Pension Scheme Redesign and Wealth Redistribution Between Members and Sponsor: The USS Rule Change in October 2011

'How Much Money Did You Lose in October 2011?'

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Contributions

1. 1st study of a real-world pension scheme (USS), as opposed to hypothetical Dutch schemes.
2. 1st of a ‘balance of cost’ DB scheme, where the sponsor bears almost all of the risk (Old-Scheme).
3. 1st with two sections of the pension scheme - FS and CRB (New Scheme).
4. 1st with a ‘cap and share’ rule for the contribution rate (New-Scheme).
5. 1st to incorporate dynamic asset allocation.
6. 1st to include deferred pensioners, spouses pensions and tax-free lump sums.
7. 1st to have 6 asset classes, RPI and CPI inflation and 5 other factors.
8. 1st to have a horizon year longer than a working life (54 years).

Forecasting.1

For the next 54 years we need to forecast :-

1. Asset returns
2. Yield curves
3. RPI and CPI inflation
4. Longevity
5. Academic salaries for each age cohort
6. The numbers of active members, deferred pensioners and pensioners in each age cohort

Forecasting.2

VAR(1) model:

$$\mathbf{x}_{t+1} = \mathbf{c} + \mathbf{B}\mathbf{x}_t + \zeta_{t+1}, \quad \zeta_{t+1} \sim N(\mathbf{0}, \boldsymbol{\Sigma})$$

13 state variables (1993-2010 – 72 observations): UK equities, European equities, US equities, Hedge funds, Commodities, UK property, UK dividends, US dividends, RPI and CPI, and the three yield curve parameters.

The largest eigenvalue of the estimated coefficient matrix (**B**) is less than one, and so the system is stable.

Nelson-Siegel yield curve:-

$$y_n(t) = \beta_{1,t} + \beta_{2,t}\left(\frac{1-e^{-\lambda n}}{\lambda n}\right) + \beta_{3,t}\left(\frac{1-e^{-\lambda n}}{\lambda n} - e^{-\lambda n}\right)$$

Building the USS Model.1

The USS rule book has 295 pages, and replicating this is not sensible or realistic.

We have modelled the rules that changed, and some other important aspects of the rules.

Rule Changes in October 2011

1. The final salary section was closed to new members, who had to join the newly established CRB section.

   Final salary pension = (Accrued years/80)×(*Final Salary*)

   CRB pension = (Accrued years/80)×(*Average Revalued Salary*)

Building the USS Model.2

2. Limited price indexation of pensions in payment: 0% to 5% = full; 5% to 15% = half; above 15% =0
3. The up-rating of deferred pensions for CPI inflation was capped at 2.5% - the legal minimum.
4. The retirement age rises in line with the state pension age.
5. Moving from 'balance of cost' to 'cap and share'.
   *Increases in the contribution rate are shared 65% : 35% between the sponsors and the active members.
6. Increase in the final salary members' contribution rate from 6.35% to 7.50% of pensionable salary.

Building the USS Model.3

Some unchanged rules that we also modelled:-

1. Tax-free lump sum payments on retirement of 3 times the initial pension
2. Spouses' pensions - half the member's pension

Pension Liabilities

1. Active/Deferred members:-

$$L^{x,FS}_{A/D,t} = N^{x,FS}_{A/D,t} \times \left(\frac{P^{x,FS}_{A/D,t} \times S^{x,FS}_{A/D,t}}{A} \right) \times \left\{ \frac{\left(1 + e^{x,FS}_{A/D,t}\right)}{\left(1 + h^{x,FS}_{A/D,t}\right)} \right\}^{R^{x,FS}_{A/D,t} - G^{x,FS}_{A/D,t}} \times \left\{ \left[1 - \left(\frac{1 + h^{x,FS}_{A/D,t}}{1 + p^{x,FS}_{A/D,t}} \right)^{-W^{x,FS}_{A/D,t}} \right] \Big/ \left(\frac{1 + h^{x,FS}_{A/D,t}}{1 + p^{x,FS}_{A/D,t}} - 1 \right) \right\}$$

2. Pensioners:-

$$L^{x,FS}_{P,t} = N^{x,FS}_{P,t} \times PEN^{x,FS}_{P,t} \times \left\{ \left[1 - \left(\frac{1 + h^{x,FS}_{P,t}}{1 + p^{x,FS}_{P,t}} \right)^{-q^{x,FS}_{P,t}} \right] \Big/ \left(\frac{1 + h^{x,FS}_{P,t}}{1 + p^{x,FS}_{P,t}} - 1 \right) \right\}$$

Parameters: No of members, Salary, No. of accrued years, Salary growth rate, Inflation rate, Discount rate, Retirement age, Life expectancy, Current age

Contribution Rates

Contribution rate

1. We assume that USS only adjusts the contribution rates when the funding ratio is below 90% or above 120%.
2. The total contribution rate is adjusted so as to eliminate any deficit or surplus over a spread period of 15 years.
3. We also set an upper limit of 35% on the contribution rate (Ernst and Young) (also 29% as a robustness check)

Asset Allocation & Age-Cohorts

Asset Allocation:-

1. Fix-mix allocation of USS as at 2011
2. Risk management - as the funding ratio drops the money is moved into low risk assets
3. Risk shifting - the opposite of risk management

Age Cohorts

	Age	FS	CRB	Total
Future	-30 to25	11	11	22
Actives	25 to 65	8	3	11
Deferreds	25 to 65	8	3	11
Pensioners	65 to 95	6	0	6

Computing the NPVs and the Redistribution

The SDFs (Pricing Kernels) are computed as follows:-

$$-\log\left(m_{t+1}\right) = y_t^{3-month} + \frac{1}{2}\boldsymbol{\varphi}_t^{\mathrm{T}}\boldsymbol{\Sigma}\boldsymbol{\varphi}_t + \boldsymbol{\varphi}_t^{\mathrm{T}}\boldsymbol{\zeta}_{t+1}$$

$\boldsymbol{\zeta}_{t+1} \sim \mathrm{N}(\mathbf{0}, \boldsymbol{\Sigma})$ is a column vector of disturbances from the VAR(1) model

$y_t^{3-month}$ is the 3 month UK interest rate at time *t* estimated using the Nelson-Siegel yield curve

$\boldsymbol{\Sigma}$ denotes the variance-covariance matrix of the residual error terms of the VAR(1) model

$\boldsymbol{\varphi}_t$ is a column vector of the time-varying prices of risk.

Computing the NPVs and the Redistribution

The column vector of the time-varying prices of risk is expressed as:-

$$\boldsymbol{\varphi}_t = \boldsymbol{\Sigma}^{-1}\left[\mathbf{c} + \frac{1}{2} diag\left(\boldsymbol{\Sigma}\right)\right] + \boldsymbol{\Sigma}^{-1}\mathbf{B}\mathbf{x}_t$$

where the parameters **c**, **Σ** and **B** come from the VAR(1) model.

The column vector $\mathbf{x}_t$ contains the state variables of the VAR(1) model at time t.

