Markov Chain Modeling of Policy Holder Behavior in Life Insurance and Pension

Lars Frederik Brandt Henriksen. University of Copenhagen.
Jeppe Woetmann Nielsen. Edlund A/S.
Mogens Steffensen. University of Copenhagen.
Christian Svensson. Formerly Edlund A/S.

Outline

- Approaches to policy holder behavior
- Risk and behavior models
- Reserves
- Example
- Conclusion and recommendations

Approaches to policy holder behavior

- Policy holder behavior
  - Surrender option

    Early termination of the contract
  - Free policy option (paid-up policy option)

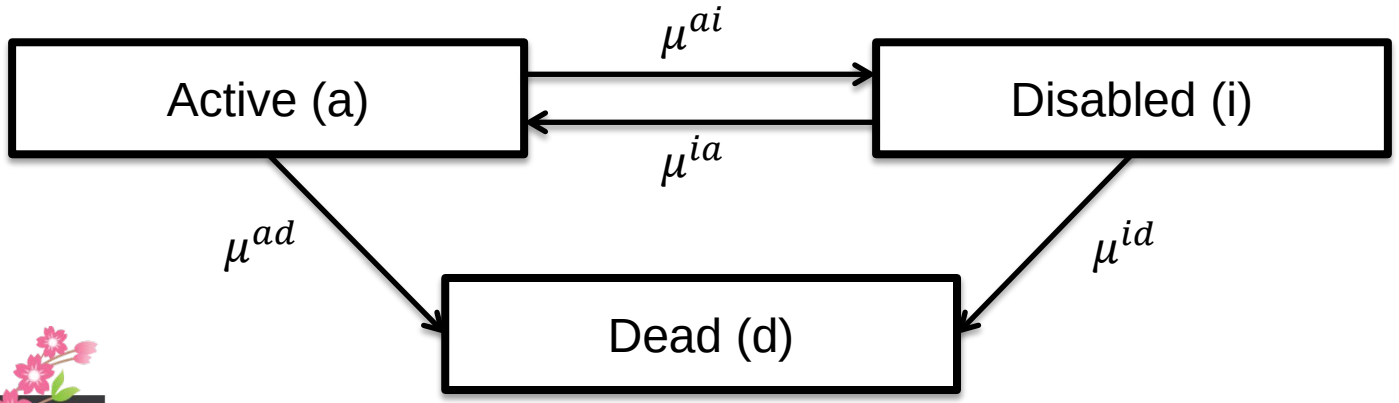
    Stop premium payment and reduce benefit

Approaches to policy holder behavior

- Modeling by worst-case behavior (not here)
- Modeling by expected behavior
  - Intensity modeling by Markov chains
  - Dependence between policy risk and behavior by contract design

