Institute of Actuaries of India

Subject ST4 — Pensions & Other Employee Benefits

November 2011 EXAMINATION

INDICATIVE SOLUTIONS

1. Designing a package of benefits, whether they are to be provided to individuals by the State,a employer or the individuals themselves, requires a series of inter-dependent decisions.

Where a benefit scheme is being set up for a group of individuals the decisions to be made will include:

- Why the company wishes to introduce the benefits now? e.g. paternalism, attract / retain talent, address employee turnover etc.
- On what events should benefits be provided, e.g. on death, on retirement, on leaving employment, whilst unable to work, during employment, on divorce?
- Should the benefits be pre-determined, i.e. defined benefit, or should they be dependent on the purchasing power of the contributions made and resulting investment proceeds, i.e. defined contribution?
- If the benefits are to be defined, should they be defined in monetary or real terms?
- If in real terms should they be related to purchasing power or earnings? e.g. use of Net Replacement Ratio
- In what form should the benefits be provided, e.g. an annuity, a cash lump sum, goods, services?
- What level of benefit should be provided? Are there competitive pressures? Should there be any guarantees?
- Should the individuals be given any options about the events, forms or levels of benefits?
- Should the approach differ between individuals in the group? e.g. various geographies; regular vs. contract
- If they should differ, in what way, e.g. form, level, real nature, events?
- How would the administration be handled? e.g. simple vs. complex schemes, cost of administration
- How easy is the scheme for communication and understanding?
- What are the financial constraints of the company? e.g. level, predictability and stability of cost

In attempting to answer all of these questions the sponsor of the benefits will need to consider their own needs and the needs of the individuals in the scheme. A conflict will therefore arise in trying to achieve the right balance between providing benefits that will be adequate to meet the recipients' needs and keeping down the costs of the benefits. A further conflict may arise in deciding whether the recipients or the sponsor should be exposed to any risks and uncertainties that may arise.

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2.(i)

- A defined benefit scheme is one in which benefits payable on different contingencies are defined in advance.
- The contingencies covered by a defined benefit social security pension scheme include:
  - Retirement on reaching a particular age
  - Inability to work through ill health
  - Death
- Benefits payable under the scheme
  - Level of pension may be significant macroeconomic decision for the economy. State schemes range from those providing relatively low flat-rate benefits to an expensive earnings related schemes with high targeted benefits
  - State scheme could be used to target benefits to those most in need (i.e. means-tested benefits)

- State may wish to ensure substantial provision for all from the state or encourage private provision, for example by way of tax concessions.
- State could provide flat rate benefits, same level to everyone or earnings related benefits
- May prescribe certain earnings threshold or ceiling for the benefit payments
- Or give credit for family responsibilities by giving a bigger pension to those who have dependants at retirement or who are looking after dependants before retirement

- Contributions or otherwise funding
  - If a government decides to provide pensions, it must also decide how they are to be financed
  - State can decide whether or not it funds in advance to meet future pension payments
  - If funded, a decision will be needed on how to invest the assets
  - It may be attractive to ask citizens to pay at least part of the cost of state pensions by specific earmarked contributions.
  - Contributions required can be at the same level from everyone or earnings related
  - Usually any earnings threshold or ceilings would be mirrored in the contribution arrangements
  - Alternative is to meet current pension payments directly from contributions made by the current workforce.

(ii)

- The costs are potentially volatile due to the possibility of abuse and, if earnings related, also due to the possibility of unexpected levels of salary increase throughout economy
- If the benefit payable is based on final salary, it could be abused. Companies could increase salaries just before retirement in order to increase state pensions.
- Benefits based on final salary is an expensive approach if the main objective is to target the needy
- The cost of the benefits could be higher than anticipated:
  - Improving life expectancy
  - Price inflation being higher than expected
- Birth booms in the past and falling birth rates in recent times, together with improvements in longevity, leading to a lower ratio of working to retired population can cause problems for PAYG arrangements
- If fund in advance, investment experience might be poorer than expected
- Fraud or non-payment of contributions

[9]

3.(i)

