Institute of Actuaries of India

Asset - Liability Management in Indian Defined Benefit Schemes

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Indian Actuarial Profession

Serving the Cause of Public Interest

Presentation Structure

1. **Introduction to asset and liabilities duration**
2. Interaction of asset and liability values for changes in interest rates.
3. Using the zero coupon yield curve for liability valuation
4. Analysing actuarial gains and losses
5. Impact of duration on asset- and liability-side actuarial gains and losses
6. Does unitizing assets lead to greater efficiency
7. Long term asset-liability management approach
8. What does Ind AS 19 mean for P&L volatility and asset-liability management?

Introduction to Duration

Term to maturity	Measures time flow of returns but ignores the timings of all cash flows except the final payment.
Payback Period (PP)	Ignores the time value of money and any cash flows beyond the project date; used as a coarse filter
Duration (liability)	Broadly the expected remaining lifetime of the obligation; Measures the impact of changes in interest rate on series of future cash flows
Duration (asset)	Measures bond's sensitivity to interest rate changes, captures both time value and whole of the cash flows

Methods To Calculate Duration

Macaulay's Duration	$V = \frac{\sum C_t * v^t * t}{\sum C_t * v^t}$ Where, C_t = Cash flow at time, v^t = PV factor, t = time at which cash flow occurs $P = \sum C_t * v^t$, price of a bond
Meaning?	Measures the time it takes for a price of a bond to be repaid by its internal cash flows
Example	For an 8% coupon (annual) 3 – year bond with YTM of 10% $V = \frac{1*8*v+2*8*v^2+3*108*v^3}{8*v+8*v^2+108*v^3} = 2.78$

Methods To Calculate Duration

Modified Duration	$V = -\frac{1}{P} \times \frac{dP}{di}$ $dP = - V \times P \, di$
Meaning ?	It shows the change in duration for change in yield. Bond price and interest rate move in opposite directions. An inverse relationship exists between modified duration and approx % interest rate change.
Example	If interest rate increases by 100 bps (1%), V is 5, dP = - 5 %

Factors Affecting Duration

Coupon payments and time to maturity	Duration increases immediately on the day a coupon is paid, but throughout the life of the bond the duration is continually decreasing as time to the bond's maturity decreases.
Coupon rate and its yield (YTM)	When a bond pays a higher coupon rate or has a high yield, the holder of the security receives repayment for the security at a faster rate: 

Duration of equities and debt instruments with options

Equities: Dividend and terminal value (say after a long period of 30 years) will contribute to duration

Option bearing 'Debt': Issuer's call option, Bond Holder's put option

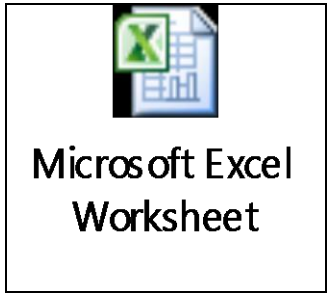
Exercising the call option depends on interest rate movement. Example, if interest rates fall, a bond issuer will exercise the option. Probability and time of exercise of option will be used for calculating duration.

Link between ERL & V_{DBO}

We use Expected Remaining Lifetime (ERL) to arrive at approx DBO duration

Example:

Withdrawal rate = 30%, Survival rate = 70%,
Current age = 50 yrs, Retirement age = 60 yrs



Link between ERL & V_{DBO}

- From the example above we get, ERL = 2.27 yrs which is a reasonable approximation to V_{DBO} = 2.75 yrs

- A fund manager/ trustee can use this ERL information from the actuarial reports to approximately determine V_{DBO}

- Options can change the V_{DBO} e.g., option to commute part of pension

Link between ERL & V_{DBO}- Contd

For 50 YEAR OLD				
	Discount rate 8%		Discount rate 10%	
Withdrawal Rate	V(DBO)	ERL	V(DBO)	ERL
2%	9	10	9	10
5%	7	8	7	8
10%	6	6	5	6
30%	3	2	3	2
50%	2	1	2	1

