EXAMINATION

12 November 2010 (am)

Subject F102 — Life Insurance Principles

MARKING SCHEDULE

This paper was poorly answered in general, and even obvious bookwork was not done well by the majority of candidates.

QUESTION 1

This question was generally poorly answered. It was not an underwriting or an investment question. Risk results from incorrect pricing. Targeting a market with lower longevity does not help if your pricing is wrong.
No credit was given for:

- Underwriting and then reducing benefits for healthy lives as this is not really an option.
- Don't offer surrender values
- Limiting age to which payouts will take place
- Targeting a lower risk market if it was not accompanied by a statement on differential pricing.
- Monitoring if it was not accompanied by what will be done with the results.

Suggested solution:

- Keep up to date with mortality trends
    - Own experience ✓
    - Industry research ✓
    - Medical advances ✓
    - Ensure pricing is up to date ✓
- Include appropriate margins
    - and allowance for improvements ✓
- Reinsure (if they can get a reinsurer to take the risk) ✓
    - Would also need to consider the costs ✓
- Consider different annuity rates to different groups
    - Will need to underwrite ✓
    - Significant product development costs ✓
    - Will also affect the costs of the "normal" annuities as poorer lives are now removed from the population✓
- Limit the amount sold
    - Will also limit potential profit ✓
- Sell with-profit or unit linked annuities
    - Under with-profit, share risk with policyholders ✓
    - Under unit-linked, risk is passed on to the policyholder ✓
- Monitor what competitors are doing to avoid selection against your company
- Mortality bonds, swaps, derivatives ✓
    - If company is big enough and can incur costs ✓
    - Try and hedge by selling insurance products to same market ✓

QUESTION 2

Part 1 was generally well answered.

Students did not cover the non-unit reserves as part of the liabilities at all, leading to extremely poor marks in questions (ii) and (iii). In part (iii) many students wrote about solvency in general and not about the specific situation in the question.

In Part (iv) students needed to give the detail to get any marks for option pricing techniques. Vague statements as found in the notes without application to the situation scored no marks e.g. the cost of the guarantee is the benefit that is paid less the benefit that would have been paid if there was no guarantee.

Suggested solution:

(i) Advantages

- A policyholder in poor health does not have to buy a life annuity ✓
- Allows the opportunity to transfer remaining capital to his dependants ✓
- Can choose level of income as part of financial plan ✓

Risks

- Pension not guaranteed for life - money could run out ✓
- Investment risk – need to disinvest when the market is down ✓

(ii)

- For the unit linked liabilities
    - invest in the underlying assets as per the policyholders instruction ✓
- Non-unit liabilities
    - Reserves need to be set up as recoveries will reduce over time ✓
    - Assets backing the liabilities are mainly for the future expenses ✓
    - Invest in real assets ✓
    - Index-linked bonds or equity ✓
- Unlikely to need cash as long as the company is still selling ✓

(iii)

- There will be no effect on the assets backing the units as the liabilities will also have fallen by 25% ✓
- The assets backing the non-unit liabilities may have fallen by 25%. ✓
- In addition, the future income from the fee on assets has decreased significantly. ✓
- The costs which it needs to cover, will not have fallen. ✓ These are fixed and increasing with inflation (or something similar). ✓
- Some of the free assets are also likely to be in equity – reducing free assets too ✓
- Solvency will thus decrease ✓

(iv)

- Mortality (and thus age and gender) can be ignored – essentially an investment guarantee ✓
- Identify an appropriate stochastic model providing rates of return on investments ✓
- Generate investment scenarios for the projection period allowing for the underlying assets ✓
- Project asset values for each scenario ✓
- Check the value of the pension payable and compare with the guarantee ✓
- If the guarantee is more than zero, record this ✓
- Don't discount – will add a margin or discount to the start of the year at the appropriate rate from the scenario based on investments in which the premiums for the guarantee will be invested. ✓✓
- Repeat for the remainder of the months ✓
- Repeat and calculate the cost for each of a large number of scenarios (say 10000) ✓
- Determine the average cost per scenario to find the expected cost ✓
- alternatively can use the distribution of costs to set price ✓
- Decide on margins to include to establish the price ✓
- Will have to differ for different risk profiles in the investments ✓

- Can also use option pricing ✓
- 11 European put options ✓
    - on underlying assets as chosen by policyholder (or something similar) ✓
    - Strike price is the level in the first month ✓
    - and exercise date is the date the pension is payable ✓

QUESTION 3

The question tested student's ability to apply a number of concepts: capital management, with-profits structures and earnings. A broad understanding of the syllabus was thus needed. The question was poorly answered overall. Strong candidates noted some of the practical implications.

