# CSP-IC Illustrative Solutions
# Spring 2008

## 1.

**Solution:**

**(a)**

First Premise:
Real economic value of the firm is PV(asset cash flows) – PV(liability cash flows)

Second Premise:
Central objective of asset liability management (ALM) is to manage the sensitivity of the real economic value of the firm to changes in interest rates

- ALM measures should be based on economics
- Firm should use ALM to control the degree to which its value is affected by interest rate changes

**(b)**

**(i)**

STAT and GAAP accounting measures have economic value

- Attention is on assets and liabilities as defined by current accounting principles
- Balance sheet as defined by accounting conventions can be seriously flawed as a basis for estimating economic value
- Accounting measures have economic significance
  - Low value can be costly
  - High value can be beneficial
- These values must be incorporated into a complete ALM analysis

**(ii)**

Risk is costly

- ALM implicitly assumes risks can be fully hedged or that market participants are risk neutral and only concerned with expected values
- Adjust cash flows downward to recognize risk, some cash flows exhibit greater uncertainty
- Cash flow uncertainty is different overall when measured as a portfolio than as a sum of individual risks or for individual assets or liabilities
- Risk may be decreased by diversification

**1.** **(b) continued**

**(iii)**

Managing interest rate exposure is not enough

- Managing the value of the firm goes far beyond effects of interest rate changes
- Must take into account all sources of risk

**(iv)**

Asset liability management is not just asset management

- Managing the value of the firm includes managing liabilities
- Manage liabilities:
  - Over time by changing mix of business
  - Over time by offering or discontinuing product features in new sales
  - Through reinsurance transactions

**(c)**

**(i)**

Describe the key considerations when examining the economic value of any insurance company as it pertains to 'Asset-Liability Management for a Going Concern'.

- Measures must take into account future cash flows from:
  - Existing balance sheet items
  - Business the firm reasonably expects to retain
  - New business (non-renewal) it reasonably expects to issue or acquire

- Retained and new business reflect the value of a going concern
  - Current accounting rule only count these if the firm is purchased for an amount over the book value
  - Excess over book value is goodwill on acquirer's books
  - Market price in an acquisition reflects these values

- Shareholder value is economic value plus franchise value
  - Economic value reflects cash flows from business already on the books
  - Franchise value reflects cash flows from future business (future retentions plus future new sales)

**1.** **(c)(i) continued**

- Franchise value is a hidden asset with a real duration
  - Critical to determine its duration
  - Recognize that future premiums may depend on interest rates
  - Understand extent that the firms own pricing strategy will be affected by interest rates and also competitive and regulatory constraints
  - Premiums charged by different firms may respond differently to changes in interest rates

- Include competitor effects and implications for investment and pricing strategy

**(ii)**

Propose ways to protect the insurer's shareholder value from interest rate risk.

- Managing shareholder value involves minimizing risk of duration mismatch
  - Asset duration depends in part on its pricing strategy
  - When future premiums vary inversely with interest changes, then future retentions are an asset with positive duration
  - Duration of assets must be lower than if future retentions are ignored
  - The greater the value of future retentions, the lower must be the duration of assets

- The firm's investment and pricing strategies cannot be determined independently
  - Marked contrast to usual practice of focusing on the current balance sheet and computing an asset duration and a liability duration

- Impact of competition
  - Consider competitor pricing strategy also
  - Interest effects can affect shareholder value indirectly by altering relative prices charged by firm and competitors
  - Interest effects may raise or lower the firms growth rate

- To minimize the interest rate risk to shareholder value, two additional factors must be taken into account:
  - Investment strategy must reflect pricing strategy of the firm and competitors
  - Investment strategy must reflect the sensitivity of existing and potential customers to price differentials between the firm and competitors

# 2.

**Solution:**

**(a)**

Capital Budgeting Techniques

- capital budgeting techniques can tell a company whether a given capital investment is likely to cover the cost of capital
- capital budgeting is a simple ranking capital investment based on their expected rate of return
- it determines which investments will return at least the company's cost of capital
- then the company can allocate funds to as many of these investments as possible

Limitations:

- the capital budgeting technique generate a universe of feasible investments but does not set out selection criteria
- it results in a random group of projects with no clear strategic focus
- the company's long term objectives are not incorporated in the technique
- sometimes it may be necessary to fund projects which return less than the company's cost of capital in order to support long term strategic planning

**(b)**

**(i)**

Actuarial appraisal value = PV of distributable cash flow
Distributable cash flow = After tax earnings - increase in required capital + investment income on required capital
After tax earnings = premiums - commissions - benefits - increase in statutory reserves + investment income on reserves and cashflows

**12/31/2008**

Earnings before inv inc = 2000 - 600 - 300 - (1500 - 0) = -400
Inv income on stat reserves = 1500 x 0.08 = 120
After tax Earnings = -400 +120 = -280
Required capital = 1500 x 0.10 = 150
Inv income on req capital = 150 x 0.08 = 12
Distributable cash flow = -280 -(150-0) + 12 = -418
PV = -418

## 2. (b) continued

**12/31/2009**

Earnings before inv inc = 1200 - 350 - 700 - (900 - 1500) = 750
Inv income on stat reserves = 900 x 0.08 = 72
After tax earnings = 750 + 72 = 822
Required capital = 900 x 0.10 = 90
Inv income on req capital = 90 x 0.08 = 7
Distributable cash flow = 822 - (90-150) + 7 = 889
PV = 889 x 1.12 ^ -1 = 794

