Utility and Usefulness of stochastic risk models for strategic pension policies

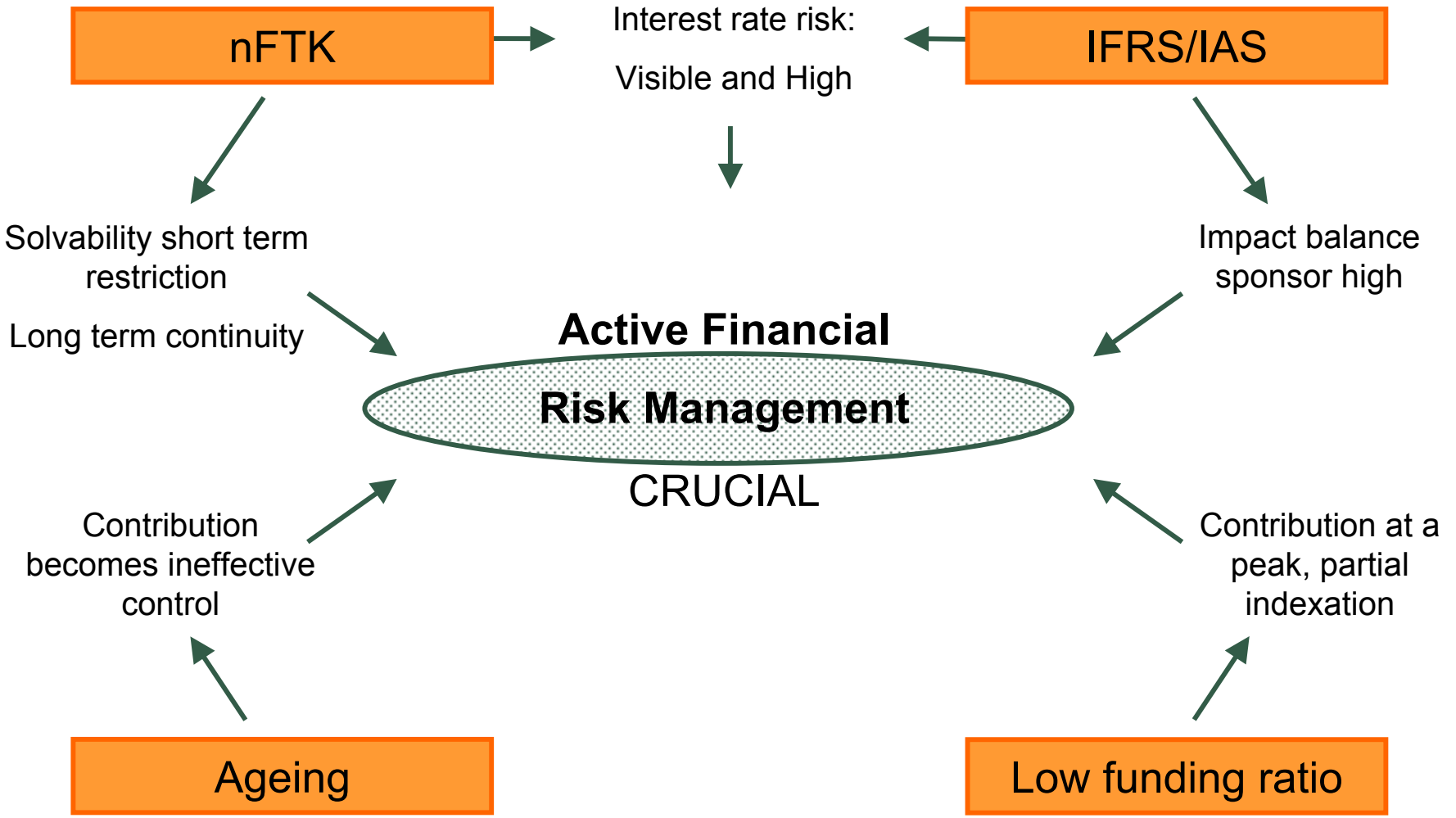
Huub van Capelleveen

Cardano Risk Management

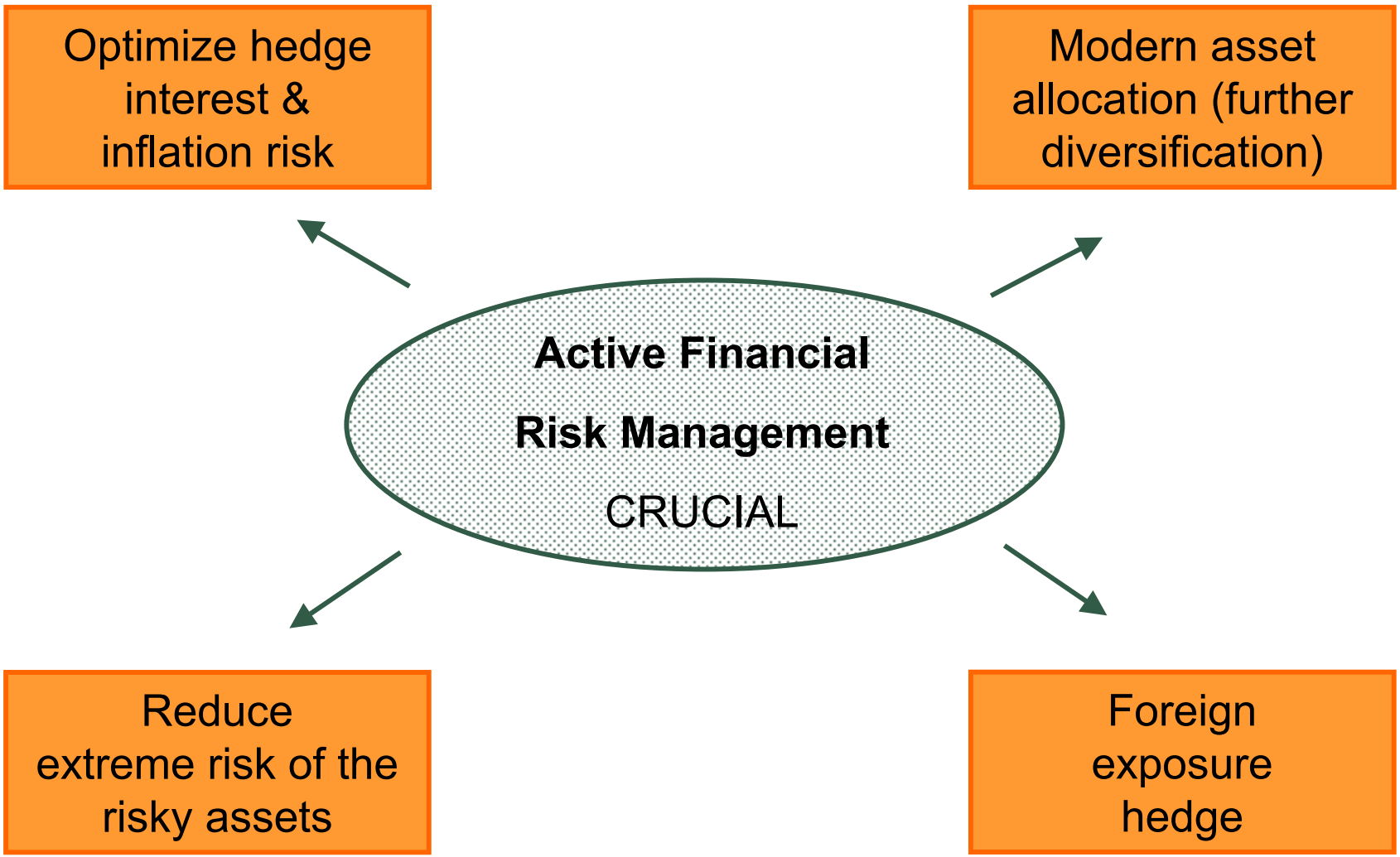
Januari 20th 2005

Investment policy and risk management:

Last effective control?



Controls within Risk & Asset Management



Increased interest in …

"I, too, hate being a greedy bastard, but we have a responsibility to our shareholders."

- Corporate Governance
- Riskmanagement
- Accountancy

Valuation techniques

- Option valution
  - Black & Scholes THE innovation 20th century
  - Later modifications endless
    - Bi- en Tri-nominal trees, Monte Carlo etc.
    - Multi-factor, stochastic volatility etc.
    - However, B&S “still rules” as basis
  - Application in
    - Explicit options (Exchange traded, Over The Counter)
    - Embedded Options [embedded in ‘normal’ products or policies]
    - Real options [investment problem = option problem]
- Risk adjusted valuation of all returns (RAROC)
  - Arbitrage free principle, so B&S dominates again

Difference between ALM and Arbitrage free valuation

- Two apparently different approaches: ALM and arbitrage free
  - ALM
    - Simulationmodel, modelled with embedded VAR-model
    - Long term averages based on (subjective) expectation
    - Usually “adjusted” Normal distributions for 1 year returns
  - Arbitrage free valuation
    - Theoretical framework for valuation of derivatives
      - Compose a different hedge strategy which gives together with the derivative for all possible outcomes the same result as a riskless interest generating position (martingale)
      - Integrate over all possible solutions
    - Long term ‘expectation’ based on forward pricing
    - Usually lognormal distributions
- ALM and arbitrage free valuation seem to contradict

How to make ALM and Arbitrage free compatible

Cardano RISK MANAGEMENT

- Valuation of derivatives has to be consistent with ALM (VAR) model
- Requirement: arbitrage free valutation
  - Equivalent Martingale Measure (EMM): all discounted tradables are martingale
  - Change of measure is equivalent to drift adjustment (Girsanov's theorem)
  - All aspects of ALM disappear or change in arbitrage free context: mean reversion, auto correlation and cross correlation
- Based on an EMM model we can value all sorts of (embedded) options
- Challenge: very time consuming: determine on every point in time for every scenario an embedded VAR model under EMM

What can go wrong?