For 40 YEAR OLD				
	Discount rate 8%		Discount rate 10%	
Withdrawal Rate	V(DBO)	ERL	V(DBO)	ERL
2%	13	17	12	17
5%	9	13	8	13
10%	6	8	6	8
30%	3	2	3	2
50%	2	1	2	1

V_{DBO} is marginally higher than ERL at high withdrawal rates and low discount rate

V_{DBO} is much higher than ERL at low withdrawal rates and high discount rate

Significant drivers for V_{DBO}

DBO largely comprises of annuity cash flow	**Mortality rate** **Apply experience to choose appropriate factor to standard tables**
DBO largely comprises of lump sum pension	**Withdrawal rate** Apply experience to categorize withdrawal rate by: a. Age b. Grade c. Location (factory/ admin office)

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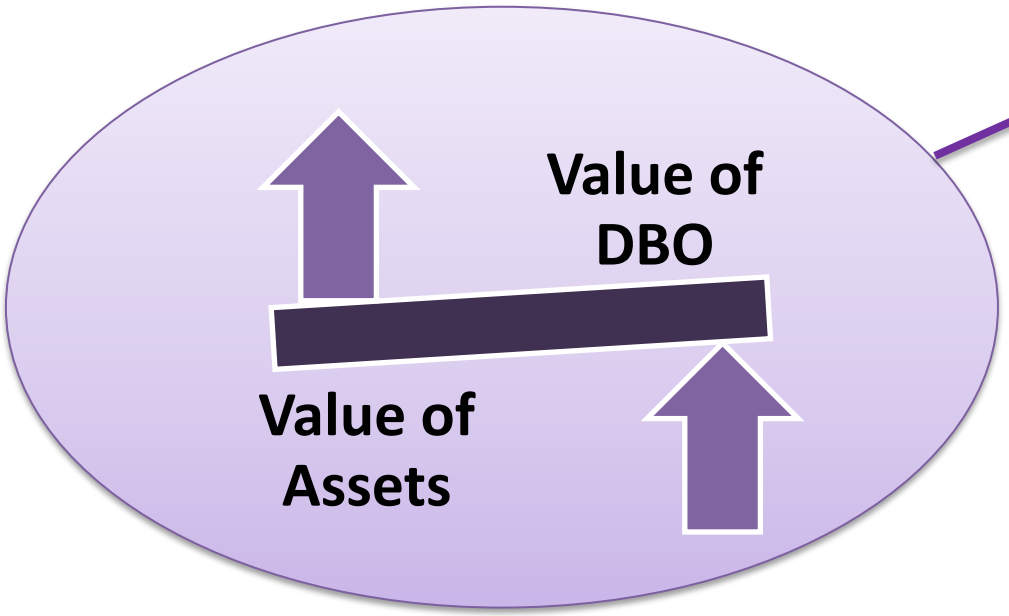
Interaction of asset and liability values for changes in interest rates

Q. Can profit/loss in dP offset loss/profit in DBO?

If $V_{Assets} = V_{DBO}$ then for a change in interest rate (di),

dP(A) = dP(DBO)



If a change in interest rate causes an increase in the value of liabilities, It will be balanced by an equal increase in Assets due to matching of duration

Interaction of asset and liability values for changes in interest rates

Example - Calculate V_{DBO}:

X=50 years, Ret. Age =60 years, Mortality=0.1%, withdrawal rate= 10%

Q. What will be V_{DBO}=

A. 10 years

B. >10 years

C. < 6 years

D. < 10 years, > 6 years

Interaction of asset and liability values for changes in interest rates

$$V_{DBO} = \sum_{k=1}^{k=60-x} {}_k p_x = 5.8317$$

To match Duration of assets with duration of DBO

Q. Which average to use ?

a) Simple Average

b) Weighted Average

Q. Which weights to use ?

a) Age

b) Completed years of service

c) Liability

Example:

Employee no.	DBO	Age (years)	Expected future lifetime (years)
1	10 L	50	3
2	1 L	30	8
		Arithmetic mean	5.5