For a given scenario, the SDF for a cash flow in year *k* (m_{t+k}^*) is the product of the SDFs for each of the first *k* years, i.e:

$$m_{t+k}^* = m_{t+1} \times m_{t+2} \times \ldots \times m_{t+k}$$

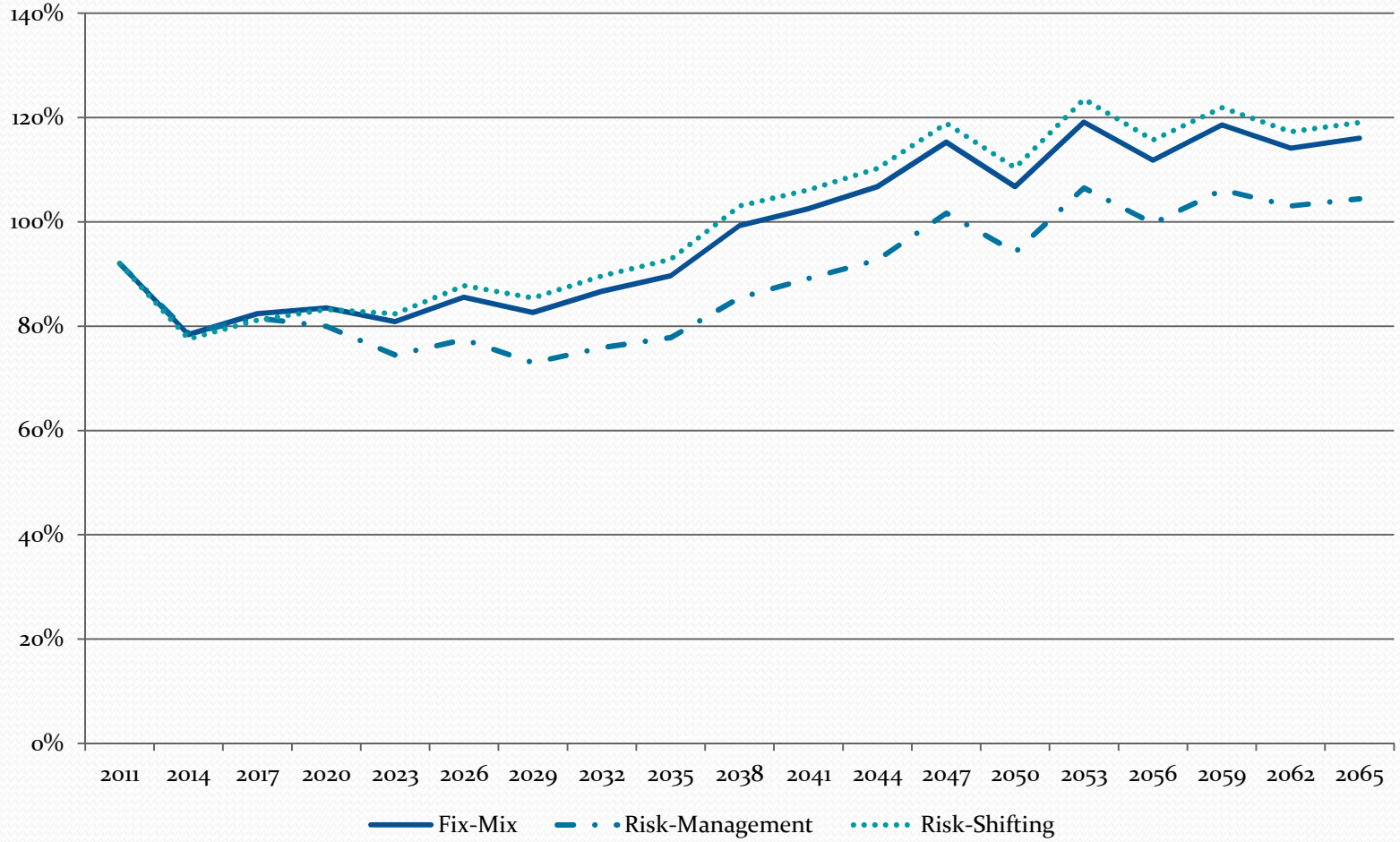

Fig. 1: Post-October 2011 Scheme Mean Funding Ratios for the Three Asset Allocation Strategies

