Foundations of CFE Exam

Exam CFEFD

MORNING SESSION

Date: Wednesday, October 31, 2018
Time: 8:30 a.m. – 11:45 a.m.

INSTRUCTIONS TO CANDIDATES

General Instructions

1. This examination has a total of 100 points. It consists of a morning session (worth 60 points) and an afternoon session (worth 40 points).

   a) The morning session consists of 7 questions <u>numbered 1 through 7</u>.

   b) The afternoon session consists of 5 questions <u>numbered 8 through 12</u>.

   The points for each question are indicated at the beginning of the question. Questions 1 – 4 pertain to the Case Study.

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 because 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 CFEFD.

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

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Tournez le cahier d'examen pour la version française.

CASE STUDY INSTRUCTIONS

The case study will be used as a basis for some examination questions. Be sure to answer the question asked by referring to the case study. For example, when asked for advantages of a particular plan design to a company referenced in the case study, your response should be limited to that company. Other advantages should not be listed, as they are extraneous to the question and will result in no additional credit. Further, if they conflict with the applicable advantages, no credit will be given.

> ***Questions 1 – 4 pertain to the Case Study.***
> ***Each question should be answered independently.***

1.   (*8 points*)

   (a)   (*2 points*)

   (i)   Explain why the cost of capital for an insurance company may be higher than what is implied by its beta (stock market correlation).

   (ii)   Assess the appropriateness of Blue Ocean's hurdle rate (Case Study, Section 5.1.7) compared to RPPC's cost of capital (Case Study, Section 1.2.6).

   (b)   (*1 point*) Describe two frictional costs that Blue Ocean (Case Study, Section 5) should consider in its capital plan.

   (c)   (*2 points*) Explain four factors that RPPC's board should consider when evaluating capital allocation decisions of Blue Ocean's management.

   (d)   (*2 points*) Explain three business reasons for Blue Ocean to use insurance-linked securitization (ILS) rather than reinsurance on its Marine Claims line.

   (e)   (*1 point*) Blue Ocean is considering a dividend payment plan or a share repurchase.

   (i)   Describe why share repurchases and dividend payments are equivalent in perfect capital markets.

   (ii)   Explain the concern RPPC may have with Blue Ocean paying dividends instead of repurchasing shares.

2. (*10 points*) To finance its potential expansion into Vietombia (Case Study - Section 4.3), Frenz analyzes funding sources that would not increase the firm's leverage ratio.

(a)   (*1 point*) Assess the appropriateness of the following sources of capital for Frenz's Vietombia expansion.

(i)   Angel investors

(ii)   Private placement

You've been asked to put together a business plan for the Vietombia expansion. The following questions should be addressed:

I.   How will we know that the expansion will be successful?
II.   Who else is using this strategy? Who may implement this strategy in the near future?
III.   What advantages do we have over other firms?

(b)   (*3 points*) Explain how each of questions I-III will be addressed in your business plan.

(c)   (*1 point*) Explain how Frenz's growth from the Vietombia project could impact shareholder value.

RPPC has considered setting up a Corporate Venture Capital Division (CVCD) to further diversify the business and support its current companies.

(d)   (*1 point*) Describe three benefits to Frenz if RPPC chooses to set up a CVCD.

(e)   (*3 points*)

(i)   Identify three fundamental metrics that Frenz is using to evaluate its projects for further capital investment.

(ii)   Provide an example of how Frenz is using each of the metrics identified in part (i).

(f)   (*1 point*) Explain why Frenz's hurdle premium may be different from Blue Jay Tire's.

3. (*7 points*) Frenz decided to invest in Vietombia and has completed construction of its new production facility. An earthquake has damaged the facility and disrupted local operations, and Frenz requires short-term financing to cover $3.2M in facility repair expenses.

(a) (*1 point*) Describe the following three types of collateralized loans.

(i) Floating lien

(ii) Trust receipt

(iii) Warehouse arrangement

Frenz has secured a 12% annual percentage rate (APR) loan for the three months it will take to repair the facility. It plans to use its coffee bean inventory as collateral and the lender requires a warehouse arrangement to secure the loan. The warehouse fee is $40,000 paid at the end of the term.

