Institute of Actuaries of India

Subject ST1 – Health and Care Insurance

May 2009 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

Given:

From:	To:	Probability:
Healthy	Death	0.03
Healthy	Disabled	0.02
Disabled	Death	0.04
Disabled	Healthy	0.20

(i)

Transition Rate:
P(healthy to healthy) = 0.95
P(healthy to death)=0.03
P(healthy to disabled) = 0.02
P(disabled to healthy) = 0.20
P(disabled to disabled) = 0.76
P(disabled to death) = 0.04
P(death to death) = 1

Probability of being in different state at the end of each year:

Year	Healthy	Disability	Death	Total
0	1	0	0	1.0000
1	0.9500	0.0200	0.0300	1.0000
2	0.9065	0.0342	0.0593	1.0000
3	0.8680	0.0441	0.0879	1.0000
4	0.8334	0.0509	0.1157	1.0000
5	0.8019	0.0553	0.1427	1.0000

(ii)
PV of premium $= P(1+0.95v+ \ldots\ldots \ldots+0.8334v^4) = 4.1625$ P
PV of disability benefit $= 100000*(0.02v+0.0342v^2 +\ldots\ldots.+0.0553v^5) = 17,344$
PV of death benefit $= 150000*(0.03v+0.0593v^2+\ldots \ldots..+0.1427v^5) = 54,785$
PV of expense $=500+ 150*(0.95v+ \ldots\ldots\ldots+0.8334v^4) + 250* (0.02v+0.0342v^2 +\ldots\ldots.+0.0509v4) = 1007$

Premium equation is
4.1625 P = 17344+54785+1007
Annual Premium = 73136/4.1625 = Rs 17,570

(iii)
Use cashflow model, which would involve projecting expected net profit flows from the policy in each policy year.

Each years profit would be calculated as premium less expense and claim cost less increase in reserve plus investment income less tax less cost solvency margin.

The claim cost will be calculated as the PV of all claim payments arising due to the occurrence of event in that particular year.

That could be calculated by multiplying the occurrence rate by the annuity factor based on the above stated decrement rates and relevant interest rate.

There would be separate annuity factors for series of payments on occurrence of death and disability. For death it would be annuity certain for rest of period where as for disability it would be paid contingent on the life remaining in a disabled state.

For reserve calculation you would need separate set of cashflows but may be at more prudent assumption.

The future profit flows would then be multiplied by the probabilities of initial policyholders remaining in status of premium payment (healthy) to the start of each year allowing for deaths, disabilities and lapses, to produce profit signature.

The assumption used in cashflow projection would be best estimate.

Discounting at the risk discount rate (RDR) and summing the present value gives the net present value (NPV) for the policy.

The RDR should reflect the shareholders' required return on capital and allow for the relative riskiness of the product.

A non-negative NPV indicates that the shareholders will obtain their required return on the capital.

We can calculate Internal Rate of return, which will indicate what the profitability means in terms of the return obtained on the shareholders capital.

We can calculate discounted payback period which would indicate in how many years the accumulated loss at the rate of RDR shall become positive. This gives after how many years shareholders will be able to recover their capital with a return equal to the RDR.

These profit measures should be recalculated on a range of different possible assumptions for the future experience in order that the robustness of the profit can be ascertained.

[14]

Solution 2

(i)

During the term of the policy some of the CI might be a common cause of claims resulting in increased expected future claims cost at each review.

If this increased cost is reflected in reviewed premium this may result in premium increases that are unacceptable to policyholders.

If these premiums were quoted, healthy lives would lapse policies and instead buy policies where such commonly insured events are qualified from other insurers (because these would be cheaper).

Lives in worse health will stay as they would be subject to underwriting on buying new policy because of their poor health which would lead further deterioration in claim experience.

Therefore there would be selection against the insurer.

Policyholders may become dissatisfied when they see new life threatening conditions are not covered and hence may seek insurance elsewhere.

(ii)
Policyholder will be suspicious that insurance companies would always revise the CI cover to their advantage.