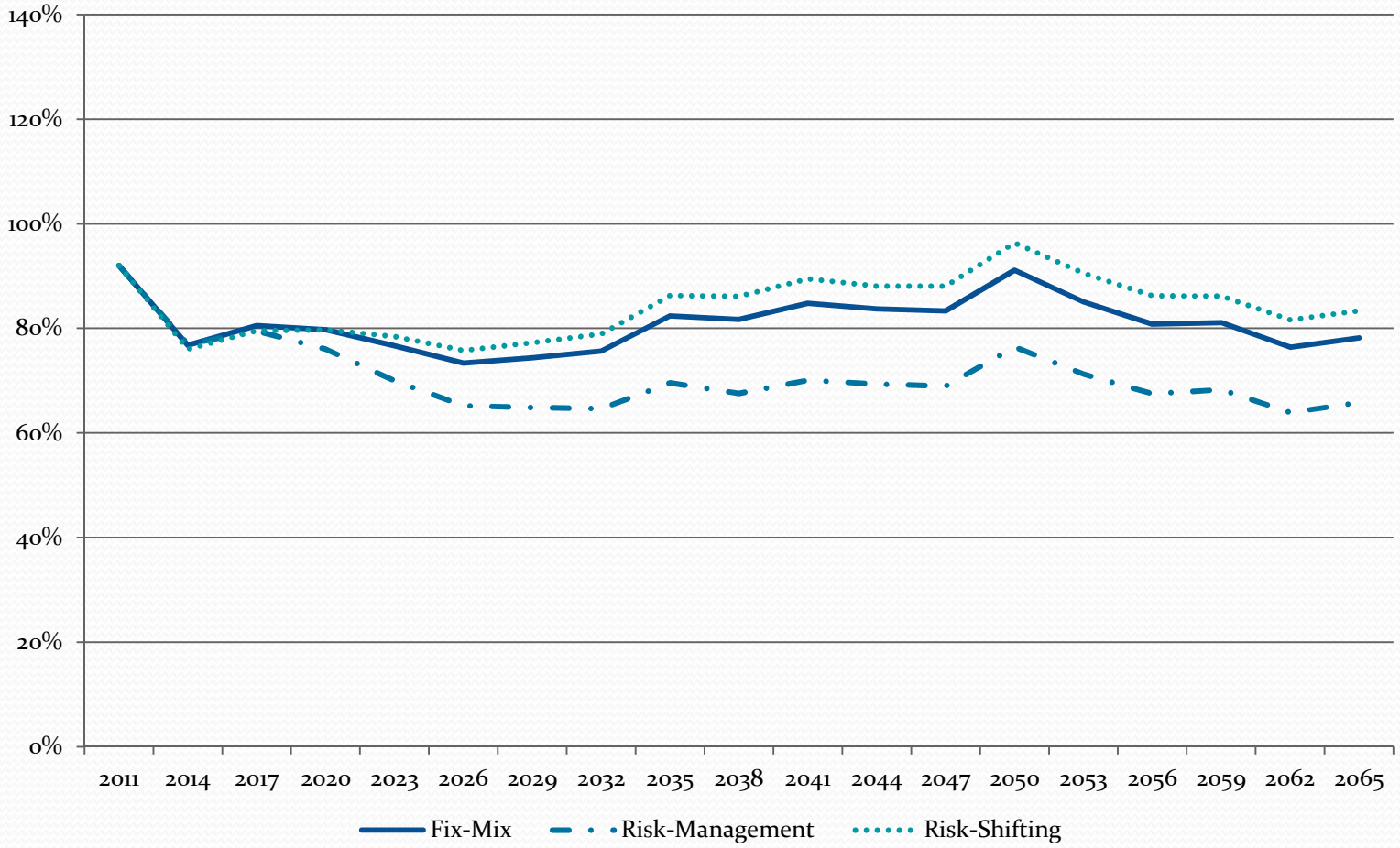

Fig. 2: Pre-October 2011 Scheme Mean Funding Ratios for the Three Asset Allocation Strategies

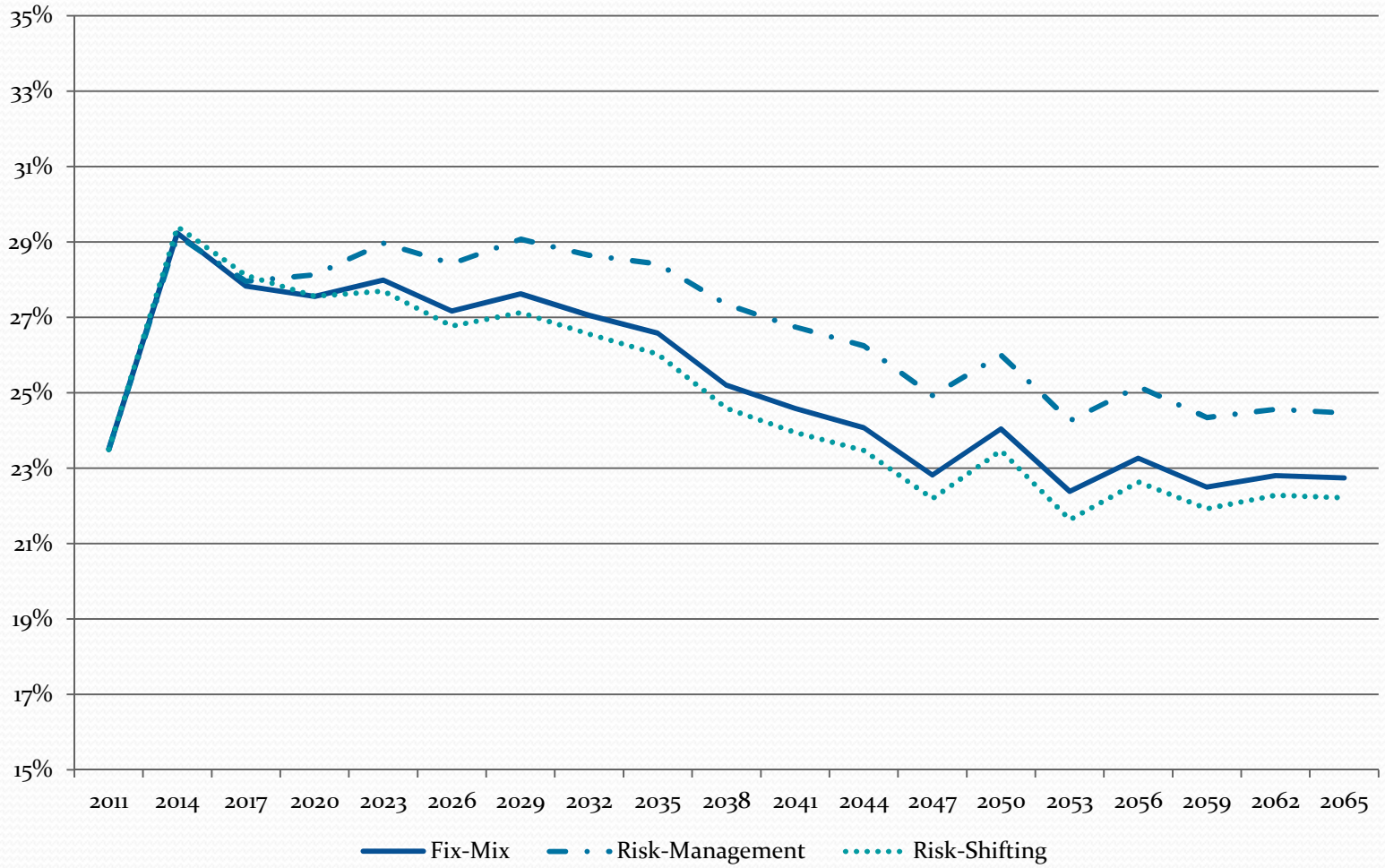

Fig. 3: Post-October 2011 Mean Contribution Rates for the Three Asset Allocation Strategies

