
Guest Lecture

Risk Management for Pension Funds

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NO RISK

NO PENSION FUND

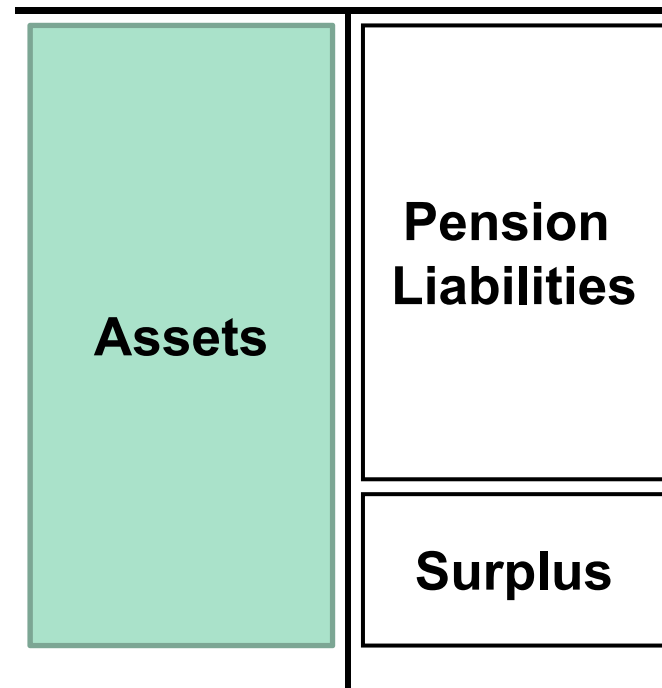
- Pension Funds exist, because individuals cannot bear certain risks themselves, such as:
 - How long do I live?
 - What if the market crashes exactly on the day of my retirement?
 - ...
- We will look at 2 examples of risks and management

Pension Balance Sheet

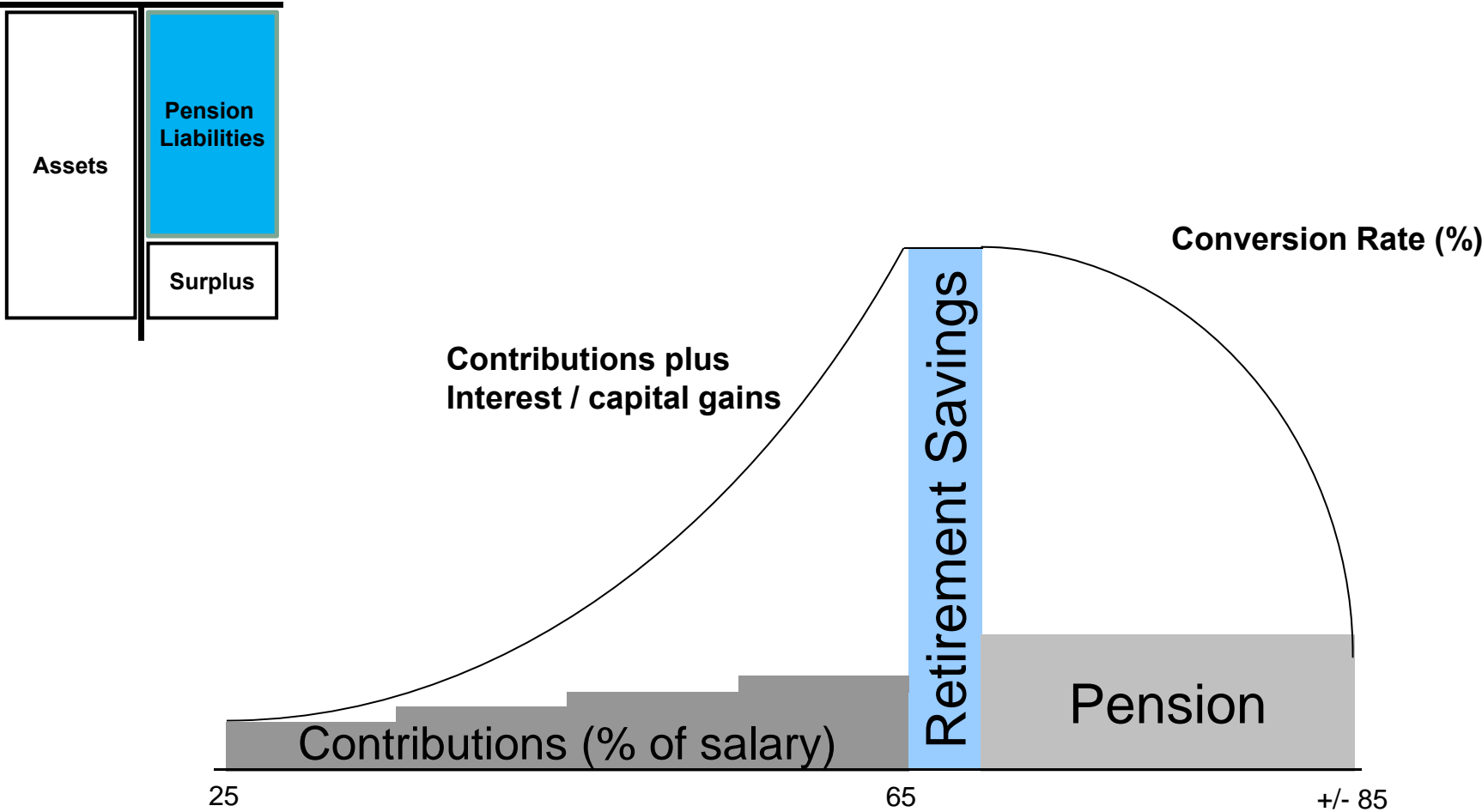
Assets	Pension Liabilities
	Surplus

Pension Balance Sheet

- Risks on the **asset side**:
 - Interest rate risk
 - Credit Risk
 - Equity Risk
 - Real Estate
 - ...



