

# ILA LPM Model Solutions

## Fall 2020

### 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.
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:

- (1b) Describe and evaluate methods and metrics used to design and price these products, and assess their profitability.
- (1q) Describe and evaluate the types of assumptions commonly used in actuarial pricing and product development.
- (2d) Describe and evaluate how Source of Earnings analyses can enhance understanding of the drivers of earnings, and apply the methodology.

### Sources:

LPM-165-19: Life Products and Features, ILA Committee, 2019

Post Level Term Experience Results, 2014, pp. 21-44

ASOP 54: Pricing of Life and Annuity Products, Jun 2018

LPM-154-19: Introduction to Source of Earnings Analysis, 2015, Exclude Appendix

### Commentary on Question:

*This question compares Term Insurance and UL product characteristics and the selection of appropriate assumptions. A secondary focus is on profitability measurement comparisons & a source of earnings analysis. Candidates did well on parts (a) and (c) and struggled more on parts (b) and (d). See separate comments below.*

### Solution:

- (a) You are given the following information about Term Co's 5 and 10-year level term life insurance products:

## 1. Continued

- They are renewable at a higher premium amount beyond the initial level term period pattern
- The issue age range is 18-65
- There is no maximum face amount
- Premium rates per 1,000 do not vary by face amount
- The mortality pricing assumption is based on Term Co experience and varies by gender and attained age

Critique the mortality pricing assumption.

### Commentary on Question:

*This question tests candidates' understanding of types of assumptions commonly used in actuarial pricing and product development. Candidates were asked to evaluate mortality assumption for a Term product. Many candidates did well on this question. Full credit was awarded to candidates who made two well explained points below.*

- Attained age mortality tables make it difficult to be competitively priced across a range of issue ages
- Currently there is no face bands, mortality is generally better for higher bands than the rest.
- Renewal mortality in the post-level period is influenced by unhealthy lives retaining coverage (anti-selection)
- Post-level term mortality is largely dependent on the magnitude of the shock lapse
- Consider separating smoker/non-smoker or other underwriting criteria

(b) You are given Term Co's 10-year term GAAP results for the prior quarter:

Aggregate Reserve Rollforward	
Beginning of Period Reserves	675,000
Net Premium	370,000
Reserve Released for Maintenance Expenses	(125,000)
Interest Added to Reserves	X
Reserve Released for Death Benefits	(220,000)
Reserve Released for Surrenders	(18,000)
End of Period Reserves	695,500

## 1. Continued

Actual Experience	
Net Premium	390,000
Investment Income	9,500
Death Benefits Paid	245,000
Surrender Benefits Paid	0
Maintenance Expenses Paid	128,000

- (i) (0.5 point) Calculate X in the Aggregate Reserve Rollforward. Show all work, including writing out relevant formulas used in any calculations.
- (ii) (2.5 points) Create a Source of Earnings analysis for the actual results.
- (iii) (1 point) Determine the expected total variance between actual results and projected valuation results. Show all work, including writing out relevant formulas used in any calculations.

### Commentary on Question:

*This question tests candidate's understanding of Source of Earnings analyses. Candidates were asked to apply the methodology to perform a numerical calculation for a given scenario with different drivers of earnings. Most of candidates did relatively well in part (i) and (ii), but poorly on part (iii). Many candidates don't understand what's the difference between the net profit on valuation basis vs. actual result basis.*

#### (i) Interest Added to Reserves

$$\begin{aligned} &= \text{End of Period Reserves} - (\text{Beginning of Period Reserves} + \text{Net Premium} + \\ &\text{Reserve Released for Maintenance Expenses} + \text{Reserve Released for Death} \\ &\text{Benefits} + \text{Reserve Released for Surrenders}) \\ &= 695,500 - (675,000 + 370,000 - 125,000 - 220,000 - 18,000) = \mathbf{13,500} \end{aligned}$$

# 1. Continued

<b>(ii)</b>		<b>Actual Results</b>
<b>Source of Earnings Analysis</b>		
<b>In Force Profit Margin</b>		
	Actual Gross Premium	390,000
	GAAP Reserve Premium	<u>(370,000)</u>
Net		20,000
<b>Experience - Investment Gains</b>		
	Investment Income	9,500
	GAAP Reserve Interest	<u>(13,500)</u>
Net		(4,000)
<b>Experience - Mortality</b>		
	Actual Death Benefits	(245,000)
	GAAP Reserve Released for Death Benefits	<u>220,000</u>
Net		(25,000)
<b>Experience - Lapse</b>		
	Actual Surrender Benefits	-
	GAAP Reserve Released for Surrender Benefits	<u>18,000</u>
Net		18,000
<b>Experience - Expenses</b>		
	Actual Expenses	(128,000)
	GAAP Reserve Released for Expenses	<u>125,000</u>
Net		<u>(3,000)</u>
<b>TOTAL</b>		<b>6,000</b>

**(iii)** On the Valuation basis, it will just be the inforce profit margin (or difference in actual gross premium and GAAP reserve premium that results in a profit margin), which is 20,000

The net profit from actual results is 6,000 from part (ii)

Therefore, the expected total variance between actual results and projected valuation results is  $6,000 - 20,000 = 14,000$

(c) Describe considerations that should be incorporated into the following term assumptions before they are used to price the UL product:

- (i) Mortality
- (ii) Lapse
- (iii) Interest

## 1. Continued

### **Commentary on Question:**

*This question continues to test candidates' understanding of types of assumptions commonly used in actuarial pricing and product development. Candidates were expected to focus the arguments on difference for each assumption between Term and UL products based on different characteristics of the products. Candidates generally did well on this question.*

#### **(i) Mortality**

Mortality can generally be expected to be similar across term and UL although adjustments would be needed for:

- Mortality is influenced by shock lapses on term which do not impact UL
- Term mortality is based on higher face amounts leading to better mortality
- Term has low long term persistency leading to improved mortality rates
- Implementation of the AUW program can result in 5-10% increase in expected mortality for those that qualify
- For those who do not qualify and need to go through full underwriting, the mortality should be similar

#### **(ii) Lapse**

- Term will have selective lapsation after level period, which does not apply to UL
- UL lapses need to be supplemented with an assumption for partial withdrawals
- UL lapses tied to market performance, guarantees, the level of crediting rates, as well as overall interest environment etc.

#### **(iii) Interest**

- Term reserve interest rates will not be directly applicable to UL
- UL interest rate assumptions will need to be more complicated. In addition to a rate of return on assets, UL needs assumption for the rate credited to the account which can either be guaranteed, or based on portfolio of assets backing the fund

- (d) List considerations when selecting a profitability metric.

### **Commentary on Question:**

*This question asks candidates to make general comments on the considerations when selecting a profitability metric. Some candidates misunderstood the question to propose different profitability metrics for Term and UL products. Partial credit was given when candidates provided valid explanation and consideration for selected profitability metric.*

## **1. Continued**

- The expected pattern of profits over time (for example, the pattern of gains and losses, however measured);
- the significance of the product's underlying risks (for example, the size and pattern of risk capital); and
- any other considerations that the actuary determines are relevant (for example, limitations of the profitability metric for the product being priced; multiple metrics may be adopted if deemed appropriate and relevant)

## 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.

### Learning Outcomes:

- (1a) Describe the designs of the common life and annuity products and evaluate their associated features and inherent risks.
- (1p) Describe and apply methods for pricing term conversions.
- (1q) Describe and evaluate the types of assumptions commonly used in actuarial pricing and product development.

### Sources:

Level Term Lapse Rates – Lessons Learned Here and in Canada, Product Matters, Oct 2011

Term Conversions: Pricing and Reserving, Product Matters, Mar 2017

Term Conversions - A Reinsurers Perspective, Product Matters, Jun 2012

Report on the Conversion Experience Study for the Level Premium Term Plans, 2015

LPM-165-19: Life Products and Features, ILA Committee, 2019

### Commentary on Question:

*Commentary listed underneath question component.*

### Solution:

- (a) Evaluate ABC's plan to set term lapse assumptions for 2020 new business based on ABC's historical lapse experience for the level term and post-level term periods.

#### Commentary on Question:

*Most candidates were able to identify ABC should not just use company's historical lapse experience. At the end of level term period there are shock lapses due to steep post level term premium increases. However, most candidates missed the fact that competition and preferred underwriting classes drove premium rates down which led to higher lapse rates historically.*

*Partial credit was awarded if a candidate mentioned lapse assumptions should reflect conversion rates or lapse rate may decrease once conversion is offered.*

## 2. Continued

ABC should not just use historical lapse experience for new business pricing assumptions as term products have changed significantly in the last decades and may not be relevant appropriate for new business.