So some element of independence in the review would be helpful.

It would also assure policyholders to know that their policy was keeping pace with the best practices in the market and that it will continue to meet their needs by including all current life threatening conditions.

Marketing the review as a "keeping the benefit up to date" review of CI definition etc might make it more likely to be accepted. This would reduce the risk of selective withdrawal.

Review may also result in a reduction in premium as some conditions for benefit become obsolete and are removed, which would be more appealing for the policyholders.

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Solution 3:

(i)   Credit risk is the risk of loss arising from a reinsurer defaulting on its obligations.

The credit exposure is a measurement of how much the insurer would lose if reinsurer defaults.

Ways of managing the credit risk and the exposure can be managed include:

- Prescribing minimum credit rating of reinsurers
- Regular monitoring of their credit rating
- Spreading the risk among a number of reinsurers
- Using credit derivatives to transfer credit risk to a 3rd party
- Insuring the credit risk with a general insurance company
- While selecting reinsurance company, aggressive pricing by a reinsurer to be seen in the light of potential default risk
- Analyzing the capital adequacy of the reinsurer

- The reinsurance contract valid for short time intervals. This may imply additional efforts for negotiations and instability of reinsurance premiums
- The decision to reinsure can factor the default risk (e.g. EPV of reinsurance premiums > EPV of claims made from reinsurer factoring credit risk as well)
- Retaining most morbidity risk, minimizing reinsurance
- Preferring excess of loss reinsurance over quota share
- The reinsurance contract to provide for ring-fencing of reserves created by reinsurer for claim payments to the insurance company

(ii)
Key factors include the amount of fluctuation in claims costs that the company finds acceptable. The size of the company's free assets is crucial here. The lower the acceptable fluctuation, the lower the retention limits.

The cost of capital is an important factor; the higher the cost of capital required to reduce the claim fluctuation, the lower the retention limit.

Any reduction in solvency margin requirement permissible through reinsurance would also influence the retention limit. The company might decide to take complete advantage of any regulatory relief in maintaining solvency margin by going for maximum reinsurance.

The quality of underwriting might affect future claim experience; hence this could be another factor.

If the reinsurance is being used to reduce new business strain then the retention level will be particularly sensitive to product design, expected new business volume and mix, and on the existing level of free assets.
If income protection is a new line of business where the company does not have very reliable own experience then the company might go for lower retention limits to reduce claim uncertainty.

The company might reinsure more than purely financial factors would suggest if it is looking to obtain reinsurer's assistance in certain areas e.g. underwriting, specialized product development etc.

The cost and the types of reinsurance available would also affect the retention limit.

[10]

Solution 4:
(i)
There will be fewer policies in force at the end of the year than expected. As fewer policies would be in force per policy fixed expense might go up hence reducing the emerging profit more than expected.

Higher lapse rate in a year might lead to the conclusion that over all lapse rates would be high and hence upward revision in future lapse rate which may further reduce the value of in force policies and hence lower EV.
The lapse of a policy would trigger the immediate release of the reserves held under the policy. Therefore the important issue to consider is whether the present value of future profits lost on

lapse is higher or lower than the release of reserves, bearing in mind that the latter contains prudential margins.

For example, if a policy has charged level premiums for an increasing risk (e.g. morbidity risk increasing with age), then later on in the policy term a lapse can in fact increase the embedded value.

This is because the present value of future claims and expenses will exceed that of future premiums, and so a reserve has to be held.

On lapse, this reserve is released fully to the company and thus directly increases the EV.

If the policy does not lapse then most of the reserve is required to pay the excess of claims/expenses over premiums, and the only contribution to the EV is the present value of the future release of the prudential margins within the reserves.

Thus overall, a lapse in this situation will increase the EV.

(ii)
A major impact would be increase in the value of assets over the year.

However corresponding increase in reserve is likely due to fall in valuation interest rate.

But increase or decrease as a result will depend on the degree of mismatching between asset and liabilities

And also on any restriction on changing valuation bases.

