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We have a technical premium, what’s next?

A pricing strategy for non-life insurance taking into account competition and lapses.

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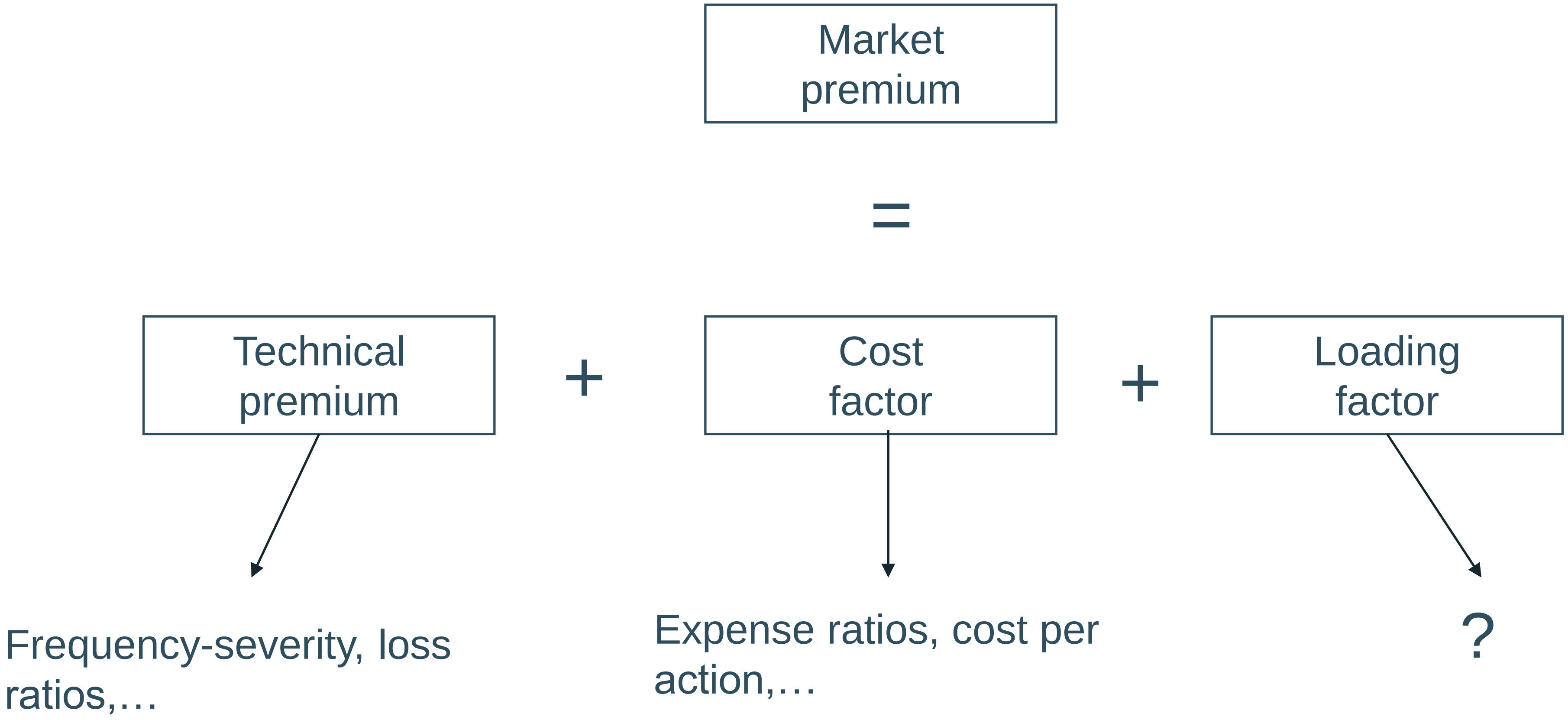
20 October 2022

