

DP-IU & IC Illustrative Solutions

November 2007

All Solutions apply to both Canada and United States unless otherwise specified

1.

Learning Objectives: 7

**Learning Outcome: Recommend appropriate measure for particular product.
Measure profitability.**

Cognitive Skills: Recall

Solution:

(a)

Profit goals should fit company strategy, allow company to compete, and provide adequate reward to owners

- What accounting basis should be used?
 - Should you use stockholder earnings or solvency earnings?
 - Regulators and rating agencies want to see solvency accounting
 - Stockholders want to see stockholder accounting
- How should risk be reflected in the profit goals?
 - Use best estimate assumptions in pricing and set profit goals to reflect the degree of risk
 - Ways to reflect the degree of risk
 - Use formula that calculates the profit margin based on a given degree of risk
 - Subjectively set the profit margin based on estimated degree of risk
 - Perform sensitivity testing to determine the degree of risk
- What discount rate should be used?
 - Influenced by:
 - Company's marginal and weighted average cost of capital
 - Returns on similar investments
 - Current and future capital position
 - Use of discounting

1. (a) continued

- Common choices
 - Cost of capital
 - Investment rate (pre-tax or after-tax)
 - Risk-free rate

(b)

Aggressive growth would generally lower your ROE in short term

Growth in new business is dictated by:

- Accounting practices (past and current)
- Reinvestment and dividend practices
 - Age and size of the inforce block

(c)

Available statutory surplus not earning annual return equal to ROE objective

- Dividends not paid to stockholders but reinvested at investment earnings rate less than ROI
- Annual statutory income reinvested at investment income rate less than ROI
- DAC is amortized at a rate less than the ROI due to some degree of conservatism in GAAP for life insurance companies. This causes a non-level (increasing) emergence of ROE.

2.

Learning Objectives: 6

Learning Outcome: Understand the relationship between the product design and the selection of appropriate assumptions for pricing the product (mortality, persistency, investment returns, expenses, etc.).

Cognitive Skills: Recall, Analysis, Synthesis

Solution:

(a)

The disclosures and communications made regarding the data used, as required by ASOP #23, Data Quality are:

- Source of data
- Whether the actuary reviewed the data
- Extent of actuary's reliance on the data
- Any material judgmental adjustments or assumptions that the actuary used
- Any limitations on the pricing work due to uncertainty about the quality of data
- Any unresolved concerns which could have a material impact on the pricing
- Any results which are highly uncertain or have a material bias on the quality of data
- Nature and magnitude of the uncertainty or bias
- Any conflicts with applicable law, regulation or other authority

(b)

Interest rate risks take 2 forms

- Maturity Mismatch Risk is a mismatch of timing of asset cash flows with policy benefits, leading to reinvestment/disinvestment by the insurer
 - Reinvestment risk: liability Cash Flows are longer than asset Cash Flows
 - Capital Value risk: liability Cash Flows are shorter than asset Cash Flows
- Option Risk, assets may have call/prepayment options, and liabilities may have put options.
 - An example is a spike in interest rates which reduces the values of existing investments
 - This leads to an increase in surrenders as policyholders purchase SPDA elsewhere at higher credited rates
 - The original insurer is forced to liquidate assets at depressed values

2. (b) continued

- This risk is increased if original insurer invested in long duration assets, and higher interest rate decreased activity in call/prepayment options
- Renewal Crediting Strategy can affect policyholder satisfaction.
 - A high credit rate leads to fewer surrenders, and fewer assets liquidated for surrenders are reinvested at higher interest rates
 - A low credit rate leads to more surrenders, tempered by surrender charges

(c)

Moody's global speculative grade corporate default rates fell in 2006

- This marked the 5th consecutive annual decline
- The default rate for all of Moody's rated corporate issuers fell in 2006
- The average recovery rates for defaulted bonds increased in 2006
- The Moody's forecast for 2007 is a pendulum swing in the opposite direction
- Expect global speculative grade corporate default rates to double

Recommendation is not to use speculative grade corporate bonds, or to use a small percentage in the portfolio.

3.

Learning Objectives: 6C

Learning Outcome: Explain the effect of each assumption on product pricing.

Cognitive Skills: Recall, Analyze, Application

Solution:

(a)

The higher the dividing line, the higher the average mortality of both preferred and non-preferred classes

- This would interact with competitor's dividing line (especially those offering products through same broker)
 - If ABC's dividing line is lower, the average mortality of preferred class would be expected to be better and lower premium is charged.
 - Better risks are attracted to ABC.
 - ABC will likely attract insureds who just make it into preferred class.
- Insureds who get into preferred class would:
 - Purchase larger policies – because of lower rates this is a good deal
 - Exhibit lower lapse rates
 - Exhibit lower not taken rates
- The opposite applies to non-preferred class
- Lower lapses may lead to better mortality because healthy lives are staying
- Lower not taken rates mean lower underwriting costs per unit issued

(b)

(i)

Preservation of Total Death Theory

$$(1-qw^{\text{Norm}})qd^{\text{Norm}} = (1-qw^{\text{Norm}}-qw^{\text{Extra}})qd^{\text{Actual}} + qw^{\text{Extra}} \times \text{SelectPct} \times qd^{\text{Select}} + qw^{\text{Extra}} \times \text{NonSelectPct} \times qd^{\text{Norm}}$$

$$(1-10\%) \times 5/1000 = (1-10\% - 20\%)qd^{\text{Actual}} + 20\% \times 75\% \times 2/1000 + 20\% \times (1-75\%) \times 5/1000$$

$$qd^{\text{Actual}} = 5.64285/1000$$

$$\text{Increase in mortality} = (qd^{\text{Actual}} - qd^{\text{Norm}}) / qd^{\text{Norm}} = (5.64286 - 5) / 5 = 12.86\%$$

3. (b) continued

(ii)

