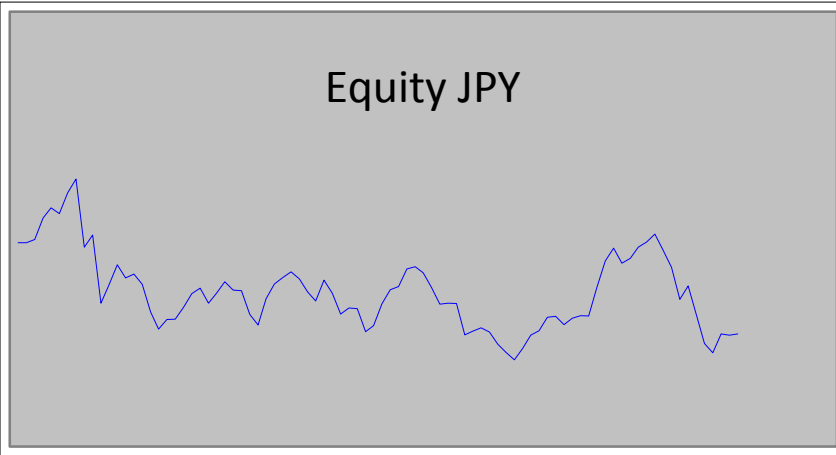
$$I(t) = I(t-1) + \sum_{i=1}^N Z_i(t)$$

\oplus	-1	1
