ILA LP Model Solutions
Fall 2015

1. Learning Objectives:

1. The candidate will understand feasibility step of new product and how it drives design.

3. The candidate will understand the relationship between the product features, their inherent risks, and the selection of appropriate pricing assumptions, profit measures and modeling approaches.

Learning Outcomes:

(1a) Explain considerations for successful product development.

(1c) Identify gaps between product design and the operations of the company, its procedures and systems

(3c) Analyze results and recommend appropriate action from an array of risk and profit measures such as: Statutory, GAAP, Return on Equity, Market Consistent Pricing, Embedded Value

Sources:

Atkinson & Dallas, Life Ins. Products and Finance Chapter 2 Product Development

Relationship of IRR to ROI on a level Term Life Insurance Policy, Product Matters, June 2013, pp. 18-21

Risk Based Pricing – Risk Management at Point of Sale "Product Matters" June 2009

Atkinson & Dallas, Life Insurance Products and Finance, Chapter 11 Profit Measurement and Analysis

Commentary on Question:

Commentary listed underneath question component.

Solution:

(a) Critique the team structure and propose changes to increase the effectiveness of the team.

1. Continued

Commentary on Question:
Most candidates were able to obtain at least half of the total grading points. Candidates who successfully wrote down at least four of the statements obtained full credit.

Many candidates were able to identify the lack of experience of the Legal and Pricing directors, however only a few suggested that the implementation director should understand the marketing needs as well. A good number of candidates were able to suggest adding people from other departments such as administration and investment, and adding a leader.

- Legal person only worked with health products, strong knowledge of variable annuity (VA) products and regulations needed to work on this team.
- Actuary does not have any experience with VA products; actuarial knowledge in VA products is needed to work on this team
- Implementation person has strong IT and system knowledge, however may lack of understanding of the marketing needs.
- This team doesn't have a leader who should be the one moves the team along quickly, overcome obstacles, and does not dominate the decision making process.
- Actuary needs to understand system constraints and process, not mentioned in the question.
- Regardless of what the senior management demand, the team should be more than just a committee to make suggestions, then there will be a danger that the team may try to anticipate what the senior management want vs develop the best product.
- The team should have the authority, responsibility and accountability to make product related decisions within broadly defined parameters.
- Developing a new product requires support from almost all areas of a company. Suggest including investment area, client service desk, etc

(b) Calculate the following profitability metrics using distributable earnings as the basis:

(i) Internal rate of return (IRR)

(ii) Traditional value of new business (VNB)

(iii) Risk based VNB

Show all work.

1. Continued

Commentary on Question:
Most candidates were able to illustrate good understanding of the IRR and VNB calculation methodologies. Different treatments to timing of the capital were also considered acceptable and full marks were given.
Many candidates were able to correctly write down the formula for the risk-based VNB, however many failed to use risk free rate in calculations.

Distributable earnings = PV AT profit - increase in RC + inv income on RC

	1	2	3
AT Profit	-100	250	400
Required Capital	400	450	550
Economic Capital	300	337.5	412.5
Change in RC	400	50	100
NHR	180	202.5	247.5
Investment income of RC	28.0	31.5	38.5
Distributable earnings	(472.0)	231.5	338.5

472 = 231.5 / (1+i) + 338.5 / ((1+i)^2)
I = IRR = 12.7%

VNB = -472 + 231.5 / (1+h) + 338.5 / ((1+h)^2) = 18.2

risk based VNB = PV AT profit - frictional costs of RC - time value of future options/gtees - cost of nonhedgeable risk

Distributable earnings	(472.0)	231.5	338.5
PV Dist Earn (at hurdle)	18.2	490.2	279.8
PV Dist Earn (at rfr)	63.6	535.6	313.0
6% NHR	10.8	12.15	14.85
Cost of NHR	36.2	25.4	13.7

risk based VNB = -0.2

1. Continued

(c) Explain why the GAAP ROI over the projected period is different than the IRR.

Commentary on Question:
For the IRR, candidates generally did well. For the GAAP ROI, candidates typically got the DAC and tax inclusion of the calculation, but tended to miss the other components.

- The internal rate of return (IRR) for a policy is a single interest rate that discounts all policy cash flows back to the issue date of the policy, such that the sum of discounted cash flows equals zero.
- A GAAP ROI calculation typically includes GAAP income plus imputed interest on required capital in the numerator and required capital plus stat/GAAP differences (DAC, reserves, taxes) in the denominator.

2. Learning Objectives:

2. The candidate will understand the design and purpose of various product types, benefits and features.

Learning Outcomes:

(2b) Construct and recommend a design that is consistent with the market needs.

(2c) Evaluate the feasibility of the recommended design.

Sources:

Source: LP-116-10: Variable Annuities, Kalberer and Ravindran , Ch. 5, 9-11 (Page 130-136)

Commentary on Question:

Commentary listed underneath question component.

Solution:

(a) For the new EIA with GWBL:

(i) Assess the risks in the Lifetime Flexible Deferral Period Option from both a pricing and hedging perspective

(ii) Evaluate the risk management concerns for the Index Switch Option

(iii) Assess how an increase in first year commission may impact NJK Life and the customer in:

- An up market
- A down market

Commentary on Question:

For part (i), some candidates listed/defined general pricing risks, and did not apply/relate them to the product and feature specific to the question. In addition, some candidates listed pricing and hedging risks for the ISO in part (i), which was only asking about the FDPO.

For part (iii), many candidates answered in terms of the impact to agents, when the question asked about impacts to the company and to the customer.

(i) Pricing Perspective: The goal is to set a price to cover the guaranteed cost under a stressed scenario. Sometimes there is no single optimal point. So may need to value a range of optimal behavior across different deferral periods, which may lead to a higher price.