- The funding level is currently satisfactory giving the employer a cushion to take some risk.
- The employer may expect that equities will outperform bonds over the long term and hence reducing the cost of the scheme.
- However if equities perform very strongly then the funding level would exceed 120% and some of the out performance would result in a tax payment on the investment income earned over the year.
- The investment performance of a portfolio 100% invested in equities is likely to be volatile.
- Therefore a risk that the funding level could fall below 80% requiring special contributions that would disrupt the company's cash flow plans.
- By investing all money in equities means it has not achieved the diversification benefit. The diversification enables a scheme to take advantage of some of the beneficial characteristics of one asset class, whilst not being unduly exposed to its disadvantages.
- The scheme's assets are entirely mismatched to its liabilities as specified in the statutory basis (bond yields).
- If the liabilities involve a high level of benefit outgo relative to cash flow into the scheme, it

may be appropriate for the scheme to have higher yielding investments. Equities do not qualify as higher yielding investments.

(ii)

- Carry out Asset Liability Model (ALM) projections for several alternative investment strategies (e.g. 100% bonds, 75% / 25%, 50% / 50%, 100% equities etc.)
- Carry out large number of simulations for each investment strategy (choose the number as compromise between reliability of results and practical computation) e.g. 1000 or 10000
- Choose the period over which projections to be made
- Choose a stochastic investment model(in particular modelling performance of equities , bonds)
- This will also generate the discount rate on the statutory basis at future valuation dates
- Choose liability cash flow model (including demographic assumptions)
- In particular salary growth should be linked with the price inflation under the investment model
- Under each simulation calculate results of valuations in each future year over the time period chosen (Note that the incidence of good/bad valuation results in individual future years is important in this case, because employer has to pay special contributions or may suffer tax, if there is a particularly good/bad result in any one year).
- Consider distribution of results of all the simulations by reference to a relevant feature e.g. probability that funding level will fall below 80% (or above 120%) over the period chosen.
- Any sensible outputs acceptable, provided reference made to probability of contributions/funding level etc. meeting certain conditions
- Compare the output from the distribution of results for each chosen investment policy allows shortlist of reasonable investment policies to be drawn up, account employer's tolerance of risk.

[9]

4. The component method projects a population subdivided by age (or age groups) by identifying the factors that cause a population to change in size, namely:

- Mortality
- Fertility
- Migration.

Future population size subdivided by age is obtained by using deterministic recursive formulae which relate the future population size to past population sizes.

The rates of mortality, fertility and migration will need to be age specific.

The structure of the model is:

$P_x(n)$ = Survivors to n of $P_{x-1}(n-1)$ + migrants during $(n-1, n)$ who survived to be age x at n
$P_0(n)$ = Births during $(n-1, n)$ + migrants during $(n-1, n)$ who survived to be age 0 at n

Where $P_x(n)$ is the population aged x last birthday at n. Time points, e.g. n, always refer to the middle of the respective calendar year, e.g. mid-year n.

If we use the following notation:

B(n) births during $(n-1, n)$

$M_x(n)$ migrants during (n − 1, n) who survive to be age x last birthday at n. If there is net emigration this figure can be negative

$q_{x-½}$ (n − 1) probability that a life aged x − 1 last birthday at n − 1 dies in (n − 1, n) assuming those aged x − 1 last birthday at n − 1 have birthdays uniformly distributed over the calendar year.

$½q_0$(n − 1) probability that a life born in (n − 1, n) dies in (n − 1, n), then the relationships can be expressed as:

$Px(n) = P_{x-1}$ (n − 1) (1 − $q_{x-½}$ (n − 1)) + $M_x(n)$
$P_0(n) = B(n)$ (1 − $½q_0$ (n − 1)) + $M_0(n)$

The projections are usually completed separately for each sex.

Let's see how the relations above are developed.

The number Px (n) of individuals who are aged x last birthday in the middle of year n consists of the survivors from those who were aged x −1 in the middle of the previous year, i.e. P_{x-1}(n − 1) plus the net number of immigrants, i.e. immigrants less emigrants.

If we assume that the individuals aged x last birthday were all on average aged $_{x\ +½}$, then the appropriate survival factor is equal to 1− $q_{x-½}$(n − 1) .

For individuals aged 0 last birthday, the formula is slightly different. The number of babies who are under 1 year old is the number of births during the previous year who have survived an average period of ½ year. So the approximate survival probability required here is equal to $½q_0$ (n − 1).

