ILA LPM Model Solutions
Fall 2021

1. **Learning Objectives:**
1. The candidate will understand the designs and risks of the common life and annuity products and features, as well as the methods and metrics used to design and price these products.

Learning Outcomes:
(1s) Describe the framework, process, and significant considerations for creating mortality tables. Describe and apply the methods for determining exposures, and considerations for developing select period mortality rates.

Sources:
Table Development, Society of Actuaries, 2018 (exclude Appendices C,D,F,G,H)

Ending the Mortality Table (Living to 100 Symposium)

Experience Assumptions for Individual Life Insurance and Annuities

Commentary on Question:
This question was testing the candidate's knowledge of mortality table development, including the development process, impacts of different distribution channels, dealing with limited data for older ages, and ending the mortality table.

Full credit was awarded to candidates who fully described responses instead of listing and provided justification on recommendations.

Candidates generally did well on this question with most candidates performing particularly well on parts b, c, and d.

Solution:
(a)
(i) Describe the five steps of the Table Development Flow Chart.

(ii) List important considerations for three of the Table Development Flow Chart steps.

1. Continued

Commentary on Question:
Candidates generally did not do well on part i. Many candidates described the steps of establishing experience assumptions instead of the steps of table development. Candidates received partial credit for listing steps of the table development flow chart without describing. Partial credit was awarded for providing 2 to 4 steps correctly.

Candidates generally did well on part ii. To receive full credit, candidates had to provide one or more consideration for three separate steps of the table development flow chart. Partial credit was awarded for providing considerations for fewer than three steps. For candidates who answered part (i) incorrectly, credit was awarded in part (ii) if the considerations listed were reasonable for the steps provided. Examples of acceptable considerations are listed below. Other reasonable considerations were accepted for partial or full credit.

(i)
1. Develop Data
   - Review predecessor studies
   - Define the goals of the table
   - Review available data

2. Identify table dimensions/data analysis
   - Analyze the study's variable to determine which subset best predicts the event under study
   - Conduct outlier analysis

3. Populate table
   - Smooth out inputted rates by graduation
   - Differentiate between count based and amount-based rates
   - Consider improving insufficiently credible data with grouping

4. Review and adjust rates
   - Conduct creative and enforcement reviews
   - Enforce relationships between rates
   - Project future rates by using existing data and assumptions about the future

5. Assess financial impact and finalize table
   - Consider reporting parameters
   - Weigh using Internal vs Industry tables
   - Finalize tables (trend and loading factors)
   - Documentation of the project
   - Determine how project oversight would be administered

1. Continued

(ii)

Step 1: Key considerations include dealing with limited availability, inconsistent definitions, formatting issues, and lag issues

Step 2: Key considerations include identifying target variables, considering type of analytics, considering model requirements, and developing factors

Step 3: Key considerations include determining type of graduation method and dealing with insufficient credible data or lack of data

Step 4: Key considerations include determining relationships between adjacent rates and between an array of rates

Step 5: Key considerations include impact on reserves, stat surplus, GAAP equity, cash flows, premiums, and dividends

(b) You are concerned about the mortality variation by distribution channel and with the mortality table development due to the advancing age of the block.

   (i) Compare the differences in mortality by LBD Life's distribution channels.

   (ii) Describe ways to address any mortality variation from different distribution channels.

   (iii) Describe potential issues with the mortality table development due to the advancing age of the block.

Commentary on Question:
For part (i), most candidates generally understood the differences between the three distribution channels but did not fully understand their impacts on mortality. Partial credit was awarded to candidates who provided an incorrect level of mortality with reasonable justification (i.e. direct written business would have lower mortality, on average, since its target market is younger insureds.).

For part (ii), most candidates were able to provide at least one way to address mortality variation. Full credit was provided to candidates who provided two or more suggestions for addressing mortality variation. Partial credit was given for providing only one method. Examples of reasonable answers are listed below. Other reasonable responses were awarded partial or full credit.

1.   Continued

For part (iii), many candidates recognized that credibility in older ages would be an issue of mortality table development. Few candidates provided a second issue besides credibility. Full credit was given for candidates who provided two or more potential issues. Examples of reasonable answers are listed below. Other reasonable responses were awarded partial or full credit.

(i)

- Direct selling policies may have higher mortality than career agency or independent advisor written policies because of anti-selection due to more incentive to shop around or "churn" the business.
- Direct selling policies may have higher mortality compared to career or independent advisor as the policies tend to be guaranteed issue and/or smaller size policies.
- Socio-economic factors, e.g., affluent markets which may use an independent advisor may have an impact on mortality.
- Career agencies are expected to have relatively low mortality due to career agents being more closely aligned with the insurance company leading to less anti-selection.

(ii)

- Adding either a PAD or factor adjustment for the different distribution channels will help address risk.
- Reinsurers can add valuable insight and help address issues with extra mortality risk
- Underwriting of new issues can be adjusted to address risk (stricter underwriting leads to better mortality).
- Adjust commission schedule to incentive agents to retain policies longer, resulting in less anti-selective lapsation which worsens mortality.

(iii)

- Data is generally limited in older attained ages leading to credibility issues.
- Older insureds are at risk of outliving the mortality table and reaching maturity.
- Future mortality improvement trends will vary from past improvement due to medical advancements, different living styles, etc. and should be considered.
- A method of ending the mortality table must be selected.

1. **Continued**

(c) Recommend an approach to finalize the mortality rates for:

(i) Ages 90-95

(ii) Ages 96-105

Commentary on Question:
Candidates generally did well on part (c).

Full credit was awarded to candidates who understood that the company would have more limited experience in ages 96-100 versus 90-95 and provided reasonable recommendations for finalizing mortality rates. Full credit was awarded to candidates who provided justification of their recommended approach. Examples of reasonable recommendations are provided below.

(i)

- For ages 90-95, credibility weight the company's own experience against the Society of Actuaries (SOA) table using a credibility method such as Limited Fluctuation Credibility Theory (LFCT) or Bühlmann credibility.
- Assuming the company has credible experience, use graduation to smooth the experience data using Whittaker-Henderson/Whitaker-Henderson Lowrie method or B-splines method.

(ii)

- For ages 96-105, the company does not have credible mortality experience. Use the SOA mortality table directly.
- There is limited company data available above age 96. Use table extension to extend the SOA mortality table past attained age 105.

(e) Describe the four methods of ending a mortality table beyond age 105.

Commentary on Question:
Most candidates did well on part (d) and were able to describe three or four methods of ending a mortality table. To receive full credit, candidates had to accurately describe all four methods. Partial credit was awarded if a candidate listed fewer than 4 methods or simply listed the methods without describing.

1. Forced Method
   Select an ultimate age and set the mortality rate at that age equal to 1 without any changes to other mortality rates. This creates a discontinuity at the ultimate age.

1.   Continued

2. Blended Method
   Select an ultimate age and blend the rates from some earlier age to dovetail smoothly into 1 at the ultimate age.

3. Pattern Method
   Let the pattern of mortality continue until the rate approaches or hits 1 and set that as the ultimate age.

4. Less-than-1 Method
   Select an ultimate age but end the table at whatever rate is produced at that age so that the ultimate rate is less than 1.

2.

Learning Objectives:
1.   The candidate will understand the designs and risks of the common life and annuity products and features, as well as the methods and metrics used to design and price these products.

3.   The candidate will understand common issues and practices related to In Force and New Business Product Management, and how experience studies are designed and used for evaluating past experience and for setting assumptions.