(b) (*1 point*) Calculate the effective annual rate of the loan. Show your work.

Following the earthquake and Frenz's subsequent recovery, RPPC has determined that the catastrophe response was insufficient. A consultant has recommended RPPC appoint an advisory board to address future incidents.

(c) (*2 points*) Recommend two appointments from staff at existing RPPC companies for the catastrophe advisory board. Justify your recommendations.

RPPC has also asked for changes to Frenz' compensation packages to retain key employees during recovery from catastrophic events. Frenz has proposed increasing the amount of compensation paid in stock options, which will be awarded six months after a catastrophe.

(d) (*2 points*)

(i) Describe two potential conflicts of interest that may be introduced by this type of compensation.

(ii) Propose two ways to adjust the catastrophe compensation package that reduces the conflicts you identified in part (i).

Additionally, Frenz decides to offer unlimited vacation after the resolution of a company catastrophe to retain key employees.

(e) (*1 point*) Describe possible effects of this employee benefit change.

4. (*8 points*) A consulting actuary has been hired to review Blue Ocean's Solar Energy Insurance reserve model (Case Study Section 5.2.4).

(a) (*2 points*) Describe four examples of model risk within the Blue Ocean reserve model.

(b) (*2 points*) Recommend four methods for reducing Blue Ocean's model risk. Justify your recommendation.

Projected reserves (Case Study, Section 5.2.3) are highly dependent on the amount of solar production lost when mechanical issues occur. Jay Brown admitted to setting this assumption conservatively based on wind farm data. The consultant will provide greater accuracy for the assumption.

(c) (*2 points*) Design a method for a more reasonable estimate of the amount of solar production lost when mechanical issues occur using a Fermi-style analysis.

Assume:

- A five-year time horizon (i.e. reserves are released after five years)
- Reserves are calculated at the beginning of each year and do not change
- Blue Ocean's cost of capital is 12%
- Reserves earn a 5% return on investment
- Ignore the impact of taxes
- Probability distribution of reserve changes:

Probability	Change in Reserve	Management Action
40%	10% reduction	Continue project
30%	20% reduction	Continue project
30%	10% increase	Abandon project

(d) (*2 points*) Calculate the maximum amount that Blue Ocean should pay the consultant for a better estimate of the amount of solar production lost when mechanical issues occur.

5. (*8 points*) Nelson Life is converting its variable annuity actuarial projection and valuation models to a new modeling platform. The Chief Modeling Officer (CMO) for Nelson Life and her modeling team will be responsible for all aspects of the conversion.

The CMO wants to assign roles and responsibilities to each of the members of the modeling team.

    (a)   (*3 points*)

        (i)   Propose a structure for the modeling team that would encourage compliance with the Proposed Modeling ASOP.

        (ii)   Propose the scope of responsibilities for each sub-team of the modeling team.

        (iii)   Identify the major model risk that each sub-team would be responsible for managing.

The new modeling platform is a closed vendor system, with limited ability to view the internal logic or customize the code.

    (b)   (*3 points*)

        (i)   Assess two model risks which are likely to be lower due to using a closed system. Justify your response.

        (ii)   Assess two model risks which are likely to be higher due to using a closed system. Justify your response.

        (iii)   Propose actions to mitigate the risks identified in part (ii) above.

5. Continued

As part of the year-end audit, Nelson Life was provided a list of observations related to the current variable annuity model used in production.

I. A list of permissions showed that the variable annuity model could be accessed by 45 employees that worked outside of the variable annuity user group.
II. In the year-end report for the model, management includes a footnote that a legacy block, accounting for 0.1% of the risk exposure as of 12/31/2017, is not included in the model due to a known model limitation.
III. The mortality improvement assumption in the model was different from the documented assumption approved by management.
IV. The projected death benefits from the model for calendar year 2017 did not accurately reflect the death benefits that were paid out in 2017.

(c) (*2 points*)

(i) Evaluate whether each observation is a potential violation of the Proposed Modeling ASOP. Justify your answer.

(ii) Propose a risk mitigation solution for each violation identified in part (i).