-1	-1	1
1	1	-1

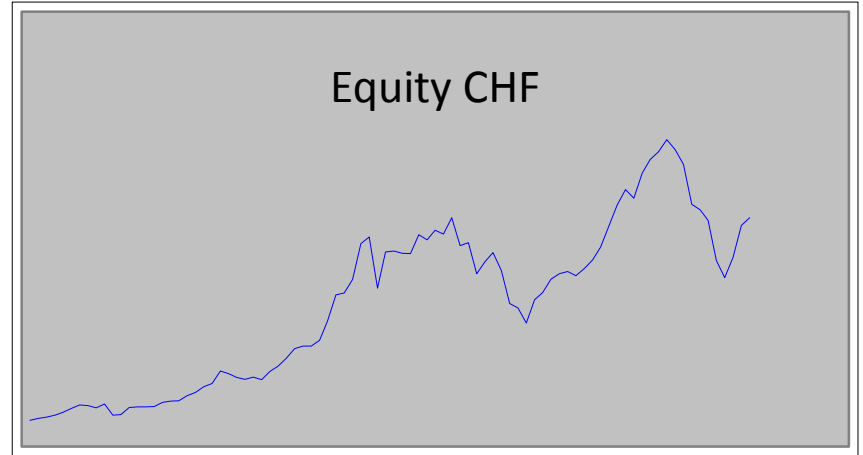


Equity Indices 1988 - 2010

