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Risk assessment of UK DB pension schemes

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University of Waterloo, June 2016

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Agenda

- 1 Introduction
- 2 Economic capital
- 3 Stochastic model
- 4 Model assumptions
- 5 Results
- 6 PPF
- 7 Conclusions

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Background

Regulatory developments

- Basel 2/3.
- Solvency 2.
- Pensions Regulations.

Pensions: Developments in the UK

- Pensions Act (2004): PPF and the Pensions Regulator.
- Private pension membership: 46% (1997) to 32% (2012).
- DB scheme membership: 34% (1997) to 8% (2012).

Questions:

- ① Impact of capital requirements on individual DB pension schemes.
- ② Role of the PPF for the risk management of the entire sector.

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Economic Capital Formulation

Economic capital is the excess of assets over liabilities in respect of accrued benefits required to ensure that assets exceed liabilities on all future valuation dates over a specified time horizon with a prescribed high probability.

Notations:

X_t : Net cash flow of the scheme;

L_t : Value of s179 liability of the scheme;

$I_{s,t}$: Accumulation factor;

$D_{s,t}$: Discount factor.

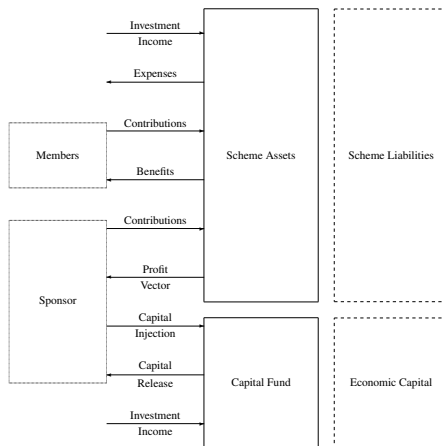
Building blocks

$P_t = L_{t-1}I_{(t-1,t)} - X_t - L_t$: Profit vector, with $P_0 = -X_0 - L_0$.

$R_t = \sum_{s=0}^t P_s I_{s,t}$: Accumulated retained profits until time t ,

$V_t = \sum_{s=t+1}^T P_s D_{t,s}$: Present value of future profits at time t .

Eligible Scheme Cashflow and Capital Requirement



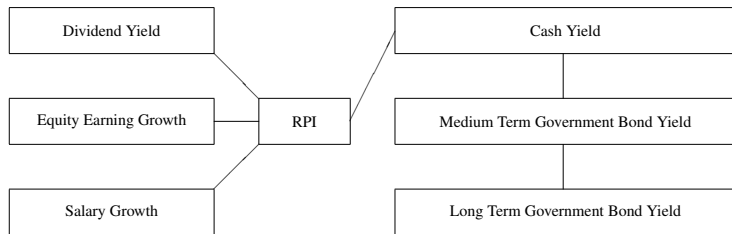
$$\text{Capital requirement: } C_t = \max \left[- \min_{s=t}^T V_s D_{t,s}, 0 \right].$$

$$\text{Economic capital requirement: } \rho(C_t) = \text{VaR}(C_t, p = 0.995).$$

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Stochastic model: Economic Variables



The individual economic random variables, Z_{it} s, are modelled as:

$$Z_{it} = \mu_i + Y_{it}, \text{ where } Y_{it} = \beta_i Y_{i(t-1)} + \varepsilon_{it} \text{ and } \varepsilon_{it} \sim N(0, \sigma_i^2).$$

The error terms

- are assumed to be independently distributed across time t ;
- which are directly connected to each other are dependent;
- which are indirectly connected are still dependent, but more weakly so.

Stochastic model: Longevity

The mortality model used is developed in three steps:

- Step 1:** Set S1PM and S1PF as the baseline mortality tables for males and females respectively.
- Step 2:** Project these base mortality tables from year 2006 to year 2012 using the mortality projection table published by the Institute and Faculty of Actuaries.
- Step 3:** Finally, model the future stochastic mortality improvements starting from 2012 by modelling stochastic uncertainty around the central mortality projection (Sweeting (2008)).

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Membership Profile

Table: Average membership profile of eligible schemes.