Principle of Conservation of Deaths

$$A q(x+r, t-r) + (1-A)q^{AS}(x, t) = q(x, t)$$

A is the percentage of selective lapse = $20\% \times 75\% = 15\%$

$$15\% \times 2/1000 + (1-15\%)q^{AS}(x, t) = 5/1000$$

$$q^{AS}(x, t) = 5.52941/1000$$

$$\text{Increase in mortality} = (5.52941 - 5)/5 = 10.59\%$$

(c)

Average Premium Rate

$$= (\% \text{ Preferred}) \times \text{Preferred Rate} + (1 - \% \text{ Preferred}) \times \text{Non-Preferred Rate}$$

$$= 80\% \times 4.4 + (1 - 80\%) \times 9.9 = 5.5 \text{ per thousand}$$

Expected Mortality

$$= (\% \text{ Preferred}) \times \text{Preferred Mortality} + (1 - \% \text{ Preferred}) \times \text{Non-Preferred Mortality}$$

$$= 80\% \times 4 + (1 - 80\%) \times 9 = 5.0 \text{ per thousand}$$

$$\text{Expected Profit Margin} = (5.5 - 5.0)/5.0 - 5\% = 5\%$$

$$\text{New Percentage Preferred} = 80\% \times 95\% = 76\%$$

$$\text{Actual Mortality} = 76\% \times 4 + 24\% \times 9 = 5.2 \text{ per thousand}$$

Average Premium Rate stays the same

$$\text{Actual Profit Margin} = (5.5 - 5.2)/5.2 - 5\% = 0.77\%$$

4. United States

Learning Objectives: 1, 3, 5

Learning Outcome: Model features, plan the design, identify gaps between design and company operation, and describe tax constraints.

Cognitive Skills: Application, Analysis, Synthesis

Solution:

(a)

(i)

Description

- Single sheet of paper contains summary of product development process
- Visual representation of product development process for the project team
- Contains
 - Combination of team members representing all areas to get the project completed (include actuarial, underwriting, etc.)
 - Stages and major milestones
 - Collaborative quality of tasks or meetings
 - Guidelines, standards, and regulations necessary
- High level map shows 5-6 milestones, 10-20 relationship for a task
- Develops common vocabulary
- Best practice of developing a systemic perspective for a set of tasks

(ii)

Benefits

- Better control of product development process by the project team
- Management has better control over getting project completed
- Better upfront communication means less rework and quicker completion
- New product can benefit from following established process
- Team can move from looking at the big picture to smaller segments
- Team can even focus on a single critical issue

(b)

- Determine the benefit structure
- Payments based on original death benefit, or death benefit at time or acceleration
- How do riders like inflation protection affect the benefit
- COI charges level or attained age

4. (b) continued – U.S.

- Mortality concerns such as
 - Less anti-selection on accelerated versus stand-alone
 - Not all accelerated claims end in death – some recover
 - Capture mortality difference using first principle approach of assumed incidence and termination rates
 - Assume higher mortality for those who use acceleration
- Reserve issues – have to handle multiple reserves for a policy
 - May need separate LTC minimum reserve
 - Disabled life reserve if receiving benefit
 - Reduce death benefit to account for accelerated payment
- Tax issues
 - If have level premium qualifies as life insurance reserve
 - If have separate premium subject to DAC, and premium tax could be different than for the base life insurance Premium
 - Accelerated charges assessed against cash value not subject to DAC or premium tax
- Scenario test
 - Incidence levels
 - Severity levels
 - Age mix
- You are entering a new market with conditions that don't have a lot of history
 - Need to be careful in adjusting mortality/morbidity assumptions
 - Monitor experience as your work may not be based on reliable data

(c)

- Only qualified benefits are eligible to be pre-funded in the cash surrender value
- Charges for QAB rider can be taken into account when calculating guideline premiums but the rider benefits are not included in the future benefits
- The guideline premiums can be increased to reflect reasonable charges for the QAB
- The value of the QAB is also reflected in cash value accumulation tests
- Charges for the QAB can be amortized over the term of the QAB or life of base policy
- Non-QAB cannot be taken into consideration in calculating guideline premiums
- But pre-funding of the Non-QAB benefit does increase premiums paid for the base policy
- LTC is treated similar to a Non-QAB
- LTC rider is treated as a separate contract

4. (c) continued – U.S.

- Use of any policy value to pay LTC rider charge considered distribution
- Withdrawal from the base life policy to fund rider could generate taxable income
- Policyholder receives LTC benefits tax free

4. Canada

Learning Objectives: 1, 3, 5

Learning Outcome: Model features, plan the design, identify gaps between design and company operations, and describe tax constraints

Cognitive Skills: Application, Analysis, Synthesis

(a)

(i)

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- Contains:
 - Combination of team members representing all areas to get the project complete (including actuarial, underwriting, etc.)
 - Stages and major milestones
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4. (b) continued - Canada

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 - Less anti-selection on accelerated versus stand-alone
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 - Capture mortality difference using first principle approach of assumed incidence and termination rates
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- Scenario test
 - Incidence levels
 - Severity levels
 - Age mix
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 - Need to be careful in adjusting mortality/morbidity assumptions
 - Monitor experience as your work may not be based on reliable data

(c)

- Use viatical settlement
 - The 3rd party will own the policy
 - The 3rd party has to continue paying premiums
 - Cash payment made by the 3rd party represents percent of policy face
 - Must check to be sure legal
 - Transfer of consideration considered disposition
- Obtain a collateral loan
 - Payments to be made extra-contractually so loan not viewed as disposition of policy
 - Tax free receipts to terminally ill
 - At time of death, the policy proceeds first are used to pay off loan and any interest
 - Remainder goes to the beneficiary
- Insurer could define terminal illness as a disability

5.

