

****BEGINNING OF EXAMINATION****
INVESTMENT
MORNING SESSION

Questions 1-4 pertain to the Case Study

- 1.** (5 points) LifeCo's ALM Report indicates a need to rebalance the assets supporting the non-traditional life segment.
 - (a) Describe the constraints on asset sales when rebalancing this portfolio.
 - (b) Evaluate LifeCo's investment strategy for this segment, and recommend any necessary changes.

2. (9 points) LifeCo is considering selling its closed block of Institutional Pension (GIC).

Liability book value (in \$ millions)	\$1,500
Maturity (in years)	2
Annual liability crediting rate	6.60%
1 year risk-free rate	1%

You are given the following information:

	Scenario 1	Scenario 2
1 year risk-free rate 1 year forward	3%	2%
Withdrawal rate at the end of year 1	4%	2%
Withdrawal rate at the end of year 2	100%	100%
Probability	30%	70%

There are no new deposits.

- (a) (4 points) Compare the option pricing method and the actuarial appraisal method for estimating the fair value of liabilities.
- (b) (2 points) Outline practical considerations in applying the option pricing method.
- (c) (3 points) Calculate the fair value of liabilities using the option pricing method with the risk-free interest rate for discounting.

- 3.** (9 points) You are LifeCo's Investment Actuary and a member of the ALM Committee. The Committee is currently reviewing the risk exposures of the Non-Traditional Life portfolio as contained in your December 31 ALM Report.
- You have recently switched LifeCo's ALM reporting to effective duration from modified duration
 - Your effective duration calculations use a base yield curve and a yield curve shocked by 1 basis point
 - No explicit hedge has been set up for the minimum credited interest guarantees
 - LifeCo's head of Investments has proposed the sale of \$50 million (in present value) of 15-year zero-coupon bonds in order to increase cash holdings to partially address the key rate duration mismatch
- (a) Describe the limitations of LifeCo's reported effective durations as an interest rate risk measure.
- (b) Estimate the economic impact of a 100bp drop in interest rates based on your reported effective durations.
- (c) Compare this estimate with your reported "margin squeeze" impact and briefly explain reasons for any differences to the ALM committee.
- (d) Describe any interest rate 'bets' evident from the reported partial durations.
- (e) Estimate the revised partial durations following this proposed transaction.
- (f) Estimate the revised impact of margin squeeze following this proposed transaction.
- (g) Explain how the potential margin squeeze should be incorporated into any assessment of interest rate bets.

- 4.** (9 points) LifeCo wants to modify the design of its Equity Linked GIC product to reduce the impact of a large decline in the stock market just before maturity. LifeCo believes that these modifications should be done in such a way that the participation rate is as high as possible and the profit margin remains the same.

The Company is also concerned about the cost of purchasing call options for the Equity Linked GICs and is considering applying the dynamic hedging program it developed for its Variable Annuities.

- (a) Compare the options embedded in LifeCo's Equity Linked GIC and Variable Annuities.
- (b) Recommend potential changes to the Equity Linked GIC product that would meet LifeCo's goals for the redesigned product.
- (c) Describe the process used to evaluate the cost and efficiency of dynamic hedging.
- (d) Evaluate LifeCo's Variable Annuity dynamic hedging program as an alternative to purchasing call options for its Equity Linked GIC product.
- (e) Contrast the hedging of Equity Linked GICs as a stand-alone product to that of an investment option of a Variable Universal Life product.

- 5.** (8 points) You are constructing a model that will be used for dynamically hedging the guaranteed minimum death benefits (GMDB) on a variable annuity portfolio. The following models have been proposed:
- (i) Lognormal
 - (ii) Regime Switching
 - (iii) Time Series Model with GARCH Volatility
 - (iv) Empirical
 - (v) Wilkie
 - (vi) Stable Distribution
- (a) (3 points) Evaluate each model for modeling equity returns.
- (b) (5 points) Assess the suitability of each model for dynamic hedging and recommend a model to be used for dynamically hedging the GMDB.