- Level term period:
    - Fierce competition and introduction of preferred classes drove premium rates down, which led to high replacement activity and lapse rates in earlier decades.
    - New generation level term lapse rates (post early to mid-2000's) tend to be lower than in prior decades.
  - End of level term period shock lapse:
    - Rate competitions led more companies to lower premiums in level period and try to recoup with steeper post-level term rates, which resulted in higher shock lapses for new generation products.
  - Post-level term period:
    - Higher shock lapses and increased post level term premiums would result in a different residual cohort exhibiting different lapse behaviors.
- (b) ABC will introduce a conversion option on its term products, allowing policyholders to convert to one of ABC's permanent products before the end of the initial level term period.
- (i) Explain how a conversion option benefits the policyholder.
  - (ii) State two reasons why companies would offer conversion options on their term products.
  - (iii) (2 points) Explain the advantages and disadvantages of building conversion costs into ABC's term products as opposed to their permanent products.

### **Commentary on Question:**

*For part (i), most candidates discussed one of the benefits is unhealthy individuals can convert to permanent policy without being re-underwritten. Only a few candidates mentioned the other benefit of conversion for healthy lives.*

*Candidates did well on part (ii). Credit was awarded if a candidate mentioned permanent product is (generally) more profitable than term.*

*Most candidates did well on part (iii), but only few candidates discussed the disadvantage from the profitability tracking / experience study perspective.*



## 2. Continued

- (i) Policyholders gain access to permanent coverage that does not reflect high concentration of less healthy individuals who typically persists post-level term and contribute to rapidly increasing premiums after the initial term.

Moreover, conversion privilege is an option to policyholders. If policyholders are healthy enough to get re-underwritten, they benefit from qualifying for a new plan and if they are unhealthy, they can exercise the conversion privilege.

- (ii) 1. Help sales of term products:  
Conversion option makes the product more attractive with future benefit to the policy holder and makes the product more competitive if all your competitors are offering a conversion privilege.
2. Help increase permanent business:  
It helps retain healthy lives that might otherwise lapse if they purchase permanent insurance with another company and also rolls them into a potentially more profitable product.

- (iii) Advantages:

- Covering conversion costs in the term product is fairer, since it is spread across those who have the right, though not the obligation, to convert to a permanent product.
- Conversion costs then depend on the volume of business with the conversion option. Pricing for conversion costs in permanent products is more difficult because the actuary must accurately estimate not just the term conversion rate, but the volume of permanent business across which the conversion costs are to be spread.

Disadvantages:

- Term is a very price sensitive product. Allocating conversion costs may put the carrier at a disadvantage compared to those who embed conversions costs in permanent products or do not assume any conversion costs.

## 2. Continued

- Depending on the carrier's administrative capabilities, there is misalignment between the line of business where conversion costs are paid for (term block) and where the costs will occur (permanent block). This may overstate term's profitability and understate permanent product's profitability when reporting earnings. It may also result in a misalignment of excess mortality when performing experience studies since converted policy claims will increase mortality for the permanent product.

- (c) ABC's Pricing Actuary has proposed the following assumptions to price the conversion option of its 10-year term product. ABC uses the same mortality rates for term and permanent life business.

<b>Conversion Rate:</b>	6% at the end of each year in years 1 to 10
<b>Post - Conversion Mortality:</b>	120% of ABC's current point-in-scale mortality rates for all conversions in durations 1-10
<b>Lapse rate:</b>	0% in all years
<b>Interest rate:</b>	0% in all years

Additionally, you are given the following for a policy issued at age 50:

Converted face amount = initial face amount = 500,000

$q_{[50]}$	0.0011
$q_{[50]+1}$	0.0014

$$\sum_{t=0}^{\infty} {}_t p'_{[50]+1} * q_{[50]+1+t} = 0.81$$

$$\sum_{t=0}^{\infty} {}_t p'_{[50]+2} * q_{[50]+2+t} = 0.79$$

${}_t p_{[x]+s}$ ,  $q_{[x]+s}$  denote survivorship and mortality for ABC's base mortality assumptions (prior to the conversion offering)

${}_t p'_{[x]+s}$  denotes survivorship of a converted policy

- (i) (3 points) Calculate the expected conversion cost of this policy for conversions in the first 2 durations using ABC's proposed conversion assumptions. Show all work, including writing out relevant formulas used in any calculations.
- (ii) (2 points) Critique the proposed conversion rate and post-conversion mortality assumptions, based on the findings of the *SOA Report on the Conversion Experience Study for Level Premium Term Plans*.

## 2. Continued

### Commentary on Question:

Candidates generally struggled with part (i) as many did not appropriately set up the formula for the extra mortality cost  $K_{(50,r)}$  nor did many capture conversion as a decrement in calculation  $A_{(50,2)}$

For part (ii), most candidates stated that conversion mortality should be revised and the conversion rate should be higher in late durations, but most candidates were not able to identify the 6% conversion rate is too high according to SOA study

(i) where:

$K_{(50,r)}$  = PV of extra mortality cost for age (50 + r)

$q'_{[50]+t}$  = mortality of converted policy =  $1.2 * q_{[50]+t}$

AR = Amount at risk = 500,000

$$K_{(50,r)} = \sum_{t=0}^{\infty} \left\{ {}_t p'_{[50]+r} * \left( q'_{[50]+r+t} - q_{[50]+r+t} \right) * AR * v \right\}$$

$$K_{(50,1)} = \sum_{t=0}^{\infty} \left\{ {}_t p'_{[50]+1} * \left( 1.2 * q_{[50]+1+t} - q_{[50]+1+t} \right) * AR * v \right\}$$

$$K_{(50,1)} = \sum_{t=0}^{\infty} \left\{ {}_t p'_{[50]+1} * \left( 0.2 * q_{[50]+1+t} \right) * AR * v \right\}$$

$$K_{(50,1)} = \sum_{t=0}^{\infty} \left\{ 0.2 * {}_t p'_{[50]+1} * q_{[50]+1+t} * AR * v \right\}$$

$$K_{(50,1)} = (0.2 * 0.81 * 500,000 * 1) = 81,000$$

$$K_{(50,2)} = (0.2 * 0.79 * 500,000 * 1) = 79,000$$

$A_{(50,r)}$  = PV at age 50 of the extra mortality cost due to conversion effected at the end of policy year r

$$A_{(50,1)} = {}_1 p_{[50]} * e * K_{(50,1)} * v$$

$${}_1 p_{[50]} = 1 - q_{[50]} = 0.9989 \text{ and } e = 6\%$$

$$A_{(50,1)} = 0.9989 * 6\% * 81,000 * 1 = 4,855$$

## 2. Continued

$$A_{(50,2)} = {}_2p_{[50]} * e * K_{(50,2)} * 1$$

$${}_2p_{[50]} = {}_1p_{[50]} * (1 - e) * (1 - q_{[50]+1}) = 0.9377$$

$$A_{(50,2)} = 0.9377 * 6\% * 79,000 * 1 = 4,444$$

Conversion cost in the first 2 durations = 4,855 + 4,444 = 9,299

(ii) 1. Conversion rate:

- 6% is high for conversion rate. SOA study showed ~1% for duration 1-9. ABC should lower the conversion rate in duration 1-9.
- Conversion rate should vary by duration. Usually highest in the last year of conversion period due to premiums are generally less expensive than permanent product. ABC should revise the conversion rate assumption to have a spike in duration 10.

2. Post conversion mortality assumption:

- According to SOA study, mortality deterioration multiplier should vary by duration at conversion due to anti-selection at the end of the level term period. ABC should use a higher mortality multiple for late converters. Also based on the study, the mortality rate should slowly reduce following the spike at conversion.

### 3. Learning Objectives:

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:

- (5f) Describe and apply methods and processes for evaluating portfolio performance, including performance attribution, sources of earnings analysis on investment income, benchmarks, metrics, and risk adjusted performance appraisals (including total return vs reported earnings).
- (5g) Describe the principles of Liquidity Risk Management in an insurance company portfolio management context.
- (5i) Describe the attributes of US Treasuries, Agency Debt Securities, Municipal bonds, Corporate bonds, Private Money Market securities, Floating Rate Agreements, Agency Mortgage Backed securities, Agency Collateralized Mortgage securities, Interest Rate Swaps and Swaptions, Credit Derivatives and High Yield Bonds, and the markets they are traded in.

#### Sources:

Managing Investment Portfolios, Chapter 5: Asset Allocation

Handbook of Fixed Income Securities, Chapter 17: Floating-Rate Securities

Managing Investment Portfolios, Maginn, John L. and Tuttle, Donald L., 3rd Edition, 2007 - Ch. 3:

#### Commentary on Question:

*Commentary listed underneath question component.*

#### Solution:

- a) Compare SAA and TAA.

#### Commentary on Question:

*Most candidates answered this question correctly.*

- SAA has a long term view while TAA has a short term view
- SAA is a passive investment strategy and TAA is an active strategy
- SAA reviewed less frequently (annually or when the investment objective changes), it requires fewer management and adjustments. TAA revisited more frequently (monthly or quarterly) and will change allocation based on short term market expectations.