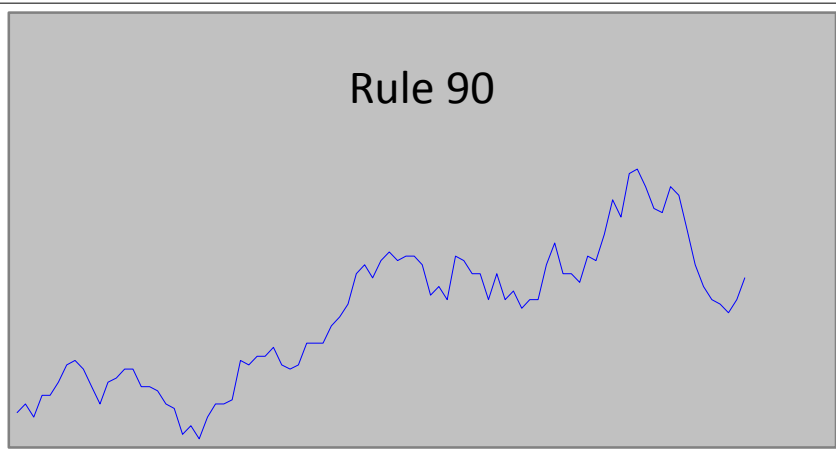
Equity JPY



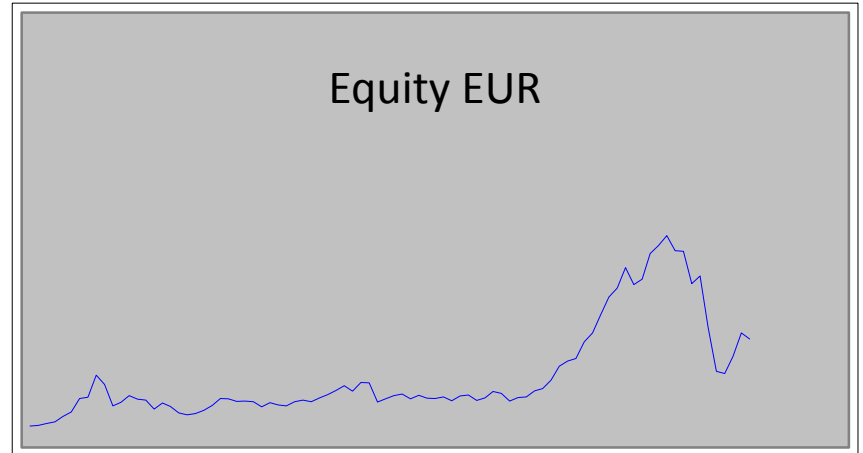
Equity CHF