Learning Outcomes:
(1a)   Describe the designs of the common life and annuity products and evaluate their associated features and inherent risks.

(1f)   Describe methodologies, approaches, considerations and tools related to the Underwriting function.

(1k)   Describe what is meant by Life Settlements and assess their impact on insurance product pricing/management.

(3b)   Describe and evaluate compliance with applicable regulations (including NY Reg. 210).

(3c)   Describe and assess the impact of adverse selection due to Life Settlements.

Sources:
LO#1-23: The Response of Life Insurance Pricing to Life Settlements, Product Matters, Sep 2006

LO#1-26: Life Insurance for the Digital Age: An End-to-End View, Product Matters, Nov 2017

LO#1-34: Report on Premium Persistency Assumptions Study of Flexible Premium Universal Life Products, May 2012

LO#3-5: LPM-159-19: New York State Department of Financial Services 11 NYCRR 48 (Insurance Regulation 210)

Commentary on Question:
Candidates generally did well in part a) and part b) but not in part c). Some candidates loss credit by not explicitly critiquing the statements. In part c), some candidates failed to identify the key difference between raising COIs and reducing the crediting rate by showing sufficient understanding under New York Regulation 210.

2. Continued

Solution:

(a) Critique each of the following statements:

    A.   *Accelerated underwriting will make it easier to sell our product because it offers the benefit of fully underwritten rates without all the hassle of blood tests and lengthy applications to fill out.*

    B.   *Life settlements are mutually beneficial since the policyholder could have otherwise lapsed their policy and the insurer would lose a stream of future premiums that will instead continue to be paid.*

    C.   *Premium financing is a low risk way to expand availability of insurance to older individuals, provided that adequate medical underwriting is performed.*

Commentary on Question:
Most candidates performed better on parts A and B. For part C, the majority missed economic/financial underwriting. Some candidates failed to critique each statement. Additional credit was given to candidates who managed to correctly critique all parts. No credit was given if candidates did not explicitly conclude "false/incorrect" for part B and C.

A. This is not entirely true/partially correct/partially true. Accelerated underwriting will introduce a simplified sales process. However, accelerated underwriting may misclassify risks compared to full medical underwriting at various steps such as predicting smokers, or the risk scoring model which could lead to "mortality slippage" which could result in a somewhat more expensive product. Additionally, there is usually a step in the triage process for accelerated underwriting which will result in some applicants getting redirected to traditional medical underwriting.

B. This is not true/incorrect. It is beneficial for policyholders as they would get higher cash value than life settlement. However, it is not beneficial for issuers/companies. While persistency is likely to be higher, it may be concentrated in business more exposed to mispricing (e.g. older issue age cells) where an aggregate % of industry table might understate old age mortality, or simply because for life settlements, higher persistency directly drives older mortality because of anti-selection (life settlement companies may carefully select policies to make offers on depending on the health of the insured). In addition, minimum premium would be paid to maintain the policy in-force.

2.   Continued

C. This is not true/incorrect. If the financial/economic underwriting is inadequate, even if the medical risk is satisfactory, the company could be exposed to risk if the financial goal being sought does not align with what would otherwise be expected based on other information available at the time of underwriting. If the policy is ultimately expected to become stranger-owned life insurance (STOLI), it could lead to a higher prevalence of minimum funding combined with higher than expected persistency; if the product is lapse supported this could become a problem for the insurer.

(b)

(i)   Critique the use of weighted average premium persistency factors for pricing.

(ii)   Propose a sensitivity test that helps to understand the risk associated with using an approach of employing a weighted average premium persistency assumption for pricing purposes. Justify your proposal.

Commentary on Question:
Candidates generally did well in part i) but some candidates suggested sensitivity tests on interest rate or mortality assumption instead of the mix of funding pattern. No credit was given in this case.

(i)   It is not appropriate to use the weighted average premium persistency factors for pricing. The use of weighted average factors can produce significantly different results than if the different funding patterns are modeled distinctly. By blending the single premium to 75 with level to 100, the projection may produce funding that carries the overall liability to some attained age in between and not adequately capture the true tail liability for level solve to 100 funded policies.

(ii)   An appropriate sensitivity test would be to test different weights to derive the weighted average - e.g. 100% level to 100 or 100% single pay. This could reveal how material of a cross subsidy might exist between different funding patterns that isn't adequately captured by a best estimate blended approach. The model must be adequately designed to respond to these sensitivity tests

2. **Continued**

(c)

    (i)   Compare the filing requirements for the proposed reduction in the credited interest rate against those for an increase in the cost of insurance (COI) rates under New York Regulation 210.

    (ii)   Recommend two ways to incorporate dynamic assumptions into a pricing model to more accurately capture the impact of the interest rate environment.

Commentary on Question:
Some candidates failed to identify the key difference between raising COIs and reducing the crediting rate in part i). Most candidates were able to recommend dynamic lapse assumptions in part ii) but some struggled to successfully identify a second dynamic assumption. Some candidates suggested stochastic modelling or scenario testing instead of specific assumptions. No credit was given in this case.

    (i)   In section 48.4 a(3), the key difference between raising COIs and reducing the crediting rate is that an actuarial memorandum is required for a change in a non-guaranteed element of an existing policy other than a change in credited interest rate based entirely on changes in the insurer's expected investment income. Policyholders need to be notified of the changes and COIs should not be changed to recoup past losses nor increased to earn a higher profit on the policy than the profit level set at issuance.

    (ii)   Two of the following examples of dynamic assumptions earned full credit:
- <u>Dynamic lapse assumption</u>: as interest rates are expected to rise and fall, the lapse rate of policies might move up or down depending on the company's general account performance in relation to what current and guaranteed rates other companies might offer
- <u>Partial withdraw/surrender</u>: premium withdraw behavior is also lined to external interest rate environment. Policyholder behavior would vary in relation to a raising/dropping interest rate environment.
- <u>Premium adjustment/funding</u>: In a declining interest rate environment, depending on how well informed the insurer or agent keeps their policyholders (e.g. inforce illustrations), policyholders may increase their premiums to achieve the original financial objective illustrated at issue.
- <u>Dump-in activities</u>: portfolio crediting may encourage dump ins, and accelerate the erosion of the portfolio rate in a declining/stagnant interest rate environment - take into consideration increased weighing of "new money"

2. **Continued**

- No lapse guaranteed cliff: depending on interest rates at the time the NLG expires at year 10, there might be a spike in lapses or an increase in funding to the extent the guarantee was keeping policies in force or depending on how favorable the inforce illustration looks at the time in relation to other options the policyholder has
- Policy loan utilization: a dynamic policy loan utilization assumption would capture the impact of interest rate more accurately by incorporating interest rate movement into the policy loan assumption .

3.   **Learning Objectives:**
1.   The candidate will understand the designs and risks of the common life and annuity products and features, as well as the methods and metrics used to design and price these products.

Learning Outcomes:
(1l)   Describe and apply the principles of "Risk-Based Pricing" and "Market Consistent Embedded Value".

Sources:
Report on Pricing Using Market Consistent Embedded Value (MCEV), Jun 2012 (excluding Appendix 2)

Commentary on Question:
This question tested candidates' knowledge of details related to the calculation of MCVNB, and how that calculation changes depending on the type of product and the details of a given scenario. The question also tested candidates ability to differentiate MCEV-based calculation from TEV-based calculations.
Most candidates displayed a reasonable level of baseline knowledge related to MCVNB but fewer were able to give all of the details and justifications needed to receive full credit. Candidates also did not perform as well when asked to evaluate changes related to various given scenarios. On the other hand, candidates were generally successful in identifying how different MCVNB components apply to different types of insurance products.