2. Continued

Hedging Perspective: Even if the DPO option is fully priced, unhedged risks can lead to adverse income after hedging. Also, hedging assuming policyholders try to maximize guarantee value may lead to volatile results when they act sub-optimally.

(ii) There is no difference in guarantee price or treatment of indices that are difficult to hedge and those that are easy to hedge.

There is a sub-optimal diversification between different asset classes, leading to higher cost of guarantee, and higher guarantee fee for customers.

(iii) Under up market, higher commissions give customer & company lower returns.

Under down market, higher cost of guarantee & commissions for insurance company. Customer is indifferent.

(b) Recommend design alternatives to the EIA with GWBL to manage the risks of the following options:

(i) Lifetime Flexible Deferral Period Option

(ii) Index Switch Option

Commentary on Question:
This was the portion of the question where candidates performed best, as they could provide many options. However, many candidates simply listed possible alternatives, which resulted in partial credit. In order to receive full credit, candidates needed to provide rationale/explanation for why/how the proposed alternative would help manage the risks.

(i) 1. Fixed deferral period condition:
An expected deferral period is set for full withdrawals.
If income is needed sooner or later than the deferral period, it can be accessed on a pro-rata basis.
As timing is more predictable, should lead to a lower price.

2. Flexible deferral period with an optimal point
Pricing and hedging could be designed so the max guarantee value is at an optimal point.
Assuming customers choose the optimal point for withdrawal, volatility and price will decrease.

2. Continued

(ii) 1. Use Index allocation to maximize diversification while offering fixed funds to give some alpha (apart from beta) to clients

2. Guided architecture to give customer a choice of funds, but constrain amount to be invested in any fund/sector

3. Give choice to allow consumers to elect any fund, but each fund has a different price

3. Learning Objectives:

1. The candidate will understand feasibility step of new product and how it drives design.

2. The candidate will understand the design and purpose of various product types, benefits and features.

3. The candidate will understand the relationship between the product features, their inherent risks, and the selection of appropriate pricing assumptions, profit measures and modeling approaches.

Learning Outcomes:

(1a) Explain considerations for successful product development.

(1b) Describe tax regulation and perform calculations to evaluate compliance.

(2a) Describe in detail product types, benefits and features.

(3b) Identify and explain the setting of an appropriate assumption for risk and other factors such as:
- (i) Available experience data
- (ii) The marketplace
- (iii) Underwriting
- (iv) Distribution channel characteristics
- (v) Reinsurance
- (vi) Expenses (fixed, variable, marginal)
- (vii) Taxes (income and premium)
- (viii) Investment strategy

Sources:

LP-105-07: Life and Annuity Products and Features

Marino and Grobe, Canadian Taxation of Life Insurance, 5th Edition, Chapter 3: Taxation of Life Insurance Policies, Dispositions, and Selected Valuation Issues

Commentary on Question:

The goal of this question is to take the candidate through a Universal Life product from the basic mechanics to taxation. Candidates are asked to investigate how the mortality may deteriorate from conversions. In addition, candidates are expected to apply Canadian tax rules to the Universal Life Product.

3. Continued

Solution:

(a)

(i) (*1 point*) Describe the effect an optional conversion feature has on mortality and lapse rates and contrast it with an automatic conversion feature.

(ii) (*1 point*) Describe other mortality and lapse patterns that have been observed on post conversion policies.

(iii) (*2 points*) Describe the important considerations reinsurers must make when reinsuring term conversions.

(I) Mortality

- Less healthy lives tend to convert and use options -> higher mortality
- Automatic conversion and renewable term has more favorable mortality experience than optional

Lapse

- Lapses tend to be lower as policyholder has exercised an option
- Lapse rates for plan with automatic conversions is higher than normal plans

Commentary on Question:

The goal of this part question was to test the candidates' knowledge of how a conversion feature can affect mortality and lapse assumptions. Part i) was answered relatively well. Most papers discussed the anti- selection effect on mortality and lapse due to a conversion feature. In part ii), many candidates failed to understand the question. Instead of describing the assumptions on post conversion policies, most focused on the impact on the conversion. Part iii) tested the candidate's understanding of the considerations in reinsuring term conversions, some candidates applied general considerations of reinsurance, not the specifics of term conversions.

(ii) Mortality

- Female ratios lower than male ratios
- Mortality ratio was generally better for policies converted prior to end of period
- Select period mortalities lowest for paramedical policies and highest for non-medical
- Higher for conversions from term policies than for term riders

Lapse

- Decreasing pattern of lapse by increasing age at conversion during the select period after conversion.

3. Continued

- By duration, FY lapses higher than renewal lapses for all age groups
- Lapse rates for last chance conversions versus prior to last chance happened to be lower
- Female lapse rates generally higher than males

(iii)

- One option is to keep all conversions in original treaty at point in scale YRT rates
  - Need to incorporate higher mortality rate which can be done differently based on treaty type
  - If coinsurance, YRT can reflect conversions only and fully reflect additional mortality
  - If YRT, must be reflected by increased overall YRT rates or separate rates for converted policies
- Another option is to cover conversions in the treaty for the permanent policies
  - The volume of conversions will be a key assumption
  - If conversions are from term block that is already reinsured, reinsurer needs to compare YRT rates with rates for original pool of term policies. Determination should be made of YRT rates properly cover anti-selection
  - If they must reinsure conversions from term policies not already reinsured, reinsurer must understand volume of conversions, volume of permanent policy business, and the originating mortality (term block)
- Data issues are also a problem for reinsurers. Lack of usable conversion experience data leads to pricing without the benefit of solid data.

(b)

(i) Calculate the present value at issue of the extra mortality cost due to conversion. Show all work.

(ii) Calculate the after-tax proceeds of a full surrender of the policy at the end of the second year after conversion. Show all work.

