
SOCIETY OF ACTUARIES
Foundations of CFE Exam

Exam CFEFD

MORNING SESSION

Date: Wednesday, May 4, 2016

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 8 questions numbered 1 through 8.
 - b) The afternoon session consists of 5 questions numbered 9 through 13.

The points for each question are indicated at the beginning of the question. Questions 1-6 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.

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.

****BEGINNING OF EXAMINATION****

Morning Session

*Questions 1 – 6 pertain to the Case Study.
Each question should be answered independently.*

1. (6 points) At the annual capital budget meeting, Big Ben's (Case Study 6.1.4) senior leaders are discussing Basel III's impact on the bank's future capital requirements. Several division leaders complain that regulatory capital and economic capital metrics give very different results.

(a) (3 points)

- (i) Describe two methods that can be used to align regulatory capital and economic capital.
- (ii) Recommend one of the methods from (i) for Big Ben to use. Support your recommendation.

Division leaders bring up the following projects while negotiating next year's capital budget:

- Lowering the minimum initial investment requirement
- Repositioning the travelers' cheque business
- Growing the credit card program
- Expanding the partnership with the insurance division

(b) (2 points)

- (i) Assess the capability of Big Ben's current budget process for allocating the appropriate amount of capital to the above items. Justify your answer.
- (ii) Recommend possible improvements to Big Ben's capital budget allocation process.

Big Ben has recently facilitated an insurance-linked securitization with Blau Company, a European insurance company that specializes in stop-loss insurance for commercial property. Big Ben's CFO tells Darwin's CEO (Case Study Section 7), "You should consider securitizing some of Darwin's existing liabilities instead of using reinsurance. Blau is pretty happy with securitization."

(c) (1 point) Recommend whether Darwin should follow Big Ben's CFO's suggestion. Justify your recommendation.

*Questions 1 – 6 pertain to the Case Study.
Each question should be answered independently.*

2. (7 points) Blue Ocean’s Solar Personal Energy Insurance proposal relies on a key estimate of “Average purchase rate for solar energy per kWh”. Assume that the 11 years of data in the Able Energy table (Case Study 5.3) are independent and identically distributed estimates.

(a) (1 point) Estimate the 90% confidence interval for the true mean purchase rate using the simple methodology in Douglas Hubbard’s, *How to Measure Anything*.

Assume the purchase rates in the Able Energy table of Case Study Section 5.3 are normally distributed with a population variance of 150 cents.

(b) (2 points) Calculate the 90% confidence interval for the true mean of the purchase rate using the same 11 years of data.

Blue Ocean is usually successful on about half the programs it attempts. Able Energy Consulting argues that in their experience, where the purchase rate was 75 cents or greater, 90% of the programs were successful. Further, if the purchase rate was less than 75 cents, only 25% of the programs were successful.

(c) (2 points) Determine the probability that the true average purchase rate is less than 75 cents. Show your work.

(d) (1 point) Recalculate Blue Ocean’s probability of a successful program. Show your work.

One key to Jay Brown’s future analysis is the spread between what it costs to generate solar energy and the purchase rate. Brown says that his point estimate of a 20-cent differential is “slightly conservative” and that although he hasn’t done any scientific studies, his 90% confidence interval for the spread around his point estimate is +/- 3 cents.

(e) (1 point) Provide three reasons why Brown’s 90% confidence interval might not represent a 90% probability.

*Questions 1 – 6 pertain to the Case Study.
Each question should be answered independently.*

- 3.** (12 points) The management of Frenz (Case Study Section 4) has asked your firm to assist in estimating their risk of loss from coffee price fluctuations.
- (a) (1 point) Identify three methods to improve probability calibration appropriate for Frenz.
 - (b) (2 points) Explain how two of the three methods from (a) can be used to estimate the 95th percentile of potential losses.

Robert Kaplan, CRO of Frenz, is worried that the methodologies used in the past to calculate tail risk are not robust enough. He asks your firm for a report on Monte Carlo Simulation.

- (c) (2 points)
 - (i) Briefly describe Monte Carlo Simulation.
 - (ii) Evaluate the appropriateness of Monte Carlo Simulation for estimating the risk of loss from coffee price fluctuations.