Membership group (Members)	Number of schemes	Average membership			
		Active	Deferred	Pensioner	Total
A: (5-99)	2,260	6 (13%)	23 (52%)	15 (35%)	44
B: (100-999)	2,828	56 (16%)	182 (52%)	113 (32%)	351
C: (1,000-4,999)	824	384 (17%)	1,103 (49%)	754 (34%)	2,241
D: (5,000-9,999)	192	1,231 (17%)	3,297 (46%)	2,601 (37%)	7,129
E: (Over 10,000)	212	6,651 (19%)	14,763 (42%)	13,608 (39%)	35,022

Model Points

Table: Eligible schemes model points.

Membership types	Age	Gender	Accrued service/benefit
Active	30	Male/Female	7 years past service
	40	Male/Female	16 years past service
	50	Male/Female	25 years past service
	60	Male/Female	34 years past service
Deferred	50	Male	Accrued pension of £3,000 per year
	50	Female	Accrued pension of £1,500 per year
Pensioner	70	Male	Pension of £6,000 per year
	70	Female	Pension of £3,000 per year

Assets, Liabilities and Investment Strategies

Table: Comparison of assets and liabilities.

	Estimated	Actual
Assets	£1,018b	£1,027b
Liabilities	£1,218b	£1,231b

Table: Distribution of eligible scheme by investment strategies.

Investment strategy	Asset allocation		Proportion of eligible schemes
	Equities	Bonds	
<i>L</i>	25%	75%	25%
<i>M</i>	50%	50%	60%
<i>H</i>	75%	25%	15%

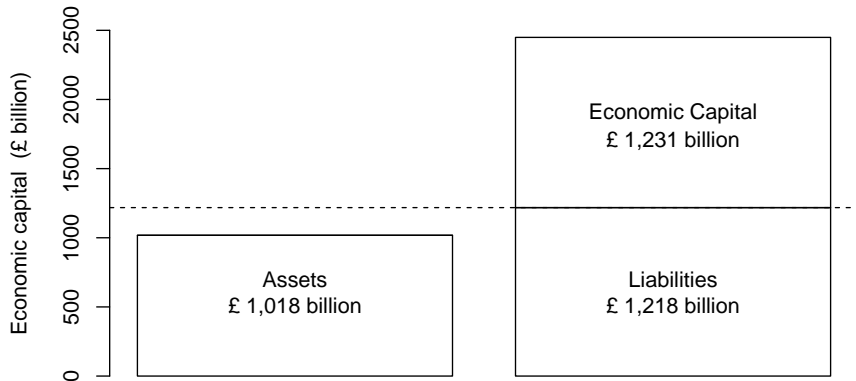
PPF broadly follows investment strategy *L*.

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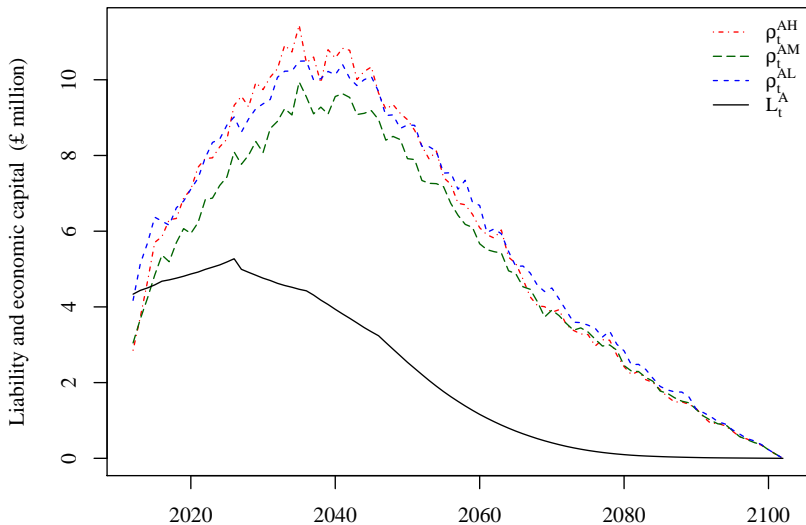
Aggregate Economic Capital for Eligible Schemes