**12/31/2010**

Earnings before inv inc = 900 - 200 - 1100 - (0 - 900) = 500
Inv income on stat reserves = 0
After tax earnings = 500
Required capital = 0
Inv income on req capital = 0
Distributable cash flow = 500 - (0 -90) = 590
PV = 590 x 1.12 ^ -2 = 470

AAV = sum of PV = -418 + 794 + 470 = 846

**(ii)**

GAAP ROE = GAAP earnings / GAAP required surplus
GAAP required surplus = Statutory required surplus + unamortized GAAP deferred acquisition costs + (statutory reserve - GAAP benefit reserves)

**12/31/2008**

GAAP Equity = 150 + 1200 + (1500 - 600) = 2250
GAAP net income = 170
GAAP ROE = 170/2250 = 7.6%

**12/31/2009**

GAAP Equity = 90 + 550 + (900 - 200) = 1340
GAAP net income = 220
GAAP ROE = 220/1340 = 16.4%

**12/31/2010**

GAAP Equity = 0 + 400 + (0 - 0) = 400
GAAP net income = 70
GAAP ROE = 70/400 = 17.5%

## 2. (b) continued

Three year ROE geometric average = [(1.076)(1.164)(1.175)]^ (1/3) -1
= 13.7%

Recommendation : As the ROE > cost of capital (13.7% > 12%), ABC should invest in this product

**(c)**

At 1/1/2008, t=0 :
Without YRT, cash flow strain equals to after tax earnings at year end 2008 discount for one period

After tax earnings = premiums - commissions - benefits - increase in statutory reserves + investment income on reserves and cashflows
After tax earnings before inv inc = 2000 - 600 - 300 - (1500 - 0) = -400
Inv income on stat reserves = 1500 x 0.08 = 120
After tax Earnings = -400 +120 = -280
Discounted after tax earning to beginning of year:
BOY after tax earnings = -280 * 1.12 ^ -1 = -250

With YRT:
Strain with YRT = premium - ceded premium - commission + reinsurance allowance - benefits + ceded benefits - chg in reserves + reserve credit - investment return on reserve credit
= before reinsurance statutory earnings - ceded premium + reinsurance allowance + ceded benefits + reserve credit - investment return on reserve credit

Ceded amount = NAAR x (1 - retention rate)
= (face amount - terminal reserve) x (1 - retention rate)
= (8000 - 0) x (1 -0.2)
= 6400

ceded premium = ceded amount x YRT rate
= 6400 x 0.1 = 640

reinsurance allowance = ceded premium x 15%
= 640 x 0.15 = 96

reserve credit = YRT premium x 60%
= 640 x 0.6 = 384

## 2. (c) continued

Strain with YRT = -250 - 640 + 96 + 384 x (1.12 ^ -1) + (300 x 0.8) x (1.12 ^ -1)
- 384 * .08
= -267.72

If YRT arrangement were to be used, first year statutory earning was decreased marginally by 17.72

# 3.

**Solution:**

**(a)**

Determination of the risk profile of a product or company
Capital budgeting and planning
Evaluation of Merger and Acquisition
Insurance product pricing
Risk tolerance and constraints
Asset and liability management
Risk adjusted return of capital calculation
Performance Measurement
Incentive compensation
Regulator and rating agency discussions

**(b)**

VAR

- assess the probability of ruin at a given quantile of the probability vs Tail-VAR
- arithmetic average of losses exceeding a given quantile

Stochastic Analysis

- uses multiple scenarios. Results can be analyzed statistically vs Stress Testing
- gives results of highly adverse scenario. Results can not be analyzed statistically

Risk Neutral

- discounting risk-adjusted future cash flow with risk free rates vs Real World
- discounting projected cash flows with risk discount rates

Diversification Effect
Time horizon to consider

- One-year horizon: covariance model
- Multi-year time horizon: economic balance sheet projected for a long period until liabilities run-off

Whether to allow negative cumulative surplus
Whether to account for new business

## 3. continued

**(c)**

Ten-year term life

- Underwriting risk
  - Should consider mortality
- Operational risk
  - Failed internal process
- Liquidity risk
  - Insufficient liquid asset

Equity Indexed Annuity

- Underwriting risk
  - Policyholder behavior risk
- Credit risk
  - Risk of default of fixed income instruments
- Market risk
  - Interest rate risk
  - Equity risk
- Operational risk
  - Hedging operational failure risk

**(d)**

**(i)**

Ranking of the scenario results:

1600, 1400, 1350, 1300, 1250, 1200, 120, -45, -500, -600
Values below the 20th percentile 20%: -500 and -600
Average of values below the 20th percentile = (-500-600)/2 = -550
Economic capital 550

**(ii)**

using the ranking in (i)

The observation we need is the .01*10th observation
VAR(10) = -600
Economic capital = 600

## 4.

**Solution:**

**(a)**

Net cash payments = Premiums less claims less expenses

Year 1: 2000 - 500 - 550 = 950
Year 2: 2250 - 650 - 600 = 1000
Year 3: 0 - 800 - 550 = -1350

* Risk Capital Cost = Risk capital x Risk capital cost rate

Year 1: 1200 x 2.5% = 30 or 0 x 2.5% = 0
Year 2: 1125 x 2.5% = 28.13 or 1200 x 2.5% = 30
Year 3: 0 x 2.5% = 0 or 1125 x 2.5% = 28.13

