Scenario Testing & Stochastic Analysis:

As discussed at the VMDF

28 August 2020

Introduction

- This document provides a summary of the scenario analysis and stochastic analysis based on the Scheme position at 31 March 2020 that was provided by the Trustee to the VMDF to facilitate discussions and understanding.
- Over the course of 11 meetings, the VMDF considered different aspects of valuation methodology, including: covenant, risk appetite, investment strategy, expected returns, discount rates and risk management. The modelling in this document is focused on
    i. The adequacy of a contribution rate of 26% of payroll, and
    ii. The effect of smoothing on the range of potential future contribution requirements.
- The presentations given to the VMDF by the Trustee were the subject of discussions in this forum that ran over a number of meetings, with detailed explanations and commentary provided orally:
    - So to make this document more readable without those oral explanations, we have added some additional explanatory commentary (which has necessitated restructuring some of the content). Otherwise the analysis presented in this document is in the same format and form as that provided to the VMDF.
- A number of concepts used in evaluating the outcome of the modelling were discussed in the "Methodology and risk appetite for the 2020 valuation" discussion document issued by the Trustee in March 2020 (the *"Discussion Document"*). This document is available on our website https://www.uss.co.uk/how-uss-is-run/2020-valuation. The key concepts are summarised on the next slide.
- This document is divided into two sections:
    - **Section 1: Scenario testing.** This involved analysis of a number of deterministic scenarios
        - Section 1 Annex: Modelling assumptions and output
    - **Section 2: Stochastic analysis.** This involved analysis of the distribution of future outcomes under different assumptions

Section 1: Scenario Testing

Deterministic scenarios projected over 20 years

- This section considers the financial development of the Scheme under a number of deterministic economic scenarios projected over 20 years from 31 March 2020. The scenarios have been provided by USSIM, the primary investment advisor to the Trustee.
  - This analysis builds on previous analysis as of 31 Dec 2019 which was discussed with the VMDF before these results were available
- The key issues which the scenario testing looked to address were:
  - The adequacy of a contribution rate of 26% of payroll; and
  - The effect of different investment strategies and, in particular, the impact of reducing the amount of growth assets.
- Six scenarios have been considered these are:
  1. **"With reversion":** This involves the Trustees "best estimate" for investment returns. These are based on USSIM's Fundamental Building Block (FBB) model at 31 March 2020, which assumes reversion of interest rates over a ten-year period
  2. **"No reversion":** This involves an alternative outcome for investment returns based on the FBB model at 31 March 2020, but without reversion, instead interest rates follow the current gilt forward curve
  3. **Redistribution:** Increased state involvement in economy, higher taxes and government spending, reducing inequality
  4. **Secular stagnation:** Weak recovery and permanent damage to economy from coronavirus
  5. **Financial repression:** Extreme version of Redistribution scenario, with forceful state involvement across the economy
  6. **40% growth asset fall:** Growth assets fall by 40%, with subsequent expected returns in line with the "with reversion" scenario. (This scenario is only evaluated in the Section 1 Annex in Tables 6 and 12.)
- A detailed description of the scenarios is provided in Section 1 Annex: Modelling assumptions and output.

- **Note:** The underlying data for the scenario testing is the Scheme membership data that has been used for the 2020 valuation. Within the projection it has been assumed that the Scheme membership experience is in line with the assumptions proposed for the 2020 valuation Technical Provisions, but with the active membership payroll growing each year by CPI+2% as the central assumption. Payroll growth of CPI+1% has also been considered as a sensitivity.

Two investment strategies were evaluated in the scenario projections

- Two investment strategies have been considered in this analysis, namely:
  - **"No derisking" strategy** based on the current portfolio; and
  - **Dual Discount Rate (DDR) strategy with 55% initial allocation to growth** assets as considered in the *Discussion Document.*
- Both strategies assume a strong covenant.
- The "No derisking" strategy assumes the current asset allocation (which is approximately 64% growth assets) is maintained for all time.
- The DDR 55% Growth assets strategy assumes:
  - A growth portfolio is held in respect of the liabilities of non-pensioners and a low risk portfolio is held in respect of the liabilities of pensioners
  - This results in approximately 55% growth assets being held initially
  - Over time as the portion of liabilities attributable to pensioners increases, there will be a proportionate reduction in the growth assets held. Under the assumptions that new entrants join the Scheme to replace current active members who leave or retire such that the total payroll grows by CPI+2% and the Trustee's expectations for investment returns and the reversion of real gilt yields, then the percentage of growth assets are expected to fall from 55% to approximately 50% over 20 years

Evaluating the level of risk in each scenario

- In considering the financial development of the Scheme we have examined its financial position in the short, medium and long term, specifically at 3,9 and 20 years from the valuation date. At each of these times the risk position was evaluated by considering three risk metrics: the Self-sufficiency (SS) deficit, 95% value-at-risk or VaR and the Covenant Support Requirement (CSR).
- **Risk metrics:**
- The **SS deficit** is the difference in the amount of assets required for a low risk investment portfolio that has a 95% probability of making all the payments for accrue benefits whilst maintaining a high funding level (SS liabilities) and the assets being held by the Scheme.
- **95% value-at-risk or VaR** a potential 1 in 20 downside outcome which the covenant might be required to support.
  The key risk metric used in this analysis is the Covenant Support Requirement (CSR). It is one measure (but not the only one) of the risk capacity which the employers' covenant needs to provide to support the level of risk taken in funding the Scheme.
- **CSR** is the sum of the self-sufficiency deficit and the 95% value-at-risk. This concept was discussed in the March *Discussion Document*.
- It would have been possible to use other measures (such as the sum of the Technical Provisions (TP) deficit and VaR), but these are more subjective to calculate and make the comparison across different scenarios more difficult.
- **Comparing with affordable risk capacity:**
  As discussed in the March *Discussion Document,* the amount of risk capacity available to cover the risk being taken in funding the Scheme could be assessed as:
  - The value of 10% of payroll over the period in which there is good visibility of the covenant (covenant horizon)
  - The covenant horizon is 30 years for a strong covenant and 20 years for a tending-to-strong covenant
  - The Trustee is of the view that there is a limit to the distance to self-sufficiency that can be supported by the employers.
- This is the metric that was used in this analysis to evaluate the acceptability of the financial position of the Scheme relative to CSR at each point of time.

The position at the valuation date, 31 March 2020

- The CSR at 31 March 2020 was higher than that at 31 December 2019 disclosed in the *Discussion Document* due to changes in interest rates and a fall in the market value of the Scheme's assets, in particular:
  - The self-sufficiency liability had increased from £97.7bn to £101.5bn
  - Assets had fallen by £6.4bn from £72.9bn to £66.5bn
  - The self-sufficiency deficit had increased from £24.8bn to £35bn
  - The CSR had increased from £43.8bn to £55.1bn.
- The self-sufficiency deficit at 31 March 2020 of £35bn, reflects:
  - An increase in the self-sufficiency discount rate to gilts+1% (from gilts+0.75%), justified by market conditions, in particular the increase in credit spreads since 31 December 2019; and
  - Changes to the mortality and some other demographic assumptions proposed for the 2020 valuation.
- The ability of employers to support risk as measured by the value of 10% of salary over the covenant horizon had increased, due to lower interest rates. Assuming payroll growth of CPI+2%:
  - For a strong covenant it had increased to £38bn; and
  - For a tending to strong covenant it had increased to £22bn.
- The *Discussion Document* also identified upper limit for the level of risk that could be supported by the sector:
  - For a strong covenant the figure was £65bn; and
  - For a tending to strong covenant the figure was £54bn.
- The Trustee's view is that the position at 31 March 2020 is at the upper end of an acceptable risk position. This is relevant when considering the outcome of the modelling.