Solution:
(a)   Describe each of the four components of MCVNB, and explain how each component is calculated.

    Commentary on Question:
    Candidates performed reasonably well on this part. Many candidates were able to partially explain each component of MCVNB but sometimes omitted elements needed to obtain full credit. Answers that simply repeated the name of the component (for example, PVFP = present value of future profits) did not receive credit.

    Present Value of Future Profits (PVFP): PVFP represents the discounted after-tax statutory profits discounted using the deterministic certainty-equivalent scenario. Time Value of Options and Guarantees (TVOG): TVOG captures the time value of embedded options and guarantees built into the product and is determined by deducting the average PVFP under a set of stochastic risk-neutral scenarios from the deterministic PVFP.

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3. Continued

Cost of Non Hedgeable Risk (CNHR): CNHR captures risks that cannot be hedged using capital market instruments, including financial and non-financial risks not covered in PVFP or TVOG. These include mortality, longevity, lapse, and morbidity risk. CNHR is calculated using sensitivities on each of these risk elements applied to the capital requirement at time zero.

Frictional Costs (FC): Frictional costs represents the taxation and investment expenses associated with holding the assets backing the required capital.

(b) Justify which of CCC Life's products are most likely to correspond to each column in the table of results by relating the components of MCVNB to CCC Life's different lines of business.

Commentary on Question:
Candidates performed well on this part. Many candidates were correctly able to identify that the differences in CNHR and TVOG were key to differentiating the three products. Candidates received partial credit if they correctly identified a product but did not provide a correct explanation.

Product #1 is the T20 Term. This is because the TVOG is small and the CNHR is large on Product #1. Because term products have no embedded guarantees or interest rate risk, TVOG is expected to be small for term. CNHR is large because term products are quite sensitive to mortality risk.

Product #2 is the VA. This is because the TVOG is large and the CNHR is small. TVOG is large for VA because it is interest-sensitive given the uncertainty around timing and amount of option claims. CNHR is small on the VA product because the GMDB and GLWB riders offset regarding mortality and longevity sensitivity.

Product #3 is the ULSG. This is because the TVOG and CNHR are both relatively large. TVOG is large because UL is sensitive to interest rates and CNHR is large because UL is also sensitive to mortality and lapse risk.

(c) Evaluate how components of MCVNB are affected for each of the following scenarios:

(i) Removal of the GMDB rider from the Variable Annuity product.

(ii) An increase in the tax rate applicable to investment income.

(iii) Introduction of a dynamic premium funding component to the ULSG stochastic model.

3. Continued

Commentary on Question:
Candidates did not perform as well on this part. Most candidates did not identify the CNHR impact related to scenario (i), and many did not identify the TVOG impact related to scenario (iii). Candidates received partial credit if they identified how a component would move but did not provide a sufficient explanation.

(i) In this scenario, CNHR would increase (and MCVNB decrease). This is because the GMDB rider and the GLWB rider largely offset each other with respect to mortality and longevity risk. But if the GMDB rider is removed, the VA product is mostly sensitive to longevity and so the CNHR will increase.

(ii) In this scenario, Frictional Costs would increase (and MCVNB decrease). Because frictional costs are defined as the taxation and expenses on the investments backing the product, an increase in the tax rate applicable to investment income directly increases frictional costs.

(iii) In this scenario, TVOG would increase (and MCVNB decrease). Because a dynamic premium assumption introduces larger variation from scenario to scenario with the cost of the embedded options in the product, the TVOG will increase.

(d) Evaluate the likely changes to profitability metrics for a product when moving from an Market Consistent Embedded Value (MCEV) basis to a Traditional Embedded Value (TEV) basis, including the impact on each component of the MCVNB calculation.

Commentary on Question:
Candidates performed somewhat well on this part. Most candidates were able to identify that TEV does not include the CNHR component, while fewer were able to identify the correct direction of movement for the other components. Candidates received partial credit if they identified the direction a component would move but did not provide a sufficient explanation.

PVFP: Likely to increase going from MCEV to TEV due to higher investment yields in the TEV scenarios.
TVOG: Likely to decrease going from MCEV to TEV because of higher spread compression over the stochastic MCEV scenarios.
CNHR: Does not exist in TEV so this component is removed going from MCEV to TEV.
FC: Likely to increase slightly going from MCEV to TEV due to higher investment yields leading to higher investment expenses.

4. **Learning Objectives:**
1. The candidate will understand the designs and risks of the common life and annuity products and features, as well as the methods and metrics used to design and price these products.

Learning Outcomes:
(1e) Describe considerations and practices related to "Lapse-Supported" insurance.

(1l) Describe and apply the principles of "Risk-Based Pricing" and "Market Consistent Embedded Value".

(1n) Describe and apply the requirements of applicable ASOPs on Life and Annuity Product Pricing and Assumptions

Sources:
LPM-152-19: Lapse Supported Insurance Analysis

Macro-Pricing, Product Development Monograph, pp. 11-41

Setting Assumptions, Exposure Draft, ASOP, Dec 2016

LPM-165-20: Life Products and Features

Commentary on Question:
Commentary listed underneath question component.

Solution:
(a) Describe the key intangible marginal cost affecting the profitability of the firm in the context of macro pricing and how it should be considered in decision making.

Commentary on Question:
Most candidates were unable to identify the intangible marginal cost. Instead, many candidates identified tangible marginal costs such as fixed or overhead expenses and received no credit.

The intangible marginal cost affecting the profitability of the firm is displacement cost. Displacement is when sales from existing products decrease due to new products entering into the market and taking sales that would have otherwise originated with the existing product. The cost is the loss of profit on the existing product due to this product losing sales to a new product.

(b) Describe one of the methods to determine the optimal price structure of a new product form that maximizes profitability.

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4. Continued

Commentary on Question:
Candidates only needed to describe one of the two methods, below. Candidates generally performed well on this question. Points were most often lost when candidates did not fully describe the method. Some candidates described the process for updating an existing product form instead of a new product form, and only received partial credit.

Method 1
- The marketing department carefully examines each price profile
- For each product price, an attainable production level is selected resulting in a set of price/production pairs
- The set of price/production pairs are plotted on a price-production graph, which then leads expected total profitability for each product price
- The price with the greatest expected profitability is selected and the project is evaluated on that basis.
  - If the expected profitability is satisfactory, then the project continues on that price structure
  - If not, consideration is given to expanding the decision set and investigating other more profitable projects

Method 2
- Similar to method 1, but avoids explicit price/production estimates
- Management determines the minimum total profitability such that the project will be carried through to completion
- The profitability serves as a minimum standard used to develop price/production pairs

(c)   Critique each of the following comments from the email:

A.   *I used the Actuarial Standard of Practice 24 definition of lapse support to verify we can use the non-guaranteed values in the illustration for the new Term product. The product is still profitable assuming higher lapses in later years therefore meets the ASOP's requirement.*

B.   *The marketing department head has requested we reduce the price in order to increase sales. The reduced price will result in a higher perceived value and thus lower lapses.*

C.   *The marketing department assured me that the agents selling the product have high persistency. Given this, we can reduce the lapse rate in all years.*

4. Continued

D. *Since we expect high persistency, we should offer a return of premium rider. The return of premium rider makes the product look cheaper, as well.*

E. *We will not need to include the reduction in the lapse assumption within the reserve calculation.*

F. *Since the product is not lapse supported, the path of the reserves does not matter and I have therefore excluded it from my analysis.*

Commentary on Question:
This question required the candidate to analyze the comments from the email. To get full credit on each question, the candidate needed to confirm if the comments were True or False and provide rationale and implications of the comments. Partial credit was given for identifying True or False, or providing rationale or implications.