Learning Objectives: 1, 3, 8

Learning Outcome: Describe the steps in the product development process. Describe considerations for prudent and practical decision making. Assess the risks underlying the design of certain products and features within those products as well as suggestions as to the management of such risks. Price products with different features including: Equity Linked

Cognitive Skills: Recall, Application, Synthesis

Solution:

(a)

Determine feasibility by looking at

- Product and company fit
 - Product should align with company's mission, vision, strategy and goals
- Regulatory barriers
 - Will the product be approved?
 - Are state variations needed?
 - How will New York differ from other states?
- Implementation barriers
 - Can administration and claims system handle the product?
 - Can I/T handle the product?
 - How much new training is required?
 - Is the new product consistent with existing distribution?
 - Does management have adequate knowledge of hedging?
 - Will volumes be enough to justify hedging program?
 - What are the target markets?
- Effect on existing products
 - Will product create new sales, or just take sales from existing products?
 - Will it cause replacements or exchanges?

(b)

Pricing pitfalls specific to Equity-Indexed SPDA

- Using inappropriate assumptions
 - Just using educated guess for key assumptions
 - Not adjusting for new target markets or distribution systems
 - Not accounting for rational buyer/seller behavior
 - Selling products an agent can exploit for commission
 - Assuming lapse objectives just to meet the annuity pricing goals
 - Subsidizing pricing
 - Not understanding embedded options and their costs

5. (b) continued

- Not understanding your environment
 - Not accurately reflecting the impact of accounting guidelines
 - Not accurately reflecting of cash flows
 - Using terminal reserves in pricing, rather than the more conservative mean reserves
 - Assuming annuity tax advantages are never taken away
- Technical mistakes
 - Calculating investment income using past profits
 - Discounting profits at too high a rate
 - Discounting future losses at too high a rate

(c)

$$\text{Premium} = \text{GMAV Costs} + \text{PV of Expenses} + \text{PV Profit} + \text{Index-based Interest Budget}$$

$$\text{Initial Bond Cost} = \text{SNFL base} \times \left(\left(\frac{1.03}{1 + \text{Net Earned rate}} \right)^{\text{Index Period}} \right)$$

$$\text{Initial Bond Cost} = 90\% \left(\left(\frac{1.03}{1.05} \right)^5 \right) \times \$100,000 = \$81,749$$

$$\text{PV of Expenses} = 3\% \times \$100,000 = \$3,000$$

$$\text{PV of Profit} = 5\% \times \$100,000 = \$5,000$$

$$\text{Index-based Interest Budget} = \$100,000 - \$81,749 - \$3,000 - \$5,000 = \$10,251$$

$$\text{Option cost as percent of premium} = \frac{\$10,251}{\$100,000} = 10.25\%$$

Use participate rate is 95%. This is based on the highest cost option given of 9.25% in the table. The excess (10.25% - 9.25%) would be profit over and above profit targets.

Year	Index (BoY)	Index (EoY)	Growth Rate	Participation	Margin	Cap	Floor	IAV
1	1100	1050	-4.55%	-4.32%	-4.92%	-4.92%	0.00%	100,000
2	1050	1250	19.05%	18.10%	17.50%	8.00%	8.00%	108,000
3	1250	1350	8.00%	7.60%	7.00%	7.00%	7.00%	115,560
4	1350	1400	3.70%	3.52%	2.92%	2.92%	2.92%	118,933
5	1400	1200	-14.29%	-13.57%	-14.17%	-14.17%	0.00%	118,933

5. (c) continued

Where:

$$\text{GMAV } (t) = (100,000) \times 90\% \times (1.03)^t$$

$$\text{Index Growth } (t) = \frac{\text{Index Value } (t)}{\text{Index Value } (t-1)} - 1$$

$$\text{Participation } (t) = \text{Index Growth } (t) \times \text{Participation rate}$$

$$\text{Margin } (t) = \text{Participation } (t) - 0.60\%$$

$$\text{Cap } (t) = \text{Min } (8\%, \text{Margin } (t))$$

$$\text{Floor } (t) = \text{Max } (0\%, \text{Cap } (t))$$

$$\text{Index Account Value } (t) = \text{Max } (\text{GMAV } (t), \text{Account Value } (t-1) \times (1 + \text{Floor } (t)))$$

$$\text{Account Value } (0) = \$100,000$$

(d)

Static Hedging

- Buy and hold investment strategy, often involving Over-The-Counter derivatives
- Most common type of static hedge is a call spread option
 - Buy a call and sell a call
 - The short call should have a strike value equal to the cap rate of the liability
- Funding ratio is usually less than 100% due to projected lapses and deaths
- Volume is an issue when dealing with options
 - Options dealers don't like to deal in low volumes
 - Fixed costs make it not affordable to hedge with low volume

Dynamic Hedging

- With shorter, simpler components, dynamic hedging has become more realistic
- Involves monitoring the delta (and other "Greeks") of the liability portfolio and holding a changing position in the index
- Delta represents the expected change in price, relative to the change in price of the index
- If $\text{Delta} \times \text{Notional Amount}$ is held, exposure to the option is fully funded
- Requires re-balancing
 - More re-balancing will give a better hedge, but higher costs

5. (d) continued

- Hedging cost is a function of volatility, which is unknown until the hedging period's end
 - Involves a position in an actual security, so there is no downside protection

6.

Learning Objectives: 3

Learning Outcome: Describe considerations for prudent and practical decision making. Assess the risks underlying the design of certain products and features within those products. Make suggestions/recommendations to management regarding risks within a product.

Cognitive Skills: Recall, Application

Solution:

(a)

Diversified Growth

- Concentric Diversification
- A related new product (term related to Whole life)
- In a new market (Independent Agents vs. Career Agents)

(b)

(i)

- Regulatory Requirements
- Barriers to entry and exit
- Accounting and reserving requirements
- Special licensing and / or reporting requirements
- Tax implications / requirements
- Education of sales representatives / staff
- Impact on existing distribution system
- Target markets / demographics
- Competition
- Effects on existing products
- Will it replace old product?
- Implementation Barriers
- Marketing
- Administrative capabilities / processes
- Software cost ⇒ Build in house or purchased
- Availability of other resources necessary
- Consideration of need to hire consultants
- Estimate costs versus potential profit
- Use of reinsurance
- Fit within ABC Life's goals, strategy, and core competencies

6. (b) continued

(ii)

