

Institute of Actuaries of India

Subject ST2 – Life Insurance

April 2016 Examination

INDICATIVE SOLUTION

Introduction

The indicative solution has been written by the Examiners with the aim of helping candidates. The solutions given are only indicative. It is realized that there could be other points as valid answers and examiner have given credit for any alternative approach or interpretation which they consider to be reasonable.

Solution 1:

i) The assumptions required are:

- Joint mortality assumption
...Including longevity / mortality improvement for the survivor post first death
- Morbidity assumption for the specified critical illnesses
- Lapse / persistency assumption. Note that if a marriage breaks down the policy is likely to be surrendered, so this risk needs to be considered here.
- Expenses and commission assumptions
...which might require an assumption on new business volumes
- Expense inflation assumption
- Investment return assumption
- Reserving assumption for projecting reserves
- ...these should be as per the regulatory requirement

[5]

ii)

The risk discount rate would be set as the sum of:

- The Risk Free rate, and
- The Risk Premium

The Risk Free rate:

- This would be the rate of return guaranteed on an asset that is considered risk-free and tradable in the market.
- A suitable proxy could be the yield on the most traded government bond in the market.

The Risk Premium

- A risk premium would be required that reflects the additional risk borne by the investors by investing in the insurance company, instead of investing in the risk free asset
- This should be reflective of the risks associated with this product.
- It needs to be set in conjunction with the profit criterion. If the profit criterion is high the RDR need not be so high.
- It may be determined using CAPM
- ...or by considering the variability of profit in the product and sensitivity to withdrawals, expense variations etc.
- Can also consider risks compared to other uses for capital such as equity investment, etc.
- Since it is a new company with no prior experience, it may choose to use a higher risk discount rate.
- The shareholders may have specified a minimum risk premium

[5]

iii)

- Mortality and morbidity
 - There might be selective withdrawals, with lives in better health choosing to surrender since the surrender benefit might become more attractive than the death benefit.
- Lapse / persistency
 - Due to economic downturn, premium paying affordability is expected to reduce, thus resulting in higher than expected lapses/surrenders
 - The economic downturn may lead to crunch in cash for some customers, resulting in higher surrenders
- Expenses
 - Unlikely to have an impact on per claim expense.
 - However, if there are very high number of surrenders, per policy expense may go up.
 - Economic downturn usually leads to lower inflation levels. Therefore, the expense inflation might be lower than expected initially.
- The prevailing interest rates would reduce and therefore future premiums will have to be invested on lower interest rates.
- RDR may change to the extent of the change in the risk free rate

[5]

[15 Marks]

Solution 2:

- i) Since the increase is at policyholder's discretion, the policyholders who are in bad health are more likely to opt for it. This anti-selection risk is likely to lead to poorer experience.

The following could be done to manage the risk:

- Define when the option could be exercised. For example, it may only be exercised at certain policy anniversaries, or when specific qualifying events occur say, birth of a child. This limits the chances of anti-selection.
- The company could limit the increase, to say 5% from the original sum assured rather than with no cap.
- Also the company can limit the number of times the option may be exercised during the policy term.
- The exercise of option may be restricted to only those policyholders who were issued standard rates (i.e. who were in good health) at policy inception.

- Anti-selection issues could mean that the underwriting may need to be tighter, which may deter sales.

[5]

ii)

- The cost of an option is the value of the excess of the premium that should, in the light of full underwriting information, have been charged for the additional assurance over the normal premium rate that is charged.
- If a life, who is in good health and who would be expected to satisfy normal underwriting requirements, exercises the option, then the option will generate little or no additional costs. The exercise of the option by lives in poor health will generate considerable additional costs.
- There are two methods in common use, namely the “North American experience” method and the “conventional” method.

North American method

- This method requires two additional items in the pricing basis:
 - A double decrement table for lives who have not yet exercised the option, with decrements of death and exercising the option represented by dependent rates of decrement at age x of $(aq)^d_x$ and $(aq)^w_x$ respectively
 - A mortality table for lives who have exercised the option, represented by mortality rates q'_x
- The present value of the benefit is then calculated as the sum of:
 - the present value of the benefit payable with respect to the lives who are not expected to exercise the option, calculated for the original SA using the decrement $(aq)^d_x$
 - the present value of the benefit payable for the increased SA for the lives who exercise the option, multiplied by the probability of exercising the option calculated using the decrement $(aq)^w_x$, calculated using a mortality rate of q'_x . This is summed for the period when the option can be exercised.