Pension Liabilities: Retirement Saving



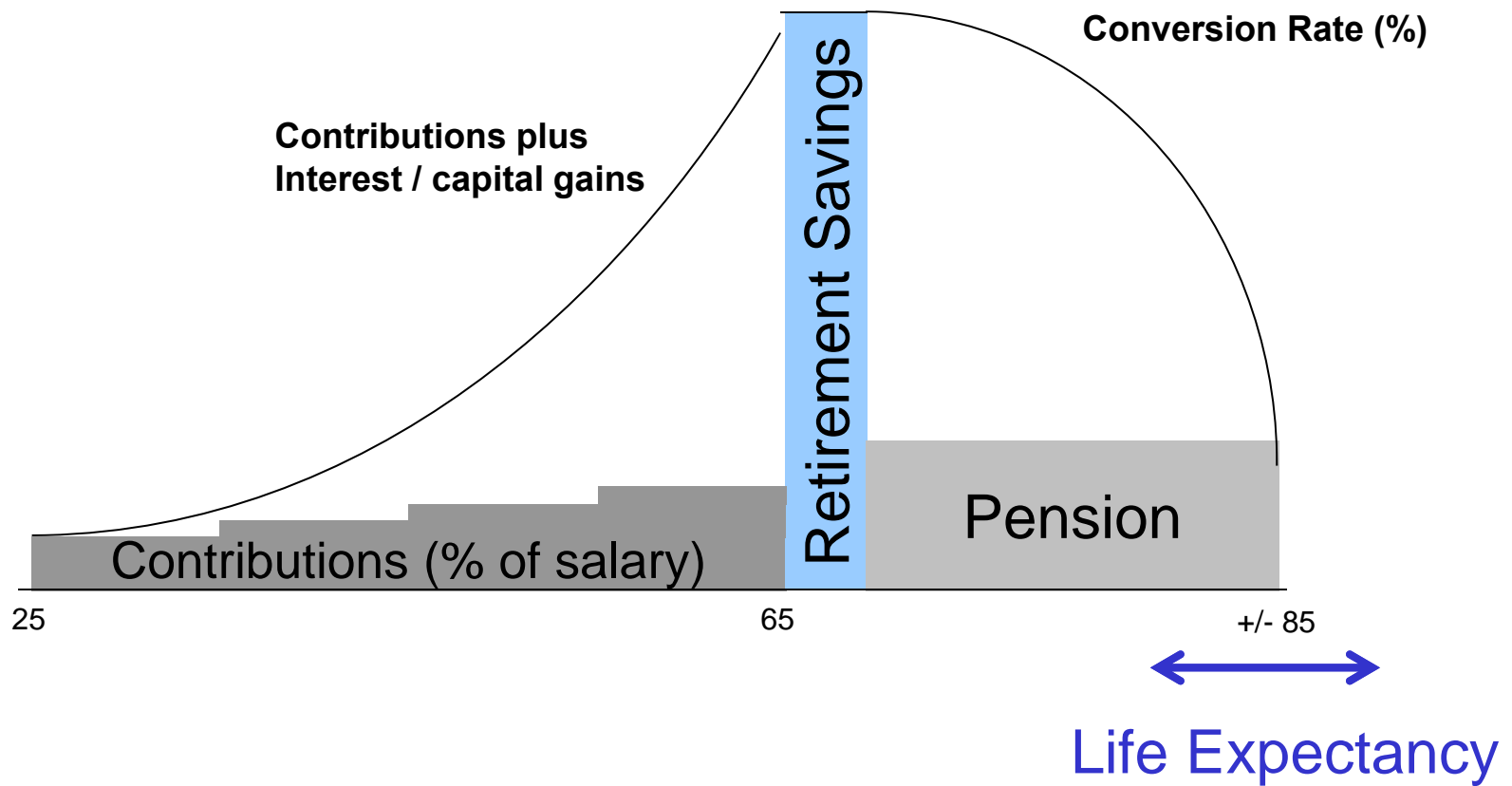
Pension Liabilities: Present Value

$$PVA_t = R \times \sum_{t=0}^{w-x} \frac{P_{x,t}}{(1+r)^t}$$

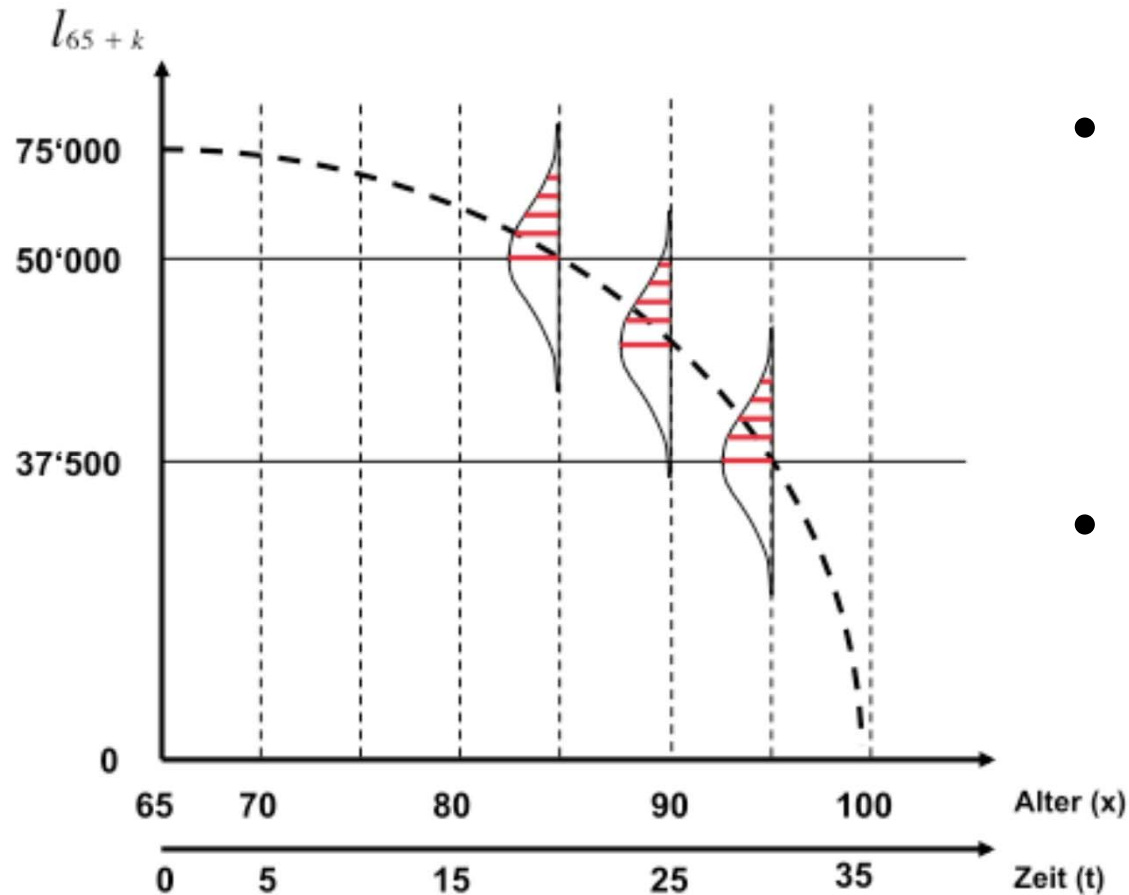
- PVA: Present Value
- R: Pension (Annuity)
- r: Discount Rate
- $p_{x,t}$ Cumulative probability of person with age X reaching age X+1 (probability of survival)
- w last year of

Age	Survival Probability	Pension * Survival Probability	Present Value @r = 2%
65	86%	55'702	54'610
66	84%	54'800	53'726
67	83%	53'814	52'758
68	81%	52'759	51'724
69	79%	51'635	50'622
70	78%	50'426	49'438
71	76%	49'125	48'162
72	73%	47'728	46'792
73	71%	46'251	45'345
74	69%	44'670	43'794
75	66%	42'988	42'145
76	63%	41'209	40'401
77	61%	39'336	38'565
78	57%	37'373	36'640
79	54%	35'323	34'630
80	51%	33'188	32'538
81	48%	30'974	30'366
82	44%	28'685	28'123
83	41%	26'331	25'815
84	37%	23'923	23'454
85	33%	21'477	21'056
86	29%	19'018	18'645
87	25%	16'572	16'247
88	22%	14'174	13'896
89	18%	11'863	11'631
90	15%	9'682	9'493
91	12%	7'675	7'524
92	9%	5'879	5'764
93	7%	4'328	4'243
94	5%	3'041	2'981
95	3%	2'022	1'983
96	2%	1'260	1'236
97	1%	727	712
98	1%	382	374
99	0%	179	175
100	0%	73	71
101	0%	25	24
102	0%	7	6
103	0%	1	1
104	0%	-	-
105	0%	-	-
Sum			945'708

What about life expectancy? (1)



What about life expectancy? (2)



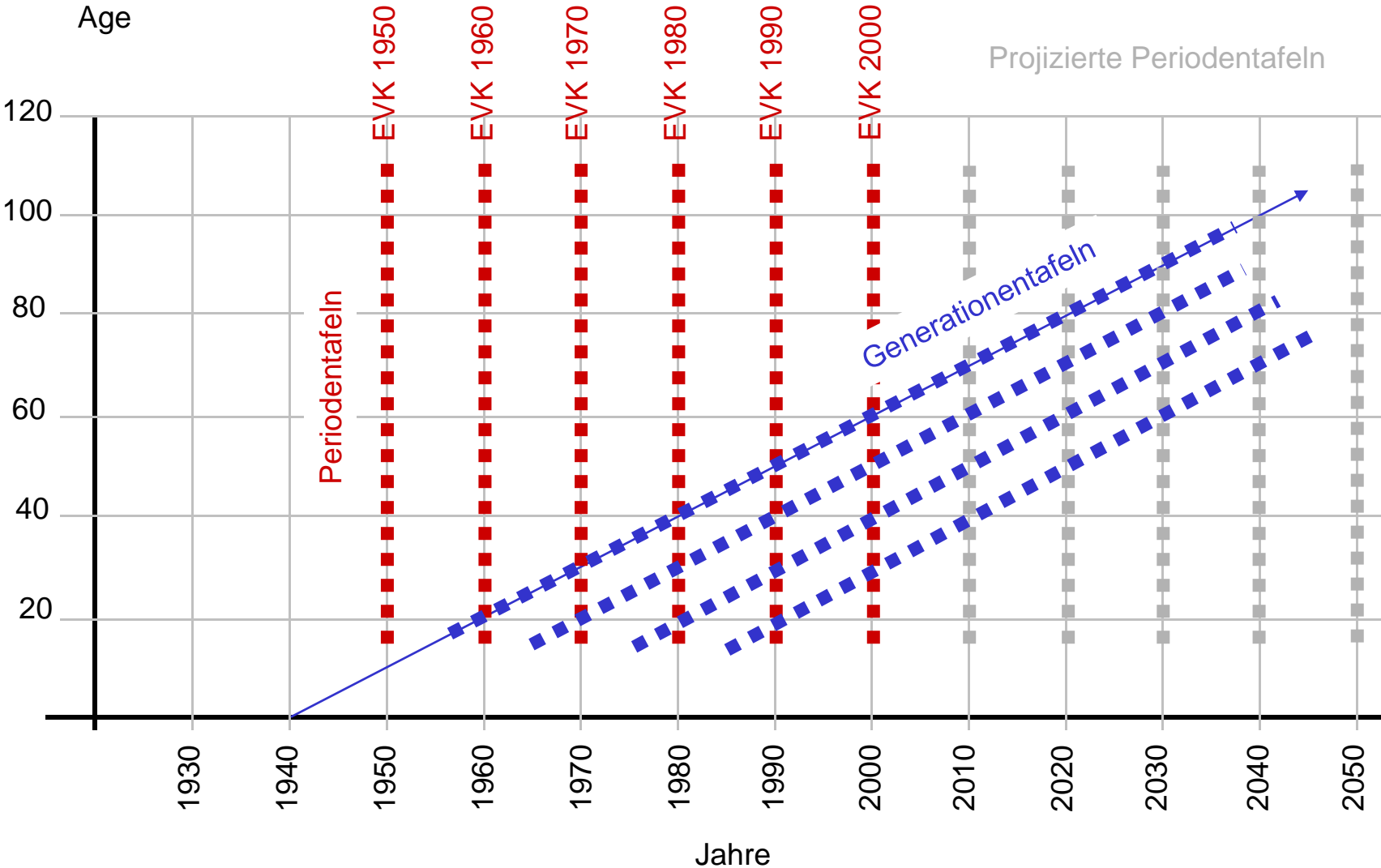
- Unsystematic Risk
 - People do not live equally long.
 - Can be diversified (large pension funds).
- Systematic Risk
 - *Life expectancy changes over time for all people.*
 - Cannot be diversified!

What about life expectancy? (3)



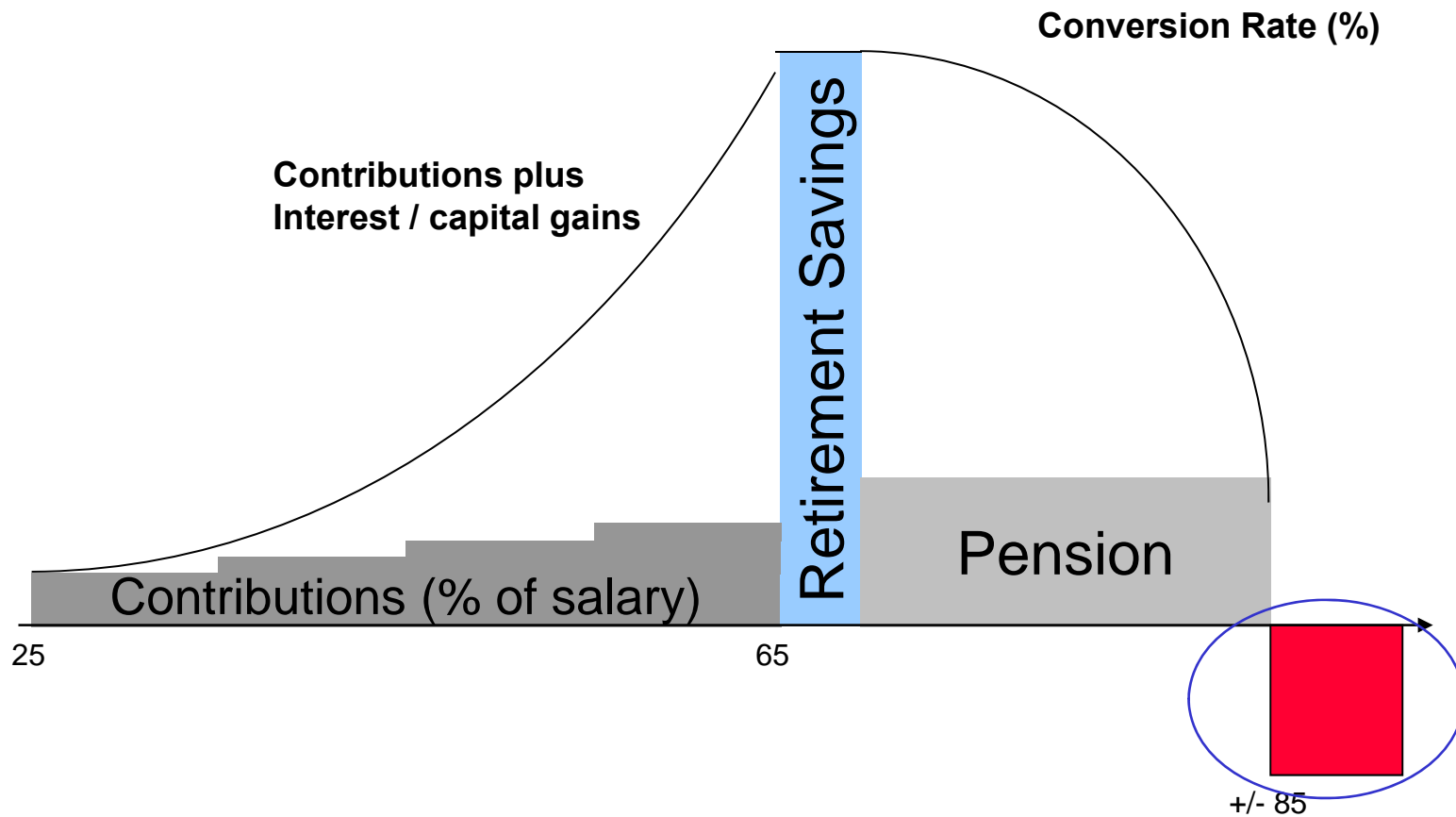
Some of the graphs/pictures are not available online