Commentary on Question:
Overall, most candidates did very well on this question. The most common mistake was using the face amount instead of amount at risk in the calculation in both part. In part b ii), candidates were asked to calculate the after-tax proceeds of a full surrender of the policy. Largely, candidates were able to apply the Canadian Tax Rules, some candidates used incorrect mortality factors to calculate NCPI, as a result, and they got no policy gain and did not get credit in the rest of the question.

3. Continued

(i)

$A(x,m,r) = {}_rp(x,m)e(x,m,r)K(x,m,r)v^r$ = PV at age x of extra mortality cost due to conversion effected at end of policy year r

${}_rp(x,m) = 0.800$
$e(x,m,r) = 10\%$
Amount at risk in policy year 1 = Face - Fund = 100,000 - 750 = 99,250
Amount at risk in policy year 2 = Face - Fund = 100,000 - 1,400 = 98,600

$K(x,m,r) = \sum {}_{t-1}p_{(y,m,r)} * (q_{(y,m,r)+t-1} - q_{[y]+t-1}) * AR_{[y]+t} * v^t$

For all years beyond policy year 2, $(q_{(y,m,r)+t-1} - q_{[y]+t-1}) = 0$ so only need to calculate first 2 years.

K(x,m,r) = 1*(0.015-0.011)*(99250)*(1.03)^-1 + (1-0.015)*(0.018-0.014)*(98600)*(1.03)^-2
K(x,m,r) = 385.44 + 366.18 = 751.62

A(x,m,r) = 0.800*10%*751.62*(1.03)^-10 = 44.74

(ii)

ACB1 = ACB0 + Premium1 - NCPI1
NCPI1 = Mortality factor (obtained from the CIA 1969-1975 mortality table) * NAR
ACB1 = 0 + 2000 - 0.018 * (100000 - 750) = 213.50
ACB2 = ACB1 + Premium2 - NCPI2
ACB2 = 213.50 + 2200 - 0.022*(100000-1400) = 244.30

Policy Gain = Fund Value * (1 - Surrender Charge) - ACB just before disposition.
Policy Gain = 1400* (1 - 40%) - 244.30 = 595.70

After-tax Proceeds = 595.70 x (1 - 35%) + ACB = 387.21 + 244.30 (ACB returned) = $631.51

(c) Explain how the Adjusted Cost Basis would compare for a Universal Life policy that was converted from a Term 10 policy if there is a charge for the conversion option which is borne:

(i) only by those people who exercise the conversion option.

(ii) by everyone whether they want the conversion option available or not.

Justify your answer.

3. Continued

Commentary on Question:
This question was testing the candidate's knowledge of Canadian tax rules to a Universal Life product. To receive maximum points, candidates needed to understand the NCPI represents the pure mortality cost under the policy each year, it should not get increased to reflect the higher conversion mortality. Overall only a few candidates did well in answering this part of the question.

(i)

- The extra premium for conversion would not be included in the ACB
- The NCPI does not get increased to reflect the higher conversion mortality
- So the ACB is unchanged from unconverted UL policy with no extra premium. Lower than (ii)

(ii)

- Extra premium for conversion is included in the ACB calc as there is no explicit "cost" for the conversion
- The NCPI does not get increased to reflect the higher conversion mortality
- So the ACB is increased.

4. Learning Objectives:

3. The candidate will understand the relationship between the product features, their inherent risks, and the selection of appropriate pricing assumptions, profit measures and modeling approaches.

4. The candidate will understand actuarial requirements of product implementation and the monitoring of experience versus product assumptions.

Learning Outcomes:

(3b) Identify and explain the setting of an appropriate assumption for risk and other factors such as:
- (i) Available experience data
- (ii) The marketplace
- (iii) Underwriting
- (iv) Distribution channel characteristics
- (v) Reinsurance
- (vi) Expenses (fixed, variable, marginal)
- (vii) Taxes (income and premium)
- (viii) Investment strategy

(4b) Evaluate, through the use of Experience Studies, how actual experience varies from expected relative but not limited to: mortality, investment returns, expenses and policyholder behavior such as policy and premium persistency.

(4c) Describe how to ensure the quality of data.

Sources:

ASOP 23 Data Quality

Experience Data Quality - How to Clean and Validate Your Data

Predictive Modeling For Life Insurance

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

LP_3 CIA 2006 - Best Estimate Assumptions for Expenses

Commentary on Question:

The question was testing the candidate's knowledge of the relationship between actual data and how it can be used to set assumptions that are used in product pricing and projections. The question first tests considerations with actual data, and then asks the candidate to identify and correct any data errors or limitations.

The candidate is then asked to determine the best approach to expense assumption setting for a particular product, and then to describe the process of using actual data to build an expense model.

4. Continued

Solution:

(a) List expense data items that should be disclosed under ASOP No. 23.

Commentary on Question:
This section wanted to test the candidate's knowledge of ASOP 23 and how it applies to using empirical data for model building and other product related studies. This content and question falls under LO's 4b and 4c.

(Most candidates understood this part and were able to list the considerations of using actual data, under ASOP 23. These candidates received the maximum allowable points under this section. Some candidates provided a different set of expense considerations, which were detailed or specific to this type of product. Very few points were awarded for candidates that answered this way, as they did not list the best practice considerations under ASOP 23.)

- The source of the data should be disclosed
- Disclose the scope and intent of the data usage
- Disclose any material defects to the data
- Disclose any adjustments made to the data
- Any conflicts that exist with applicable laws or regulations

(b)

(i) Identify the potential data errors in the sample provided.

(ii) Propose a method to correct each error.

Commentary on Question:
This section was also testing the LO's of 4b and 4c. They were asked to identify any discrepancies or deficiencies in a small subset of policy data. They were then asked to recommend possible fixes/adjustments to these discrepancies.
(Most candidates were able to identify the defects of the data. Some credit was given for candidates that just identified the defect. Full Credit was given to candidates that were also able to provide a recommendation, or "fix", to these defects.)