Net cash flow after frictional costs

Year 1: 950 - 30 = 920 or 950 - 0 = 950
Year 2: 1000 - 28.13 = 971.87 or 1000 - 30 = 970
Year 3: -1350 - 0 = -1350 or -1350 - 28.13 = -1378.13

Economic liabilities = Present value of net cash flows less risk capital cost at risk-free rate plus spread

Year 1: -(-1350/(1 + 5% + 0.5%)^2 + 971.87/(1 + 5% + 0.5%)) = 291.70 or = 318.75
Year 2: -(-1350/(1 + 5% + 0.5%) = 1279.62 or = 1306.28
Year 3: 0

Change in economic liabilities

Year 1: 291.70 or 318.75
Year 2: 1279.62 - 291.70 = 987.92 or = 987.53
Year 3: 0 - 1279.62 = -1279.62 or = -1306.28

Economic profit before tax = Net cash payments - Risk Charge - Change in economic liabs

Year 1: 950 - 30 - 291.70 = 628.30 or 950 - 0 - 318.75 = 631.25
Year 2: 1000 - 28.13 - 987.92 = -16.04 or 1000 - 30 - 987.53 = -17.53
Year 3: -1350 - 0 + 1279.62 = -70.38 or -1350 - 28.13 + 1306.28 = -71.85

Taxable Income = Premiums - Claims - Expenses - Change in Tax Reserves
= net cash payment - change in Tax Reserves

Year 1: 950 - (1400 - 0) = -450
Year 2: 1000 - (1525 - 1400) = 875
Year 3: -1350 - (0 - 1525) = 175

**4.** **(a) continued**

Tax payable = Taxable income * tax rate
Year 1: -450 x 40% = -180
Year 2: 875 x 40% = 350
Year 3: 175 x 40% = 70

Economic profit after tax = Pre-tax profit less tax
Year 1: 628.30 - (-180) = 808.30 or = 811.25
Year 2: -16.04 - 350 = -366.04 or = -367.53
Year 3: -70.38 - 70 = -140.38 or = -141.85

**(b)**

EV defined as PV of free cash flow FCF discounted at company's weighted cost of capital (CoC)
FCF = change in stat surplus - change in required surplus (RS) (distributable earnings)
Therefore, GAAP FCF ~ GAAP earnings - change in required GAAP surplus

Approximation: GAAP earnings = Net Cash Payments - tax payable - incr in reserves + incr in DAC; where Net Cash Payments = Prem -claims/db - expenses

Net Cash Payments = 2250 - 650 - 600 = 1000

Taxable Income = Premiums - Claims - Expenses - Change in Tax Reserves = net cash payment - change in Tax Reserves

Taxable income = 1000 - (1525 - 1400) = 875

Tax payable = Taxable income * tax rate
Tax payable = 875 x 40% = 350

Increase in res = 1600 - 1500 = 100

GAAP earnings = 1000 - 350 - 100 + 50 = 600

Change in required GAAP surplus = 750 - 600 = 150

GAAP FCF = 600 - 150 = 450

# 5.

**Solution:**

**(a)**

Credited rate is a function of four interest rates

- Average net interest being earned net of investment expense and defaults
- Average net interest available on new investments
- Any interest rate guaranteed by the product
- Market rate

Guarantee could be – long-term minimum interest guarantee

- Short-term current interest rate guarantee
- Bailout rate
- Cannot credit less than a long-term or short-term guarantee

Most companies will use a targeted spread

- Credited rate = earned rate – targeted spread
- But company may not always achieve targeted spread

Credited rate will affect lapse experience

- Crediting less than competitor increases lapses
- Crediting more than competitor decreases lapses
- Always compared to base lapse rates

**(b)**

i90day (Time 0) = 4.50%
i15year (Time 0) = 6.00%
Volatility Factor (Vol) = 20%
Degree of Correlation (Corr) = 60%

Z1(1) = 0.482
Z2(1) = 1.829
Z1(2) = (0.709)
Z2(2) = 0.902

$$\text{i90day}(t+1) = \text{i90day}(t) \times \exp(Z1 \times \text{Vol})$$

$$Z15\text{year} = Z1 \times \text{Corr} + Z2 \times \left(1 - \text{Corr}^2\right)^{0.5}$$

$$\text{i15year}(T=1) = \text{i15year}(t) \times \exp(Z15\text{year} \times \text{Vol})$$

**5.** **(b) continued**

**Year 1**

$$\text{i90day}(1) = \text{i90day}(0) \times \exp(Z1 \times \text{vol})$$
$$= 0.045 \times \exp(0.482 \times 0.2)$$
$$= 4.96\%$$
$$Z15\text{year} = 0.482 \times 0.6 + 1.829 \times \left(1 - 0.6^2\right)^{0.5}$$
$$= 1.7524$$
$$\text{i15year}(1) = \text{i15year}(0) \times \exp(Z15\text{year} \times \text{vol})$$
$$= 0.06 \times \exp(1.7524 \times 0.2)$$
$$= 8.52\%$$

**Year 2**

$$\text{i90day}(2) = \text{i90day}(1) \times \exp(Z1 \times \text{vol})$$
$$= 4.96\% \times \exp(-0.709 \times 0.2)$$
$$= 4.30\%$$
$$Z15\text{year} = -0.709 \times 0.6 + 0.902 \times \left(1 - 0.6^2\right)^{0.5}$$
$$= 0.2962$$
$$\text{i15year}(2) = \text{i15year}(1) \times \exp(Z15\text{year} \times \text{vol})$$
$$= 8.52\% \times \exp(0.2962 \times 0.2)$$
$$= 9.04\%$$

# 6.

**Solution:**

**(a)**

**(i)**

Loss ratio test

- usually for health, P&C
- 1 year assessment only

**(ii)**

Gross premium valuation

- compare stat reserves to gross premium reserve
- if GPV > stat reserves, then adequate reserves held.

