

EXAMINATION MARKING SCHEDULE

4 June 2010 (am)

Subject F104 — Pension and Other Benefits Principles

[Note: In general every point or sub-point will count half a mark, unless otherwise indicated, with a maximum of marks for that particular question or part thereof.]

QUESTION 1

As actuary to a very large mature defined benefit pension scheme in a developed country, you might typically make a number of investigations of experience (e.g. actual vs expected) at the triennial statutory valuation of assets and liabilities.

- i. List these*
- ii. Describe how you might analyse the mortality experience over the inter-valuation period (no formulae are necessary).*
- iii. How could you use the results of your mortality investigation?*

Items to be analysed:

- Pre-retirement mortality
- Post-retirement mortality
- Investment returns on scheme assets
- Salary increases
 - Inflationary
 - merit
- Increases of pensions in payment
- Increases of pensions in deferment (if any)
- Withdrawals
- Early retirements
- Ill-health retirements
- Proportion pensions commuted
- Expenses

Analysing mortality:

- You would aim to analyse the 3 years of data by:
 - Age
 - Sex
 - Class of member – at least:
 - Actives

- Pensioners
- The extent to which you can split the data in this way will depend on the size of the data
 - Since you would want the size of the data in each sub-group to be credible
 - Though this may not always be possible
 - Group data in age bands, e.g. quinquennial
 - But you may need to use wider bands in some age ranges, e.g. older ages
- For each sub-group calculate:
 - The 'exposed to risk'
 - The expected number of deaths
 - On the mortality assumptions of the previous valuation
 - Or perhaps on the basis of some standard table that you want to use as a benchmark
 - Basis that has been used in previous such investigations to establish a trend
 - Compare with the actual number of deaths
- Calculate a confidence interval to indicate how reliably your results might be used
- Consider the impact of any special event/factor
 - E.g. swine flu epidemic
 - In South Africa, the AIDS epidemic (in this case a geographic or urban/rural split may be useful as well or reference to established models of the epidemic)

Using the results of the mortality investigation:

- Consider how reliable the results are, i.e. credibility of the data, before making changes
- Could influence mortality assumptions for the current valuation
 - Rather than use exclusively, would probably use to modify a standard table (e.g. population or industry table)
 - If there are previous such studies, could use to identify trends in mortality.
 - Could use to assume future improvements in mortality
 - But try to strip out effects of 'once-off' events such as a flu epidemic
- If comparing with previous valuation assumptions, can use to analyse surplus arising from mortality (split by actives/pensioners). Such an analysis can influence decisions whether to:
 - Insure pre-retirement death benefits (lump sums or pensions)
 - Insure pensioner benefits (e.g. purchase pensions from an insurer).
- If commutation factors are being used in the scheme, these may be modified by the results of the analysis

QUESTION 2

In a certain developed country, the tax-approved retirement funds are subject to an EET tax basis (exempt on contributions, exempt on investment returns, taxed on benefits). Any pension in payment is taxed as income. Any lump sum benefit at retirement is subject to a progressive tax, but a fairly substantial initial amount is free of tax. Outline the benefit design considerations and practical implications of offering an option at retirement to commute part of the pension benefit for cash.

- Availability of cash at retirement is a popular benefit
 - Gives more flexibility
 - Would probably be offered by competitors and this should be checked
- If offered on reasonable terms, members likely to exercise such an option:
 - Taking the full tax-free amount and any additional amounts at an advantageous tax rate.
 - In order to minimise tax
 - Because it is popular
- Will the option result in selection against the fund?
 - E.g. members in ill-health
 - Anti-selection unlikely because of the tendency to take up the option (as above)
 - Could calculate the option on actuarially neutral terms (i.e. use valuation basis)
 - If not actuarially neutral, need to allow for in the valuation (assumption on option take-up)
- What allowance for pension increases?
 - Guaranteed increases – yes
 - Discretionary?
 - Perhaps use valuation basis
 - Do trustees have a published increase policy?
 - History of increases?
 - Perhaps allow for a portion of the increases so as not to over-anticipate what may be granted in the future
- Spouses' or Childrens contingent pensions?
 - Perhaps do not allow the option to decrease these (especially as they are probably reduced already)
- There may be legislative maxima or restrictions on take-up of the option
- Individual actuarial calculations will be relatively expensive
- Consider setting up tables of commutation functions for admin purposes
 - These may differ by
 - Age
 - Gender – but check if legislation allows
 - Member category – e.g. if different benefits (e.g. pension guarantee periods)
 - May be dependant on market conditions
 - But better that the factors should be stable over long periods
 - Easier admin
 - More member certainty about benefits