(i) Most students missed that the long term reversionary bonus rates are linked to the long term investment return. Only a few students picked up that the improved embedded value reflected improved future profitability and would not be available for immediate distribution

Suggested solution:

- Reversionary bonus rates will be determined taking into consideration the company's long term investment return assumptions
- Long term investment return should be able to support the reversionary bonus rate

- The low interest environment may have decreased long term assumptions, resulting in a decrease in the reversionary bonus rates declared.
- Bonus rates may be in line with competitors
- If the company has solvency difficulties there may be regulatory pressures on bonus declaration management
- Even if interest rates have not fallen, the assets would have fallen during the recession without a corresponding decrease in the reserves, decreasing the free surplus available. It is likely that this will be absorbed by the terminal bonus but if this is not sufficient to absorb the decrease in free assets this may have also necessitated a decrease in the reversionary bonuses declared.
- The company will be smoothing bonuses so improved free assets may not translate to increased bonuses
- Maintaining the higher reversionary bonus rates increases the guarantees and reserves under the contract affecting solvency.
- If profitability not sustainable surpluses may be deferred to terminal bonuses
- This will further reduce capital further decreasing investment freedom and ability to write new business.
- The company may be avoiding changing RBE
- The company may have changed bonus philosophy
- The increase in embedded value reflects an increase the present value of future profits which will only be available for distribution in future years.

(ii) (a) Most students identified the need for better capital management but missed the issues surrounding a decreasing with profit book and increasing unit linked book as a possible reason for demutualisation

Suggested solution:

- The company is likely to be experiencing capital strain:
    - It is small and so is unlikely to have a large capital base
    - The recent increase in sales is likely to increase the capital requirements to meet new business strain
    - This will constrain the investment freedom of the company.
    - The recession is likely to have decreased the value of assets whilst the declared bonuses have been guaranteed and liabilities are thus unlikely to have decreased for the with profits products. This would reduce the free surplus.
    - The company has probably exhausted other efficient sources of capital i.e. loans and financial reinsurance
    - The low interest rate environment and recession are likely to have increased the cost of guarantees and options decreasing the free assets.
- Demutualising will allow the company to raise capital from shareholders
- The with-profits book is experiencing poor sales. Profits from the growing unit linked book have to thus be distributed amongst a smaller group of policyholders.

- As the with-profits book diminishes, capital for new unit linked business sales is likely to come from in force unit linked business. As the with-profits policies no longer contribute to funding new business strain on the unit linked business, distributing the surplus to the with-profit policyholders may be considered as treating customers unfairly

[b] Mainly bookwork question on how to distribute profits with additions to benefits. The implications on the bonus declarations of having a decreasing with profits book and increasing unit linked book was missed.

- The company could increase the reversionary bonuses
- The company could calculate the liabilities on higher reversionary bonuses so as to eliminate the free surplus
- This will however increase the guarantees on the book as the bonuses are declared reducing the free surplus and investment freedom
- The company could declare a once of special bonus
- This would avoid changing policyholder reasonable expectations as it can be clearly attributed to the distribution of the free estate due to the company closing to new business
- This will increase guarantees faster than with reversionary bonuses
- The company could distribute the surplus via terminal bonuses
- This will avoid creating guarantees and maximize free surplus
- The company will need to account for when the profits on the unit linked business will emerge and be available for distribution
- If the profit is expected to emerge after the with-profits products have gone off the book, complications will arise
- The company may have to consider selling the business or merging with another fund as it will become too small to manage

QUESTION 4

This question was mostly bookwork, but a significant number of students were not able to score well as they did not know their work.

