Managing Contribution Risk in a Funded Public Defined Benefit Plan: Impact of CVaR Cost Constraints

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Introduction

- Governments face rising costs of underfunded civil servant DB pensions
- Appropriate funding & investment strategy may offer solution

- We propose alternative funding and investment strategies that …

✓ minimize expected pension costs
✓ control for cash shortfall risks
✓ control for contribution rate risk
✓ mitigate burden of future generations
✓ integrate ALM approach & CVaR risk metrics

Our Approach

- In general, DB plan sponsors face trade-off between contribution rate and solvency risk
- Optimal contribution- & investment strategy traditionally derived by minimizing combined “cost” criterion (e.g. Haberman & Sung (1994,1995), Ngwira & Gerrard (2007), Owadally & Haberman (2004))

- Governments might live with underfunding but not with contribution rate risk and in particular worst-case cost risk
- => We seek to minimize contribution rate risk while controlling for worst-case cost risks.

German Civil Servants Pensions

- Financing: Tax-sponsored, non-contributory, (mostly) unfunded DB plan, some states start funding and invest mostly in (own) govt. bonds
- Benefits:
  - Based on service years and final salary (~1.8% p.a., max. 72% of final pay after 40 years).
  - Not in national Social Security; not portable
- Regular retirement age: Rising to 67
- Dataset: >100,000 active Hessian Civil Servants

Modeling Future Liabilities

- 50-year projection horizon for new DB accruals for current active civil servants and new hires.
  - No real wage growth
  - Replacement hiring
  - Deriving specific mortality tables
- Discount future pension benefits at fixed real rate (3% p.a.), representing government's cost of financing ("economic valuation")
- Past pension claims excluded in the model

Finding Regular Contribution Rate

- Deterministic contribution rate of salary per year can be derived as:

$$\text{Regular Contribution Rate} = \frac{\text{PV Future Pension Liabilities}}{\text{PV Future Salary Payments}}$$

$$\text{Regular Contribution Rate} = \frac{20.8\,€\,\text{bn}}{111.5\,€\,\text{bn}} = 18.7\%$$

Modeling Assets

- Investment Universe: Equity, Bonds
- Stochastic asset model: returns (after inflation) follow restricted vector-autoregression
- Parameters based on German market indices

	Mean (%)	Volatility (%)	Correlations Stocks	Bonds
Stocks	6.6	20.7	1	
Bonds	4.8	6.7%	0.17	1

Financing Rules

- Regular Contributions (RC): Constant fraction of current payroll (level to be determined endogenously)

- Funding Deviations recovered by annuity payments over pre-specified spread period (base case: 20 years)
  - Funding Ratio<100%: Supplementary Contributions (SC) => C_t>RC
  - Funding Ratio>100%: Withdrawals (W) => C_t<RC

Plan Managers' Objective Function

- Choose combination of (constant) normal contribution rate and asset allocation that minimizes contribution rate volatility:

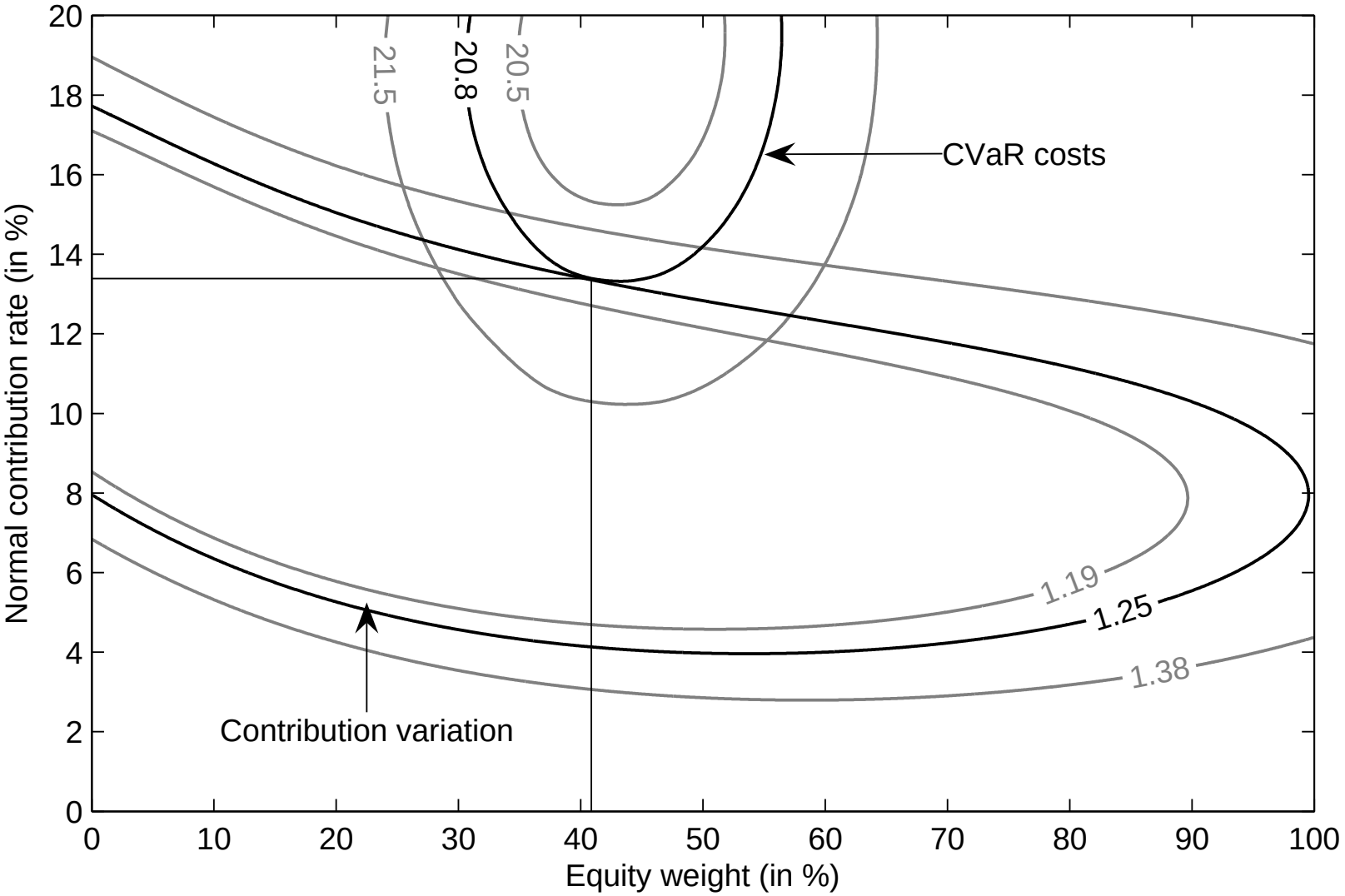
$$\min_{CR,x} E\left(\sum_t \left(\frac{C_t}{\text{Salary Payments}_t} - CR\right)^2\right)$$

- s.t. the Conditional Value at Risk Constraint:

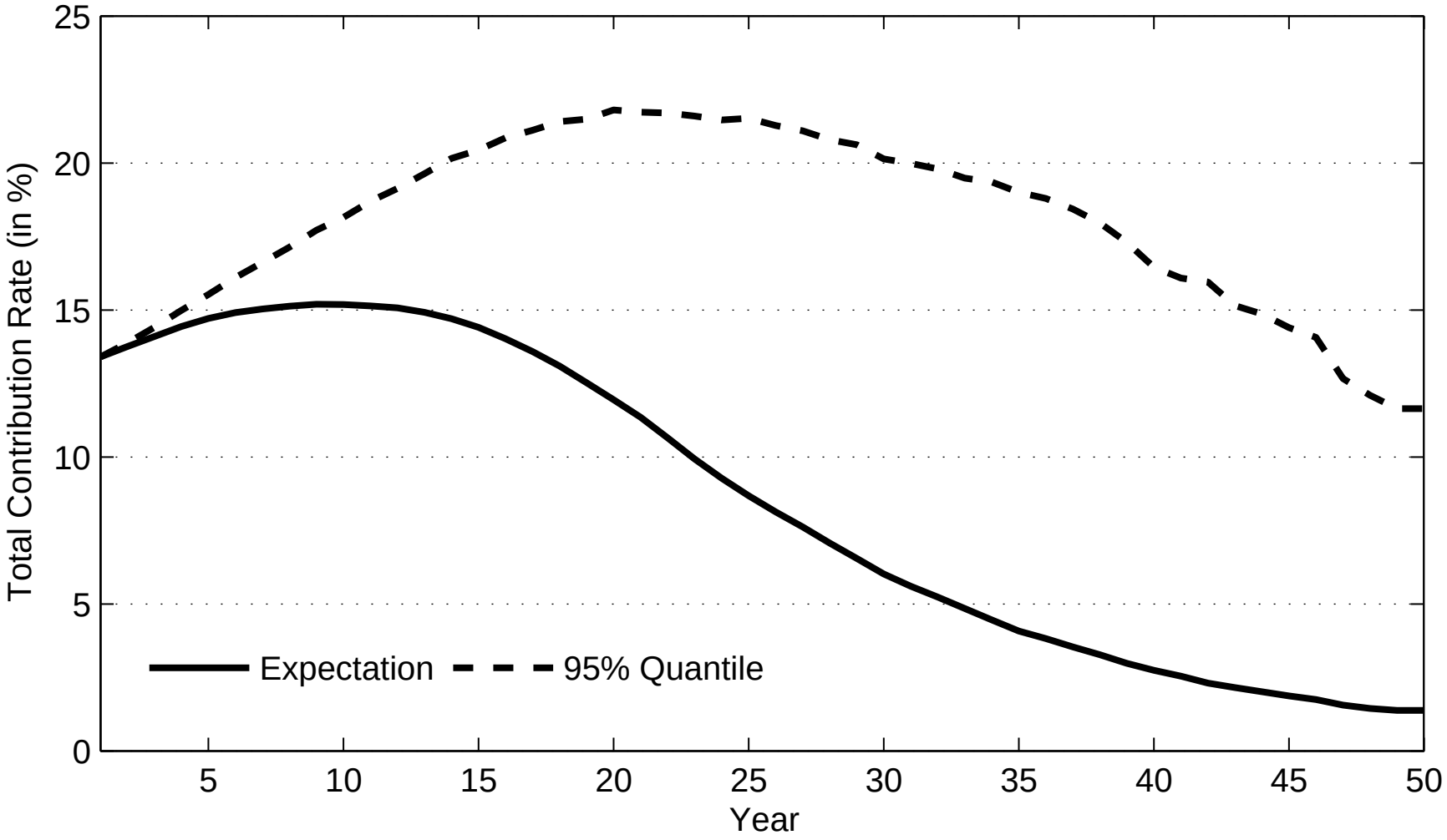
$$CVaR_{1\%}\left(TPC = \sum_t \frac{RC_t + SC_t(1+\xi_1) - W_t(1-\xi_2)}{(1+r)^t}\right) \leq c\,(= 20.8\ €bn)$$

x:	Portfolio weights	ξ_1:	Penalty Factor SC (20%)
RC_t:	Regular Contributions	ξ_2:	Penalty Factor Withdrawals (20%)
SC_t:	Supplementary Contributions	r :	Discount Rate (3%)
W_t:	Withdrawals		

Optimal Contribution & Asset Allocation



Contribution Rates over Time



Conclusions

• German civil servant pensions substantially underfunded.

• Risky investments proposed to reduce funded DB pension costs.

• We offer interesting approach to determine funding and investment strategies, explicitly accounting for fund manager's intertemporal risk budget.

• Doing so:

- üFunding combined with optimized investment strategy may substantially reduce pension costs.
- üWorst-Case Risks can be well controlled.
- üPure bond investment strategy sub-optimal.