Kaplan has decided to move forward with a Monte Carlo–based model and asks your firm to build it. After doing some research, you believe that Frenz’s earnings depend on price (P), exchange rate (ER), supply-chain prices (SCP), operational risk (OR) and demand (D) and can be closely approximated as:

$$\text{Earnings} = (P \times (0.2 \times ER) - SCP - OR) \times (10 \times D)$$

Where:

P = Price level set by Frenz

$D = 10 - P$

$ER = 5 + A$, where $A \sim N(0,1)$

$SCP = 0.6 \times ER + B$, where $B \sim N(0,1)$

$OR = C$, where $C \sim U(0,2)$

Assume Frenz sets its price at 5.

3. Continued

To simulate Frenz's earnings, your firm uses a random number generator to create the following table:

Simulation	$F(A)$	$F(B)$	$F(C)$	Earnings
1	0.4602	0.0808	0.50	118
2	0.3446	0.6915	0.75	-8
3	0.1587	0.9918	0.60	?
4	0.1151	0.5793	0.95	-29
5	0.7580	0.3085	0.10	?

- (d) (3 points) Identify the least profitable of the five simulations above. Show your work.

Assume Frenz enters the exclusive Vietombia production deal (Case Study 4.2.3).

- (e) (2 points)
- (i) Describe how the components of the earnings equation might change.
 - (ii) Explain the impact on both average earnings and volatility of earnings.

Kaplan questions your firm about the distributions of variables in the model. You admit that the risk of operational losses uses mostly professional judgment while the other variables have been measured using significant amounts of historical data.

- (f) (2 points)
- (i) Explain why further research should begin by focusing on operational risk.
 - (ii) Explain why measuring operational risk may appear difficult to Frenz's risk managers.
 - (iii) Identify two operational risks (Case Study 4.3, Exhibit 2) that would increase due to entering the Vietombia production deal. Support your answer.

*Questions 1 – 6 pertain to the Case Study.
Each question should be answered independently.*

4. (8 points) You are the Risk Champion assigned to Darwin Life. To prepare for a rating agency review, all RPPC risk champions are being asked to report on model risk with regard to the risk appetite statement (Case Study 7.6). You decide to focus your report on the following principal risk models:

- I. Credit Risk
- II. Market Risk – Interest Rates
- III. Market Risk – Equities (IVA only)

(a) (1 point)

- (i) Define model risk.
- (ii) Label each of the three principal risk models (I, II, and III above) as a fundamental, descriptive, or statistical model.

(b) (3 points) Assess the following for each principal risk model. Include the impact on satisfying risk appetite statement provisions.

- (i) Missing risk factors
- (ii) Misspecified relationships

Tim Ballmer shares plans to change the rho calculation to a 0.0001% change in interest rates, so that a “pure” first-order sensitivity to interest rates can be measured. The hedging system has machine precision of 10^{-16} .

(c) (1 point) Evaluate Tim’s plan with respect to model risk.

Your discussions of shortcomings in model risk are met with resistance at Darwin, where the strategic focus is on expanding product distribution.

(d) (3 points) Propose two practices to manage specific model risks at Darwin while not disrupting Darwin’s strategic focus. Support your proposals.

**Questions 1 – 6 pertain to the Case Study.
Each question should be answered independently.**

- 5.** (6 points) Frenz Corporation has hired you to evaluate its possible expansion to Vietombia (Case Study 4.2.3). You propose stress testing on Frenz’s capital.
- (a) (1 point) Compare mechanical stress testing with scenario analysis.
 - (b) (2 points)
 - (i) Design a single stress test using scenario analysis to measure Frenz’s exposure to currency, liquidity, and supply chain risk in Vietombia.
 - (ii) Identify the type of scenario used in the single stress test.

The COO of Frenz expresses concern that stress testing, like VaR, is not a coherent risk measure. He also prefers the likelihood and “what if” results that Frenz currently obtains from VaR and ES measures.

- (c) (1 point) Critique the COO's statements. Support your critique.

The CRO of Frenz questions the amount of computational power, time, and money it takes to perform stress testing. However, he is pleased with the “big picture” view Frenz’s current VaR and ES systems currently provide.

- (d) (1 point) Critique the CRO's statements. Support your critique.
- (e) (1 point) Identify three common pitfalls of scenario analysis.