For part A, most candidates did not do well on this part. Candidates who were familiar with ASOP 24 definition of lapse support and the implication for using non-guaranteed values in illustrations did well.

For part B, candidates generally did well. Some candidates did not recognize that the lower lapse rate will decrease the profitability

For part C, candidates generally did well and recognized that we cannot use comments from the marketing team to set lapse assumptions.

For part D, most candidates recognized that return of premium would increase persistency, but some failed to recognize that we should likely not offer the rider as persistency is already high. Some students also only commented on one sentence and ignored the other.

For part E and F, students generally did well.

A. The statement is not accurate. Actuarial Standard of Practice 24 defines lapse support as one that is not self supporting given defined persistency assumptions in the first 5 years, and assuming 100% persistency thereafter. If the product is still profitable under those conditions, it is not considered lapse supported. In this case the product would be considered lapse supported and non-guaranteed values could NOT be used in the illustration.

4. Continued

B. True – the lower the price of the product the greater the perceived value is likely to be, and thus the lower the probable lapse rate. However, the lower lapse rate will decrease the profitability of the product. The fundamental problem with lapse support is that the higher the assumed lapse rate, the lower the premium, the better the perceived bargain, and the lower the resultant lapse rate.

C. False – comments from the marketing team should not be used to set lapse assumptions. A full experience study using credible data should be used to set lapse assumptions. Agent persistency will impact lapse rates in the first few policy years, but the effect will wear off over time and the lapse rate at later durations is determined by the market.

D. The first sentence is false. Since the company expects high persistency, the return of premium rider should not be considered. The return of premium rider is better for a company that suffers from poor persistency in the early years.

The second statement is true. Return of premium riders are popular with agents, as they make a product look much cheaper, and sometimes even "free" on a "net cost" basis. Since payments under the rider go only to those who persist to the end of the specified period, it has the maximum possible lapse support, and profitability will be highly sensitive to the lapse rate.

E. False - the lapse assumption should be the same/similar in pricing and reserving.

F. False – regardless of if the product is lapse supported or not, the path of the reserves matters for profit emergence and reserve adequacy. If the reserve accumulates too slowly, you may be reporting a profit right up until the day it is discovered the reserve is inadequate. Products with significant lapse support are particularly difficult to gauge. Management needs to be sure that not only is the product lapsing at the rate designed, but that the reserve assumptions match the product design assumptions.

(d) Recommend additional considerations your team should make prior to implementing the assumption change.

Commentary on Question:
Candidates who provided considerations, with explanations and/or examples, to make prior to implementing the assumption change from the Setting Assumptions ASOP Exposure Draft received full credit. Partial credit was given if the candidate provided other reasonable considerations not covered in the Setting Assumptions ASOP Exposure Draft. A majority of candidates also listed considerations for after implementing the assumption change, for which they did not receive credit.

4.   Continued

- The marketing department said the agents selling the product have high persistency, but this should be verified with actual experience (ie. conduct an experience study) and any credible data available (ie. industry data). We should analyze the sales and persistency by each individual agent as well.
- We should consider any other existing or future known conditions (ie. economic, legislative, regulatory, demographic, technological, and social environments) that may change our opinion of what the expected lapse rate should be. We should also consider changes in the condition of internal circumstances (ie. change in claim processing or change in mix of business).
- We should consider other possible methodologies for setting this assumption.
- Consideration should be given to the impact of this assumption change on other assumptions used in pricing (ie mortality). The assumptions should be reasonable in aggregate
- We should use sensitivity analysis to evaluate the impact of reasonable alternative lapse assumptions on price and profitability.
- We should consider whether it is appropriate to adjust the assumptions by including a margin for adverse deviation.

5. **Learning Objectives:**

2. The candidate will understand the theory of "Value Creation" for life and annuity products and how to evaluate the patterns of earnings emergence under various regulatory regimes.

Learning Outcomes:

(2a) Describe, evaluate and apply the economic value creation framework.

Sources:

LPM-113-09: The Economics of Insurance: How Insurers Create Value for Shareholders, Swiss Re

LPM-154-19: Introduction to Source of Earnings Analysis
Report on Pricing Using Market Consistent Embedded Value (MCEV), Jun 2012 (excluding Appendix 2)

Commentary on Question:
Candidates performed relatively well on this question. Most of them were able to demonstrate sufficient knowledge on the topic, though some of them failed to do so. The more challenging parts included the calculation portions, in which only a few candidates were able to receive full credit.

Solution:

(a) Assuming a before tax and before risk-based capital basis:

    (i) Calculate the Economic Value created by this product.

    (ii) Calculate the change in the Economic Value, assuming an annual spread for default and liquidity of 0.5% is also included within the discount rate.

Commentary on Question:
For part i), most candidates succeeded in identifying the key components to calculate the net cash flows, however, many failed to treat Admin Fees as a cash inflow. Partial credit was given in this case. No credit was given if any components were incorrectly included.
For part ii), successful candidates were able to add 50bps for the spread. A few candidates reduced, instead of increased, the risk-free rates by 50bps. No credit was given if this was the case.

    (i)
        Net Cash flows
        = Cash inflows – Cash outflows
        = Premiums + Admin Fees + Investment Income – (Claims + Expenses + Change in Reserves)

5. **Continued**

Risk Capital Costs
= Risk Capital * Risk Capital Cost Percentage (2.5%) *(shifted 1 year: 1ˢᵗ year of risk capital cost starting at end of year 1 instead of time 0)*

Net Cash flows after frictional costs
= Net Cash flows – Risk Capital Costs

Economic Liability
= - (PV of Net Cash flows after frictional costs using risk-free rates) *(from end of year 1 onwards)*

Net CF	1,050	158	-125	-410	-705	312
Risk Capital Cost	0	45	10	10	10	10
Net CF after Frictional Cost	1,050	113	-135	-420	-715	302
Risk Free Rate		*1.00%*	*2.00%*	*2.50%*	*3.00%*	*4.00%*
Economic Liab.	**795**					
Economic Value	**255**					

Economic Value
= Time 0 Net cash flows after frictional costs – Economic Liability
= 1,050 – 795
= 255

(ii)

Add 50bps to risk-free rate each year

Net CF after Frictional Cost	1,050	113	-135	-420	-715	302
Risk Free Rate		*1.50%*	*2.50%*	*3.00%*	*3.50%*	*4.50%*
Economic Liab.	**782**					
Economic Value	**268**					

Economic Value (with 50bps spread)
= Time 0 Net cash flows after frictional costs – Economic Liability
= 1,050 – 782
= 268

Change in Economic Value
= Economic Value with spread – Economic Value without spread
= 268- 255
= 13

(b) Describe sources of frictional capital costs used in the calculation of Economic Value.

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5. Continued

Commentary on Question:
Almost all candidates were able to provide some or all of the sources of frictional capital costs, but some failed to provide any descriptions. Partial credit was given for responses without any descriptions.

1) Double taxation – Corporate tax on earnings and investment income tax for investors (schedule of invested assets)
2) Financial distress cost – depends on YKT Life's risk profile (invested assets and reserve by product types)
3) Agency cost – Use discounts applied by analysts to companies with comparable excess capital (required capital as market comparable)
4) Regulatory capital costs – arise due to regulatory restrictions that may require insurers to hold minimum levels of capital to support specific blocks of business

(c) Recommend one way in which each source of frictional capital costs could be decreased.