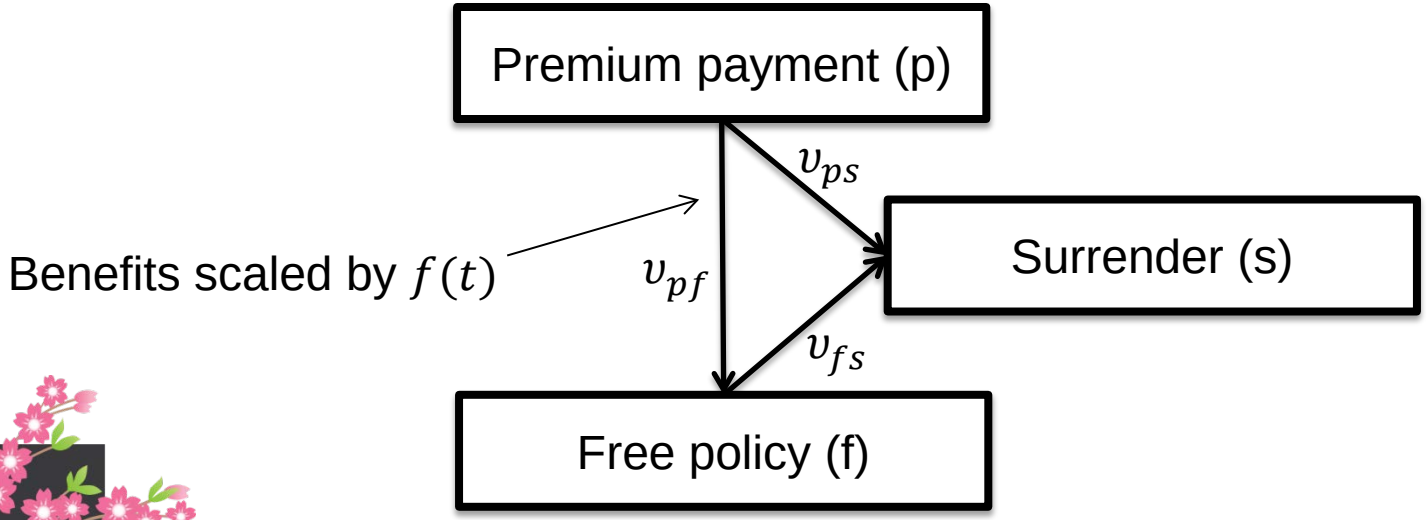
Risk and behavior models

- Disability risk model
  - Deterministic intensities



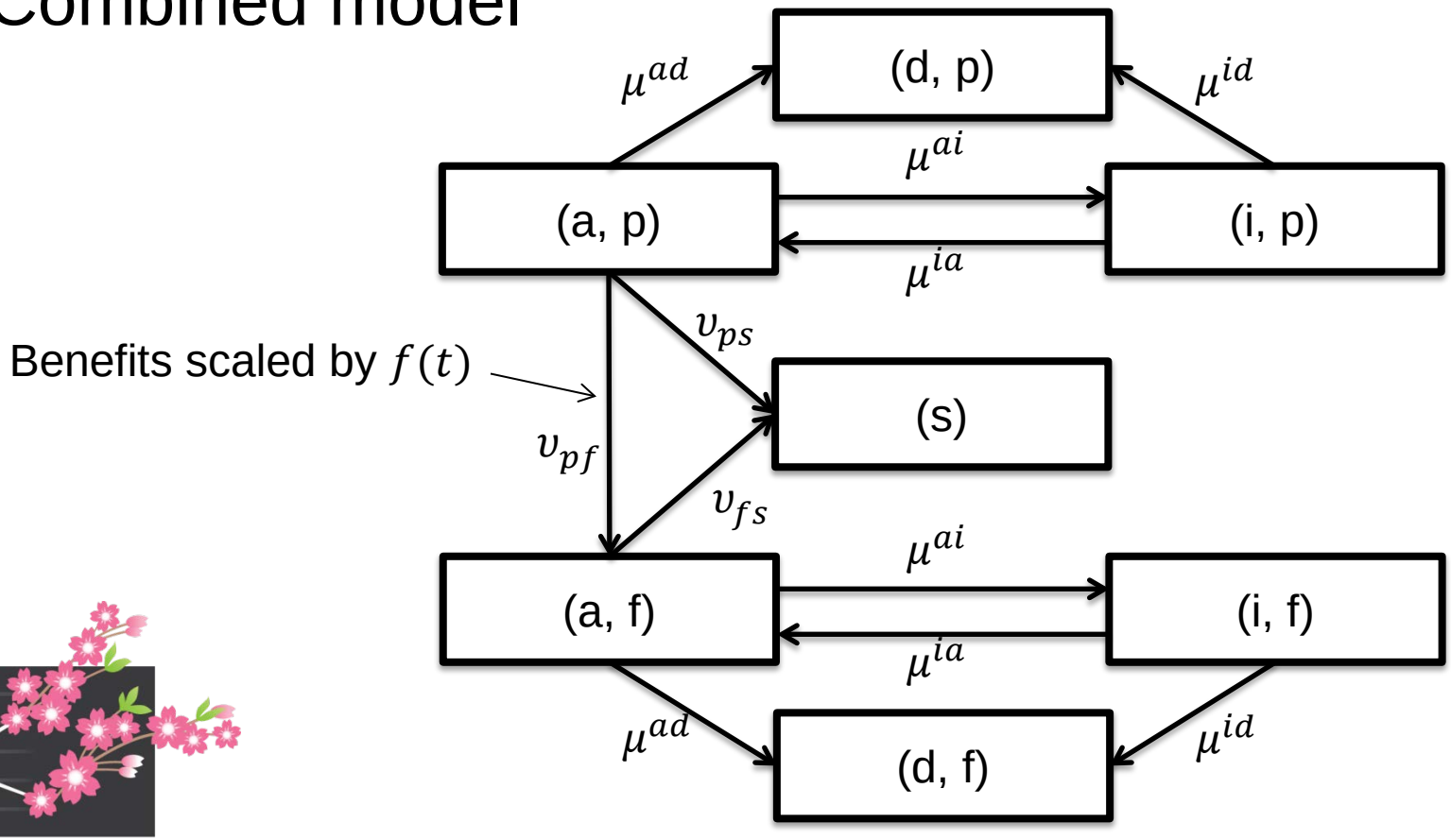
Risk and behavior models

- Behavior model
  - Contract design: Only policy holder options when active