Scenario Testing: Output results

For each of the economic scenarios we have:

- Shown the projected financial development of the Scheme with:
  - The two investment strategies already mentioned ("no derisking", and a DDR investment strategy with 55% growth assets initially as in the Discussion Document)
  - A fixed contribution rate of 26% of payroll as requested by the VMDF (with payroll assumed to grow at CPI+2%)
    Note: ***This is not an indication that the Trustee would be prepared to accept contributions of 26%.***
  - Projected investment returns equal to:
    - Best estimate returns for each scenario
    - 'Prudent' returns for each scenario, taken as the estimated 67% confidence level for each scenario, as provided by USSIM. Note that this does not necessarily correspond to a level of prudence that the Trustee would use for discount rates at 31 March 2020, but is intended to show the sensitivity of the outcome to different returns.
- The output results provided in Tables 1 to 12 on the following slides 20 to 25 in the Section 1 Annex include the following metrics:
  - **Asset level:** The expected assets of the Scheme allowing for contributions, benefit payments and asset returns.
  - **Real Internal Rate of Return (IRR) required**: The discount rate (investment return on assets held) required such that the value of future benefits accrued at that point is equal to the assets held
  - **SS deficit**: The self-sufficiency deficit being the difference between the self-sufficiency liabilities and the asset level
  - **95% VaR**: An estimate of the 1-in-20 worst case increase in self-sufficiency deficit over the next year
  - **Covenant Support Requirement**: The sum of the SS deficit and 95% VaR. The figures shown in brackets in this column of the tables is the CSR as a percentage of the value of 10% of payroll over the covenant horizon (30 years for a strong covenant)

Output results for short-term risk assessment

- **Tables 13 and 14 on slides 26 and 27** in the Section 1 Annex entitled "Short-term risk and scenario analysis data"
  - These tables provide an analysis of the short-term risk position at different times in the projection
  - The tables show the following metrics assuming payroll growth of CPI+1% and CPI+2% at 3 points of time (short term = 3 years, medium term = 9, long term = 20 years):
    - **SS deficit**: Self-sufficiency deficit
    - **10% of payroll**: the value of 10% of payroll over the covenant horizon (30 years for a strong covenant)
    - **SS deficit as a % of 10% of payroll**: SS deficit dividend by 10% of payroll over the covenant horizon expressed as a percentage
- **The adequacy of contributions of 26% of payroll (assuming a strong covenant)**
  - The implications of the results in Tables 13 and 14 for the adequacy of contributions of 26% of payroll are summarised in the following pages
  - In considering the adequacy of a contribution rate of 26% of payroll we have tested the self-sufficiency deficit against different perspectives on risk capacity of the covenant, specifically:
    - As an ***absolute*** amount of the SS deficit
    - As a ***ratio*** of the SS deficit to the value of 10% of payroll paid over 30 years

Note: All figures are in £bn and rounded to the nearest £0.1bn and are in real terms relative to CPI

Parameters used in short-term risk assessment

The following tables define the parameters used in the assessment of short-term risk at different times in the scenario projections

SS Deficit Test: Absolute measure	Self-sufficiency deficit		
	✓	×	?
Adequacy of 26% at year 20	Less than £24bn	More than £26bn	£25bn +/-£1bn
Medium-term robustness (9 years)	Less than £29bn	More than £31bn	£30bn +/-£1bn
Short-term robustness (3 years)	Less than £29bn	More than £31bn	£30bn +/-£1bn

A self-sufficiency deficit in real terms of the order of £25bn would provide a buffer to absorb whilst still remain within the value of 10% of payroll over 30 years. Using £30bn in year 3 and 9 is intended to demonstrate movement toward the long term target.

SS Deficit Test: Ratio	Self-sufficiency deficit as a percentage of the value of 10% of future payroll over 30 years		
	✓	×	?
Adequacy of 26% at year 20	Less than 77.5%	More than 82.5%	80% +/- 2.5%
Medium-term robustness (9 years)	Less than 82.5%	More than 87.5%	85% +/-2.5%
Short-term robustness (3 years)	Less than 82.5%	More than 87.5%	85% +/-2.5%

85% is the figure the Trustee uses in its Financial Management Plan in monitoring the Scheme, if the ratio is above 85% the Board reviews whether further action is required.

Summary results of the adequacy of 26% contributions

- This page provides a summary of the short-term risk adequacy results given in the Section 1 Annex
  - The adequacy of 26% contribution rate is assessed under different scenarios projected from 31 March 2020 against absolute measure detailed on the previous slide.
- A summary of results of the analysis of contribution adequacy is shown in the table below – assuming:
  - A "Strong" covenant
  - No derisking
  - Payroll growth of CPI+2%.
- BE = Best estimate returns
- The next slide provides more details on the assessment by including both the absolute and ratio metrics and lower payroll growth of CPI+1%. The picture shown is not materially different from that in the table below.

	With reversion		No reversion		Financial repression		Redistribution		Secular stagnation	
Return:	**BE**	Prudent	**BE**	Prudent	**BE**	Prudent	**BE**	Prudent	**BE**	Prudent
Adequacy of 26% at year 20	✓	✓	✓	✗	✗	✗	✓	✗	✓	✗
Medium-term robustness	✓	✓	✗	✗	✗	✗	?	✗	✓	✗
Short-term robustness	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗

26% contributions appear to be inadequate on the basis of scenario analysis

More detail on the adequacy of 26% contributions

More details on the assessment including both the absolute and ratio metrics and different payroll growth assumptions

CPI+2% Payroll Growth	Test	With Reversion		No reversion		Financial repression		Redistribution		Secular stagnation	
Return:		BE	Prudent	BE	Prudent	BE	Prudent	BE	Prudent	BE	Prudent
Adequacy at year 20	Absolute	✓	✓	✓	✗	✗	✗	✓	✗	✓	✗
	Ratio	✓	✓	✓	✗	✗	✗	✓	✗	✓	✓
Medium-Term robustness	Absolute	✓	✓	✗	✗	✗	✗	?	✗	✓	✗
	Ratio	✓	✓	✓	✗	✗	✗	✓	✗	✓	✓
Short-Term robustness	Absolute	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗
	Ratio	✓	✓	✗	✗	✗	✗	?	✗	✓	✗

CPI+1% Payroll Growth	Test	With Reversion		No reversion		Financial repression		Redistribution		Secular stagnation	
Return:		BE	Prudent	BE	Prudent	BE	Prudent	BE	Prudent	BE	Prudent
Adequacy at year 20	Absolute	✓	✓	✓	✗	✗	✗	✓	✗	✓	✗
	Ratio	✓	✓	✓	✗	✗	✗	✓	✗	✓	✓
Medium-Term robustness	Absolute	✓	✓	✗	✗	✗	✗	?	✗	✓	✗
	Ratio	✓	✓	✗	✗	✗	✗	✗	✗	✓	✗
Short-Term robustness	Absolute	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗
	Ratio	?	✗	✗	✗	✗	✗	✗	✗	✗	✗

The results are not materially different from the previous slide

Observations from the analysis for a strong covenant

- On the face of it, a contribution rate of 26% does not appear sufficient when considered against the range of scenarios, even if we continue to assume growth in the salary roll of CPI + 2% pa. An assumption for salary roll growth of CPI + 1% pa shows greater pressure on the short-term risk position.
  - The Trustee is seeking views on the assumption for payroll growth in the consultation on Technical Provisions
- **It is important that our funding plans are robust to a range of scenarios**
  - If investment returns were delivered in line with the best estimate given by the Fundamental Building Block methodology (the "with reversion" scenario), then based on these tests 26% would appear to be an adequate long term contribution rate for a strong covenant.

  However:
  - There are a number of scenarios where there is inadequate improvement in the short-to-medium term that would lead the Scheme to be exposed to further downside risk that would be difficult to deal with; and
  - There are some scenarios including "no reversion", in which, if only prudent returns are achieved, then 26% is inadequate in the long term.
- **For a Tending-to-Strong covenant** the analysis would be expected to show a more negative assessment.
- **In the long term: T**he "no derisking" investment strategy generally results in higher expected asset levels and higher VaR than the DDR 55% Growth strategy
  - The incremental level of assets in the "no derisking" case is greater than the difference in VaR in the long term
  - This results in a lower CSR than for the DDR 55% growth strategy.
- **In the short term:** The "no derisking" strategy has a higher CSR.

