Exam AFE

AFTERNOON SESSION

Date: Friday, April 29, 2011
Time: 1:30 p.m. – 4:45 p.m.

INSTRUCTIONS TO CANDIDATES

General Instructions

1. This afternoon session consists of 8 questions <u>numbered 7 through 14</u> for a total of 60 points. The points for each question are indicated at the beginning of the question. There are no questions that pertain to the Case Study in the afternoon session.

2. Failure to stop writing after time is called will result in the disqualification of your answers or further disciplinary action.

3. While every attempt is made to avoid defective questions, sometimes they do occur. If you believe a question is defective, the supervisor or proctor cannot give you any guidance beyond the instructions on the exam booklet.

Written-Answer Instructions

1. Write your candidate number at the top of each sheet. Your name must not appear.

2. Write on only one side of a sheet. Start each question on a fresh sheet. On each sheet, write the number of the question that you are answering. Do not answer more than one question on a single sheet.

3. The answer should be confined to the question as set.

4. When you are asked to calculate, show all your work including any applicable formulas.

5. When you finish, insert all your written-answer sheets into the Essay Answer Envelope. Be sure to hand in all your answer sheets since they cannot be accepted later. Seal the envelope and write your candidate number in the space provided on the outside of the envelope. Check the appropriate box to indicate morning or afternoon session for Exam AFE.

6. Be sure your written-answer envelope is signed because if it is not, your examination will not be graded.

Tournez le cahier d'examen pour la version française.

7. (*5 points*) You are a consultant hired by the Board of Directors of Plantain Whole Life (PWL) to help assess its internal control systems for actuarial aspects of financial reporting under Sarbanes Oxley 404. Regarding the actuarial aspects of the financial reporting process, the following observations are made:

- There is one actuary who calculates GAAP reserves, DAC and other actuarially determined values.

- The claims system feeds the main administration system mid-month. The main administration system is a commercially available application and provides the inforce data used by the actuary for the reserve calculations at quarter-end. It also has a statutory reserve calculation utility.

- For year-end GAAP valuations, the actuary calculates reserves using a commercially available actuarial projection software system that he has customized for PWL. These reserves are brought into a database for manipulation before being summarized in a spreadsheet. A table in this spreadsheet is then copied into an email and sent to the accountant who reports these results.

- For periods other than year-end, the actuary estimates GAAP reserves and DAC based on the statutory reserves calculated by the administrative system.

Regarding your review of the actuarial aspects of the internal control systems:

(a) (*1 point*) Identify and describe the four key risk areas used to characterize the "risk profile" of the actuarial financial reporting process under Sarbanes Oxley.

(b) (*2 points*) Describe specific kinds of business risks related to its actuarial financial reporting process that PWL may encounter.

(c) (*2 points*) Recommend adjustments to PWL's actuarial processes that may help to reduce the kinds of business risks identified in (b).

8. (*8 points*) You are given the probability distributions for credit default losses for each security held in a portfolio and asked to produce a single probability distribution for aggregate portfolio credit default losses.

(a) *(2 points)* Describe the bottom-up and top-down approaches to modeling the aggregate credit default loss without the use of copulas and the difficulties each of these approaches presents.

(b) *(1 point)* Define "copula," and describe how copulas can simplify your modeling of the aggregate credit default loss.

(c) *(2 points)* Assume you have been given the copula $C(X, Y)$, where X and Y are two random variables that are not independent of each other. Describe how you would determine $E[S]$, where $S = X + Y$.

(d) *(3 points)*

    (i) Explain upper and lower tail dependence.

    (ii) Applying the appropriate limits, determine the lower tail dependence for the following copula:

$$C(x, y) = xy/(x + y - xy)$$

    (iii) State whether lower or upper tail dependence is more relevant to credit default risk, and explain why.

9. (*5 points*) You are a consultant hired by the Board of Directors (BOD) of Ropa Vieja Life (RVL) to evaluate its governance framework. You make the following observations:

- The BOD consists of twenty-five people, twenty with backgrounds in manufacturing. To add insurance expertise, the other five members of the BOD are from RVL's senior management team.

- RVL recently created a Chief Risk Officer (CRO) role which reports to various BOD committees.

- The Chief Actuary reports to the Chief Financial Officer (CFO) and is rarely invited to BOD reviews.

- For their service on the BOD, directors get compensated primarily with stock options.