Alternatively the formulae on Page 610 of the study material may be stated.

- The present value of the premium is calculated as the sum of:
 - The present value of the premium receivable for the original SA for the policies till when the policyholder is alive and does not exercise the option
 - The present value of the premium payable for the increased SA, calculated by multiplying the Premium payable after exercising option, with the probability that the option will be exercised. This is summed for the period when the option can be exercised.

Alternatively the formulae on Page 610 of the study material may be stated.

- The difference between the expected present values of the benefits and the premiums is the expected present value of the cost of the option. This could be

charged for by an extra premium payable until the option is exercised or earlier death, calculated by dividing the cost of the option by an annuity factor for the original term of the contract.

Alternatively the formulae on Page 610 of the study material may be stated.

Conventional method

- The assumptions underlying the conventional method are:
 - all lives eligible to take up the option will do so,
 - the mortality experience of those who take up the option will be the Ultimate experience which corresponds to the Select experience that would have been used as a basis if underwriting had been completed as normal when the option was exercised.
- The present value of the benefits would then be equal to the sum of:
 - The present value of the benefit as per the original SA of the contract, calculated using a select mortality table, and
 - The present value of the benefit for the increased SA only, calculated using an ultimate mortality table that would be expected to apply at the time of exercising the option, discounted to the beginning of the contract.

Alternatively the formulae on page 616 can be reproduced.

- The present value of the premium (without the increased cost) would be calculated in a similar manner to the present value of the benefit.

Alternatively the formulae on page 616 can be reproduced.

- The extra premium to cover the cost of the option can then be calculated by equating its expected present value with the expected present value of the benefits less premiums calculated above.
- It is not possible to use this method when there are many possible dates on which an option may be exercised, or when at some (or all) of the option dates there is a choice from several alternative options, one or more of which may be chosen.

[12]

iii) The factors to be considered are:

- **Profitability**
 - The company would want to ensure that the product remains at least as profitable after introducing the option, as it was before this change in the product was suggested.
 - Therefore, the company will need to ensure that the extra premium for the option will be sufficient to cover the benefits to be provided and the expenses in most foreseeable circumstances and provide an adequate profit margin.
- **Marketability**
 - The product design needs to be attractive and marketable.

- The company may wish to investigate whether such an option is understood and found attractive by its customers.
- Since an extra premium would be payable for this option, it may not be attractive depending on the premium charged
- **Competitiveness**
 - New products need to be competitive against any similar products available in the market.
 - The company needs to investigate whether such an option is currently being offered by its competitors.
 - In particular, whether the reinsurer(s) for the current product are willing to support the new option would need to be considered.
 - If so, the company needs to ensure that the option pricing is competitive compared to the other players in the market.
- **Financing requirement**
 - Although, this is unlikely to be a major concern, the additional reserve required as a result of offering this option needs to be evaluated.
 - If the sale of the product increases considerably as a result of this option being included, the company would need to ensure that it is able to meet the financing (reserving) requirements arising out of the increased business volumes.
- **Risk characteristics**
 - The company needs to consider whether it is comfortable accepting the anti-selection risk.
 - The company would wish to consider measures that it can take to manage the additional risk posed by this option
 - The company would need to be clear about the terms and conditions of the option. When can it be exercised, and under what conditions.
- **Sensitivity of profit**
 - The company would need to consider the sensitivity of profit to variations in future experience, primarily mortality.
- **Extent of cross-subsidies**
 - The lives not exercising the option would be required to cross-subsidise the lives exercising the option.
 - Therefore there may be significant cross subsidies involved in this product, that the company will need to monitor and manage.

- **Administration systems**
 - The system should be capable of handling the option and ensuring that the process of exercising the option is as automated as possible.
 - In addition, the system should be capable of recording the change in terms of the contract
- **Regulatory requirements**
 - The company should consider if there are any regulatory, fiscal or legal concerns regarding the revised design of the product.

[9]

[26 Marks]**Solution 3:**

i) The asset share is the accumulation of premiums less deductions associated with the contract, all accumulated at the actual rate of return earned on investments.