A number of students elected to discuss the bases for the more general alteration of policies, rather than the specific bases for making a policy paid-up. No additional marks were earned for this.

The last section required the students to think but from the thoughts that emerged a number of students did not properly read the question. The question stated that the paid-up policy value was a "realistic prospective value". Any profit that would emerge in the future could only be the difference between actual experience and that anticipated in the basis, which is expected (by definition) to be zero.

Suggested solution:

(i)

- The basis needs to be such that the conversion to paid up is affordable and can be supported by the earned asset share.
- Should be consistent with the projected maturity value, allowing for premiums not received.
- Should be consistent with other alterations such as surrender values.
- Surrender value should be consistent before and after alteration to avoid lapse and re-entry.
- Basis should result in paid up value that is consistent with any information disclosed at a new business stage in line with policyholder's reasonable expectations.
- Paid up rates offered by competitors should be considered in setting the basis.

- Basis and any changes should be documented clearly.
- The calculation should be simple to understand for explanation to the policyholder and administrative capability.

(ii)

	Proportion Method	Equating Policy Values Method
Description	• Sum assured adjusted by proportion of premiums paid over total premiums payable	• Value of the contract before alteration on prospective or retrospective basis can be equated to a prospective value after alteration.
Advantages	• Simple to calculate and for policyholders to understand • Blends into maturity value	• Can produce consistent surrender values before and after alteration • For increase in benefit/extension of term can be done on the current premium basis in line with new business • Method is stable is basis is same before and after alteration • Affordable depending on basis used.
Disadvantages	• Too high at short durations – will not recover high initial expenses • To low at medium term as not taking into account investment returns • Unlikely to be consistent with surrender values • Inconsistent with competitors	• Does not necessarily avoid lapse and re-entry

(iii)

- If a realistic prospective value is used for surrender the difference between the earned asset share and the surrender value will be the full expected profit under the unaltered contract.
- If a realistic prospective value is used to calculate the value of the contract after alteration, no further profit is expected from the date of alteration.

QUESTION 5

Many students suggested that the underwriting needed to be competitive. The question did make it clear that the life insurance industry had not been established in the country concerned and consequently the issue of competition would therefore not arise. Furthermore only a few students were able to deduce that pricing of the product would also not be subject to any competition. This would allow the pricing to be conservative and reduce the need for any underwriting other than basic statements of good health.

This type of thinking would also apply to any reinsurer who was prepared to accept risk and consequently there would be little requirement to satisfy the reinsurer's need for strict underwriting.

If the student missed these two points their approach to this question would have been flawed.

Overall parts (iii) and (iv) of the question were poorly answered.

Most candidates regurgitated text from study material. In these cases points that were irrelevant were stated, e.g. with-profits bonus declarations.

A large portion of candidates had no reference to the detail in the question. Easy marks were missed.

Incomplete statements did not get marks, e.g.'More underwriting is needed because risk increased' instead of 'More underwriting is needed because risk increased due to anti-selection'.

A number of candidates stated the liabilities must be valued at the risk discount rate as opposed to expected investment return (or risk-free rate was also accepted).

Suggested solution:

(i)

- No company data. ✓
- No industry data. ✓
- No competition so premium rates can be include large margins. ✓
- offer limited premium guarantees that are reviewable with short-notice. ✓
- offer short-term contracts such as term assurance, rather than whole life. ✓
- rather offer compulsory insurance on a group scheme basis than individual policies. ✓
- must be simple to administer, so limited bells and whistles. ✓

- no-medical underwriting, rather a declaration of health, questionnaire or something similar. ✓
- first option is to have either a accept or reject policy, second option is to have exclusions. Exclusion may be more onerous to administer. ✓✓
- underwriting at claim stage. ✓
- premiums charged possibly by age bands, not too worried about gender. ✓

(ii)