As at 31 March 2012



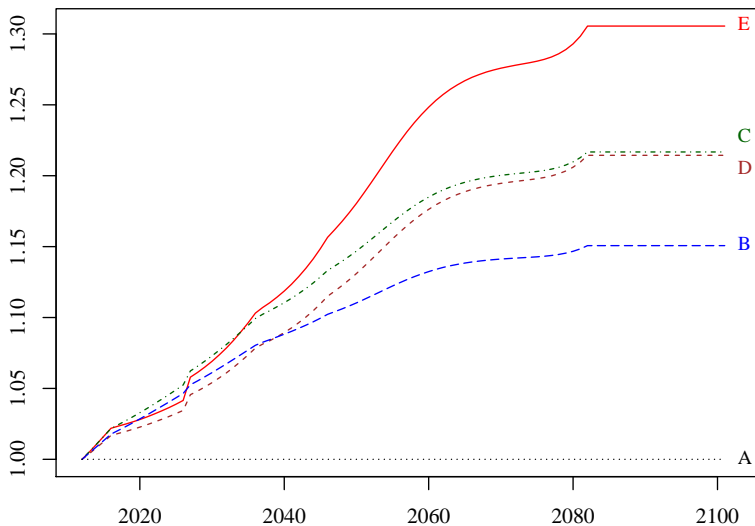
Economic Capital: Eligible Scheme in A

Membership group A



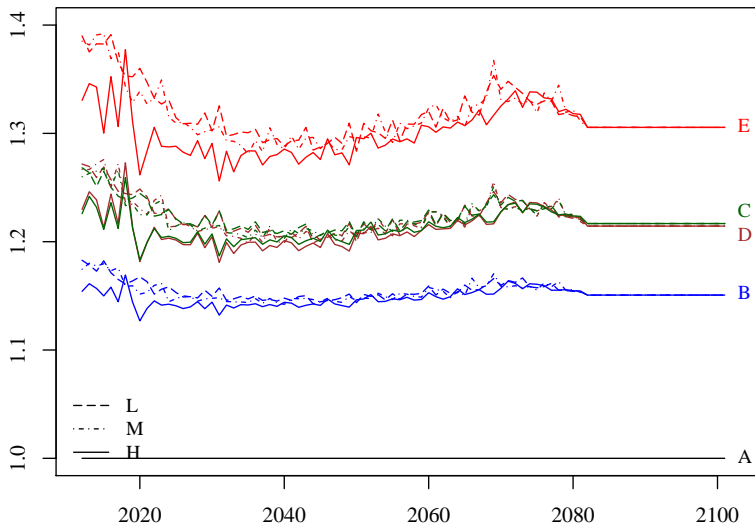
Eligible Schemes: Liability Comparison

L_t^X/L_0^X as multiples of L_t^A/L_0^A where $X=A,B,C,D,E$



Eligible Schemes: Economic Capital Comparison

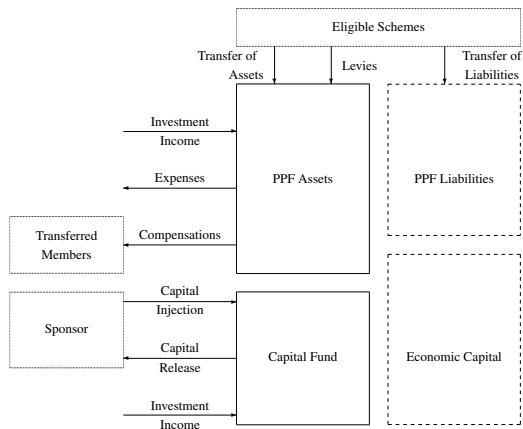
ρ_t^{XY}/L_0^X as multiples of ρ_t^{AY}/L_0^A where $X=A,B,C,D,E$ and $Y=L,M,H$



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PPF Cashflow and Capital Requirement



$$\text{Capital requirement: } C_t = \max \left[- \min_{s=t}^T R_s D_{t,s}, 0 \right].$$