Deductions would include all expenditure associated with the contract(s):

- expenses incurred and any commissions paid
- the cost of providing all benefits in excess of asset share – eg life cover or any other guarantees or options granted – possibly on a smoothed basis
- tax (if appropriate) including any reserves made for future tax liabilities
- transfers of profit to shareholders
- the costs of any capital necessary to support contracts
- any contribution to or from the free assets which, in turn, support the smoothing of bonuses and the ability to exercise greater investment flexibility
- If other than asset share is paid out on average on surrender, then the calculation could also include addition of surrender profits (or deduction of losses) from with-profits business

[6]

ii)

a) ***Higher investment in Government bonds***

- Future investment return would change depending on the change in the government bonds mix
- Though the above would depend on whether the company decides to increase the government mix or...
- ...continue with the current mix in which case the prospective asset share will not change
- If the company decides to increase the government bonds mix, it shall have to reduce the mix in other investments such as corporate bonds, equity. The future investment return would hence reduce and so will the prospective asset share.

- However, the above will also reduce the cost of guarantee, etc. from the asset share since the investments in the risky assets will decrease offsetting the reduction in asset share.
- Any change in investment mix will also be governed by the PRE and any communication to the customers on the investment strategy.
- If the asset composition changes, there could be secondary impacts due to asset reshuffling costs and the realization of capital gains/losses

b) *SH rate of return increase*

- This will increase the cost of the shareholders' capital.
- As a result, the shareholders' share of the distributed profit will increase, increasing the amount of shareholders' transfer each year.
- This will act to reduce asset shares
- Although, the ability to charge the increased cost of capital in the asset share will be limited by the PRE/TCF considerations and the regulations
- Since the estate is large, can it be used to fund the extra cost?

c) *Maximum reserving interest rate*

- At an immediate level, there will be no change because asset shares are affected only by cash flows, and the level of the reserves is therefore irrelevant.
- However, there may be a number of second-order impacts.
- If the maximum interest rate is higher than the current reserving basis, there would be no change in asset share
- If the maximum interest rate is lower than the current reserving basis this would lead to strengthening the reserves
- Strengthening of the reserving basis will mean that more capital will now be required to sell a policy. Larger deductions would therefore be required to be made from asset shares, to pay for the increased cost of capital, for all policies that require more capital than before. This will reduce the prospective asset shares for such policies.
- An increase in reserves will reduce the insurer's investment freedom. This will reduce the future investment return potential, which will in turn result in lower asset shares ultimately.
- The insurer may decide to use the large estate to fund the extra cost, depending on the role of the estate as communicated to the policyholders.

[10]

iii)

- The company may face difficulty due to the long term nature of some policies and short comings in the data recorded for each policy/asset class.
- Information will be required regarding the premiums paid by the policyholder in each year since the commencement of the policy.

- Whilst the IT systems may record this level of information, it may be very difficult to extract this information for actuarial valuation purposes, due to the complexity of the data and in the required format.
- Information will be required regarding the expenses incurred by the company each year since the commencement of the policy/ cohort of policies, and the expenses which are attributable to that cohort of policies.
- Whilst the company is likely to have the total expenses incurred each year in its annual accounts, it is unlikely to have carried out a detailed expense investigation each year to ascertain how expenses should be apportioned between various classes of business, and various policy cohorts.
- At best a broad brush approach may be used for many of the earlier years, when there is a lack of data available, by apportioning expenses based on factors such as sums assured or premium size or on a per policy basis,
- with the possibility of apportioning expenses more accurately in the most recent one or two years, when detailed expenses information may be available.
- Information regarding the cost of insurance cover for a cohort of policies will be required, this may not have been measured in detail historically.
- Data relating to the profits from surrenders and lapses, that should be taken into account in the calculation of the asset shares will be required.
- The company is unlikely to have very good data relating to the profits on surrenders and lapses, over the years.
- The company might be using a proxy to estimate the cost of guarantees and capital support rather than determining it accurately.

[8]

[24 Marks]**Solution 4:**

i)

- Appropriation price is the price at which the company will create a unit. In other words, it is the amount of money that the company should put into the fund in respect of each unit it creates in order to preserve the interests of the existing unit-holders.