B(n) and $M_n(x)$ are then determined by using separate models. Total births in (n − 1, n), B(n) are projected using:

$$B(n) = \sum ½ \left(P_x^f (n-1) + P_x^f (n) \right) f_x (n)$$

where:

- P_x^f(n) is the number of females aged x last birthday at n
- f_x(n) is the fertility rate over (n − 1, n) for women (f) aged x last birthday at the date of the birth.

The summation is over all ages for which $f_x(n) > 0$.

A sex ratio at birth must then be estimated. This estimation might be based on past births in the population concerned, assuming the ratio to be sufficiently stable. For example, an empirical UK estimate would be 1.06:1 so as to obtain male and female births as:

$$B^m(n) = \frac{1.06\,B(n)}{2.06} \quad B^f(n) = \frac{B(n)}{2.06}$$

Migration numbers could be modelled in a similar way if it is an important component of population change. Again an estimate would need to be made for the population concerned using relevant available data, government statistics for example.

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5.(i) Factors to determine sponsor's covenant

Exposure to the economic cycle: the industry in which the company operates should be considered, the manufacturing industry is exposed to the economic cycle. There is a risk that the company's fortunes could deteriorate significantly if there was an economic downturn.

Level of company debt: the higher the level of debt of the company, the lower the pension debt may rank. We might question how the company has expanded, if this has been through borrowing money then the covenant may be weaker.

Quality and views of management: the quality of management, their views on the company's financial position and future plans and their attitude to risk should be considered. This will impact on the sustainability of the current sponsor covenant.

Company accounts: the company accounts will be examined so key financial metrics can be identified. The notes to the accounts should also be considered as they may give an indication of future changes.

Implied market default risk: the market prices of issued equities or bonds and how these have changed over time.

Credit rating: the company may have a credit rating or an Independent Business Review (although given its size this may be unlikely). However, recent debt issues may have credit ratings.

Risk-based measures: any risk-based measures, e.g. a risk-based contribution to a central discontinuance fund should be examined to gauge its size.

Funding level of the scheme: as the funding level of the scheme increases the sponsor covenant becomes less important. The current funding level of the scheme should be examined, as should the intention to continue paying discretionary pension increases.

Other characteristics of the scheme: other characteristics of the scheme that may affect its ability to withstand risk should also be considered, e.g. maturity, size, whether benefits insured.

(ii) Valuation and Funding Advice

Valuation advice relates to valuing members' accrued benefits taking into account all risks whereas Funding advice relates to determining:

- the necessary contribution rate to meet any deficit, as well as the cost of future accrual
- the appropriate investment strategy
- other arrangements to finance benefits e.g. insurance.

(iii) Valuation Advice

Given the good covenant and funding position, the value of members' benefits are very unlikely to be reduced to reflect the risk of the scheme becoming under-funded or the sponsor failing.

In addition, the value may be increased to allow for discretionary pension increases if it is determined that these are likely to be provided.

Funding Advice

Given the position of the company and scheme, the trustees are unlikely to require any adjustment to be made to the contribution rate to reflect concerns regarding security.

In addition, the investment strategy can allow for a degree of mismatching and there is freedom over the use of other financing arrangements, such as insurance.

Discretionary pension increases will be allowed for in the funding advice if there is a commitment to provide them wherever possible and they are funded for explicitly.

[10]

6.(i) Two actuarial approaches to the analysis of a pension scheme are:

- Present value method
- Projection method

(ii)

The projection method is the most appropriate method for social security schemes which are unfunded or partially funded. The projection approach aims to assess whether under existing financial arrangements benefits can be paid and reserve funds maintained at required levels.

The differences between projecting social security benefits and projecting benefits from occupational schemes are:

- The projection of social security benefits is more likely to be based on population effects and data. Whereas under occupational scheme, the projection will be based on individual membership data, with calculations usually carried out at an individual level.
- The social security projections will be more concerned with general trends that are being observed in the population.
- It is unlikely that individual data will be available or that projections will be made at individual level.
- The assumptions used will differ. The assumptions for the social security scheme will reflect the population at large those for the occupational scheme will be tailored to the particular characteristics of its membership.
- The occupational scheme will almost certainly be funded, so assessment of assets and funding level is important. The social security scheme may be unfunded, in which case these issues are not a considerations.
- Projections are usually on an open membership basis, allowing for future new entrants, rather than just considering current members and accrued rights.
- The occupational scheme will divide members in to actives and deferred members, usually this is not an issue for a social security system, since members may have several periods in their life when they cease to accrue benefits but start accruing again a later date. This is very unlikely to be the case for an occupational scheme.