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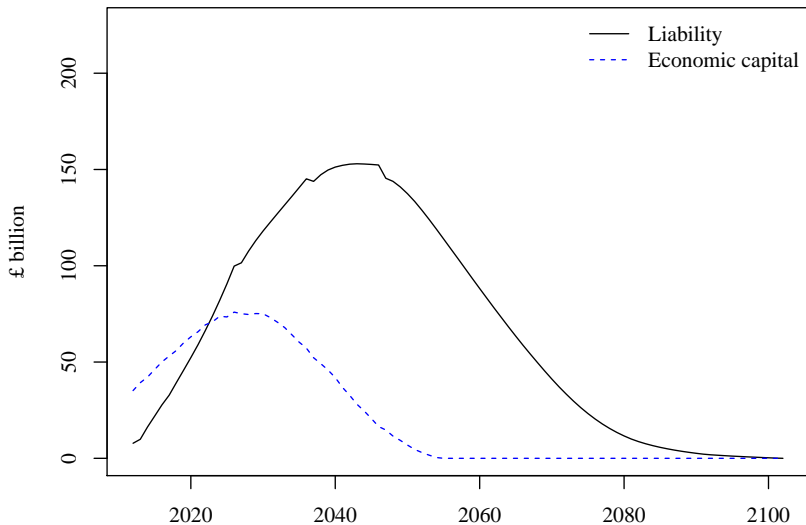
PPF: Some Additional Assumptions

- PPF levy: 0.072% of the total s179 liabilities.
- Amortisation period: 10 years.
- Funding cap: 120% of s179 liabilities.
- Insolvency rates:

Membership group	Annual insolvency rate
A	1.60%
B	0.95%
C	0.90%
D	0.53%
E	0.72%

PPF: Base Case Results

PPF schemes liability and economic capital : Base case



PPF: Sensitivity Results

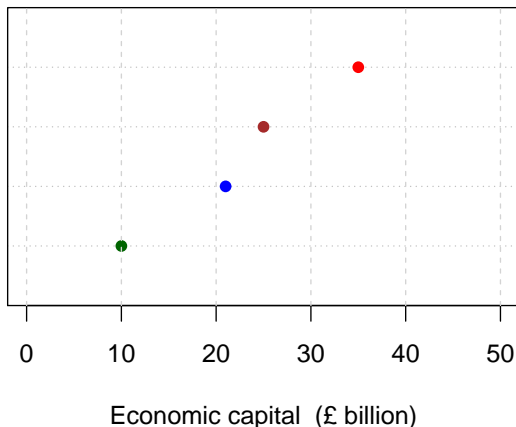
As at 31 March 2012

1: Base Case

2: 4-year Amortisation

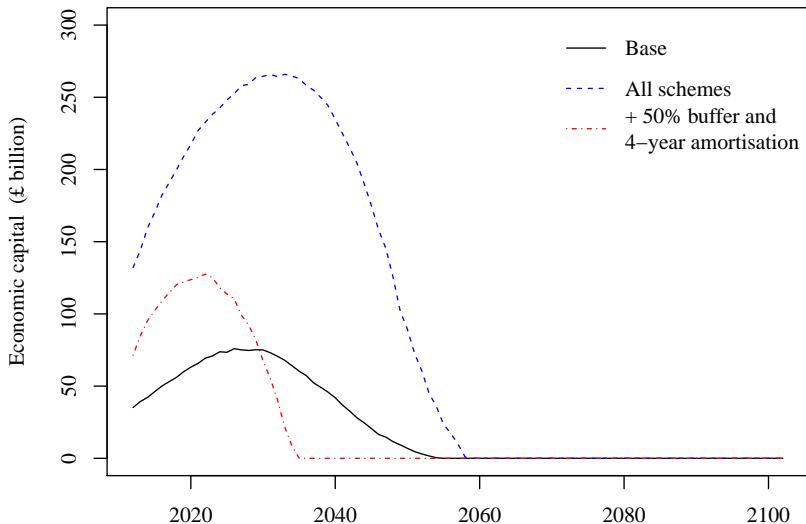
3: 50% Buffer

4: (2) + (3)



PPF Takes Over All Schemes With Insolvent Sponsors

PPF takes over all schemes with insolvent sponsors



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Conclusions

Summary

- Aggregate economic capital requirement:
 - ▶ On eligible scheme basis: **£1,200 billion**.
 - ▶ For PPF: **£35 billion**.
- **Reasonable capital buffer + shorter amortisation period** can bring down the economic capital requirement further.

Need a **holistic view**, taking PPF into account, while devising regulations for defined benefit pension sector.

References

YANG, W. & TAPADAR, P. (2015). Role of the Pension Protection Fund in Financial Risk Management of UK Defined Benefit Pension Sector: A Multi-period Economic Capital Study. *Annals of Actuarial Science*, **9**, 134–166.