- reinsurer may have experience in a similar territory. ✓
- could assist with setting risk rates. ✓
- may be able to advise on distribution strategy. ✓
- possibly give input to likely lapse experience. ✓
- will not do it for free and will require participation in risk. ✓
- sum's assured are low so individual surplus reinsurance not appropriate. ✓
- catastrophe reinsurance is required. ✓
- possible stop loss reinsurance to limit overall loss. ✓
- proportional reinsurance will be appropriate. ✓
- possibly quota share arrangement that is generous in the reinsurer's favour. ✓
- include a profit share arrangement. ✓
- financial reinsurance an option to assist with setup cost. ✓
- risk premium reinsurance is also an option, but may more complex and expensive to administer. ✓
- reinsurance commission is required to cover expenses. ✓
- as experience builds over time reduce the ceding percentage. ✓
- will be on a treaty basis. ✓
- legal risk may arise

(iii)

- there may be a lack of legislation for reserving and solvency capital. ✓
- use similar territories approach. ✓
- first principles. ✓
- no past data for mortality and lapses so initially use the pricing parameters. ✓
- would not like to recognise profit prematurely. ✓
- principle of prudence. ✓
- company will have proportionally large set-up costs. ✓
- these may not be appropriate for expense assumptions. ✓
- approximate methods may initially be appropriate. ✓
- IBNRs. ✓
- alternatively use a retrospective build up of reserves. ✓
- retrospective build up should be on a gross premium method. ✓
- allow for reinsurance. ✓
- eliminate any negative reserves. ✓

(iv)

underwriting approach:

- historical data for mortality and lapses will form the basis. ✓
- target market may be different for high sum's assured. ✓
- income of policyholders may be higher and may therefore have access to better housing, medical facilities and education. ✓
- mortality experience may be lower. ✓
- selection may be more of an issue due to the high sum's assured. ✓
- better informed policyholders may select against company. ✓
- medical underwriting may be required. ✓
- especially for disability benefit. ✓
- financial underwriting would be required to check policyholder income vs benefit ✓
- additional exclusions are applicable for disability benefit. ✓
- more options may be offered to sub-standard lives, such as premium loadings or more exclusions. ✓
- specialists test may be required, this may not be available in developing country. ✓
- for disability claims underwriting will need specialist skills. ✓
- access to medical reports essential. ✓

reinsurance:

- individual surplus reinsurance. ✓
- facultative reinsurance for very large sum's assured. ✓
- no history for disability, may require a lower retention. ✓
- for disability risk premium reinsurance may be more appropriate. ✓
- ideally mortality and disability should be on the same basis. ✓

QUESTION 6

(i) was a standard bookwork question that was surprisingly poorly answered.

(ii) referred to option-pricing which is a section in the notes. Some candidates then referred to stochastic modelling which is an entirely different section. Although this was not a Financial Economics exam, students were expected to know that an American option involves exercise at any time before a date not between two dates (although the latter is possible using an American forward option).

(iii) was an obvious stochastic modelling question but many candidates didn't indicate that they would use a stochastic model. Some students had no idea what the formula for return on capital was and instead gave the internal rate of return. Many candidates answered how they would price the guarantee using a cashflow model which was not the question that was asked.

Suggested solution:

(i)

- Profitability. ✓

- Marketability. ✓
    - Risk appetite of customers✓
    - Simplicity✓
- Competitiveness. ✓
- Financing requirement/Capital. ✓
- Risk characteristics. ✓
- Onerousness/Costs of any guarantees.✓
    - Probability of guarantee biting✓
    - Inv options✓
    - Investment conditions ✓
- Sensitivity of profit. ✓
- Extent of cross-subsidy. ✓
- Administration systems. ✓
- Consistency of other products. ✓
- Treating customers fairly. ✓
- Other regulatory and tax requirements. ✓
- Mortality/withdrawal
- Reinsurance

Max 1 mark per bullet

Volume and mix were allowed only if an explanation as to how they would impact on pricing was given.

No credit given for:

- Customer needs
- Financial requirements
- Level and form of benefits
- Data availability
- Willingness of the distribution channel to sell the product

Comments:

Ordering and grouping of points was poor with many stating administration to be the chief consideration!