**(iii)**

Claim run off test

- Looks at claims by incurral year
- Looks at sum of cash paid and claim reserve
- The sum of the two should remain constant throughout all subsequent years
- If last table showed reserves + paid claims constant through the year, then the reserves are sufficient
- If the table showed reserves + paid claims declined by duration, the reserves are conservative
- If the table showed reserves + paid claims increased by duration, the reserves are inadequate
- This test is conservative since it ignores interest earned on reserves.

**(b)**

Using the claim run off test

**Cash paid by incurral year**

| Cal year | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|
| 2003 | 10 | | | | |
| 2004 | 12 | 7 | | | |
| 2005 | 6 | 10 | 5 | | |
| 2006 | 3 | 5 | 10 | 6 | |
| 2007 | 2 | 4 | 6 | 10 | 5 |

## 6. (b) continued

**Cum Cash paid by incurral year**

| Cal year | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|
| 2003 | 10 | | | | |
| 2004 | 22 | 7 | | | |
| 2005 | 28 | 17 | 5 | | |
| 2006 | 31 | 22 | 15 | 6 | |
| 2007 | 32 | 26 | 21 | 16 | 5 |

Min level of claim reserves (back solve so that all years are smooth)

| Cal year | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|
| 2004 | 19 | | | |
| 2005 | 9 | 16 | | |
| 2006 | 4 | 6 | 10 | |
| 2007 | 0 | 0 | 0 | 0 |

Check

| Cal year | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|
| 2004 | 26 | | | |
| 2005 | 26 | 21 | | |
| 2006 | 26 | 21 | 16 | |
| 2007 | 26 | 21 | 16 | 5 |

# 7.

**Solution:**

**(a)**

**(i)**

**YRT**

Advantages

- Simple to administer
- Lower ongoing cost because only mortality/morbidity risk is ceded

Disadvantages

- Ceding commission is limited
- Low cost limits the amount of future profits; therefore, limited surplus relief

**(ii)**

**Mod-co**

Advantages

- Ceding company does not need to transfer asset backing the reserves
- Ceding company controls investment policy
- No reserve credit problem even if the reinsurer is not licensed
- Can be applied to all types of insurance product

Disadvantages

- Complex to administer due to mod-co adjustment
- Capital losses due to asset transfer during treaty termination

**(b)**

Income Statement as of Dec 31, 2010

| | **ABC Life** | **XYZ Re** |
|---|---|---|
| Gross Premium | $\frac{500000\times 10}{1000}=5000$ | 3000 |
| Ceded Premium | $5000\times 60\%=3000$ | 0 |
| Investment Income | $(3000+500)\times 10\%=350$ | $1000\times 10\%=100$ |
| Reinsurance Allowance | $3000\times 10\%=300$ | 0 |
| Mod-Co Adjustment | $60\%\times[3400-3000(1+10\%)]=60$ | 0 |
| Total Revenue | 2710 | 3100 |
| Increase in Reserve | $3400-3000=400$ | 0 |
| Expense | 50 | 25 |
| Commissions | $5000\times 20\%=1000$ | 0 |
| Mod-co Adjustment | 0 | 60 |
| Reinsurance Allowance | 0 | 300 |
| Total Benefit & Expenses | 1450 | 385 |
| Net Income | 1260 | 2715 |

## 7. (b) continued

Balance Sheet as of December 31, 2010

| | **ABC Life** | **XYZ Re** |
|---|---|---|
| Asset | $1760 + 3400 = 5160$ | 3715+0=3715 |
| Reserve | 3400 | 0 |
| Surplus | $500 + 1260 = 1760$ | $1000 + 2715 = 3715$ |
| | | |
| Liabilities & Capital | 5160 | 3715 |

# 8.

**Solution :**

**(a)**

Method of restoring surplus to adequate levels once depleted

- Establish and use internal target surplus formulas
- Emphasize products with low RBC requirements
- Move away from products with high RBC requirements
- Redesign existing products to lower RBC requirements
- Increase profits by lowering expenses
- Increase profits by increasing premiums
- Increase profits by exiting unprofitable lines of business
- Buying assets with low RBC requirements and selling high RBC assets
- Using reinsurance or M&A transactions to lower liability exposures
- Reorganize legal structure of company using subsidiaries or holding company structuring options
- Increase capital by issuing surplus notes or issuing new equity
- Stop selling new business

**(b)**

LeveragedSelect is high risk
Choose high risk because Leveraged Select has no surrender charge and allows withdrawal at book value

C3 component 3.08%*4800000 = 30184

CorpSelect is medium risk

Choose medium risk because surrender charge greater than 5% and allows withdrawal at book value

C3 component 1.54%*9800000 = 150920

**(c)**

C3 Phase I and Phase II Approach Similarities and Differences

Similarities

Scenario-based approach is used for both
Both methods try to capture the 'tail of the distribution' of scenarios