Policy 4039 has a double entry. Delete one of these entries since they are identical data values.
Policy 3211 has missing gender value. This missing value can be ignored if gender is not material to the expense study or not used in setting expense assumptions.
Policy 2070 has an inconsistent expense value in year 5. Delete the Year 5 expense value of 999 and set equal to 0.
Policy 5039 has an unexpectedly low first year expense value of 2. We can replace this value with $81, or 10% of first year premium.

4. Continued

(c) Critique the proposed method. Recommend changes if appropriate.

Commentary on Question:
This question focused on LO's 3, 3b and 4. They were asked to review the current expense assumptions for adequacy and propose any changes to assumptions or methodology.

(Very few candidates received full credit for this section. Many were able to identify a few limitations or inaccuracies with the method of expense setting. They were then able to recommend changes to those methods. Again, very few candidates were able to identify all the possible changes needed.)

Should not use the average expense per policy for the expense years 1 through 5. First year expense should be split out between fixed and variable acquisition expenses. Commissions as a percent of premium should be considered. This product is single year premium only, so commission should be estimated at 10% of first year premium.

Using average flat expenses for policy years 5- 10 is not accurate. You need to take inflation into account. You should split expenses into fixed and inflationary. Assume an average inflation rate, such as 2%. An average fixed unit expense is between $2-$4. If the block of business is in a growth mode, then fixed maintenance cost per unit could be decreased over time.

Allocating expenses on a per policy basis is not appropriate, since larger face amount policies typically have higher expenses associated with them, such as underwriting. Overhead expenses should also be allocated to each policy, not just acquisition and maintenance expenses.

(d) ECC Life plans to build a predictive model to set expense assumptions.

(i) Explain how a dataset is partitioned when building a predictive model.

(ii) Describe how each dataset partition is used to build a predictive model.

Commentary on Question:
This section focused on LO 3, asking candidates to describe how to partition actual data and how to use those partitions to build a reasonable model for expenses.

(Most candidates were able to name at least 2 of the partitions; very few were able to name all 3 for full credit. Some candidates confused the question with something more specific, and provided specific fields/dimensions to partition the data, by age/gender/face amount, for example.)

4. Continued

(i) Data should be partitioned into 3 pieces: Train, Validate and Test. These datasets should be 3 separate sets of data.

(ii) Train data is used in the initial design of the model. It helps build the model, set the important/relevant variables and the impact of these variables on modeled results. This process is an iterative one to determine the strongest model.

Validate data is used for initial calibration of the Train-based model above, providing further validation and adjustments. This model can be made more precise and decide which variables or parameters should be used. However, care should be taken to not "overfit" the model.

Test data is used in the final step of the model. If the model is deemed to be a good fit, then no further adjustments are needed. The Test Data is run through the model to verify that the model is producing reasonable results. The modeler needs to protect the predictive power of the model from any "pitfalls", such as back-testing investment strategy.

5. Learning Objectives:

3. The candidate will understand the relationship between the product features, their inherent risks, and the selection of appropriate pricing assumptions, profit measures and modeling approaches.

Learning Outcomes:

(3a) Identify and explain the setting of an appropriate assumption for product characteristics such as the following:
- (i) Riders
- (ii) Policyholder dividends
- (iii) Equity linked
- (iv) Embedded options
- (v) Return of premium
- (vi) Secondary guarantees
- (vii) Payout annuity benefits
- (viii) Crediting methodology
- (ix) Other non-guaranteed elements.

Sources:

Hardy, Investment Guarantees, Chapter 7

Commentary on Question:

This question tests candidates' understanding of portfolio replication and no-abitrage pricing by applying multi-period binomial model with risk neutral probability concept to GMAB rider on a variable annuity product.

Solution:

(a) Construct a 2-period binomial model showing the value of each of the following at the end of years 1 and 2:

(i) Account Value

(ii) GMAB Base

(iii) GMAB Payoff

Commentary on Question:

Candidates did well on this part of the question. Candidates that did not do well did not recognize the dependence of the nodes with the path history, so the payoff for up then down is not necessary the same as down then up. Option is only exercisable at the end of year 2. So the payoff at the end of year 1 should be 0 and many candidates missed it.

5. Continued

Account Value:

```
                    /  13225 = 10000*1.15*1.15
            11500
          /         \  10350 = 10000*1.15*0.9
    10000
          \         /  10350 = 10000*0.9*1.15
            9000
                    \   8100  = 10000*0.9*0.9
```

GMAB Base:

```
                    /  11500 or 13225 (depends on the ratchet at end of policy)
            11500
          /         \  11500
    10000
          \         /  10000 or 10350  (depends on the ratchet at end of policy)
            10000
                    \  10000
```

GMAB Payoffs:

```
                    /     0     = Max(0, 11500-13225)
              0
          /         \   1150   = Max(0, 11500-10350)
        0
          \         /     0     = Max(0, 10000-10350)
              0
                    \   1900   = Max(0, 10000-8100)
```

(b) Calculate the cost of exactly hedging the liability of this GMAB rider at issue. Show all work.

Commentary on Question:
This question tests if the candidate can demonstrate an understanding of calculating the replicating portfolio working backwards. To receive full credit, candidates could use either replicating the payoff method or risk neutral method.

