14. (6.5 points)

The following information is available for a property and casualty insurance company as at December 31, 2017. All amounts are in thousands of dollars ($000s).

Claim Liabilities Information:		
Undiscounted Unpaid Claim Liabilities		100,000
Premium Liabilities Information:		
Gross Unearned Premium		90,000
Selected Undiscounted Loss Ratio (% of Premium)		80.0%
Unallocated Loss Adjustment Expense (ULAE)		3,500
Maintenance Expense Ratio (% of Premium)		2.5%
Discounting Information:		
Claims Development Margin of Adverse Deviation (MfAD)		9.0%
Interest Rate MfAD		0.5%
Discount Rate		3.0%
Cumulative Accident Year Payment Pattern (Assume that payments are made in the middle of the year.)	Age (Months)	% Paid
	12	25%
	24	50%
	36	75%
	48	100%

The company started doing business in 2017 and does not purchase reinsurance.

The company holds a 125,000 bond portfolio which has a modified duration of 3.0 years. There are no other interest rate sensitive assets or liabilities.

Calculate the margin required at target for interest rate risk.

CONTINUED ON NEXT PAGE

QUESTION 14

TOTAL POINT VALUE: 6.5 | **LEARNING OBJECTIVE(S): C1, C2**

SAMPLE ANSWERS

Sample 1

Claim liabilities

t	% paid	PV @ 3%	PV @ 2.5%
0.5	1/3	$(1.03)^{-t}$	$(1.025)^{-t}$
1.5	"	"	"
2.5	"	"	"
		0.9569	0.9631

$0.9569 = {}^{1}/_{3}\,(1.03^{-0.5} + 1.03^{-1.5} + 1.03^{-2.5})$

APV = 100K*0.9638+0.09*100K*0.9569
APV = 104995.63

$$\text{Effective duration} = \frac{\left[0.5\left({}^{1}/_{3}\right)1.03^{-0.5} + 1.5\left({}^{1}/_{3}\right)1.03^{-1.5} + 2.5\left({}^{1}/_{3}\right)1.03^{-2.5}\right]}{0.9569}$$

$$\text{Effective duration} = 1.4803$$

$$\text{Modified duration} = 1.4803/1.03$$
$$\text{Modified duration} = 1.4372$$

Premium liabilities

t	% paid	PV @ 3%
0.5	0.25	$(1.03)^{-t}$
1.5	"	"
2.5	"	"
3.5	"	"
		0.9431

$$\mathrm{D_{PL}} = \left(\frac{\sum_{t=0.5}^{3.5} 0.25 * t * (1.03)^{-t}}{\sum_{t=0.5}^{3.5} 0.25 * (1.03)^{-t}}\right) - 0.5 + \frac{1}{3}$$
$$\mathrm{D_{PL}} = 1.7964$$

$$\text{Mod } \mathrm{D_{PL}} = \frac{1.7964}{1.03} = 1.7441$$

E(L) = 0.8*90K = 72K

E(L & LAE) = 72K + 3.5K = 75.5K

$$\text{PV PL@3\%} = 0.9431 * (1.03)^{0.5-\frac{1}{3}} = 0.94777$$
$$\hookrightarrow \sum_{t=0.5}^{3.5} 0.25 * (1.03)^{-t}$$

$$\text{PV PL@2.5\%} = 0.9522 * (1.025)^{0.5-\frac{1}{3}} = 0.9561$$
$$\hookrightarrow \sum_{t=0.5}^{3.5} 0.25 * (1.025)^{-t}$$

APV = 75.5K*0.9561+75.5K*0.94777*9%
APV = 78625.93

PL = 78625.93+90K*2.5% = 80875.93

Maintenance exp duration : 1/3

Maintenance exp mod D = $\frac{1/3}{1.03} = 0.3236$

$$\text{D}^{\text{PL}} = \frac{1.7441 * 78625.93 + 0.3236 * 2.25\text{K}}{80875.93}$$