## 8. (c) continued

Weighted average subsets of results are used to get results for both methods

- The C3-I method is tabular factor weights
- The C3-II method is Conditional Tail Expectation (CTE) method

Scenarios are sampled from a large, predetermined set of scenarios to reduce runtime

Scenario sampling is designed to maintain a floor of that value produced by the larger scenario set

Quantify interest rate risk in a more product specific manner than the original C3 method allowed for

Differences

Interest Sensitive Products (C3-I) vs. Variable Products with Guarantees

C3-I uses same models as CFT exercise while C3-II uses standalone models

C3-I uses calculated statutory surplus as the final result while C3-II uses assets as the run result and then subtracts reserves to get RBC

The C3-I method allows choice of 12 or 50 scenario subset to be used

C3-I method uses year by year values of key run metric for each scenario

C3-I allows exemption if:

- Significance Test Passed: If original C3 component is less than 40% of total RBC than interest rate risk is deemed not to be significant for that company
- Stress Test Passed: If Total Capital divided by RBC recalculated with annuity interest rate requirement 7.5 times higher is greater than 100%...

Where C3-II has no such exemption tests

- C3-II offers an Alternative Methodology
- C3-II uses equity returns and interest scenarios where C3-I uses only interest rate scenarios
- C3-II uses Prudent Best Estimate Assumptions vs. Conservative Statutory Assumptions for C3-I

# 9.

**Solution:**

**(a)**

Key valuation assumptions of guaranteed benefits related to policyholder behavior:

- Assumptions are dependent on the policyholder's understanding of complicated benefits.
- Are influenced by the media or their broker.
- Policyholders may not make decisions in their best financial interest.
- Can be different from history
- Industry experience may not exist

**Lapse Rates:**

Traditionally, low during surrender charge period (4-6%), then spike at end of period (20-50%), and are stable afterward (10-15%)

Rates will vary by company & by distribution channel

Lapse rates are affected by:

- Length of the surrender charge period
- Whether it's a qualified(401, 403(b), 408(b) or 408(a)) or non-qualified contract
- Tax rules
- Distributor incentives – the broker may be influenced by commission structure (trailing commissions vs. new sale)
- Are the guarantees 'in the money'?
- Policy performance relative to other variable annuities

**Annuitization Rate**

- Assumption tends to be vary low (<3%)
- On each anniversary after GMIB waiting period, policyholder must choose to annuitize or wait. Poor health or a large guarantee makes annuitization more likely.
- Age (assume no annuitizations prior to 60 or 65)
- Volatile markets – volatility means policyholders may flock to the safety of a guaranteed annuity
- Other assets – if policyholder has other assets, annuitization is less likely
- Taxes
- Commissions

## 9. (a) continued

**Mortality pre-annuitization**

Mortality has the biggest impact on the valuation of GMDB

Presence of GMDB may lead to anti-selection, as a policyholder in poor health is less likely to lapse a policy in the money

Lapse & mortality affected inversely when a policy is 'in the money'

Availability of viatical settlements: If the death benefit becomes large enough relative to the account value, viatical settlements companies may buy the policy from policyholders with marginal health issues

**Partial withdrawals and contributions**

10-15% of variable annuity policyholders withdraw money on a regular basis

May have a specific assumption for partial withdrawals, or partial withdrawals & contributions could be built in to the lapse rate

If there is free partial withdrawal feature, a separate assumption is preferred so that projected surrender charges are not overstated

Three situations can cause partial withdrawals & contributions to have a material impact on valuation.

- If a policy is part of qualified retirement plan, IRS requires withdrawals starting at age 70.5. This rule is usually met with partial withdrawals.
- Benefits that are no longer offered in the marketplace may get additional contributions, and fewer partial withdrawals
- Anti-selection occurs when the policy adjusts guarantees on a dollar for dollar basis for withdrawals instead of proportionality. Occurs to both GMDB & GMIB guarantees. Provides 'free' insurance to the policyholder. Taxes may be a disincentive.

**9.** **continued**

**(b)**

**Higher expected bankruptcy costs**

- Direct costs (administration and reorganization) include, lawyer fees and court costs;
- Indirect costs include interference from bankruptcy court (impact on operating decisions, investment decisions, and causes reductions in ongoing operating value of the firm)
- Expected present value of costs reflected in current market value
- Eliminating risk of bankruptcy will eliminate this cost, and increases the value of the firm
- As a company becomes weaker financially, it is more difficult to raise funds
- Must pass up profitable investments because cost of capital is too great

**Higher payments to stakeholders**

- For closely held firms – required rate of return must account for increased risk, higher returns needed
- For public firms – stakeholders such as managers, employees, customers, suppliers will all require greater compensation if there is a risk their 'investment' in the firm could be impacted by financial distress
- Employees will want higher wages; and reduced loyalty or work effort from employees
- Suppliers will be reluctant to enter into long term contracts
- Creditors will charge more and be less flexible
- Customers concerned about company's obligations and may be reluctant to buy

**Higher Taxes**

- Most of the world has a 'convex' tax code
- Effective Tax-rate increases with increase in pre-tax income
- Limits on use of tax carry forwards
- Create benefits to managing tax within 'optimal range'
- Reducing variance in taxable income will produce lower tax payments by keeping income within optimal range

# 10.

**Solution :**

Asset categories under CICA 3855:

Held to Maturity (HTM)

Non-derivative financial assets with fixed or determinable payments and fixed maturity that an entity has the positive intention and ability to hold to maturity.