Commentary on Question:
Candidates generally did well in this section and were able to provide reasonable ways to decrease the frictional capital costs. Some candidates failed to provide any recommendation on reducing the regulatory capital costs.

Double taxation – Insurers could manage their double taxation costs through their financing and investment decisions. For instance, insurers can finance themselves with hybrid equity, which has the tax characteristics of debt, but the risk characteristics of equity. They can also hold their investments in low-tax environments and invest in assets that are taxed favorably. Even the choice of active or passive management styles influences the tax burden on capital income.

Cost of financial distress – Companies can incur the cost of financial distress through the loss of reputation and franchise value which will increase their incentive to control their risk level. This can be achieved by either holding a greater amount of risk capital or by the use of risk transfer.

Agency costs – Reputation, transparency, and incentive structures are critical factors for reducing agency costs. Additionally, the scale of a company also impacts the transparency it can achieve. The life cycle of the company is important as young companies have not had a chance to establish a reputation.

Regulatory capital costs – The primary driver of this cost is the regulatory environment the business is written in. To a limited extent, insurers can exercise control over this cost by efficient risk transfer.

5. Continued

(d)   Explain three ways YKT Life's Economic Value may be distorted if YKT Life decides to instead use book value for assets and a fixed discount rate for valuing liabilities in the calculation of the product's Economic Value.

Commentary on Question:
Almost no candidates were able to explain that hidden reserves could be built by YKT's decision. Most candidates were able to provide the impact from either using book value for assets or a fixed discount rate for liabilities.

A company's true economic value should be based on market value-based assets and best estimate liability.

1) Use of a fixed rate for valuing liabilities ignores the impact of interest rate risks.
2) Using book value instead of market value for assets distorts the volatility and true economic condition of the underlying business.
3) If book value and/or using a fixed discount rate for liability results in a more conservative valuation, then hidden reserves are being built. Release of hidden reserves can be manipulated to affect emergence of profits that do not reflect current performance.

(e)   Management has asked for a different view of the income statement in order to see where expected profits are expected to be realized from.

   (i)   Construct a Source of Earnings profile for actual results assuming the company's hurdle rate of 7% is used to discount future cash flows. Include the following margins:

   - Investment Margin
   - Claims Margin
   - Expense Margin
   - Reserve Margin

   (ii)   Verify the sum of the margins equals the total Traditional Embedded Value of the product.

Commentary on Question:
Only a handful of candidates were able to correctly calculate all of the margins and the embedded value. Very few candidates truly understood the concept of reserve margin and hence failed to perform the calculations correctly. Similar to part a, only a handful of candidates succeeded in recognizing Admin Fees as a cash inflow.

5. **Continued**

Some candidates flipped the signs of the margins, while some applied the risk-free rates as the hurdle rate for discounting. Partial credit was given for those responses.

(i) **Investment Margin**
= PV Net Investment Income – PV Interest Credited
= 27, 195 – 22,173
= 5,022

Yearly calculations:

Net Inv. Income	0	6,510	6,603	6,669	6,705	6,711
Interest Credited	0	5,355	5,406	5,432	5,430	5,428
Inv. Margin	*0*	*1,155*	*1,197*	*1,237*	*1,275*	*1,283*

Discount CF using hurdle rate of 7%

Claims Margin
= PV AV released – PV Claims
= 93,565 – 92,192
= 1,373

Yearly calculations:

AV Released	0	4,719	5,206	5,668	6,100	103,725
Claims	0	5,074	5,598	6,095	6,559	103,725
Claims Margin	*0*	*355*	*392*	*427*	*459*	*0*

Discount CF using hurdle rate of 7%

Expense Margin
= PV Admin Fees – PV Expenses
= 219 – 7435
= -7,216

Yearly calculations:

Admin Fees	50	50	50	50	50	0
Expenses	6,000	350	350	350	350	350
Expense Margin	*-5,950*	*-300*	*-300*	*-300*	*-300*	*-350*

Discount CF using hurdle rate of 7%

Reserve Margin
= PV Change in AV – PV Change in Reserve
= 28,608 – 27,349
= 1,259

5. **Continued**

Yearly Calculations:

Chg in AV	100,000	281	-192	-663	-1,129	-98,297
Chg in Rsv	93,000	1,333	1,222	1,111	1,010	-97,676
Reserve Margin	*7,000*	*-1,052*	*-1,414*	*-1,774*	*-2,139*	*-621*

Discount CF using hurdle rate of 7%

(ii)   Income = Premiums + Admin Fees + Investment Income
Expense = Claims + Expenses + Change in Reserves

Income	100,050	6,560	6,653	6,719	6,755	6,711
Expenses	99,000	6,402	6,778	7,129	7,460	6,399
Net CF	1,050	158	-125	-410	-705	312

Discount CF using hurdle rate of 7%

Traditional Embedded Value
= PV of Net Cash Flows at Hurdle Rate
= 438

Sum of Margins
= Investment Margin + Claims Margin + Expense Margin + Reserve Margin
= 5,022 + 1,373 + (-7,216) + 1,259
= 438

6. **Learning Objectives:**
3.   The candidate will understand common issues and practices related to In Force and New Business Product Management, and how experience studies are designed and used for evaluating past experience and for setting assumptions.

Learning Outcomes:
(3a)   Recommend and justify changes to nonguaranteed elements such as credited rates, policy charges, policyholder dividends and guaranteed renewable premiums.

(3d)   Describe and evaluate the challenges insurers face in a low and potentially rising interest rate environment.

(3i)   Describe and apply the use of statistical credibility methods used for validating actuarial judgment when evaluating experience

Sources:
Credibility Theory Practices, 2009

LPM-xxx-21: Section 12.3 and last example for dividends in Section 12.4 of Statutory Valuation of Individual Life and Annuity Contracts, Claire, D.,

LPM-110-07: Policyholder Dividends

Commentary on Question:
This question tested the candidates' knowledge of Dividend scales and the considerations for setting the scale. In general, candidates did not score well on this question. Many listed items to think about but did not explain or analyze or evaluate as the question asked.

Solution:
(a)   Analyze considerations when using the three factor formula to set the dividend scale, based on the information above.

   Commentary on Question:
   Most candidates could identify the components of the three factor formula but failed to provide any analysis of the given information (for example, the impact of removing pegging).

   The Three factor formula includes investment factor (A - E), mortality factor (E - A), and expense factor (E-A). The need to reflect credible experience and smoothing techniques is important to avoid changes due to random fluctuations and a minor temporary decline due to pegging being removed.

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6. Continued

1. Investment Factor considerations: The lower portfolio yield should be recognized in the scale due to supportability. The scale should be lowered to reflect the lower yield. Also consider RCG/Ls and determine the release into surplus.
2. Mortality Factor: For mortality, it is common to use averaging. Particularly with the temporary nature of the pandemic, use a three to five year rolling average for the experience. Five year = (90+95+100+105+125)/5 = 104% A/E OR consider removing the 125% for the COVID year if we do not expect the experience to continue. For policyholder equity, consider reviewing the A/E by attained age and risk class and applying different factors by age.
3. Expense Factor: The decision to move acquisition expenses to OH may over allocate expenses to old blocks in favor of new blocks, causing pricing issues and equity issues for the existing policies. Expenses may need to be increased due to higher lapses caused by the economic downturn so per policy expense would increase and in addition, removal of pegging may cause higher lapses since the dividend is allowed to decrease, so per policy expenses increase but also any unamortized acquisition expenses.