Section 1 Annex: Modelling assumptions and output

Scenario descriptions provided by USSIM

Scenario	Description
"With reversion" Tables 1 and 7	• Consensus growth forecasts see a large recession but a robust recovery and a small permanent hit to GDP • Long-term inflation remains close to independent central bank targets • Interest rates remain low but eventually rise to equilibrium levels a little above inflation • Economy is not persistently "riskier" after the coronavirus crisis so risk assets largely recover
	Key Differences from "with reversion"
No reversion Tables 2 and 8	• Future government bond yields are consistent with current market pricing, around 100bps below Baseline • All other variables set to be consistent with this outcome, including lower GDP growth (50bps)
Redistribution Tables 3 and 9	• Increased state involvement in economy, favouring domestic industry and coercing companies to support workers • More redistributive fiscal policy – higher taxes and government spending, reducing inequality • Growth effect small – higher government vs lower private investment, higher wages but weaker global trade • Central banks more tolerant of inflation (higher by 50-100bps over next 10 years) • Short-term rates unchanged but steeper yield curve (higher inflation risk premium) • Lower corporate profits and pay-outs to shareholders, and investors demand higher equity risk premia
Secular Stagnation Tables 4 and 10	• Weaker recovery and permanent damage to economy from coronavirus crisis (lower GDP growth 50-100bps) • Central banks keep policy looser for longer as fiscal policy turns restrictive, but can't prevent lower inflation (100bps) • Interest rates pegged around zero for decades but not taken deeply negative by central banks • Equity risk premia little changed (weaker economy but "Fed put" in operation) • Persistently high profit margins as companies can borrow cheaply
Financial Repression Tables 5 and 11	• Extreme version of Redistribution scenario, with forceful state involvement in broad areas of the economy • Challenges in financing high government spending lead to "fiscal dominance", which sees central banks compelled to maintain low nominal interest rates (100bps lower) and bond yields in spite of inflation rising (to around 5%) • Aggressive policy changes see weak productivity growth in the long term (GDP growth around 50bps lower), and sharply lower corporate profits • Equities pay lower dividends and credit assets see higher default losses, while investors require higher equity risk premia
Initial 40% growth asset fall Tables 6 and 12	• An immediate fall in growth asset values of 40% is assumed, with subsequent expected returns in line with the "with reversion" scenario

Underlying assumptions for scenario testing

	31 March 2020
Assets	£66.5bn
Self-sufficiency liabilities	£101.5bn
Trustee's best estimate liabilities (DDR, strong covenant, 55% growth initial portfolio, based on FBB assumptions)	c. £60bn

Important notes

- Payroll has been assumed to grow at CPI+2% with the current benefit structure maintained. Note that this would not correspond to expected GDP growth in the scenarios and might not be fully compatible with the scenario. We also show results for CPI+1% payroll growth.
- The total contribution rate has been taken to be 26% as requested. **This is not an indication that the trustee would be prepared to accept contributions of 26%.**
- All scenario figures in the tables are in real terms (relative to CPI) and £bn – except where specified otherwise.

Scenario FBB Investment Returns provided by USSIM (Investment strategy is "no derisking")

		With Reversion		No Reversion		Financial Repression		Redistribution		Secular Stagnation	
Reference Portfolio (RP) Assets		**Years 1-10**	**Years 11-20**	**Years 1-10**	**Years 11-20**	**Years 1-10**	**Years 11-20**	**Years 1-10**	**Years 11-20**	**Years 1-10**	**Years 11-20**
Equities	Real Returns	4.52%	4.33%	4.15%	3.95%	-1.68%	4.23%	-1.17%	4.35%	3.03%	4.20%
Property		0.79%	2.30%	2.38%	2.29%	-3.19%	2.30%	-1.68%	2.49%	3.28%	2.28%
Other Fixed Income		0.49%	1.83%	0.84%	1.26%	-1.44%	-2.38%	-1.04%	2.09%	1.49%	0.59%
UK Index Linked Gilts		-4.30%	-0.15%	-1.37%	-0.70%	2.22%	-3.57%	-4.34%	-0.16%	-1.88%	-0.35%
Cash		-0.61%	0.25%	-0.93%	-0.59%	-4.18%	-3.90%	-1.35%	0.27%	-0.93%	-1.40%
Rebalancing effect		0.87%	0.49%	0.63%	0.66%	0.87%	0.49%	0.87%	0.49%	0.87%	0.49%
Total RP **Best Estimate Return** (Real)		2.32%	3.36%	2.99%	3.15%	0.66%	2.00%	-1.27%	3.43%	2.62%	3.21%
Total RP **Prudent Return** (67% confidence level, Real)		0.89%	2.29%	1.56%	2.06%	-0.80%	0.97%	-2.73%	2.39%	1.16%	2.17%

Note that RP returns correspond to the expected returns on the Reference Portfolio at valuation date

Underlying assumptions for scenario testing: investment returns and contributions

Investment returns for the Indicative DDR case

- The investment returns for the "no derisking" case are shown on the previous slide. The table below contains the investment returns used in the "indicative DDR" case. The allocation between the pre and post retirement sub-portfolios is assumed to move from 55%/45% to 50%/50% uniformly over 20 years in all cases. This is a simplification relative to the theoretical asset allocation, which would be slightly different from this because the proportions of non-pensioner and pensioner liability varies by market conditions and discount rate.
- The returns below, provided by USSIM, are total real returns (CPI+) per annum. The CPI assumption is in line with that proposed for use in the valuation in all scenarios.

		With Reversion		No reversion		Redistribution		Secular Stagnation		Financial Repression	
Investment strategy		**Years 1-10**	**Years 11-20**	**Years 1-10**	**Years 11-20**	**Years 1-10**	**Years 11-20**	**Years 1-10**	**Years 11-20**	**Years 1-10**	**Years 11-20**
55% growth	**Best Estimate**	1.97%	3.16%	2.72%	2.87%	-1.30%	3.24%	2.41%	2.92%	0.74%	1.45%
50% growth	**Best Estimate**	1.77%	3.02%	2.53%	2.74%	-1.32%	3.10%	2.31%	2.74%	0.76%	1.15%
55% growth	**Prudent**	0.72%	2.20%	1.38%	1.94%	-2.59%	2.31%	1.12%	1.99%	-0.55%	0.53%
50% growth	**Prudent**	0.61%	2.16%	1.31%	1.86%	-2.52%	2.23%	1.10%	1.86%	-0.45%	0.28%

Contribution rates

- Contribution rates are assumed to be fixed at 26% p.a. This is taken as a total contribution rate, from which an allowance for DC benefits and expenses is deducted to give a DB contribution. The DC element increases over time as a higher proportion of salary is expected to cross the salary threshold.
- No additional deficit recovery contributions are assumed.

Underlying assumptions for scenario testing: other assumptions

Gilt yields

- In the no reversion ("Yields Follow Forwards") scenario, gilts do not revert and the 31 March 2020 yield curve applies throughout, with valuations following this curve.
- In all other scenarios, the gilt yield curve is assumed to shift uniformly from the 31 March 2020 yield curve for projections at future times to a different terminal curve at time 10 onwards. The terminal curves have been based on information provided by USSIM, adjusted approximately such that they are consistent with the inflation assumption.
- In each scenario, the terminal curve differs. The baseline and Redistribution both revert to a similar level at longer durations (around 1.2% above the 31 March 2020 market curve) but Redistribution lags at shorter durations. In secular stagnation, the reversion is more limited (around 0.3% above the 31 March 2020 curve). In the Repression scenario, yields decline by around 2.2% from their 31 March 2020 levels and are negative at all durations by year 10.