### 3. Continued

- (b) You are given that DEF's numerical risk aversion is 4, and the following for the funds under consideration:

	Fund A	Fund B
Expected Return	10%	8%
Historical Return	11%	7%
Standard Deviation of Return	5%	3%

- (i) Calculate the utility for each fund. Show all work, including writing out relevant formulas used in any calculations.
- (ii) Calculate Roy's safety-first criterion for each fund, assuming the spending rate is 5% and the inflation rate is 2%. Show all work, including writing out relevant formulas used in any calculations.
- (iii) Recommend which fund DEF should invest in. Justify your answer.

#### Commentary on Question:

*Candidates were given partial credit if they demonstrated an understanding of what the question was asking (i.e. partial credit was given to candidates who did not get the correct final answer but included the formula and showed all work).*

*Some common mistakes included: (1) using historical return instead of expected return and (2) using additive formula when calculating the required yield.*

- (i)  
Utility = Expected Return - 0.005 \* Risk Aversion \* (Standard Deviation of Return)<sup>2</sup>  
Utility (A) = 0.10 - 0.005 \* 4 \* (0.05<sup>2</sup>) = 0.09995 (or 9.995%)  
Utility (B) = 0.08 - 0.005 \* 4 \* (0.03<sup>2</sup>) = 0.07998 (or 7.998%)

- (ii)  
Roy's Safety First Ratio (SFR) = (Expected Return - Required Yield)/Standard Deviation of Return

$$\begin{aligned} \text{Required Yield} &= (1 + \text{Spending Rate}) * (1 + \text{Inflation}) - 1 \\ &= (1+5%)*(1+2%)-1 = 7.1\% \end{aligned}$$

$$\begin{aligned} \text{SFR (A)} &= (0.10 - 0.071)/0.05 = 0.58 \\ \text{SFR (B)} &= (0.08 - 0.071)/0.03 = 0.3 \end{aligned}$$

- (iii)  
Recommend fund A because it has higher utility and higher safety-first ratio.

### 3. Continued

- (c) Both funds include investments in floating rate securities (“floaters”) which back the guaranteed crediting rate offered by the UL product. The floaters are based on a three-month London Interbank Offer Rate (LIBOR) with a floor. Critique the following statements:
- A. *The floater’s price is very sensitive to interest rates. The price fluctuation is more sensitive than a fixed coupon bond. A factor that may change the price of a floater is whether the floor is reached.*
- B. *Investing in floaters with a floor is a good strategy if you think that the LIBOR will increase above the guaranteed crediting rate.*
- C. *This portfolio will not face any reinvestment risk because the average duration of the floaters is longer than the duration of the UL guaranteed crediting rate.*
- D. *The duration of floaters will not be impacted by changes in interest rates because floaters adjust their coupon rates based on LIBOR, unless they are reaching the floor.*

**Commentary on Question:**

*To receive full credit, candidates had to (1) state whether the statement was correct or incorrect, and (2) provide justification for each. Many candidates struggled with part (c).D.*

(c).A: *Statement is incorrect.*

- The price of a floater has little sensitivity to interest rates since the floater’s coupon adjusts with interest rate movements
- Floater price is less sensitive to changes in the interest rates when compared to fixed coupon bond
- The price of a floater may change is the cap or the floor is reached
- If the floor is reached, the floater behaves like a fixed rate bond

(c).B: *Statement is incorrect.*

- Investing in a floater with a floor is a good strategy if you think that the reference rate will decrease when the floor is reached
- The floor provides protection, so if you think that the rate will increase above the guaranteed crediting rate, the floor will not be triggered

(c).C: *Statement is incorrect.*

- The portfolio will face reinvestment risk because the coupons or principal will need to be reinvested at the current rate if it’s less than the original coupon or purchase rate.

### 3. Continued

- Even if the floater duration is longer than the duration of the UL guaranteed crediting rate, the adverse movement in the rate will result in lower yield on the reinvested coupons.
- A longer asset duration can have reinvestment risk

(c).D: *Statement is incorrect.*

- Floater's sensitivity to each component of the coupon formula is estimated using index duration and spread duration.
- Index duration measures the floater's price sensitivity to changes in the reference rates while holding the quoted margin constant.
- Spread duration measures the floater's price sensitivity to a change in the quoted margin or spread assuming the reference rate remains unchanged.
- If we assume that the index duration will have no impact, the spread duration will have an impact with the market movement.



#### 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:

- (1a) Describe the designs of the common life and annuity products and evaluate their associated features and inherent risks.
- (1q) Describe and evaluate the types of assumptions commonly used in actuarial pricing and product development.
- (1r) Describe and evaluate the role of Behavioral Economics in understanding and modeling policyholder behavior in the life and annuity context.

#### Sources:

LPM-166-19: Annuity Product and Features

Modeling of Policyholder Behavior for Life and Annuity Products, SOA

#### Commentary on Question:

*Commentary listed underneath question component.*

#### Solution:

- (a) Describe two challenges insurers face in modeling policyholder behavior.

#### Commentary on Question:

*For maximum points, candidates must give descriptions in addition to listing two examples. Many candidates received partial credit because they described only one challenge. Most candidates addressed data availability/credibility as a challenge but struggled to provide other examples.*

#### Solution:

- (1) Data availability: rapid product development combined with the rise of new product designs has resulted in a lack of credible experience data available to insurers
  - (2) Model complexity: modeling policyholder behavior requires complex models and sophisticated techniques which may not be available in insurers' existing software packages
- (b) With regard to understanding and modeling policyholder behavior, you are given the following current practices for XYZ insurance company:

## 4. Continued

Category	XYZ Current Practices
Data collection, analysis, and assumption setting	<ul style="list-style-type: none"> <li>• Reviewing company experience analysis</li> <li>• Maintaining an assumption repository for policyholder behavior including information from the administrative system</li> </ul>
Modeling	<ul style="list-style-type: none"> <li>• Assumptions are owned by each functional group (Pricing, ALM, Valuation)</li> </ul>
Validation	<ul style="list-style-type: none"> <li>• Model steward validates changes and results at high level</li> </ul>
Governance process	<ul style="list-style-type: none"> <li>• Based upon resource availability, periodic updates are performed for experience data</li> <li>• Assumption changes are recommended and approved informally within each functional group</li> </ul>

Evaluate whether XYZ's current practices are consistent with industry current practices for each category.

### Commentary on Question:

*For maximum points, each of the current practices must be evaluated, including providing examples of how the practice could be improved to become consistent with industry practice. Many candidates did not receive maximum credit because they either failed to suggest changes or did not address each bullet point. Of the four categories, candidates had the most success addressing the governance process.*

### Solution:

- Data analysis, collection, and assumption setting
  - XYZ should also look at external data (e.g., industry).
  - For the repository, should consider expanding beyond admin to include data from underwriting or sales systems.
- Modeling
  - Modeling packages/approaches should be reviewed across functions to ensure there are no inconsistencies
- Validation
  - Should have a model steward. However, should have a formal process for both high level and detailed validation of changes and results.

## 4. Continued

- Governance process
  - Periodic updates should not be based on resource availability. A formal process should be put in place for updating experience data.
  - Informal recommendation and approval are not consistent – Chief Actuary or other appropriate individual(s) should provide formal signoff on assumption changes.
  
- (c) XYZ has completed product development for a new Indexed Annuity product and has experience with a Variable Annuity with a Guaranteed Minimum Withdrawal Benefit (GMWB) product.

Critique the following statements:

- A. *The cost of adding a GMWB rider is typically higher on an Indexed Annuity than a Variable Annuity.*
  
- B. *XYZ must hedge a GMWB on an Indexed Annuity using the same approach currently used on the Variable Annuity GMWB.*
  
- C. *XYZ can follow basic CARVM reserving, as covered in Actuarial Guideline 33, for the Indexed Annuity.*
  
- D. *Because XYZ does not have a clearly defined hedging strategy, it must use the book value of relevant hedging instruments as the basis for its reserving.*

### **Commentary on Question:**

*To receive maximum points, candidates must provide analysis of each statement beyond simply answering true/false. Most candidates received partial credit for providing supporting detail for some statements but often were not able to articulate the relevant differences between variable and indexed annuities.*

Solution:

- (A) False. Cost is usually higher on a Variable Annuity since Indexed Annuity usually has a floor of zero
- (B) Not necessarily true as some companies do not hedge the GMWB on a Fixed Indexed Annuity
- (C) True. XYZ does need to follow AG 33, but AG 35 also applies since the method of crediting interest to the annuity is nontraditional
- (D) False. With no clearly defined hedging strategy, XYZ must use fair market value of hedging instruments.

## 4. Continued

- (d) You are asked to perform a projection of liabilities for XYZ's new Indexed Annuity product and are given:

<b>Indexed Annuity Assumption</b>	<b>Current Data Source</b>	<b>Current Structure (Static or Dynamic)</b>
Surrenders	Company data	Dynamic
Withdrawals	Company data	Static
GLB Utilization	Company data	Static
Annuity Payments	Company data	Dynamic

Evaluate the appropriateness of the data source and structure for each of the above assumptions.