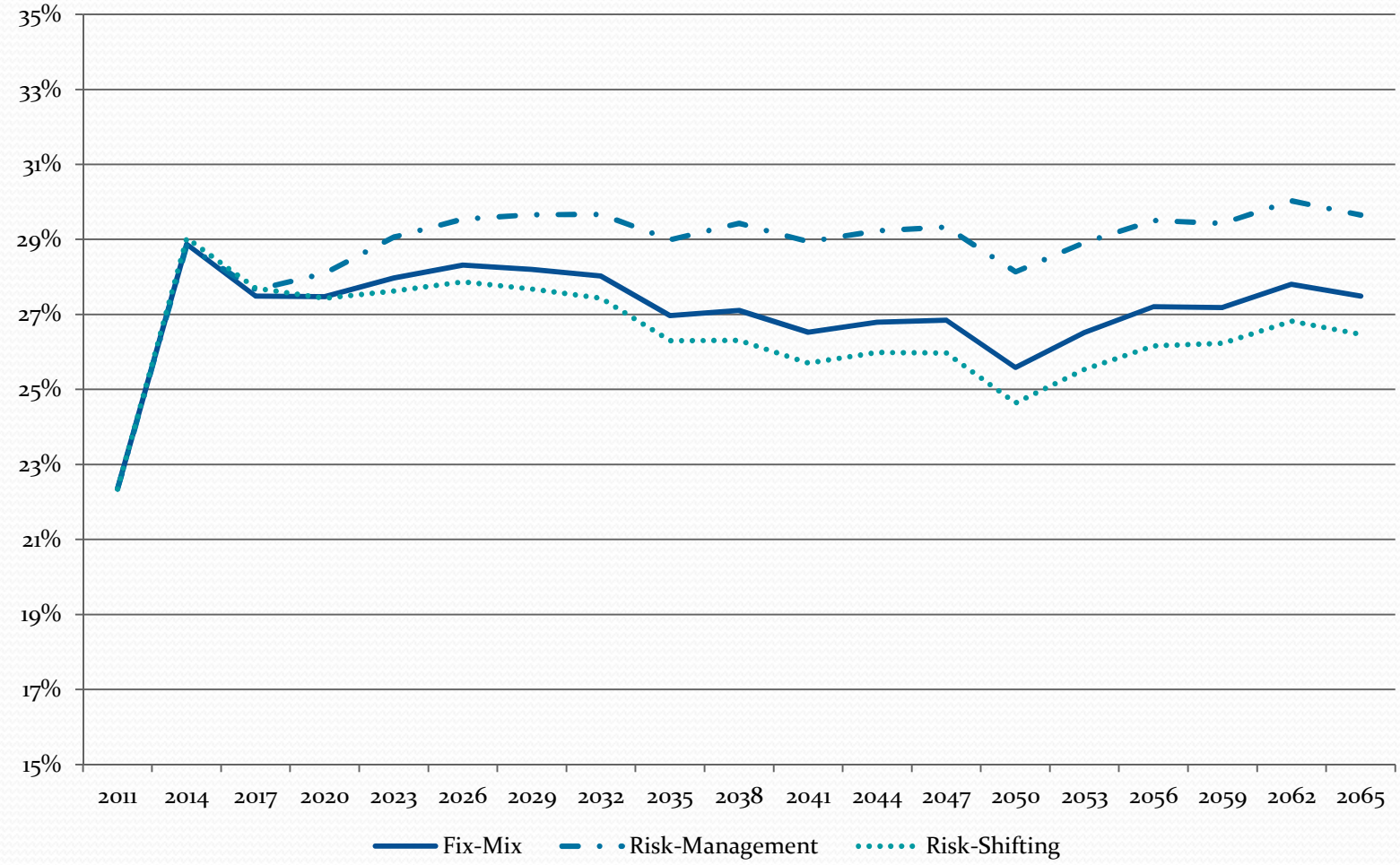

Fig. 4: Pre-October 2011 Mean Contribution Rates for the Three Asset Allocation Strategies

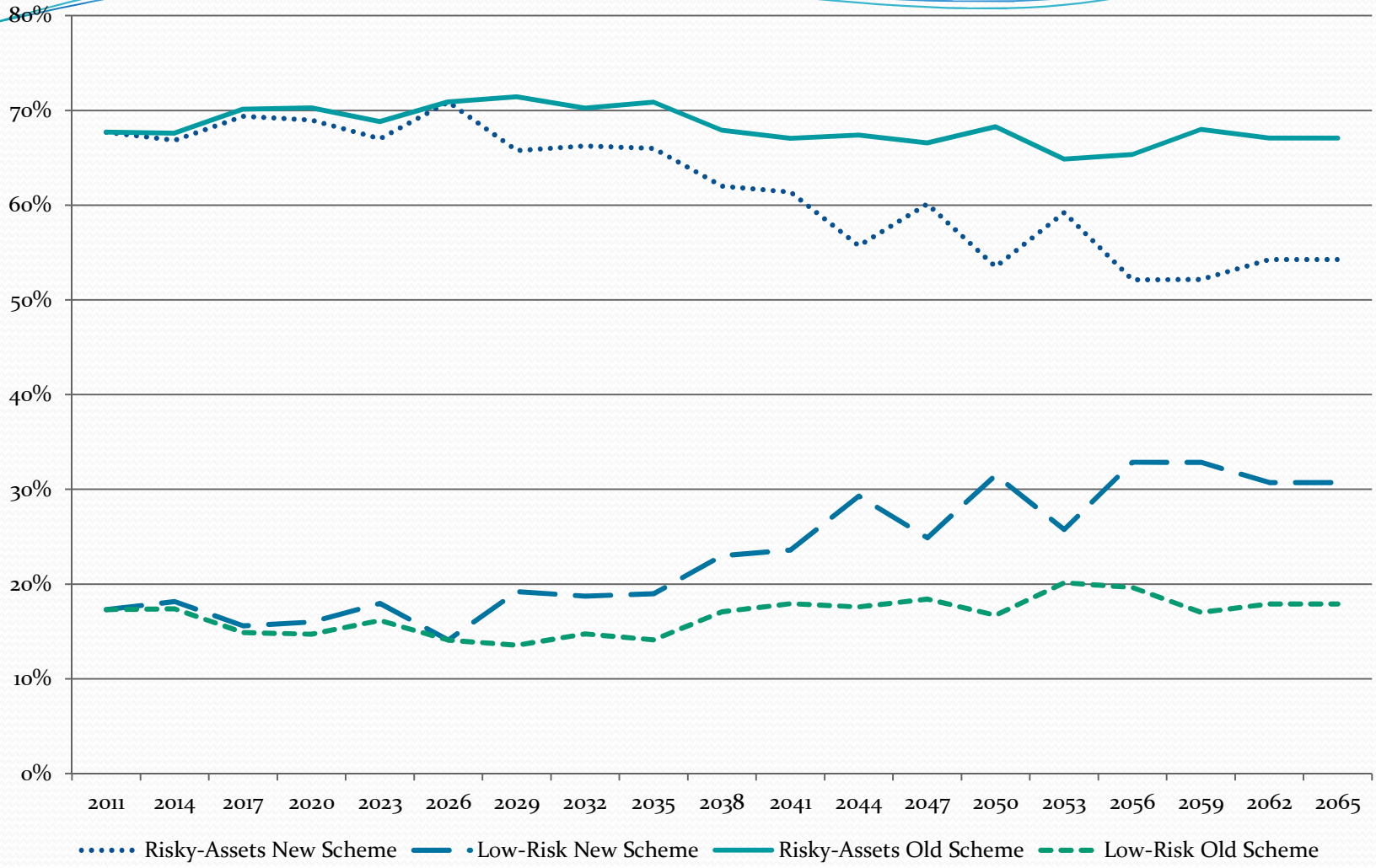

Fig. 5: Mean Risk-Shifting Asset Allocation for the Pre and Post-October 2011 Schemes