Discount rates

- The discount rate for valuing self-sufficiency liabilities is Gilts+1% at year 0, this being Gilts + 0.75% plus a 0.25% adjustment to reflect credit spreads. The margin over gilts used at future projections is reduced over the first 10 years to allow for the unusually high credit spread at 31 March 2020 to be reduced. These are shown in the table below.

Scenario	Discount rate
All scenarios except redistribution:	Time 0-9: Gilts+1% reducing linearly to Gilts+0.75% Time 10+: Gilts+0.75%
Redistribution:	Time 0-9: Gilts+1% reducing linearly to Gilts+0.95% Time 10+: Gilts+0.95%

Other assumptions

- Other data and assumptions are in line with those proposed for the 2020 valuation.
- The self-sufficiency liabilities allow for future CPI to be an additional 50bps higher than the CPI inflation assumption proposed for the valuation, in line with the Trustee's basis for self-sufficiency.

Metrics shown in tables

Table heading	Description
Assets	A projected value of the Scheme's assets at the time stated under the given scenario & expected return assumptions
Real IRR required	The investment return ('internal rate of return') required, in real (relative to CPI) terms, in order for the projected assets held to meet the projected liabilities, from that point forward. Note that the scenarios have different prevailing market conditions, so the likelihood of achieving the return varies by scenario.
SS deficit	Self-sufficiency deficit: the shortfall between the projected assets and the projected self-sufficiency liabilities.
95% VaR	An estimate of the 1-in-20 worst case increase in self-sufficiency deficit over the next year
Covenant Support Requirement "CSR"	The sum of the self-sufficiency deficit and the 95% VaR: a potential downside outcome which the covenant might be required to support. Where additional percentages in parentheses are included, these are the ratio of this value to the expected value of additional contributions of 10% of pay over the covenant horizon: 30 years for a strong covenant.

All figures are in real terms relative to CPI

Investment strategy: “no derisking” (1)

Scenarios: FBB returns with and without gilt-yield reversion (£bn, real terms)

Fixed contributions of 26% of payroll

Table 1	Best Estimate returns					Prudent returns				
With reversion	Assets	Real IRR required	SS deficit	95% VaR	CSR*	Assets	Real IRR required	SS deficit	95% VaR	CSR*
0	66.5	1.2%	35.0	20.1	55.1 (146%)	66.5	1.2%	35.0	20.1	55.1 (146%)
3	71.1	1.1%	26.0	18.9	44.9	68.2	1.3%	28.9	18.8	47.7
6	76.0	1.0%	17.7	18.0	35.7	70.0	1.5%	23.7	17.7	41.4
9	81.2	0.9%	11.0	17.7	28.7	71.6	1.6%	20.5	17.1	37.6
20	112.6	-0.1%	-7.8	22.0	14.2 (30%)	88.3	1.1%	16.5	19.9	36.4 (77%)

Table 2	Best Estimate returns					Prudent returns				
No reversion	Assets	Real IRR required	SS deficit	95% VaR	CSR*	Assets	Real IRR required	SS deficit	95% VaR	CSR*
0	66.5	1.2%	35.0	20.1	55.1 (146%)	66.5	1.2%	35.0	20.1	55.1 (146%)
3	72.4	1.0%	35.8	21.5	57.3	69.5	1.2%	38.8	21.5	60.3
6	79.0	0.8%	35.0	22.7	57.7	72.7	1.2%	41.3	22.6	63.9
9	86.0	0.6%	33.7	23.9	57.6	75.9	1.2%	43.8	23.7	67.5
20	117.9	-0.3%	23.8	28.9	52.7 (91%)	92.2	0.9%	49.5	28.1	77.6 (134%)

* Percentages refer to proportion of expected value of contributions of 10% of pay for 30 years (assuming continual pay growth at CPI+2%)

Investment strategy: “no derisking” (2)

Scenarios: Redistribution and Secular stagnation (£bn, real terms)

Fixed contributions of 26% of payroll

Table 3	Best Estimate returns					Prudent returns				
Redistribution	Assets	Real IRR required	SS deficit	95% VaR	CSR*	Assets	Real IRR required	SS deficit	95% VaR	CSR*
0	66.5	1.2%	35.0	20.1	55.1 (146%)	66.5	1.2%	35.0	20.1	55.1 (146%)
3	63.9	1.7%	32.1	18.5	50.6	61.2	2.0%	34.9	18.4	53.3
6	61.6	2.2%	30.0	17.1	47.1	56.4	2.7%	35.2	16.9	52.1
9	59.1	2.7%	29.8	16.0	45.8	51.8	3.6%	37.1	15.8	52.9
20	79.1	1.7%	21.6	18.7	40.3 (88%)	61.7	3.3%	39.0	17.9	56.9 (125%)

Table 4	Best Estimate returns					Prudent returns				
Secular stagnation	Assets	Real IRR required	SS deficit	95% VaR	CSR*	Assets	Real IRR required	SS deficit	95% VaR	CSR*
0	66.5	1.2%	35.0	20.1	55.1 (146%)	66.5	1.2%	35.0	20.1	55.1 (146%)
3	71.7	1.1%	32.5	20.1	52.6	68.7	1.3%	35.4	20.0	55.4
6	77.3	0.9%	28.9	20.0	48.9	71.1	1.4%	35.1	19.8	54.9
9	83.3	0.8%	25.4	20.1	45.5	73.4	1.4%	35.3	19.6	54.9
20	114.2	-0.2%	4.3	23.6	27.9 (54%)	89.6	1.1%	28.9	21.8	50.7 (99%)

* Percentages refer to proportion of expected value of contributions of 10% of pay for 30 years (assuming continual pay growth at CPI+2%)

Investment strategy: “no derisking” (3)

Scenarios: Financial repression and Initial 40% fall in growth assets (£bn, real terms)

Fixed contributions of 26% of payroll

Table 5	Best Estimate returns					Prudent returns				
Financial repression	Assets	Real IRR required	SS deficit	95% VaR	CSR*	Assets	Real IRR required	SS deficit	95% VaR	CSR*
0	66.5	1.2%	35.0	20.1	55.1 (146%)	66.5	1.2%	35.0	20.1	55.1 (146%)
3	67.7	1.4%	55.7	23.5	79.2	64.8	1.6%	58.5	23.5	82.0
6	69.0	1.5%	83.6	28.1	111.7	63.3	2.0%	89.2	28.2	117.4
9	70.2	1.7%	124.1	34.5	158.6	61.7	2.4%	132.5	34.7	167.2
20	83.9	1.4%	156.7	42.8	199.5 (235%)	65.5	2.9%	175.1	43.4	218.5 (258%)

Table 6	Best Estimate returns**				
Initial 40% growth asset fall	Assets	Real IRR required	SS deficit	95% VaR	CSR*
0	49.6	3.0%	51.9	20.2	72.1 (191%)
3	53.0	2.8%	44.1	18.5	62.6
6	56.7	2.7%	37.0	17.3	54.3
9	60.5	2.6%	31.7	16.5	48.2
20	83.4	1.4%	21.4	19.5	40.9 (87%)

** Assume best estimate returns in line with “with reversion” after the 40% fall in growth assets

* Percentages refer to proportion of expected value of contributions of 10% of pay for 30 years (assuming continual pay growth at CPI+2%)

Investment strategy: Indicative DDR (55% growth) (1)

Scenarios: FBB returns with and without gilt-yield reversion (£bn, real terms)

Fixed contributions of 26% of payroll

Table 7	Best Estimate returns				Prudent returns			
With reversion	Assets	SS deficit	95% VaR	CSR	Assets	SS deficit	95% VaR	CSR
0	66.5	35.0	19.1	54.1	66.5	35.0	19.1	54.1
3	70.3	26.8	17.6	44.4	67.8	29.3	17.6	46.9
6	74.4	19.3	16.5	35.8	69.2	24.5	16.4	40.9
9	78.5	13.7	15.9	29.6	70.4	21.7	15.6	37.3
20	105.2	-0.4	18.4	18.0	85.6	19.3	17.5	36.8