What about life expectancy? (4)

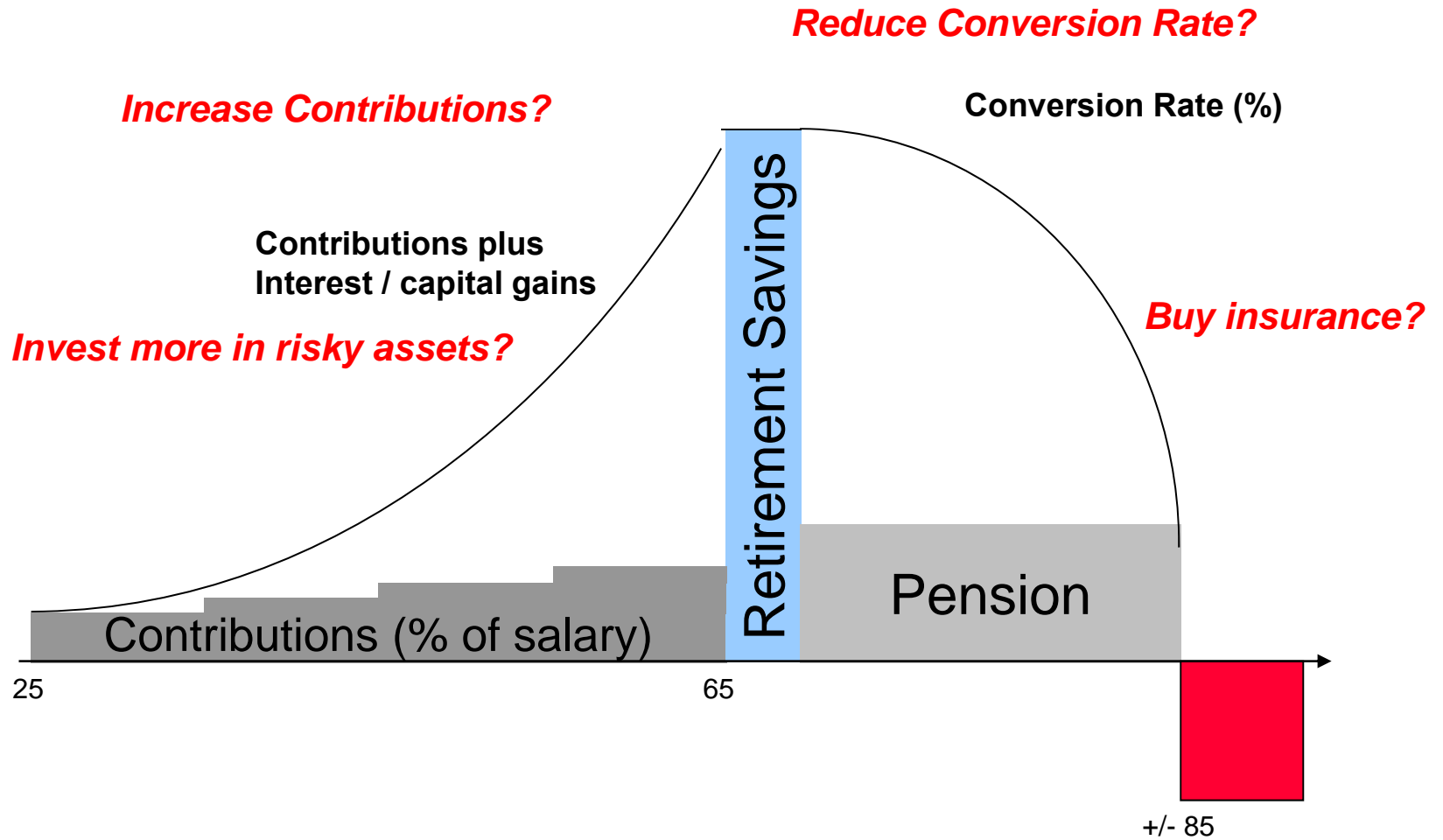


What about life expectancy? (5)

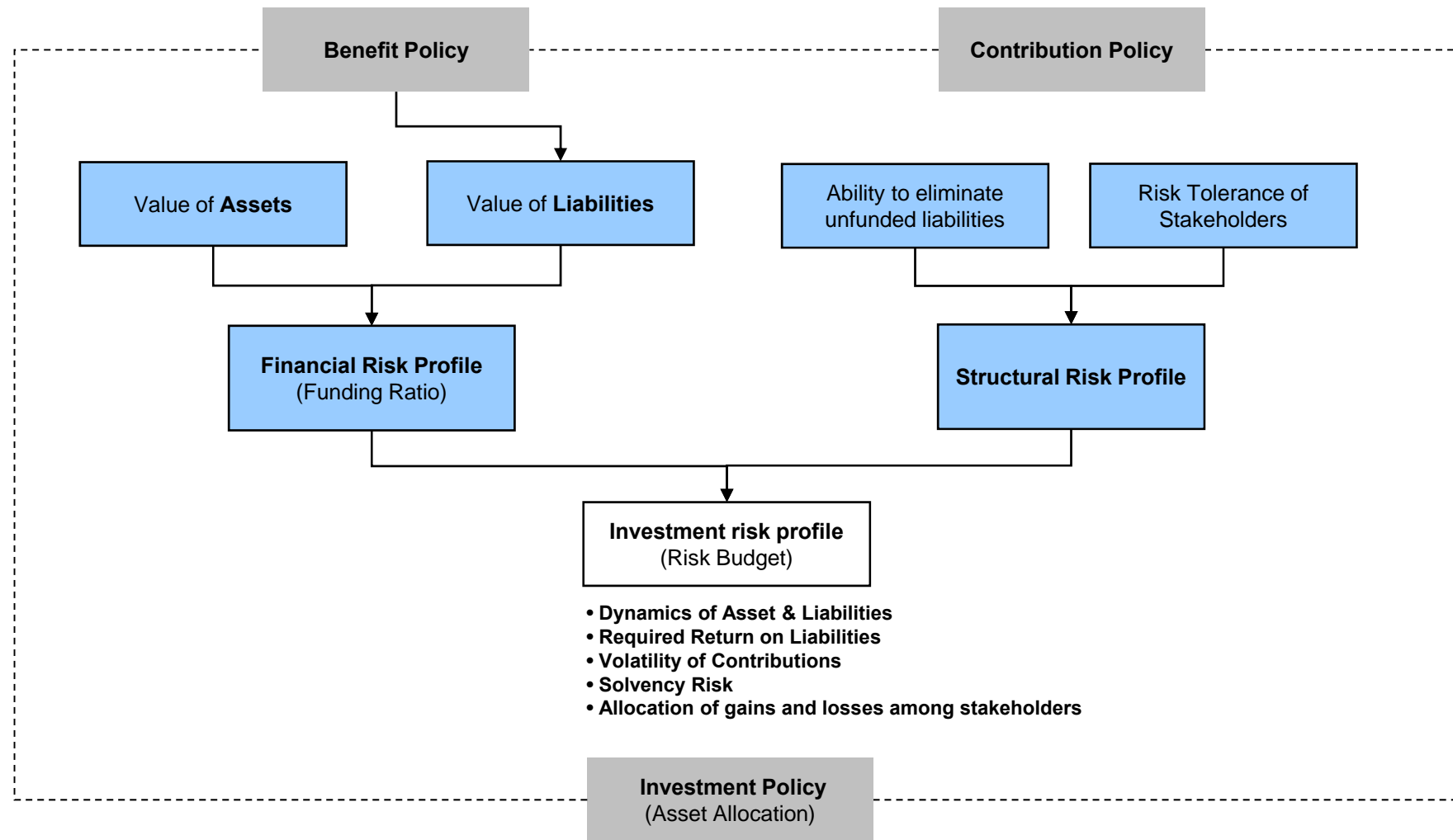
What happens if we live longer than expected?