- Term marketed to lower income & younger clients versus whole life – different target market
- Term market in independent agent channel is very competitive – need competitive price
- Term is simple to administer – Only minor changes needed to admin system
- Reinsurance on term insurance is readily available
- Independent agents will be familiar with product, little education

(c)

(i)

- Penetration pricing strategy is being used
 - Low price to generate high volume of sales
 - Could build economies of scale
 - Ideal for term insurance because it is “commodity-like”
 - Create Name Recognition

(ii)

- Buyer-Oriented Strategies
 - Neutral Pricing
 - Set prices near industry average
 - Segmented Pricing
 - Different prices for different types of buyers
 - Skim Pricing
 - High price to maximize profit margins
- Competitor-Oriented Strategies
 - Independent Pricing
 - Price independent of competitors
 - Cooperative Pricing
 - Few companies dominate and match price changes
 - Adaptive Pricing
 - Review competitors to set price
 - May set price a bit above industry leader
 - Opportunistic Pricing
 - Drive prices down so that only the most efficient can survive
 - Predatory pricing
 - Set prices below cost
 - Only for short period of time
 - Can result in significant loss

6. (c) continued

- Profit-Oriented Pricing Objective
 - Focus on absolute or relative target return objective

7.

Learning Objectives: 2

Learning Outcome: Analyze how consumer behavior impacts product design.

Analyze how the forces of the marketplace and competition impact product design.

Describe the questions to ask sales and marketing areas.

Cognitive Skills: Recall, Analysis

Solution:

(a)

Reasons why individuals lapse their life insurance coverage

- No longer need insurance (e.g. Mortgage paid off; no longer have dependents)
- Product no longer meets needs
- Can't pay premiums
- Replacement for new policy
- Poor customer service
- Another product is a better fit or more competitive
- Don't understand the product

(b)

Reasons why a 13-month lapse rate is commonly used to measure persistency

- Captures whether second premium was paid on annual pay policies
- First year lapse rate is usually the highest
- Early lapses indicate a problem with the product design or distribution channel
- Early lapses have a significant impact on profit (recovery of acquisition costs)
- Early lapses are susceptible to direct company action
- Early lapses are an indicator of how effectively the business is being sold
- Early lapses are a good indicator of long term persistency

(c)

Sales force incentives that can be implemented to improve persistency

- Persistency bonus
- Charge back commissions on early surrenders
- Trips, prizes, or awards based on persistency
- Increase renewal commissions
- Level or Levelized commissions
- Asset-based commissions (trail commissions)
- Have agents participate in a profit sharing plan
- Producer reinsurance agreement
- Point system based on premium and product features of the application (more points if higher premium, annual pay)

7. (c) continued

- Establish a persistency honor roll
- Show impact of favorable persistency to agents
- Show persistency results to field management

(d)

Strategies that a conservation unit can use to improve persistency

- Educate policyholder on the benefits of keeping the policy in force
- Recommend alternatives to lapsing the policy if the policyholder can't afford premiums (reduce face amount, use cash value to pay premium, reduce premiums)
- Allow late remittance (extend grace period without requiring evidence of insurability)
- Offer to reinstate lapsed policy without evidence of insurability

8.

Learning Objectives: 2

Learning Outcome: Analyze how the forces of the economy, demographics, and consumer behavior impact product design.

Cognitive Skills: Recall

Solution:

(a)

In general, a market segment must meet the following requirements:

- Customers have similar product needs
- Customers have similar purchasing behavior
- Needs and behavior must be distinguishable from other segments
- Profit potential should be large enough to help development and maintenance of marketing mix tailored to the needs of the segment
- Customers should be accessible through a distribution channel and sales promotions
- Size and composition of the segment should be stable over company's planning period

(b)

The primary bases used for consumer market segmentation are:

- *Geographic Segmentation*
 - Divides total market according to needs and preferences of populations in different locations
 - Regulation and law in various locations strongly influence product marketing
 - Many companies adjust products and promotion efforts according to region
- *Demographic Segmentation*
 - Based on personal characteristics of people in the market
 - Includes age, sex, marital status, household composition, income, education, occupation, nationality, race/ethnic group, social class
 - Demographic variables are easy to identify and measure
 - Demographic information is readily available

8. (b) continued

- *Geodemographic segmentation*
 - Divides customer into segments with similar demographic characteristics into geographically defined cluster
 - Based on theory that people with similar backgrounds, financial means, and attitudes tend to live in the same areas and adopt similar social values, tastes and behaviors and would be interested in similar products and services.

- *Psychographic Segmentation*
 - Divides customer markets based on characteristics that describe their lifestyle and activities
 - Theory is that consumer markets consist of certain “types” of consumers, each having different purchasing behavior
 - Divides consumers into groups based on the following aspects of their lives: activities, interests, opinions

- *Behavioristic Segmentation*
 - Divides markets according to consumer behavior toward a product
 - Most commonly used factors include: Benefit sought, usage rate, buyer readiness, preferred method of purchase, risk tolerance, customer loyalty

9.

Learning Objectives: 4

Learning Outcome: Recommend designs for products and features to reach particular goals

Cognitive Skills: Recall

Solution:

- **Bail Out Provisions**
 - Waives surrender charges if declared interest rate drops below specified rate
 - May be for limited period
 - Or until renewal rate in excess of bailout rate is declared
 - Dependent on interest rate environment (i.e., interest rate risk)

- **Medical Bail Outs**
 - Waiver of surrender charges if confined to nursing home or long term care facility
 - Or if terminally ill
 - Need to clearly define eligible conditions
 - Need to investigate qualifications for benefits
 - Independent of interest rate environment

- **Penalty Free Partial Withdrawals**
 - Can surrender part of account value without surrender charge
 - One withdrawal per contract year
 - Limit on amount withdrawn
 - May be carryover provision to future years

- **Return of Principle Guarantee**
 - Amount paid on full surrender not less than premiums paid less partial withdrawals
 - Applies if surrender charges not offset by interest credited
 - May generate higher statutory reserves
 - May want to apply commission chargeback on surrender to prevent churning by agents

10.

