

# Disability Risk: Theory and Empirical Result

Peter Nielsen,  
RGA International

Kai Kaufhold,  
NMG Consulting

# About the speaker



- **Peter Nielsen**
- Chief Pricing Actuary (German office)
- M. Sc. in mathematics (Köln), member of DAV and SAV, various actuarial roles in German life insurance industry

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## ▪ **Reinsurance Group of America**



- Total Revenues: 12.5B USD
- Total Assets: 60.5B USD
- Life Reinsurance In Force: 3,300B USD  
(As of December 31, 2017)

# About the speaker



- **Kai Kaufhold**
- Partner, NMG Consulting
- Life reinsurer, consultant on reinsurance and quantitative analysis of biometric risks.



shape your thinking

- **NMG Consulting**
- Specialist consultancy focusing on insurance and wealth management sectors
- Vertically integrated consulting backed by proprietary research to shape strategy, implement change and manage performance
- ~100 employees across eight countries

# The next 30 minutes ...



- Background about disability income protection products in Australia and Germany
- Simulation of disability income risk

# Why Australia?

**Swiss Re increases reserves  
US\$373 mil for Group  
Disability**

**Hannover Re hands  
Over US\$130 to  
Individual DI losses**

**Munich Re  
Adds US\$180  
Into Grp & Ind  
Disability Res**

**RGA increases reserves  
US\$300 million, others  
follow**

**AMP amps up  
IP and group res  
US\$83 million**

# Volume

- Annual premium in Mio. EUR 2017

	Germany	Australia
DI	8,900	2,700
TPD	0	1,300
Total	8,900	4,000

# Disability Income: Germany vs. Australia

## ■ Product specifications – **Disability Definition**

Germany	Australia
<ul style="list-style-type: none"><li>• Own occ / own or suited occ</li><li>• Impairments are expected to be permanent (i.e. longer than 6 months)</li><li>• grade of disability is at least 50%</li></ul>	<ul style="list-style-type: none"><li>• Own occ</li><li>• Temporary disability</li> <li>• unable to perform more than 10 hours per week / unable to generate more than 20% of the monthly income</li></ul>

# Disability Income: Germany vs. Australia



## ■ Product specifications – **Rate Guarantees**

Germany	Australia
<ul style="list-style-type: none"><li>• High guaranteed rates</li><li>• Discount by reviewable profit participation</li></ul>	Non-guaranteed rates

# Disability Income: Germany vs. Australia

- Product specifications – **Waiting Period**

Germany	Australia
No waiting period but prognosis time frame	Waiting periods: 14, 30, 60, 90, 180 days, 1 year, 2 years

- „The waiting period is the period you must wait before the benefit period starts“ (in Germany: „Karenzzeit“)

# Disability Income: Germany vs. Australia



- Product specifications – **Agreed Value / Indemnity**

Germany	Australia
Agreed Value	<ul style="list-style-type: none"><li>Agreed Value: Payout based on your income at time of application</li><li>Indemnity: Payout based on income at time of claim</li></ul>

# Disability Income: Germany vs. Australia

- Product specifications – **Benefit Period**

Germany	Australia
Long term (e.g. until age 55, 60, 65, 67)	Short term (between 1 and 5 years) Long term (e.g. until age 55, 60, 65, 70 or 99)