6. (7 points) ABC Life has issued a 2-year GIC that has no policyholder options and pays interest at maturity.

Single Premium 100 million
 Payout in 2 years 110 million
 Initial Assets (MV) 100 million of 3-year zero coupon corporate bonds

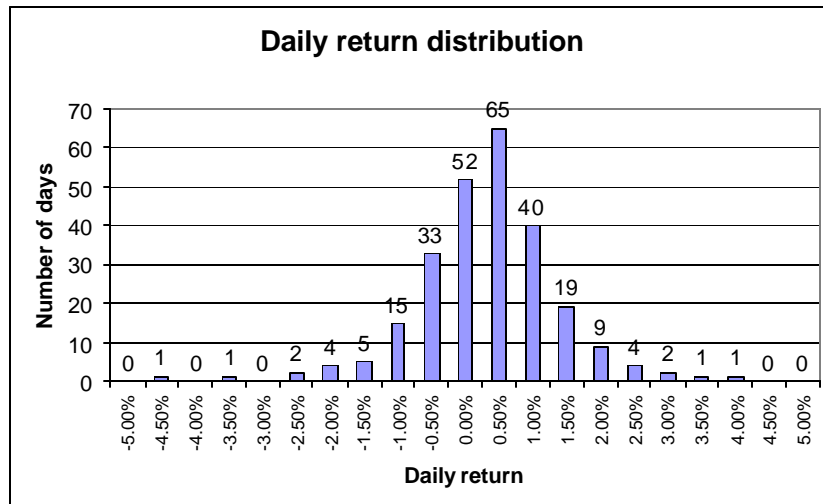
Treasury zero-coupon rates			
	Term, Years		
Year	1	2	3
0	3%	4%	5%
1	4%	4%	4%
2	3%	4%	5%

	Bond Spread Curve		
Corporate bond spreads	1 year	2 year	3 year
	0.1%	0.3%	0.5%

Assume:

- the bond spread curve does not change from issue
 - expenses are negligible
 - GIC issues occur at the beginning of the year
 - payouts occur at the end of the year
- (a) Compute the Total Returns in year 1 for both assets and liabilities using the Total Return Approach.
- (b) Disaggregate the Total Returns into their components, e.g. C-risks.
- (c) Outline the advantages of the Total Return Approach over the book-value approach.

7. (9 points) The graph below shows the distribution of the daily returns of a particular equity portfolio in one year with a total of 254 trading days. For example, there were 65 days with daily return between 0.00% and 0.50%. The average daily return is 0.04% and the standard deviation of the daily return is 1.07%. The current value of the portfolio is \$10 million.



- (a) Explain the objective of a Value at Risk (VaR) calculation
- (b) Calculate:
 - (i) The one day VaR at a 95% confidence level using the above histogram.
 - (ii) The 10 day VaR at a 95% confidence level assuming a normal distribution.
- (c) Evaluate the advantages and disadvantages of these methods of calculation and the Monte Carlo Simulation approach.
- (d) Describe how to test the accuracy of the alternative models.
- (e) List the limitations of VaR as a measure of risk, and explain how the Conditional Tail Expectation approach and stress testing might complement VaR as a risk measure.
- (f) Calculate the 95% Conditional Tail Expectation based upon the distribution in the graph above using interval midpoints as estimates of average values.

8. (4 points) Acme Motors offers the following investment options to the participants in its Defined Contribution plan:

1. A U.S. equity fund
2. An international equity fund
3. A fixed income fund

You are considering adding a Stable Value Fund option.

- (a) Explain why a Stable Value Fund would be offered as an option.
- (b) List the risks to Acme Motors and its participants associated with the Stable Value Fund option.
- (c) List the risks to the issuer of the underlying GIC or BIC contracts that support Acme Motor's DC plan's stable value fund.
- (d) Propose ways the issuer can manage these risks.