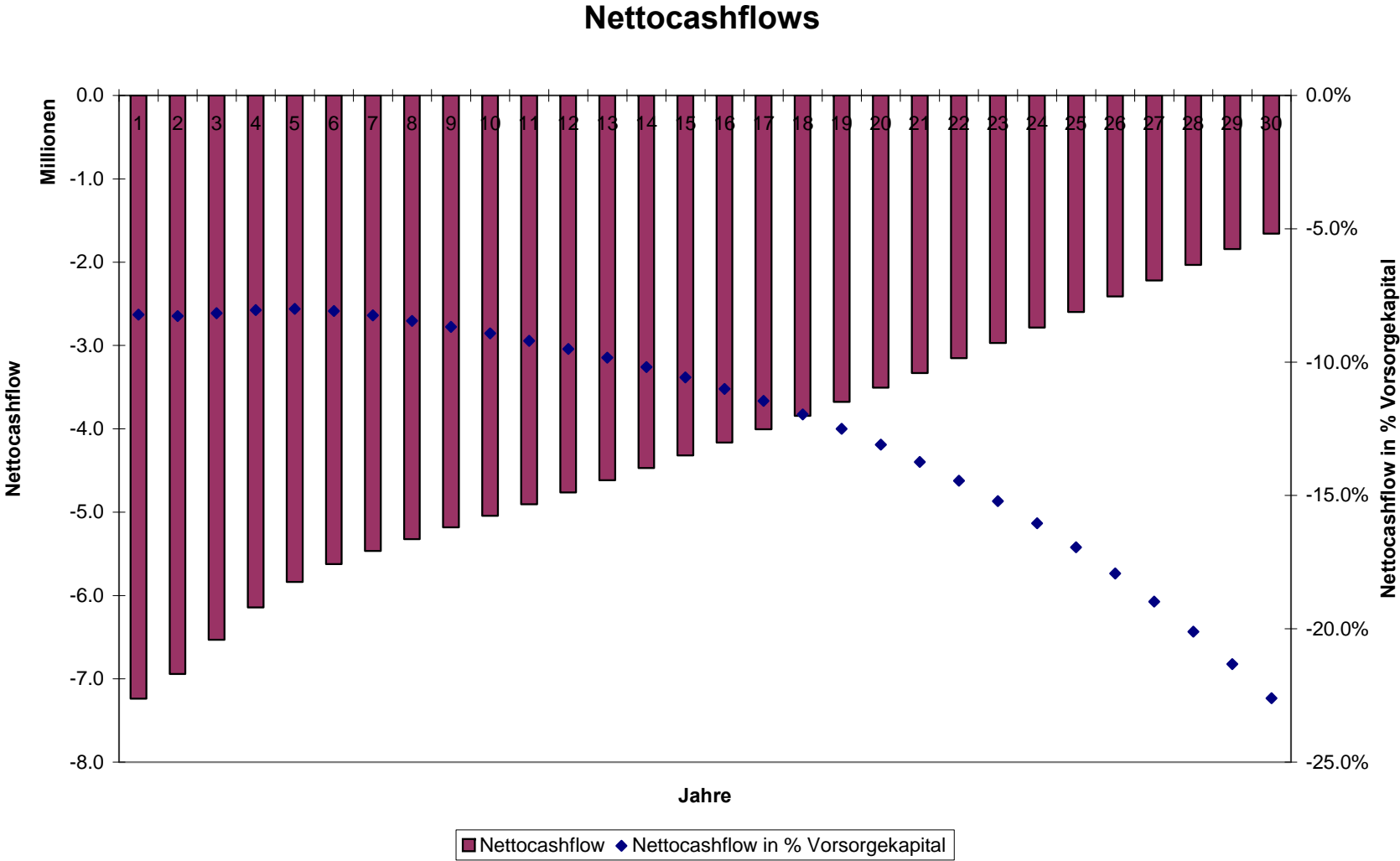
What about life expectancy? (6)



Asset & Liability Management

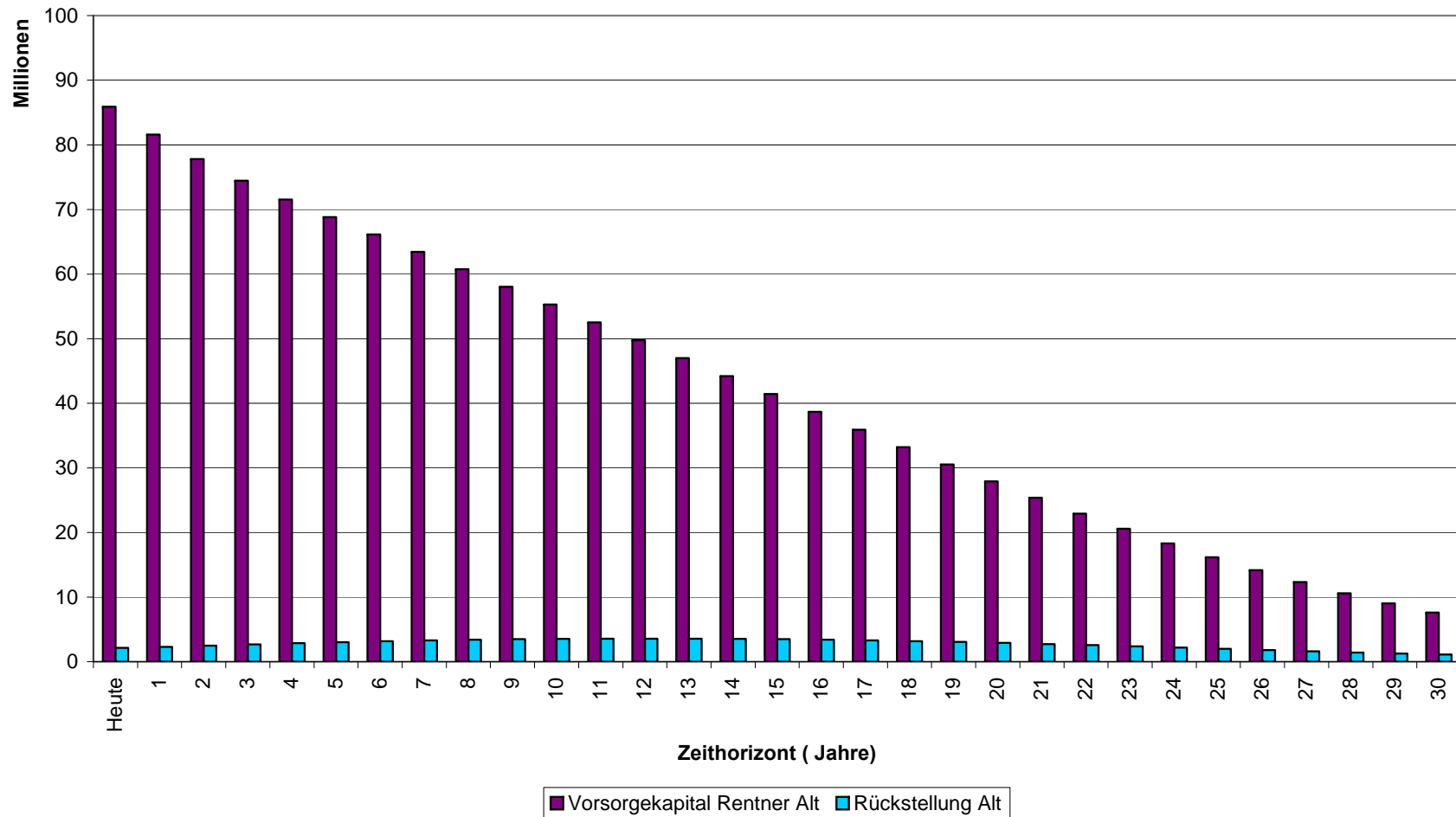


Example: Projection of Cash Flows



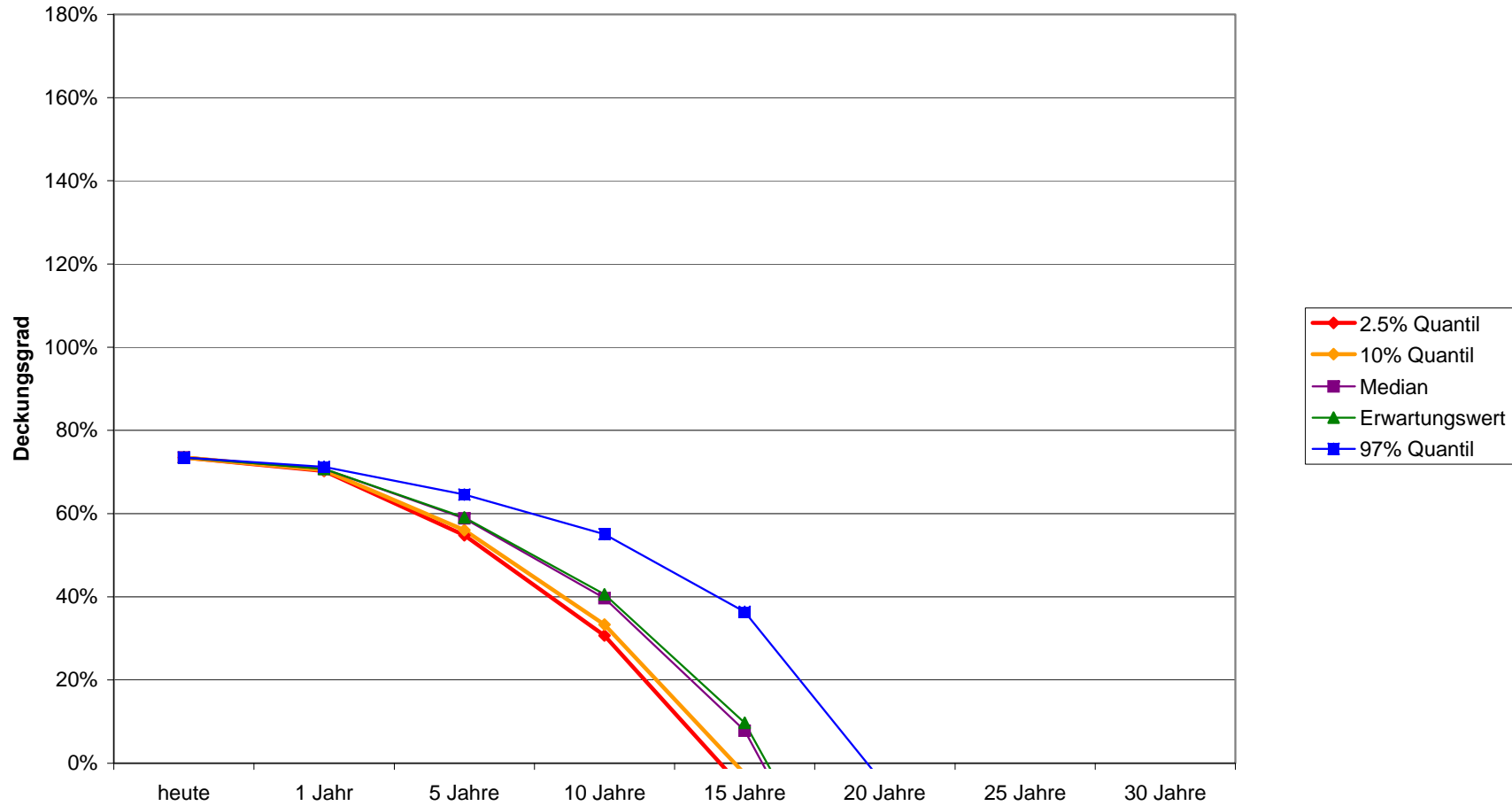
Example: Projection of Pension Liabilities