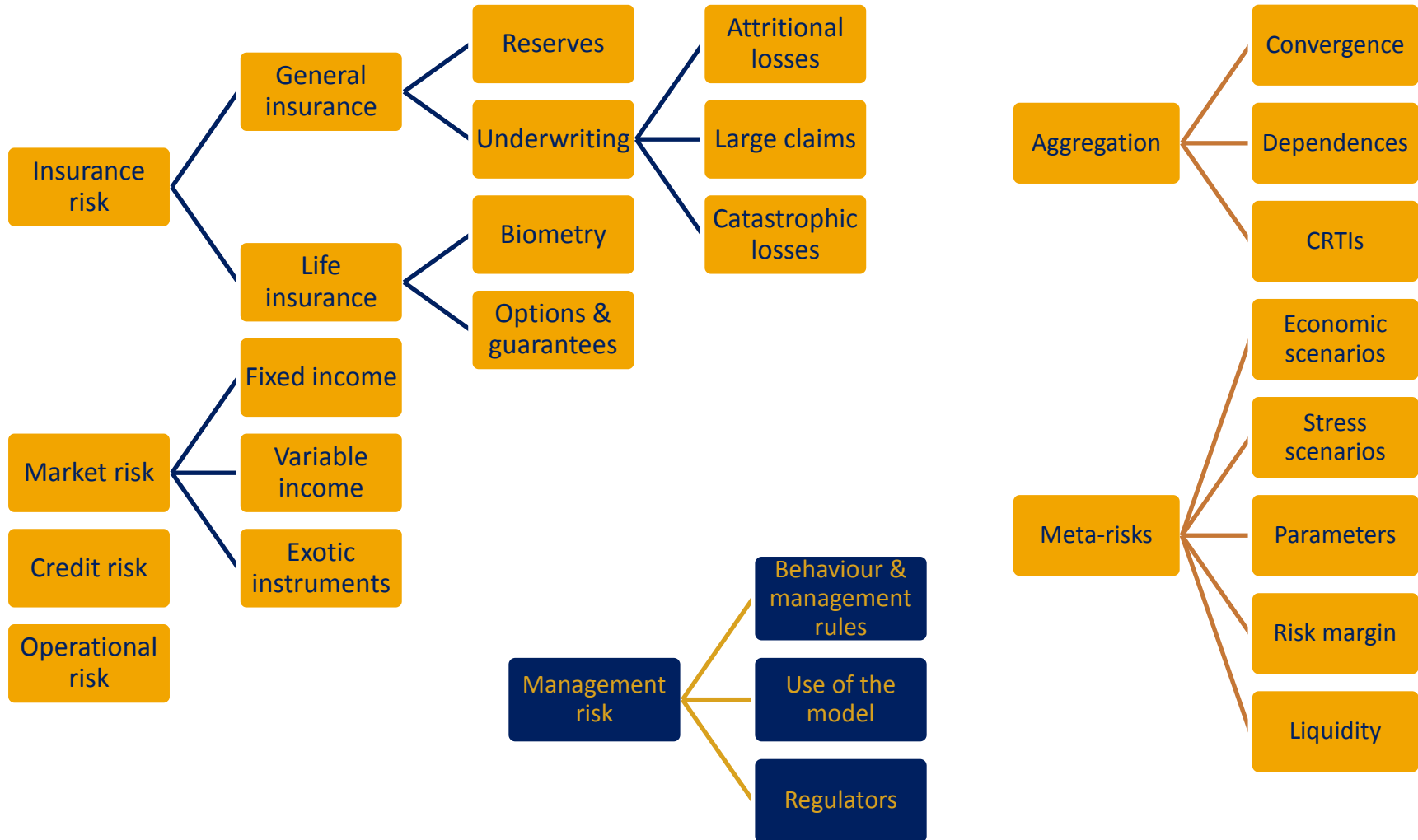
Rule 90



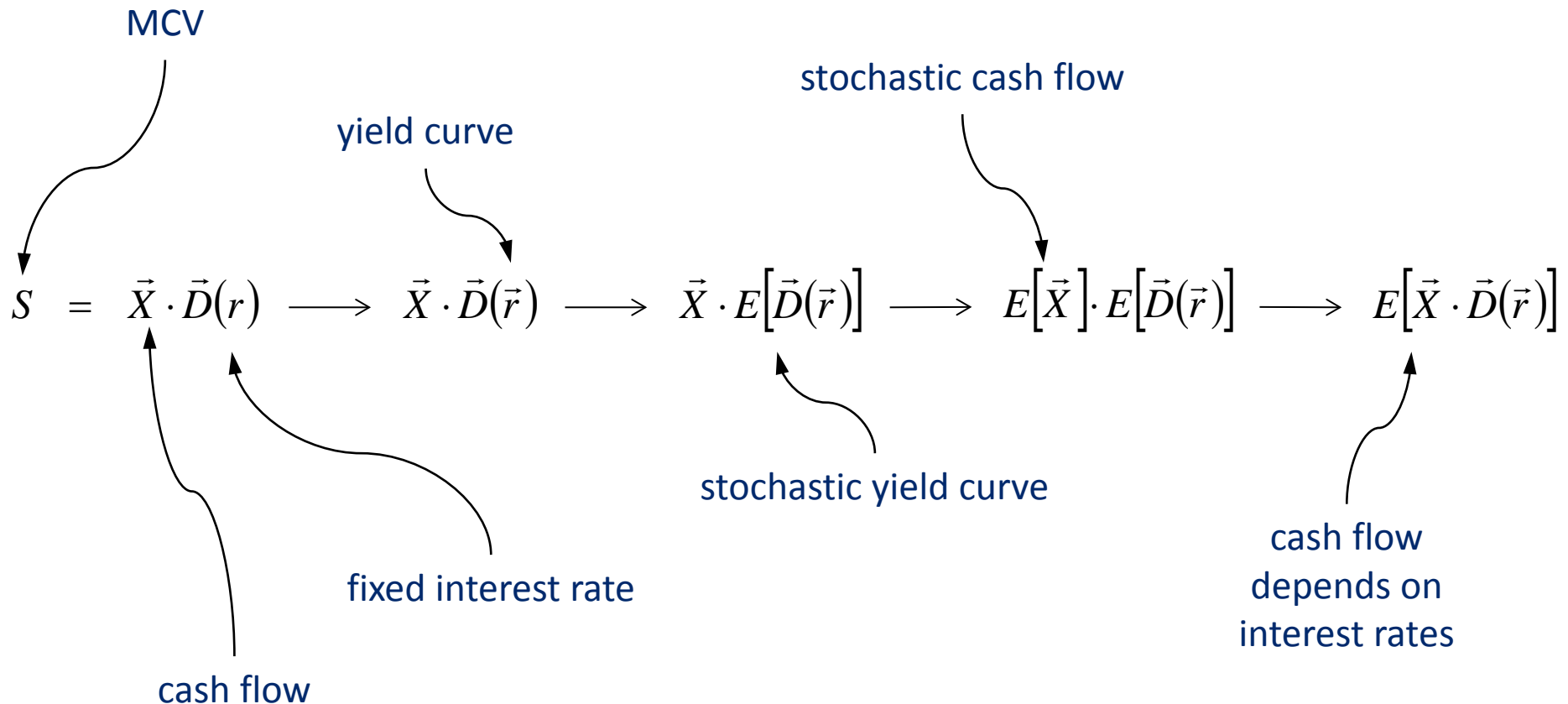