(ii) One needs to find the prices of exchange traded options ✓or use Black-Scholes to price a replicating portfolio✓
Options on the underlying may not be available so one may need to approximate the underlying investment portfolio using options on equity and bond indices. ✓

Solution 1
If it is assumed that the benefits are paid at the end of the month ✓
As benefits can be paid monthly after age 55, the guarantee is equivalent to

- a series ✓of **European** ✓ put ✓ options
- on the underlying investment funds ✓
- There will be 181 options in all with strike dates ranging from the 55th birthday to the 70th birthday ✓
- The strike price for each option will be the guaranteed benefit ✓

In order to find the cost of the guarantee, conditional probabilities would be required

Solution 2
A Forward American Put option could be used. ✓ ✓
Forward date is 55th birthday✓
Strike date is 70th birthday✓
On underlying investments✓
Strike price a function of the guarantee ✓ (which would invalidate Black-Scholes✓)

No credit given for:
Discussions of the North American method.
Discussions on how a model would be used to price the guarantee

(iii)

A stochastic model is required to provide the distribution. ✓
A number of model points will be chosen to represent the expected new business. ✓
The profile of the existing business (modified to allow for any expected future changes ✓) can be used to obtain the model points. ✓
For each model point and each simulation, benefit, premium and fee cashflows would be simulated using a realisation of a stochastic model of rates of return of returns ✓. The model should allow for reserving and supervisory capital requirements ✓which will provide an estimate of the capital required ✓. The net present value of the profits will be calculated using a discount rate that reflects the return required by the company ✓. The results for each model point will be grossed up to give the return on capital for the life office ✓. A large number of simulations will be required in order to obtain the distribution. ✓

QUESTION 7

(i) Some students got confused between persistency and withdrawal. Many showed they don't know that a trend relates to time (as opposed to gender).

(ii) Some evidence of time pressure. Of most concern were the students who identified that this may be selective withdrawal but who suggested adjustments to the pricing basis that would only exacerbate the situation. Many failed to demonstrate that they understood how to project historic information for pricing purposes.

Suggested solution:

(i) First a period of investigation will be required that is long enough to allow for trends to be detected ✓ – this means at least three periods of data ✓ are required. If there are significant changes in the economic environment, these should be taken note of✓. The data would then need to be divided by:

Duration ✓

Sales method ✓

Frequency and size of premium ✓

Original term ✓

Age ✓

Period ✓

{or divided into homogenous groups ✓if no rating factors mentioned}

For each duration the number of policies surviving in-force to the end of the year ✓ will be divided by the adjusted the number of policies in force at the start of the year ✓ adjusted for the number of death claims and maturities ✓ to give the persistency rate ✓. The withdrawal rate is 1- the persistency rate. ✓ The persistency rates for men and women with otherwise identical characteristics can then be compared to assess if there is a gender effect ✓. For each cell, the withdrawal rates by period can be compared to assess if there is a trend. ✓The correlation between the different risk factors would need to be determined in order to examine whether correlation effects are evident. ✓
Statistical tests required
Checks against industry or reinsurer data should be made to see if they are experiencing the experiencing the same

Notes:
Quite a few students got the denominator and numerator mixed up but could describe the factors in the persistency rate. A half mark was given for the exposed to risk method of calculating withdrawal rates if the persistency approach was not used.

(ii) The analysis would be done by age ✓, sex ✓, duration ✓, channel ✓, smoker status ✓and underwriting status ✓. {Province was also given credit but vague references to geographic location or suggestion of cities did not} The values should be projected from the investigation period to reflect the experience on policies sold in the future ✓ e.g. an adjustment may be required for HIV prevalence ✓ and anticipated changes in underwriting ✓. The rates will be derived from adjusted standard table mortality rates ✓ where the adjustment is based on the experience analysis ✓ subject to credibility✓and possibly allowing for margins✓. Given the lower persistency among women, the adjustment should be sufficient to discourage selective withdrawal by women. ✓
Notes:
This question was about selective lapsation. If women are leaving, then chances are that competitors could be luring them away with better rates leaving us with lives with heavier mortality so checking against reinsurer or industry experience was considered important and earned credit. However, if female mortality was heavier than expected, the appropriate response is not to raise female rates as this will result in an insurance spiral.