### **Commentary on Question:**

*Partial credit was given if the candidate only indicated if the source or structure were appropriate with no additional detail. For maximum points, candidates must provide an evaluation. Most candidates failed to provide additional commentary for data sources, such as credibility concerns or the use of external data.*

*Regarding structure, many candidates struggled to indicate the correct approach, particularly for annuity payments.*

Solution:

- Surrenders
  - Company data is appropriate, but credibility should be reviewed since there will be differences between the variable and indexed annuity product features
  - Dynamic structure appropriate since surrenders will be sensitive to changes in market conditions
- Withdrawals
  - Company data is appropriate, but credibility should be reviewed since there will be differences between the variable and indexed annuity product features
  - Static structure is appropriate (withdrawals won't vary much)
- GLB Utilization
  - Company data is appropriate but should consider supplementing with industry data
  - Should use dynamic structure
- Annuity Payments
  - Company data is appropriate but should review due to differences between the variable and indexed annuity product features
  - Dynamic is inappropriate – should use static structure since it won't vary much.

## 5. 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:

- (1r) Describe and evaluate the role of Behavioral Economics in understanding and modeling policyholder behavior in the life and annuity context.

### Sources:

LPM-110-07: Policyholder Dividends, De Palo, 1997

Modeling of Policyholder Behavior for Life and Annuity Products, SOA, 2014, pp. 6, 9-16 & 19-73

### Commentary on Question:

*In general, candidates didn't do well, especially in part b). Most candidates were able to critique some of the recommendations in part c) but unfortunately no one was able to point out all inappropriateness with proposed changes.*

### Solution:

- (a) List the Dividend Actuary's key considerations in determining a reasonable amount of annual contributions to surplus.

#### Commentary on Question:

*Full points were awarded if candidate listed any 3 out of 4 bullets below. The majority of candidates that were able to connect with correct source material earned all points in this part. Many candidates confused the question with "Contributory principle" or "dividend actuary's responsibilities". No point were given in either case.*

1. Allow the company to grow at target rate
  2. Avoid increasing unit expense costs
  3. Maintain total surplus over long periods at least at a minimum level related to future risks
  4. Should not be varied by growth of new business or changes in new business strain
- (b) Compare the considerations for the charge applied on dividends for mutual companies versus the charge for profits paid to stockholders for stock companies.

## 5. Continued

### **Commentary on Question:**

*Candidates did poorly on this part. Almost all candidates attempted to explain ownership difference of mutual companies and stock companies which was not what the question asked. Some focused on comparing “amount” as which one would have a higher charge while the question was asking about “considerations”. Candidates did demonstrate a slightly better understanding of mutual companies than stock companies.*

Mutual companies and stock companies have different considerations for a charge on dividend/profits:

- For mutual companies, the most important consideration is the ability to support expected long-term growth
- For stock companies, a charge on profits must be determined in a fair fashion due to limitations imposed by law

In addition, for mutual companies, the charge on dividends should be:

- Sufficient to maintain the company’s target surplus
- Limited to the statutory after tax ROI. Therefore should include a provision for target statutory surplus

For stock companies, some states limit the annual transfer of earnings and surplus from par policies.

(c) RST’s dividend rates from prior years are:

2016	2017	2018	2019
4%	4.5%	4.5%	4.5%

RST’s Dividend Actuary has given the following commentary associated with the dividend recommendation of 7% for 2020, which will be paid out in cash:

- *Investment returns outperformed previous years.*
- *Lapse assumption is currently determined based on the company’s experience results. It follows a static structure for all par life insurance products.*
- *Lapses have been very high in previous years but they have reduced considerably this year; this will be considered for future dividend setting.*
- *Mortality assumptions are currently determined based on the RST’s own experience. A new mortality study was released this year which will be applied to reserves in the next year. The dividend rate has been reduced to smooth the results for next year’s dividend.*
- *As a result of this expected change in the mortality assumption, there will be changes made to the policy rating system, which are expected to offset any resulting decrease in future dividends.*

## 5. Continued

- *RST entered into a new reinsurance contract this year which has ceded away a portion of the mortality risk. The pricing team has taken this into consideration for future pricing, but dividends have not been adjusted in response.*

Critique the recommended dividend rate based on the commentary above. Propose changes to any assumptions if necessary.

### **Commentary on Question:**

*Overall, this part of the question was not answered well by candidates. Most candidates were able to produce a few valid points however did not produce a comprehensive analysis. Also, a large percentage of candidates did not answer the second part of 5(c) to propose changes to assumptions. Candidates needed to provide critiques specific to the context of this question to receive points. For example, no points were rewarded for critiques related to financial reinsurance as opposed to risk reinsurance asked in the question.*

Typically, in order to meet policyholder reasonable expectation, it would be advisable to set the dividend no less than previous years dividend.

Investment is a key driver of dividend rates. Investment returns outperforming previous years would support the recommendation of a higher dividend rate than previous year. That being said, 7% is a significant increase. Therefore, it would be recommended to consider stabilizing the dividend increases with pegging or substitution method over a number of years to avoid undue yearly fluctuation.

A single year's decrease in lapse is inconsistent with the high lapse in previous years. This should warrant careful investigation of causes of the sudden decrease. It is also important to assess whether the new lapse pattern is reflective of future trend, i.e. whether it is a one-off experience driven by a one-time event. It is recommended to exercise caution in passing a single year lapse experience in dividend.

The policy classifications should not change to the detriment of an in-force cohort. Therefore, changes made to the policy rating system should create a new dividend class for new business that do not impact dividend determination on the in-force block.

The fact that the expected change in the mortality assumption would be offset by policy rating system suggests there might be cross-subsidization of one experience class by another, which should be avoided.

## 5. Continued

Risk reinsurance should be reflected in the proper dividend component as an expense of the line of business. It is not necessary to change pricing in response to risk reinsurance.

Dividends have been kept consistent over the past 3 years, so comparison only to previous year could be inappropriate. Recommend comparing to past 3 years.

The pattern of the dividend over the past 3 year suggests that pegging/substitution was possibly used to avoid dividend decreases, so caution is needed when comparing to previous year only.

Company history is also important in setting dividends given limited information on previous dividend scales is available.

Expenses were not included in the recommendation, but should also be reviewed.

### Propose changes to any assumptions if necessary

Lapse – it is reasonable that lapse assumption is based on RST’s own experience assuming it is credible. Lapse assumptions can differ by product and external factors, and its materiality on financial results should be considered. A dynamic approach is not always better, as it depends on whether the complex structure is worthwhile. If lapse is a significant assumption for the product, a dynamic approach is recommended. If lapse is not a significant assumption for the product, static approach is fine.

Mortality - Mortality should also be reviewed due to changes in lapses (very high in previous years but reduced for current year) as they are often correlated, such as anti-selection, which would impact mortality experience. Recommend considering industry mortality table or other outside data sources to be considered in addition of company's own experience.



## 6. 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:

- (4a) Evaluate and analyze traditional and advanced reinsurance transactions, and prepare related financial statement entries.
- (4b) Describe and evaluate indemnity reinsurance and evaluate its use, forms, and requirements.

### Sources:

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

Tiller, 4th edition, Chapter 5: Advanced Methods of Reinsurance

### Commentary on Question:

*The purpose of this question was to test the candidate's knowledge of reinsurance options and their impact on company financials. Most candidates did well on part (a) but struggled with part (b).*

### Solution:

- (a) Compare the effectiveness of the following types of reinsurance for each of the company's objectives.
  - (i) YRT
  - (ii) Coinsurance
  - (iii) Modified Coinsurance
  - (iv) Funds Withheld Coinsurance

### Commentary on Question:

*Candidates generally performed well on this question. Full credit was given if the candidate answered correctly whether each of the four company objectives were effective or ineffective, for each of the four types of reinsurance.*

- (i) YRT
  1. Effective for reducing capital based on mortality risk.
  2. Ineffective for expanding into the annuity business due to focus on mortality risk.

## 6. Continued

3. Ineffective for achieving expense efficiencies due to small expense allowances.

4. Effective for mitigating mortality risk.

### (ii) Coinsurance

1. Effective for reducing capital based on various risks (mortality, lapse, asset/investment, etc.).

2. Effective for expanding into the annuity business since it covers many risks associated with annuity products.

3. Effective for achieving expense efficiencies because of the expense allowance from the reinsurer.

4. Effective for mitigating mortality risk.

### (iii) Modified Coinsurance

1. Effective for reducing capital based on various risks (mortality, lapse, asset/investment, etc.).

2. Effective for expanding into the annuity business since it covers many risks associated with annuity products.

3. Effective for achieving expense efficiencies because of the expense allowance from the reinsurer.

4. Effective for mitigating mortality risk.

### (iv) Funds Withheld Coinsurance

1. Effective for reducing capital based on various risks (mortality, lapse, asset/investment, etc.).

2. Ineffective for expanding into the annuity business due to funds withheld.

3. Ineffective for achieving expense efficiencies due to additional costs associated with setting up trust or escrow accounts.