Up state at time 1:

We need a portfolio Pu = aue-r + buSu exactly meet GMAB payoffs at time 2:

au + 13225 bu = 0
au + 10350 bu = 1150

au = 5290, bu = -0.4

Pu = aue-r + buSu = 5290 exp(-0.05) -0.4 * 11500 = 432

5. Continued

Down state at time 1:

We need a portfolio Pd = ade-r + bdSd exactly meet GMAB payoffs at time 2:

ad + 10350 bd = 0
ad + 8100 bd = 1900

ad = 8740, bd = -0.8444

Pd = ade-r + bdSd = 8740 exp(-0.05) -0.8444 * 9000 = 714

At time 0:

We need a portfolio P0 = ae-r + bS0 exactly meet Pu if AV rises and Pd if AV falls at time 1:

a + 11500 b = 432
a + 9000 b = 714

a = 1729, b = -0.1128

P0 = ae-r + bS0 = 1729 exp(-0.05) -0.1128 * 10000 = 517

Method 2: Risk Neutral Method

pu + pd =1

puSu + pdSd = S0er

pd = (10000exp(0.05) - 11500) / (9000-11500) = 0.3949

e-2r * [0*pupu + 1150*pupd + 0*pdpu + 1900*pdpd] = e-2(0.05) * [1150*(0.395)*(1-0.395) + 1900*0.395*0.395] = 517

(c)

(i) Calculate the risk neutral probability of the Large Cap Fund having an annual account value return of -10% in a given year. Show all work.

(ii) Assess the appropriateness of using the risk neutral probability measure to determine the chance of the option being in or out of the money. Justify your answer.

Commentary on Question:

Candidates did well on the first part of the question, receiving full score.

Candidates did well on the second part of the question. Candidates that received full marks stated that risk neutral (RN) is not appropriate (or real world (RW) should be used) and provided appropriate explanations. Candidates that suggested that RN is appropriate and only provided definition of RN received no points.

5. Continued

(i) $pu + pd = 1$
$puSu + pdSd = S0er$
$11500pu + 9000pd = 10000\exp(0.05)$
$11500(1-pd) + 9000pd = 10000\exp(0.05)$
$pd = (10000\exp(0.05) - 11500) / (9000-11500) = 0.3949$

(ii) Risk neutral (RN) is not appropriate when it comes evaluating "in-the-moneyness" probability. This is because RN is best used for portfolio replication and determining the market consistent price. If we are interested in calculating the probability of the option being in or out of the money in the future, real world is more appropriate. In-the-moneyness depends on the future performance of the underlying the investments and the real world measure projects the true distribution of the outcomes for the account values.

6. Learning Objectives:

3. The candidate will understand the relationship between the product features, their inherent risks, and the selection of appropriate pricing assumptions, profit measures and modeling approaches.

Learning Outcomes:

(3a) Identify and explain the setting of an appropriate assumption for product characteristics such as the following:
- (i) Riders
- (ii) Policyholder dividends
- (iii) Equity linked
- (iv) Embedded options
- (v) Return of premium
- (vi) Secondary guarantees
- (vii) Payout annuity benefits
- (viii) Crediting methodology
- (ix) Other non-guaranteed elements.

(3c) Analyze results and recommend appropriate action from an array of risk and profit measures such as: Statutory, GAAP, Return on Equity, Market Consistent Pricing, Embedded Value

Sources:

Predictive Modeling for Life Insurance by Deloite

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

Commentary on Question:

The question tests the candidates' understanding of predictive modeling and emerging distribution channels. The question also tests the candidates' knowledge of the mortality impact of a predictive model on age, marital status and gender.

Solution:

(a) NBD Life is building a predictive model that will be used to predict the likelihood that an insurance policy is purchased based on information available in a user's social media profile. Describe the steps required to build this model.

Commentary on Question:

Most candidates knew that data needed to be collected, and the model needed to be built, validated, tested and monitored. A number of candidates did not comment on the need to define the target variable, calculate the correlation between the predicted and independent variables, and the need to pare down predictive variables, group values, and replace missing values.

6. Continued

The first step in the process to build the model is data preparation, which includes the following. The statements with an asterisk (*) would give full credit. The other statements shown could be substituted for those statements.

*-Collect and organize all the data obtained from social media profile into a central dataset
*-Create variables from the raw social media profile data (may need mapping)

-Create synthetic variables (i.e. calculate Age using date of birth)

-Load all data (purchase history and social media profile) into a statistical software package

The second step is to perform data analysis:
-Getting comfortable with the data (e.g. calculating min / max / average Age of users)

-Define the target variable(s)

*-Calculate correlation between predicted and independent variables one at a time (e.g. correlation of current Age and probability to purchase)

*-Pare down list of potential predictive variables by only keeping variables that stand out by being highly correlated with purchasing policy, well populated, and sufficiently distributed

-May remove the following variables from model because they are not sufficiently populated: religion, # of posts per day, etc.

The third step is the variable transformation:
*-Group excessive categorical values: to increase credibility (e.g. quinquennial ages)
*-Replace missing values (remove or provide neutral or best estimate)

-Cap extreme values or outliers (e.g. cap ages at product issue age limits e.g. 18-65)

-Capture trends (e.g. turn current City living in into a Province)

The final steps are the following:

6. Continued

*-Train (model build set): carry out iterative process that produces the strongest model. Usually test a variety of statistics to determine best model. Variables are added or removed, one at a time, to determine model fit. Each time model is compared to determine best model. Each variable that survives should be correlated with the target.
(E.g. # of Facebook friends may not be highly correlated with probability of purchase- remove this variable)

-Validation: initial model is adjusted using the validation data in order to make sure the model is not over-fit.

-Test: use to test the predictive power of the model.

-At end of process, monitor the results

(b)

(i) Assess the appropriateness of the impact that each model variable has on the predicted mortality rate.

(ii) Explain any concerns you have about using this model to set mortality assumptions.

Commentary on Question
Most of the candidates did well on part (b)(i) in understanding the mortality impact of the model on age, marital status and gender. However, for part (b)(ii), a number of candidates were not able to explain many of the mortality concerns and issues the model presented.