Interest rate margin

$$\text{margin} = |\Delta \text{ A} - \Delta \text{ L}| = |\Delta \text{ A} - \Delta \text{ CL} - \Delta \text{ PL}|$$
$$\Delta \text{ A} = 125\text{K} * 3 * 0.0125 = 4.6875\text{K}$$
$$\Delta \text{ CL} = \text{APV} * 1.4372 * 0.0125 = 1886.33$$
$$\Delta \text{ PL} = 80875.93 * 1.70458 * 0.0125 = 1.7232\text{K}$$
$$\text{margin} = |4.6875\text{K} - 1886.33 - 1.7232\text{K}| = 1078.03$$

Sample 2

Claim liabilities

	t	% paid	PV @ 3%	PV @ 2.5%
12-24	0.5	1/3	0.3284	
24-36	1.5	"	0.3189	
36-48	2.5	"	0.3096	
			0.9569	0.9638

$$\text{PV@3\%} = 100000 * 0.9569 = 95690.9$$
$$\text{PV@2.5\%} = 100000 * 0.9638 = 96383.45$$

$$\text{Macauley duration} = \frac{[0.5 * 0.3284 + 1.5 * 0.3189 + 2.5 * 0.3096]}{0.9569} = 1.4803$$

Modified duration $= 1.4803/1.03$
Modified duration $= 1.4372$

Premium liabilities

	t	PV @ 3%	PV @ 2.5%
25%	0.5	0.2463	
25%	1.5	0.2392	
25%	2.5	0.2322	
25%	3.5	0.2254	
		0.9431	0.9522

Adjustments

$\text{PV@3\%} = 0.9431(1.03)^{0.5-\frac{1}{3}} = 0.9478$

$\text{PV@2.5\%} = 0.9522(1.03)^{0.5-\frac{1}{3}} = 0.9569$

$$\text{Macauley duration} = \frac{[0.5 * 0.2463 + \cdots + 3.5 * 0.2254]}{0.9431} = 1.963$$

$\text{With adjustment} = 1.9630 - \left(0.5 - {}^{1}/_{3}\right) = 1.7964$

$$\text{Modified duration} = \frac{1.7964}{1.03} = 1.7441$$

$\text{APV(claim)} = \text{PV@2.5\%} + 9\% * \text{PV@3\%} = 104996$

$\text{PV(Prm liab)} = (\text{UPR} * \text{ELR} + \text{ULAE})\text{PVfact}$
$\text{PV@3\%} = (90000 * 80\% + 3500)0.9478 = 71559$
$\text{PV@2.5\%} = (90000 * 80\% + 3500)0.9569 = 72246$

$\text{APV(prm)} = \text{PV@2.5\%} + 9\% * \text{PV@3\%} = 78686$

$\text{Pcl Liabs} = \text{APV(prm)} + 2.5\% * 90000 = 80936$

$\text{margin} = 0.5\%|125000 * 3 - 104996 * 1.4372 - 80936 * 1.7441| = 415$

EXAMINER'S REPORT

Candidates were expected to know how to calculate the various components of the MCT formula, including claims liabilities and premium liabilities.

EXAM 6C SPRING 2018 SAMPLE ANSWERS AND EXAMINER'S REPORT

Claim liabilities

Candidates were expected to know how to calculate claims liabilities and its duration.

Common mistakes included:

- Not calculating the modified duration
- Not calculating the claims development PfAD
- Using the wrong payment pattern

Premium liabilities

Candidates were expected to know how to calculate premium liabilities and its duration. Note that various durations for the maintenance expenses were accepted: candidates could use the same duration as the rest of the premium liabilities or calculate a separate duration for maintenance expenses.

Also, the discounting methodology demonstrated in the March 2015 CIA educational note on premium liabilities was accepted. **However, candidates should note that this method will not be accepted for the upcoming exams and only answers based on the most recent CIA educational note will be accepted.**

Common mistakes included:

- Using the same payout pattern for premium liabilities as claim liabilities
- Not calculating the modified duration
- Adding maintenance expenses in the undiscounted losses+LAE
- Not adding the adjustment for premium liabilities in the duration
- Using the wrong rate for the maintenance expense calculation
- Not adding the maintenance expenses to the premium liabilities

Margin required at target for interest rate risk

Candidates were expected to know how to apply the interest rate shock test to calculate the capital required for interest rate risk. Candidates were also expected to know how to calculate the market risk margin by summing its components. Various rates were accepted as the rate was not included in the question.

Common mistakes included:

- Not doing the test for both a positive and a negative shock
- Not showing how the margin was selected (max, abs)