Introduction and motivations

Basic setting



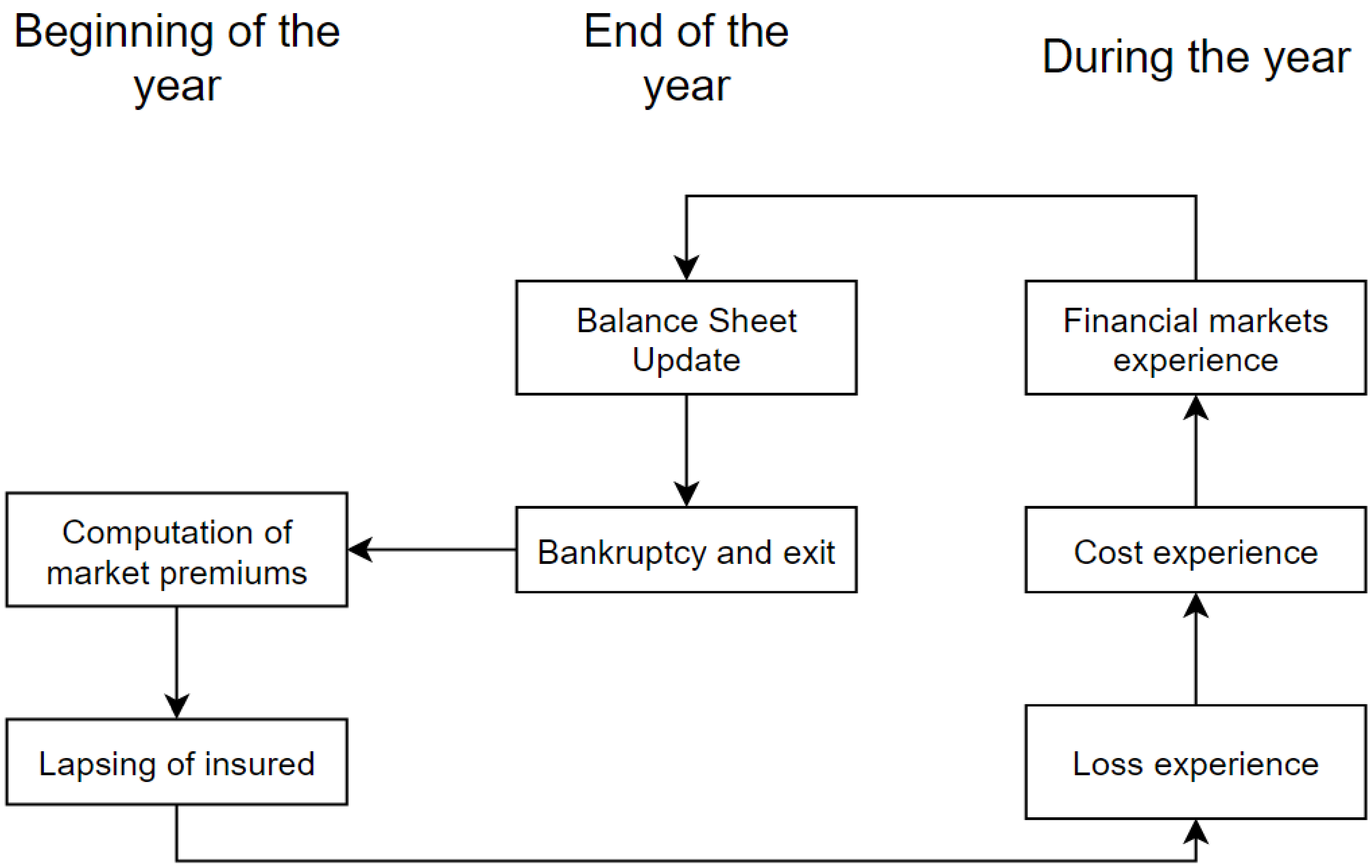
=> New general methodology for non-life insurance pricing based on market simulations.

Structure of the presentation

1. Introduction
2. Model of the insurance market
3. Optimization process
4. Calibration and simulations
5. Conclusion and key takeaways