****END OF EXAMINATION****
MORNING SESSION

****BEGINNING OF EXAMINATION****
INVESTMENT
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Beginning With Question 9

9. (3 points) You are given a 5-year, BB rated zero-coupon bond with par value of 100.

You are given the following information

The 1-year transition matrix is:

Initial Rating	Rating at Year end (%)					
	AA	A	BB	B	C	Default
AA	95	3	2	0	0	0
A	2.5	93.5	2.5	1.5	0	0
BB	1	2	95.75	0.75	0.5	0
B	0	2	5	85	7	1
C	0	0	3	7	85	5

The 1-year forward zero-coupon curve is:

Category	1-Year	2-Year	3-Year	4-Year
AA	3.5	4.1	4.7	5.0
A	3.7	4.3	4.9	5.3
BB	4.0	4.7	5.3	5.7
B	5.6	6.0	6.8	7.4
C	10.0	12.0	11.0	9.0

Using the CreditMetrics approach:

- (a) Calculate the possible 1 year forward values of the bond.
- (b) Calculate the credit VaR at the 99% confidence level.
- (c) Calculate the capital charge using the value obtained in (b).

- 10.** (3 points) DM Life is considering hedging its credit risk with Credit Default Swaps (CDS).
- (a) Explain FAS 133's rules for qualifying for hedge accounting.
 - (b) Formulate a hedge strategy that would qualify for hedge accounting under FAS 133.

- 11.** (3 points) An associate at your firm follows a select group of options. From time to time he feels he can develop information and views in terms of expected return and risk that are not reflected in current market prices.
- (a) Explain why observed option prices might differ from those predicted by the Black-Scholes model.
 - (b) Explain whether a Black-Scholes option model would be useful in evaluating a specific option investment strategy.

12. (4 points) You are given the following statistics on a real estate portfolio.

Property Type	Portfolio Weighting	Index Weighting	Portfolio Returns	Index Returns
Warehouse	15%	15%	5.50%	6.00%
Apartment	15%	15%	3.00%	4.00%
Retail	50%	40%	7.88%	7.50%
Office	20%	30%	4.25%	4.00%
Total	100%	100%	6.06%	5.70%

The real estate portfolio manager has made the following assertion:

“When it comes to real estate investing, I know exactly which properties are great performers!”

He also provided the following two recommendations:

- Sell some of the apartment holdings because the occupancy rates are high in all of the apartment buildings in the portfolio leaving little room left for any major price appreciation.
 - Invest in a retail complex being developed on the outskirts of town because of the potential for price appreciation.
- (a) Evaluate the validity of the real estate portfolio manager’s assertion.
- (b) Critique each of the recommendations.

- 13.** (5 points) You are the Mortgage Backed Security analyst at ABC Life Insurance Company. ABC's chief economist, Jane Schmeau, is projecting that interest rates will rise sharply over the next 12 months and then continue to rise steadily into the foreseeable future. Ms. Schmeau makes the following statement:

“Because it is solely the current level of interest rates that determines the rate of mortgage refinancing, the rate of mortgage prepayments will drop sharply in my projected interest rate scenario”.

- (a) (1 point) Assess Ms. Schmeau's statement.
- (b) (4 points) Describe the characteristics, advantages and disadvantages of each of the following securities based upon Ms. Schmeau's economic projection. Select one of these bonds for purchase.
- (i) A newly issued PAC with a 7 year average life, a collar of 100%-250% PSA, and a 6 year lockout period
 - (ii) An intermediate pay sequential PAC with a 7 year average life and 6 years of prepayment lockout
 - (iii) Z bond
 - (iv) Z-jump bond

14. (7 points) Your company is considering adding a Market Value Adjustment (MVA) to its SPDA. The SPDA has the following characteristics:

- surrender charges decline over 5 years
- minimum guaranteed credited rate of 3.0%
- initial crediting rate is 4.0% fixed for 5 years and reset annually thereafter using a new-money rate

The MVA Factor being considered uses the following formula:

$$\left[\frac{1+j}{1+i} \right]^{T-t} \text{ for } i > j$$

where:

- i is the current market rate
- j is the fixed crediting rate
- $T-t$ is the fixed rate period remaining

You asked a student to calculate the duration of the SPDA without the MVA. The student's immediate response is:

“This product is sold as a 5 year CD in the bank channel, it will behave like a zero coupon bond with 5 year maturity and effective duration close to 5 years.”

- Assess the student's response.
- Describe the benefit of the MVA feature from an ALM perspective.
- Compare the effective duration of SPDA with and without the MVA.
- Describe in what situation a return of premium feature applied before the surrender charge will be in-the-money with 4 more years of initial guarantee remaining.
- Assess the impact on effective duration of the return of premium feature.
- Assess the impact of minimum guaranteed rate on the effective duration of the SPDA with MVA.

- 15.** (8 points) BMC Olympiad Inc. is looking for a potential acquirer within the next 12 months. You have been asked to assess the company's near-term credit risk exposure before proceeding with an appraisal analysis of BMC Olympiad's operating businesses.

You are given the following information:

- Company's credit rating: BBB
 - Risk-free rate: 5% per annum compounded continuously
 - Market value of company's assets today: \$21 billion
 - Market value of company's equity today: \$5 billion
 - Company's debt due to be repaid including interest one year from now: \$17 billion
 - Volatility of equity returns: 80%
 - Volatility of asset returns: 20%
 - A company with similar credit risk has five-year corporate zero-coupon bonds trading at 350 basis points above risk-free rate
 - Assumed recovery rate in the event of a default: 40% (as percent of bond's no-default value)
- (a) Estimate the risk-neutral probability that the company will default on its debt using Merton's model.
- (b) Determine the expected loss on the debt and the expected recovery in the event of a default.
- (c) Compare the default probability produced by Merton's model versus the annualized risk-neutral default probability inherent in the company's current corporate bond pricing. Explain possible reasons for discrepancy between these two estimates of default probabilities.

- 16.** (8 points) BH Life is a small insurance company that has sold a product with a minimum return guarantee. The investment guarantee is equivalent to a European put option on the S&P 500 index with a notional amount equal to 5,000 times the index.

You are given the following information:

- Risk free rate is 2.5%
- Current index value is 1200
- Strike price is 1100
- Time to maturity is 1 year
- Black Scholes value of the put option with implied volatility of 22% is \$242,900
- No dividends
- Trading costs equal 0.10%
- Proceeds are invested at the risk-free rate
- Risk-free rate and volatility do not change during the year

The firm wishes to delta hedge the risk on the put with quarterly rebalancing by using shares of a fund that track the S&P 500.

- (a) (2 points) Calculate the expected profit at the time the product is sold assuming that expected volatility is 22% and the put option was priced using a volatility of 25% per year.
- (b) (1 point) Calculate the initial hedge position the firm should hold for delta neutrality if the volatility assumed in their hedge is 22%.
- (c) (3 points) Calculate the firm's net gain or loss on the transaction, assuming that over the course of the year the S&P 500 takes the following path given below, and that the volatility assumed in their hedge is 22%. $N(d_1)$ factors are provided for European options with the same maturity date and strike price and a volatility of 22%.

Time	Index Level	$N(d_1)$
Point of sale	1200	
End of Quarter 1	1250	0.8051
End of Quarter 2	1150	0.6700
End of Quarter 3	1050	0.3783
End of Quarter 4	1000	

- (d) (2 points) Describe other risk management strategies the firm can use.

- 17.** (4 points) You are considering investing in government issued fixed income securities in the three countries listed below.