Risk and behavior models

- Combined model



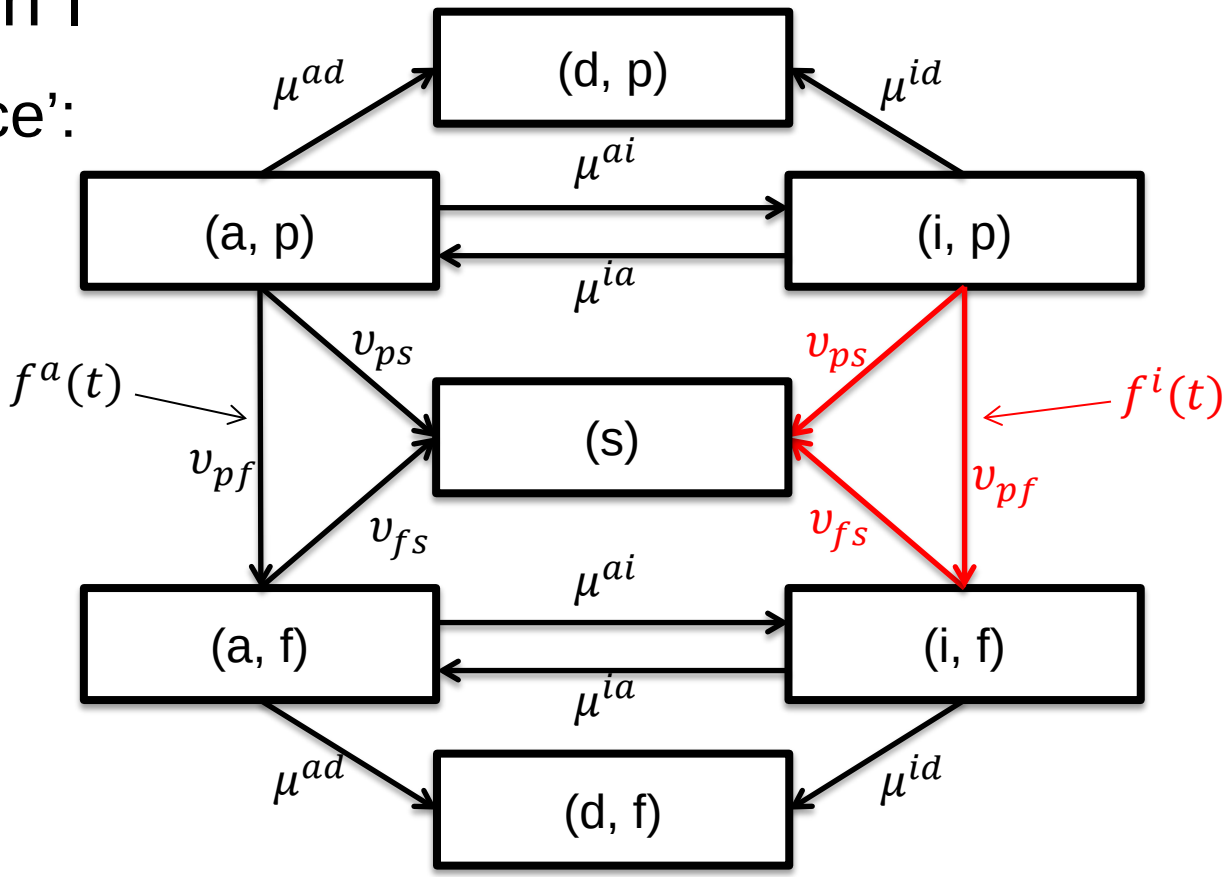
Reserves

- In general complex expressions for reserves
  - Explicitness depends on reactivation
  - Relatively easy to handle with system of ordinary differential equations (Thiele)