Model of the insurance market

Market model



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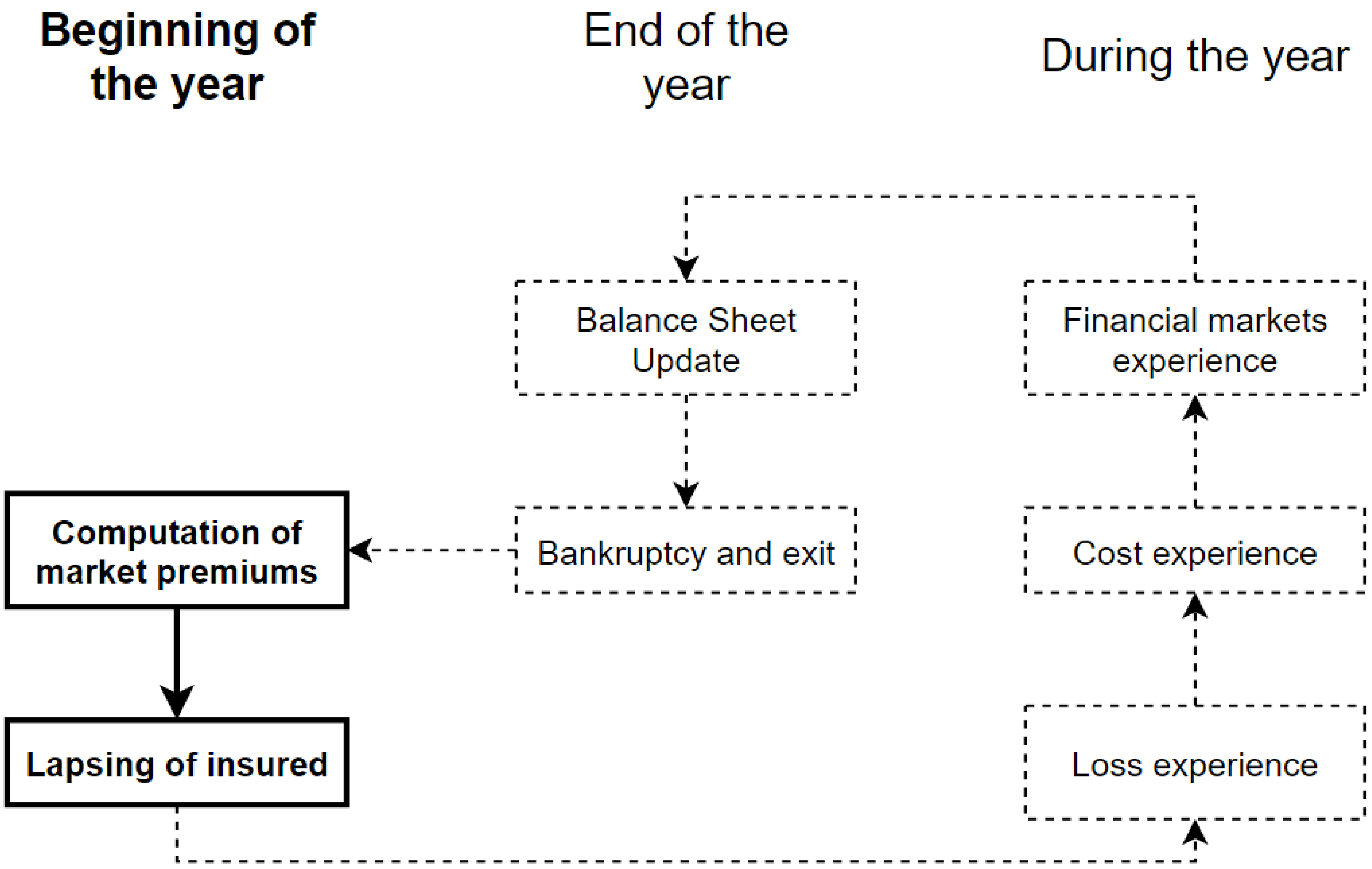
Market model: start of the year