It may be calculated as:

- the market “offer price” value of the assets held by the fund plus the expenses that would be incurred in the purchase and any stamp or other duty payable in respect of such a purchase
- plus the value of any current assets, such as cash on deposit or investments sold but not yet settled
- less the value of any current liabilities, such as investments purchased but not yet settled or loans to the fund
- plus any accrued income, such as interest income from fixed-interest securities and deposits, net of any outgo, such as fund charges
- less any allowance for accrued tax, if applicable

This gives the net asset value of the fund on an “offer basis”. Dividing by the number of units existing at the valuation date, ie before any new units are created, gives the appropriation price.

[5]

ii)

- Errors in the calculation of the price at which units are allocated or de-allocated.
- Errors in the calculation of the price at which units are created or cancelled.
- The valuation date of the units needs to be consistent with the dealing date to avoid anti-selection by policyholders
- The basis used to calculate the unit prices should depend on whether the company is a net allocator or redeemer of units. There is a risk the pricing doesn't reflect the company's change in position with a corresponding change in the pricing basis.
- There may be a risk that systems carry inaccurate or out of date information. For example incorrect accrued interest or dealing costs

[4]

iii)

- Where allowed by the contract terms, the variability of expense deductions will be clearly mentioned in literature.
- Furthermore, increases have been implemented from time to time. PRE should therefore permit further increases.
- The past uneven timing of such increases may be replaced by regular annual increases to set the PRE better.
- The increase in expense charge over the years may have been lower than the maximum permissible, which might have set the PRE accordingly and which may limit any future increase to below the maximum.
- No changes have been made in the past to the AMC, although this charge may have been increased elsewhere in the industry.
- So the starting point would be expectation that the AMC would not change.
- Nevertheless, the AMC which is variable would have been stated in all the literature and the terms and conditions, which could allow the company to vary it in future.
- Though this might depend on the event that would justify an increase
- Solvency of the company is paramount. Policyholders' primary expectation is that the company will remain solvent and would be able to pay claims when they arise.
- And thus if the solvency is threatened, increase in AMC should be acceptable.

[7]

[16 Marks]

Solution 5:

i)

- Entry into new markets may not work as the company has no prior track record or reputation for these product types
- The direct sales force will require extensive training and may lack confidence with the new products
- Annuities and term assurances may not be profitable business for the company, as it has no experience in underwriting or pricing these product types
- Brokers' market is price sensitive. So profit margins on annuities and term assurance are likely to be low
- The company also has no track record of WP business (eg: no record of bonus rates), so entering the brokers' market may not succeed.
- Sales force for managing the brokers' market will have to be setup from scratch and therefore management of the existing product and distribution could be impaired.

[5]

ii)

- The expense of selling higher volumes of business, which will not be recouped immediately, including the valuation strain on annuities, term assurances and the WP business
- The above will be even more if the premium rates are very competitive.
- Setting up and managing the with profits fund, which would lead to additional work in all areas (regulatory framework, bonus declaration, reporting etc.)
- The required minimum solvency margin for all the new product types, particularly under term assurance where it is very high
- Designing and building the new products, including the marketing costs to create market awareness
- Creating the supporting processes for sales and administration, particularly an underwriting function
- Costs of training the distribution would be high given the unfamiliarity of the new products to them
- Expansion of office space including increasing of workforce

[6]

iii)

- The company should invest so as to maximise the overall return on the assets, subject to the risk being taken on being within the financial resources available to it.
- For annuities, closely matched investments are needed for level annuities. These will be fixed interest stocks of appropriate term.
- For index-linked annuities and expenses, index-linked investments will be required.
- However, it may not be possible to have matching assets for all the annuities, due to the long terms
- The reserves for term assurances are likely to be small, particularly if the business is reinsured. Fixed interest stocks will be suitable.
- Investment strategy needs to be developed for WP business.
- The investment strategy needs to be documented and communicated to the policyholders which would be essential in forming the PRE.
- The investment policy would need to take into account the bonus philosophy of the company i.e. mix of reversionary and terminal bonus.
- Fixed interest investment will be required to match the guaranteed benefits.
- Some proportion of investments in equity is likely.
- The assets backing the required solvency margin should be invested in line with the assets backing the corresponding mathematical reserves.
- The free assets will probably be invested in equities.

[8]

[19 Marks]