- If a model is not arbitrage free:
  - Money machines can easily be generated
    - Especially dangerous when optimizing
- Notionals are very big so mispricing will have large effects
- Small deviations usually blow up in ALM (error-on-error)
- Adjust prices to the market: bid-ask, liquidity etc.
  - Take into account discrepancy between theoretical price and market prices

How to optimize the strategy

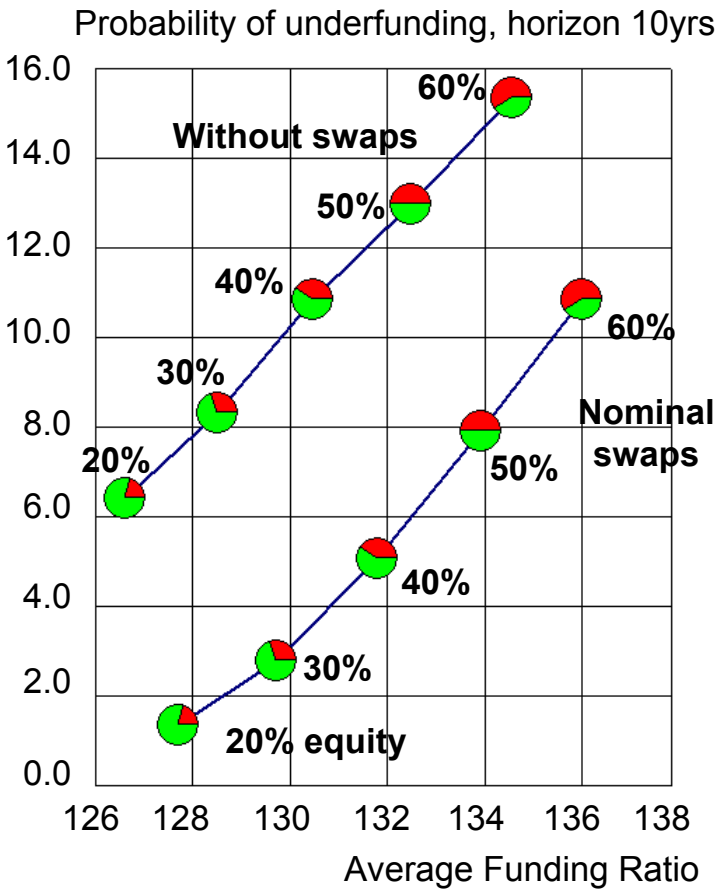
- Determine the risk
  - Case: the interest rate risk in FV context
    - Nominal interest versus real interest (inflation linked)
- Determine which risks are efficient in a risk/return context
  - Case: fully hedged or under/over hedging
    - Risk and Return are multi criteria
      - Funding level vs contribution vs average indexation
      - Underfunding vs high contributions vs no indexation
      - Different ambitions at different risk levels represent the concave utility function
    - Importance of Risk and Return criteria differ per horizon
- Using an ALM model we optimize
  - Educated trial and error vs optimization shell
  - Boundary conditions from regulator

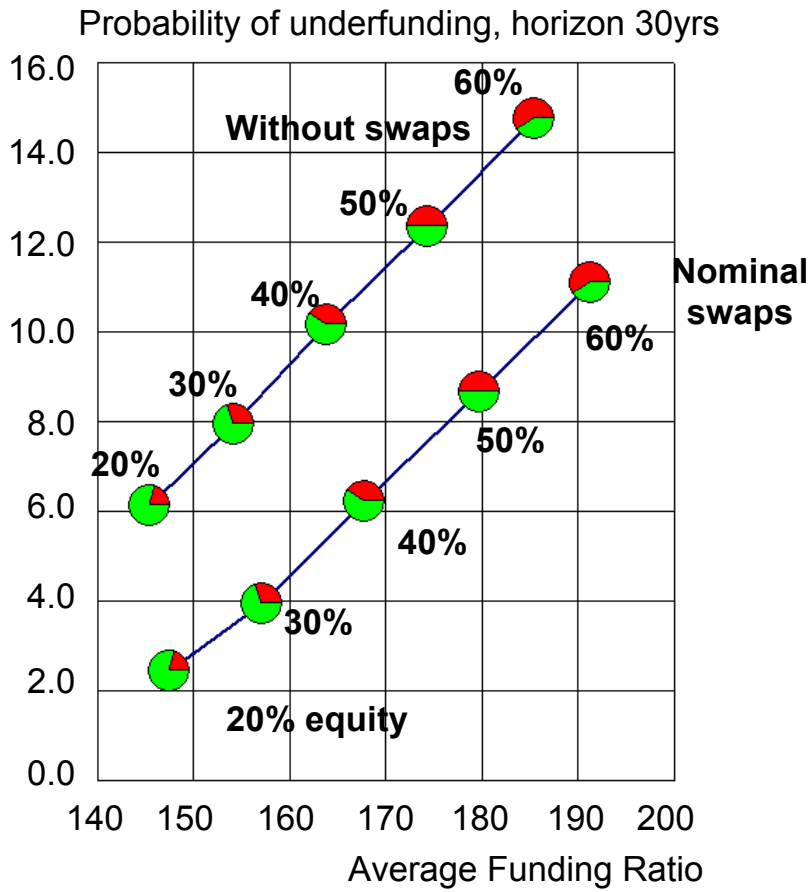
Interest rate risk:
What to do and how?