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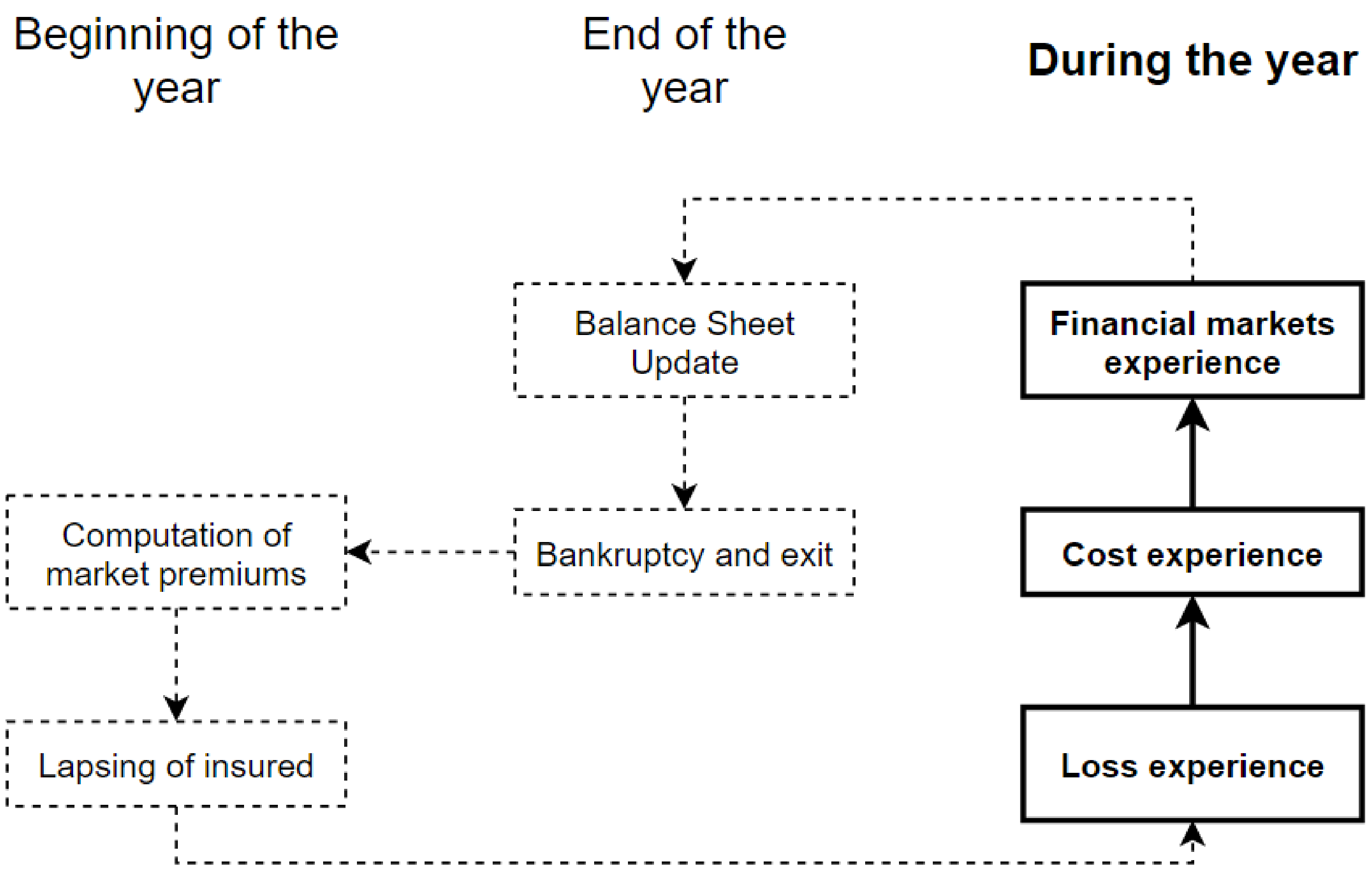
Computation of premiums and lapsing

- **At the beginning of the year, each insurer computes the market premium for each insured in its portfolio :**

$$p_{i,j,t} = t_{i,j,t} + c_{i,j,t} + l_{i,j,t}$$

  - Technical premium: frequency – severity model.
  - Cost factor: linear function of the technical premium.
  - Loading factor: proportional to technical premium.
- Market premium too high: policyholder changes of insurer.
- Insureds chose the insurer with **smallest market premium.**

Market model: during the year



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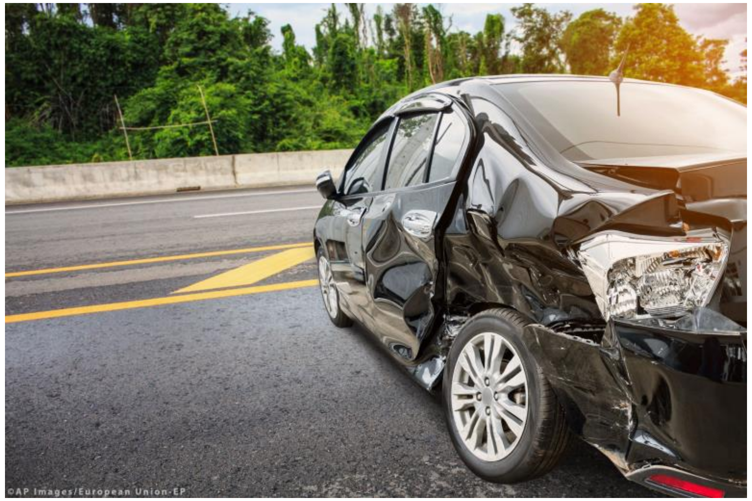
Random experience



Claims

- Simulations using frequency-severity model.
- Frequency $F_{i,t}$: modelled using GLM with a Poisson distribution.
- Severity $S_{i,t}$: modelled using a Gamma distribution.
- Loss experience: $L_{i,t} = F_{i,t} \cdot S_{i,t}$.