Equity EUR



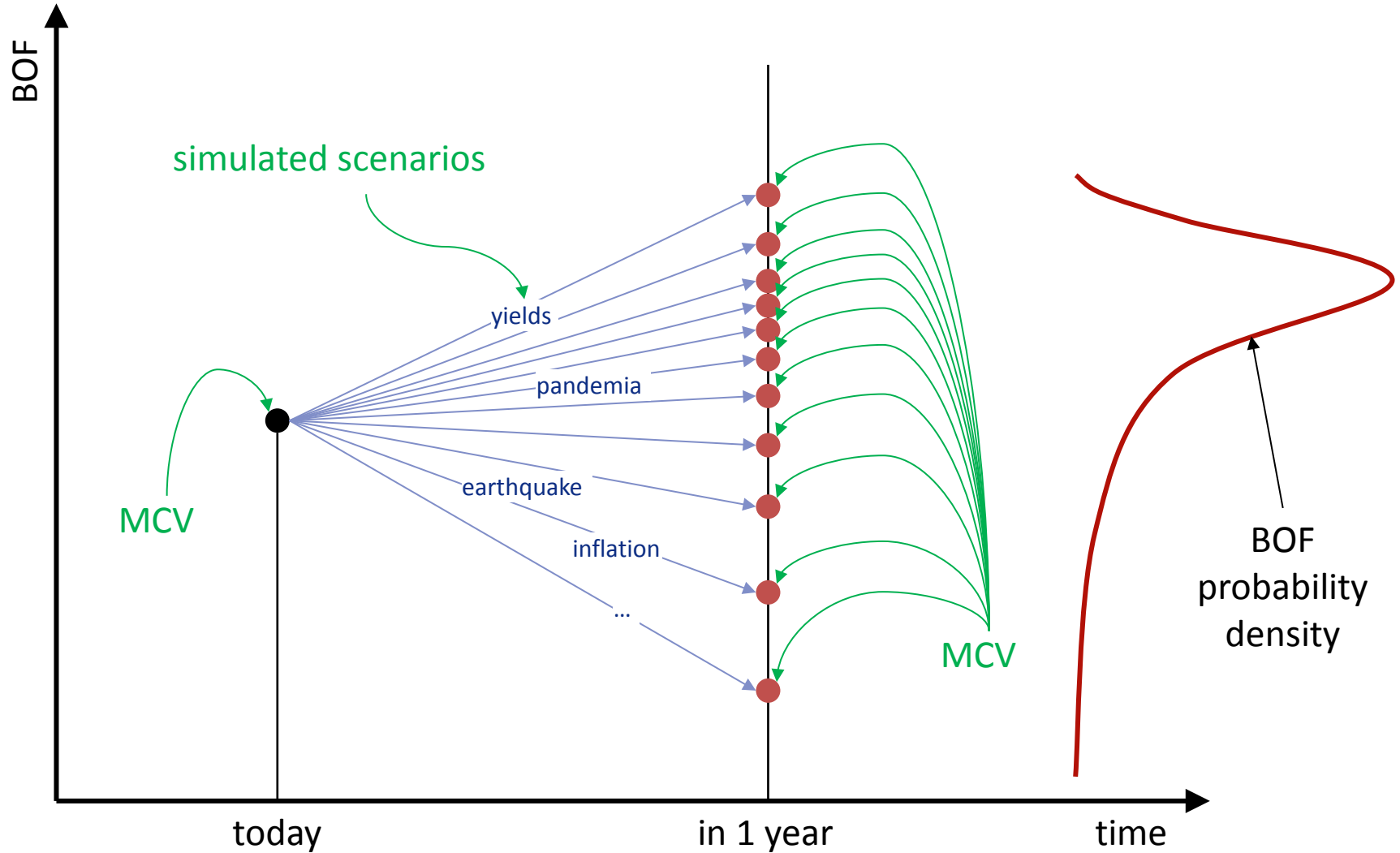
Major Risk Models



Life options & guarantees