(b)

    (i)   Evaluate the update program.

    (ii)   Evaluate the use of the currently payable scale in the illustration of new policies.

Commentary on Question:
Many focused on the equity of the inforce scale versus the new business scale which was not the intent of the question. Candidates also failed to identify how the program provisions relate to invested assets or earnings. Some candidates suggested alternative provisions rather than evaluating the given program. In part (ii), most candidates failed to identify that the currently payable scale could be used for illustrations.

(i)
- Investment income credited must include all sources of investment earnings. The Actuary must bridge the gap between statutory accounting and how inv income is tracked for dividend purposes.
- The Moody's benchmark, would not be appropriate for determining policyholder dividends on the par whole life.
- Changing to market yield strategy would necessitate all sources of investment earnings including unrealized gains and losses. Consider creating a similar process to IMR for unrealized gains and amortize over a similar period. Make sure there is similar treatment for unrealized as realized losses.
- Only actively invested assets should back the dividend scale.

6. Continued

- Some non-loaned policies may elect to not update as they prefer the current program provisions to the updated provisions. Need to account for that in the impact to the divisible surplus and retained earnings.
- The variable loan rate without direct recognition would help drive up the portfolio rate when interest rates are increasing, but illustration when the variable rate is low could be misleading.
- Recommend either including direct recognition or limit the illustrated loan rate.

(ii) The illustration should not exceed the currently payable scale, but can be lower if justified. Illustrations on new business should be limited to the currently payable scale and pegging would not apply. Although, inforce policies can illustrate pegging if that's the company practice.

7.

Learning Objectives:

4. The candidate will understand the various forms of traditional reinsurance, will be able to assess how and when they are effectively used, and will be able to perform the associated accounting (from both ceding and assuming perspectives) for basic reinsurance transactions.

Learning Outcomes:

(4c) Describe risk transfer considerations, and evaluate their impact on reinsurance agreement provisions.

(4e) Describe and evaluate how strategic/customized reinsurance solutions may enhance insurer prospects.

Sources:

LPM-160-19 Strategic Reinsurance and Insurance

Commentary on Question:

Commentary listed underneath question component.

Solution:

(a)

(i) Explain the objectives for the company in considering the use of reinsurance for each motivation category.

(ii) Identify the mapping of the following reinsurance solutions to the motivation categories. Justify your answer.

1. Life in force solutions
2. Solutions supporting growth
3. Solutions for mutual insurers

Commentary on Question:

Few candidates provided the complete answer for this section. Most provided limited information. Most candidates provided some detail to the Corporate Finance Driven section of part a(i). For the other motivations, candidates did not provide enough details that supported the correct answer. Overall students performed poorly on part a(i).

Candidates performed fairly well on the second part of the question, a(ii). Most understood the question and was able to provide at least one mapping answer for each category.

7. **Continued**

(i)
Structured protection:
- Improve the efficiency of their current risk transfer programs (like reducing the cost of mortality or reducing their exposure to interest rate risk)
- Improve their capacity for difficult to reinsure risks
- Reduce their exposure to certain risk concentrations (like catastrophic risks in a certain geographic area).

Corporate finance driven:
- Free up any redundant capital (that could be held up due to the regulation XXX requiring redundant capital) which can help improve their financing results (such as their return on equity)
- Optimize their capital structure
- Replace traditional capital
- Use reinsurance as a means of reducing surplus and earnings volatility to reduce their Cost of Capital.

Enabling strategy and growth:
- The insurer and reinsurer could cooperate together in a way that aligns their long term strategic goals and objectives and they could mutually achieve growth together through a strategic partnership

(ii)
Life in force solutions could be mapped to Corporate Finance Driven solution, helps free up capital to pursue other more profitable ventures and improve overall returns.
It could also be mapped to Enabling Strategy & Growth, which supports expansion into new markets and to launch new products.

Solutions supporting growth would map to Enabling Strategy and Growth, whereby the reinsurer provides advise and expertise to the insurer to help them grow their business.

Solution for Mutual Insurers would map to Corporate Finance Driven and Enabling Strategy & Growth, the reinsurer could help provide them with additional source of capital that they would normally be unable to raise on the capital markets. The reinsurance can also help provide financial flexibility to handle unexpected events.

7. Continued

(b) Describe areas where reinsurance provides value to buyers and sellers in merger and acquisition deals.

Commentary on Question:
Candidates demonstrated a good understanding of what was being asked in this question. Most were not able to provide all the details for the answer but almost all candidates that attempted an answer received some credit. A typical response from candidates included about 3-5 bullet points. For full credit, about 8-10 bullet points were needed.

- The reinsurer can provide a flexible/efficient form of financing for the M&A deal, without increasing the leverage for the buyer. This capital financing can be done before or after the deal has been completed.
- Reinsurance can be used to restructure the risks in a way that would improve the value of a business to make it more attractive for an M&A deal.
- Reinsurance can be used to transfer away risks that are not attractive or risks that the acquirer does not want to retain after an M&A
- There is more confidence that the dividends of the merged business can be met over a longer term horizon which helps to manage the expectations of policyholders and shareholders
- The reinsurer can also provide advice and risk management expertise both before and after the deal has been completed
- Reinsurers can provide confidence to all stakeholders and external audiences in an M&A deal. They provide assurance that the best risk management practices and due diligence have been applied throughout the M&A process
- Reinsurers provide stakeholders with more confidence that they are making a financial commitment
- Finally, it provides stakeholders with reassurance that the merged/acquired entity will be managed using best practices in terms of risk management moving forward

(c) Critique each of the following statements concerning reinsurance:

A. *Reinsurers cost of capital is less expensive than insurer cost of capital.*

B. *Reinsurance capital offers more flexibility to a company than traditional capital.*

C. *An insurance company should avoid the use of collateral when it uses reinsurance to monetize the value of long-term savings and protection policies.*

7. **Continued**

      D.   *Increasingly sophisticated regulatory capital requirements will increase the use of reinsurance employed by smaller mono-line insurers, with the objective to avoid being acquired.*

      E.   *Under Solvency II, non-life reinsurance has become more attractive for insurers.*

Commentary on Question:
Candidates were given additional credit for making an explicit statement of True or False. They then gained additional points for justification. The majority provided a True or False answer to each statement, however, only very few were able to provide enough details to earn full credit for this question.

A. **This is true**, as reinsurers are often more diversified and are therefore less risky, so the cost of capital that they provide for insurers in corporate finance driven solutions is often lower than the cost of capital of the insurer

B. **This is true**, this is because reinsurance capital is often provided over a shorter term than other forms of capital, it is also private and does not need to be approved by shareholders or by the SEC, so the capital can be raised quickly and efficiently. Because of these factors, the capital can also be more tailored and targeted to address specific risks in the company that traditional forms of capital are unable to achieve.

C. **This is not true** as collateral would provide the reinsurer with more security and reduce the reinsurer's counterparty risk with the insurer. The structure of the reinsurance could require upfront ceding commission to the reinsurer.

D. **This is partially true**, as the smaller mono line insurers are less diversified. Reinsurance will be held to reduce their risks and reduce their required capital which will allow them to become more competitive. The main objective is to improve their solvency position and to improve their overall competitiveness, and may increase the company's attractiveness for acquisition.

E. **This is true**, as Reinsurance better reflects the risk mitigating effects of reinsurance. Not all types of reinsurance are adequately considered under the standard formula.