- Probably use valuation basis
- May be 'smoothed' in practice

QUESTION 3

An employer in a developed country wishes to establish a pension scheme for its employees. Discuss briefly the factors that the employer will take into account in deciding on the types and amounts of benefits to be provided.

- What are the customs/practices in the industry/country?
- What are competitors doing?
 - Eer will wish to attract/retain staff
- Type & amount of benefits must be attractive
 - So they must meet needs of ees
 - Must meet needs of different classes of ees
 - So may vary by class of ee
 - Examples of needs might be:
 - Income in retirement
 - Income on death of a breadwinner
 - Lump sum to meet cash needs on death
 - Amount of income may be based on a Net Replacement Ratio approach
- Might reflect attitude/culture of eer:
 - E.g. paternalism may result in DB benefits
 - Risk aversion may result in discretionary pension increases
 - Equity may result in DC-type withdrawal benefits
 - Offering options, to what extent would eer consent be required.
 - Size of eer may affect degree of commitment to benefits/welfare of ees
- Legislative environment and government influence:
 - Compulsory benefits
 - Minimum benefits (e.g. leaver benefits)
 - Tax incentives
 - For type of benefit e.g. income
 - For amount of benefit, e.g. maxima
 - Availability of State Benefits
 - Opportunities for integration
 - Opportunities for cost saving
- Financial constraints on employer
 - Acceptable level of costs
 - Need for stability of costs
 - Predictability of costs in long term
 - Will interact with level of member contributions that can be negotiated
- Need for benefits to be
 - Simple to administer
 - Inexpensive to administer

- Easy for members to understand
- Easy to communicate to members
- Need to facilitate other business requirements:
 - Reorganisations, downsizing, mergers, succession planning

QUESTION 4

You have just completed the actuarial valuation of a final salary defined benefit pension fund, with the following results:

	R'000
Present value of benefits for pensioners:	1 700
Present value of past service benefits for all in service members allowing for future salary increases:	3 800
Present value of benefits accruing for all members in the year after the valuation date allowing for future salary increases:	500
Present value of future service benefits for members aged 30 allowing for future salary increases:	240
Present value of future contributions by all members:	3000
Present value of contributions by all members in the year after the valuation date:	200
Present value of all future contributions by members aged 30:	100
PV all future svc benefits to all members allowing for future salary increases	8000

Members contribute at the rate of 5% of salary.

- (i) Define and calculate the standard contribution rate and actuarial liability for each of the following funding methods:
- (a) Entry Age (new members assumed to enter at age 30)
 - (b) Projected Unit
 - (c) Attained Age
- (ii) Discuss the characteristics of the standard contribution rate and actuarial liability for each of the three funding methods.

(i)

(a) Entry Age Method

The standard contribution rate (SCR) is found by dividing the present value of all future benefits by reference to projected final earnings for a member entering at a "normal age" by the present value of his total earnings throughout his expected future membership.

The actuarial liability (AL) is found by deducting from the present value of total benefits on projected final earnings for all members the value of the SCR multiplied by the present value of total projected earnings for all members throughout their expected future membership.

$$\text{Standard contribution rate (SCR)} = 240 / (100 \times 20) = 12\%$$

$$\text{Actuarial liability (AL)} = 1700 + 3800 + 8000 - 12\% \times (3000 \times 20) = 6300$$

(b) Projected Unit

The SCR is found by dividing the present value of all benefits which will accrue in the year following the valuation date, by reference to service in that year and projected final earnings by the present value of members' earnings in that year.

The AL is the present value of all benefits accrued at the valuation date by reference to projected final earnings.

$$\text{SCR} = 500 / (200 \times 20) = 12.5\%$$

$$\text{AL} = 1700 + 3800 = 5500$$

(c) Attained Age

The SCR is found by dividing the present value of all benefits which will accrue to present members after the valuation date, by reference to service after the valuation date and projected final earnings, by the present value of total projected earnings for all members throughout their expected future membership.