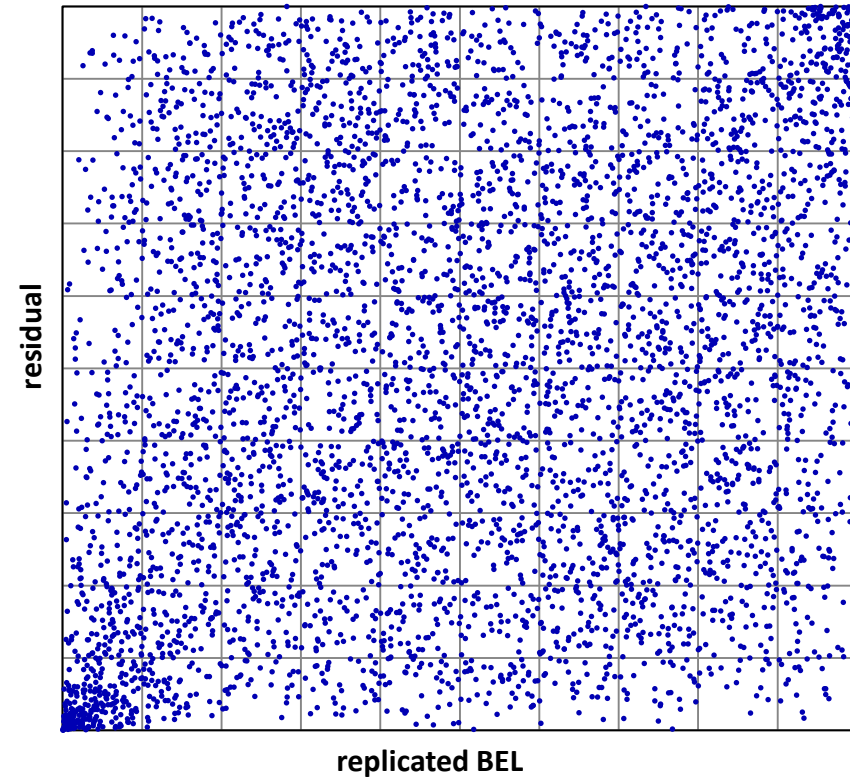
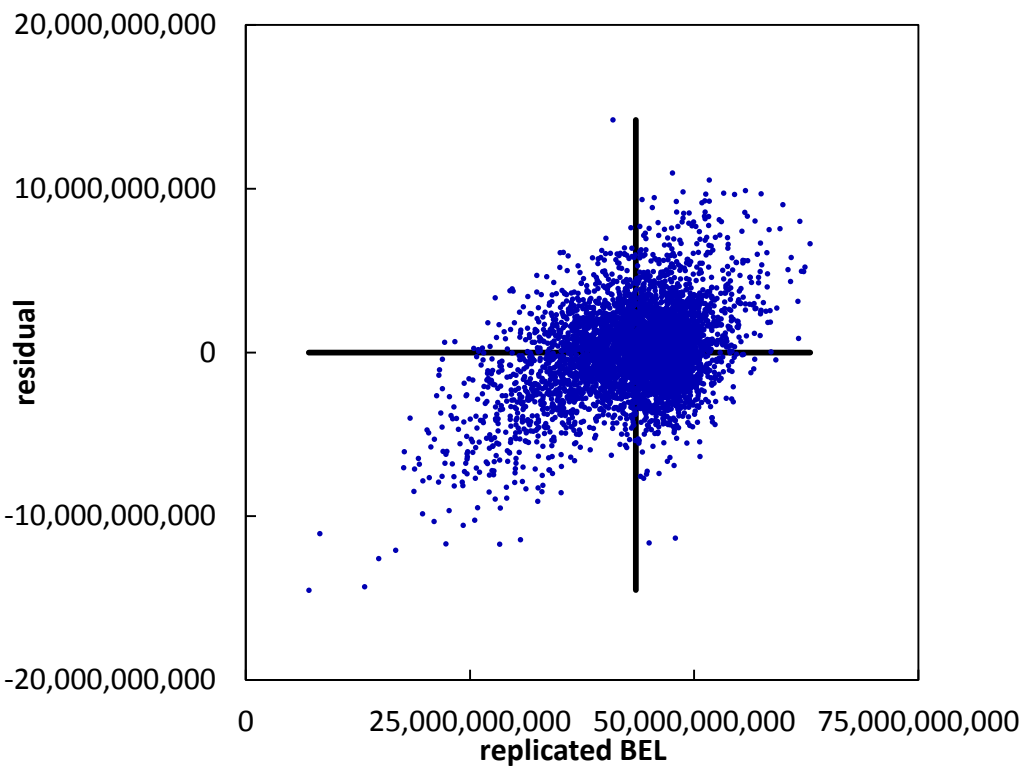
BOF & SCR