6. (*11 points*) Blake Corporation sells variable annuities targeting client ages 40-65. Blake's CRO wants to model the longevity risk in its annuities to determine the capital Blake should hold for the risk.

Blake uses the following model to project future mortality:

$$\ln\left(m_{x,t}\right) = a_x + b_x k_t$$

where $m_{x,t}$ is the mortality rate for age x over the period $[t, t+1)$, a_x and b_x are age-specific constants calibrated to actual data, and k_t follows the process:

$$k_t = k_{t-1} + d + e_t \ (d \sim \text{constant drift}, \ e_t \sim N(0,v))$$

It is currently year "Y", and mortality has improved steadily for the last 80 years. Blake calibrated the model with industry data from year "Y-80" to "Y-40", and simulated k_t from year "Y-40" to "Y-1". The graphs below show simulated paths with 95% confidence intervals.
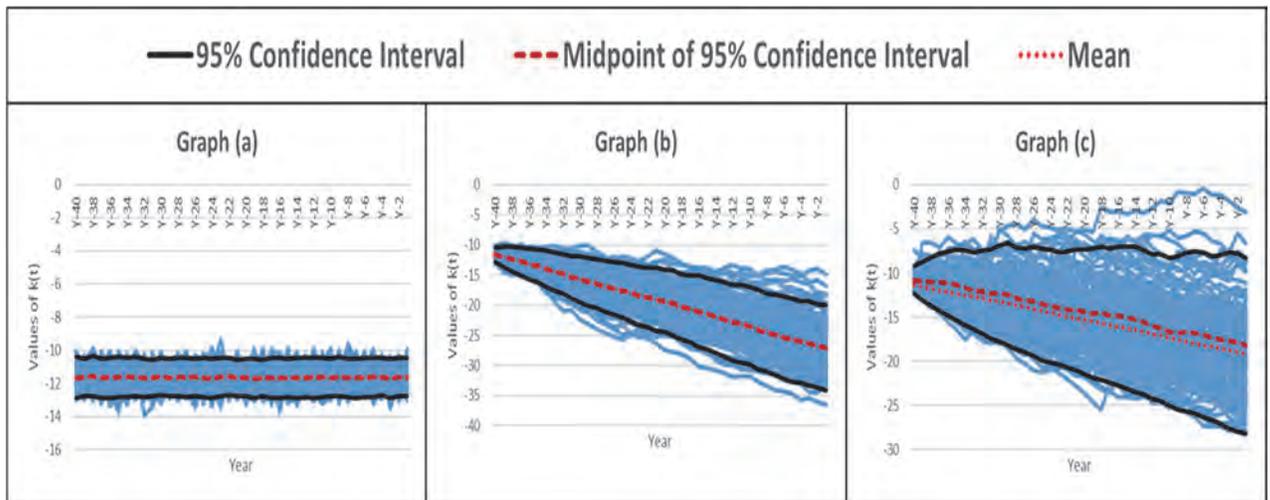
(a)   (*2 points*)

(i)   Explain which graph illustrates the correct simulation.

(ii)   Explain why the other two graphs are incorrect.

6. **Continued**

Assume that k_t is correctly simulated. Blake projected 1,000 mortality rates per year for "Y-40" to "Y-1". The graphs below show the 95% confidence intervals implied by simulation vs. actual mortality. Assume ages less than 40 are mapped to age 25, and ages above 40 are mapped to age 50.
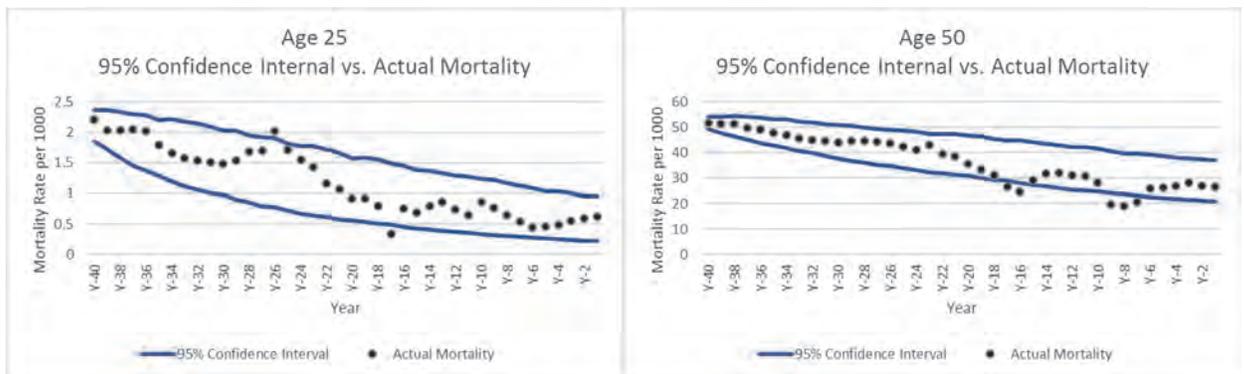
(b)   (*2 points*) Analyze the fit of the calibrated model for mortality rates.