4. Effective for mitigating mortality risk.

## 6. Continued

- (b) Life Co is entering a Mod-Co reinsurance arrangement with Reinsurance Inc.

<b>Life Co</b>	<b>Year 1</b>	<b>Year 2</b>
Premiums	2,000	0
Expenses	50	10
Commissions	250	0
Reserves	1,500	1,800
Benefits Paid	0	50
Investment Income	10%	10%
<b>Reinsurance Co.</b>	<b>Year 1</b>	<b>Year 2</b>
Allowance	10%	10%
Mod-Co Interest Rate	5%	5%

- (i) Construct Life Co's Gain from Operations statement for years 1 and 2 under the reinsurance agreement.
- (ii) Construct Reinsurance Inc's Balance Sheet for years 1 and 2 under the reinsurance agreement.

### **Commentary on Question:**

*For part (i), most candidates who had a broad knowledge of financial values in reinsurance agreements received some credit for this part, but very few candidates achieved full credit for this question. Full credit was given if the candidate not only provided Life Co's gain from operations in year 1 and in year 2, but also showed their work in obtaining those values.*

*For part (ii), candidates generally performed poorly on this question. The most important step in getting this correct was recognizing that the question was asking for the Balance Sheet values of Reinsurance Inc. Candidates that recognized this received partial credit. Full credit was given if the candidate was able to provide the correct asset, liability, and surplus values in year 1 and year 2, but very few were able to do that.*

*Note the solution provided here assumes 100% coinsurance. However, since the question did not state the coinsurance percentage, values were adjusted based on the coinsurance percentage assumed by the candidate.*

See Excel attachment.

## 7. Learning Objectives:

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:

- (5i) Describe the attributes of US Treasuries, Agency Debt Securities, Municipal bonds, Corporate bonds, Private Money Market securities, Floating Rate Agreements, Agency Mortgage Backed securities, Agency Collateralized Mortgage securities, Interest Rate Swaps and Swaptions, Credit Derivatives and High Yield Bonds, and the markets they are traded in.

### Sources:

LIBOR and SOFR, 2019

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

### Commentary on Question:

*This question focused on SOFR, interest rate swaps, and calculating a swap rate.*

*The question tested knowledge of SOFR, and how it is different from LIBOR. Candidates were asked to explain how those differences impacted different products.*

*Candidates were asked to evaluate statements about swaps, then to calculate the swap rate based on given information.*

### Solution:

- (a) You are given the following about GHI Financial:
  - GHI sells a UL product crediting the London Interbank Offered Rate (LIBOR) semi-annually to policyholders.
  - GHI holds a 3-month British Pound to Japanese Yen cross currency swap indexed at LIBOR
  - GHI holds an overnight index swap receiving a fixed interest rate and paying LIBOR
  - GHI holds a 6-month interest swap paying LIBOR and receiving a fixed rate semi-annually
- (i) Evaluate the considerations GHI should take when moving from LIBOR to the Secured Overnight Financing Rate (SOFR) for each item above.
- (ii) Propose changes needed to apply SOFR for each item above.

## 7. Continued

### **Commentary on Question:**

*Candidates received credit for identifying the key differences between LIBOR and SOFR, and how those impacted each of the 4 items listed. Candidates needed to apply their knowledge of the LIBOR and SOFR differences on each of the listed items but most candidates simply stated the differences between LIBOR and SOFR without applying to any of the items.*

*For part (a)(i), candidates received full points when they evaluated the differences between LIBOR and SOFR for each bulleted item individually. Many candidates provided considerations but weren't clear which consideration was appropriate for each bullet point item listed, and so only received partial credit once, rather than partial credit for each statement.*

*For part (a)(ii), candidates received credit for providing recommendations to address issues identified in part (a)(i) for each item. Similar to the part (a)(i) commentary, candidates needed to clearly provide recommendations for each item, but most candidates provided general recommendations that were not tied to any item.*

(a)(i)

- **UL Product crediting LIBOR semi-annually**  
LIBOR has different length of terms, but SOFR has only an overnight rate which will be too volatile for setting credited rates. SOFR is a risk-free rate while LIBOR includes a credit risk spread.
- **3-month British Pound to Japanese Yen cross currency swap**  
SOFR is only in USD. SOFR has only overnight rates, causing a mismatch with the 3-month duration.
- **Overnight index swap receiving fixed and paying LIBOR**  
Since overnight swaps are settled daily the SOFR will match. SOFR is risk-free while LIBOR includes a credit risk spread.
- **Interest rate swap pay LIBOR receive fixed semi-annually**  
SOFR only has overnight rates so there will be a duration mismatch with swap payments.

(a)(ii)

- **UL Product crediting LIBOR semi-annually**  
A credit risk premium should be added to LIBOR rates. A moving average of the SOFR can be used to reduce the volatility.
- **3-month British Pound to Japanese Yen cross currency swap**  
Add a margin to account for currency differences or select a more appropriate index such as SONIA or TONAR.

## 7. Continued

- **Overnight index swap receiving fixed and paying LIBOR**  
As long as the credit risk is immaterial, no change is required since both are overnight rates. Depending on counterparty risk, a credit risk premium may need to be added.
  - **Interest rate swap pay LIBOR receive fixed semi-annually**  
Add a term premium to SOFR or use a 6-month average rate to replace LIBOR. Depending on counterparty risk, a credit risk premium may need to be added.
- (b) Critique the following statements about the 6-month interest rate swap. Justify your answer.
- A. *The swap was entered into through an exchange.*
  - B. *The notional amount of the interest rate swap is the amount paid upon agreement of the swap.*
  - C. *The timing of cash flows for both the fixed-rate payer and floating-rate payer must be the same.*
  - D. *The way interest accrues for each period of the transaction are the same for the fixed-rate and floating-rate payments.*

### **Commentary on Question:**

*Candidates generally did well on this part, with the last statement being the most difficult. For each statement, full credit was given if correctly indicating the statement was correct or incorrect and for justifying the assessment. Only partial credit was given if correctly indicating the statement being correct or incorrect without providing justification.*

- **The swap was entered through an exchange.**  
Incorrect. Interest rate swaps are over-the-counter (OTC) instruments, which means they are not traded on an exchange.
- **The notional amount of the interest rate swap is the amount paid upon agreement of the swap.**  
Incorrect. The notional amount does not move from party to party. It is used only as a reference to determine the interest rate payments to be made.
- **The timing of cashflows for both the fixed-rate payer and floating-rate payer must be the same.**  
Incorrect. This is rarely the case in a swap. Parties would agree to the timing when entering the swap.

## 7. Continued

- **The way interest accrues for each period of the transaction are the same for the fixed-rate and floating-rate payments.**

Incorrect. Normally fixed rate payments are based on 30/360 day count. Floating rate payments use actual/360.

- (c) You are given the following information about the 6-month interest rate swap paying LIBOR and receiving a fixed rate quarterly:

Notional Amount	1,000,000
Swap Settlement Date	June 1, 2020
Swap Arrangement	Financial Settlement of the swap
Swap Spread	15 basis points
3-Month LIBOR on June 1, 2020	4.05%
Price of 3-Month Eurodollar Futures Contract settling on November 30, 2020	95.85
Annual forward rate on June 1, 2020	4.5%
Annual forward rate on September 1, 2020	4.75%

Calculate the following for the interest rate swap. Show your work, including writing out the relevant formulas used in any calculations.

- (i) The swap rate
- (ii) The payments due to GHI at August 31, 2020 and November 30, 2020.