Learning Objectives: 2

Learning Outcome: Analyze how the forces of the marketplace and competition impact product design

Cognitive Skills: Recall, Analysis, Synthesis

Solution:

(a)

Types of commission schedules

- *Heaped*
 - Features relatively high first-year commissions and lower renewal commissions
- *Level*
 - Provides the same commission rate for the first and renewal years
- *Levelized*
 - Provides different percentages for first-year and renewal commissions, but the differences between these percentages are smaller than the differences between first-year and renewal commissions under heaped commission schedules

Compare Scales and Their Purposes

- Heaped commission schedules are designed to reward agents for generating sales by emphasizing high first-year commission rates
- Level and levelized commission schedules are designed to reward agents for conserving business by emphasizing renewal commission rates that are higher than those under a heaped schedule
- Heaped commission schedules place the persistency risk with the insurance companies
- Level and levelized commission schedules shift much of the persistency risk to the agent
- Not being able to recover acquisition costs using heaped commission schedules may be strongest argument for level or levelized commission schedules
- Aligning agents' interests with those of companies may be what is needed to arrest the churning of business – with use of level or levelized commission schedules
- Level and levelized commission schedules tie commission payments to long-term company interests, which will improve producer retention by providing agents with more stable, increasing incomes.

10. (a) continued

- Heaped commission schedules reduce the need for new agent financing costs compared with level or levelized commissions
- Due to high replacement activity of 1980's and early 1990's, some companies looked at introducing more level commission schedules for their products.
- Insurance companies are eager to reduce their acquisition costs in order to maintain a competitive edge in their products – with use of level or levelized commissions.
- The benefits to the company of more levelized commission scales include lower lapse rates and improved profitability

(b)

Recommended Commission Scale: (various possible answers, as long as they are supported)

- *If Recommend Heaped*
 - Size of company: higher front-end will encourage sales
 - Persistency may not be a major concern since initial premiums are low
 - High replacement activity is not a concern
- *If Recommend Level or Levelized*
 - Competitive nature of level premium term market may cause high replacement activity
 - Easier to recover acquisition costs, which may help the smaller company
 - Persistency risk transferred to agents

11. United States

Learning Objectives: 1, 3, 6, 8

Learning Outcome: For a given product / situation, describe the steps in the product development process. Describe and analyze the tax and regulatory constraints – policy holder perspective. Identify the assumptions needed for a particular product design. Price products with different features. Identify the most influential assumptions for the particular feature.

Cognitive Skills: Recall, Synthesis

Solution:

(a)

- Lapse
 - ROP will lower the Ultimate lapse rates to 1% from 6%
 - Reducing lapse rates by 50% can significantly affect profits
- Interest – Interest rate assumption much more critical since rider develops reserves
- Mortality – Lower lapses will result in lower mortality than normal
- Expenses – Additional cost of administering rider
- Average Size and Age Mix – Average size may decrease because rider adds cost
- Sales Distribution and Volume – Age mix may decrease because ROP cheaper at younger issue ages.

(b)

- The Product must comply with SNFL for life insurance
- Minimum Nonforfeiture benefits must be met
- To qualify as life insurance, the product must comply with section 7702
- To qualify for favorable distribution tax treatment, the product must comply with section 7702A
- Product must conform to the NAIC Life Insurance Illustration Model Regulation
 - Must comply with the Self-Support Test
 - Must comply with the Lapse-Support Test

(c)

(i)

The maximum cash value permissible in qualifying as a life insurance contract is the NSP

The total premium paid is the basis in the contract and therefore there is no taxable gain in returning the premiums

11. (c) continued – U.S.

$$\text{Surrender benefit}_t = t \times \text{premium} \times \text{ROP}\%$$

$$\text{Maximum CV}_t = \text{Face Amount} \times \text{NSP}_t$$

Year	Benefit	Max CSV
17	9,520	7,135
18	11,520	5,475
19	13,680	4,114
20	16,000	2,214

(ii)

To avoid becoming a MEC, need to demonstrate that 7-pay premium is greater than the contract premium, on both an annual and cumulative basis in the first 7 years.

$$7 \text{ pay premium is } \frac{\text{NSP}}{a_{x:7}} \text{ or } \frac{(M_x - M_{x+20})}{(N_x - N_{x+7})} = 1,904.22$$

Contract would pass 7702A and will not become a MEC

(iii)

The face amount could be increased in later years to meet the NSP requirement

$$\text{Adjusted face amount} = \frac{\text{Benefit}}{\text{NSP}}$$

Year	Benefit	NSP	Adjusted Face Amount
17	9,520	0.07135	133,427
18	11,520	0.057445	200,539
19	13,680	0.041141	332,515
20	16,000	0.022144	722,538

Could lower ROP percentage to company with CVAT

$$\text{Adjusted ROP}\% = \frac{\text{Max CV}}{(t \times \text{premium})}$$

11. (c) continued – U.S.

Year	Adjusted ROP%
17	$\frac{7135}{(17 \times 800)} = 52\%$
18	$\frac{5745}{(18 \times 800)} = 40\%$
19	$\frac{4114}{(19 \times 800)} = 27\%$
20	$\frac{2214}{(20 \times 800)} = 14\%$

11. Canada

Learning Objectives: 1, 3, 6, 8

Learning Outcome: For a given product/situation, describe the steps in the product development process. Describe and analyze the tax and regulatory constraints – policy holder perspective. Identify the assumptions needed for a particular product design. Price products with different features. Identify the most influential assumptions for the particular feature.