Table 8	Best Estimate returns				Prudent returns			
No reversion	Assets	SS deficit	95% VaR	CSR	Assets	SS deficit	95% VaR	CSR
0	66.5	35.0	19.1	54.1	66.5	35.0	19.1	54.1
3	71.9	36.4	20.3	56.7	69.1	39.1	20.3	59.4
6	77.7	36.3	21.3	57.6	71.9	42.0	21.4	63.4
9	83.7	36.0	22.3	58.3	74.7	45.1	22.4	67.5
20	110.2	31.5	25.9	57.4	88.9	52.9	26.1	79.0

Investment strategy: Indicative DDR (55% growth) (2)

Scenarios: Redistribution and Secular stagnation (£bn, real terms)

Fixed contributions of 26% of payroll

Table 9	Best Estimate returns				Prudent returns			
Redistribution	Assets	SS deficit	95% VaR	CSR	Assets	SS deficit	95% VaR	CSR
0	66.5	35.0	19.1	54.1	66.5	35.0	19.1	54.1
3	63.9	32.2	17.4	49.6	61.4	34.6	17.4	52.0
6	61.5	30.1	16.0	46.1	56.9	34.7	15.9	50.6
9	59.0	30.0	14.9	44.9	52.6	36.4	14.8	51.2
20	76.7	24.0	16.7	40.7	61.8	38.9	16.6	55.5

Table 10	Best Estimate returns				Prudent returns			
Secular stagnation	Assets	SS deficit	95% VaR	CSR	Assets	SS deficit	95% VaR	CSR
0	66.5	35.0	19.1	54.1	66.5	35.0	19.1	54.1
3	71.2	32.9	18.9	51.8	68.6	35.5	18.9	54.4
6	76.4	29.8	18.5	48.3	70.9	35.3	18.5	53.8
9	81.7	27.0	18.3	45.3	73.1	35.6	18.2	53.8
20	107.3	11.2	20.2	31.4	86.9	31.6	19.6	51.2

Investment strategy: Indicative DDR (55% growth) (3)

Scenarios: Financial repression and Initial 40% fall in growth assets (£bn, real terms)

Fixed contributions of 26% of payroll

Table 11	Best Estimate returns				Prudent returns			
Financial repression	Assets	SS deficit	95% VaR	CSR	Assets	SS deficit	95% VaR	CSR
0	66.5	35.0	19.1	54.1	66.5	35.0	19.1	54.1
3	67.8	55.5	22.5	78.0	65.3	58.1	22.6	80.7
6	69.3	83.2	27.0	110.2	64.3	88.3	27.2	115.5
9	70.7	123.5	33.5	157.0	63.2	131.1	33.8	164.9
20	78.5	162.1	41.7	203.8	63.3	177.3	42.6	219.9

Table 12	Best Estimate returns*			
Initial 40% growth asset fall	Assets	SS deficit	95% VaR	CSR
0	51.9	49.6	19.4	69.0
3	54.8	42.3	17.7	60.0
6	58.0	35.7	16.3	52.0
9	61.1	31.0	15.4	46.4
20	81.6	23.3	17.4	40.7

* Assume BE returns in line with "with reversion" after the 40% fall in growth assets

Short-term risk and scenario analysis data – CPI+2%

Summary of scenario analysis underlying the adequacy tests – assuming (i) a Strong covenant and (ii) no derisking. All figures £bns, in real terms.

Table 13

CPI+2% Salary Growth	Metric	With Reversion		No reversion		Financial repression		Redistribution		Secular stagnation	
Return:		BE	Prudent	BE	Prudent	BE	Prudent	BE	Prudent	BE	Prudent
Year 20	SS deficit	-7.8	16.5	23.8	49.5	156.7	175.1	21.6	39.0	4.3	28.9
	10% of payroll	47.1	47.1	57.9	57.9	84.7	84.7	45.6	45.6	51.3	51.3
	Ratio	-17%	35%	41%	86%	185%	207%	47%	86%	8%	56%
Medium-term (Year 9)	SS deficit	11.0	20.5	33.7	43.8	124.1	132.5	29.8	37.1	25.4	35.3
	10% of payroll	37.7	37.7	45.4	45.4	63.7	63.7	36.7	36.7	43.1	43.1
	Ratio	29%	54%	74%	97%	195%	208%	81%	101%	59%	82%
Short-term (Year 3)	SS deficit	26.0	28.9	35.8	38.8	55.7	58.5	32.1	34.9	32.5	35.4
	10% of payroll	37.2	37.2	40.4	40.4	44.1	44.1	36.9	36.9	39.4	39.4
	Ratio	70%	78%	89%	96%	126%	133%	87%	94%	82%	90%

Notes

Assumes continual payroll growth at CPI+2%.

10% of payroll: Expected value of contributions of 10% of payroll for 30 years. Ratio is SS deficit/10% of payroll

Short-term risk and scenario analysis data– CPI+1%

Summary of scenario analysis underlying the adequacy tests – assuming (i) a Strong covenant and (ii) no derisking. All figures £bns, in real terms.

Table 14

CPI+1% Salary Growth	Metric	With Reversion		No reversion		Financial repression		Redistribution		Secular stagnation	
Return:		BE	Prudent	BE	Prudent	BE	Prudent	BE	Prudent	BE	Prudent
Year 20	SS deficit	-7.8	16.2	22.0	47.4	149.8	168.0	21.6	38.8	3.6	27.9
	10% of payroll	33.5	33.5	40.9	40.9	59.0	59.0	32.6	32.6	36.4	36.4
	Ratio	-23%	48%	54%	116%	254%	285%	66%	119%	10%	77%
Medium-term (Year 9)	SS deficit	10.8	20.3	33.2	43.3	122.5	130.9	29.6	36.9	25.1	34.9
	10% of payroll	29.9	29.9	35.7	35.7	49.4	49.4	29.1	29.1	34.0	34.0
	Ratio	36%	68%	93%	121%	248%	265%	102%	127%	74%	103%
Short-term (Year 3)	SS deficit	26.0	28.9	35.8	38.7	55.6	58.5	32.1	34.8	32.4	35.4
	10% of payroll	31.1	31.1	33.7	33.7	36.6	36.6	30.9	30.9	32.9	32.9
	Ratio	84%	93%	106%	115%	152%	160%	104%	113%	98%	107%

Notes

Assumes continual payroll growth at CPI+1%.

10% of payroll: Expected value of contributions of 10% of payroll for 30 years. Ratio is SS deficit/10% of payroll

Section 2
Stochastic Analysis

Stochastic analysis was prepared in response to a VMDF request

- This section contains the stochastic analysis that was discussed with the VMDF as a result of a request from UUK's actuarial advisor, Aon.
- In particular, it considers potential **contribution requirements** and **self-sufficiency deficit outcomes** at future valuations.
- The analysis is:
  - Based on the parameters (including discount rates) requested by Aon (the actuarial adviser to Universities UK)
  - With and without a "smoothing" mechanism intended to dampen the impact of market conditions at a particular valuation date and allow for these to emerge more gradually over time.
- The impact that different investment strategies could have is also discussed.
  - We have considered the same two investment strategies as for the scenario modelling:
    - No-derisking, and
    - DDR approach with an initial 55% growth asset allocation.
- The modelling in this section has been undertaken by USSIM, the primary investment advisor to the Trustee.