But the weighted average= $\frac{10 * 3+1 * 8}{10+1}$ = **3.5 years**

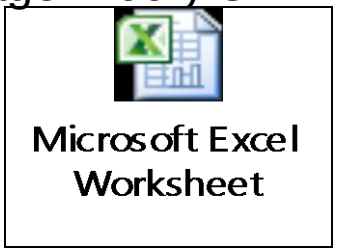
ALM for Privilege Leave and Sick Leave

- If PL can be availed as well as cashed, then different duration would apply to the obligation

Duration of Cashing or Endowment Assurance	→	Withdrawal + Mortality Rate
Duration of the Availing or Pure Endowment Stream	→	Availing +Withdrawal + Mortality Rate

- **We use expected remaining lifetime to arrive at leave duration**

Example Withdrawal rate = 30%, Survival rate = 70%, Availment rate=10%, Current age = 50 yrs, Retirement age = 60 yrs



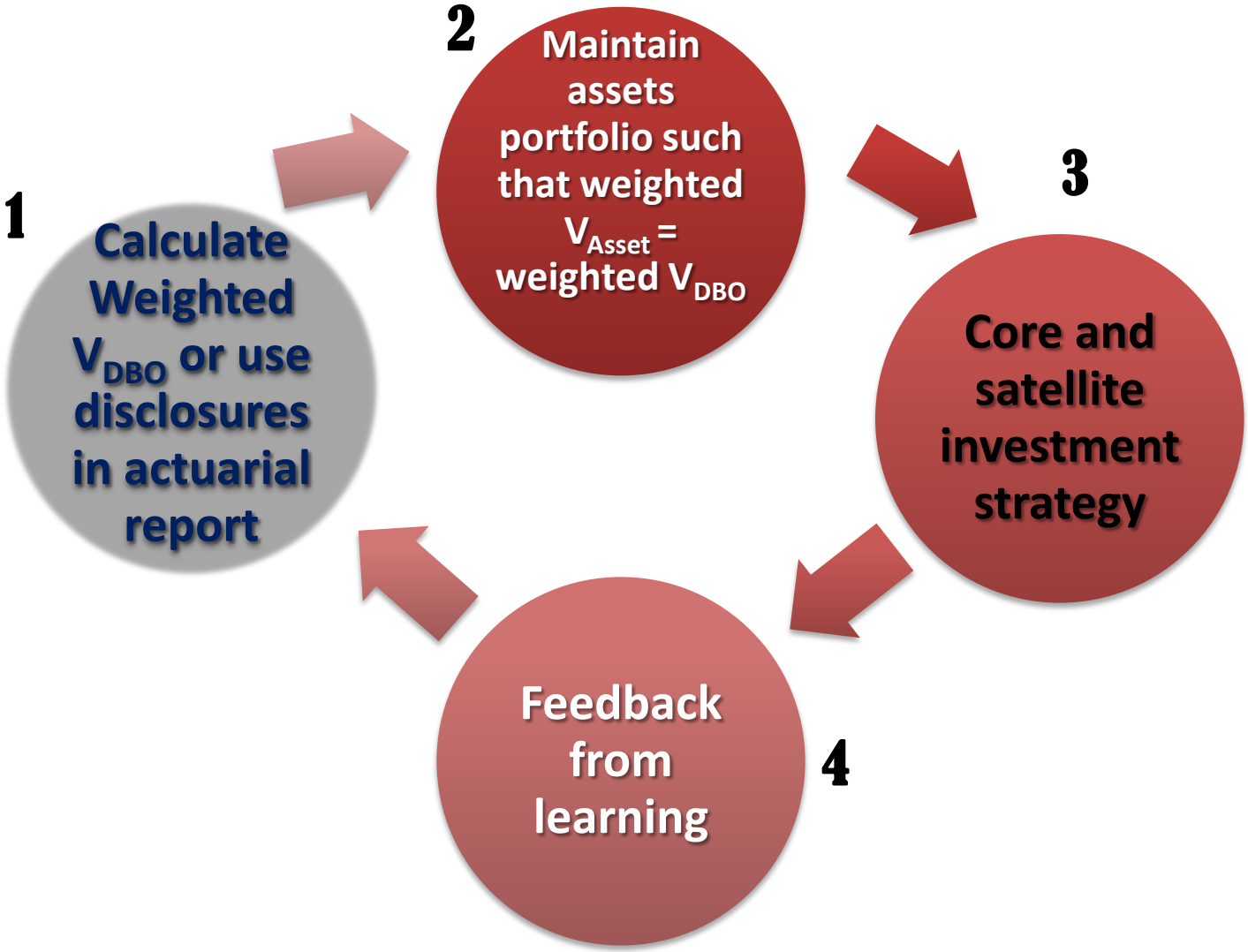
ALM for Privilege Leave and Sick Leave

- SL that can be only availed will have a duration drawn from “availing + withdrawal + mortality rate”.

- Duration changes depending on the model used to value leave.