The AL is the present value of all benefits accrued at the valuation date based on projected final earnings (i.e. is equal to that under the projected unit method).

$$\text{SCR} = 8000 / (3000 \times 20) = 13.3\%$$

$$\text{AL} = 1700 + 3800 = 5500 \text{ (as per PUM)}$$

(ii)

Entry Age Method

The normal entry age is either estimated from actual membership assumed or calculated from the decrement table employed.

The theoretical contribution rate required for a new entrant would increase with increasing entry age.

The contribution rate for the new entrant is generally insufficient to meet the costs of the future service for the present membership.

Therefore the AL is greater than the present value of accrued benefits on projected final earnings and hence provides greater security than the Projected Unit or Attained Age SCR.

The AL for the entry age method will exceed that for the attained age method, provided that the assumed entry age is lower than the weighted average age of the membership (and the discount rate is greater than the assumed rate of salary growth)

For stability it is necessary that the new entrants, if any, should have an entry age equal to the "normal age" which has been assumed.

It is therefore possible for the contribution rate to be stable even for funds that are closed to new entrants (or growing or diminishing in numbers)

If a scheme were to be set up to provide benefits for future service only, the new entrant contribution rate would usually be insufficient to meet the cost of future service benefits since the initial members would probably have a higher average age than the normal new entrant

Projected Unit

The contribution rate will be stable if the age & sex distribution of the membership remains constant
This generally implies a continuing flow of new entrants

The value of the assets will equal the AL assuming the SCR has been paid and all the assumptions are borne out in practice

As such all the benefits for members are fully secured by the assets held

Attained Age

The SCR for the attained age method exceeds that under the entry age method provided the average age is greater than that assumed for entry and exceeds the SCR of the projected unit method provided the average period to normal retirement is greater than 1 year

No account is taken of new entrants to the scheme.

As a result, if the scheme were closed to new entrants the contribution rate required should remain stable if all the assumptions were met.

If the scheme remains open to new entrants the method tends to overstate the contribution rate required

because new entrants tend to enter at a younger age than the present age of the existing membership and this generally implies that a lower contribution rate is required for new entrants.

The AL for the attained age is not maintained by the payment of the SCR.

Hence the SCR should not be calculated due to the ageing of the membership (if it is recalculated at later ages the SCR will overfund the liabilities)

QUESTION 5

A pension scheme provides death in service cover of a lump sum of 2 times basic salary plus a spouses pension of 25% of basic salary.

List the principal assumptions required to determine the cost of the benefits and outline the factors that need to be considered in setting them.

Mortality

Rate of mortality of those who join the scheme and whether this is likely to change in the future.

Mortality of spouses who would receive a pension.

Need to understand who are or will be members of this scheme and whether the profile is likely to change in the future and if there are any constraints on entry, e.g. if the scheme relates to an employment and members must satisfy a preemployment medical before joining.

We have no information on size or scope of the scheme so a reasonable starting point would be a standard industry or national mortality table if this exists.

If not, then a table for a similar country/industry could be used. This would be adjusted as the actuary saw appropriate to reflect the particular profile of those who will join the scheme.

If this is a new scheme it could well be a relatively ad hoc adjustment which would then be reviewed as experience develops

A similar approach is needed for the mortality of spouses.

However it is highly unlikely that a specific table would exist unless this was a well developed country.

Again a standard table with a relatively ad hoc adjustment is likely to be made which would then be reviewed with experience.

It is likely the actuary would take a cautious approach, i.e. over-reserving.

Proportion married, age of spouse

The proportion of members who join who have a spouse (however defined).

The age of the spouse.

The actuary could ask for marital status and age of spouse of each new member and price accordingly.

However, it may be impractical to ask and verify this information and in particular keep an up to date record.

(There is no indication of whether marriage needs to take place prior to joining the scheme).

Therefore a proportion married and spouses age could be assumed based on an appropriate benchmark (e.g. proportion married in the working population).

This could be graded by age, however in practice this may prove difficult unless there are significant variations.