Available for Sale (AFS)

Non-derivative financial assets that are not classified as one of the other categories (AFS, HTM, L&R). "All other" classification as captures assets that do not fall into one of the other categories.

Held for Trading (HFT)

Non-derivative financial asset that is held with the intent to trade in the short term

Loans and Receivables (L&R)

Non-derivative financial assets with fixed payment patterns but are not quoted in the active market.
Excludes all debt securities and loans & receivables designated as AFS or HFT

| | **Initial Measurement** | **Subsequent Measurement** | **Gains & Losses** |
|---|---|---|---|
| **HTM** | Fair Value | Amortized Cost | • when realized<br>• impairments recognized immediately |
| **AFS** | Fair Value | Fair Value | • Recognized in other comprehensive income<br>• Transferred to net income when realized |
| **HFT** | Fair Value | Fair Value | • Recognized immediately in net income |
| **L&R** | Fair Value | Amortized Cost | • When realized or asset impaired |

# 11.

**Solution:**

**(a)**

**(i)**

MfADs

- PfADS must be reasonable in aggregate
- larger MfAD needed
- opportunity exists for "death-supported" product
- may need MfADs for assumptions of transfer of funds

**(ii)**

Non-economic assumptions:

- Mortality
  - policyholder behaviour creates prospect of anti-selection not found in term
- Expenses
  - higher expenses than term due to:
  - additional administration
  - cost of accommodating policyholder options
  - higher investment costs may arise from wider range of policyholder investment choices
- Lapses
  - design features lead to considerations for lapses term would not have
  - surrender charges: back-end surrender charge may lower surrender
  - may vary by different interest rate scenario
  - fund bonuses: may lower surrender
  - policyholders may do partial withdrawals instead of full surrenders
- Expected premium
  - unlike term with fixed premium need assumption for future expected premiums
  - may be affected by interest rate scenario

## 11. continued

**(b)**

**(i)**

Required to be an FCIA

- per CIA subject to CIA's rules of Professional Conduct
- need work in Canada as defined by CIA for 3 of last 6 years
- at least one year of valuation of Canadian insurance actuarial liabilities
- experience with CIA Standards of Practice
- CIA continuing professional development up to date
- has not been subject of adverse finding of CIA disciplinary tribunal

**(ii)**

Must produce annual Appointed Actuary's Report

- Annual Dynamic Capital Adequacy Testing report required:
  - report must be filed with OSFI
  - must report in writing to CEO or chief agent on any matter that might have material adverse effects on Company and that requires rectification

- If participating account:
  - AA must write report to directors on fairness to participating policyholders of any established or amended policy
  - must write report on fairness to par p/hs of method of allocating investment income to par account

- must file Minimum Continuing Capital and Surplus Requirements report (or TAAM)

# 12.

**Solution:**

**Management Expense Ratios (MER)**

Similar

- MERs / investment spread should vary by fund according to term of contract
- Actuary generally should not assume a change in fund charges in the future.

**Maturity date**

Different - Seg Funds

- Contracts should be projected to at least earliest possible maturity date
- Should test effect of allowing a proportion of customers to renew their contracts

Different - UL

- Contracts should be projected until the maturity date of the contract

**Contract guarantees**

Similar

- Guarantees should be modeled according to the terms of the contract
- Level of guarantees at the valuation date should reflect actual guaranteed amounts in effect at that date

**Model should reflect elective and automatic increase in benefits (rachets/resets)**

Similar

- For elective increases, actuary should assume some proportion of contract holders will increase benefits
- Need not assume policyholders will act with 100% efficiency in an economically rational manner

Different - Seg Funds

- Ratchets & resets for segregated funds

Different - UL

- May have mortality anti-selection if allow elective increases without underwriting

## 12. continued

**Fund transfers**

Similar

- Model should allow contract holders to transfer monies between investment options
- Assume some proportion of contract holders will elect to transfer monies when in financial best interest
- Need not assume policyholders will act with 100% efficiency in an economically rational manner

Different - UL

- Tax consequences of policyholder actions should be considered when the taxation of funds is different (i.e., segregated and general funds available within the contract)

**Elective partial withdrawals**

Similar

- Model should allow policyholders to withdraw monies without surrendering their contracts
- Withdrawals modeled should vary according to economic environment and past policyholder behaviour
- Assumptions should be set so they interact with full surrenders appropriately
- Anti-selection if no adjustment to benefit amounts

Different - UL

- May be affected by tax treatment of policyholder funds

**Investment options**

Similar

- Should assume existing investment options will continue to be offered unless there is clear reason to justify otherwise

**Future deposits / expected premiums**

Similar

- Future deposits / premiums may produce significantly different liabilities
- Policyholder behaviour may be influenced by the guarantees in the product design

Different - seg funds

- Generally acceptable not to model additional deposits but may wish to model if deposits increase policy liabilities and can be reasonably expected

## 12. continued

Different - UL

- Future premium assumption key for UL valuation
- Initial premium assumption should be consistent with policy administration system.
- May be exposed to mortality anti-selection if policyholders pay minimum amount required to keep policy inforce (or extended term / reduced paid-up, no lapse guarantee)

**Surrender charges and transaction fees**

Similar

- Model should take into account surrender charges and transaction fees only if reasonably anticipated.
- Existence of heavy back-end surrender charges may create a cliff lapse
- Generally would not be considered available for the payment of guaranteed policy benefits