(i) The following two statements would earn full credit:
-Increase Age: increase mortality - this makes sense since the older an individual, the likely higher probability of death
-If male: mortality decreases, but should increase above female mortality from historical experience. Studies to date suggest male mortality greater than female mortality.

The following outlines another possibility for credit, if the statements above were not completely addressed:
If married: decrease mortality - some studies show that joint policies have lower mortality compared to single or survivors.

6. Continued

(ii) Four of the following statements would earn full credit:
-Mortality needs relatively large amount of data to predict results (low frequency of life insurance claims is a challenge)
-Where did the Company get the Mortality data to develop the model?

-Insufficient data to analyze mortality experience over a short time horizon

-Data issues using Facebook profile (fraud, fake profiles, missing data, etc)

-Model does not include any interaction variables

-No smoking status

-No underwriting assessment needed

-No policy size, duration, plan type, distribution channel.

-Since Since qx = e^K / (1 + e^K), there is no way for qx to equal 1; that is, there is no "reasonable" terminal age.

7. Learning Objectives:

1. The candidate will understand feasibility step of new product and how it drives design.

Learning Outcomes:

(1a) Explain considerations for successful product development.

(1b) Describe tax regulation and perform calculations to evaluate compliance.

(1c) Identify gaps between product design and the operations of the company, its procedures and systems.

(1e) Recommend ways to close the gaps between design and the internal/external constraints.

Sources:

Life Insurance and Modified Endowments Under IRC §7702 and §7702A, Chapter 2 The Requirements for Qualification

Commentary on Question:

The goal of this question is to test the candidates fundamental understanding of the policyholder taxation rules under section 7702 and to get the candidate thinking about how the choice of test under the guideline can influence product design and tax-free buildup. The candidate is expected to perform the premium limitation calculations under section 7702 and explain the mechanics and consequences of each test.

The first part is generally answered well. In the second part, some candidates did not perform both tests and received partial marks.

Solution:

(a) Describe the key elements of the Cash Value Accumulation Test (CVAT) and the Guideline Premium Test/Cash Value Corridor Test according to Internal Revenue Code Section 7702.

Commentary on Question:

Candidates did well on this questions. Candidates that did well on this question provided a full description of the elements of the CVAT and GPL. Candidates that did not do well did not provide an adequate description.

Listing four of the following statements for each CVAT and GPL would earn the candidate full marks for this question:

7. Continued

CVAT:

- CVAT is a prospective test
- CSV cannot be greater than the NSP at all future points in time
- NSP is based on current and future death benefits, endowment benefit and qualified additional benefits
- Interest rate used is max of 4% or guaranteed interest rate in the contract
- CVAT test uses reasonable mortality charges which can't exceed CSO table
- CSV is calculated without surrender charges, policy loans or dividends, expenses are excluded

GPL:

- GPL is a retrospective test
- The sum of the gross premiums paid to date cannot exceed the gross premium limitation
- Gross premium limitation is the max of the Guideline Single Premium and the sum of the Guideline Level premiums paid to date
- Guideline Premium is based on current and future death benefits, endowment benefit and qualified additional benefits plus reasonable expenses
- For Single premium - interest rate used is max of 6% or guaranteed interest rate in the contract
- For Level premium - interest rate used is max of 4% or guaranteed interest rate in the contract

(b) Determine whether each of the above products complies with Section 7702. Show all work.

Commentary on Question:
Candidates who did well, recognized that 2nd test is required if the 1st test fails and performed all calculations correctly, stating the conclusion whether each product complies with Section 7702.

Partial marks were given to candidates who incorrectly calculated that the 1st test passes for all products and stated that the 2nd test is not required.

1) CVAT
For CVAT, the max cash value must be less or equal to the NSP calculated using:
i = max(5%, 4%) = 5%
no expenses are used in CVAT
NSP = PV(Death Benefits)
NSP1 = 1000*(0.2/1.05+(1-0.2)*0.6/1.05^2+(1-0.2)*(1-0.6)*1.0/1.05^3) = 902.28
NSP2 = 934.24

7. Continued

NSP3 = 952.38

2) GSP / GLP

Guideline premium (GP) = PV (Death Benefits) + PV(Expenses) at i=6%
Guideline premium test = sum gross premium < max (GSP, sum (GLP))
GSP = (NSP + 12*Expense per Policy* ax) / (1 – Expense per Premium)
= 98,555.90
GLP = (GSP @ 5%) / (ax at 5%) = 48,985.97

3) Tests:

Fail one test so must test the other.

Per 1000	**CVAT Test** [pass if CSV < NSP]			**GLP Test** [pass if sum GP < max (GSP, sum (GLP))]		
Product/ Year	1	2	3	1	2	3
Limit:	NSP1 = 902	NSP2 = 934	NSP 3 = 952	max(GSP, 1* GLP) = 986	max(GSP, 2*GLP) = 986	max(GSP, 3*GLP) = 1470
1	CSV1=500	CSV2=750	CSV3=1000	GP1 = 300	GP2 = 600	GP3 = 900
	Pass	Pass	Fail	Pass	Pass	Pass
2	CSV1=250	CSV2=500	CSV3=750	GP1 = 400	GP2 = 800	GP3 = 1200
	Pass	Pass	Pass	Pass	Pass	Pass
3	CSV1=325	CSV2=650	CSV3=975	GP1 = 650	GP2 = 1300	GP3 = 1850
	Pass	Pass	Fail	Pass	Fail	Fail

4) Conclusion:

Product 1 complies with Section 7702 (under Guideline Premium Limit)
Product 2 complies with Section 7702 (under either test)
Product 3 does not comply with Section 7702

8. **Learning Objectives:**

3. The candidate will understand the relationship between the product features, their inherent risks, and the selection of appropriate pricing assumptions, profit measures and modeling approaches.