- Fully hedge the interest rate risk?
  - Don’t base hedge solely on duration of bonds and the liabilities
  - Take into account (cross/auto) correlation with other asset classes
  - Take the indexation ambition into account:
    - Interest rate risk partially real, partially nominal
  - Do you have to hedge the real liabilities?

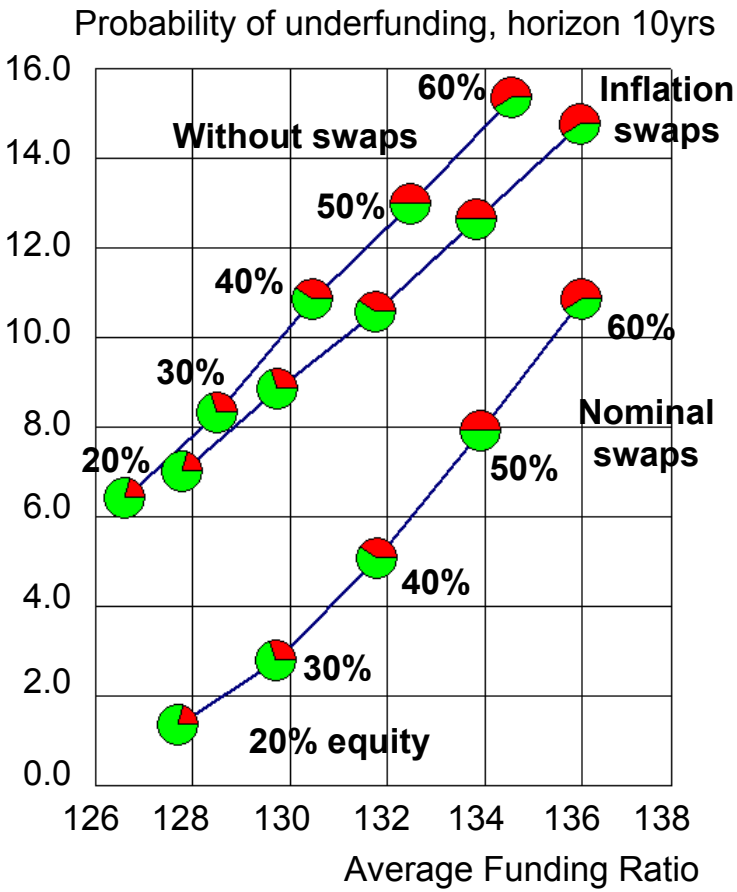
➔ How to optimize the interest rate hedge?