Entwicklung Vorsorgekapital (Altrentner)



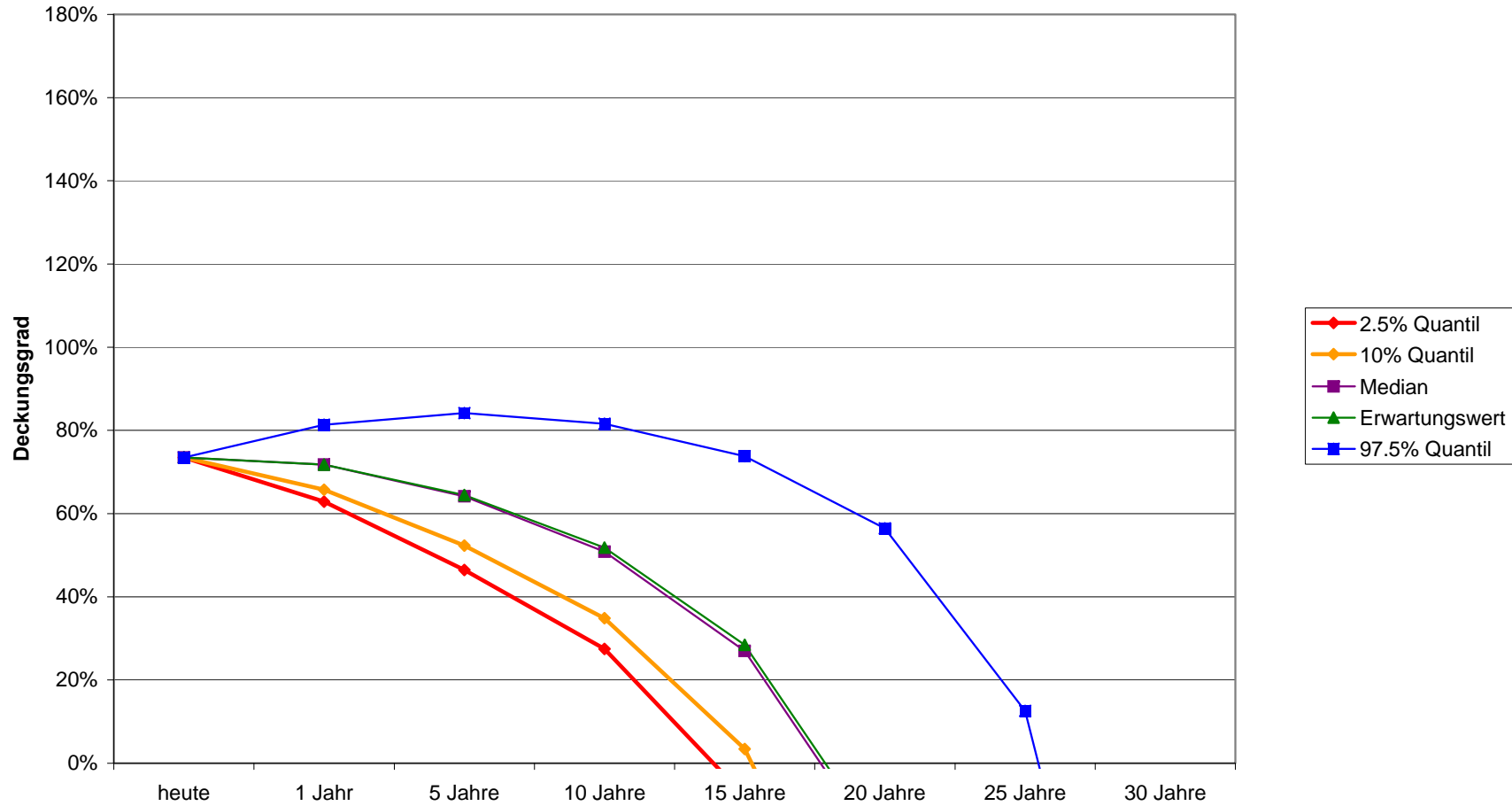
Example: Projection of Cover Ratio (1)

Anlagestrategie: Geldmarktanlage
(Rentnerkasse ohne Arbeitgeber)

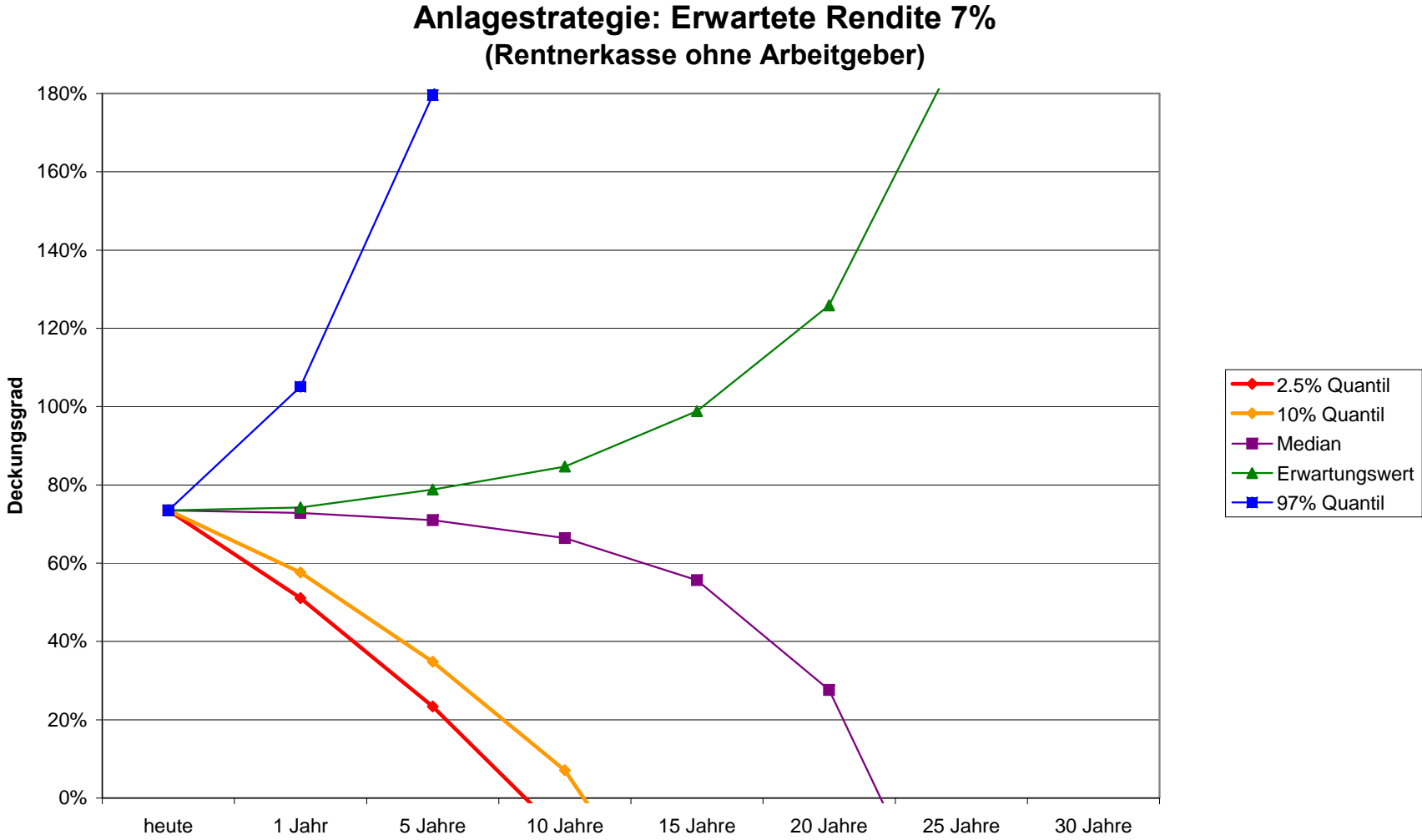


Example: Projection of Cover Ratio (2)

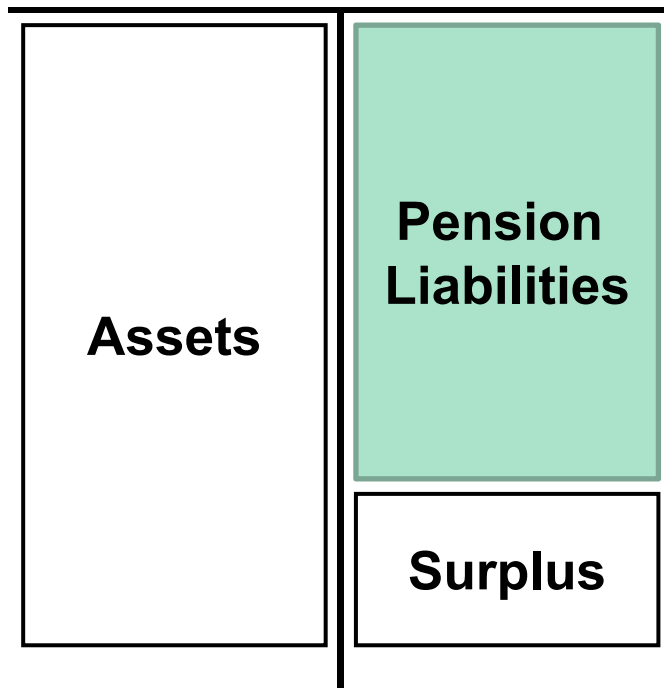
Anlagestrategie: Erwartete Rendite 4%
(Rentnerkasse ohne Arbeitgeber)



Example: Projection of Cover Ratio (3)



Pension Balance Sheet



- Risks on the liability side:
 - Life expectancy
 - **Discount rate & Interest rate risk**

Discount rate (1)

- What is the correct discount rate? Somebody has thought of this already...
- Nobel prices between 1990 - 1997:
 - Modigliani, Franco and Merton Miller (1958): “The Cost of Capital, Corporate Finance, and the Theory of Investment”, American Economic Review
 - Miller, Merton and Franco Modigliani (1961): “Dividend Policy, Growth and the Valuation of Shares”, Journal of Business
 - William F. Sharpe (1964): “Capital Asset Prices: A Theory of Market Equilibrium under Conditions of Risk”, The Journal of Finance
 - Black, Fischer and Myron S. Scholes (1973): “The pricing of options and corporate liabilities”, Journal of Political Economy
 - Robert C. Merton (1974): “On the Pricing of Corporate Debt: the risk structure of interest rates”, Journal of Finance

Discount rate (2)

- Different pensions have different liabilities with different payout structures. Therefore, discount rates between pensions must also be different.
- Example: nominal fixed risk free cash flows must be discounted with the risk free rate with equal maturity.
- However, in the “real world” the following guidelines are used for the discount rate:

Technischer Referenzzinssatz

Ein zentrales Element von FRP 4 ist die Definition des technischen Referenzzinssatzes. Dieser wird wie folgt festgelegt:

$$i^{\text{ref}} = \frac{2}{3} \times \text{durchschnittliche Performance der letzten 20 Jahre in \%} \\ + \frac{1}{3} \times \text{Rendite für 10-jährige Bundesanleihen in \%} \\ - 0.5\%$$

Das so erhaltene Ergebnis wird auf 0.25% abgerundet. Es darf jedoch weder unter die Rendite für 10jährige Bundesanlagen liegen noch 4.5% übersteigen. Die durchschnittliche Performance wird auf der Basis des Pictet BVG-25 Index plus (Nachfolgend „BVG Index“) bestimmt.