Rates of Interest

The rate of interest or investment return that should be assumed on the premiums prior to death.

The rate of investment return to value the spouse's pension from the date of member's death.

If they exist, a government bond of appropriate maturity term would be the ideal match, although there may be some local regulations/legislation requiring a particular type of investment.

Any higher rate of investment return presumably reflects an investment with a degree of risk, (e.g. corporate bonds or equities if this is a developed market)

For the spouse's pension, again, an appropriate government bond of appropriate term would be the basis of calculation.

Although in practice the benefit may be secured with an annuity. In either event an assumption needs to be made about the appropriate rate of interest at the future date of death.

Salary Growth

The rate of salary increase (depending on how cost is determined).

Salary growth is important if the benefit cost is not assessed on a one year basis.

Should look at salary growth due to general inflation and merit increases separately.
Depending on the size of the membership it may be possible to assess from scheme statistics, otherwise general population statistics would be adopted.
Above would only be undertaken if salary growth significant to calculation.

Expense and/or administration costs

These would presumably reflect anticipated costs.
Should also ascertain cost of insuring the benefits.

QUESTION 6

A large pension fund in a developed country accumulates a retirement benefit on a defined contribution basis till retirement at age 60, when the benefit must be taken as a pension. At age 60, the member has the following options:

- *Use the benefit amount to purchase a life annuity from an insurer, thereby transferring the pension liability from the fund to the insurer. There is considerable flexibility as to the type of annuity that may be purchased.*
- *The member's share is left to accumulate in the fund but a certain percentage (ranging between 3% and 17%) of it may be drawn down as a pension each year. The pensioner decides on the percentage at each anniversary of his/her retirement and that percentage is applied to the share at that point in time and the amount is converted to a monthly pension for the ensuing year. At age 75, however, the remaining share must be used to purchase an annuity from an insurer.*
- i. *The Fund has appointed several advisors to whom the members may turn for advice on whether to draw their pension from the fund (and at what rate) or whether to purchase an annuity from an insurer. You are one of these appointed advisors. State with reasons the information you may require and factors you may consider in giving such advice.*
- ii. *While the Trustees are responsible for the investment of the fund's assets, there is also a desire (and legal framework) to allow a degree of investment choice for the members. Discuss the factors peculiar to this scheme that the Trustees would have to address to facilitate this.*

Information and factors for advice:

- It is not clear whether the option to purchase an annuity can only be exercised at ages 60 and 75 or whether, if the draw down is chosen at 60, the annuity can be purchased at any age up to 75. This should be established. If the latter more extended option period is available, one would need to know:
 - Age/sex of the member
 - Current annuity rates available from insurers
 - Whether these rates are historically high or low
 - What interest rate is implicit in the annuity rates and how this compares with what may be expected from the investment returns on the fund
 - What interest rate changes are expected up to age 75

- Bearing in mind that once the annuity is purchased, the pensioner is 'locked into' that rate for the duration of the annuity.
- In general, one would want individual personal information:
 - Age
 - Sex
 - Current salary
 - Marital status
 - Ages of spouse & children
 - Number of dependants (e.g. children) – all above data for calculating the annuity
 - Member's degree of risk aversion – the drawdown option is inherently more risky
 - Size of the member's share – smaller share means less flexibility and more risk in the drawdown option
 - What are the member's cash flow needs in first 15 years?
 - Regular – annuity may be better
 - Irregular – drawdown may be better
 - Member's health?
 - Good – annuity may be better if they live longer
 - Bad – maximum drawdown may be better, especially if balance of fund available to dependants
 - How does pension compare with member's total sources of income/wealth?
 - Small % means more freedom to take risks e.g. drawdown
- What happens to the balance of the fund on death during drawdown phase?
 - Is it available for dependants?
 - What are the tax implications?
 - What is the cost of equivalent life cover?
- What are the expenses during the drawdown phase vs expenses of purchasing a pension (e.g. commission)?
- Get quotations on purchasing an annuity on various options
 - E.g. guarantee periods, escalations, spouse's pension, children's pension etc.
- Does the member have investment choice in a drawdown situation?
 - What range of choices?
 - Can switches be made?
 - How frequently?
 - At what cost?
 - This would all affect the level of returns that could be expected