Different - UL

- Some considerations for lapses of UL policies that are not necessarily applicable to other policy types. Policyholder behaviour may be influenced by:
  - Policy features such as surrender charges, persistency bonuses, access to cash values w/o full surrender
  - Taxation aspects of the policy
  - Vary by economic scenario
  - Marketing of the policy
  - Form of agent compensation

**Benefit Charges**

Different - Seg Funds

- Risk charge for guaranteed benefits determined by actuary
- Not shown explicitly to policyholder

Different - UL

- COI charges are explicit, shown on illustrations to policyholder
- COI charges may be guaranteed or non-guaranteed

# 13.

**Solution:**

**(a)**

Revised mortality risk component of MCCSR is the sum of 2 components-

- Volatility risk
- Catastrophe risk

Must be calculated for all mortality risk supported by the general account
Adjustments are allowed for adjustable and participating plans
Products must be grouped based upon similarity of adjustability features
All cash flow projections to be calculated net of authorized reinsurance amounts and reflect valuation decrements with provisions made for adverse deviations
Calculated results to be reduced by amounts of policyholder and any unauthorized reinsurer deposits

Phase-in to be fully implemented by 3rd quarter 2008
During phase-in periods calculated amounts to be multiplied by:

$$\alpha + (1-\alpha)\,{}^{n}\!/_{12}$$

where $\alpha$ is ratio of amount calculated under the old method to the amount calculated under the new method and n is the number of quarters that have elapsed since year-end 2005.

**(b)**

Volatility component V = $\sqrt{\sum S^2}$

Where S = 2.5∗A∗B∗E/F and

A =standard deviation of projected net death claims
B = maximum (0.5∗ln(D),1)
D = Macualay duration of projected net death claims
E = Total Net Amount at Risk (= Face amount minus Reserves)
F = Face amount

Variance of projected death claims = 49,000,000
Hence A = 7,000

D = 7 , 0.5∗ln(7) = 0.5∗1.9459 = 0.973
Hence B = 1

## 13. (b) continued

Face Amount F = 10 billion
Reserves = 0.9 billion
Hence E = 9.1 billion
Finally S = 2.5∗7,000∗1∗9,100,000,000/10,000,000,000
=15,925

Catastrophe Component $K = \alpha * C * E/F$

Where

$\alpha$ = .05 if adjustable, 1 otherwise
C = projected death claims in the following year
E and F as explained above

K = 1∗75,000,000∗0.91 = 68,250,000

Mortality Risk = V+K = 15,925 + 68,250,000 = 68,265,925.

# 14.

**Solution:**

**(a)**

**(i)**

Expected Profit on In-force business

This is the expected profit on business inforce at the beginning of the period
Includes expected release of PFADs, assuming best estimate assumptions are realized. Also includes expected management fee income and earnings on deposits.

**(ii)**

Impact of New Business

Point of sale impact of writing new business during the period. The difference between premium received and expenses incurred and liabilities established at point of sale.

**(iii)**

Experience Gains and Losses

The difference between actual earnings and earnings that were expected to materialize using best estimate assumptions. Should not include management actions or changes in assumptions during the period.

**(iv)**

Other

Includes sources of earnings not in other categories. If it is large, should investigate and refine analysis. Items that are material should be disclosed separately.

## 14. continued

**(b)**

Identify possible impacts to the OSFI's SoE disclosure in the reporting period following the implementation of Section 3855.

- impacts expected profits on in-force business
- tax related adjustments to the actuarial liabilities apply to the restated balance sheet.
- future tax assets may be created from new temporary differences in respect of post 1995 business to the extent that market value exceeds the book value of assets supporting liabilities.
- asset carrying values will be more volatile but earnings volatility will not be expected to increase for assets backing liabilities.
- earnings volatility may be more volatile for surplus.
- loss of comparability to prior period results
- the SOE might be modified to add a line for the total movement in fair value of assets and a subtractive line for the asset movement required to support policy liability changes
- the difference between the two, representing the movement in asset values that is not reflected in the change in policy liabilities, will show up in net income
- if assets backing liabilities are classified as Available for Sale there will be a disconnect between the change in policy liabilities charged to income and the investment income credited to income.
- could add an additional component to the SOE for impact of market value fluctuations
- Selling a lot of new business can significantly change the asset composition of the asset segment supporting the liabilities.
- source of earnings will be more complex when you use market values for assets
- unrealized gains or losses booked to Other Comprehensive Income would not flow through the income statement and would be excluded from the source of earnings analysis.

# 15.

**Solution:**

**(a)**

**(i)**

Inforce valued using embedded value

- Economic Value = PV (distributable earnings) @ hurdle rate
- hurdle rate = WACC

Reasons Economic value (ECV) better than embedded value (EV)

- EV only considers regulatory frictional costs. When distributing frictional costs, some of the less risky segments will receive too much
- EV tends to favour high yield investments

**(ii)**

CAPM doesn't consider frictional costs in determining a discount rate

- Base cost of capital, this is what shareholders could get investing on their own
- to create value need to earn higher than planned on investments
- frictional costs include:
  - double taxation, costs of frictional distress, agency costs, regulatory costs
- hurdle rate used should be the weighted average cost of capital

**(b)**

**(i)**

Basic shortcoming of DCF or NPV is that they cannot properly capture management's flexibility to adapt when uncertainty is resolved

doesn't reflect options

CCA must be used when dealing with options.