Costs

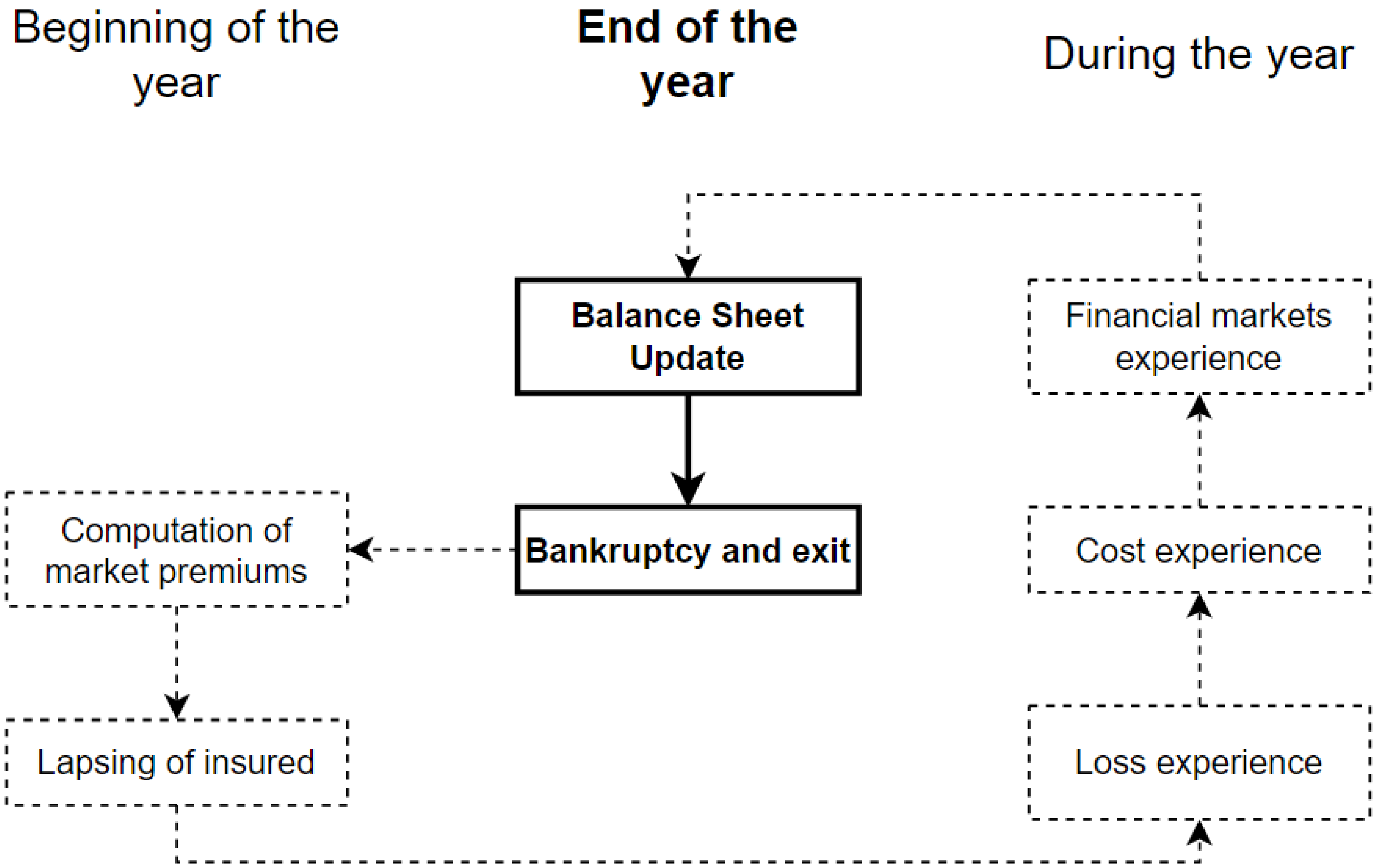
- Constant costs + costs per claim:

$$C_{j,t} = \alpha_{j,t} + \beta_{j,t} L_{j,t}.$$

Financial markets

- Capital of insurers:
  - γ invested in risk-free instruments.
  - $1 - \gamma$ invested in market portfolio.
- Market portfolio: deterministic.