Cognitive Skills: Recall, Synthesis

(a)

Exempt Test

- Determine the accumulating fund for a 20-pay endowment at age 85 policy (exempt test policy)
- Determine the policy's accumulating fund
- Compare the policy's accumulating fund to the exempt test policy's accumulating fund
- If policy accumulating fund > exempt test fund, then policy is "non-exempt"
- Otherwise policy is exempt
- Policy must be tested every year

Restoring Exempt Status

- If policy fails exempt test on an anniversary, it can be retested 60 days later, giving the owner 60 days grace to restore the exempt status
- Possible actions to restore status:
- Death benefit can be increased up to 8% in a policy year in accordance with the terms and conditions of the policy
- If required DB increase > 8%
 - For the amount in excess of 8%, there is the deemed issue of a separate exempt test policy
- Excess premiums can be forced into a separate side account (subject to annual accrual taxation) until they can be deposited into the policy
- Causing a withdrawal from the cash value of the policy
 - Which may result in taxable policy gains being included in the income of the policyholder

(b)

Factors that Increase the Adjusted Cost Basis (ACB)

- Cost of an interest in the policy acquired by the policyholder
- Premiums paid by or on behalf of the policyholder
- Interest paid on a policy loan
- Policy gains required to be included in the policyholder's income from the disposition of an interest in the policy
- Policy loan repayments in excess of the deduction permitted

11. (b) continued - Canada

Factors that Decrease the Adjusted Cost Basis (ACB)

- Proceeds of disposition of an interest in the policy
- The cumulative total of all amounts which is the net cost of pure insurance (NCPI)

(c)

Calculate ACB at Third Anniversary (prior to withdrawal)

Add:

$$\text{Total Premiums Paid: } 17,000 + 17,000 + 17,000 = 51,000$$

Subtract:

$$\text{Total NCPI: } 527 + 632 + 745 = 1,904$$

$$\text{ACB} = 51,000 - 1,904 = 49,096$$

Prorate ACB for amount partially withdrawn

Percentage of Accumulating Fund Withdrawn

$$= \frac{\text{Amount Withdrawn}}{\text{CSV}}$$

$$= \frac{30,000}{58,879}$$

$$= 51\%$$

$$\begin{aligned} \text{Prorated ACB} &= 51\% \times \text{ACB} = 51\% \times 49,096 \\ &= 25,015 \end{aligned}$$

Taxable Gain

If Amount Withdrawn > Prorated ACB

$$= \text{Amount Withdrawn} - \text{Prorated ACB}$$

$$= 30,000 - 25,015$$

$$= 4,985$$

11. (c) continued - Canada

ACB after partial surrender

= ACB Prior to Withdrawal + Taxable Gain –
Proceeds of Disposition (amount withdrawn)

= 49,096 + 4,985 – 30,000

= 24,081

(d)

Actions to ensure profit margins remain at target

- Review Experience
 - Premium payment patterns
 - Partial withdrawal patterns
 - Automatic death benefit increases to restore exempt status
- Test additional premium payment patterns to determine impact on persistency
- Test premium payment patterns to assure not too profitable (hence uncompetitive)
- Test premium payment patterns to assure not too unprofitable
- Review and test impact of premium paying patterns on commission costs
- If necessary, re-price entire product to help assure overall margins are met

12.

Learning Objectives: 1, 4, 6

Learning Outcome: Marketing, design and pricing considerations for Inflation-Indexed Income Annuities

Cognitive Skills: Recall, Synthesis

Solution:

(a)

- Need to select an Inflation Index for the annuity so it can match inflation well
- Variable Income Annuities
 - Annuity payments increase $\frac{(1 + \text{NIF})}{(1 + \text{AIR})}$ each year
 - The growth depends on the underlying fund performance each year (NIF)
 - The growth depends on the Assumed Interest Rate (AIR)
 - The change in payment could be more or less than the corresponding inflation rate
- Fixed Annuity with payments increased X% each year
 - The change in payment could be more or less than the corresponding inflation rate

(b)

- Combination of TIPs and credit default swaps
 - Long position in TIPs
 - Short position in credit default swaps
 - Credit spreads generated from short position in credit default swaps
 - Liability contingent on defaults in the pool underlying the swap
 - Disadvantage is tax on phantom income from TIPs
- Combination of CPI Swaps and nominal corporate bonds
 - Exchange nominal coupon on bond for inflation-adjusted coupon under a payer CPI swap
 - Structure payments and notional to fit well with the liability CPI swaps
 - Advantage is greater investment strategy flexibility for matching liabilities
 - Advantage is more liquidity than TIPs market

(c)

(i)

Theory 1: Mortality rate continues to increase but at a lower rate

- *Pattern Method:* Let the pattern of mortality continue until the rate hits or is close to 1

12. (c) continued

(ii)

Theory 2: Natural limiting to lifespan, mortality rate jumps to 1 eventually, shape doesn't matter

- *Forced Method:* Select an ultimate age and set it = 1 without changing the rest

(iii)

Theory 3: Rates converge to an ultimate rate less than 1.00

- *Less-Than-One Method:* Select an ultimate age and end the table even if that age's rate is < 1
- The financial impact of any method (over another) is insignificant because few annuitants are that deep into the table

13.

Learning Objectives: 6, 9

Learning Outcome: How does assumption setting affect investment strategy?

Explain how a stochastic model would be used for pricing.

Cognitive Skills: Recall, Application, Synthesis

Solution:

(a)

- Quantile for α is V_α , such that the probability $(L_0 \leq V) \geq \alpha$
- L_0 is the present value of losses, discounted at the risk-free rate
- V_α is the smallest sum that can be held in risk-free assets so that there is probability α of having enough to pay the guarantee
- CTE is the expected loss in the upper $1-\alpha$ of the tail
- $CTE_\alpha(L) = E[L_0 | L_0 > V_\alpha]$

When there are large losses in the tail, CTE is a better measure of risk than the quantile because the quantile does not account for the size of the losses in the tail

(b)