Blake is considering both a second model and additional mortality data back to year "Y-100". The period between year "Y-100" and "Y-80" included a major war. Blake calibrated the two models and projected 1,000 mortality rates for each of the past 40 years.

	Model 1	Model 1	Model 2	Model 2
Time period used for calibration	[Y-100, Y-40]	[Y-80, Y-40]	[Y-100, Y-40]	[Y-80, Y-40]
Total Mean Squared Error	0.00015	0.0001	0.003	0.0001
Total number of outliers for ages 0-39	81	77	305	150
Total number of outliers for ages 40-65	134	126	284	56

Note: $Total\ Mean\ Squared\ Error = \sum_{age=0}^{65}\left(\frac{\sum_{i=1}^{T}\left(projected\ mortality - actual\ mortality\right)^2}{T}\right)$

where T = number of projection years.

(c)   (*3 points*)

   (i)   Evaluate the performance of the two models with the two calibration time periods.

   (ii)   Recommend the model and calibration time period for modeling Blake's variable annuities.

Question 6 continued on the next page.

6. **Continued**

Blake also sells 10-year term life insurance, using static assumptions for base mortality and mortality improvement based on Blake's experience. A consultant suggests using the term life insurance mortality improvement assumptions for Blake's variable annuities, with deterministic shocks to model longevity risk.

(d)   (*2 points*)

(i)   Analyze the appropriateness of the mortality assumptions used for term life insurance.

(ii)   Critique the consultant's approach for modeling longevity risk for variable annuities.

Recently, many of Blake's competitors are repeatedly lowering annuity prices to compete for business. Blake's stochastic pricing model suggests that the competitors' prices are unprofitable. Thus, Blake believes it is unlikely that its competitors are using stochastic pricing models.

(e)   (*2 points*)

(i)   Describe one possible game theory scenario that could explain the current market situation.

(ii)   Propose Blake's best course of action given the competitive environment. Justify your proposal.

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7. (*8 points*) Your company employs 1,000 sales representatives.   You are considering whether or not to hire a sales assistant for each sales representative. You are given the following data:

Additional total company revenue from 1,000 sales assistants

Revenue ($ million)	Probability
0	20%
25	30%
100	30%
200	20%

- Cost of a sales assistant: $30,000
- One-time fixed hiring costs: $3 million

(a)   (*3 points*)

(i)   Describe Expected Value of Perfect Information (EVPI).

(ii)   Explain how EVPI can help make the decision of whether to hire 1,000 sales assistants.

(iii)   Calculate the EVPI for the decision to hire 1,000 sales assistants. Show your work.

You run a pilot program which hires ten sales assistants and track the results for a year. You observe the following:

- Total revenue increase is $700,000.
- The sum of the squared revenue increases is $70.4 billion.
- There are no fixed costs allocated to the pilot program.

(b)   (*2 points*)

(i)   Calculate the 90% confidence interval for the mean revenue increase using the data above. Show your work.

(ii)   Recommend whether to hire sales assistants for each sales representative. Justify your recommendation.

7. **Continued**

(c) (*3 points*)

(i) Describe two drawbacks of the pilot program for making the hiring decision.

(ii) Propose two alternate methods that address these drawbacks. Justify your proposals.

END OF EXAMINATION
Morning Session

USE THIS PAGE FOR YOUR SCRATCH WORK