The fall in bond yield will also result in a reduction in future investment return assumption, which will reduce the projected future profit.

It will also reduce the risk discount rate, which will have the effect of increasing the value of expected future profit.

If it is assumed that the assets and liabilities are perfectly matched and that the valuation rate of interest for the liabilities can be moved exactly in line with the change in yields then if bond yields fall so that the value of assets backing the liabilities increases by X, then the value of liabilities will also increase by X, so there is no net change to the EV.

The future investment returns will fall, and (if we had perfect matching) this will approximately reduce the future investment return proceeds from the assets by X (this must offset the initial increase in market value, since the asset amounts actually received will not be any different since the coupons and maturity amounts are fixed, and we have assumed perfect matching and therefore do not have to crystallise any changes in market value by cashing in before maturity).

However to counteract this we also have an additional X of reserves which will be released in the future profits within the calculation.

Thus, overall the impact of a lower yield in a perfectly matched scenario would likely be to increase in the EV, assuming that the discount rate also reduces in line with the bond yields. This is because the various asset and liability changes would more or less cancel each other out (both in the net assets and PVFP calcs), and the most important remaining impact will be a higher present value of future profits due to a lower assumed discount rate (if it is changed).

(iii)
Increase in claim incidence rate during the year will reduce the profits and hence the free assets at the end of the year which will lead to the reduction in EV.

The increase in incidence rate would be expected to continue and so reduce the expected future profit as well and hence the EV.

The higher incidence rate would result in a higher reserve and hence delay the emergence of profit, which will reduce the EV.

However if the company has got right to review the premium rates, it might increase the premium rate and hence maintain same level of future profit and reduce the negative impact of higher incidence rate.

The possibility of selective lapses in future would reduce the expected future profits and hence the EV.

(iv)
Lower sales than expected would result in lower increase in EV than expected assuming the business is profitable.

Per policy expenses might go up because of lower new business and hence need upward revision in expense assumption leading to reduction in future expected profit and hence reduction in EV.

[14]

Solution 5:
(i)
The health insurance premium does not generally contain any saving element, which normally exists in endowment type of product to pay maturity or surrender value, and hence emergence of profit under health policies is less sensitive to the interest rate assumptions.

The health insurance liabilities are normally for short terms so assets of shorter durations are held and hence the value of assets is less sensitive to the interest rate movement.

The amount of reserves would be relatively low compared to an endowment plan and hence any variation in investment return would have less impact on profit.

Also because of relatively low reserves any change in valuation interest rate would have little impact on emergence of profit.

(ii)

First the objective of the investment strategy should be defined, for example to reduce the probability of the company's insolvency below 1% due to asset liability mismatch.

Suitable model and parameter assumptions would be required to project the asset and liability cashflow on existing as well as future new business. The parameter assumptions would be about asset class, expenses etc. The model could stochastic or deterministic.

The assumption should be realistic, dynamic and consistent with other related assumptions.

The realistic cash flows are estimated and projected to quantify the value of assets and liabilities at the end of each time period. The valuation basis should reflect the assets held and any regulatory constraints.

Suitable statistics should also be calculated to enable the user to see whether the objective of the investment strategy is met i.e. profitability and probability of ruin.

A number of scenarios should be projected to ensure that strategy would be viable in most of the scenarios.

Various strategies might be considered by comparing how each one of them is placed against the benchmark objective.

[5]

<u>Solution 6:</u>
(i)Option
The method and assumptions depend on the purpose of the reserving exercise.

For example, for statutory or solvency purposes a prudent approach will be taken, whereas for internal purposes a best estimate approach may be more applicable.

The choice as to whether to exercise the option depends heavily on the self-perceived health of the policyholder. A policyholder who perceives himself to be in poor health or more susceptible to illness is more likely to exercise the option, thus selecting against the insurer.