(iii)

- The appropriate method to be used here is the projection method
- A model can be built that can take in to account following assumptions:
  - Numbers, sex and ages of the senior citizens
  - Mortality assumptions
  - Sickness rates
  - Cost different levels of health care
  - Inflation for care costs
  - Administration expenses
  - Investment return

- New entrants
- Charging structure
- Social, marital and economic status of the population
- Financial incentives from the government, if any

- Key part of the modelling process is to estimate the key assumptions and project them.
- Determining the assumptions can be difficult and may require considerable judgement.
- Since this is the first time such initiative has been undertaken, no industry wide data available
- We may have to look any population statistics published by the government or similar data available in other countries
- Historic data from these sources will be a starting point for the assumptions. However, what has happened in the past may not happen in the future. Therefore, there needs to be analysis of trends and allowance for future changes, for example, improving mortality rates and medical advances
- Care needs to be taken with small population data as it is less credible and more difficult to use to predict what will happen.
- The model will enable the trustees to understand what is going on in the finances. It will help them quantify, minimise and monitor the possible financial risks in running the health care program.

[13]

7.(i) **Advantages**

- Administration savings – no need to operate a pensioner payroll
- Buy-out terms may be attractive
- No investment, mortality or expense risk with the scheme
- Volatility in employer's contribution can be avoided by running a smaller scheme which does not have pensioner's liabilities

Disadvantages

- No contact with pensioners
- Awarding discretionary pension increases is problematic
- Scheme loses investment & mortality profits
- Buy-out terms may be expensive
- Have to pay for insurer's expenses & profits
- Planning funding difficult as annuity costs can be volatile
- Cash flow problems if several members with large pension outgo retire in the same year as the full cost of providing pension has to be paid to the insurer immediately by liquidating the assets
- Investment constraints due to need for cash on retirement.

(ii)

- Annuity prices are often driven by the market in government bonds.
- This means that the level of yield on bonds will influence the annuity rates. Higher yields increase the annuity rate provided the insurance companies reflect the same in their pricing without making any substantial adjustment for the reinvestment risk
  (1 Mark)
- However what has happened in the past may not happen in the future. Hence the trend would reverse if the yield on bonds starts dropping.
- Increase could be due to improvement in company's own experience with regards to longevity risk and expenses
- Due to competitiveness in the market as more and more players started becoming active in this segment.

(iii)

- Continuation of the scheme without any further accrual of benefits (as a closed scheme)
  - No guarantee that the discontinuance benefits are met, as the cost of the benefits still be affected by future investment and mortality experience
  - Since the benefit is payable based on the final salary, the cost of the benefits is still uncertain as the benefit may increase in line with average price or earnings inflation

- Transfer of liabilities to another pension scheme operated by the same sponsor
  - Any surplus or deficit arising out the scheme will relate to a larger group of individuals

- Transfer of funds to the scheme members and other beneficiaries to extinguish the liability
  - In many countries it will not be possible to pay the capital value of benefits to a beneficiary so this option may not exist
  - If it is allowed then the benefits are likely to be very different from the discontinuance benefits depending on the experience

- Transfer of funds to an insurance company to invest and provide benefits
  - Legislation may permit funds for an individual to be placed with a benefit provider chosen by the beneficiary
  - Benefits will depend on the terms and conditions of the new provider and the experience of the individual
  - There will be few insurers willing to accept the risks associated with guaranteeing the benefits. Those that are willing to do so will charge a premium for the risk.
  - This may mean that the funds are not sufficient to cover the cost of the accrued benefits.

- Transfer of the liabilities to a central discontinuance fund to guarantee some or all of the benefits

- Legislation or order of scheme may restrict/determine options.

[17]

8.(i) SCR = 12 %
Value of Assets = 120 m
Value of Liabilities = 150 m (240 m – 90 m)
Deficit = 30 m

Value of 1% over total future service = 90 m / 15 = 6 m
Amortisation = 30 m / 6 m × 1% = 5 %

RCR = 15 % + 5 % = 20 % total
= 17 % Company after 3 % from members

(ii)
Actuarial Value of Assets may be unduly conservative. If based on actual split Rs.120 m becomes Rs. 127.5 m.
{120 x 1 / [(0.5 * 0.7) + (0.5 * 0.9)] * [(0.25 * 0.7) + (0.75 * 0.9)]

However depends on overall strength of basis and the assumptions used to value both assets and liabilities, which should be consistent.