# Disability Income: Germany vs. Australia



- Product specifications – **Premium Payment Mode**

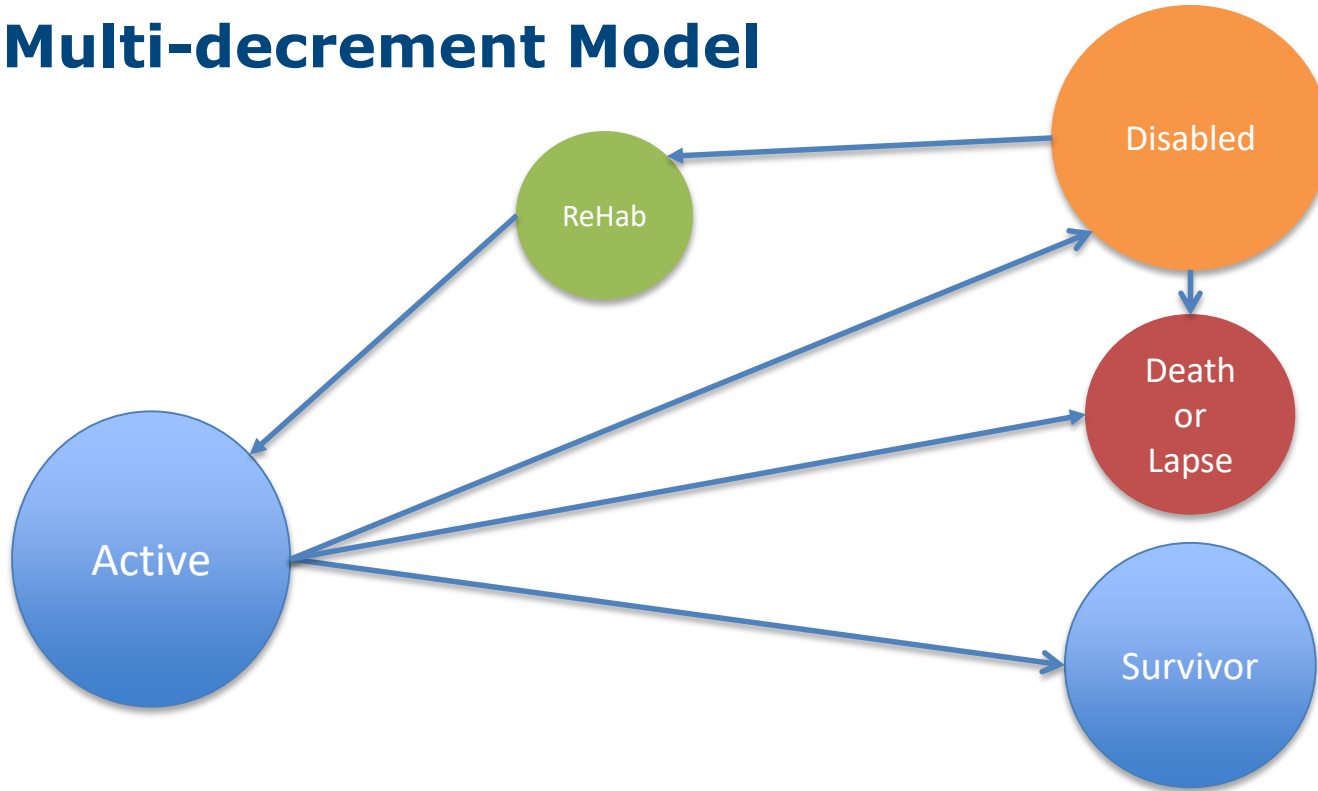
Germany	Australia
Level	Stepped (Level)

# Simulation of Disability Income Risk



- Two datasets: Australian DI, German DI
- Multi-state model:  
Active, Disabled, Lapsed, Death,  
Reactivated, Disabled Death, Survivor
- Multiple decrements:
  - Disability (due to accident or due to sickness)
  - Lapse (voluntary & death)
  - Termination (from disabled state: death, rehabilitation)

# Multi-decrement Model



# Simulation of Disability Income Risk



- Actives

$$\textit{Survival Prob} = \textit{Prob}(\textit{no disability}) \times \textit{Prob}(\textit{no lapse or death})$$

- Disableds

$$\textit{Survival Prob} = \textit{Prob}(\textit{no termination})$$

# Simulation of Disability Income Risk

Parametric survival models in continuous time:

$$\text{Survival} = S_t = e^{-H_x(t)} = \exp\left(-\int_0^t h_{x+s} ds\right)$$

- with hazard rate function  $h_x = h_x(\boldsymbol{\theta})$ ,  
e.g. force of mortality  $\mu_x$  or  
intensity of incidence rate of disability  $i_x$