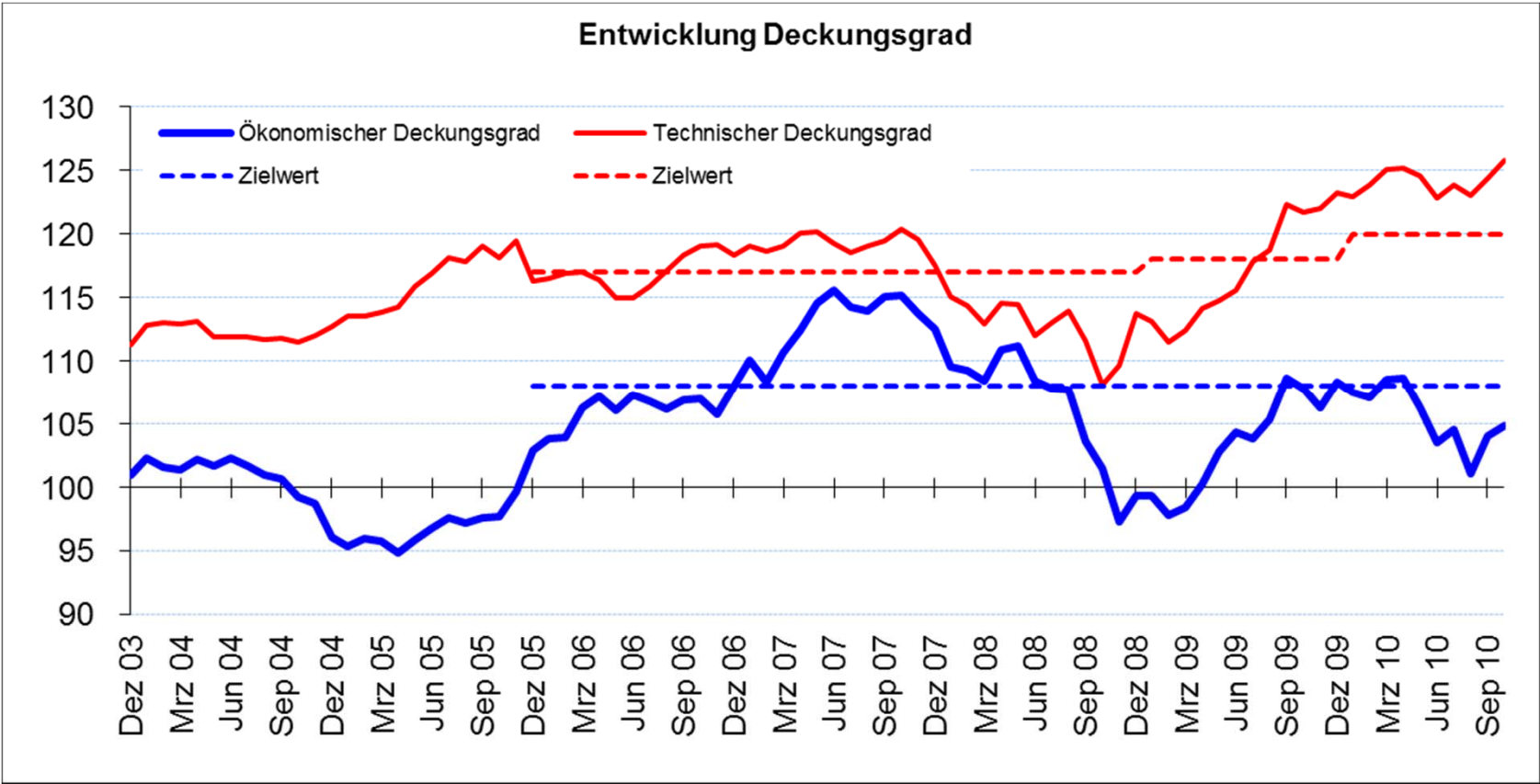
Who bears what risk?

Measures to finance unfunded liabilities

Stakeholder ► ▼ Measure	Plan Sponsor	Employees	Pensioners
1) Increase Assets	<ul style="list-style-type: none"> ▪ Warranty ▪ Additional Funds / Contributions 	No measure possible.	No measure possible.
2) Decrease Liabilities (Future benefits above regulatory minimum)	No measure possible.	<ul style="list-style-type: none"> ▪ Reduce Interest Rate on Savings. 	No measure possible.
3) Contributions <i>only in addition to 1,2</i>	<ul style="list-style-type: none"> ▪ Temporary increase of contributions (without increase in benefits). 		No measure possible.
4) Decrease Liabilities (Below regulatory minimum) <i>only in addition to 3</i>	No measure possible.	<ul style="list-style-type: none"> ▪ Reduce Interest Rate on Savings below Minimum Rate. 	No measure possible.

Cover Ratio with fixed and market interest rate

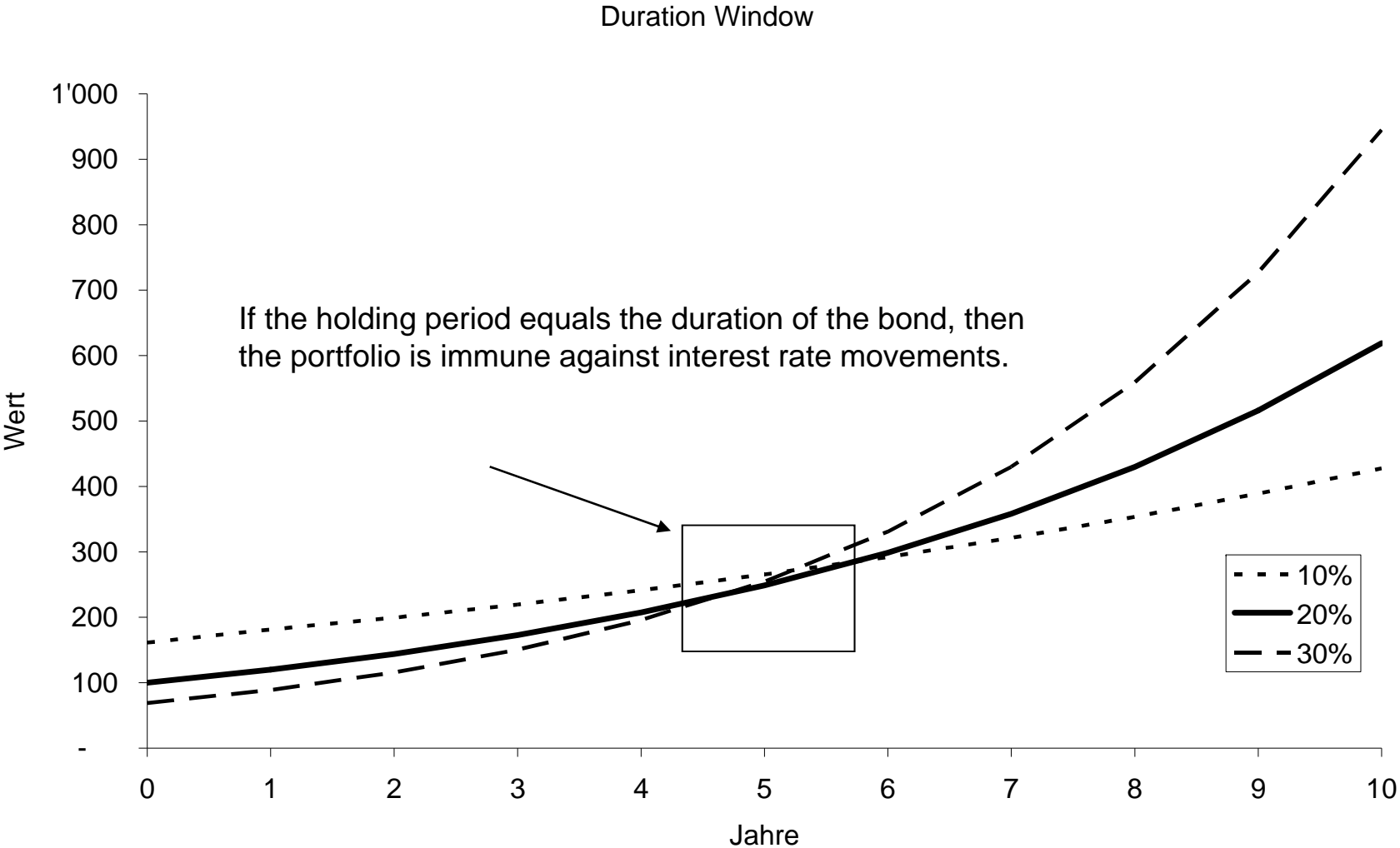
Pension fund with high level of pensioners (> 90%)



Duration Matching (1)