- If an employer chooses to fund PL or SL, then the V(Assets) may equal V(DBO) for ALM purposes.

Matching Duration of DBO and Assets



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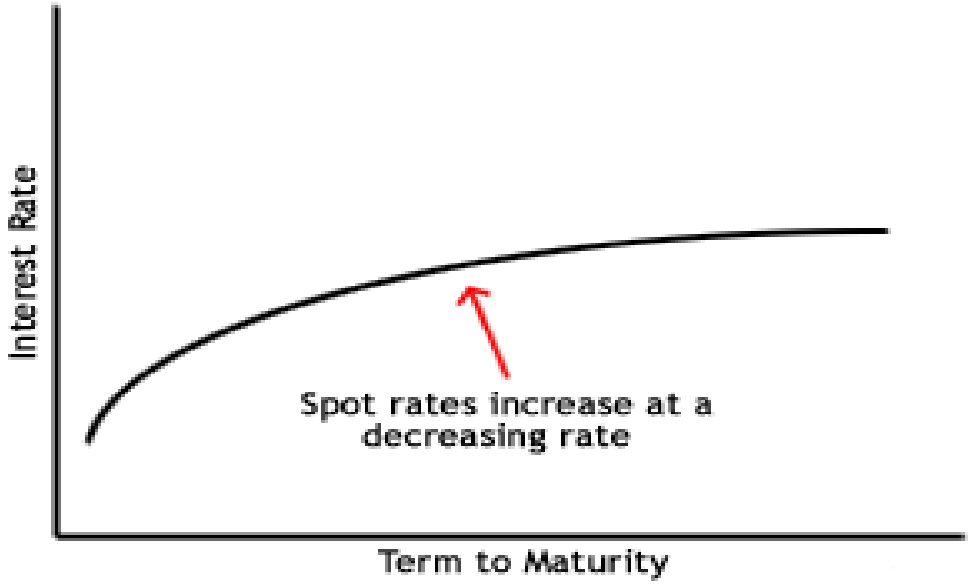
Introduction- Discount Rates

Framework – Matching Calculation	Liability is valued by reference to the market instruments which seek to match characteristics of liability cash flows. Discount rates are implicit in the market prices of matching market instruments.
Framework – Budgeting Calculation	The measurement of liability is approached from the viewpoint of how liability is going to be financed and the discount rate is based on expected returns from a pre – determined investment strategy.

C.A. Cowling, R. Frankland, R.T.G Hails, M.H.D Kemp, R.L. Losbey, J.B. Orr & A.D. Smith *Developing a framework for the use of discount rate in actuarial work, A discussion paper, presented to IFoA,* 2011