The desirability of the option also depends on the financial needs of the policyholder at the option date. For example, it may be that the policyholder no longer has a desire for cover in the event of diagnosis of a critical illness, and so opts not to extend it despite it being "a good deal"

To value the option, we can use either the conventional method or the North American experience method

North American experience method
- Assumptions will be needed on the proportions of policyholders choosing to extend cover.
- If prudence is required, we would overstate the proportion choosing to extend.
- Assumptions will also be needed for the morbidity and mortality experience during the original term, and of those policyholders who choose to extend cover thereafter.
- We would then analyse the experience split by age, sex, *etc*, and allow for any trends and margins when projecting future morbidity/mortality.

- To reflect the anti-selection opportunity, we would make a much higher claim incidence rate assumption for post-option experience.
- The assumptions would ideally be based on post-option past data, if available.
- This will be needed for a variety of model points, *eg* sample terms and ages.
- We also need to know details about the premium rates of the policies taken up under the option.
- Insurability will usually be guaranteed at the company's standard premium rates at the time of extension.

Conventional method
- This assumes that all lives take up the option.
- We then need an assumption for the morbidity experience of the whole group as at the end of the existing term. This would also be based on past experience.
- We would again analyse the experience split by age, sex, *etc*, and allow for any trends and margins when projecting future morbidity/mortality.
- Calculate the expected extra cost of claims from the future "option" policies, over the standard premium rate, and discount at a prudent interest rate.
- In calculating the extra cost of the option, claim incidence rates and mortality prior to the option date would be assumed to be low, for prudence, and lapses   would be ignored.

Under both methods, if the extension premiums are on *guaranteed* terms rather than the standard rates then in force, this poses an extra risk to the insurer since it is bound by these rates for the extended term. This is particularly important if the profitability of the current rates is in question.

We need to know the extent of the option. For example, do the policies taken up under the option also have further options to extend again at the end of the new term? If so, the risks are compounded and further assumptions are needed as to the second (or further) extensions.

We also need to allow for the expenses of administering the option.

The assumptions used in the valuation of the option should be consistent with those used to value the guaranteed benefits and the assets.

The experience on similar options on similar contracts may be useful.

Reinsurers may be able to offer us some assistance in setting assumptions.

(ii)UPR
The allowance for unexpired risk will consist of an unearned premium reserve (UPR), and if necessary, an extra allowance called the additional unexpired risk reserve.

The two will cover the allowance for both future claims and associated expenses on the unexpired portion of cover.
We first need an assumption as to how business is sold throughout the year. In the absence of any other information, it would be reasonable to assume that PMI business is sold evenly throughout the calendar year.

We also need an assumption on the length of cover provided by the policies. As the premiums are annual, it is again reasonable to assume that cover is one year long.

An alternative, and more accurate approach, would be to use the *actual* unexpired period calculated on a policy-by-policy basis, in which case the last two assumptions would not be required.

Next, we need an assumption on the earnings of the premium, *ie* how the risk on the policy is spread over the year.

One option would be to assume that it is even over the year. The UPR in this case would be a simple proportion of the written premium based on the number of days cover unexpired (either assumed or actual, as above) as at the calculation date.

However, it is perhaps better argued that there will be more claims over the winter period (*eg* for pneumonia), in which case the risk is greater over those months. For example, in the UK, the months of November to February might give more risk exposure.

The UPR can be adjusted to allow for this by using a monthly approach to the calculation, putting more risk weight on the winter months.

There is also an increase of risk with age, as health deteriorates with age and claims are more likely at the end of the policy year. However, over the space of one year, this variation in risk is not great and could be taken to be negligible.

We need to consider the purpose of the reserving exercise.

For example, if it is for statutory purposes, we would want a prudent method, whereas for internal purposes we would want a best estimate basis.

An approximate allowance for prudence could be built in, for example, by taking a larger premium for the calculation (even the full written premium, so that when we take the proportion to calculate the UPR, the result would be larger).

For an ongoing company, the UPR should be reduced for the uneven incidence of expenses over the year. This will lower the reserve, the desirability of which depends again on the purpose of the calculation.

Finally, the reserve should be increased if necessary to allow for inadequate premiums, giving the additional unexpired risk reserve. In order to assess this, the adequacy of past premiums should be analysed.