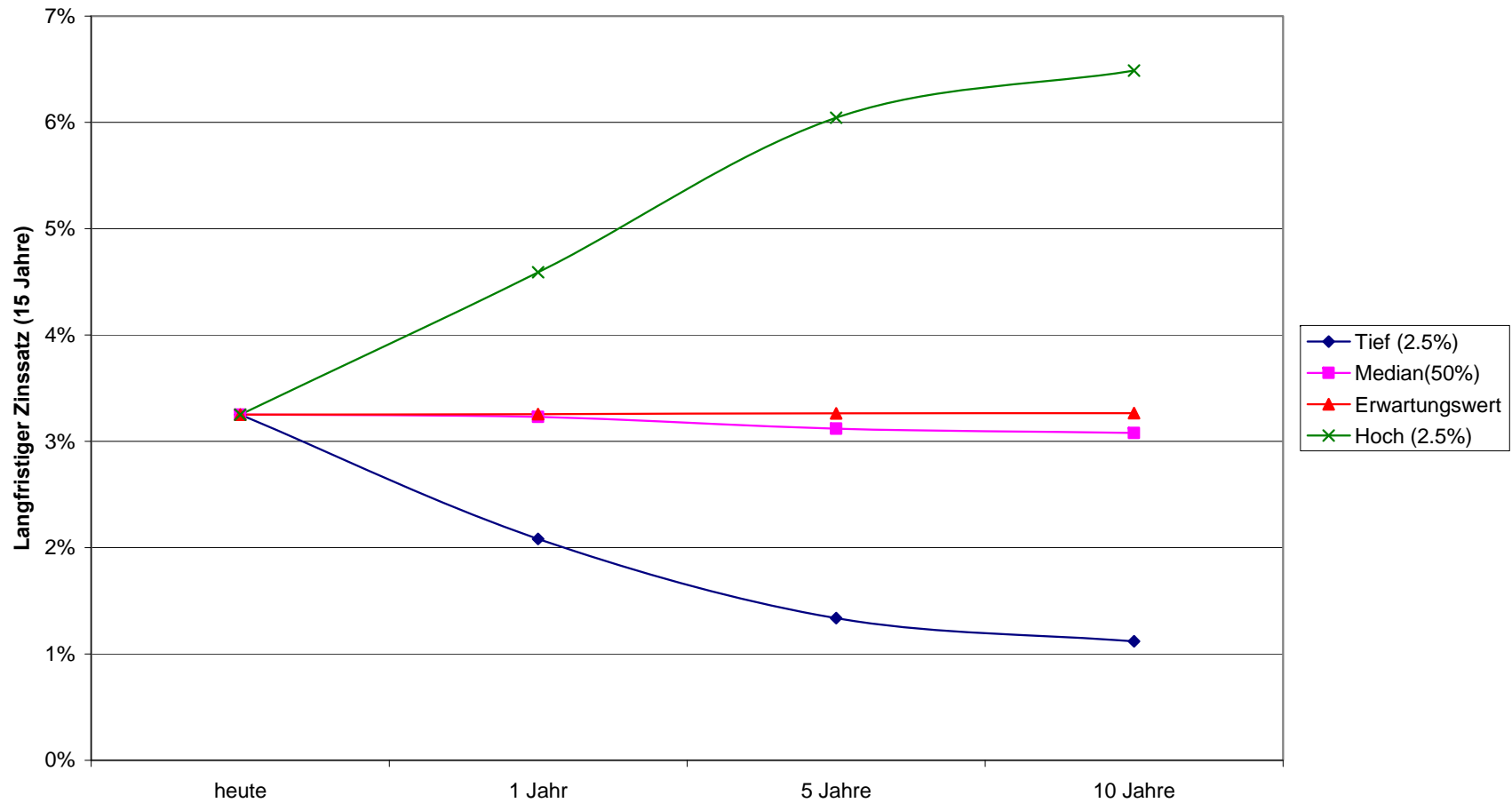
- **Duration** as measure for interest rate risk
- **Example** (very high interest rates to show effect...)
 - Today's interest rate 20% (all maturities)
 - Bond with maturity of 10 years and a coupon of 20% (Duration +/- 5 years)
 - Scenario 1: Parallel shift in interest rates by +10%
 - Scenario 2: Parallel shift in interest rates by -10%
 - Coupons are reinvested in the bond

Duration Matching (2)



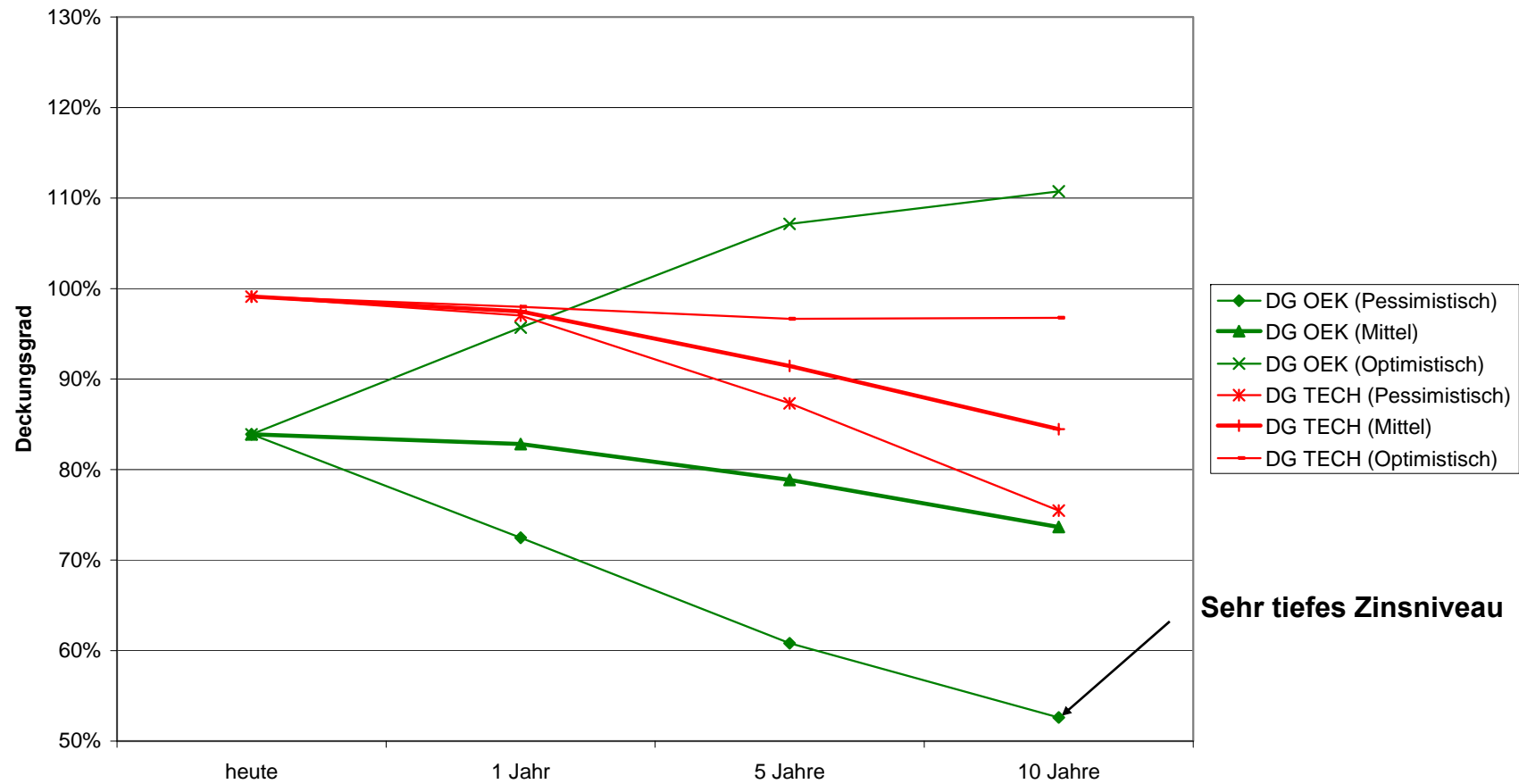
Example: Duration Matching (1)

Simulierte Zinsentwicklung



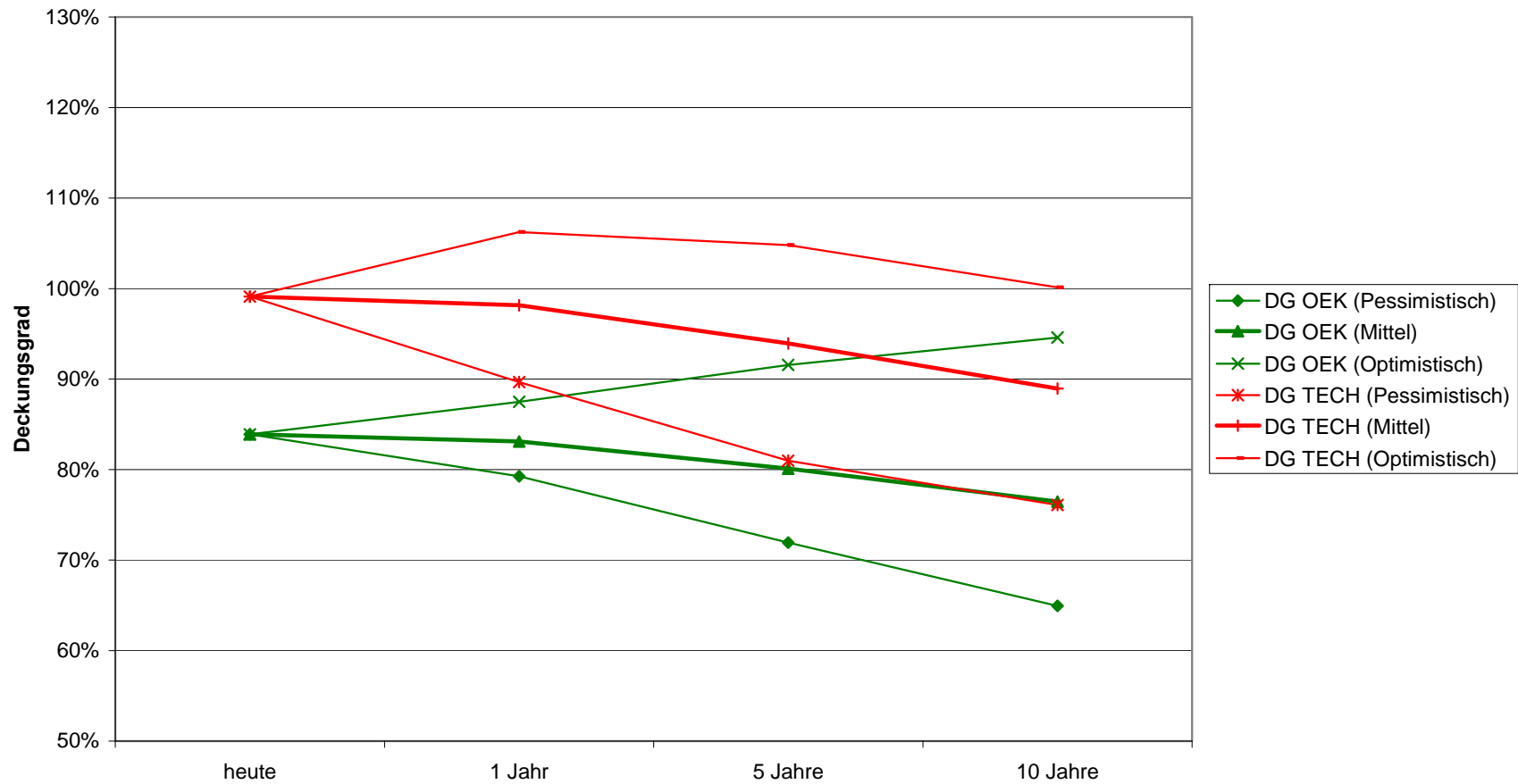
Example: Duration Matching (2)