(a) (*1 point*) Describe the ideal Board governance framework that is applicable to the insurance sector using Moody's perspective.

(b) (*4 points*) Evaluate RVL relative to Moody's perspective on ideal Board governance, and recommend four changes which would help RVL improve its governance framework.

10. (*8 points*) Hamsik Life calculates Economic Capital (EC) for its Individual Disability Income (IDI) product line using the liability runoff approach. For the IDI product line, guaranteed renewal premiums are paid annually to attained age 65 and are determined using an interest rate assumption of 6%.

    (a)   (*1 point*) Identify and describe three aspects of morbidity risk in the IDI product line that Hamsik should consider when modeling this risk.

    (b)   (*1 point)* Explain why using an industry morbidity table may be insufficient to assess Hamsik's morbidity risk exposure in its IDI product line.

    (c)   (*3 points*) The Chief Risk Officer (CRO) of Hamsik has observed that the fixed renewal premiums are a series of embedded call options on interest rates. As such, the CRO is considering entering into a series of forward starting interest rates swaps to hedge the risks associated with granting these options.

        (i)   Explain how Hamsik could use this offsetting derivatives strategy to hedge $100 million of IDI premium coming due in three years.

        (ii)   Describe the trades at both time zero and at the end of three years.

    (d)   (*1 point*) Identify two concerns that the CRO of Hamsik may have with the strategy described in part (c) above.

    (e)   (*2 points*) Hamsik is considering two other strategies to mitigate the interest rate risk associated with the IDI block. These are:

        (i)   For new issues, re-price using a 1% interest rate assumption in place of the 6% assumption;

        (ii)   Coinsurance of IDI inforce block.

    Evaluate these options and their effectiveness in mitigating the interest rate risk.

11. (*10* points) Arroz Life currently offers a guaranteed minimum maturity benefit (GMMB) on its variable annuity contracts, and is planning to add a guaranteed minimum income benefit (GMIB). The GMIB will guarantee a minimum conversion rate, g, of the lump sum separate account value balance to a fixed whole-life annuity at the maturity date.

You are assessing the GMIB using a single, representative contract on a male age 50, with a conversion rate of 10% ($g = 0.1$) maturing at age 65 ($n = 15$ years) with the initial fund value of $100 invested in an S&P 500 equity fund.

Current long-term interest rates are 4%. You assume a flat yield curve with long-term yields following an AR(1) process defined by the following:

$\ln(1+i_t) = 0.07 + 0.97(\ln(1+i_{t-1}) - 0.07) + 0.004\,\varepsilon_t,$ where ε_t are independent and identically distributed $\sim N(0,1)$.

A random discounted annuity is given by:

$$a_{65}^d(t) = B(t,n)a_{65}(n)$$

Where $B(t,n)$ is a stochastic discount factor which is the value at t of a unit sum payable at n, where there is no default risk. Assume that $a_{65}^d(t)$ has a lognormal distribution.

You are considering implementing a dynamic hedge (H_t) for a GMIB comprised of three investment components:

- H_t^a: a forward annuity (a) with term $n - t$;
- H_t^B: a bond component; and
- H_t^F: an S&P 500 equity fund.

Where $H_t = H_t^a + H_t^B + H_t^F$
$H_t^a = F_t g a_{65}^d(d_1(t))\Phi(t)$
$H_t^B = -F_t g a_{65}^d(t)\Phi(d_1(t))$
$H_t^F = F_t \{g a_{65}^d(t)\Phi(d_1(t)) - \Phi(d_2(t))\}^2$

11. Continued

You are given:

Long-Term Yield i	Fixed Whole Life Annuity Paying $1 per annum to Male Aged 65: $a_{65}(15)_i$
4%	11.30
5%	10.38
6%	9.57
7%	8.87

(a)   (*2 points*) Identify the similarities and differences in assessing capital requirements for the GMIB versus the GMMB using an actuarial approach.

(b)   (*1 point*) Assess the appropriateness of the 10% conversion rate.