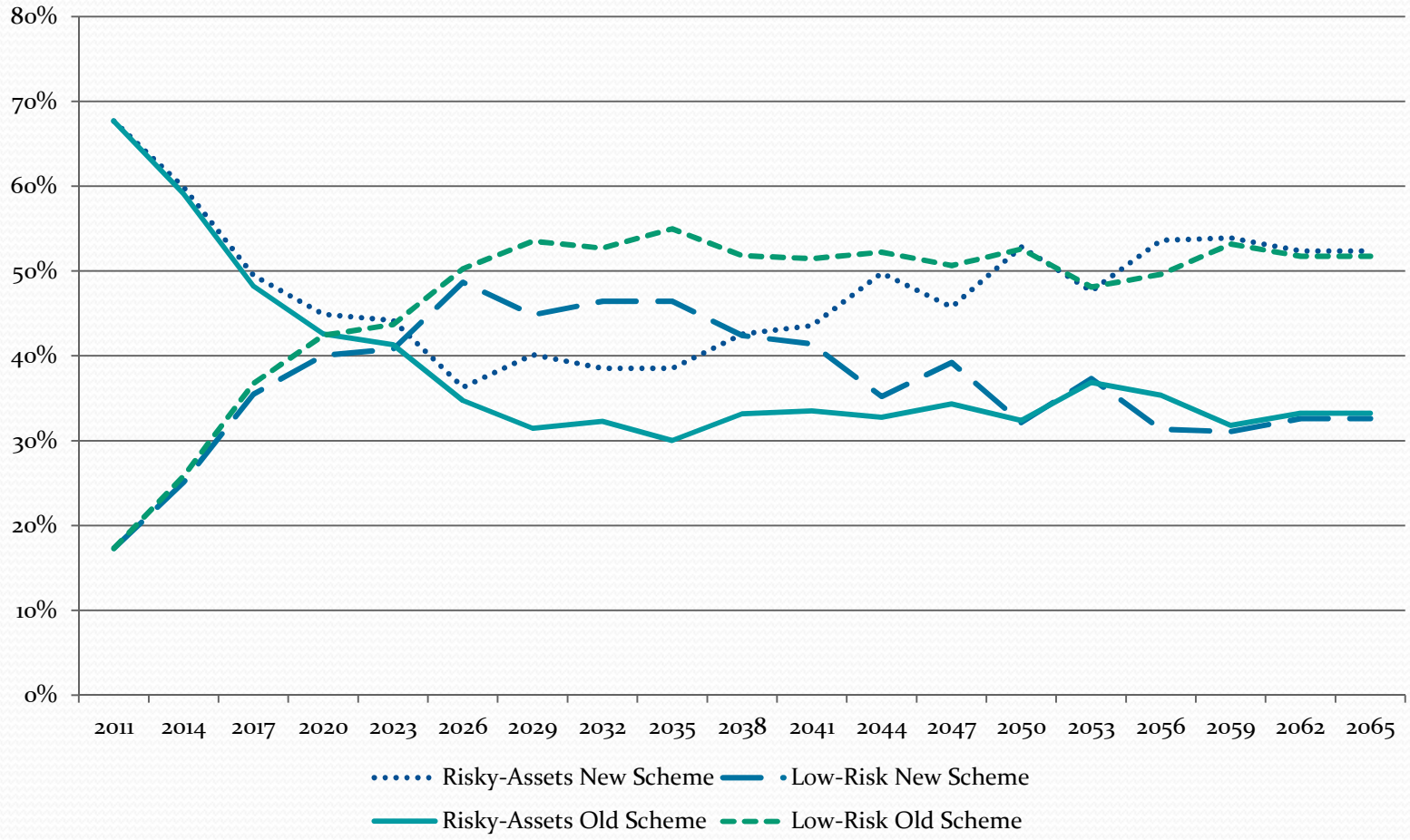

Fig. 6: Mean Risk-Management Asset Allocation for the Pre and Post-October 2011 Schemes

	Fix Mix		Risk Management		Risk Shifting	
	Post	Pre	Post	Pre	Post	Pre
Mean funding ratio	98.52%	80.94%	89.17%	70.96%	100.97%	84.23%
SD of the funding ratio	14.66%	5.10%	11.82%	6.80%	15.95%	5.86%
Mean FS contribution rate	25.21%	27.09%	26.65%	28.76%	24.80%	26.49%
SD of the FS contribution rate	2.28%	1.38%	1.94%	1.67%	2.48%	1.44%
Mean risky allocation	67.70%	67.70%	47.88%	38.38%	62.19%	68.36%
SD of risky allocation	0	0	8.04%	10.28%	6.37%	1.93%
Mean low risk allocation	17.30%	17.30%	37.12%	46.62%	22.81%	16.64%
SD of low risk allocation	0	0	8.04%	10.28%	6.37%	1.93%
Mean asset return	3.87%	3.87%	2.43%	2.09%	4.23%	4.39%
SD of asset returns	1.76%	1.76%	1.67%	1.68%	1.82%	1.80%

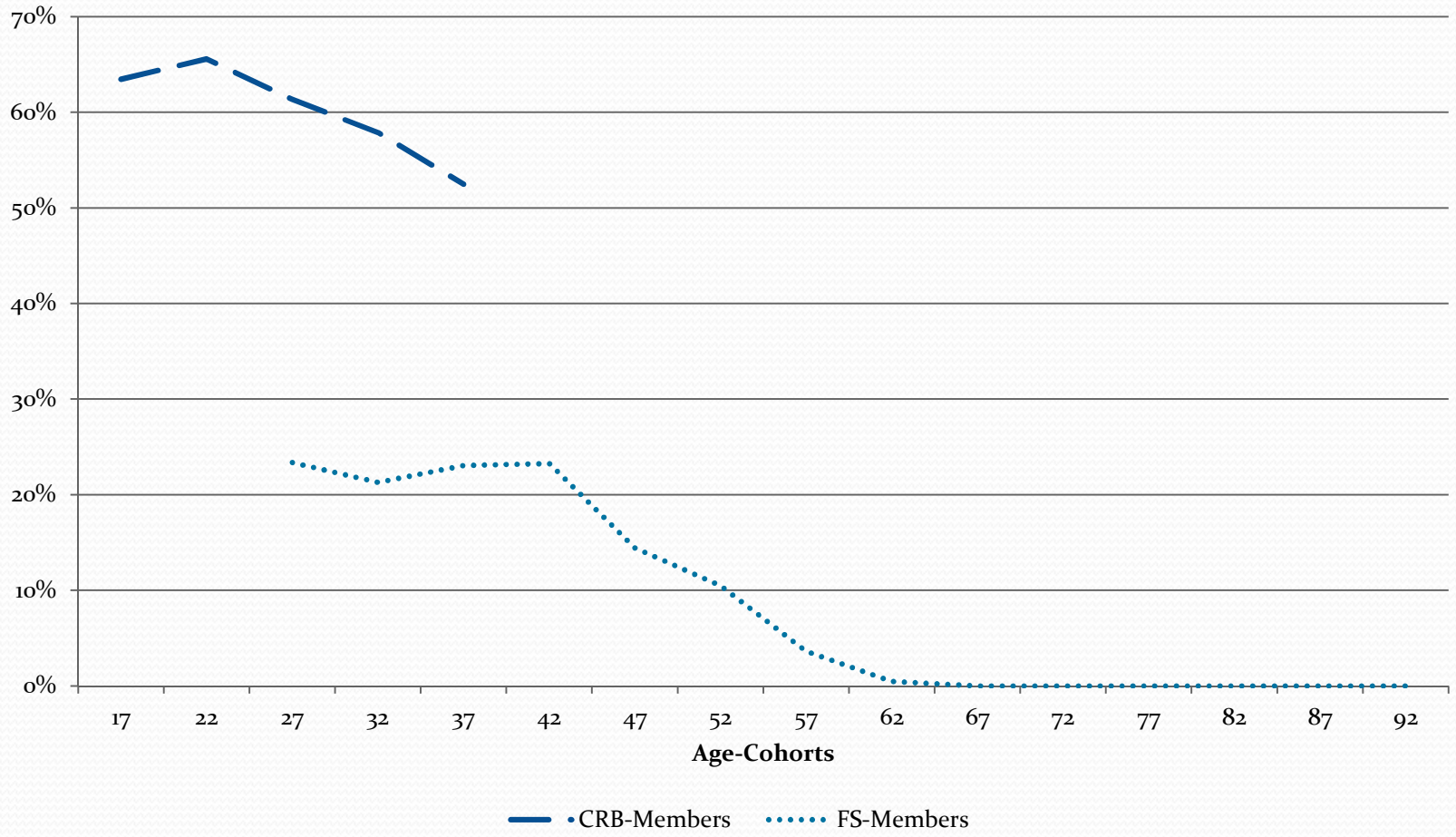

Fig. 7: Percentage Drop in the NPV for Each Age Cohort Due to the Rule Change (**SDFs**)