[12]

Solution 7:
(i) Accelerated critical illness benefit

This benefit is provided when a policy pays the sum insured upon death or
diagnosis of a *critical illness*, whichever occurs first.
If the life assured suffers a critical illness, then the sum assured is paid and the policy is terminated, *ie* payment of benefit is "accelerated" forward from payment on death.
Some policies accelerate a portion of the sum assured in which case the contract stays
in force and pays the *balance* of the sum assured upon subsequent death.

 Most policies accelerate 100% of the sum assured.
(ii) Cash plans or Hospital cash plans

These products pay a pre-specified cash sum on the occurrence of certain
medical events (hospital stays, physiotherapy, need for spectacles, *etc*).
Typically the benefits paid are low relative to the true cost and represent cash in
hand rather than *indemnity* benefits.
In the USA, "hospital cash plan" is the term used for an *indemnity product*.

(iii)
Possible reasons include:
- The rates are based on risk premiums assessed for the target market e.g. HNI segment
- The rates have an inbuilt discount as these polices can be bought only if customer buys another savings oriented plan with premium above a minimum level
- This product is different from the market – illnesses covered are different, number of illnesses covered are less
- We have re-assessed our rates based on our experience in the past
- Charging higher premiums may not be fair to policyholders
- At proposed rates, the profit criterion is met
- Regulator has prescribed new industry table for pricing such risks, the market would adapt this as well
- The commission levels / expenses are lower than the market
- This is a reviewable product, so premiums are expected to be lower than the constant premium products
- This product has tighter underwriting standards, so premium rates reflect the benefits. The loadings for risky lives are expected to compensate for the differential in premium rates with the market
- We have a good reinsurance deal leading to reduced risk exposure – part of the benefit is passed on to the customer
- This is stand alone product, the premium would be lower than an accelerated product
- The premiums paid under this product are not eligible for tax benefit, so lower premium is desirable to compensate customers vis-à-vis other products in the market which are eligible for tax benefit
- The premium rates are exclusive of VAT, gross premiums are in line with the market
- The rates are lower only at some sample ages, at other ages the rates are in line with the market

[10]

Solution 8:
Factors the regulator would consider include:
- Insurer must remain solvent
- Customer needs are met
- Insurer files adequate reports to assess viability
- Benefits are clearly described
- Value for money
- Impact on the health insurance market

- Ease of understanding by customer
- Claims admin process
- Profitability
- New Business Strain
- Commission levels
- Whether confirms to market practice
- Fairness of policy conditions
- Whether the risk is insurable and possibility of moral hazard

[7]

Solution 9

(i)   *A without-profits critical illness insurance*

Investment return
The reserves that build up under this product are comparatively small, therefore the investment return is not a key assumption. The price is relatively insensitive to this assumption, and so it won't be too serious if the assumption turns out to be wrong.

Expenses
Competition for this business is often on price, therefore there will be fairly small margins in the premium rates. This is the second most important assumption for this class of contract after morbidity. The typically small premium size makes the expenses more significant. As the market is likely to be price-sensitive, the expense assumption is likely to be critical in determining the volume of sales and hence in maximising the total contribution to overheads and profit. However, if the assumption used is too low, the company may write far more new business than expected, but at a loss; if the assumption used is too high, new business volumes may be much lower than expected, with the result that contributions towards fixed costs are insufficient.

Withdrawal rates
There is usually no benefit payable on withdrawal, but there will still be lapses. These are likely to be from among the healthier lives, and so the expected future morbidity experience of the remaining portfolio will be heavier. The company will make a loss on a particular policy if it lapses when its asset share is negative. Otherwise there will be a profit. So, the importance of this assumption is different for early and late withdrawals.