Market model: end of the year



Profit and Loss

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Bankruptcy

End capital

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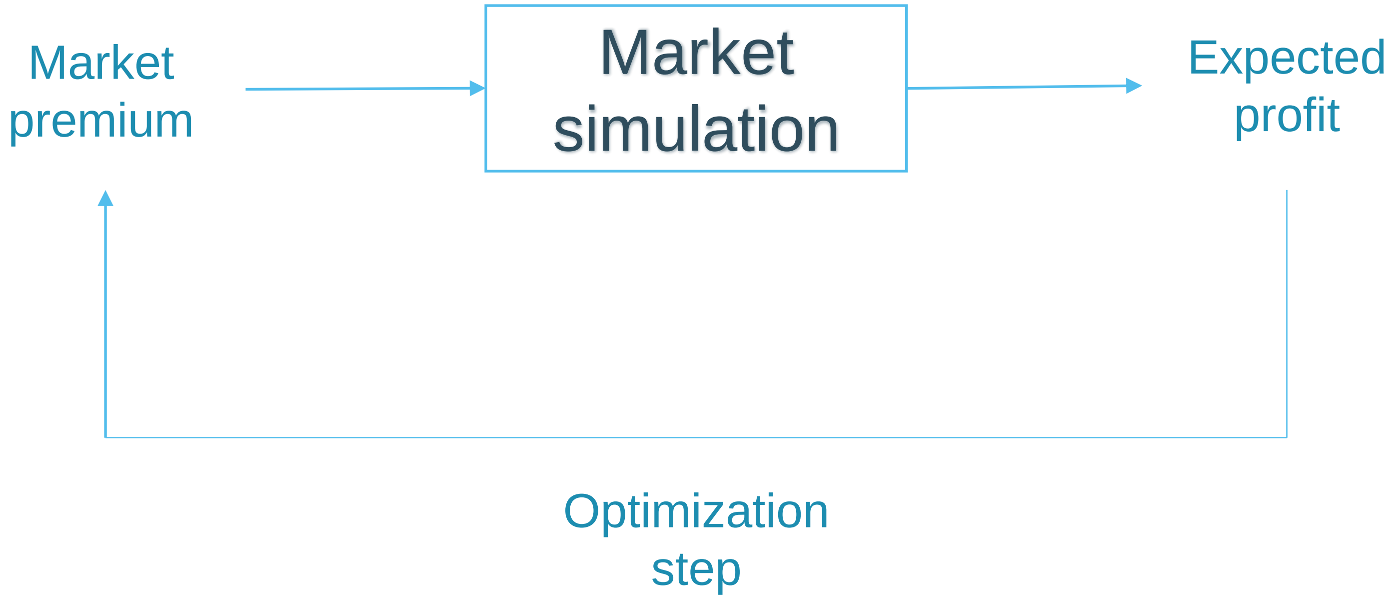
Capital requirements

Bankruptcy and lapsing - Consequences

Bankrupt insurer →  → **Cheapest insurer(s)**

Optimization process

General optimization scheme



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Optimization problem

- **Optimization function**
  - Maximization of discounted expected profit:

$$\max_{p_{i,j,t}} \sum_{t=1}^{T_{max}} \mathbb{E}\left[\frac{\pi_{j,t}}{(1+\delta)^t}\right]$$

- **Optimization constraints**
  - **Deterministic constraints:**
    - Premiums constraints: maximum/minimum premium.
  - **Probabilistic constraints:**
    - Solvency constraint: probability of bankruptcy $< 0.5\%$.
    - Market share constraint: high probability of high market share.

Lagrangian relaxation

- **General idea**:
  - Modelling probabilistic constraints strictly: very difficult.
  - Idea: probabilistic constraints do not need to be satisfied exactly.
  - Objective function incurs (big) penalty when constraints not satisfied.
- **Relaxed optimization function:**

$$\max_{p_{i,j,t}} \sum_{t=1}^{T_{max}} \mathbb{E}\left[\frac{\pi_{j,t}}{(1+\delta)^t}\right] -$$

$$A \cdot \sum_{t=1}^{T_{max}} \left(P\left[Bankruptcy_{j,t}\right] \geq 0.5\% + P\left[\rho_{j,t} \geq \rho^{(min)}\right] \leq 95\%\right)$$

with: $A \rightarrow \infty$, subject to premium constraints.