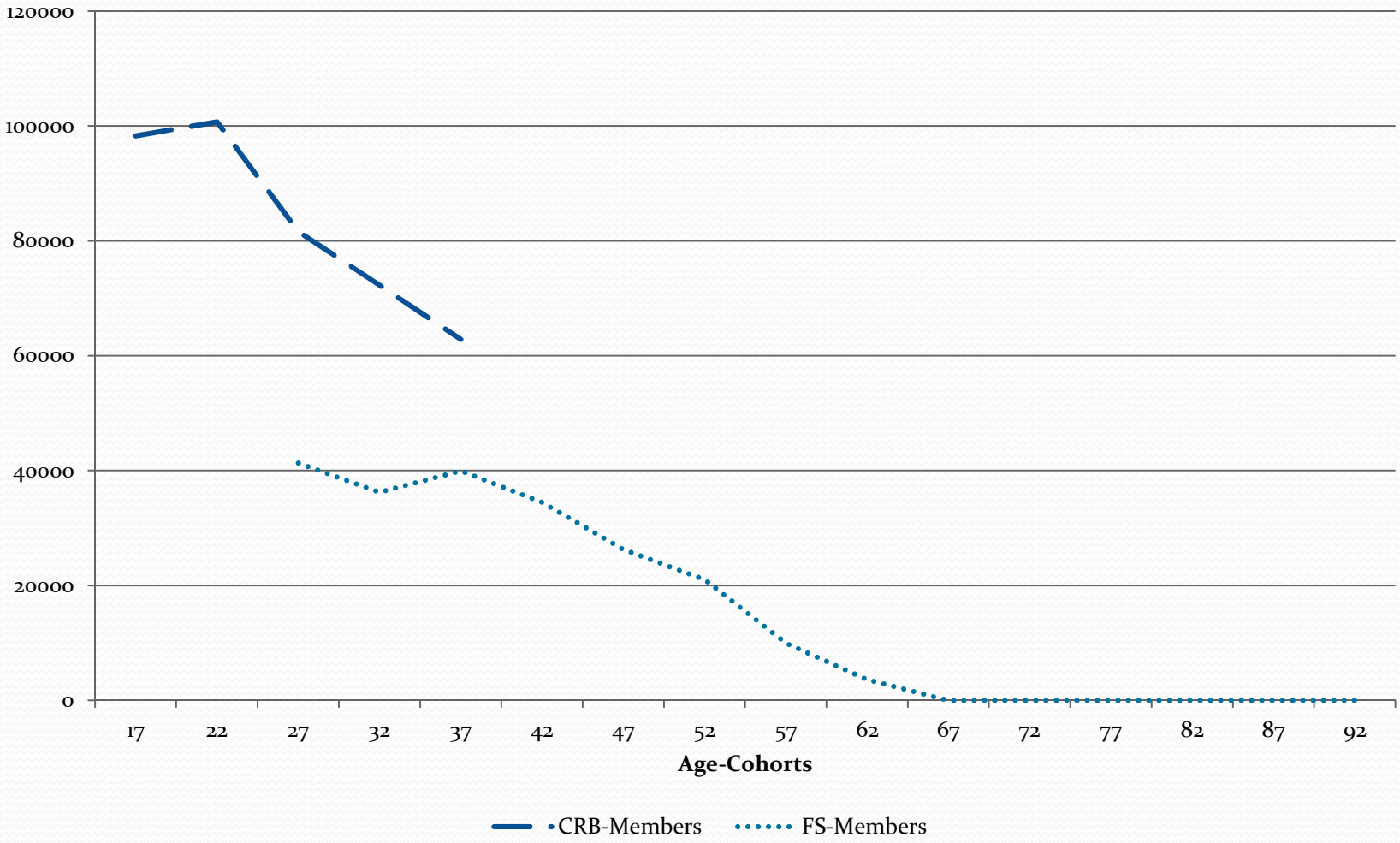

Fig. 8: Percentage Loss Per Head for Actives in Each Age Cohort (**SDFs**)