(c)   (*4 points*) Complete the table of values below given a simulated random normal variate of 2.164 for $t = 1$. Show your work.

t	n	i_t	$B(t,n)$	$a_{65}(n)_i$	$a_{65}^d(t)$	F_t	$\Phi(d_1(t))$	$\Phi(d_2(t))$	H_t
0	15	4%	$B(0,15)$	11.30	$a_{65}^d(0)$	100	0.0104	0.0061	H_0
1	15	i_1	$B(1,15)$	$a_{65}(15)_i$	$a_{65}^d(1)$	110	0.0004	0.0002	H_1

(d)   (*2 points*) Identify potential shortcomings with the dynamic hedging strategy described above and the associated assumptions. Recommend possible enhancements.

(e)   (*1 point*) Describe a potential static replication approach that Arroz could employ to manage the GMIB risk.

12. (*10 points*) Wier Green (WG) is a widely held, well capitalized, debt-free publicly traded paper producer. Recently, WG has experienced large income volatility attributed to the following two factors:

- Significant fluctuations in the price of pulpwood, a main input to the paper production process;

- An inability to pass along cost increases to its customers.

(a) (*2 points*) Describe five considerations companies should take into account when deciding whether to hedge risk or manage risk.

(b) (*3 points*) Explain the advantages and disadvantages of managing versus hedging WG's exposure to pulpwood price volatility.

(c) (*2 points*) The CFO of WG has proposed acquiring TreeToppler, a primary producer/wholesaler of pulpwood, to hedge their exposure to pulpwood price volatility. The proposed acquisition price is $55/share. TreeToppler is currently trading at $50.

Evaluate the CFO's rationale for the acquisition from the perspective of WG's shareholders.

(d) (*3 points*) WG is considering modernizing its production process by investing heavily in a new and costlier technology. The new technology is much more environmentally friendly than the prevailing technology because it uses less pulpwood.

    (i)   Describe the five steps of the process through which this disruptive technology can displace currently prevalent technology.

    (ii)   Explain the strategic implications for WG of investing in the new technology.

13. (*9 points*) You are a modeling actuary for Juan Life & Annuity (JLA), a small US life insurance firm. JLA's product portfolio consists of:

- Universal Life: Most policies were sold several decades ago when interest rates were high. The guaranteed crediting rate on the majority of the business is greater than or equal to 4%.

- Term Policies: The term product has had better than expected mortality for each of the last 10 years.

- Single Premium Immediate Annuities (SPIA): 70% of SPIAs are basic 10-year certain and life policies. 20% are joint, last-to-die-policies. 10% are indexed to inflation using the Consumer Price Index (CPI). Numerous manual adjustments have been made to the administrative system to correctly reflect the inflation indexing.

- Variable Annuities (VA): VAs were sold with GMDBs and GMIBs which are not hedged. This product is no longer offered due to recent market volatility.

The Chief Actuary of JLA asks you to create an Economic Capital model. She suggests starting with the company's deterministic cash flow testing models that use seven specified scenarios for asset adequacy analysis. She recommends using a one-year mark-to-market approach but has not decided on other key aspects of the project.

(a)   (*2 points*) Describe four ways to mitigate model risk.

(b)   (*2 points*) Describe the changes that will need to be made to the cash flow testing models to create the Economic Capital model.

(c)   (*1 point*) Describe two advantages and two disadvantages of using stress scenarios for Economic Capital analysis.

(d)   (*4 points*) For each of the four products, propose two significant stress scenarios for assessing JLA's exposure to risk. Justify your proposal.

14. (*5 points*) Consider the following:

Case 1: A medium-sized Canadian bank has its Chief Investment Officer approve the overall risk management strategies of the company.

Case 2: A multi-national bank based in London (operating in different currencies) reports all exposures to supervisory authorities in Euros.

Case 3: A German bancassurance company ignores illiquid instruments in its stress testing under the assumption that the instruments' market value would have little to no change.

(a) (*2 points*) For Case 1:

  (i) Identify concept(s) from the Basle framework which apply to this case.

  (ii) Identify concept(s) from the OSFI framework which apply to this case.

  (iii) Describe how the case is deficient relative to these frameworks and propose a corrective action.

(b) (*1 point*) For Case 2:

  (i) Identify concept(s) from the Basle framework which apply to this case.

  (ii) Describe how the case is deficient relative to this framework and propose a corrective action.

(c) (*2 points*) For Case 3:

  (i) Identify concept(s) from the COSO framework which apply to this case.

  (ii) Identify concept(s) from the Basle framework which apply to this case.

  (iii) Describe how the case is deficient relative to these frameworks and propose a corrective action.

END OF EXAMINATION
Afternoon Session

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