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Calibration and simulations

Belgian insurance market

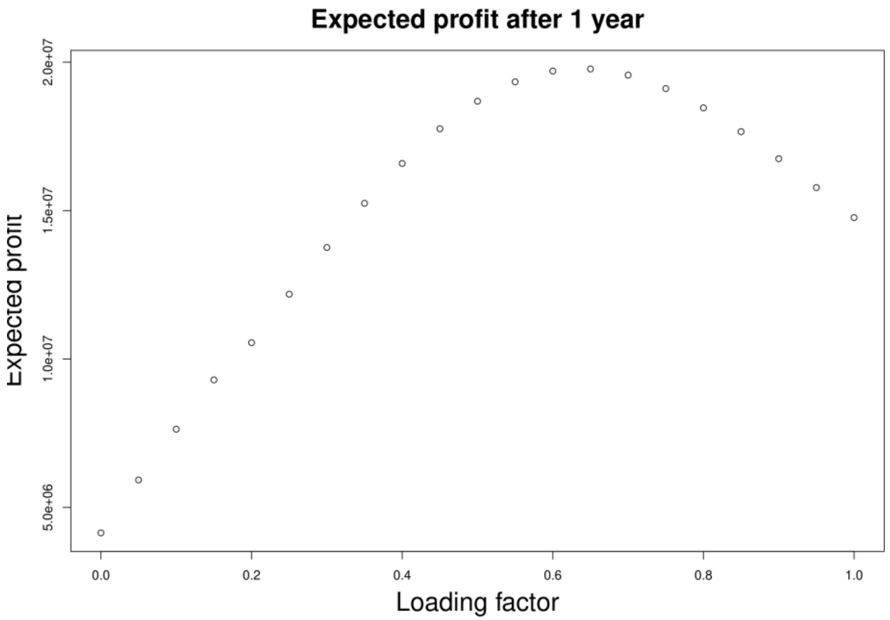
Calibration process

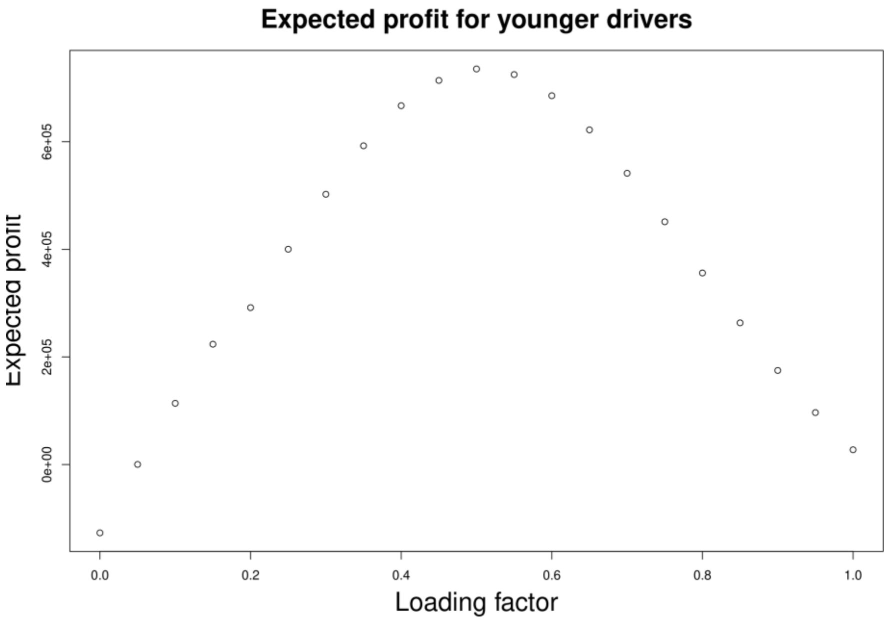
- Reference insurer: **AG Insurance**.
- Calibration of our market: based on SFCR of the different insurers.
- Data from year 2019.
- Use of boostrapped dataset for portfolios of insurers.

Assumptions for lapsing

- Number of factors that make the insured more/less likely to lapse during a given year:
  - Age of the policyholder: younger insured more likely to lapse.
  - Urban/rural policyholder.
  - Number of claims of insured.
  - Length of the policy of the insured.
  - Premium paid compared to the premium offered in the market.

One-year simulation process





- Optimal loading factor: 64% of technical premium for whole portfolio, 51% for younger drivers.
- Profit: small when market premium is too high or too low.