Stochastic Analysis: Summary of work undertaken

- The analysis set out in this section has been prepared based on the principles set out in the document submitted by Aon to the VMDF on 7th April 2020 entitled: *"Thoughts for Developing a Risk Framework"*
- This analysis has been prepared to **illustrate the impact of applying a smoothing mechanism to contribution rates over multiple valuation cycles**.
  - Broadly speaking smoothing is achieved by only amending the future service contribution rate for changes outside a 10% multiplicative corridor, and increased flexibility in the deficit recovery plan to maintain a 2% deficit recovery contribution, if possible.
- In the following slides we cover:
  - Our Modelling Parameters and Key Assumptions
  - Example of the Mechanism
  - Modelling Results:
    1. **Impact of the Investment Strategy** on Contribution Rates and the Self Sufficiency Funding Level for Smoothed/Un-Smoothed Rates
    2. **Impact of the Economic Environment** on Contribution Rates and the Self Sufficiency Funding Level for Smoothed/Un-Smoothed Rates
    3. **Probability of the Self-sufficiency deficit** being greater than £35bn real (Appendix)

Stochastic Analysis: Notes on modelling

- The numeric outcomes based on the stochastic modelling in this section differ slightly from those using deterministic projections under a different model. That notwithstanding, this does not change the observations drawn from this modelling.
- We assume the contributions change immediately at each valuation rather than some time later which they do in practise.
- The corridor, within which there is no change in the future service contribution rate, is applied to the DB future service rate only, with the DC contributions and expenses being added separately.
- The current benefit structure is assumed to apply throughout, including allowance for the future anticipated changes to Normal Pension Age, which is linked to changes in State Pension Age.
- This analysis is based on proposed 2020 valuation Technical Provisions demographic assumptions.
- The modelling parameters are detailed on the next slide.
- The parameters used in this modelling are based on those requested by Aon in the VMDF and their illustration in this document does not imply acceptance by the Trustee.

Stochastic Analysis: Modelling Parameters

- The following table outlines the parameters used to define the contribution rate at each valuation point of the stochastic projection for the Smoothed and Un-Smoothed Cases:

Contribution Policy	Future Service Contribution Rate	Deficit Recovery Contribution (DRC)	
		In Surplus @ Valuation Date	In Deficit @ Valuation Date
Un-Smoothed	Outright Future Service Cost	0% (No Surplus Recovery)	DRC based on: Recovery Period: 10 Years Outperformance: None
Smoothed	+/- 10% Corridor vs rate paid @ previous valuation (described further in example overleaf)	0% (No Surplus Recovery)	Max (2%, DRC based on: Recovery Period: 20 Years Outperformance: 50bps over discount rates)*

- The following tables outline the variations over which we have tested the smoothing rules, and the parameters applied to all cases.

Modelling Variations	
Asset Strategies:	No DeRisking (March 2020 Reference Portfolio)
	DDR DeRisking, "Strong Case" (55% trending to 50% Growth Assets)
Economies:	Standard FBB ("with reversion")
	"Yields Follow the Forwards" ("no reversion")

Global Parameters for contributions	
Discount Rates:	Pre Retirement : CPI + 2.00%
	Post Retirement : Gilts + 0.75%
Payroll:	Indexed by CPI + 2.00%
Expected CPI:	2.1%

* Note that in feedback to the VMDF, Aon commented that they had envisaged the deficit recovery mechanism operating slightly differently, with parameters being flexed within a range in order to maintain the same DRC. We would not expect this to materially change the conclusions however.

Stochastic Analysis: Smoothing contributions rates

The rules used within the modelling for smoothing the contribution rates at successive valuations are as follows:

- Increases or decreases in the future service contribution rate within 10% of the current future service contribution rate being paid, do not change the future service contribution. Moreover, the shortfall/additional funds arising from this approach is added/subtracted from the deficit and dealt with in the recovery plan
- Increases or decreases in the future service contribution rate of more than 10% of the current future service contribution rate are immediately reflected in the contribution rate (only the difference greater than 10% is reflected)
- The deficit recovery plan, including the effect of the under or over payment of future service contributions, is modified at each future valuation date to maintain the deficit recovery contributions at a rate of 2%. The deficit recovery contribution will increase above 2% only if the deficit can not be met by assuming a deficit recovery period of 20 years and out-performance of 50bp above the discount rate.
- The technical provisions and future service contribution rates are calculated assuming:
  - A pre-retirement discount rate of CPI+2%
  - A post-retirement discount rate of gilts+0.75%.

An example of how the contribution rate is calculated (future service contribution plus deficit recovery contribution) is provided on the next slide.

Stochastic Analysis: Example to illustrate approach

- The tables below outline the evolution of the Future Service Rate and Deficit Recovery Cost for a single scenario with smoothed and unsmoothed contribution policies. Note that for the purposes of providing an example, this is based on DB contributions only, excluding DC contributions and expenses.

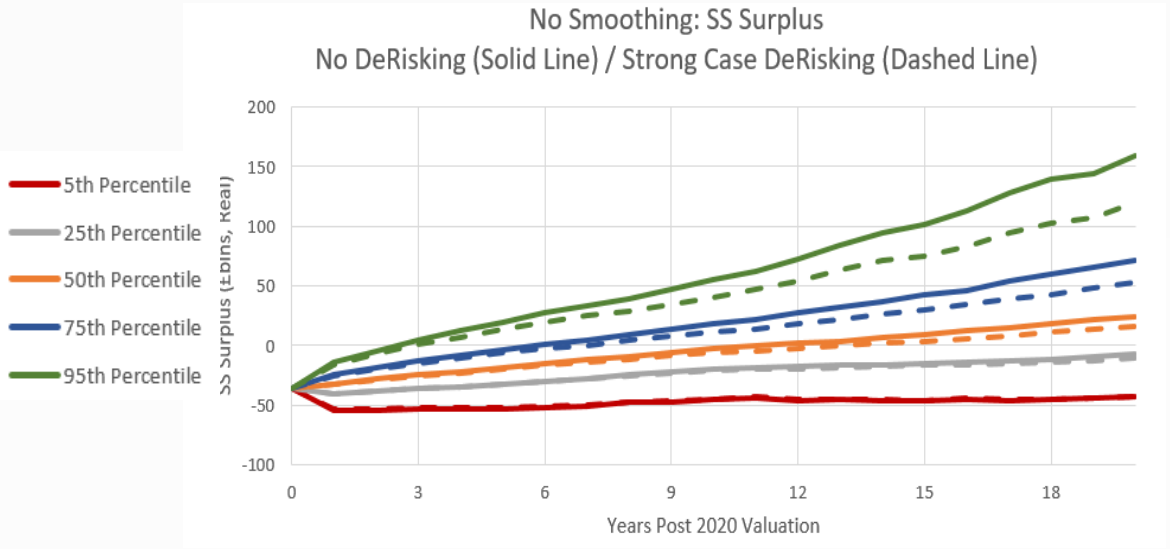
Future Service Cost	**2020**	**2023**	**2026**	**2029**	**2032**	**2035**	**2038**
Future Service Cost scenario *(example)*	**28.7%**	**26.0%**	**24.9%**	**21.4%**	**19.1%**	**19.2%**	**24.2%**
Smoothed Contributions							
Future Service Contribution last valuation		28.7%	28.7%	27.7%	24.2%	21.5%	21.3%
10% Corridor		+/-2.9%	+/-2.9%	+/-2.8%	+/-2.4%	+/-2.2%	+/-2.1%
Excess outside Corridor		0%	-1.0%	-3.5%	-2.7%	-0.2%	+0.8%
Future Service Contributions	**28.7%**	**28.7%**	**27.7%**	**24.2%**	**21.5%**	**21.3%**	**22.1%**
Technical Provisions Surplus (£bn)	*-13*	*-13*	*-1*	*14*	*15*	*1*	*29*
Deficit Contributions	**2.8%**	**2.0%**	**2.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**
Total DB Contribution	**31.5%**	**30.7%**	**29.7%**	**24.2%**	**21.5%**	**21.3%**	**22.1%**
Unsmoothed Contributions							
Future Service Contributions	**28.7%**	**26.0%**	**24.9%**	**21.4%**	**19.1%**	**19.2%**	**24.2%**
Technical Provisions Surplus (£bn)	*-13*	*-10*	*5*	*19*	*19*	*4*	*33*
Deficit Contributions	**14.3%**	**9.8%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**
Total DB Contribution	**43.0%**	**35.8%**	**24.9%**	**21.4%**	**19.1%**	**19.2%**	**24.2%**