8.   **Learning Objectives:**
1.   The candidate will understand the designs and risks of the common life and annuity products and features, as well as the methods and metrics used to design and price these products.

5.   The candidate will understand the role of the Investment Actuary and the Portfolio Management Process in the Life Insurance company context, as well as the common forms of Fixed income securities and their uses, and the methods and processes used for evaluating portfolio performance and asset allocation.

Learning Outcomes:
(1a)   Describe the designs of the common life and annuity products and evaluate their associated features and inherent risks.

(5j)   Describe how an insurance company can hedge against the cost of borrowing through forward rate futures, and perform related calculations.

(5k)   Describe the role of LIBOR and SOFR in an insurance company investment management context.

Sources:
LPM-164-21: Ch. 7 (sections 7.2-7.5 & 7A) of Derivatives Markets, McDonald, 3rd Edition

LPM-169-20: Secured Overnight Financing Rate (SOFR)

LPM-170-20: LIBOR's Demise and a $200 Trillion Question

LPM-166-20: Annuity Product and Features

Commentary on Question:
Commentary listed underneath question component.

Solution:
(a)   Describe risks JPB Life could face if interest rate rises rapidly.

       Commentary on Question:
       The question asked candidates to evaluate the crediting strategy on the pricing consideration of a new deferred annuity product. Candidates needed to clearly explain why new rate will be uncompetitive in the rapid rising interest rate environment if using asset portfolio yield as a basis to receive full credit. Most of candidates did well in explaining the excess lapse risk and liquidity risk, but very few commented on the profitability.

8. **Continued**

- During a rising interest rate environment, the net yield of the asset portfolio underlying a block of existing deferred Annuities will lag the net new money rate being used to price new issue. Therefore, the crediting rate will lag the rates being offered by competitors on new issues. The crediting rate will be uncompetitive.
- If the crediting rate is uncompetitive, excess lapses will occur. If the excess lapses are high, in an extreme case, ABC Life may be forced to liquidate assets and probably incur realized losses on the sale of assets in order to meet the surrender demands.
- Excess lapses will result in the profit margin not being met. That will cause lower-than-expected profitability.

(b) JPB Life currently has 500 million of assets under management, predominately invested in corporate bonds. Due to the appeal of the current low interest rate environment, JPB Life is planning to borrow 250 million to fund future business growth. The investment manager decided to use LIBOR as the benchmark rate.

Evaluate the investment manager's proposal.

Commentary on Question:
The question tested candidate's understanding of the role of LIBOR in an insurance company investment management. Candidates needed to demonstrate an understanding of the shortcomings of the investment manager's proposal as well as the issues with using LIBOR as a reference rate to receive full credit. Candidates generally did well on this question, but many failed to comment on the credit risk that embedded in LIBOR.

- It is not appropriate to use LIBOR as the benchmark rate in this transaction.
- LIBOR reflects the banking sector's credit risk, since ABC Life is predominately invested in corporate bonds, which already entails a level of credit risk, borrowing another large chunk of money (one half of the existing assets) using this reference rate will further expose ABC Life to even more credit risk
- Banks can strategically provide misleading quotes to benefit themselves, so LIBOR has lost its reliability
- LIBOR will soon be replaced by SOFR hence it is not ideal for funding future business

(c) Recommend a financial instrument for JPB Life to hedge against any increases in the cost of borrowing in a rising interest rate environment. Justify your answer.

8. Continued

Commentary on Question:
This question asked candidate to describe how derivatives instruments can work to hedge against the cost of borrowing. Full credit was awarded to candidates who provided with either one of the two answers below, however, candidates had to clearly demonstrate an understanding of how the interest rate risk is mitigated in a rising interest rate environment through each instrument to receive full credit.
Most candidates did well in this question.

ABC Life can use a Forward Rate Agreement (FRA) to hedge against the increase in the cost of borrowing

In a FRA, payment is based on the reference rate; i.e. borrower is paid if the reference rate is above the FRA, and the borrower pays if the reference rate is below the FRA rate.

OR

ABC Life can use an interest rate swaps to hedge against the increase in the cost of borrowing

Interest rate swaps are agreements in which the parties exchange fixed-rate interest payments for floating-rate interest payments. ABC Life can benefit from this instrument in a rising interest rate environment because the value of the incoming SOFR-based payments is now higher, even though the cost of the fixed-rate payments to the counterparty remains the same.

(d) You are given the following information:

Days to Maturity	Zero Coupon Bond Price
90	0.99009
180	0.97943
270	0.96525
360	0.95328

(i) Calculate the difference between the implied forward rate of a 270-day loan commencing on day 90 and the implied forward rate of a 90-day loan commencing on day 90.

(ii) Identify a strategy to replicate the cash flows of a 10 million 90-day loan commencing on day 180 using zero coupon bonds.

8. Continued

Commentary on Question:
This question tested candidate's understanding about how to construct a synthetic portfolio using zero-coupon bonds. Most candidates did well in part (i) about calculating implied forward rate, but didn't do well in part (ii), not many candidates were able to synthetically create same effect of required cashflows using zero-coupon bonds.

(i) Implied forward rate of 270-day loan commencing on day 90
Starting day t=90   Maturity length s=270
Zero Coupon Bond Price
$P(0, t) = P(0,90) = 0.99009$
$P(0, t+s) = P(0, 90+270) = P(0, 360) = 0.95328$
Implied forward rate: $r_0(t, t+s) = P(0,t)/P(0, t+s) -1$
$r_0(90, 90+270) = P(0,90)/P(0, 360) -1 = 0.99009/0.95328-1 = 3.86\%$

Implied forward rate of 90-day loan commencing on day 90
Starting day t=90   Maturity length s=90
Zero Coupon Bond Price
$P(0, t) = P(0,90) = 0.99009$
$P(0, t+s) = P(0, 90+90) = P(0, 180) = 0.97943$
Implied forward rate: $r_0(t, t+s) = P(0,t)/P(0, t+s) -1$
$r_0(90, 90+90) = P(0,90)/P(0, 180) -1 = 0.99009/0.97943-1 = 1.088\%$

Difference = $r_0(90, 90+270) - r_0(90, 90+90) = 3.86\% -1.088\% = 2.77\%$

(ii) Implied forward rate of 90-day loan commencing on day 180
Starting day t=180   Maturity length s=90
Zero Coupon Bond Price
$P(0, t) = P(0,180) = 0.97943$
$P(0, t+s) = P(0, 180+90) = P(0, 270) = 0.96525$
Implied forward rate: $r_0(t, t+s) = P(0,t)/P(0, t+s) -1$
$r_0(180, 180+90) = P(0,180)/P(0, 270) -1 = 0.97943/0.96525-1 = 1.469\%$

For a 10 million 90-day loan commencing on day 180, the cashflows are as follows:
- on day 180, we receive $10M loan
- on day 270, we pay back $10M loan with interest
  $10M*(1+1.469\%)=$10.1469M

We need to have cashflows net out to zero on day 0, 180 and 270 using the strategy.

8. **Continued**

To accomplish this, on day 0,
- we buy a $10M zero coupon bond with maturity at day 180.

Price of bond = face amount * P (0, 180) = $10M * 0.97943 =$9.7943M

- we short sell a $10.469M zero coupon with maturity at day 270

Price of bond = face amount * P (0, 270) = $10.1469M * 0.96525 =$9.7943M

	Day 0	Day 180	Day 270
Loan amount worth 10M on day 180		10.000	-10.1469
Buy 0.9794 *$10M zero coupon bonds maturing on day 180	9.7943	-10.000	
Short-sell 1.01469*(-10M)*0.9653 zero couple bonds maturing on day 270	-9.7943		10.1469
Total	0.0000	0.000	0.000

9.