Reserves

- Simplification I

  'Independence':



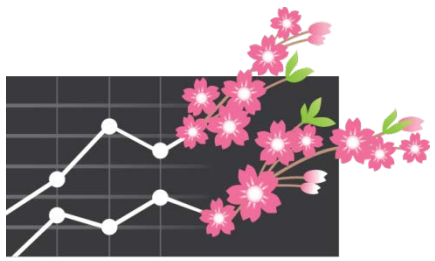
Reserves

- Simplification II

'Same $f(t)$':

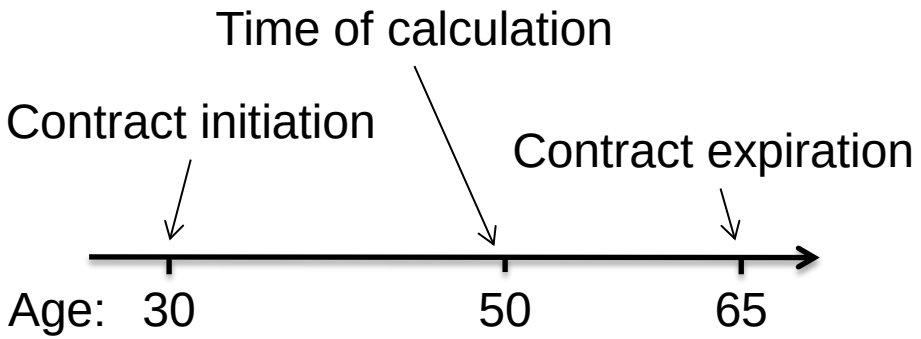
$$V^a(t) = \int_t^n e^{-\int_t^s r} p_{pp}(t,s)c(t,s)ds + \int_t^n e^{-\int_t^s r} W(t,s)c^+(t,s)ds$$

- $W(t,s) = \int_t^s p_{pp}(t,\tau)\nu_{pf}(\tau)f(\tau)p_{ff}(\tau,s)d\tau$
- $c(t,s)$ cash flow in case of no free policy intervention
- $c^+(t,s)$ cash flow in case of free policy intervention