- Since stock returns are lognormal, they have parameters:

$$\mu_{LN} = n[\ln(1-m)]$$

$$\sigma_{LN}^2 = n\sigma^2$$

- Here,

$$n = 60 \text{ months}$$

$$\mu = .01$$

$$\sigma = .05$$

$$m = \text{monthly management charge} = .0015$$

13. (b) continued

- Then, Prob (Cost of GMMB = 0) is:

$$\begin{aligned}
 1 - \Phi \left(\frac{\ln \left(\frac{\text{Guarantee}}{\text{Initial Value}} \right) - \mu_{LN}}{\sigma_{LN}} \right) &= 1 - \Phi \left(\frac{\ln \left(\frac{1.05}{1.00} \right) - n[\mu + \ln(1-m)]}{\sqrt{n}\sigma} \right) \\
 &= 1 - \Phi \left(\frac{\ln(1.05) - 60[.01 + \ln(1-.0015)]}{\sqrt{60}(.05)} \right) \\
 &= 1 - \Phi \left(\frac{-0.46114}{0.38730} \right) \\
 &= 1 - \Phi(-1.19) \\
 &= 1 - (1 - 0.883) \\
 &= 0.883 \\
 &= 88.3\%
 \end{aligned}$$

(c)

$$\begin{aligned}
 V_\alpha &= \left\{ G - F_0 \exp \left[-z_\alpha \sqrt{n}\sigma + n(\mu + \ln(1-m)) \right] \right\} e^{-r\left(\frac{n}{12}\right)} \\
 z_\alpha &= \Phi^{-1}(90\%) = 1.28 \\
 V_\alpha &= \{1.05 - 1.00 \exp[-0.4957 + 0.5099]\} (0.8187) = 0.0292
 \end{aligned}$$

$$\begin{aligned}
 CTE_\alpha(L) &= e^{-r\left(\frac{n}{12}\right)} \left\{ G - F_0 \frac{\exp \left[n \left(\mu + \ln(1-m) + \frac{\sigma^2}{2} \right) \right]}{1 - \alpha} \Phi(-z_\alpha - \sqrt{n}\sigma) \right\} \\
 CTE_\alpha(L) &= (0.8187) \{1.05 - (1.00)(17.949) \Phi(-1.67)\} = 0.1690
 \end{aligned}$$

(d)

- Fails to account for extreme market movements / volatility bunching
- Autocorrelations in the data are ignored
- Only works for short time intervals

13. continued

(e)

- Single paths used to model extreme behavior lack credibility
- Single path may not accurately account for the risk in all contracts
- Difficult to interpret the results
- Risks for GMMB are dependent in nontrivial way
- GMMB claims have low frequency and high severity
- Deterministic scenarios are influenced too much by recent experience

(f)

Recommend the two-regime switching lognormal model (RSLN-2)

- This better captures extreme market movements
- It also is better fit with long-term stock return data
- Better accounts for tail risk

14.

Learning Objectives: 1, 5

Learning Outcome: Actuarial development of assumptions. Identify gaps between product design and operations, procedures, and systems.

Cognitive Skills: Recall, Synthesis

Solution:

(a)

- People Cost
 - Company does not have enough expertise
 - Hire consultant or allow employees to learn on the job
 - Opportunity cost
 - Deferred maintenance projects
- Communication/Training Costs
 - Complex product for home office, field and regulators
 - May cause market conduct issues
 - More state variations or longer approval process
- Scale
 - Higher cost for admin system
 - Cost effective hedge program
- Difficult to Price
 - Anti-selection in market if any errors in pricing
 - Costly to fix

(b)

(i) and (ii) combined

- Lapses
 - Based on relationship of guarantee and account value
 - Use a dynamic formula
 - As in-the-moneyness increases, the lapse rate decreases
- Withdrawal Rates/Utilization
 - Depends on dollar for dollar provisions and account value
 - Vary by in-the-moneyness
 - Create cohorts
 - Higher use for lifetime benefits
 - Savvy policyholders exercise options when best for them, worst for company

14. (b) continued

- Reset Activity
 - Driving by increase in account value relative to guarantee
 - Consider sophistication of policyholder or relationship with agent
- Stochastic Pricing
 - Capture variability of policyholder behavior
 - Used to estimate utilization based on in-the-moneyness
 - Use real-world scenarios; hedging uses risk neutral
- Transfer Activity
 - Fixed charges increases the in-the-moneyness for small contracts
 - Separate behavior for size of contract
- Materiality of Assumptions
 - Elaborate functions are not necessary in models when the assumption doesn't affect

(c)

- Product Design
 - Add incentive to not take withdrawals for a period of time
 - Have difference charges for different investment strategies (more aggressive, pay more)
 - Charge for policyholder behavior
- Use risk pooling, securitization, or investment strategy
- Use hedging
 - Perfect hedge is difficult
- Use reinsurance
 - Create risk of reinsurer insolvency

15. United States

Learning Objectives: 1, 2, 8

Learning Outcome: For a given situation, describe the steps in the product development process; analyze how the forces of the marketplace and competition impact product design; for a given product, price products with different features including riders

Cognitive Skills: Recall, Analysis, Synthesis

Solution:

(a)

- Channel conflict is friction between channels due to at odds behavior.
 - Due to clash of goals, expectations not understood, sales cannibalism
 - Vertical conflict is between manufacturer and distributor
 - Most frequent and severe type
 - Strained relations to open warfare
- Ways to Manage Channel Conflict
 - Avoidance
 - Separate brand
 - Different geographic area
 - Different target market
 - Separate products
 - Integration
 - Hancock did this
 - Meeting to share goals
 - Cross-selling opportunities
 - Disproved myth that new channel hurts agency sales
 - New channel won't hurt agency sales
 - Consumers select their channels
 - Agency and internet can complement each other
 - Internet customers still want advice
 - Internet does not fulfill this need
 - Lead generation = Increased agent productivity

(b)

(i)

Concurrent engineering:

- Systematic approach to integrated design of products and processes
- Developers consider at the outset all elements of product life cycle
- Sequential method – info flows are bidirectional

15. (b) continued – U.S.

- Decisions based on downstream / upstream inputs
- A different management practice
- Product cycle from market opportunity to product obsolescence

(ii)

Fuzzy front end

- Overall project criteria
- Direct links to those forming strategy
- Greater interaction between suppliers, developers, customers

(iii)

Fuzzy after launch

- Importance of distribution, service, disposal impact much earlier in product development process

15. Canada

Learning Objectives: 6 A, B, D – Canadian-only material

Learning Outcome: Select appropriate assumptions for a given product.