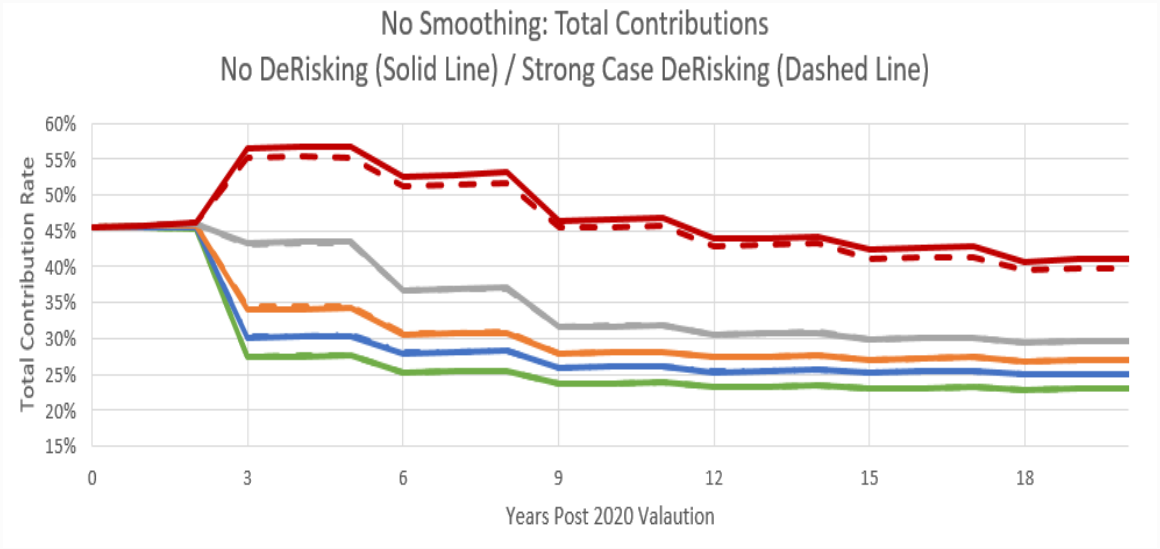
Stochastic Analysis: Impact of changing the Investment Strategy

- Comparing the impact of different investment strategies under smoothed and unsmoothed contribution rates is challenging as emerging deficits are recovered via different means.
- The application of an **unsmoothed contribution rate** give rise to an "adequate contribution rate" for each investment strategy.
    - Median and downside SS funding position evolutions are therefore similar between the two investment strategies assuming an unsmoothed contribution rate (the contribution rate is assumed to "recover" an emerging shortfall).
- The application of a **smoothed contribution rate** limits the Deficit Recovery Contribution, thus leading to larger funding gaps for a given investment strategy.
- The next slide isolates the behaviour of the Self Sufficiency funding position under two different investment strategies assuming **a no-smoothing contribution rate strategy.**
- For ease of comparison, we analyse the impact of smoothed vs unsmoothed contribution rates by holding the investment strategy constant (we assume a "No-DeRisking" strategy). This analysis is shown on the two pages after the next one.

Impact of Investment Strategy – No smoothing

- Unsmoothed contribution rates give rise to an “adequate contribution rate” for each investment strategy (comparing “no derisking” with the indicative dual discount rate 55% growth investment strategy for a strong covenant).
    - In this case, the contribution rates “compensate” for any emerging deficit in both investment strategies.
    - As a result the median and downside SS funding position evolutions are similar between the two investment strategies.
    - There is however an increased upside associated with No-Derisking vs DDR in the unsmoothed case due to the higher expected return.
    - Higher investment risk associated with No-Derisking compared with the DDR would increase intra-valuation SS deficit volatility.
- The graphs below show the SS funding level and Contribution rate (including DC costs) evolution between the two investment strategies for the No-Smoothing Case:





No-Derisking gives more upside in SS Funding Level due to higher expected returns. However it also experiences higher Contribution upsides (i.e. higher contributions in downside scenarios) to compensate for high Funding Level Volatility

Stochastic Analysis Results: Impact of contribution smoothing

- The following slides show **Total Contribution Rate** and **Self-Sufficiency Surplus** distribution evolutions over time allowing for smoothed and unsmoothed contribution rate strategies.
- We show these under two economic scenarios:
  - "with reversion" scenario (i.e., Base Case FBB); and
  - "no reversion" scenario ("Yields Follow the Forwards").
- Each time step represents triennial valuation points.
- The Contribution Rates include an allowance for the cost of DC and are quoted as a percentage of Total Payroll.
- The Self Sufficiency Surplus is quoted in real terms (£bn).
- We also provide some high level observations from this distribution evolution analysis; and
- A slide outlining the probability of the Self Sufficiency deficit being greater than £35bn (in real terms) over a 20 year horizon allowing for the different investment strategies, economic assumptions and smoothing mechanisms.

Results with and without smoothing – "With reversion" scenario (Base Case FBB), No Derisking

The tables below show the contribution rates and SS Surplus over time on a stochastic basis for the smoothed and unsmoothed contribution policy:

	Date	Total contribution rate by centile					Date	Self Sufficiency Surplus by centile				
		5th	25th	50th	75th	95th		5th	25th	50th	75th	95th
No Smoothing	2020	45.5%	45.5%	45.5%	45.5%	45.5%	2020	-35.7	-35.7	-35.7	-35.7	-35.7
	2023	55.2%	43.1%	34.4%	30.2%	27.5%	2023	-53.7	-36.5	-24.7	-13.1	4.6
	2026	51.1%	36.7%	30.6%	28.0%	25.3%	2026	-52.0	-30.0	-15.1	1.0	27.3
	2029	45.5%	31.7%	28.0%	26.0%	23.6%	2029	-47.5	-21.9	-5.6	13.7	47.0
	2032	42.9%	30.6%	27.4%	25.4%	23.1%	2032	-46.1	-18.0	1.8	27.6	73.1
	2035	41.1%	29.8%	27.1%	25.2%	22.9%	2035	-45.9	-15.1	8.6	43.0	101.1
	2038	39.7%	29.4%	26.8%	24.9%	22.8%	2038	-45.7	-11.5	18.0	60.1	139.1

	Date	Total contribution rate by centile					Date	Self Sufficiency Surplus by centile				
		5th	25th	50th	75th	95th		5th	25th	50th	75th	95th
With Smoothing	2020	34.0%	34.0%	34.0%	34.0%	34.0%	2020	-35.7	-35.7	-35.7	-35.7	-35.7
	2023	41.4%	34.5%	33.6%	31.5%	30.4%	2023	-56.8	-39.5	-27.8	-16.3	1.0
	2026	40.5%	33.9%	31.8%	30.7%	28.1%	2026	-58.2	-34.6	-19.1	-2.7	23.1
	2029	37.2%	32.3%	30.6%	28.6%	26.3%	2029	-54.7	-27.4	-10.2	9.3	42.9
	2032	36.6%	31.6%	29.5%	27.6%	25.5%	2032	-54.1	-23.8	-3.4	23.1	67.0
	2035	35.3%	30.9%	28.9%	27.2%	25.0%	2035	-55.1	-20.5	3.3	38.0	95.0
	2038	35.4%	30.5%	28.4%	26.8%	24.7%	2038	-56.4	-18.4	12.5	54.7	131.5

Results with and without smoothing – "No reversion" scenario (Yields follow the forwards), No Derisking

The tables below show the contribution rates and SS Surplus over time on a stochastic basis for the smoothed and unsmoothed contribution policy:

	Date	Total contribution rate by centile				
		5th	25th	50th	75th	95th
No Smoothing	2020	45.5%	45.5%	45.5%	45.5%	45.5%
	2023	60.0%	46.3%	36.1%	31.4%	28.5%
	2026	55.8%	39.1%	32.2%	29.2%	26.5%
	2029	51.9%	35.2%	30.7%	28.0%	25.3%
	2032	51.9%	35.7%	31.0%	28.2%	25.5%
	2035	50.3%	34.6%	30.4%	27.8%	25.0%
	2038	48.6%	33.8%	29.9%	27.5%	24.9%

Date	Self Sufficiency Surplus by centile				
	5th	25th	50th	75th	95th
2020	-35.7	-35.7	-35.7	-35.7	-35.7
2023	-62.0	-42.5	-30.2	-18.1	-0.2
2026	-62.4	-36.9	-21.3	-4.3	21.8
2029	-65.1	-34.2	-15.9	4.3	40.4
2032	-72.8	-35.1	-12.3	14.1	63.4
2035	-75.2	-32.0	-5.8	29.3	91.4
2038	-80.1	-32.5	-0.1	44.4	124.9

	Date	Total contribution rate by centile				
		5th	25th	50th	75th	95th
With Smoothing	2020	34.0%	34.0%	34.0%	34.0%	34.0%
	2023	43.4%	36.2%	33.6%	31.5%	31.5%
	2026	42.6%	34.4%	32.6%	31.8%	29.3%
	2029	41.0%	34.4%	32.3%	30.7%	28.0%
	2032	42.1%	34.5%	32.4%	30.2%	27.8%
	2035	41.1%	34.1%	31.9%	29.8%	27.3%
	2038	41.3%	33.9%	31.4%	29.5%	27.0%

Date	Self Sufficiency Surplus by centile				
	5th	25th	50th	75th	95th
2020	-35.7	-35.7	-35.7	-35.7	-35.7
2023	-65.0	-45.7	-33.5	-21.3	-3.7
2026	-68.7	-42.0	-25.8	-8.9	18.0
2029	-73.3	-41.0	-21.2	-0.9	35.3
2032	-82.6	-42.4	-18.7	8.8	57.9
2035	-87.4	-39.8	-12.2	22.5	85.3
2038	-92.4	-42.1	-7.1	36.5	115.0

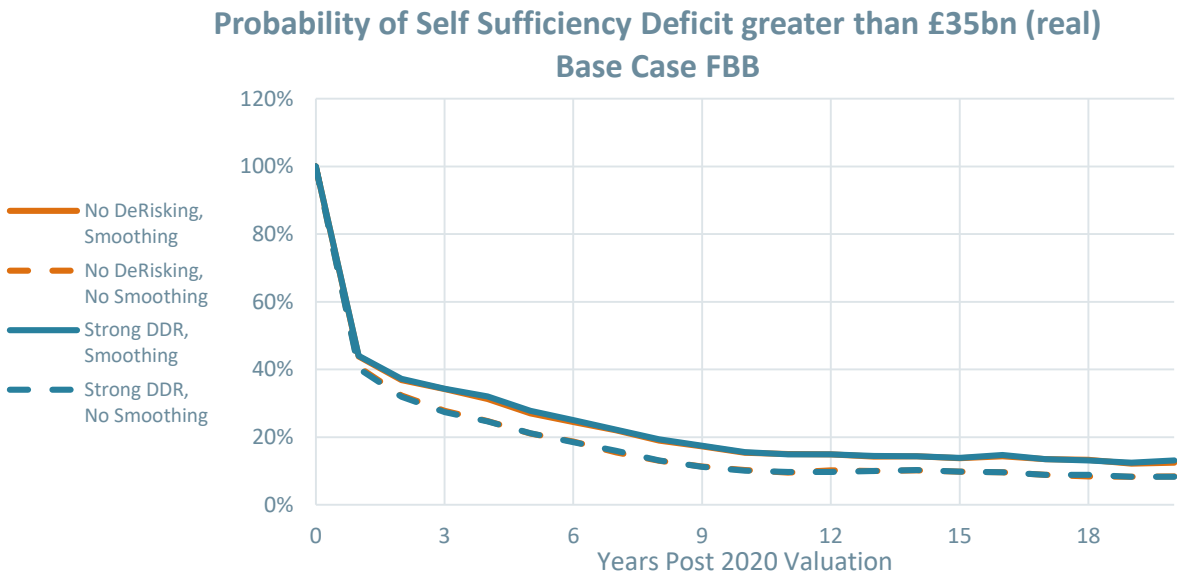
Isolating the Smoothing Mechanism – Observations

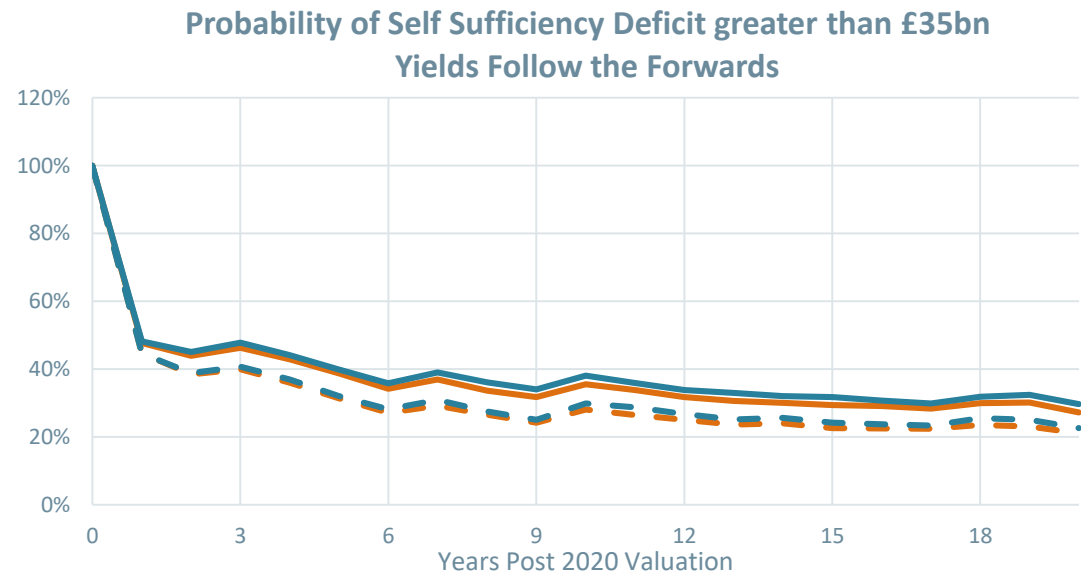
Based on the indicative analysis shown, for a given investment strategy:

- **At The Median:**
  - No Smoothing recovers the SS deficit earlier, mainly as a result of higher DRCs
  - No Smoothing results in a higher total contribution rate in the early years, however this reverses in later years.
- **Below The Median:**
  - No Smoothing experiences higher contribution rates, but lower SS deficits relative to Smoothing
  - Over the "Yields Follow the Forwards" environment, Smoothing results in an SS deficit greater than £35bln (real) at the 25th pctl across all time periods.
- **Above The Median:**
  - No Smoothing experiences slightly lower contributions rates than Smoothing
  - This is likely due to the fast recovery of the TP deficit.
- Relative to No-Smoothing, the Smoothing mechanism reduces the size of total contributions payable in adverse cases, however it experiences larger downside SS Deficits.

What is the probability of the SS deficit being greater than £35bn (real)?

The charts below shows the probability of the Self-Sufficiency deficit being more than £35bn for the different investment and smoothing cases over the "with reversion" base case FBB and "no reversion" Yields Follow the Forwards





- The probability of the SS deficit being > £35bn (real) in the future is **lowest** for the no smoothing scenarios under both economic environments.
- The No-Smoothing case pays a higher rate in 2020 which reduces the SS deficit by 2023 (on average, vs the Smoothing case). This creates a feedback loop whereby the required contribution rate trends lower under no-smoothing thereafter.
- The Impact of the Investment Strategy is limited for the No-Smoothing case across both economic environments (as per commentary on slide 36).