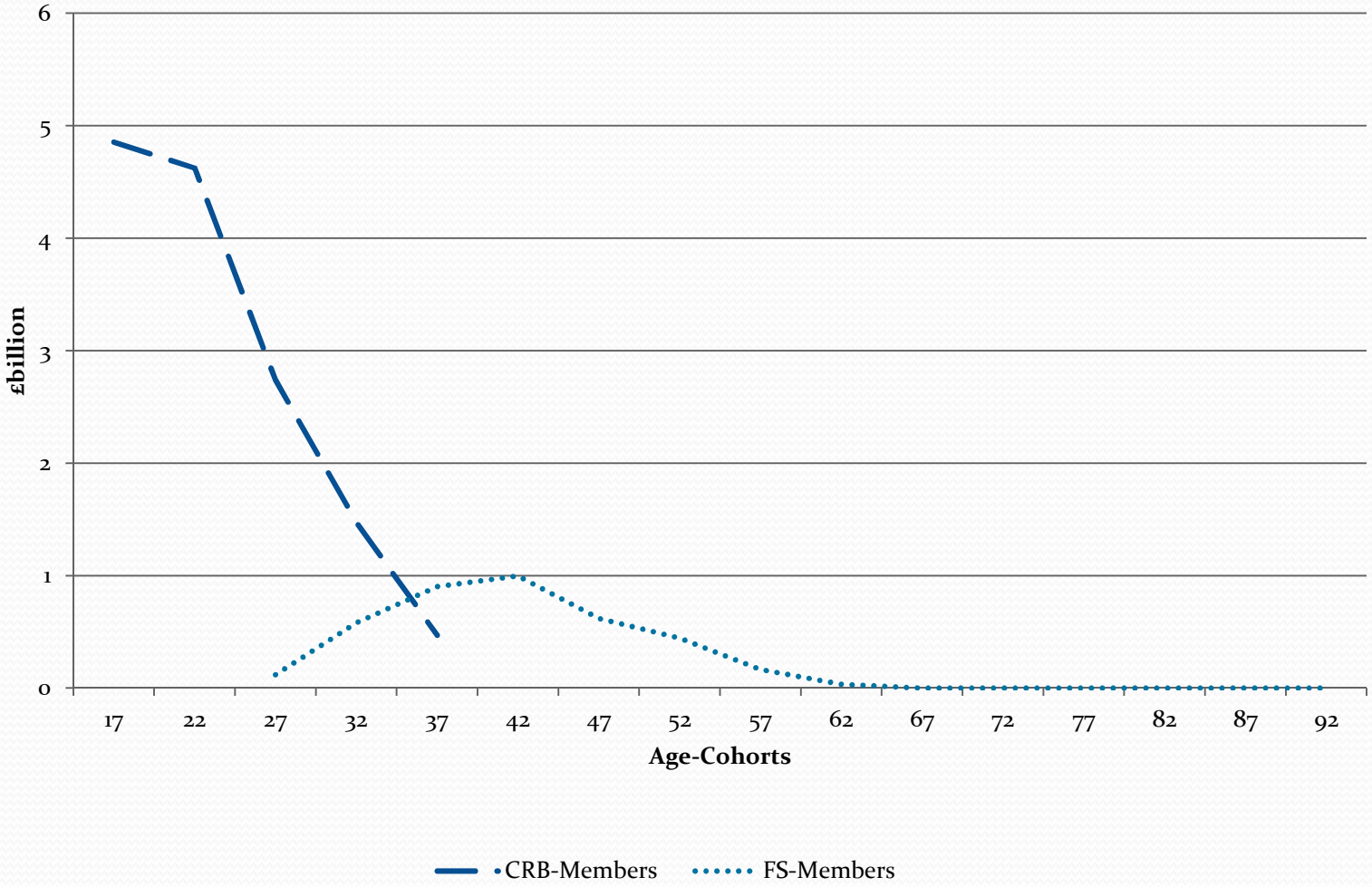

Fig. 9: Losses Per Age Cohort in £bn. (**SDFs**)

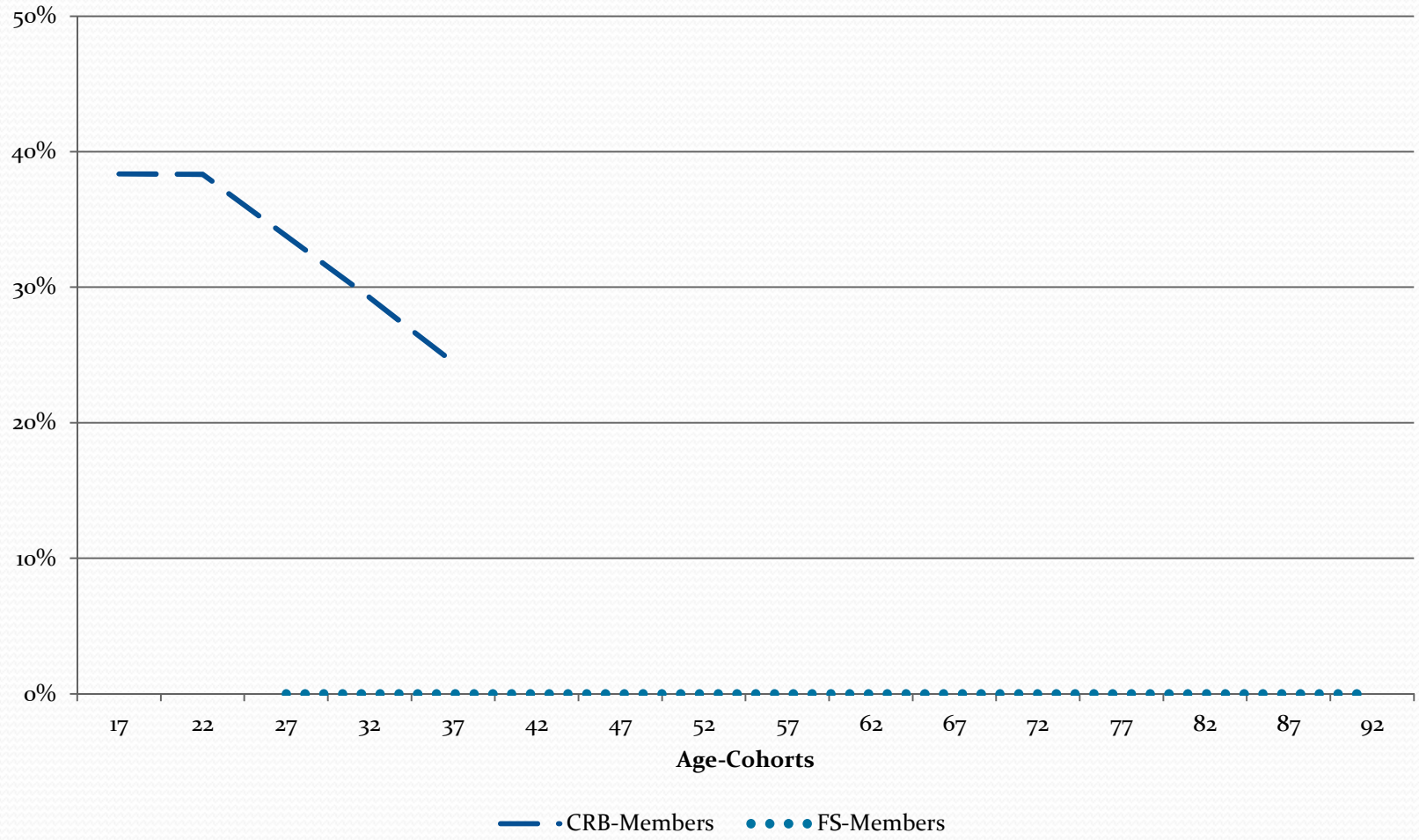

Fig. 10: Mean Percentage Drop per Head for Actives in Pension Received at Age 65.