### Commentary on Question:

*Most candidates found the calculation very difficult and did not do well. Calculating the swap rate required many steps. Partial credit was given to candidates who demonstrated knowledge of the steps required. Very few candidates completed all the steps correctly. Very few candidates correctly calculated the payments.*

### Part (i)

1. Calculate the number of days in each payment period: 92 in first period and 91 in the second period.
2. Use the given Eurodollar futures rate to calculate the second period floating rate.  $100 - 95.85 = 4.15\%$
3. Calculate the Floating Payments as  
Notional Amount \* period floating rate \* (# of days / 360)  
First Period:  $\$1,000,000 * 4.05\% * 92/360 = \$10,350.00$   
Second Period:  $\$1,000,000 * 4.15\% * 91/360 = \$10,490.28$

## 7. Continued

4. Calculate the forward discount rates as  
 $(1 / (1 + \text{annual forward rate} * \# \text{ of days} / 360))$   
First Period:  $1 / (1.045 * 92 / 360) = .988631$   
Second Period:  $1 / (1.0475 * 91 / 360) = .988136$
5. Calculate the Present Value of the Floating Payments using the Floating Payments calculated in Step 3 and the forward discount rates calculated in Step 4.  
 $\$10350 * .988631 + \$10490.28 * .988631 * .988136 = \$20,480.29$
6. Swap rate = Fixed interest rate such that Present Value of Fixed Rate Payments equals the Present Value of Floating Payments  
= Present Value of Floating Payments /  $\sum(\text{Notional amount} * \# \text{ of days in period} / 360 * \text{forward discount factor}(t))$   
=  $\$20,480.29$  divided by  
 $[(\$1,000,000 * 92 / 360 * .988631) + (\$1,000,000 * 91 / 360 * .988631 * .988136)]$   
= 4.10%

Part (ii)

Calculate payments due on 8/31 and 11/30

Period 1 Floating Payment = \$10,350.00

Period 2 Floating Payment = \$10,490.28

Fixed Payments for each period =

Notional amount \* (swap rate + swap spread) \* (# of days/360)

Period 1 Fixed Payment =  $\$1,000,000 * (4.10\% + .15\%) * 92 / 360 = \$10,859.65$

Period 2 Fixed Payment =  $\$1,000,000 * (4.10\% + .15\%) * 91 / 360 = \$10,741.61$

The payment made is Floating less Fixed

Period 1:  $\$10,350.00 - \$10,859.65 = -\$509.65$  (or receiving \$509.65)

Period 2:  $\$10,490.28 - \$10,741.61 = -\$251.33$  (or receiving \$251.33)



## 8. 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:

- (2c) Describe and evaluate the emergence of earnings under various financial reporting regimes US Statutory, US GAAP, Canadian CALM and Solvency II regimes.
- (2e) Describe and evaluate fundamental strategies for enhancing value through active in-force and operational management.

### Sources:

Earnings Emergence Insurance Accounting under Multiple Financial Reporting Bases, SoA, 2015, pp. 4-6, 10-24, 45-53

Evolving Strategies to Improve Inforce Post-Level Term Profitability, Product Matters, Feb 2015, pp. 23-29

### Commentary on Question:

*This question tested candidates' knowledge of various reserving bases and how they react to changes in assumptions and experience. Many candidates answered the question by listing information about the different reserving bases, but did not always directly address the question that was asked. Some candidates also gave relatively little justification for their answers and therefore only received limited partial credit. The graphs included in the question were also difficult for some candidates to interpret.*

### Solution:

- (a) JKL's actual experience from this block shows higher mortality than expected in the first 5 years. Assume the earnings are projected again with slightly higher expected mortality rates for years 6 to 10.

Identify which of the following will have the higher expected change in earnings in year 6:

- A. US Statutory
- B. CALM

Justify your answer.

### Commentary on Question:

*Many candidates had difficulty using the provided Excel spreadsheet to answer the question. Some candidates answered the question only based on the provided earnings projection instead of considering the effects of slightly higher mortality rates. Some candidates also discussed which basis had the higher earnings instead of the higher change in earnings.*

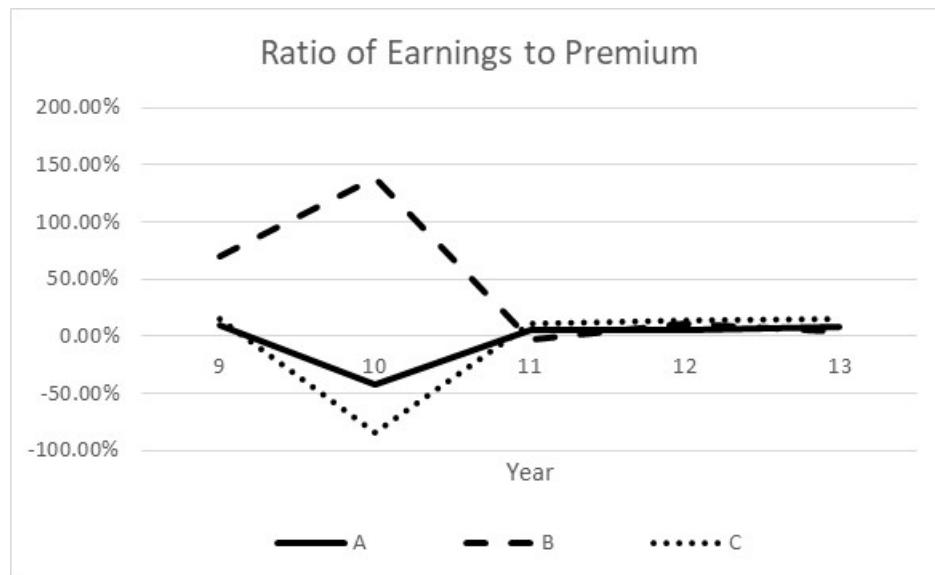
## 8. Continued

Based on the given values, US Statutory earnings emerge slower in earlier years and faster in the latter half of the level term period. CALM earnings are based on the size and pattern of the PFAD, and assumptions are re-evaluated annually with any changes in assumptions immediately recognized in income.

When the expected mortality changes starting in year 6, US statutory reserves are not recalculated, but CALM reserves are. US Statutory earnings in year 6 will be reduced due to the increased claims, offset by the additional reserve release. CALM earnings in year 6 will also be reduced due to increased claims, offset by additional reserve release, but also reflects the full impact of the assumption change leading to a higher recalculated reserve.

Therefore, CALM has a higher expected change in earnings compared to US Statutory.

- (b) You are given the follow graphs of the annual ratio of earnings to premium projections for years 9-13 assuming that only the pricing shock lapse rate was lowered in year 10 by one third:



Assume the product has no surrender value.

## 8. Continued

Identify which graph corresponds with each of the following methods:

- (i) US GAAP
- (ii) US Statutory
- (iii) CALM

Justify your answers.

### **Commentary on Question:**

*Many candidates correctly identified that line B corresponded to a US Statutory basis. Fewer candidates were able to distinguish between US GAAP and CALM. Some candidates misinterpreted the graph as starting from policy issue instead of duration/year 9 as labeled. Some candidates also misinterpreted the graph as reflecting the dollar amount of earnings instead of the ratio of earnings to premium.*

*Candidates who correctly matched the graphs to the reserving methods received partial credit, but justification was required for full credit.*

- (i) US GAAP corresponds to graph C. Under US GAAP for a term product, reserves are not recalculated due to an assumption change. Similarly to CALM, US GAAP will reflect a significant loss at the end of the level premium period, but there is no offset from an assumption change leading to a reserve release.
  - (ii) US Statutory corresponds to graph B. At the end of the level premium period, US Statutory will experience a significant reserve release leading to the high ratio of earnings to premium in duration 10. US Statutory reserves are also not recalculated based on any assumption changes and are instead based on prescribed methodology.
  - (iii) CALM corresponds to graph A. CALM earnings behave similarly to US GAAP; however, an assumption change in year 10 due to improved lapse experience results in a higher reserve release which is immediately recognized in income. Therefore, the negative earnings at the end of the level premium period are less severe than US GAAP in this scenario.
- (c) JKL's inforce was priced based on the Traditional Approach of a jump to YRT premiums at the end of the level term period. JKL just completed re-pricing based on CALM and Solvency II using the Graded Approach. Under this approach, the post-level-term (PLT) YRT rates will increase gradually over 5 years jumping to the original YRT schedule in year 16.

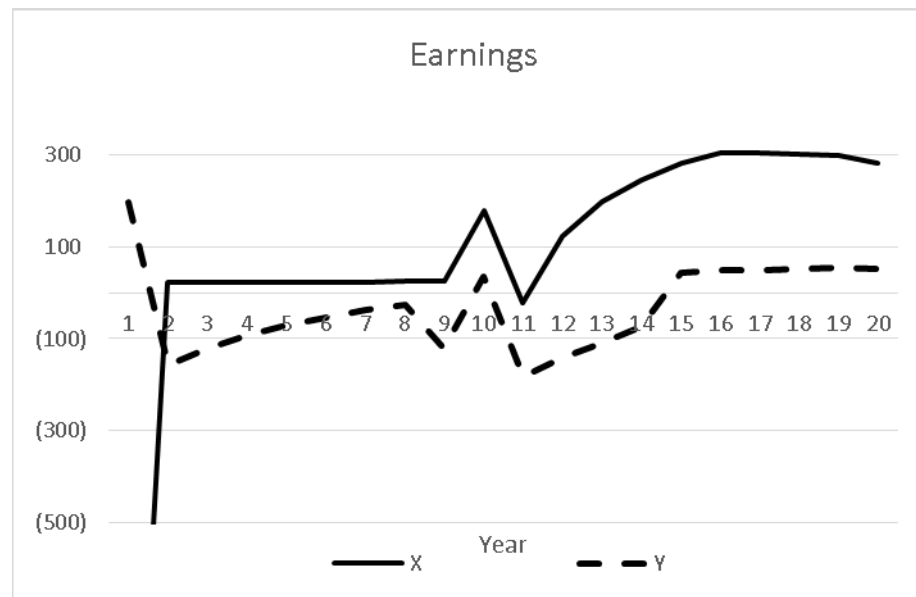
## 8. Continued

The following were the pricing assumptions used for the Traditional and Graded Approaches:

Assumptions	Traditional Pricing	Graded Premium Re-Pricing
Premium (Yr 11+) (% 2015 VBT*)	300%	Grade from 100% to 300% in years 11-16
Mortality (Yr 11+) (% 2015 VBT)	300%	Grade from 100% to 300% in years 11-16
Shock Lapse Rate (Yr 10)	85%	50%
Post Level Lapse Rates (Yr 11+)	Grade to 10% in year 14	
CALM Mortality and Lapse PfADs (Yr 11+)	10%	10%
Risk Margin	50% years 1-9, 200% in Years 10+	Grade from 50% to 200% in years 9-15

\* Valuation Basic Table

You are given the following results for the repricing compared to the traditional pricing:



## 8. Continued

(i) (2.5 points) Identify which graph corresponds with each of the following methods:

- CALM
- Market Consistent (Solvency II)

Justify your answers.