If value of past service liabilities only used then the funding method should be changed to PUM or AAM. Under the PUM method the SCR will be higher than 15% since average age is 45 vs.

Entry Age of 30; could be around 18%.

Why is current asset mix so far from benchmark, should this be taken into account in the assumptions for future investment return? This would impact upon the valuation result.

Should the asset mix be changed to better match liabilities and minimize volatility of contribution rates?

Valuation funding method only determines the pace at which the cost is met but not the actual cost; pay less now and more later or vice versa.

EAM could be maintained but reworked on a new entry age, which if amortised and added to reworked SCR may result in little or no change to the RCR.

However moving the Entry Age would change value of expected future contribution, thereby changing the past service deficit.

What are the company's recruitment patterns, what is a realistic entry age, will the scheme remain open to new entrants.

(iii)

As the same assumptions are required for single life commutation and augmentations, the Trustee is asking a reasonable question.

- Need, however, to consider whether it might be appropriate to pick different assumptions.
- Trustees' have a responsibility to act in the best interest of all beneficiaries:
- Fairness to the member might suggest the same factors should apply.
- Consider the (theoretical) situation where a member purchases an extra Rs.1,000 pension by augmentation at 60 using the factor of 25:1, and immediately commutes it at 16:1, getting Rs.16,000 back for original investment of Rs.25,000.
- Security of other beneficiaries entitlements might suggest otherwise.
- For commutation it is prudent to minimise the amount of cash given in return for each Re.1 of pension (or maximise pension given up to provide specified cash amount) i.e. use assumptions that produce "low" factors.
- For augmentation it is prudent to maximise the cost of securing each Re.1 of pension i.e. use assumptions that produce "high" factors.
- Unless scheme is extremely well funded (i.e. >>100% on solvency basis), so these are not issues, and it's in the interest of all members to make option terms as favourable as possible.
- The issue of selection could theoretically be used to justify different factors, e.g.
  - Members in poor-health would maximise commutation.
  - Members in good-health more likely to purchase pensions.
- In practice, selection is unlikely to be a major issue for commutation or augmentations.

Member's Expectations

- If factors have been different historically, probably not an issue for members.
- Members likely to take cash as tax free.
- It can be argued that commutation is an option that members are not obliged to take, so there is no requirement for terms to be "fair".
- On the other hand there is the potential for dispute at some point.
- This would be avoided if commutation factors were increased

Funding Position of the Scheme/ Strength of Employer

- If commutation is anticipated in the funding valuation, increasing commutation factors will immediately increase disclosed liabilities / contribution requirements.
- If commutation is not allowed for explicitly, increasing the commutation factors is likely to reduce prospects for future favourable experience, increasing sponsor's costs in the long term.
- Therefore, the strength of the employer and its long term commitment to funding the scheme need to be considered.
- The sponsor should not unknowingly be exposed to significantly increased costs when options are taken up.

Trust Deed and Rules

- Possible, but unlikely that different factors are explicitly specified in rules.
- More likely that rules will state how factors are determined, and this might justify differences e.g.
  - Commutation factors determined from time to time by the actuary on a basis consistent with that used for determining employer contribution requirements − i.e. suggests "best estimate" assumptions, factors reviewed every 3 years.
  - Terms for augmentations are recommended on a case by case basis on assumptions consistent with market conditions at the time option is exercised − i.e. suggests factors based on an immediate annuity basis or similar.

Legislation

- Tax restrictions on commutation terms may limit the factors to something below the "fair value" of the pension being commuted, even on a best estimate basis.
- Tax treatment of alternative forms of benefit
  - Commuted pension tax-free vs. pension taxed as income — it can be argued that lower commutation factors can be justified on the basis that the equation of value should be carried out net of any tax involved.
  - Alternatives available for funds used for augmentation payment?
- Sex-equality legislation

Miscellaneous other issues in determining option terms

- Frequency of use of each set of factors.
- Non-standard circumstances where standard factors may not be

appropriate:

  - trivial commutation
  - ill-health commutation
- Administrative issues should not be significant, other than that using the same factors will be simpler.

[22]

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