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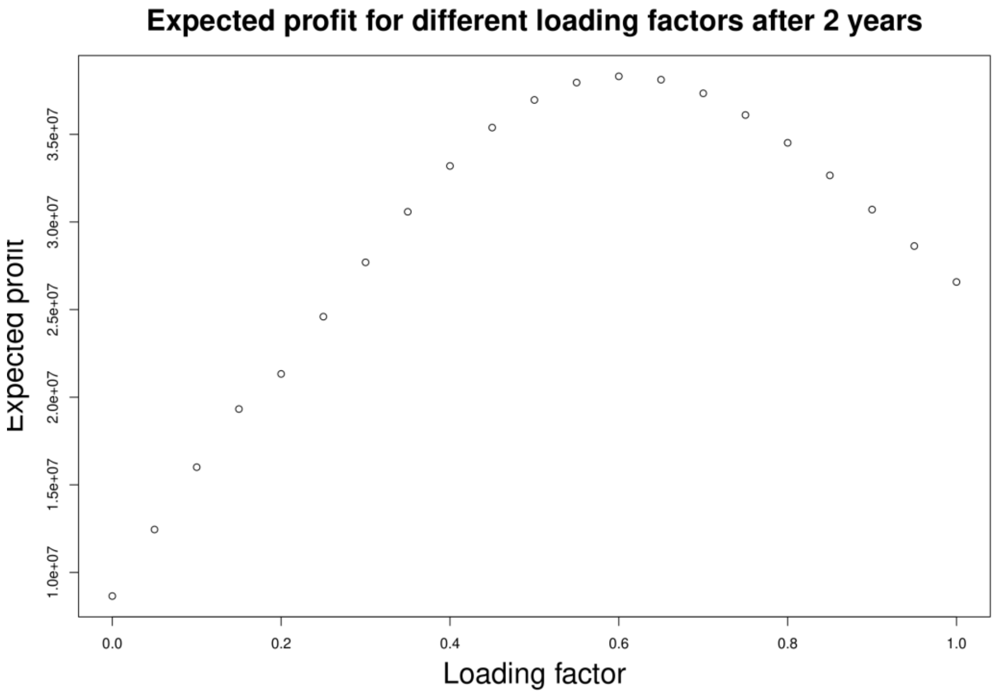
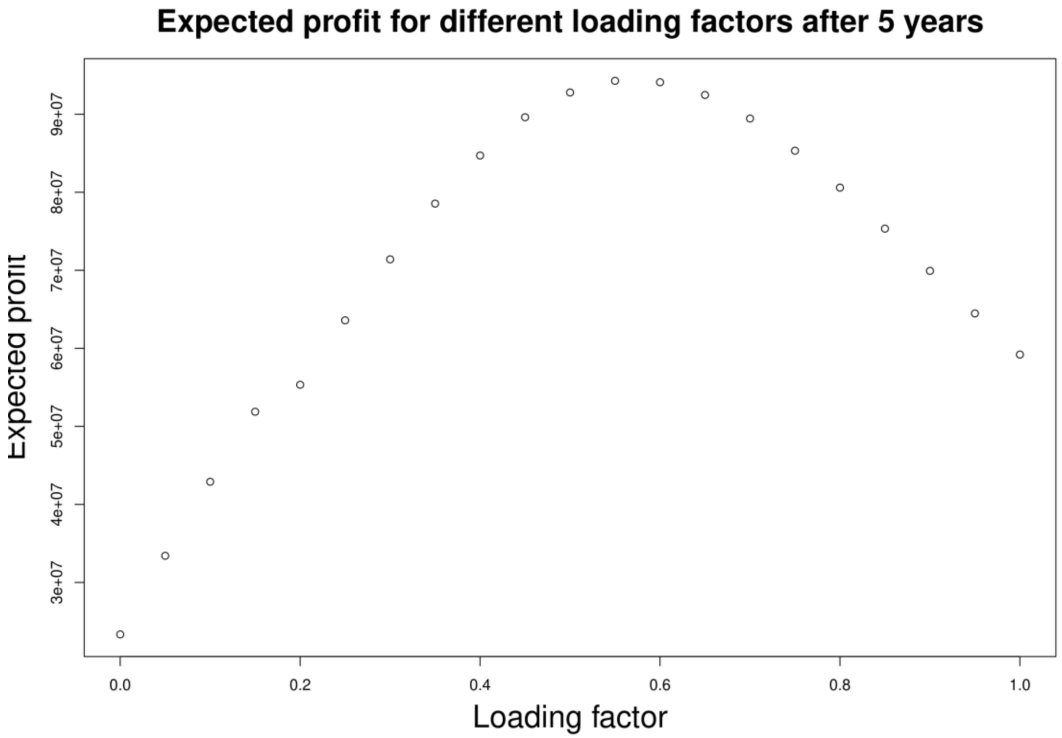
Multiple-year simulation process





- Optimal loading factor: ~60% after 2 years, ~55% after 5 years.
- Longer horizon => smaller loading factor.

Conclusion and key takeaways

Conclusion

- Development of a market model in order to simulate an insurance market.
- Optimization algorithm for the computation of optimal market premium of a non-life insurer.
- Calibration of the model to the Belgian Motor TPL insurance market.
- Simulations of this calibrated market model.
- Computation of the optimal market premium for a given portfolio.

Key takeaways

- Combination of technical actuarial modelling, advanced optimization methods and a lot of creativity for the calibration.
- Can be improved in a number of ways (use of larger datasets, more realistic assumptions, computational efficiency,…).
- Important contribution to the literature at a time where the insurance sector is facing important evolutions: digitalization, real-time pricing methods, changing mobility behavior, …
- Part of the new tools needed to tackle these challenges.
- Looking forward to further improve and test it during future projects !

Thank you!

Questions?