Incorporate expenses into product pricing.

Cognitive Skills: Recall, Analysis, Synthesis

Solution:

(a)

- Additional lapses at end of term period
 - Some are antiselective
 - Wild guess
- Expense assumption
 - May not be competitive if fully allocated
 - Higher expenses for preferred
 - Small company may need to use marginal expenses
- Mortality Assumption
 - Most mortality risk goes to reinsurer, so assumption may not be too important
 - Mortality affected by antiselective lapses
- Preferred mix
 - Qualifying percentage depends on underwriting criteria
 - Affected by competitors
- Interest assumption not too important

(b)

- 80% of business written by top 10 companies
- 75% of term is preferred
- Upward trend in premiums
- Companies think they price adequately
- Some companies plan to lower rates
- Top companies use fully allocated expenses. Small companies use marginal expenses – not competitive if use fully allocated
- Large variance in additional lapse assumption, more so in antiselective assumption
- Most mortality risk passed on to reinsurers. Low retention.
- Companies are assuming profit in renewal years. Looking at initial term only, profit margin is negative. Negative reserves longer than initial term.

15. continued – Canada

(c)

- Recommend entering the market
 - Increasing premium trend
 - But difficult to price with fully allocated expenses
 - Be competitive with less profit margin
 - Or be less competitive with acceptable margin
 - Need expense management

16.

Learning Objectives: 1

Learning Outcome: Analyze steps in the product development process of product – actuarial development, modeling

Cognitive Skills: Recall, Analysis

Solution:

(a)

Purpose of asset / liability modeling for fixed deferred annuities include:

- Test different interest rate scenarios
 - Make company aware of risks (disintermediation, liquidity)
 - Change investment strategy or product design to mitigate risk
 - Educate stakeholders about risk and minimize collateral damage
- Design an appropriate investment strategy
- More accurately calculate investment income
- Develop appropriate crediting strategy

(b)

- Exact Matching:
 - Match asset and liability cash flows
 - Start from last liability cash flow and work backward
 - Each period, enough assets have to be purchased to cover liability cash flows
 - Problems:
 - Asset and liability cash flows are uncertain (rebalancing needs)
 - Long-term liability requires long-term assets, which may be unavailable
 - Premium paying products have positive cash flows for several years, which is hard to reflect
- Duration Matching
 - Match duration of asset to duration of liability
 - Use duration or convexity
 - Easier than exact matching
 - Immunize portfolio from small interest rate changes
 - Problems:
 - Need to periodically rebalance (causes transactions costs and may be expensive)
 - Matching duration could actually result in a cash flow mismatch
 - Does not protect against large interest rate changes
 - Assumes parallel interest rate shift only

16. (b) continued

- Horizon Matching
 - Use exact matching for 5-10 years, then use duration matching when cash flows are less predictable
- Product Cash Flow Matching
 - Cash flows on offsetting products could be matched
 - For example, use Term-to-100 premium to fund Annuity Income Benefit

(c)

Macaulay Duration =

$$\frac{\sum_{t=1 to n} t \times \text{Cash Flow}_t \times v^t}{\sum_{t=1 to n} \text{Cash Flow}_t \times v^t}$$

Year (t)	Cash Flow _t	Cash Flow _t × v ^t	t × Cash Flow _t × v ^t
1	80	$\frac{80}{1.07}$	$1 \times \frac{80}{1.07}$
2	80	$\frac{80}{1.07^2}$	$2 \times \frac{80}{1.07^2}$
3	1080	$\frac{80}{1.07^3}$	$3 \times \frac{80}{1.07^3}$
Sum		1026	2859

$$\text{Macaulay Duration} = \frac{2859}{1026} = 2.79$$

$$\begin{aligned} \text{Modified Duration} &= \frac{\text{Macaulay Duration}}{(1+i)} \\ &= \frac{2.79}{1.08} \\ &= 2.60 \end{aligned}$$

17. United States

Learning Objectives: 6 A/B, 1 B/C

Learning Outcome: Identify the assumptions needed for a particular product design. Select appropriate assumptions needed for a particular product design, reflecting product characteristics.

Cognitive Skills: Recall, Analysis

Solution:

(a)

- Assumptions
 - Liability: lapses, mortality, expenses
 - Assets: investment return, defaults, investment expenses
 - Scenarios: interest rate scenarios – use stochastic or deterministic
- Structure of each assumption
 - Split into classes of similar experience
 - Number of classes must be practical
- Available Experience
 - From own company or similar
 - May need to reflect trends (e.g. mortality improvement)
 - Look at quality and credibility of data
 - May need to adjust for company or external factors (rules and regulations)
- Check data for consistency and reasonableness
- Document assumptions
 - What they are
 - How we derived them
 - From which data?
- Monitor and update assumptions on a regular basis
 - Update frequency may depend on assumption
 - Lapses more often than mortality

(b)

- People will buy product for the no lapse guarantee
 - This will be a lapse supported product
 - Should expect extremely low ultimate lapses
 - Bonus should lower lapses before year ten
 - May be a spike in lapses after bonus paid

17. Canada

Learning Objectives: 6 A/B, 1 B/C

Learning Outcome: Identify the assumptions needed for a particular product design. Select appropriate assumptions needed for a particular product design, reflecting product characteristics.

Cognitive Skills: Recall, Analysis

Solution:

(a)

- Assumptions
 - Liability: lapses, mortality, expenses
 - Assets: Investment return, defaults, investment expenses
 - Scenarios: Interest rate scenarios – use stochastic or deterministic
- Structure of each assumption
 - Split into classes of similar experience
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- Check data for consistency and reasonableness
- Document assumptions
 - What they are
 - How we derived them
 - From which data?
- Monitor and update assumptions on a regular basis
 - Update frequency may depend on assumption
 - Lapses more often than mortality

(b)

- Lapse rates tend to be lower for
 - Older policy owners
 - Non-smokers
 - Richer policy owners (larger policies)
- Lapse rates tend to be less different between male and female
- Ultimate rates about 1-2%