# Simulation of Disability Income Risk

Example: Gompertz law of mortality

$$\mu_{x,t} = e^{\alpha + \beta x + \gamma t}$$

where

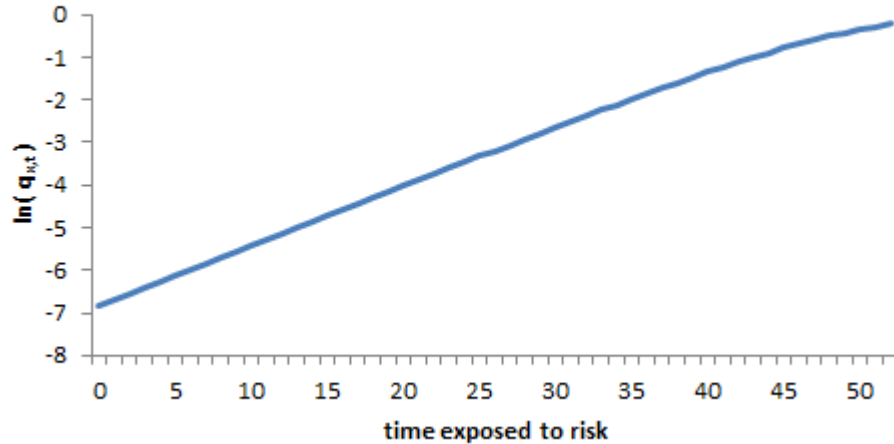
$$\alpha = \alpha_0 + I_F \alpha_F + I_{smoker} \alpha_{smoker}$$
$$\beta = \beta_0 + I_F \beta_F$$

$$I_F = \begin{cases} 1 & \text{females} \\ 0 & \text{males} \end{cases} \quad \text{and} \quad I_{smoker} = \begin{cases} 1 & \text{smokers} \\ 0 & \text{nonsmokers} \end{cases}$$

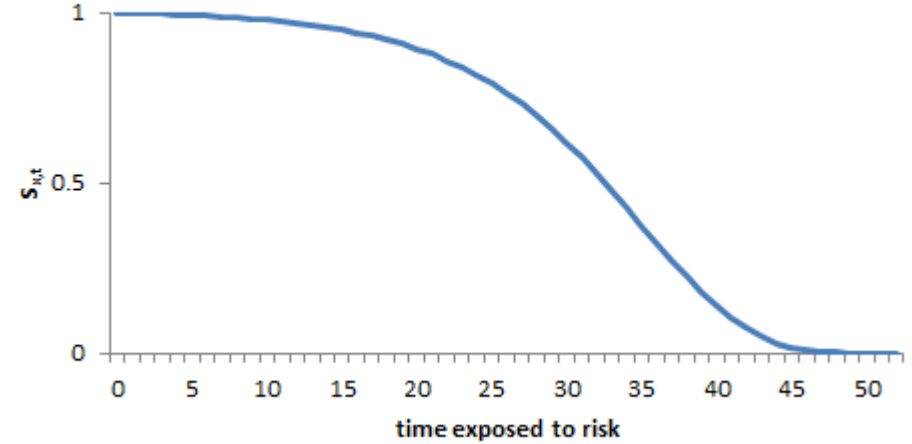
# Simulation of Disability Income Risk

## Incidence of disability due to sickness

Incidence rates



Survival probability



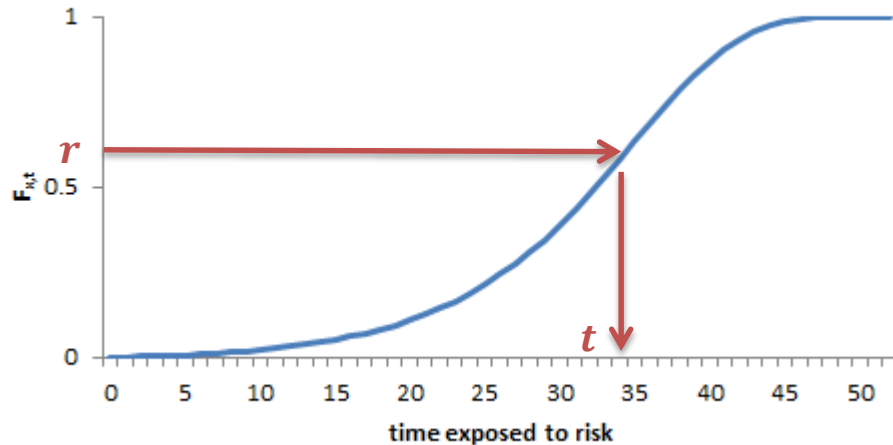
# Disability Income Risk Model (AUS)