Investment Strategy Factors:

- Generally the trustees would wish to maximize net returns with an acceptable level of risk
- Since a share of fund is earmarked for each member/pensioner, the investment of that share should ideally match that member/pensioner's particular circumstances e.g.
 - Term of liabilities
 - Appetite for risk
 - Option choices

- Financial sophistication
- As it is a large fund, there will be a wide range of such circumstances
 - So a single over-arching investment strategy would not be optimal for many of the members/pensioners
 - Provision of investment choice may go some way toward solving this problem.
- Perhaps offer several investment media with a range of:
 - Risk levels
 - Terms
 - Asset classes, e.g.
 - Equities
 - Bonds – with a suitable mix of terms to match pension liabilities
 - Money-market
 - A balanced fund
 - A smoothed investment fund (may need restrictions on switching out to prevent anti-selection).
 - In a way, purchasing an annuity is simply another option (but irreversible)
 - But not too many, else
 - Members might become confused
 - Admin may become too complex/expensive
 - Legislation may impose a restriction on choices available
 - A lifestyle option, moving into pension matching investments
 - Over what period?
 - Choice or compulsory?
 - Will it be the default option?
 - Could give a lesser benefit if equity returns good in the last few years
 - So need good member communication
 - How to handle early and late retirement?
 - Trustees must provide appropriate returns/investment managers in each choice
 - Have a default option if choice not exercised
 - Appropriate to a majority of members
 - Recognising that a high proportion of members will probably go with it.
 - When and how often is switching allowed?
 - At what cost and who pays?
- Provision of investment advice:
 - Do the trustees have a responsibility for this?
 - E.g. members may make an inappropriate choice
 - Particularly if some members financially unsophisticated
 - What format?
 - Individual counselling
 - Group presentations, roadshows
 - When and how often?
 - Who picks up the cost?
- Matching of annuity purchase price:

- As approaching retirement and especially in drawdown period
- Need to match annuity purchase price with appropriate mix of bonds
- With similar expected mean term
- Less matching requirement in pre-ret period if the member's intention is to go the drawdown route

QUESTION 7

Briefly describe the main methods of financing a social security system, indicating in each case how the contribution rate would be calculated.

Pay-as-you-go (PAYG):

- Unfunded approach
- $CR = (\text{benefit expenditure in that year}) / (\text{total salaries of the contributing population that year})$
- In its pure form, contribution income in each year exactly equals benefit outgo for the same year. Hence no fund build-up.
- Stability of Contrib rate depends on population profile and differential between average conts and average benefits.
- Contribution rate tends to increase as system matures.
- In practice, usually a contingency reserve (working balance) to smooth out contribution rate.
- This can be done consciously by calculating the conts over a control period from time to time. (Equalised PAYG).
- Note that PAYG is susceptible to ageing of the population and may in future require:
 - Raising of taxes, or
 - Cutting of benefits

General Average Premium (GAP):

- Contribution rate calculated to be level over the lifetime of the system
- $CR = (\text{pv all future benefits incl new entrants}) / (\text{pv all future contributing salaries incl new entrants})$
- Later contrib. reviews would also take into account the reserves already built up.
- Initially contrib. rate higher than for PAYG
- Builds up a fund that is later drawn upon.
- Contribution rate stable if initial assumptions are borne out in practice.

Terminal Funding:

- Intermediate between PAYG and GAP
- Benefits are pre-funded at the time they are first awarded
- $CR = (\text{pv of benefits awarded in a year}) / (\text{pv of total contributing salaries in that year})$
- CR not affected by whether benefit received as a lump sum or an annuity

- Hence widely used to finance benefits from an occupational injuries fund

Scaled Premium:

- CR is intermediate between PAYG & GAP extremes
- Initial CR = $(\text{pv benefits paid over a control period}) / (\text{pv contributing salaries paid over the same period})$
- Longer the control period, the closer the method is to a GAP approach
- Fund is reviewed annually:
 - As soon as fund begins to fall, the CR is recalculated for the next rolling control period
 - But with constraint that fund must not reduce over the new control period
 - So the contributions plus the investment income from the fund must be sufficient to meet the benefit payments in any year
 - As the fund capital remains untouched it is possible to invest in long term assets.