Using the zero coupon yield curve for liability valuation

Q. Which curve to use when matching duration for deferred lump sum (gratuity, defined benefit lump sum)?

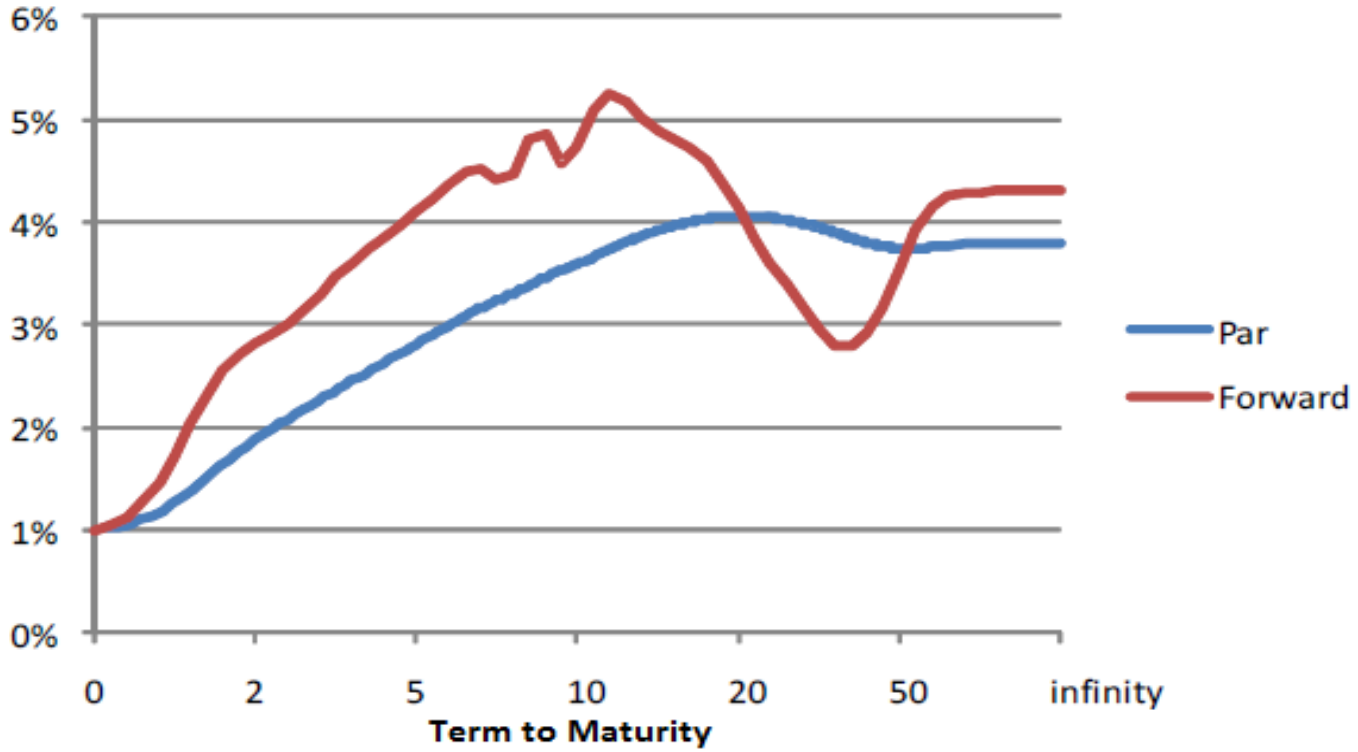


Zero Coupon Yield Curve

For valuation purposes, V_{DBO} to match with Term to Maturity (para 78, AS 15 R)

Par and Forward Rate Yield Curves

- A par yield is the YTM on a bond that is trading at par
- Forward rate is the rate of interest applicable between two future dates for an investment made now.



Types of interest rates & Relationships

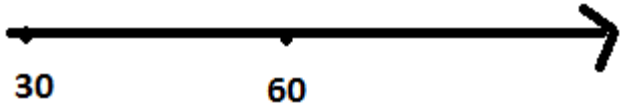
B(t, T) = Zero Coupon Bond Price	$e^{([R(t,T)*(T-t)]}$
R(t) = Spot Rate (Zero coupon yield curve)	$\frac{1}{(T-t)}\int_t^T f(t,T)$
F(t, T, S) = Forward Rate	$\frac{1}{(S-T)} * \log\frac{B(t,T)}{B(t,S)}$
f(t, T) = Instantaneous Forward Rate Curve	$-\frac{\partial \log B(t,T)}{\partial T}$
r(t) = Instantaneous Risk Free Rate (short Rate)	The force of interest that applies in the market at time t