Example

- Contract

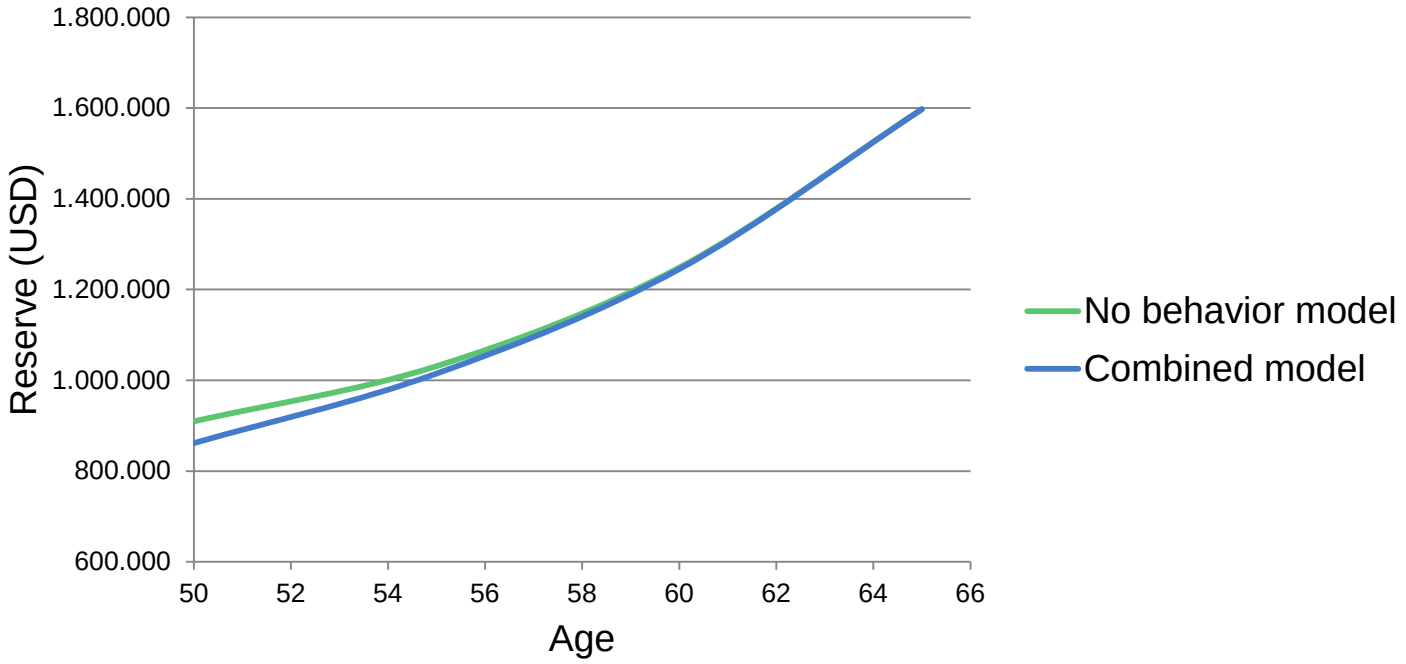


Premium
20,000 USD p.a. when active

Benefits	Amount
Disability annuity	100,000 USD p.a.
Term insurance	400,000 USD
Pure endowment at expiry	1,597,593 USD