ANSWER:
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(ii) (2.5 points) Recommend which of the two pricing approaches you would use to calculate the PLT premiums under each of the following valuation bases:

- CALM
- Market Consistent (Solvency II)

Justify your answers.

### **Commentary on Question:**

*For part (i), many candidates interpreted the graph as reflecting earnings under each basis, instead of reflecting the change in earnings attributable to the repricing. For example, line X on the chart reflected that the repricing sharply reduced earnings in duration 1, it did not necessarily indicate a significant loss in duration 1.*

*For part (ii), a range of recommendations were acceptable and credit was given for reasonable justifications; one such example is provided below. Some candidates answered part (ii) by recommending a reserving basis instead of recommending a pricing approach for each reserving basis. Such answers received limited credit.*

*For both parts, many candidates did not give justifications for their answers and therefore received only partial credit.*

(i) The CALM reserve reflects the present value of future cash flows plus provisions for adverse deviation. The Market Consistent reserve reflects the present value of liability cash flows plus a risk margin.

Under the re-pricing, we can expect more policies to remain in force in years 11+ due to lower lapses under the graded premium repricing, and therefore lower mortality due to reduced anti-selection.

## 8. Continued

Under CALM, with no changes in PFADs, the greater volume of policies remaining in force will lead to an increased present value of future cash flows and therefore an increased reserve in year 1. Income emerges over the lifetime of the business with the release of PFADs which flow into income. Therefore, CALM corresponds to graph X.

Under Market Consistent, without additional explicit conservatism in assumptions and with the grading of the risk margin, the results of the repricing will show a large increase in earnings at inception, with reduced earnings in the remaining years. Therefore, Market Consistent corresponds to graph Y.

- (ii) Under CALM, the graded pricing approach is recommended. Under this approach, earnings are higher in every year except for year 1. In addition, graded rates are more attractive to the policy owner, while the company retains the rights to increase premiums up to the maximum if needed. Experience supports that this approach results in improved earnings.

Under Market Consistent, the traditional approach is recommended. Under this approach, earnings are higher in most years compared to the graded approach. In addition, the company likely has confidence in this approach due to experience, while still maintaining the flexibility to change rates as experience emerges.

## 9. Learning Objectives:

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:

- (5b) Describe and evaluate how a company's objectives, needs and constraints affect investment strategy and portfolio construction (including capital, funding objectives, risk appetite and risk return tradeoff, tax and accounting, accounting considerations, and constraints such as regulation, rating agency ratings and liquidity.
- (5g) Describe the principles of Liquidity Risk Management in an insurance company portfolio management context.

### Sources:

Managing Investment Portfolios, Maginn, John L. and Tuttle, Donald L., 3rd Edition, 2007 - Ch. 5: Asset Allocation (sections 2-4)

Handbook of Fixed Income Securities, Fabozzi, Frank J., 8th Edition, 2012 - Ch. 9: U.S. Treasury Securities (pp. 194-205)

Handbook of Fixed Income Securities, Fabozzi, Frank J., 8th Edition, 2012 - Ch. 25: Agency Mortgage-Backed Securities

Managing Investment Portfolios, Maginn, John L. and Tuttle, Donald L., 3rd Edition, 2007 - Ch. 8: Alternative Investments Portfolio Management (section 3)

LPM-162-19: Liquidity Risk Management: Best Risk Management Practices

### Commentary on Question:

*Commentary listed underneath question component.*

### Solution:

- (a) Rank FAC's asset classes from most to least liquid. Justify your ranking.

### Commentary on Question:

*Candidates generally performed well on this question. Most candidates were able to recognize that cash is the most liquid asset and real estate is the least liquid asset. Candidates lost points when they did not adequately justify the ranking.*

## 9. Continued

Ranking from most liquid to least liquid:

1. Cash
2. Treasury Bonds or Agency MBS
3. Agency MBS or Treasury Bonds
4. Corporate Bonds
5. Real Estate

- Cash is by definition the most liquid asset.
- Treasury Bonds are highly liquid due to the round the clock secondary market combined with high levels of trading.
- Agency MBS are highly liquid due to the guarantees and large issuance.
- Corporate Bonds are actively traded but do not have the guarantees of Treasuries nor Agency MBS.
- Real Estate is an illiquid asset. It takes time to sell and is not actively traded on most markets.

- (b) Propose changes to improve FAC's liquidity risk management.

### **Commentary on Question:**

*Candidates generally performed poorer on this part compared to the rest of the question. Most candidates were able to recognize the following:*

- *FAC needs a written liquidity policy that is reviewed regularly*
- *FAC's current portfolio could create liquidity risks and recommend re-allocating from less liquid assets (e.g. real estate) to more liquid assets (e.g. treasury bonds)*
- *FAC should impose surrender charges for their product*

*Most candidates did not write enough statements to earn full credit or did not tie back to FAC's specific situation.*

Credit was given for any reasonable recommendation. The following list is a sample of statements that would receive full credit for this part:

- Management needs a written policy which should be approved by senior management and reviewed regularly.
- The company needs some quantitative tools for evaluating risks and more useful qualitative tools.
- FAC should impose surrender charges. The lack of surrender penalties in product design creates liquidity risks.
- Sales of FAC's current portfolio of illiquid corporate bonds could be problematic as a cash flow source.
- Similarly, the lack of liquidity in real estate versus Treasuries/MBS should be considered.
- IFA distribution networks are prone to greater panic withdrawal risk than tied agents and direct marketing distribution.



## 9. Continued

- The company should manage its access to financial markets and have an ongoing presence in its funding channels.
- FAC's plan to use capital to provide for liquidity risk is an ineffective means of managing the risk.

(c) Critique the following statements:

- A. *Due to current economic conditions, Treasury bonds will outperform corporate bonds over the next six months. While long term expectations are well grounded, FAC needs an immediate revision to its strategic asset allocation to take advantage of the current pricing anomaly.*
- B. *Mortgage-backed security valuation requires sophisticated modeling of prepayment rates. FAC has built a model with 53 parameters that fits historical data almost perfectly, which gives a significant advantage over the market.*
- C. *Adding Real Estate to FAC's strategic asset allocation improves risk diversification and increases the liquidity and Sharpe ratio of the portfolio.*

### **Commentary on Question:**

*Part c) was very well done. Most candidates were able to:*

- *Indicate that the SAA portfolio should not be changed due to short-term changes in market expectations.*
- *Suggest that the proposed model needs to be simplified.*
- *Show an understanding of the impact that adding real estate to the asset allocation has on risk diversification and liquidity.*

*However, some candidates were unsure of the impact that adding real estate would have on the Sharpe ratio.*

### Statement A)

The strategic asset allocation (SAA) is based on long-term expectations of risk and target return, and should not be impacted by short-term changes in market expectations. The policy portfolio should only be revised due to changes in the investor's long-term market forecasts, not due to short-term projections.

### Statement B)

Mortgage-backed security valuation does require sophisticated modeling. Models with the most useful future projections should be simple and use far fewer than 53 variables. A model using too many variables may fit historical data very well (ie. overfitting), but likely will not provide accurate future projections.

## 9. Continued

Statement C)

- Real Estate is an important diversifier as it responds differently than stocks or bonds to various market conditions.
- Real estate is an illiquid asset, so adding real estate to FAC's strategic allocation would reduce the overall liquidity of the portfolio.

Sharpe ratio is affected by both the expected return and risk. Since adding real estate improves diversification, the denominator will be smaller, and the Sharpe ratio should increase.

## 10. 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:

- (1m) Describe and apply the methodology for evaluating pricing sensitivities using a "Pricing Surface".
- (1q) Describe and evaluate the types of assumptions commonly used in actuarial pricing and product development.