Replicating portfolios

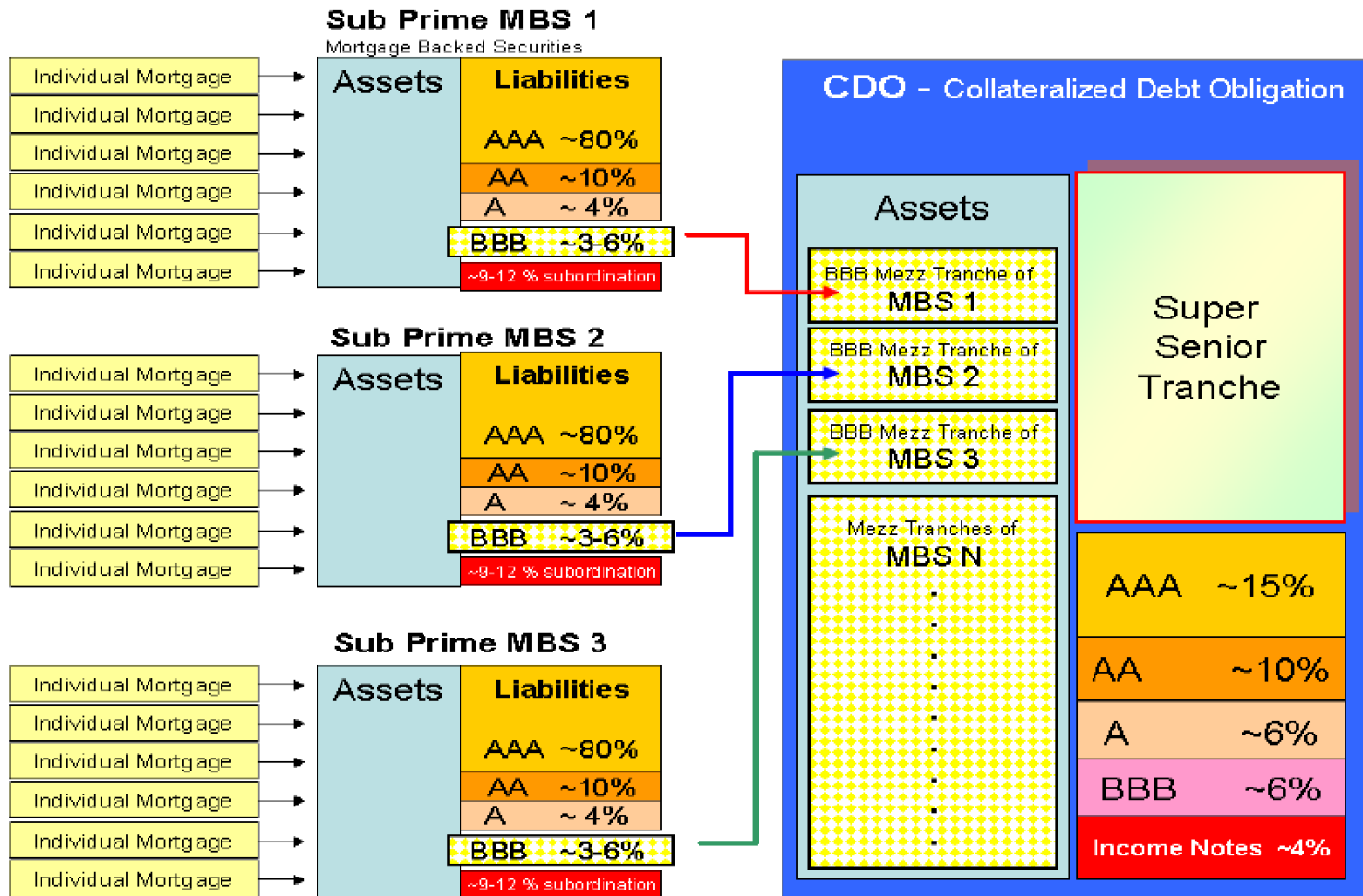
- Life insurance options & guarantees intimately weave market and insurance risk together
 - BOF = average over (risk neutral) economic scenarios
 - ⇒ Monte Carlo
 - ~ 1 hour 😞
 - SCR = BOF statistic over (real world) economic scenarios
 - ⇒ nested Monte Carlo
 - ~ 1 year ☠️
- Standard solution
 - replicating portfolio = BOF closed form estimate
 - ⇒ approximation of an approximation 💣