SCORE by Risk Factor	Disability (sickness)	Disability (accident)	Lapses (incl. deaths)	Terminations (incl. deaths)
Occupation (blue collar)	4	10	1	1
Waiting Period 14D	2	4	1	1
Waiting Period 60D	-1	-	-	-
Waiting Period 90D+	-2	-3	-1	-1
Gender (female)	2	-1	1	-
Smoker	2	2	1	-
Indemnity vs Agreed	-1	-	-	-

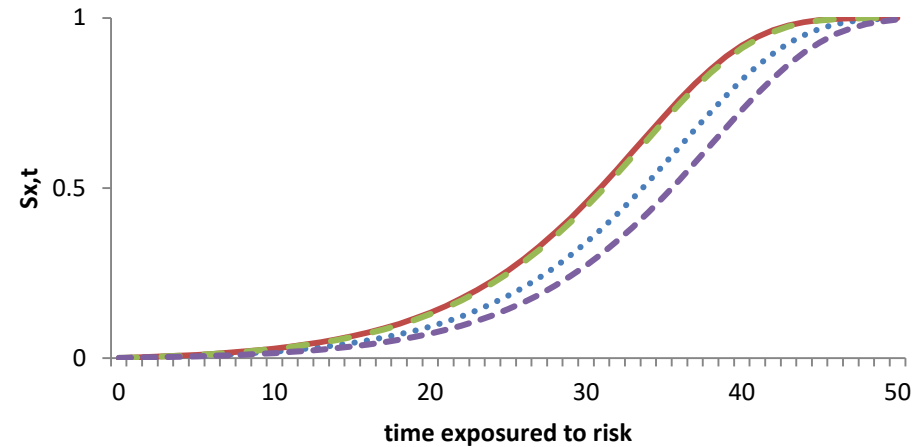
# Simulation of Disability Income Risk

## Two-step Monte Carlo simulation

### Process Risk



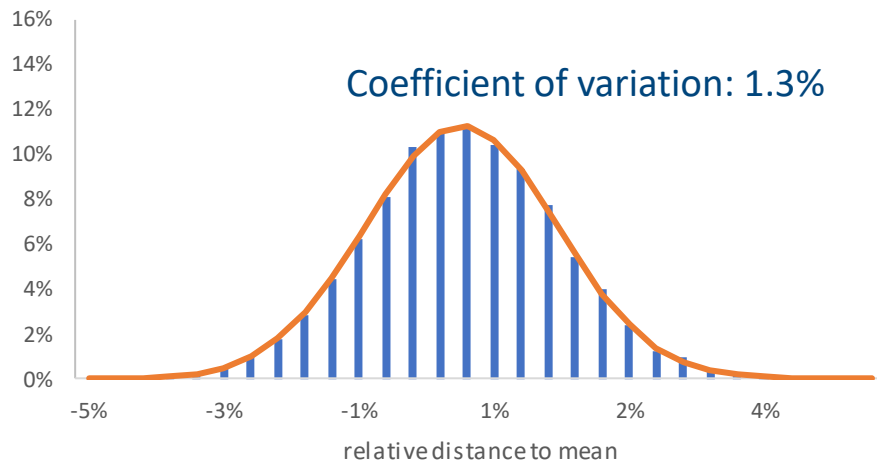
### Parameter Risk



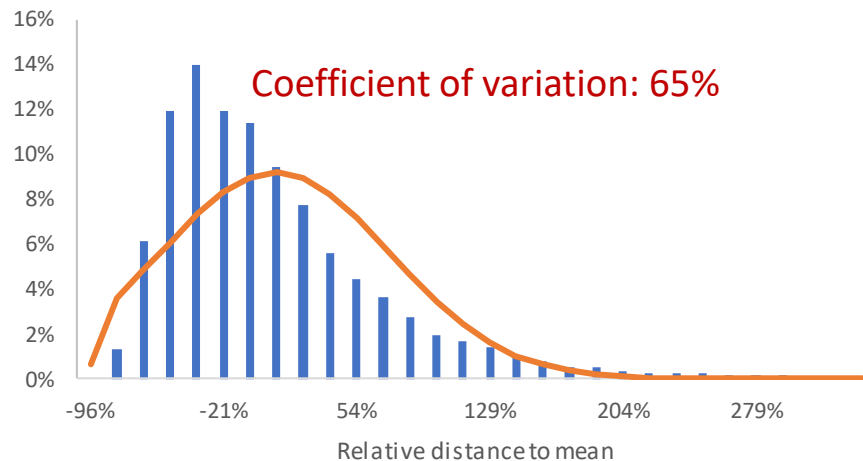
# Simulation of Disability Income Risk

## Simulation Results: German DI

Disability Claims Process Risk only



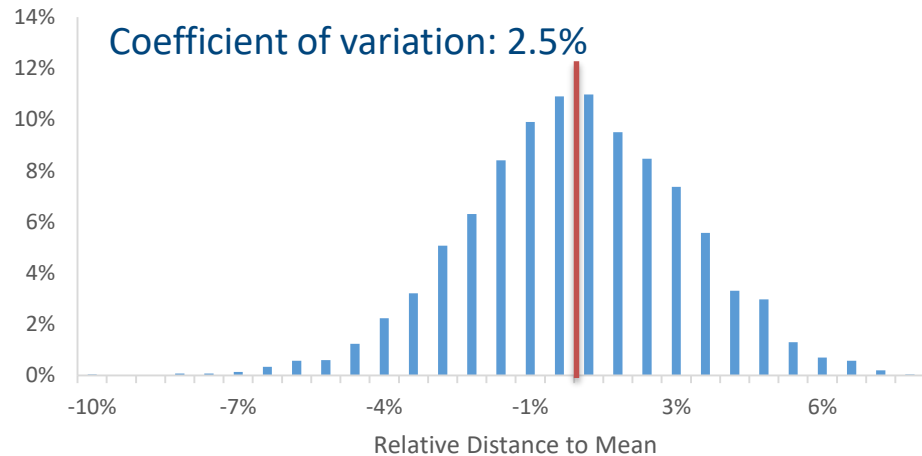
Disability Claims incl. Parameter Risk



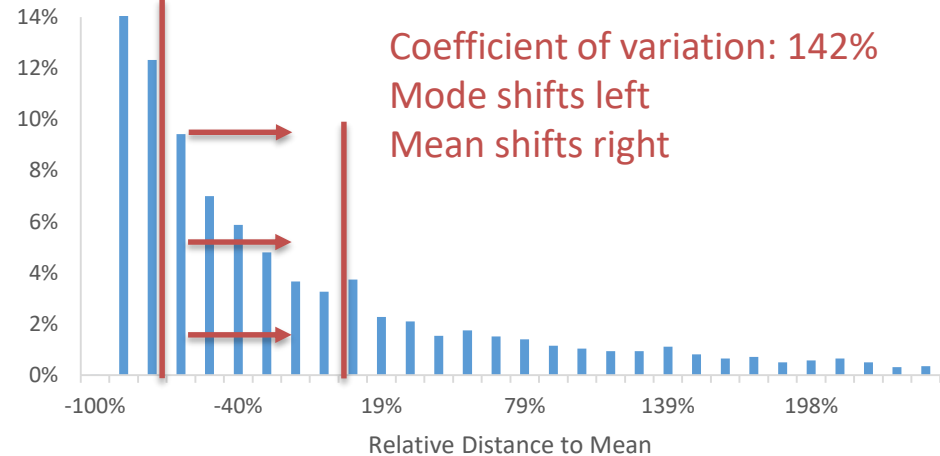
# Simulation of Disability Income Risk

## Simulation Results: Australian DI

Disability Claims Process Risk only



Disability Claims with Parameter Risk



# References



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**Thank you very much for your attention!**



Contact details:

**Peter Nielsen**

address: RGA International German Branch Office  
Kaiser-Wilhelm-Ring 15  
50672 Cologne, Germany

phone: +49 (0)221/964 998-71

mail: [pnielsen@rgare.com](mailto:pnielsen@rgare.com)

web: [www.ica2018.org](http://www.ica2018.org)

**Thank you very much for your attention!**



Contact details:

**Kai Kaufhold**

address: Kalscheurener Str 55  
50354 Hürth, GERMANY

phone: +49 152 2886 5458

mail: [kai.kaufhold@nmg-group.com](mailto:kai.kaufhold@nmg-group.com)

web: [www.nmg-group.com](http://www.nmg-group.com)