Regulatory guidance on discount rate

AS 15, paragraph 78	Entity to use discount rate determined with reference to market yields at the balance sheet date on **government bonds**
IAS 19, paragraph 83	Entity to use discount rate determined with reference to market yields at the end of the reporting period on **high quality corporate bonds**
FAS 87, paragraph 44	Entity to use discount rate determined with reference to returns on **high - quality fixed income investments** currently available and expected to be available during the period to maturity of the pension benefits
IFA Discount rate working party	Entity to use **G sec discount rates only, not corporate bond** or any other higher rate **because enterprise can not gain from scheme failure [clause 6.4.2.2, Cowling et al (IFoA, 2011)]**

Accounting for Pension Benefits

Q. Which duration to choose when cash flows are deferred annuities (DB pension)??



$$V_{Duration} = V_{Deferred} + V_{Annuity}$$

It is not clear that shareholders get any benefit from possible default on pension obligations. Hence, discount rate used for calculating pension liabilities in company accounts should appropriately **make no allowance for sponsor default**

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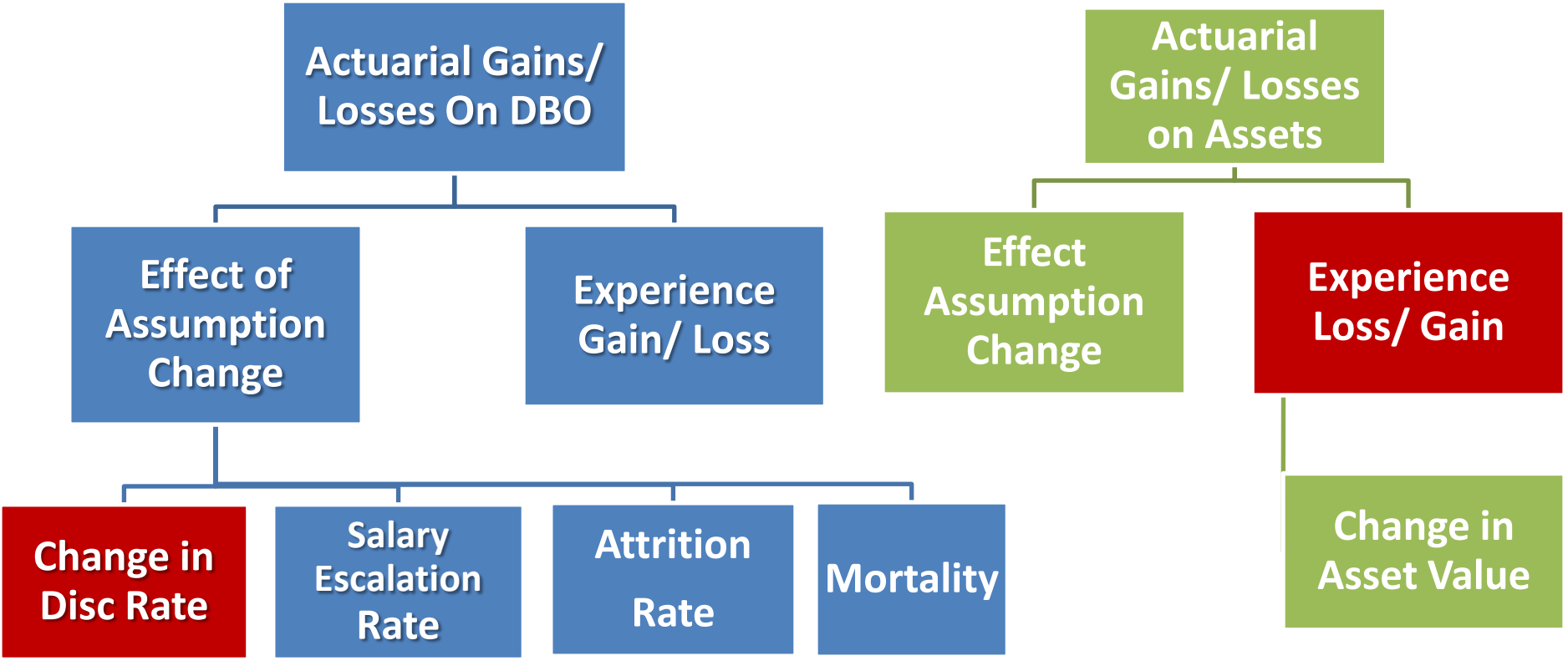
Analysing actuarial gains and losses