You are given the following information:

Country	A	B	C
Continent	Europe	Asia	Asia
Population	3M	400M	50M
Oil Exports	1B	150B	5B
Agriculture Exports	1B	150B	15B
Agriculture Domestic	3B	450B	40B
Manufacturing Exports	8B	150B	300B
Manufacturing Domestic	13B	600B	240B
Total GDP	26B	1500B	600B
Government type	Stable Democracy	Stable Democracy	Emerging Democracy
Inflation Range	2%-20%	0%-30%	8%-16%
Infant deaths per 1000	1	3	5
Life expectancy	75	70	65

- (a) Describe the risks of the potential investments and propose how to mitigate them.
- (b) Rank the countries by their political stability and justify your ranking.

18. (6 points) You are a Risk Manager for a US-based trading company with international operations. The company has the following risk exposures:

- a contract to deliver 1,000 ounces of gold semi-annually for one year at a maximum price of \$400 USD per ounce
- beginning of period 1 year LIBOR (in USD) on a \$10,000,000 bank deposit payable at the end of the year
- 7,000,000 Euro receivable from financing a customer purchase due in 1 year

You are given the following information:

- Available hedging instruments include currency forwards, USD swaps, and gold options.
- Current exchange rate = .75 Euro / \$1 USD
- Risk free rates

	USD	Euro
6 month	2.5%	4.0%
1 year	3.0%	5.0%

Swap rates (USD)	Floating rate	Fixed Rate
	6 month LIBOR	2.75%
	1 year LIBOR	3.25%

- Option price per 1 ounce gold contract with strike of USD 400:

	Buy Call	Sell Call	Buy Put	Sell Put
6 month	4.0	3.6	6.0	5.2
1 year	6.0	5.6	8.0	7.2

- Describe the advantages of managing risk of strategic exposures in general as defined in Chew.
- Propose a methodology to completely hedge the company against its strategic risks.
- Calculate the market value of the risks in USD.

- 19.** (6 points) BB No-Show Inc, a US company, is negotiating to buy a Japanese company. The deal is expected to be closed in 3 months, with cash payment in Japanese Yen.

The chief financial officer of BB No-Show Inc has decided to buy an at-the-money call option on Japanese Yen to hedge against a sudden increase in Yen relative to the US dollar.

You are given the following information:

- Option type: at-the-money European call option.
- Maturity date of the option: 3 months (65 trading days)
- The option-holder has the right to buy 220 billion of Japanese Yen.
- US Treasury bond rates are 1% compounded continuously
- Japanese government bond rates are 0.05% compounded continuously
- Current exchange rate: 1 USD = 110 Japanese Yen
- Japanese Yen / USD exchange rate has daily volatility of 0.62%

An asset price S follows the stochastic process $dS = \mathbf{m}Sdt + \mathbf{s}Sdz$

- (a) Apply Ito's lemma to derive the process followed by $G = S \exp(r(T-t))$ where r is the risk-free rate and $(T-t)$ is the time to maturity.
- (b) Interpret the derived stochastic process if G is a stock paying dividends at a continuous rate.
- (c) Define the stochastic process of G in the risk neutral world, assuming G is the spot foreign exchange rate.
- (d) Calculate the value of the call option using the applicable Black-Scholes formula for this call option on Japanese Yen.

20. (3 points) You are given the following information at time $t = 0$:

- Total assets supporting participating life = \$74,081,822
- Total participating life liabilities = \$66,673,640
- Maturity of policy = 10 years
- Guaranteed interest rate of the policy = 3% continuously compounded
- 10-year European call option values for an asset with current price \$74,081,822:

Strike price	Call Value
\$85,000,000	\$8,520,220
\$90,000,000	\$7,625,000
\$95,000,000	\$4,502,535
\$100,000,000	\$1,204,330
\$105,000,000	\$820,300

Calculate the equilibrium participation level for policyholders.

****END OF EXAMINATION****
AFTERNOON SESSION