Replication quality in the bulk



Replicating portfolios the smart way

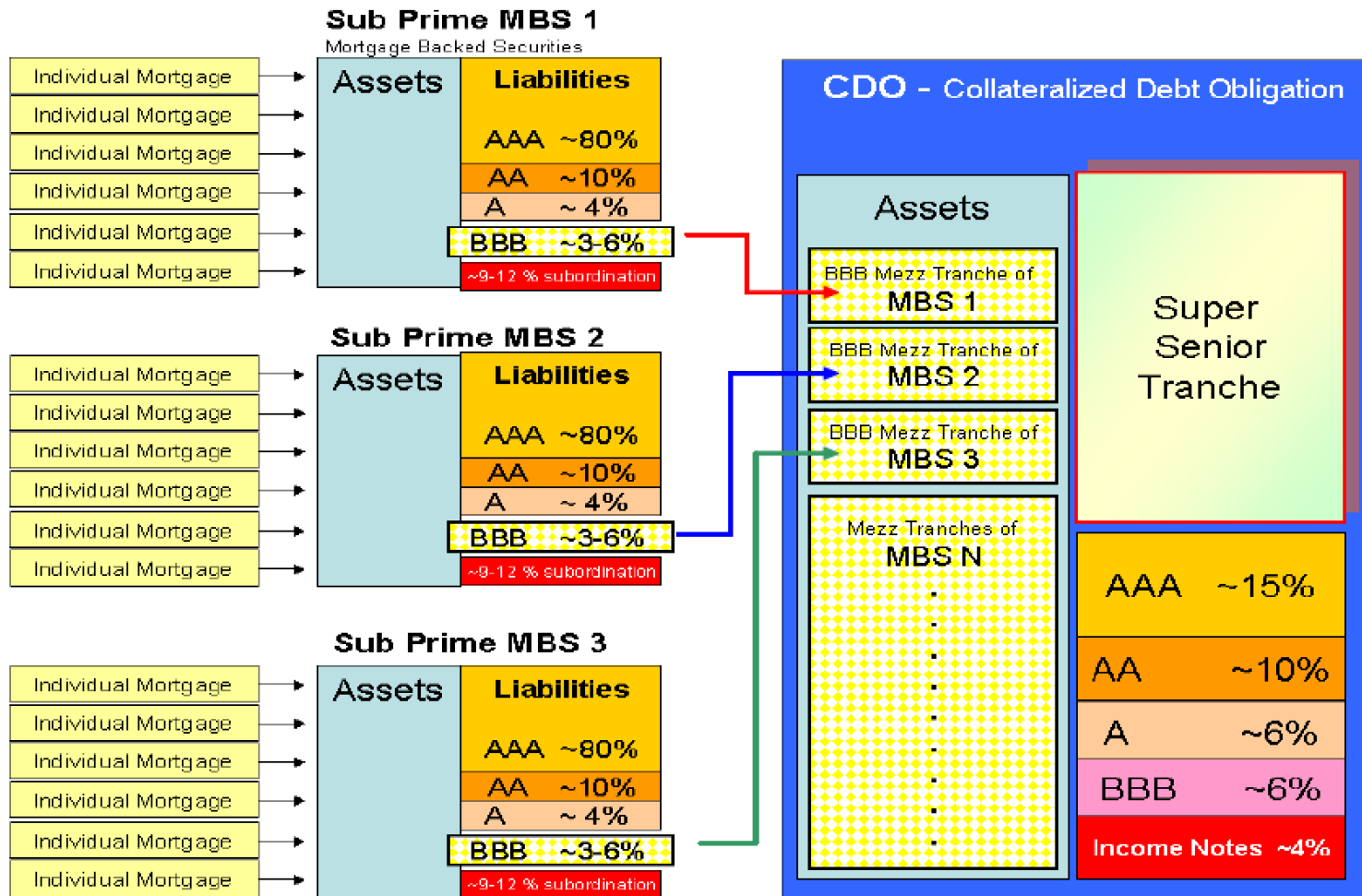
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 - ⇒ Monte Carlo
 - ~ 1 hour 😞
 - SCR = BOF statistic over (real world) economic scenarios
 - ⇒ nested Monte Carlo
 - ~ 1 year ☠️
- Standard solution
 - replicating portfolio = BOF closed form estimate
 - ⇒ approximation of an approximation 💣
- Better solution
 - nested Monte Carlo with variance reduction techniques
 - ⇒ replicating portfolio = control variate 😊



Transmutation of Junk into AAA



Trust is Good



Who's showing the way?

The regulator?

The rating agencies?

Analysts?

Treasury?

The actuaries?

Conclusions

- Actuaries have an important responsibility to assume:

Foster a healthy attitude towards models

- Academics have an important role to play:

Keep exploring new modelling techniques

Contact

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