Learning Objectives:

2. The candidate will understand the theory of "Value Creation" for life and annuity products and how to evaluate the patterns of earnings emergence under various regulatory regimes.

4. The candidate will understand the various forms of traditional reinsurance, will be able to assess how and when they are effectively used, and will be able to perform the associated accounting (from both ceding and assuming perspectives) for basic reinsurance transactions.

5. The candidate will understand the role of the Investment Actuary and the Portfolio Management Process in the Life Insurance company context, as well as the common forms of Fixed income securities and their uses, and the methods and processes used for evaluating portfolio performance and asset allocation.

Learning Outcomes:

(2e) Describe and evaluate fundamental strategies for enhancing value through active in-force and operational management.

(4a) Evaluate and analyze traditional and advanced reinsurance transactions, and prepare related financial statement entries.

(5a) Describe the portfolio management process in an insurance company, and the role of Investment Policy, the Investment Actuary, and external portfolio managers.

(5j) Describe how an insurance company can hedge against the cost of borrowing through forward rate futures, and perform related calculations.

Sources:

Life in-force management: improving consumer value and long-term profitability, Swiss Re Sigma, 2017

The Handbook of Fixed Income Securities, Fabozzi, 8th Ed. Ch. 62 - Interest-Rate Swaps and Swaptions

The Handbook of Fixed Income Securities, Fabozzi, 8th Ed. Ch. 66 - Credit Derivatives, pp. 1541 - 1559

Derivatives Markets, McDonald, 3rd ed., Ch. 7 - Swaps of Derivative Markets, Sections 7.2-7.5 & 7A

Tiller, 4th Edition, Chapter 4: Basic Methods of Reinsurance

9. Continued

Commentary on Question:
This question required candidates to explain tools for managing common interest rate and related asset risks associated with accumulation-driven life insurance products.

Solution:

(a)

    (i)   Define the swap rate.

    (ii)   Calculate the present value of the floating rate payment.

    (iii)   Calculate the swap rate.

Commentary on Question:
Candidates were generally able to define the swap rate, however many candidates had difficulty applying their knowledge to the calculations. Common errors included incorrectly computing the period forward rates and forward discount factors from the given forward rates.

(i) The swap rate is the singular rate on which the fixed payments in a swap are based.

(ii) Period Forward Rate = Forward Rate * number of days in quarter / 360

FDF = Forward Discount Factor
Q1 FDF = 1 / (1 + Q1 Period Forward Rate)
Q2 FDF = Q1 FDF / (1 + Q2 Period Forward Rate)
Q3 FDF = Q2 FDF / (1 + Q3 Period Forward Rate)
Q4 FDF = Q3 FDF / (1 + Q4 Period Forward Rate)

Floating Rate Payment = Notional Amount * Period Forward Rate

PV Floating Rate Payment = Floating Rate Payment * FDF

	Number Days in Q	Forward Rate	Period Forward Rate	FDF	Floating Rate Pmt at End of Quarter	PV Floating Rate Pmt
Q1 2021	90	2.00%	0.50%	0.995025	500,000	497,512
Q2 2021	90	5.00%	1.25%	0.982741	1,250,000	1,228,426
Q3 2021	90	8.00%	2.00%	0.963471	2,000,000	1,926,942
Q4 2021	90	11.00%	2.75%	0.937685	2,750,000	2,578,633
						6,231,514

(iii) Swap Rate = $\frac{\Sigma \text{ PV Floating Rate Payments}}{\Sigma \text{ Notional Amount} * (\text{days in quarter} / 360) * \text{FDF}}$

9. **Continued**

	Notional Amount * (90 / 360) * FDF
Q1 2021	24,875,622
Q2 2021	24,568,515
Q3 2021	24,086,780
Q4 2021	23,442,122
	96,973,039

Swap Rate = $\dfrac{6,231,514}{96,973,039}$

Swap Rate = **6.43%**

(b) Explain key factors that would increase the value of a pay fixed interest rate swaption.

Commentary on Question:
Most candidates correctly identified and explained why an increase in interest rates increases the value of a pay fixed interest rate swaption and many also received credit for interest volatility. Few candidates identified and explained the impact of strike rate and time to expiration.

A pay fixed interest swaption gives the buyer a right to establish a position in an interest rate swap where they would pay at a fixed rate and receive floating rate payments.

Yield curve – An increase to the level of slope of the yield curve will increase the value of a pay-fixed swaption, given the floating rate payments would become more valuable.

Interest volatility – There is a positive relationship between swaption values and the assumed interest rate volatility. An increase to the volatility of interest rates increases the likelihood of favorable movements of the underlying, thus increasing the value of the pay-fixed swaption.

Strike rate – The value of a swaption is essentially the difference between the prevailing swap rate and the strike rate. Thus, a decrease to the strike rate, all else equal, will increase the value of a pay-fixed swaption.

Time to expiration – Effects are ambiguous, depending on other factors such as the current yield curve, volatility, and the strike rate. Increasing the swaptions time to expiration can either increase or decrease its value.

9. Continued

(c) Recommend two other potential derivative strategies that address risks not covered by XYZ's interest rate swap; include an assessment of the cash flow needs.

Commentary on Question:
Many candidates recommended credit default swaps to address default risk arising from lower rated Bullet bonds and currency swaps to address foreign exchange risk from euro-denominated Bullet bonds. Only partial credit was awarded if the strategies were not fully explained or assessed in terms of XYZ's needs. Almost all candidates failed to assess the impact of the above derivative strategies on XYZ's cash flows.

Credit default swaps (CDS) are recommended to mitigate the default risk arising from lower rated Bullet bonds. Purchasing CDS' can hedge XYZ's portfolio against these lower rated securities, transferring credit risk off XYZ's balance sheet. XYZ may have to pay an upfront premium, which may be positive or negative, and then during the premium leg XYZ would need to pay a regular coupon to the protection seller.

Currency swaps are recommended to provide protection against the foreign exchange risk stemming from XYZ's euro-denominated Bullet bonds. XYZ would want to receive dollars, and pay Euros, to hedge the risk of the US subsidiary's exposure to fluctuating Euro to USD exchange rates. XYZ's cash flow needs will depend on the relationship between the reference rates for euro and dollar-denominated debt. After entering the swap, if the dollar declines relative to the euro, then XYZ will pay to the counterparty.

(d) Propose a reinsurance structure to address XYZ's policyholder persistency risk and optimize its capital position. Justify your proposal.

Commentary on Question:
Most candidates received partial credit by recommending a modified coinsurance arrangement and providing rationale supporting the appropriateness of this structure. To receive full credit, commentary on mitigating persistency risk and capital implications was required. Credit was also given for funds withheld coinsurance if properly justified.

Since XYZ seeks reinsurance to optimize its capital position but does not wish to sell or transfer any assets, they should use a modified coinsurance ("modco") reinsurance agreement that will allow them to continue controlling and investing their own assets to benefit from strong asset performance.

9.   **Continued**

Yearly renewable term (YRT) reinsurance isn't appropriate since it only transfers mortality risk which isn't a primary concern for XYZ given their stringent underwriting performance. Modco reinsurance will transfer a quota share of all risks, including persistency risk, thereby reducing XYZ's exposure to surrender benefits.

Entering into a modco reinsurance agreement will also provide capital and surplus relief to XYZ, thereby allowing XYZ to release some of its capital for other business opportunities.