In a Fully Funded and Matched Scenario,
Actuarial l/g on DBO due to assumption = Actuarial g/l on FVA due to experience
PS: Applies only to fair valued or UL debt assets

Analyzing actuarial gains and losses

Q. Does Experience Loss affect ALM?

For protection from huge losses we need to be **Fully Matched:**

a) By amount (fully funded)

b) By duration

Q. What if the scheme is underfunded?

EXAMPLE: Analysing actuarial gains and losses

	2014
PV of DBO at start of yr	304,111
Current Service Cost	94,941
Interest Cost	24,025
Benefits Paid	(4,941)
Actuarial Loss/(Gain)	**(25,093)**
PV of DBO at end of yr	393,043

	2014
FV of Plan Assets at start of yr	301,701
Contributions by Employer	59,910
Benefits Paid	(4,941)
Expected Return on Plan Assets	25,532
Actuarial (Loss)/Gain	**(7,893)**
FV of Plan Assets at end of yr	374,309

	2014
Insurer Managed Funds: **non-unit linked**	22.9%
Insurer Managed Funds: unit-linked	**77.1%**

	2014
Present Value of DBO	393,043
Fair Value of Plan Assets	374,309
Funded Status [Surplus/ (Deficit)]	**(18,734)**
Experience Adjustment on Plan Liabilities: (Gain)/ Loss	5,784
Experience Adjustment on Plan Assets: Gain/ (Loss)	**(7,893)**

Actuarial gain on DBO is partly offset by actuarial loss on FV of Assets

Analysing actuarial gains and losses

Actuarial work ultimately focuses on **interactions between assets and liabilities**, rather than on each entirely in isolation.

So in theory the approach should be agnostic between the two sides of the Balance Sheet, with no particular bias towards liabilities over assets or vice versa.

[Hint: Behavioural Finance!]

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Q. Where to find longer assets?

Negative Real Interest Rate Scenario **Inflation & earnings inflation > risk free rates**	**Assets can't match liabilities on a YTM/ GRY method, so a move toward real assets (e.g. equity, property) is advisable**
If liability duration is 12 yr ++, it is unlikely to find an asset class to match.	**Extrapolating risk premiums is necessary while deciding to invest in equity, which arguably has the longest duration**
Asset Duration of 20 or 30 years Government bonds is not more than 10-12 years	**EXAMPLE:** **1. 8% GOI, 2034, V_{Assets} = 10 years** **2. 8% GOI, 2044, V_{Assets} = 12 years**

IRDA Investment Regulation s, 2013

No.	Type of Investment	Percentage to funds under Regulation 3 (b)
i.	Central Government securities	Not less than 20%
ii.	Central government Securities, State Government Securities or Other Approved Securities	Not less than 40% (incl. i above)
iii	**Balance to be invested in Approved Investments**	**Not exceeding 60%**

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Does unitizing assets lead to greater efficiency?

Transparency	**Change in assets is a function of change in interest rate**
Weighted Duration Disclosure	**Insurance companies to disclose weighted duration of the bond fund in monthly fact sheet to aid decision making**
More Volatility	a) Traditional funds b) Mismatch of V_{Assets} & V_{DBO}