Anlagestrategie: Geldmarktanlagen (1 Jahr Laufzeit)
(Erwartete Rendite: 2.75%)



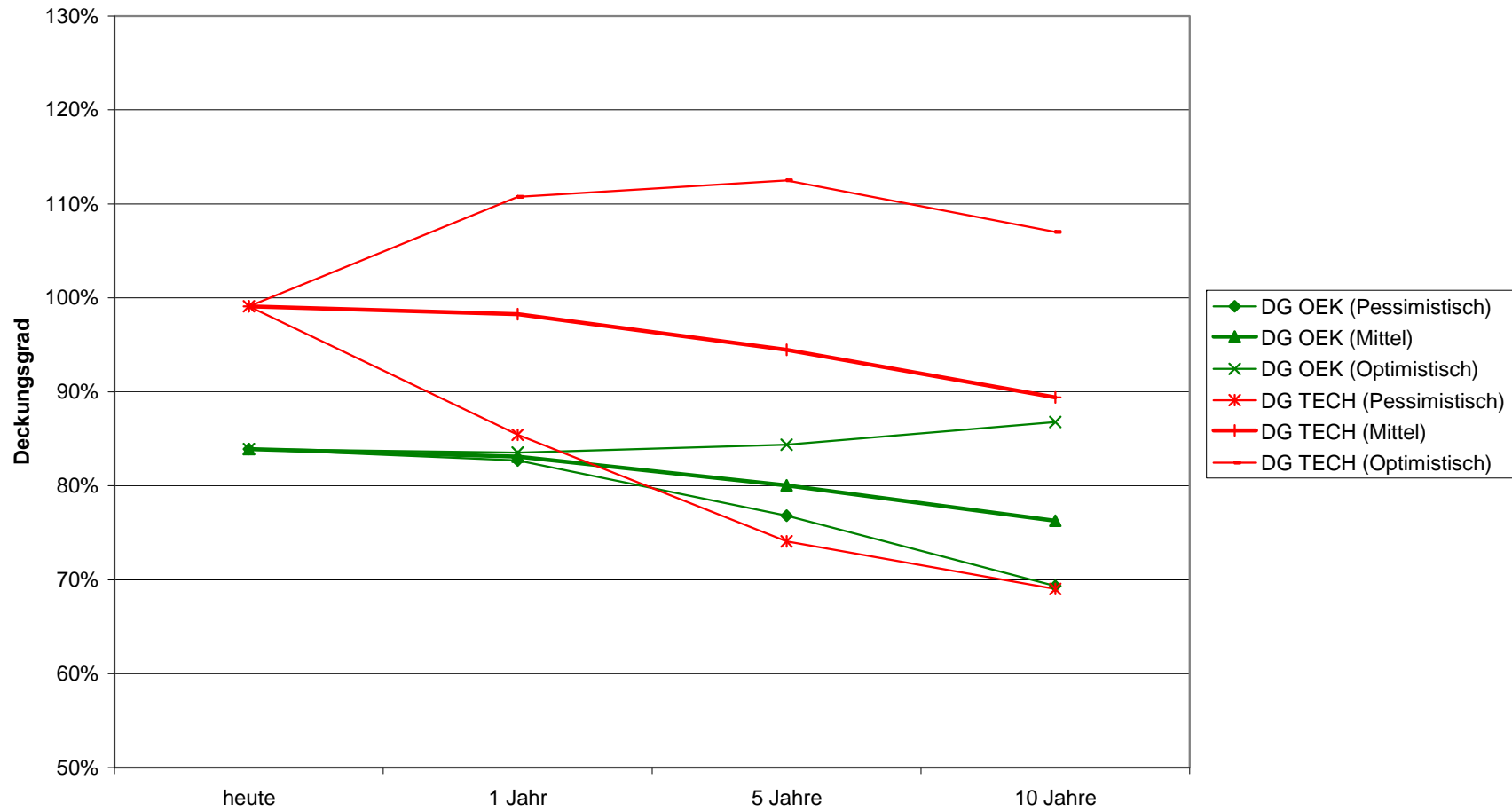
Example: Duration Matching (3)

Anlagestrategie: Obligationen mit 10 Jahren Laufzeit
(Erwartete Rendite: 3.25%)



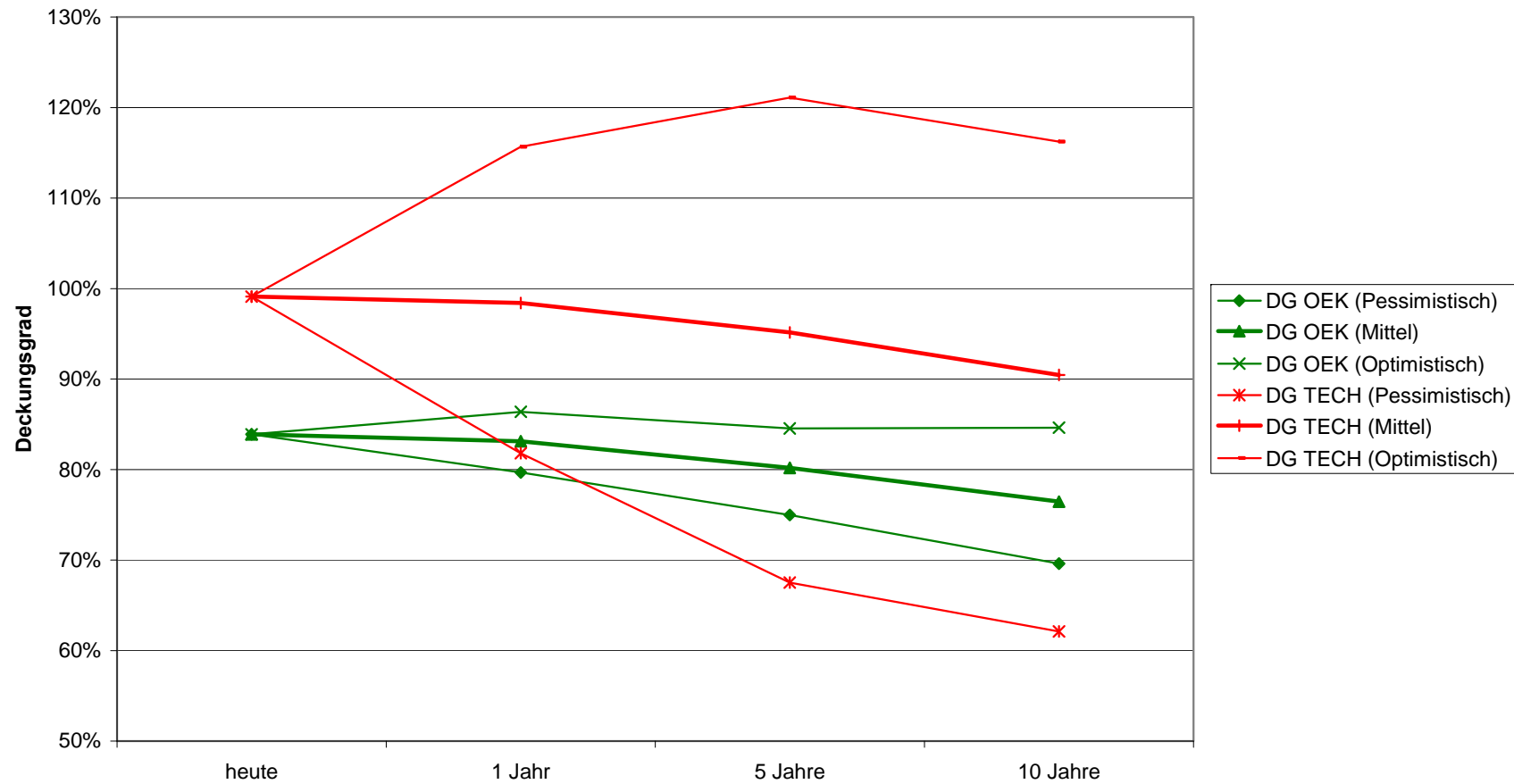
Example: Duration Matching (4)

Anlagestrategie: Obligationen mit 15 Jahren Laufzeit
(Erwartete Rendite: 3.25%)

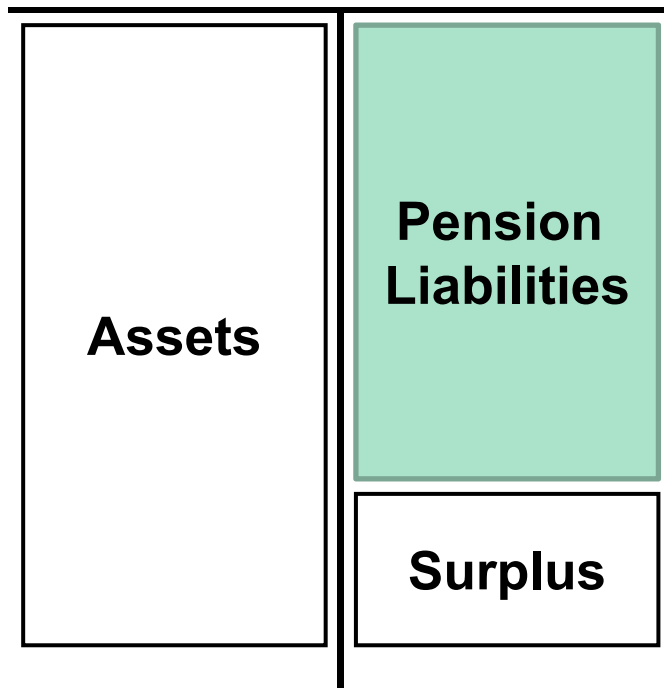


Example: Duration Matching (5)

Anlagestrategie: Obligationen mit 20 Jahren Laufzeit
(Erwartete Rendite: 3.25%)



Pension Balance Sheet



- Risks on the liability side:
 - Life expectancy
 - Interest rate risk & Valuation (discount rate)
 - ...