Learning Outcomes:

(3a) Identify and explain the setting of an appropriate assumption for product characteristics such as the following:
- (i) Riders
- (ii) Policyholder dividends
- (iii) Equity linked
- (iv) Embedded options
- (v) Return of premium
- (vi) Secondary guarantees
- (vii) Payout annuity benefits
- (viii) Crediting methodology
- (ix) Other non-guaranteed elements.

(3e) Describe when a stochastic model should be used, its advantages and disadvantages, how to build it and how to analyze its results

Sources:

Stochastic Modeling: Theory and Reality from an Actuarial Perspective, IAA, Intro, I – I.B.2, I.E, II.A.1 – II.A.3, III, IV.A – IV.A.9

SOA Research 2014 - Modeling of Policyholder Behavior for Life and Annuity Products, pp. 9-16, 23-33, 45-67

Commentary on Question:

This question is testing the candidate's knowledge of stochastic pricing and GMWB riders. Candidates needed to explain the alternatives to stochastic pricing and behavior economics as related to GMWBs instead of just creating a list. To do well on this question, candidates needed to be able to accurately describe the source material and relate it to the GMWB rider.

Solution:

a)

(i) (*1 point*) Explain when stochastic modeling should be used.

(ii) (*1 point*) Describe the disadvantages of using a stochastic model.

(iii) (*3 points*) Describe three commonly used alternatives to stochastic modeling.

(iv) (*3 points*) Explain how each alternative described in (iii) could be used, if at all, in pricing the GMWB rider.

8. Continued

Commentary on Question:
In general, candidates did fairly well on parts i and ii. Most candidates were able to describe situations where stochastic modeling could be used and list several disadvantages. However, candidates did not do well on parts iii and iv. Candidates were able to give one or two alternatives but few could accurately describe all three; and even fewer could explain if they would be appropriate for pricing GMWB riders. Especially for part ii, there are other answers that would receive credit (I included the most common responses from candidates).

(i) When required by regulations or standards of professionalism
When analyzing extreme outcomes or tail risks
When using certain risk measures like VAR or CTE
To understand where stress tests fall in the broader range of outcomes

(ii) Stochastic models are complex to understand
Users may not fully understand the results; black box phenomenon
Calibration and validation are complex
Stochastic models are costly and time consuming; require internal expertise

(iii) Stress/Scenario testing – use alternative sets of assumptions; often scenarios should represent extreme outcomes; used to test materiality of assumption
Static/Load factors – use previously generated load factors to account for risk; factors are usually a multiplicative adjustment applied to deterministic model to account for variability
Ranges – used to measure results around a best estimate; create a confidence interval above and below the best estimate

(iv) Stress testing – can be used to illustrate the rider risk by showing results under worse case scenarios like the stock market crash; different withdrawal patterns may be used after market crash.
Static factors – this is unlikely to have any usefulness in pricing rhe rider; company is unlikely to have any internally developed factors
Ranges – rider costs are generated by tail outcomes in market return distributions; therefore range around best estimate will severely underestimate the cost of the rider

(b) Describe four ways that behavioral economics could be applied when setting assumptions for the timing and amount of withdrawals for the GMWB rider.

Commentary on Question:
Only about half of the candidates referenced the correct source material. Candidates that did well on this question provided enough details to describe how it would be used for GMWB riders. There are other answers that would receive credit (I included the most common responses from candidates).

8. Continued

Reliance on defaults (anchoring) – product design (or communications) may suggest beginning withdrawals at age 65; since the product allows for 6% withdrawals, there may be a tendency for customer to use that default option

Mental accounting (framing) – policyholder may have mentally assigned this as a retirement account; timing and amount of withdrawals may be based on spending needs and not on maximizing value of product

Love of free – policyholder may view the ability to increase the base on which withdrawals are taken as a free way to increase their retirement income; may delay withdrawals to get more of this free benefit

Hyperbolic discounting – policyholder may heavily discount the value of future guaranteed withdrawals; may take excess withdrawal now that hurts future benefits

9. Learning Objectives:

3. The candidate will understand the relationship between the product features, their inherent risks, and the selection of appropriate pricing assumptions, profit measures and modeling approaches.

4. The candidate will understand actuarial requirements of product implementation and the monitoring of experience versus product assumptions.

Learning Outcomes:

Identify and explain the setting of an appropriate assumption for product characteristics such as the following:

(i) Riders
(ii) Policyholder dividends
(iii) Equity linked
(iv) Embedded options
(v) Return of premium
(vi) Secondary guarantees
(vii) Payout annuity benefits
(viii) Crediting methodology
(ix) Other non-guaranteed elements.

(4a) Describe and evaluate compliance with illustration regulation and other policy form regulations

Sources:

LP-110-07 with reference to Canadian Dividend Illustration Policy for parts a) & b)

Commentary on Question:

This question was testing the candidates knowledge on setting a Company Dividend Policy by explaining the Dividend Actuary's role in developing and recommending a dividend scale (part a) and by evaluating a sample dividend policy (part b).

Overall, students did well on this question.

Solution:

a) Explain the role and responsibilities of the Dividend Actuary in the U.S.

Commentary on Question:

Students did very well on part a. To get full credit candidates needed to list four correct statements. One common error was to say the Dividend Actuary should recommend the dividend scale to senior management instead of the Board of Directors and not understanding the Board of Directors have the final say on the approved dividend.

9. Continued

- The Dividend Actuary is responsible for developing an overall dividend scale of policyowner dividends that is equitable and follows the contributory principle.
- With Senior Management, they propose a scale to the Board of Directors who is responsible for approving the dividend scale.
- If the Board of Directors chooses not to distribute dividends in the manner recommended by the Actuary this must be disclosed in the Statutory Annual Statement.
- The Dividend Actuary must be a member of the American Academy of Actuaries and meet proper requirements for signing public statements.
- The Dividend Actuary is required to disclose the scale in the Statutory Annual Statement in Schedule M.