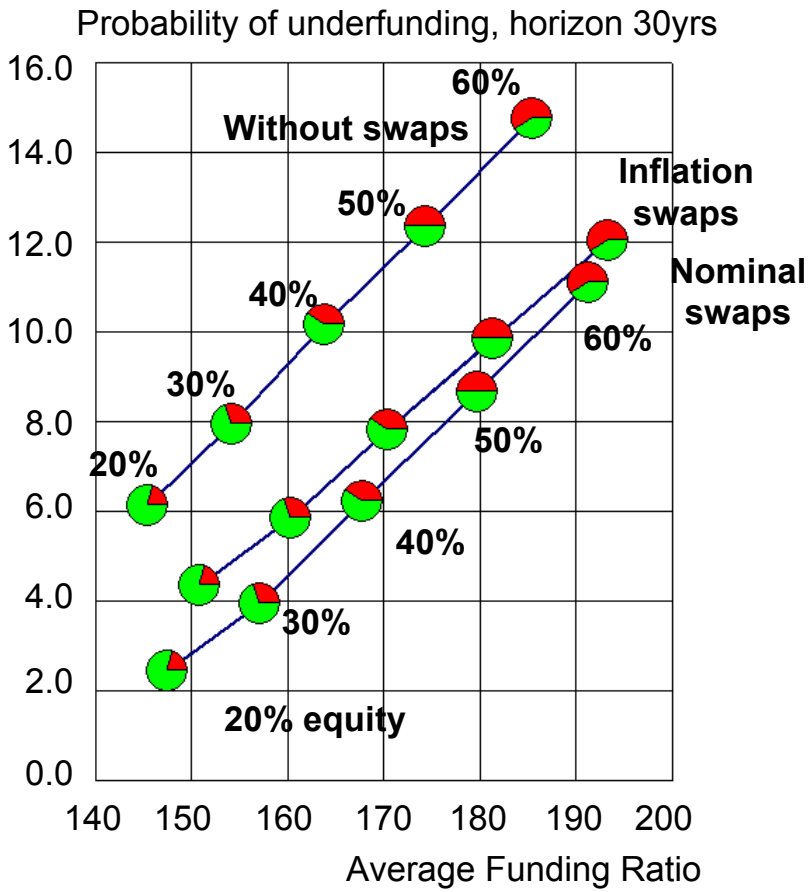
Efficiency in ALM: nominal hedge





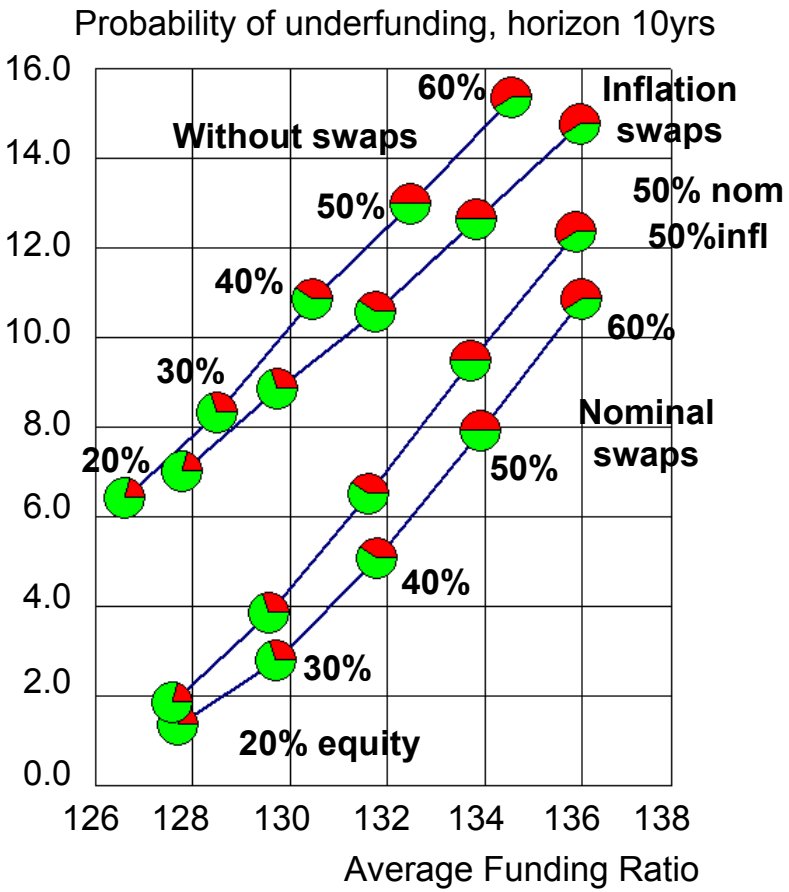
Nominal versus real hedge (inflation swap)