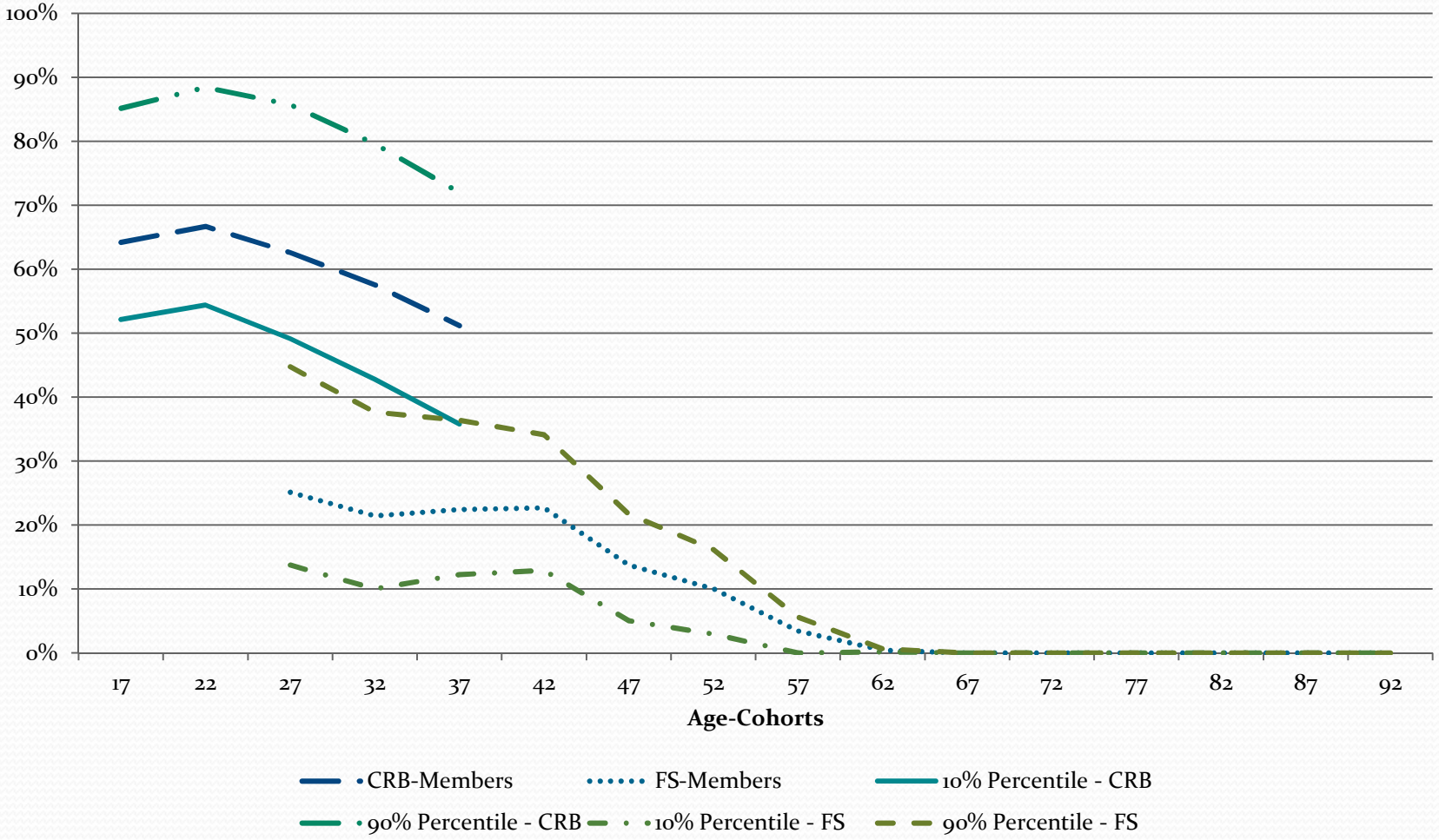

Fig. 11: Expected Percentage Drop in the NPV for Each Age Cohort Due to the Rule Change (**Riskless rate**)

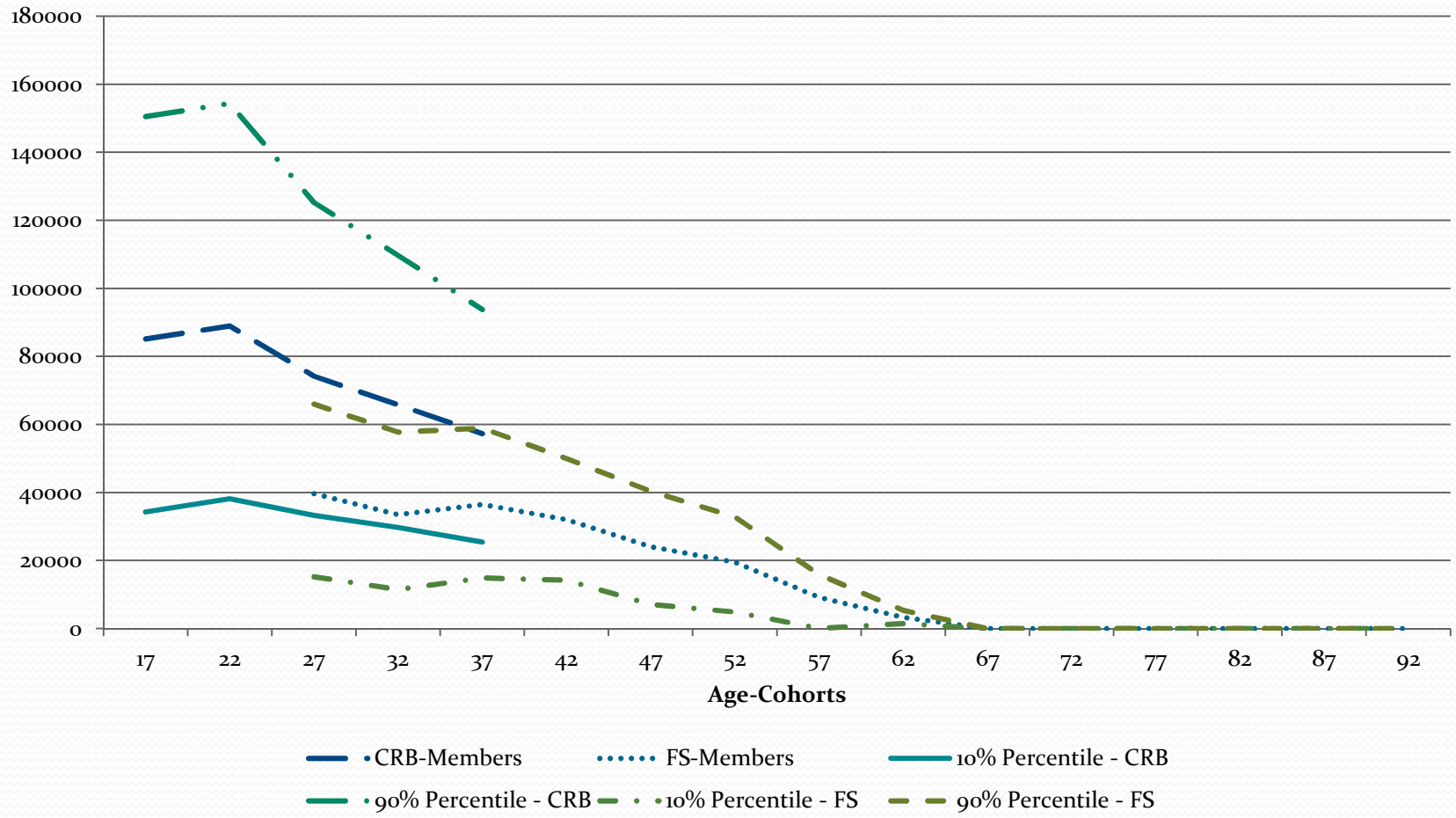

Fig. 12: Expected Percentage Expected Loss Per Head for Actives in Each Age Cohort (**Riskless rate**)

Conclusions

1. In the long run the pre-October 2011 scheme was not viable – CR 27% & FR 80%
2. The post-October 2011 scheme is viable in the long run – CR 23% (23.5% currently) & FR of over 110%; but it has medium term problems.
3. Risk shifting and fix-mix asset allocation are preferable to risk management.
4. Transfer of £32.5 billion from members to the sponsors (or £600 million p.a.)
5. The cost of this transfer is unevenly distributed across cohorts.
6. For future members the drop in wealth is about £100,000.
7. A. Riskless rates, and B. a 29% CR cap broadly confirm these results.