(b) Critique each statement in the Dividend Policy to ensure it complies with U.S. regulations. Justify your answer.

Commentary on Question:
*To get full credit for part b candidates needed to say if the statement was appropriate **and** give justification for their answer. Many candidates did not give proper justification and did not receive full credit. Candidates did well on parts i, iv, v and vi. Candidates did poorly on part ii not understanding the statement and not recognizing the connection between the expense of establishing CEA Life and the dividend scale. On part iii, most candidates said the statement was appropriate and did not give any justification.*

i.) This policy is inappropriate.
- The annual dividend scale should examine each block of business separately and only consider experience that is credible.
- Initially it could be ok to combine business as there is no credible experience for CEA Life and it is allowed to use company experience for smaller blocks until credible experience emerges. However, once experience emerges the dividend scale for U.S. issued policies should be based on its own experience.
- The Dividend Actuary could also use industry experience until credible experience emerges, especially if the experience of the two countries is expected to be very different

9. Continued

ii.) This policy is inappropriate
- The annual dividend scale should only vary in proportion to how the major sources of earnings vary.
- The dividend scale for participating policyholders cannot be impacted due to an unfair charge of profits being paid to shareholders.
- Although it is correct to reflect one-time exceptional costs within the dividend scale, these costs should be spread over a number of years creating a more level dividend scale.

iii.) This policy is appropriate
- Either a Portfolio yield, Investment Yield Method (IYM) or a combo of the two methods are acceptable when allocating actual investment earnings to participating business.
- The dividend actuary must use the contributory principle for setting the recommended dividend scale.

iv.) This policy is appropriate
- Smoothing of capital gains over several years is necessary and reasonable.
- Smoothing could be done with pegging or substitution.
- Gains (both realized and unrealized) should be spread out over the average duration of bonds and the economic cycle as it pertains to common stocks.
- The dividend actuary has to consider whether capital gains should be paid faster than the spreading based on surplus levels.

v.) This policy is appropriate
- The Board is advised by the Dividend Actuary and Senior Management as to the amount that should be distributed, but the Board is legally responsible to set the aggregate amount of dividends to be distributed and may choose not to distribute the recommended dividends.

vi.) This policy is only partially correct
- Although it is correct to reflect the mortality, expense and persistency experience within the dividend scale several additional factors should be taken into consideration in setting the scale including taxes, special tax items (DAC and Equity Based, Tax vs Stat reserves), mergers, and risk reinsurance charges (as an additional expense)

10. Learning Objectives:

1. The candidate will understand feasibility step of new product and how it drives design.

2. The candidate will understand the design and purpose of various product types, benefits and features.

Learning Outcomes:

(1a) Explain considerations for successful product development.

(1c) Identify gaps between product design and the operations of the company, its procedures and systems.

(1e) Recommend ways to close the gaps between design and the internal/external constraints.

(2b) Construct and recommend a design that is consistent with the market needs.

(2c) Evaluate the feasibility of the recommended design.

Sources:

LP-102-07: Equity Indexed Annuities: Product Design and Pricing Consideration.

Commentary on Question:

Overall, the students did well on this question. It seemed pretty straight forward. There was only 1 section (b (ii)) where students seemed to struggle a bit more.

Solution:

(a) Determine the product design that will provide the highest payoff to the policyholder. Show all work.

Commentary on Question:

Most students did very well on this portion of the question and many got full points.

Annual Accumulation Values = S_{t+1}/S_t-1: Year 1: 5%, Year 2: -9.52%, Year 3: 15.79%, Year 4: 9.09%, Year 5: -8.33%
Guarantee = 100*90%*(1.04)^5=109.50
Product A:
100*(1+(.75)(.05))*(1+(.75)(0))*(1+(.75)(.1579))*(1+(.75)(.0909))*(1+(.75)(0))= 123.95
since CAR > Guarantee, payoff = 123.95
Product B: 100*(1+(.65)(.05+0+.1579+.0909+0))=119.42
since SAR > Guarantee, payoff = 119.42
Product C: 100*(1+(.6)(110/100-1))=106.00
since Guarantee > 106, payoff = 109.50

10. Continued

Product D: 100*(1+(.55)(120/100-1))=111.00
since > Guarantee, payoff = 111.00

Product Design A provides to highest payoff.

(b) For product design A:

(i) Calculate the option value. Show all work.

(ii) Assume non-option expenses are 3 per year. Calculate a participation rate, β, such that the non-option expenses and the option are funded by the premium. Show all work.

(iii) Recommend changes to the product design to mitigate the risk in a high volatility environment with respect to the stock market values.

Commentary on Question part b:
Most students did well on (i) and (iii). Fewer performed well on (ii)

(i) **Many Students did well on this secition** Set up variables: P = 100, r = 5%, d = 0, σ = .10, α = .75, n = 5
d1 = (.05 - 0 + .005)/(.1) = .55, d2 = .45, Φ(d1) = .7088, Φ(d2) = .6736
*H = 100 * (e^(-.05) + (.75)(1*(.7088) - e^(-.05)*(.6736)))^(5) = 100 * (1.00225)^5 = 101.13 => Option value*

(ii) **Many students had difficulty with this section:**
Non-Option Expenses = 3
P = Non-Option Expenses + Option Value
P = Non-Option Expenses + P * (exp(-r) + β * (Φ(d1) - exp(-r)*Φ(d2)))^n
100 = 3 + 100 * (exp(-0.05) + β * (0.7088 - exp(-0.05) * 0.6736))^5

(iii) **Almost all of the students got at least two from the following list:**
Lower Participation Rate
Impose a Cap
Lower Guarantee Rate
Shorten the Term
Limit Premium amounts sold