CCA uses risk neutral decision tree discounting expected future values at the riskless rate

## 15. (b) continued

**(ii)**

The flexibility to defer the decision to launch the product is a real option. Options to delay, contract, expand etc can be valued.

Allows management to value different options to know how it can react if the market acceptance is good or bad

Allows uncertainly to be resolved before committing to launch the product

CCA captures the fact there are options and allows for their proper valuation

**(iii)**

S=20
S+ = 36
S- =12

V+ = 180
V- = 60
I = 112

20 = p * (36) + (1-p) * 12 / 1.08 p=.4

p = ((1+r) * S - S-)/(S+ - S-)

E+ = max (V+-I,0) = max (180-112,0) = 68

E- = max (V- - I,0) = max (60-112,0) = 0

Value to PH @ t=0 is ((p * E+) + ((1-p) * E-)) / (1+r)

= (.4 * 68 + .6 * 0)/1.08 = 25

# 16.

**Solution:**

**(a)**

**Step 1**

Should be the amount of assets at the balance sheet date that goes to zero at the last date of the last liability cashflow
Should be reasonable policyholder expectations not all
Scenario tested assumptions do not require a margin for adverse deviation
For best estimate assumption include margin for adverse deviation

**Step 2**

After "balance sheet" date
Consist of premium and claim liabilities
Exclude claim cash flows prior to the balance sheet date

**Step 3**

value policy liabilities both with and without discounting
for value without discounting, the provision for adverse deviation is reduced
If policy liabilities without discounting are larger, report this amount without reservation
If policy liabilities without discounting are lower, report this amount with reservation

**Step 4**

Low margin = $3.75 / e_x$
High margin = $15 / e_x$

**Step 5**

An addition or subtraction
20% not 25%
The sign is what maximize the policy liabilities

**(b)**

For deterministic CALM, actuary would test additional scenarios if necessary
UL policies have significant amount of uncertainty

# 17.

**Solution:**

**(a)**

Life insurance policies classified as pre-1996 or post-1995
Classification based on issue date of policy
Post-95 includes pre-96 policies whose terms have changed (other than limited number of allowed changes)
Only policies issued to Canadian residents are eligible for a reserve
Reserves net of reinsurance are used for tax purposes
Tax reserve for pre-1996 policies

- MTAR = MAX (Net 1.5 FPT Reserve, CSV)
- Tax Reserve = MTAR - Outstanding Policy Loans
- Policy 1: Tax Reserve = Max (84,000 - 69,000 , 12,000) - 0 = 15,000
- Policy 2: Tax Reserve = Max (30,000 - 24,000 , 15,000) - 4,000 = 11,000
- Policy 3: Tax Reserve = Max (49,000 - 44,000 , 10,000) - 0 = 10,000
- Total pre-1996: Tax Reserve = 15,000 + 11,000 + 10,000 = 36,000
- interest and mortality assumptions are those used to set the premium for non-par policies
- interest and mortality assumptions are those used to set the cash surrender value for par policies

Tax reserve for post-1995 policies

- MTAR = Net Stat Reserve
- Tax Reserve = MTAR - Outstanding Policy Loans
- Policy 4: Tax Reserve = (40,000 - 43,000) - 0 = -3,000
- Policy 5: Tax Reserve = (90,000 - 78,000) - 6,000 = 6,000
- Total post-1995: Tax Reserve = -3,000 + 6,000 = 3,000
- must exclude projected income and capital taxes (other than IIT) from tax reserves
- negative reserves are allowed

Total Tax Reserve = 36,000 + 3,000 = 39,000

## 17. continued

**(b)**

Insurance companies are subject to a tax on the income that accrues annually within a life insurance policy

Intended to prevent tax-free accumulation of investment income - proxy policyholder tax

Existing guaranteed non-par life insurance policies (EGLIPs) - issued before January 1, 1990 - are excluded

IIT = 15% x (life investment income - amounts reported to policyholders as taxable income)

- can deduct life investment losses carried forward from the previous 7 years

Life investment income = prescribed yield x average MTARs for current and previous year

- MTARs are gross of reinsurance
- policy loans are not deducted from MTARs

Prescribed yield = 55% x average interest rate on Government of Canada bonds

Policy 1: IIT = 0.15 x 0.55 x 5% x (80,000 + 84,000) / 2 = 338

Policy 2: IIT = 0.15 x 0.55 x 5% x (28,000 + 30,000) / 2 = 120

Policy 3: IIT = 0.15 x 0.55 x 5% x (46,000 + 49,000) / 2 = 196

Policy 4: IIT = 0.15 x 0.55 x 5% x (41,000 + 44,000) / 2 = 175

Policy 5: IIT = 0.15 x 0.55 x 5% x (79,000 + 82,000) / 2 = 332

Total IIT = 338 + 120 + 196 + 175 + 332 = 1,161

**(c)**

- Changes would apply for taxation years commencing after October 1, 2006
- MTARs for pre-1996 would be based on policy reserves reported in financial statements (same as post-1995)
- Change would be spread over a 5 year period
- Reversal period for existing temporary differences significantly shortened (from term of liabilities to 5 years)
- Significant increase in reserves deductible for tax purposes for post-1995 policies with move to CICA 3855
- For post-1995 business, change in MTARs attributable to CICA 3855 spread evenly over 5 years
- There will continue to be differences between the financial statement policy liabilities and allowable tax reserves even after the 5 year transition period.