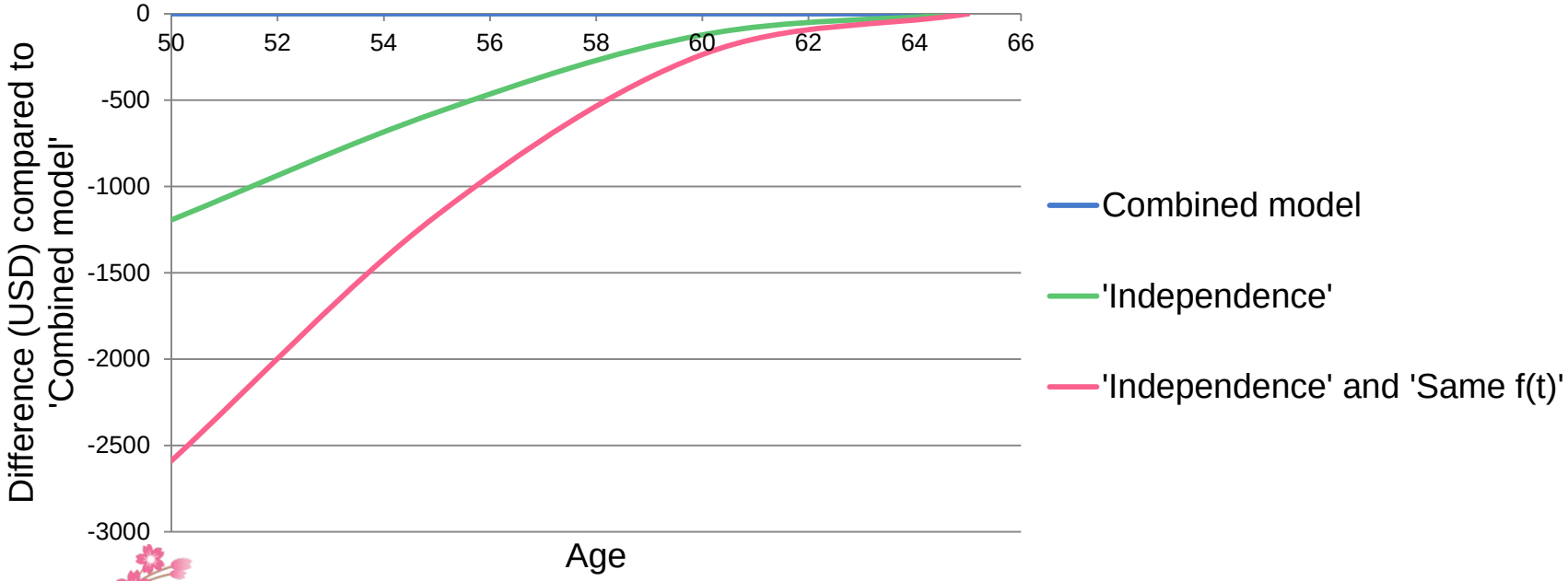
Example

- Reserves



Example

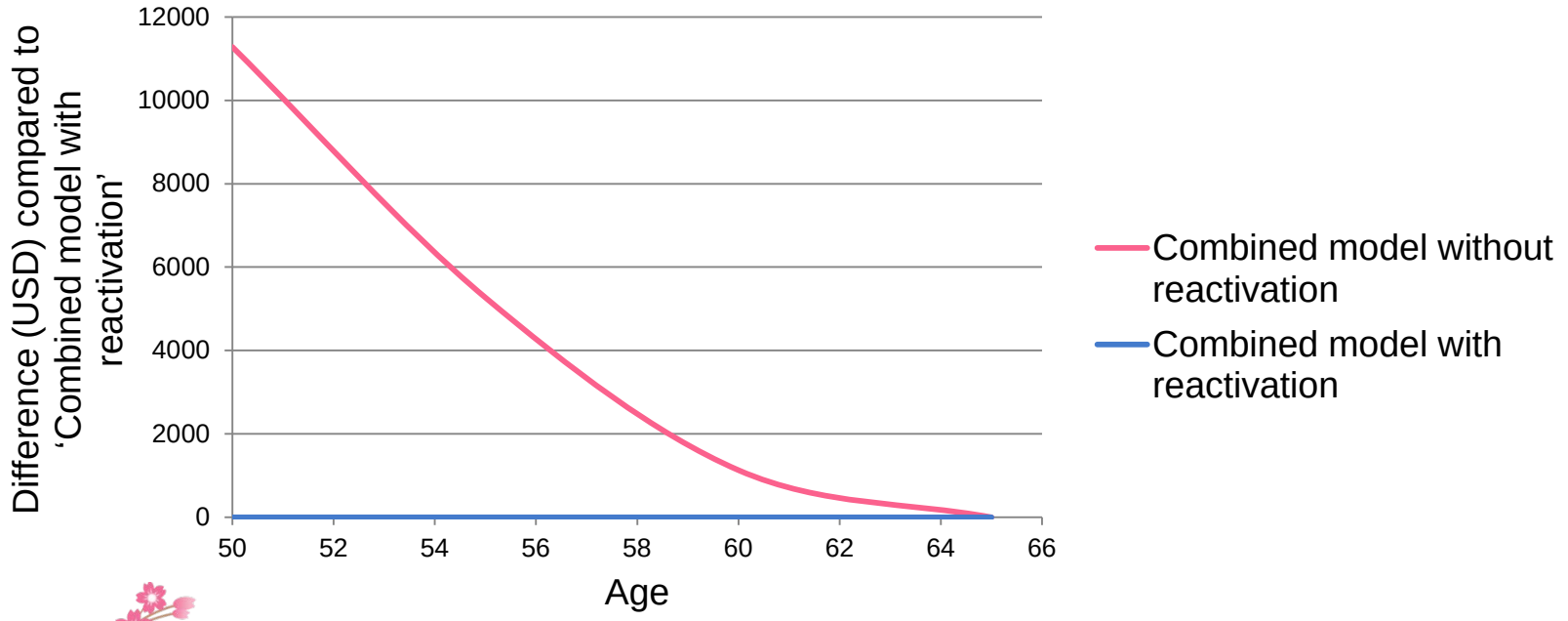
- Consequence of simplifications



- The sign and size of the error is contract dependent
- The error is systematic

Example

- Consequence of modeling without reactivation



- The size of the error is contract dependent
- The error is systematic

Conclusion and recommendations

- Without behavior modeling

  ’right’ = ‘simple’ – (5% to 6%)
- Simplified behavior modeling

  ’right’ = ‘simple’ + (0% to 1%)
- Without reactivation

  ’right’ = ‘simple’ – (1% to 2%)
- Contract and basis dependent

You don’t know how ‘wrong’ is wrong
until you know how ‘right’ is right

edlund
– inside insurance

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COPENHAGEN