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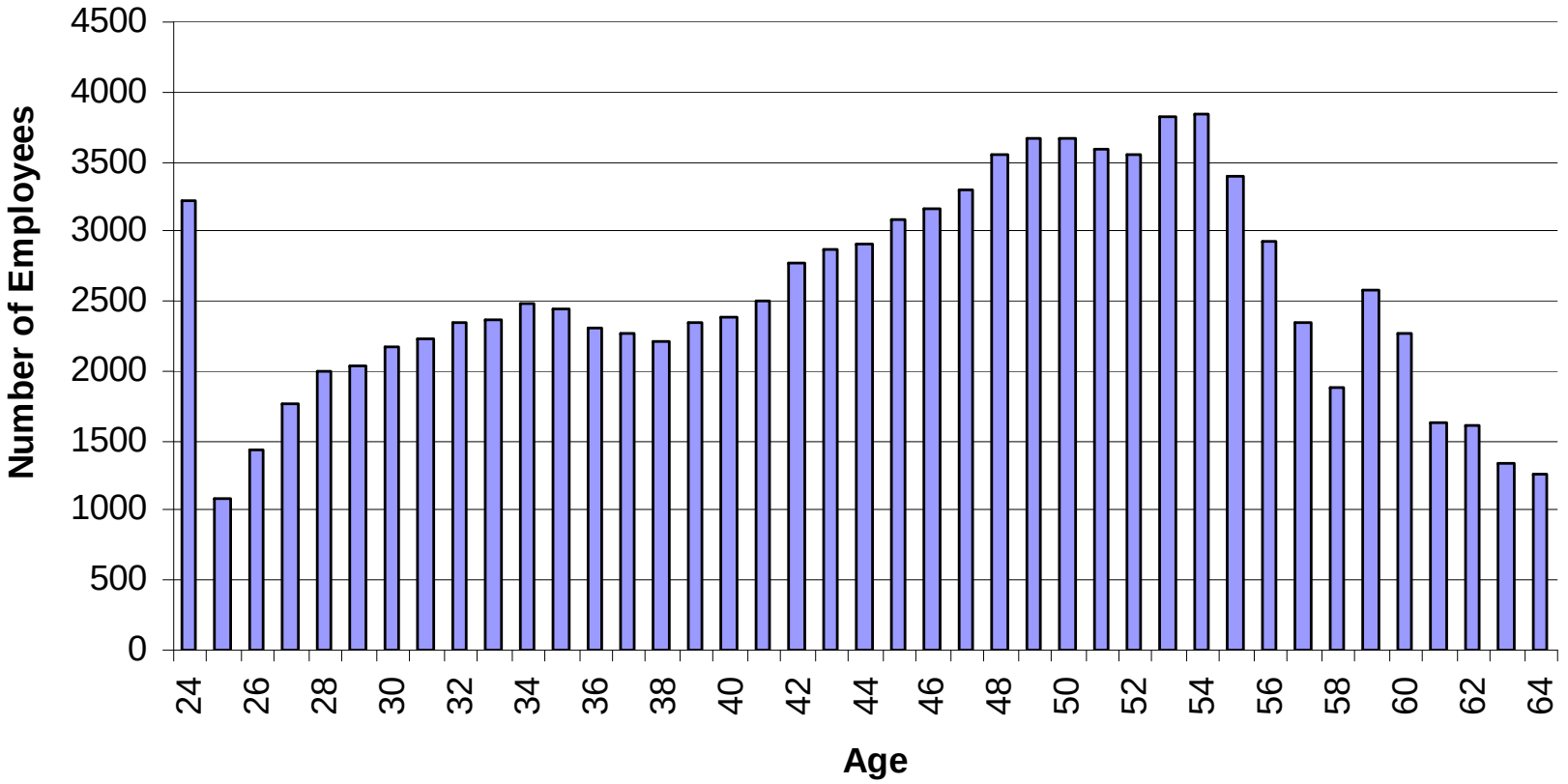
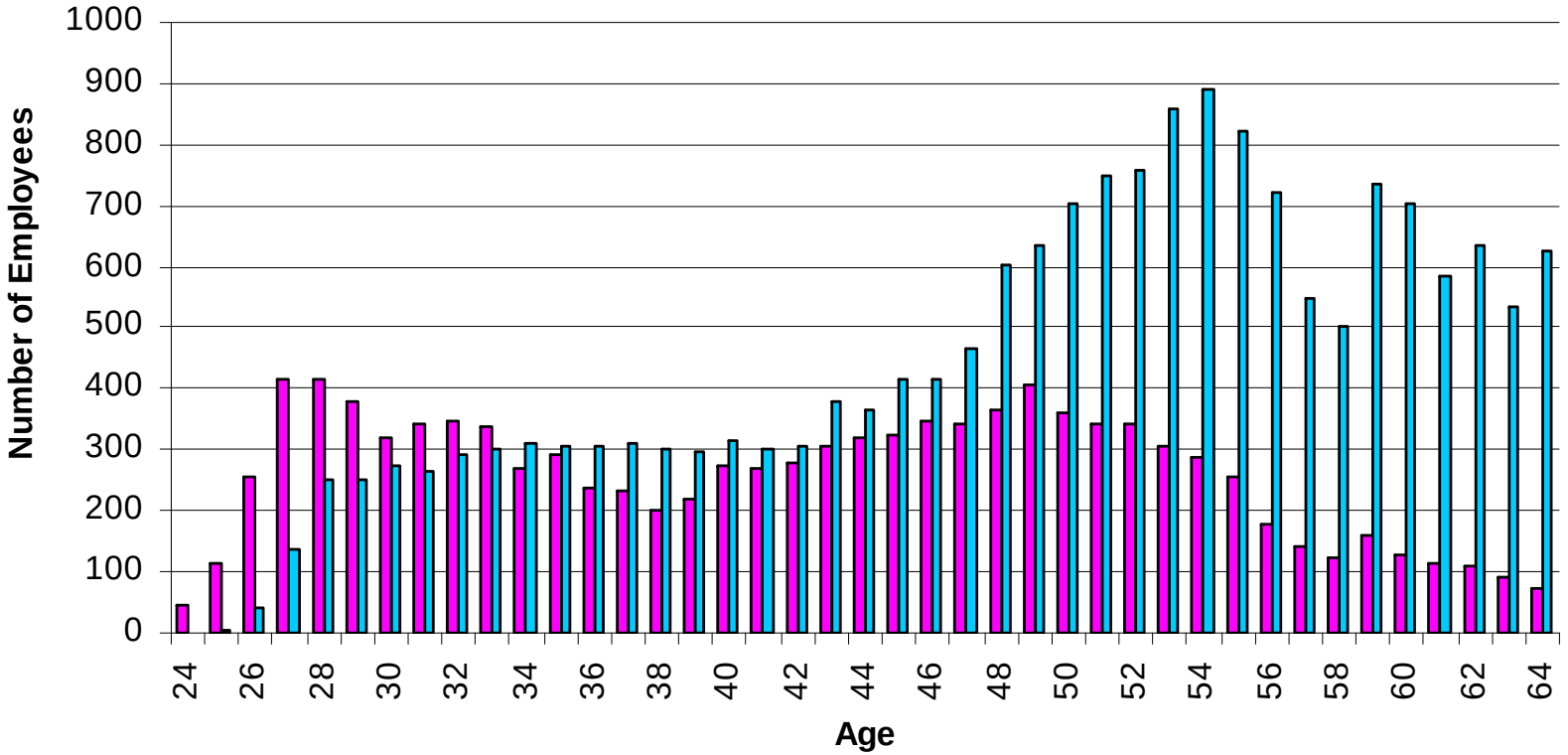
Back-up

Age Distribution – Total Workforce



Age Distribution – „Höherer Dienst“



Current Civil Servants Workforce

	Avg. Age	Avg. Salary (EUR)	Number
Total Workforce	44.7	39,000	104,919
Salary Groups			
Level 1	47.7	46,000	28,946
Level 2	45.6	38,000	63,843
Level 3	40.3	31,000	11,609
Level 4	43.7	26,000	503

Asset Allocation & Costs

	Spread period (in years)				
	1	10	20	50	∞
Normal contributions (in %)	23.0	13.0	13.4	13.9	14.1
Equity weight (in %)	45.0	42.2	40.9	39.9	39.4
Bond weight (in %)	55.0	57.8	59.1	60.1	60.6
Contribution rate volatility p.a. (in %)	3.24	1.38	1.25	1.14	1.09
1%-CVaR pension costs (in € bn)	20.8	20.8	20.8	20.8	20.8
Expected pension costs (in € bn)	-0.62	2.74	3.20	3.29	3.31