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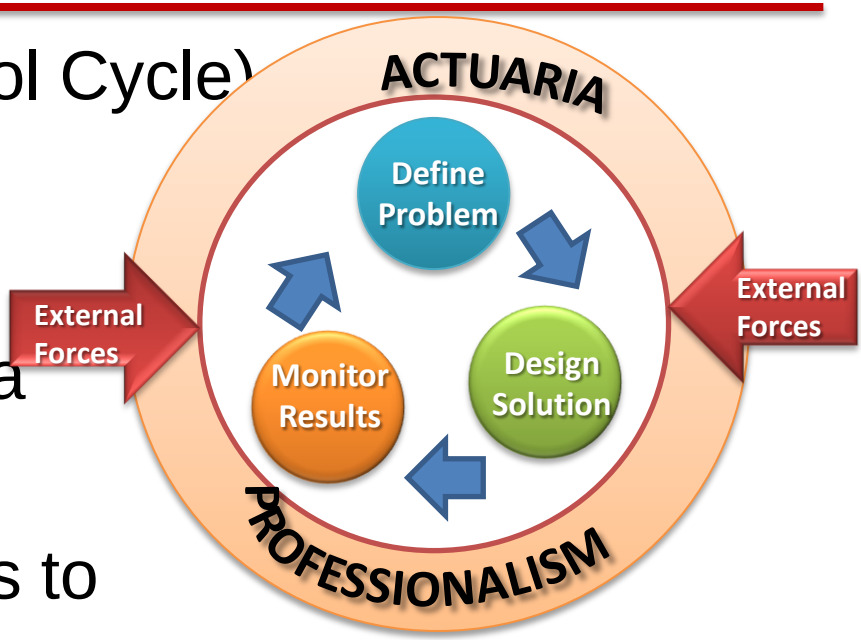
Long term asset-liability management approach

1. Feedback (Actuarial Control Cycle)



Analyse Experience Gain/ Loss of the past 5 years data

Use this Experience analysis to alter assumption setting (attrition, salary rate) if a pattern in observed in the experience loss/ gain for consecutive years

Long term asset-liability management approach

2. Ensure for a DBO, the right V_{DBO} is chosen

3. Ensure for the right Assets right V_{Assets} is chosen

4. Check Assumption change gain/ loss on DBO due to change in discount rate = Experience loss/ gain on Assets (if UL or fair valued)

5. For fund with long durations e.g. 12 yr + need not worry about short term fluctuations in long-term asset class values viz. equity, but should continue to be in equity

6. Tax is usually (in India) an upside for approved post-employment benefit funds.

ALM – Points to Consider

Identify Assets with similar characteristics as Liabilities	In market consistent valuations, identify assets/ instruments that have precisely the same characteristics as liability viz. liquidity, credit risk, mortality, longevity, options.
On-going Financing of Liabilities	Market consistent approaches may not be appropriate for on-going financing of liabilities
Valuing Assets at Historic Cost	Any asset strategy when assets are valued at 'historic cost' is a liability hedge (until the asset is sold) provided the liability is valued at a FIXED discount rate – UNREALISTIC!
ALM in AS 15/ IAS 19	AS 15/ IAS 19 is a fair or market value based standard, a matching framework for liability valuation is consistent with an ALM strategy that broadly matches the assets with the liabilities' term, nature and currency

Impact of credit risk on ALM of DB schemes

Change in credit spread	**Leads to more volatility especially as discount rate is the G Sec or risk-free rate, especially if business cycles change more frequently thereby expanding or compressing the credit spread** **G Sec funds are hence a closer match due to regulatory guidance on valuing DBO based on risk free rate**

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What does Ind AS 19 mean for P&L volatility and asset-liability management

More Disclosures	Narrative description of asset liability matching strategies, including annuity purchases and other techniques to mitigate risk (not a requirement of AS15)
Convergence of discount rate and EROA	EROA is replaced by recording net interest income using discount rate use to measure the defined benefit obligation
Treatment is different	All actuarial gains/ losses directly enter the OCI
Accounting standpoint	$V_{Assets} = V_{DBO}$ becomes less relevant (as volatility is parked in OCI) but the scheme can have losses/ gains from duration mismatch

References

Insurance Regulatory Development Authority (Investment) (Fifth Amendment) Regulations, 2013

C.A. Cowling, R. Frankland, R.T.G Hails, M.H.D Kemp, R.L. Losbey, J.B. Orr & A.D. Smith *Developing a framework for the use of discount rate in actuarial work, A discussion paper, presented to IFoA,* 2011


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