Morbidity
This would be a key assumption. The CI table should relate to the underlying illnesses covered by the product. The premium of this product would be directly proportional to the risk incidence implied by the CI table selected. Under-estimation of this assumption could result in premiums being inadequate

Mortality
Unless this is accelerated product, mortality is unlikely to be a key assumption. For stand alone product, higher mortality assumption is likely to result in lower premium and vice versa. Interaction between mortality and morbidity assumptions in cashflow projections would also have impact on the premium rates

Risk Discount Rate
This could be either standard rate used for all products or rate could be based on specific risk expectations from this product. Normally the Board of Directors of the company would approve the RDR to be used. The premium rates would be sensitive to the rate used – higher the discount rate lower the premiums and vice versa

Tax
Current taxation can be assumed to continue in future unless specific information about change in tax treatment is available. If the company is expected to incur losses during the lifetime of the product may assume zero taxation and may have significantly lower premium rates depending upon the level of normal tax rate

(ii) **A without-profits immediate needs long-term care annuity**
Investment return
Investment return, mortality and (in those cases where the annuity payments vary with the degree of incapacity) morbidity, are the key assumptions for this product. The single premium, less initial expenses, must be invested at outset to provide a future, guaranteed income stream. The amount of this income stream will depend crucially on the investment returns available at the outset. The single premium is likely to be invested in index-linked bonds of appropriate duration, assuming that the benefits are inflation linked. A highly matched strategy should secure a relatively certain real yield. If such a strategy is used, it is essential that the annuity pricing assumption is not higher than this yield, as this would lock the company into a guaranteed loss. The pricing assumption will need to be reduced in any case – both as a result of the uncertainty of the liability duration due to variable mortality, and to the extent that appropriate matching assets may be unavailable. This assumption must be reviewed regularly in the light of changing investment conditions.

Expenses
The expense assumptions are important because terms are guaranteed, but less so than investment return because the relative impact of expenses on profit is lower. The majority of expenses will occur at the outset (*eg* underwriting, contract issue) and their amounts will be better known.

Withdrawal rates
There is very unlikely to be any withdrawal benefit and no further premiums are payable, and so there is no reason for anyone to withdraw from this product. Therefore this assumption is not at all important. However, if there were a withdrawal benefit, the assumption could become very important, depending on the size of the withdrawal benefit payable.

Morbidity
This would be a key assumption. The CI table should relate to the disability intended to be covered in the product.

Mortality
This assumption is likely to be significant as in event of death, the annuity payments would stop. Interaction between mortality and morbidity assumptions in cashflow projections would also have impact on the premium rates

Risk Discount Rate
This could be either standard rate used for all products or rate could be based on specific risk expectations from this product. Normally the Board of Directors of the company would approve the RDR to be used. The premium rates would be sensitive to the rate used – the higher the discount rate the lower the premiums and vice versa. An issue would be whether to consider the duration of liabilities while setting this rate and whether there are risk free asset classes available corresponding to the long duration.

Tax
urrent taxation can be assumed to continue in future unless specific information about change in tax treatment is available. If the company is expected to incur losses during the lifetime of the product may assume zero taxation and may have significantly lower premium rates depending upon the level of normal tax rate

[10]

<u>Solution 10:</u>
Factors XYZ would consider include:
- Volume of current PMI business
- Potential of health insurance market
- Scope to offer health insurance products other than PMI
- Attitude of people towards health insurance
- Government policy
- Tax incentives for customers to buy health insurance
- Tax incentives for health insurance company
- Capital requirement
- Possibility of foreign investment and related regulations
- Regulatory requirement wrt reserves, solvency margin
- Business model – non –life v/s standalone health insurance v/s life insurance
- Break even time period
- Internal rate of return in 5 to 10 years
- Views of reinsurers operating in the market
- Possible distribution channels and their viability
- Availability of manpower and cost of talent acquisition
- Health care provided by State - whether free or restricted
- Status of competition – non-life, life and other standalone health insurers
- Assessment of business risks – operational, credit, market, liquidity, pricing
- Availability of data for pricing
- Profitability of existing players
- Market practice for claims processing – Third party administrators, self processing, industry body
- Regulations on rural, social sector business
- Prevailing claim ratios, business mix (individual v/s Group, single premium v/s regular premium, one year v/s long term)

[12]

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