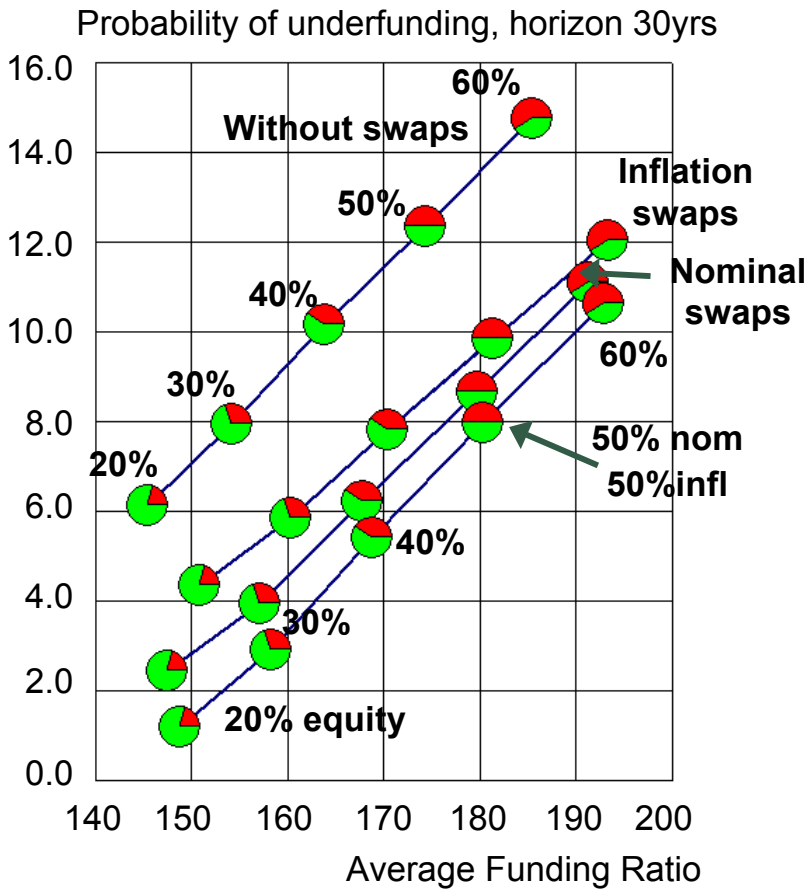




Long term: Inflation swaps are a good alternative

Nominal and real hedge combined





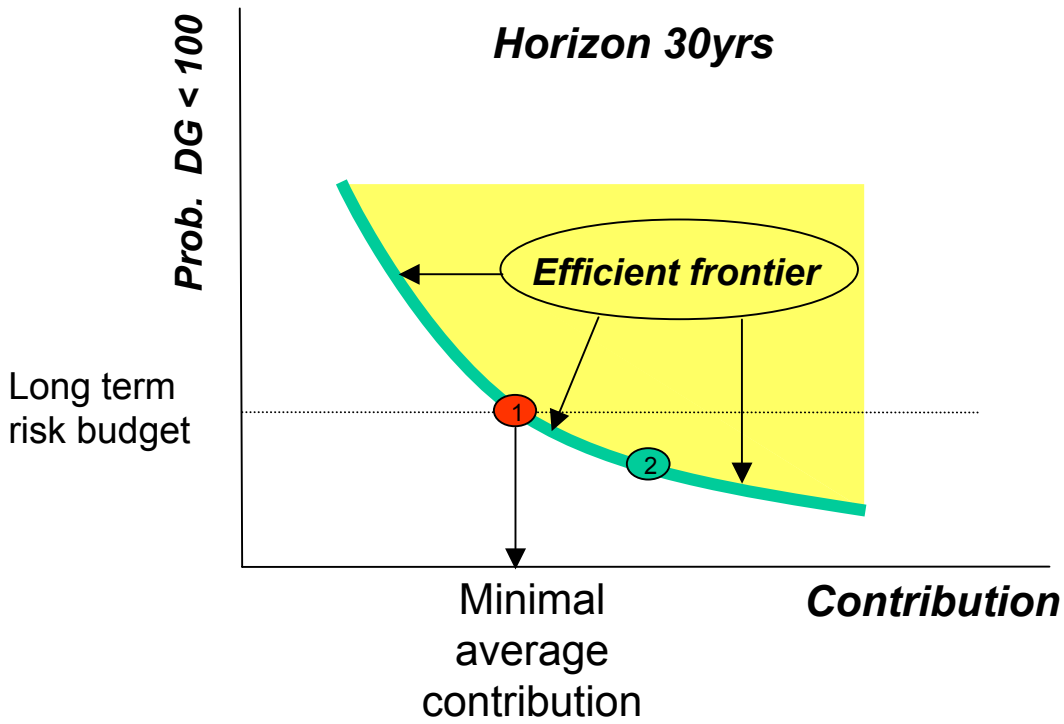
A mix of nominal and inflation swaps is even more effective on a long horizon, and nearly as effective on a short horizon

Effective strategies for interest rate risk

- In case of low funding ratio and short horizon restrictions:
  - Nominal hedge effective
- Long term:
  - Combination nominal and inflation swaps effective
- Optimal: dynamic interest rate risk strategies
  - Mostly nominal in case of low funding
  - Increasingly real at higher funding ratios
- How to cope with different horizons in optimalization?