### Sources:

LPM-107-07: Experience Assumptions for Individual Life Insurance and Annuities

The Use of Predictive Analytics in the Development of Experience Studies, The Actuary, 2015  
Predictive Modeling for Life Insurance: Ways Life Insurers Can Participate in the Business Analytics Revolution, Product Matters, 2018  
Evolving Strategies to Improve Inforce Post-Level Term Profitability

### Commentary on Question:

*Commentary listed underneath question component.*

### Solution:

- (a)
  - (i) Describe the pricing goals for the "shock" premium rate for year 6.
  - (ii) Calculate the 95<sup>th</sup> percentile confidence interval of the policy year 5 lapse rate. Show all work, including writing out relevant formulas used in any calculations.

### Commentary on Question:

*Candidate generally performed well on this question.*

*In part (ii), various errors in calculating the standard deviation were common.*

- (i) The goal for the shock premium is to ensure appropriate pricing:
  - As underwriting will have worn off, an increase in premium is needed to cover increased mortality risk.
  - The jump in premium will cause anti-selection – only policyholders who cannot obtain cheaper coverage elsewhere will persist, worsening mortality deterioration.
  - Goal is to increase the premium enough to cover increased mortality risk, but not too much which would drive all good risks away.

## 10. Continued

Some companies may have additional goals such as replacement or conversion to permanent products. Some companies may choose to use an aggregate rate design which is simpler to administer than a multi-class structure.

$$(ii) \quad \begin{aligned} \text{Expected \# of lapses} &= \text{expected lapse rate} * \text{policy exposure} \\ &= 90\% * 8300 = 7470 \end{aligned}$$

$$\begin{aligned} \text{Variance} &= \text{Exposure} * \text{expected lapse rate} * (1 - \text{expected lapse rate}) \\ &= 8300 * 90\% * 10\% = 747 \end{aligned}$$

$$\begin{aligned} 95^{\text{th}} \text{ CI of \# of lapses} &= \text{Expected \# lapses} \pm 1.96 * \text{Std Deviation of \# lapses} \\ &= 7470 \pm 1.96 * (747^{0.5}) \end{aligned}$$

$$= (7416, 7542)$$

$$\begin{aligned} 95^{\text{th}} \text{ CI of lapse rate} &= 7470/8300 \pm 1.96 * (747^{0.5})/8300 \\ &= (89.4\%, 90.6\%) \end{aligned}$$

- (b) Recommend lapse assumptions for policy years 5 and 6 for the upcoming product repricing. Justify your assumptions.

### **Commentary on Question:**

*The candidates who performed well on this question tended to take one of two approaches: (1) apply credibility theory to derive new lapse assumptions or (2) calculating the 95% CI for year 6 and recommending lapse assumptions within the 95% CIs for both years*

*Other reasonable answers were accepted, as long as candidates justified their answer.*

### **Credibility Approach:**

Applying limited fluctuation and using 5% error rate:

$$Z = \min (1, (0.05 * (\# \text{ lapses})^{0.5}) / 1.96)$$

$$\text{Year 5 } Z = \min (1, 0.05 * (7835^{0.5}) / 1.96) = 1$$

$$\text{Year 6 } Z = \min (1, 0.05 * (394^{0.5}) / 1.96) = 0.506$$

Year 5 is fully credible, so the actual lapse experience can be used.

Year 6 is not fully credible, so the actual lapse experience must be blended with industry or other data.

## 10. Continued

Recommend:

$$\text{Year 5} = 7835/8300 = 94.4\%$$

Year 6 =  $0.506 \cdot (394/450) + (1 - 0.506) \cdot 80\% = 83.8\%$ , using the existing assumption in lieu of industry data

### CI Approach:

Calculate the CI for Year 6:

$$\begin{aligned} \text{Expected \# of lapses} &= \text{expected lapse rate} * \text{policy exposure} \\ &= 80\% * 450 = 360 \end{aligned}$$

$$\begin{aligned} \text{Variance} &= \text{Exposure} * \text{expected lapse rate} * (1 - \text{expected lapse rate}) \\ &= 450 * 80\% * 20\% = 72 \end{aligned}$$

95<sup>th</sup> CI of # of lapses = Expected # lapses +/- 1.96 \* Std Deviation of # lapses

$$= 360 \pm 1.96 \cdot (72^{0.5})$$

$$= (343, 377)$$

$$\text{95}^{\text{th}} \text{ CI of lapse rate} = 360/450 \pm 1.96 \cdot (72^{0.5})/450$$

$$= (76.3\%, 83.7\%)$$

Actual lapses for both years 5 and year 6 are above the 95% CI, indicating that the lapse assumption is too low. The lapse assumption should be increased to the higher end of the CI of 90.6% for year 5 and 83.7% for year 6.

- (c) LMN is developing lapse assumptions for a new 10-year level term product, which is annually renewable after year 10. LMN has not sold 10-year level term products in the past. The Pricing Actuary has set the 10-year level term lapse assumptions based on the 5-year level term experience

Critique the Pricing Actuary's lapse assumption.

### Commentary on Question:

*Most candidates recognized that the Pricing Actuary's recommendation was inappropriate. Candidates who performed well were able to clearly articulate why the recommendation was inappropriate and suggest alternatives.*

This recommendation is not appropriate.

- Shock lapses will occur after year 10, not after year 5. The amount of the shock lapse may be different.
- Industry data shows that lapses tend to be lower during the level term period for longer term products, so the level term lapses for the 10 year product will likely be lower than the 5 year product.

## 10. Continued

- Lapse rates on level term plans issued recently tend to be much lower than older plans from the 90s, so the data from LMN's existing 5-yr term products may not be applicable to a newly designed product.
  - Other product features or differences in design may affect lapse rates, such as differences in policy size, distribution channel, ability to convert to permanent product.
  - It would be more appropriate to source industry data or consult with a reinsurer to obtain appropriate and relevant data.
- (d) The experience studies actuary recommends use of a predictive analytics model to develop lapse experience studies for the 5 year and 10 year level term products instead of LMN's traditional approach.
- (i) (2 points) Describe the different methods and steps used in developing a predictive analytics model versus LMN's traditional approach for experience analysis studies.
- (ii) (2 points) Evaluate the actuary's recommendation. Justify your answer.

### **Commentary on Question:**

*Most candidates performed moderately well on this question.*

*For part (i), a common error was listing advantages and disadvantages of predictive analytics and/or traditional approaches instead of explaining the steps and methods of each. For part (ii), candidates could agree or disagree with the recommendation, but had to provide pros/cons of predictive analytics and justify their answer to receive full marks.*

## 10. Continued

(i)

Step	Predictive Analytics	Traditional
Data Collection & Validation	<ul style="list-style-type: none"> <li>• Uses a number of variables that traditional approaches would not consider.</li> <li>• May require sourcing external data (e.g. credit scores)</li> <li>• No limit on number of variables included</li> <li>• Data needs to be partitioned into training and validation</li> </ul>	<ul style="list-style-type: none"> <li>• Mostly relies on past experience data.</li> </ul>
Exploratory Data Analysis	<ul style="list-style-type: none"> <li>• Analyze the properties of each variable</li> </ul>	
Variable Transformation	<ul style="list-style-type: none"> <li>• Attempt to mitigate data imperfections/</li> </ul>	<ul style="list-style-type: none"> <li>• Preferred approach is generally smoothing.</li> </ul>
Model Building	<ul style="list-style-type: none"> <li>• Select the form of the lapse model (e.g. GLM).</li> </ul>	<ul style="list-style-type: none"> <li>• Generally, no different models are used</li> <li>• A/E is assessed for credibility and a new lapse rate is determined.</li> </ul>
Model Validation	<ul style="list-style-type: none"> <li>• Statistical techniques are used to validate the model.</li> <li>• Use holdback data</li> </ul>	<ul style="list-style-type: none"> <li>• More of a reasonability check.</li> </ul>
Final Calibration	<ul style="list-style-type: none"> <li>• Refit the model as needed</li> </ul>	
Implementation and Ongoing Monitoring	<ul style="list-style-type: none"> <li>• Results of lapse model could be used as scoring engine for another risk model</li> </ul>	<ul style="list-style-type: none"> <li>• Results are also monitored but not used in as many ways</li> </ul>

(ii)

Predictive analytics has many advantages:

- Allows the examination of relationships between variables; correlations between lapse factors can be studied statistically
- Provides better insight into the interactions of various factors
- Supported by statistical tests and theory
- Trends can be captured more readily

## 10. Continued

- Isolated the true effect of each variable, standardizing the effect of other variables
- Allows use of factors not used in traditional methods

However, there are also disadvantages:

- More complicated. Traditional approaches to lapse studies are well established and easier to explain to management.
- Requires specific expertise to implement, which LMN may not have.
- More time consuming (and therefore more expensive)
- Pricing models may not be able to handle more refined assumptions that would result from a predictive analytics approach
- Requires a lot of data, which may be difficult to acquire, especially given LMN's lack of experience with 10-year term.

Predictive analytics can be powerful, but LMN should evaluate the costs (of obtaining data and developing data) vs the expected benefits and ensure the more complex assumptions that would result can be used in the pricing model before proceeding.