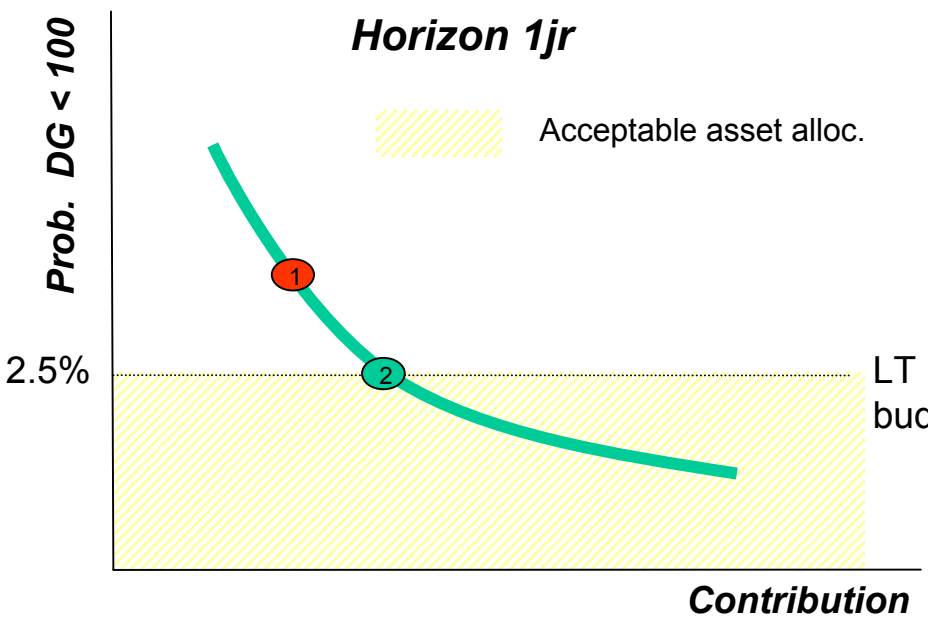
How to cope with different horizons

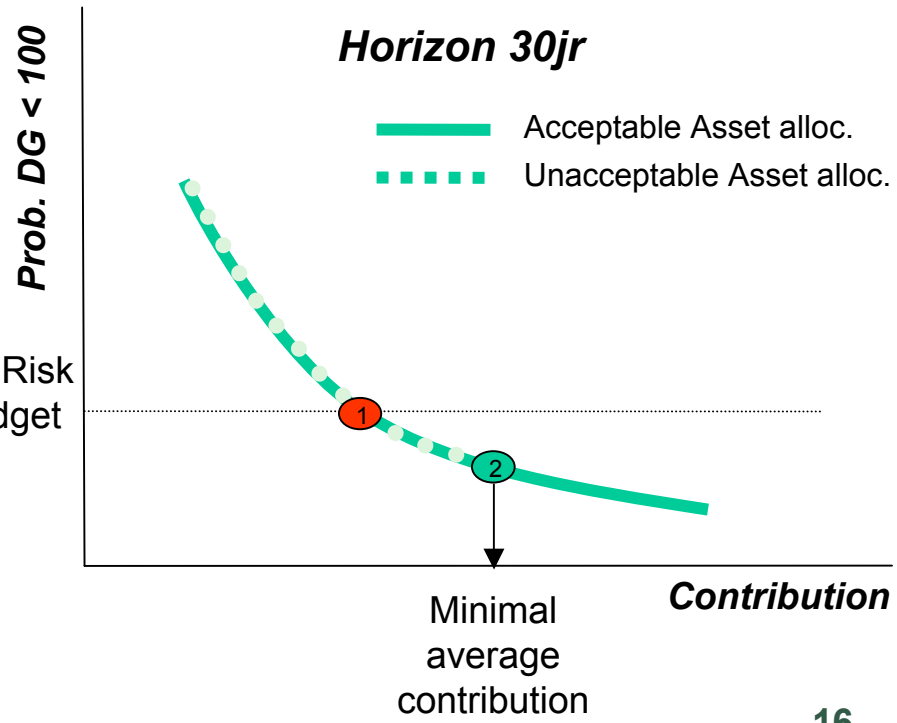
- One horizon: minimize contribution given risk budget on a long horizon (5yr, 10yr, 30yr)



Impact nFTK: 1yr solvency requirement

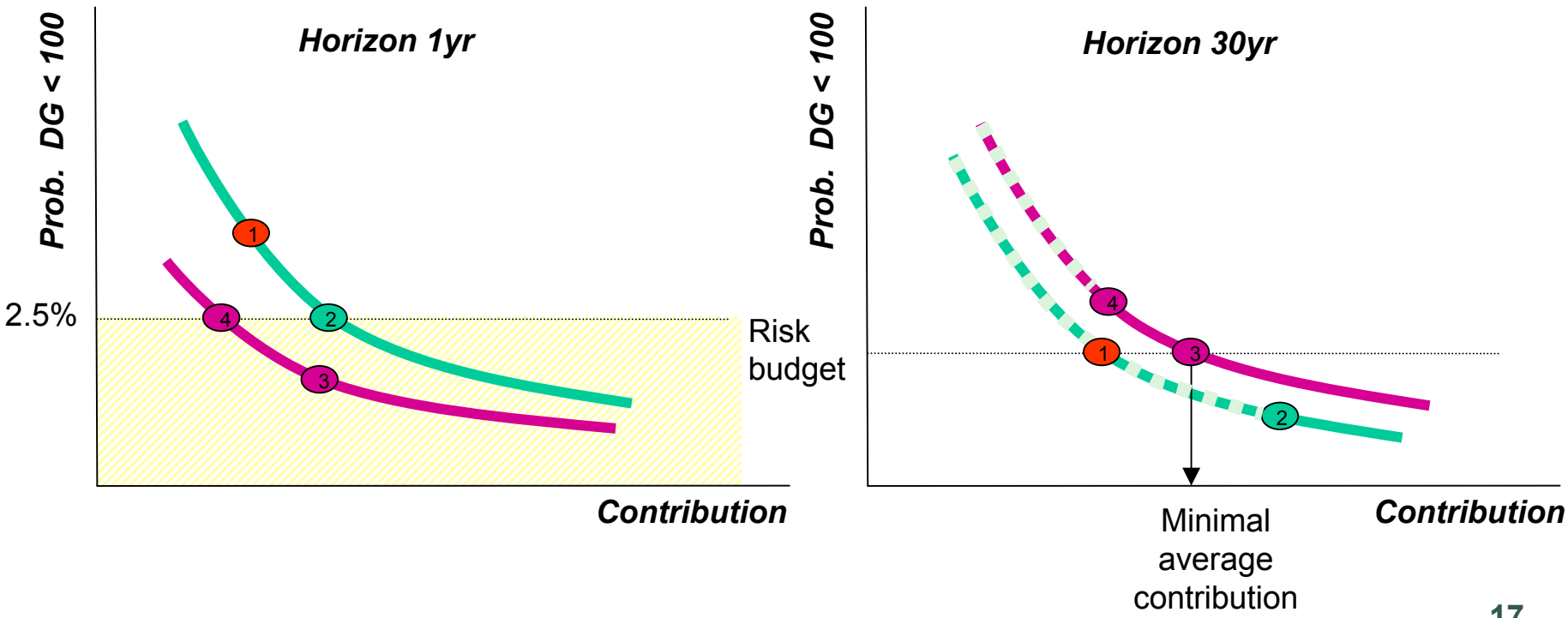
- Optimal solution on long horizon no longer allowed:





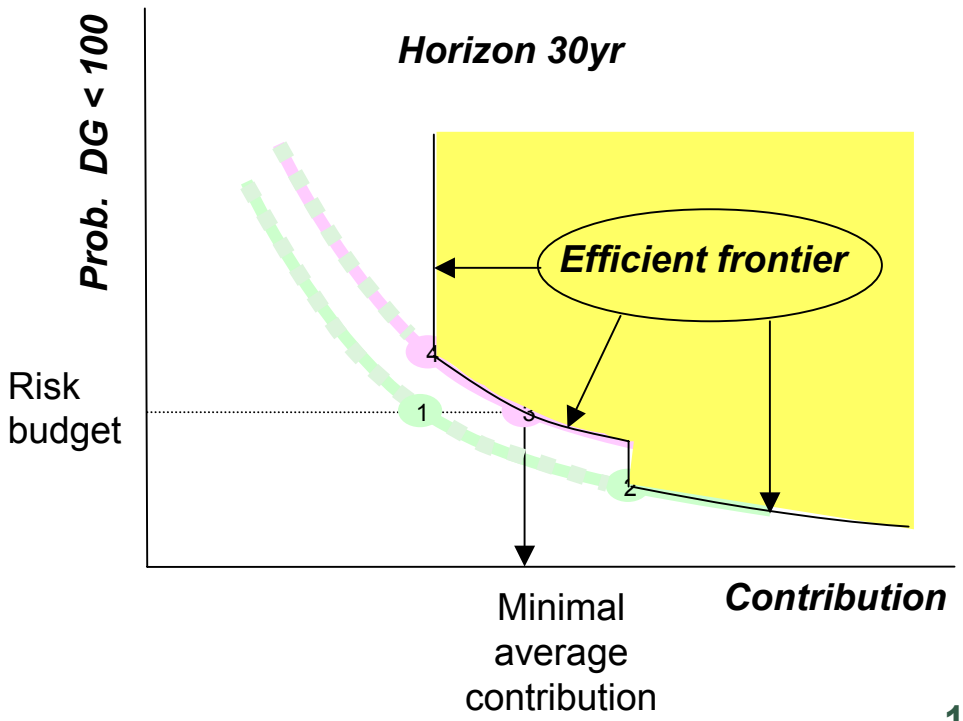
Alternative asset allocations

- Some sub optimal asset allocation, pass 1yrs solvency requirement
- Given the FTK-restrictions, these allocations can become optimal



Asset allocations in FTK

- Optimize asset allocation according to risk budget, 1yr solvency requirement is a constraint
- The 1yr solvency requirement implies a new Efficient Frontier
- New asset allocations should be efficient with risk budget on a long and a short horizon
- Use a wider range of products



Robustness parameters

- Key parameters in ALM
  - Expected long term interest rate (mean reversion level)
  - Expected risk premium
  - Expected volatility
  - Long term correlations

- Optimal strategies given a set of parameters should also be robust for other sets
  - More robust nearly optimal strategies can be preferable
  - Optimize over different parameters
    - Minimax problem
    - Game theory: see key parameters as opponents

Conclusion

- Active financial risk management increasingly important for pension funds
- Derivatives can help substantially
- Optimization in ALM difficult
  - Multi criteria
  - Multi horizon
  - Multi parameters

"Winning is crucial to my retirement plans."