Questions 1 - 6 pertain to the Case Study.
Each question should be answered independently.

- 6.** (6 points) You have been hired by RPPC to review the corporate governance of Frenz.
- (a) (2 points) Compare U.S. corporations and partnerships in terms of:
 - (i) Ownership structure
 - (ii) Owners' liability
 - (iii) Tax implications
 - (iv) Organization longevity
 - (b) (1 point) Describe the role of corporate governance.
 - (c) (3 points)
 - (i) Describe the requirements under the Dodd-Frank Act that are meant to strengthen corporate governance.
 - (ii) Recommend four changes to Frenz's board structure (Case Study 4.3, Exhibit 1) to enhance the effectiveness of corporate governance. Justify your recommendations.

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7. (8 points) You are the CRO of a life insurance company. The interest rate environment is considered low. To improve return on assets, the CIO proposes a new, aggressive investment strategy for new cash flows.

Your department's intern, Violet, makes the following assertions regarding simulating the new investment strategy:

- I. Unlike its variance, the semi-variance of a random variable cannot be estimated via simulation.
- II. If a risk measure is convex and has positive homogeneity, sub-additivity follows.

- (a) (2 points) Critique each of Violet's assertions. Support your answers.

Violet fits the following parametric expressions for the current portfolio's expected return, X , and the new investment strategy's expected return, Y , where β is non-negative:

$P(X > F_X^{-1}(u), Y > F_Y^{-1}(u))$	$P(X > F_X^{-1}(u))$	$P(Y > F_Y^{-1}(u))$
$u^{2-\beta} - 2u + 1$	$1 - u$	$1 - u$

- (b) (3 points) Show that the upper and lower tail dependence of the current portfolio and the new portfolio are, respectively:

$$\Lambda_U(X, Y) = \beta, \text{ and}$$

$$\Lambda_L(X, Y) = \begin{cases} 0 & \text{if } \beta \neq 1 \\ 1 & \text{if } \beta = 1 \end{cases}.$$

7. Continued

The CIO wants to understand the implications of investing in the new aggressive portfolio if dramatic market changes occur within one year.

- (c) (3 points) Identify, in the table below, the scenario(s) for which you would recommend the new investment strategy. Justify your recommendation(s).

Expectation	Value of β		
	$\beta = 0$	$\beta = 1$	$\beta = 1.5$
The current portfolio is expected to experience a dramatic rise	(i)	(ii)	(iii)
The current portfolio is expected to experience a dramatic decline	(iv)	(v)	(vi)
The current portfolio is expected to experience a dramatic change with unknown direction	(vii)	(viii)	(ix)

8. (7 points) You have been hired as a consultant for a consortium of private equity firms (“the Consortium”) seeking to acquire the Lavendre Corporation, a U.S. company. The Consortium believes Lavendre has underperformed due to mismanagement.

(a) (1 point) Describe the free rider problem.

The Consortium has asked you to concentrate on a leveraged buyout (“LBO”) takeover strategy. The Consortium has created Eggshell Company as the takeover vehicle for the purchase of Lavendre.

The following table applies to the Lavendre Corporation:

Market Value of Equity	\$9 billion
Market Value of Debt	\$3 billion
Shares	300 million
Book Value of Equity	\$12 billion

Assume no frictional costs such as loan interest, taxes, or transactional costs. Assume Eggshell Company will be able to obtain a 10% toehold at \$35 per share, and will then tender \$40 per share for an additional 40% of the shares.

(b) (1 point) Calculate the amount of capital Eggshell Company needs to raise to purchase 50% of Lavendre.

The Consortium has secured a bank loan for 60% of Eggshell’s capital needs, using Lavendre’s shares as collateral for the loan. The remaining capital need will be financed by equity contributions from the Consortium’s member firms.

Assuming the Consortium will replace the existing Lavendre management, the value of Lavendre is expected to increase by \$3 billion.

(c) (2 points) Calculate the Consortium’s profit after completing the LBO.

After receiving news of the Consortium’s toehold and \$40 tender offer, Lavendre management found a white knight that offered \$42 per share for control of Lavendre.

The Consortium will now need to raise its bid to \$44 per share and secure a similar loan for 60% of the total purchase amount.

(d) (1 point) Calculate the Consortium’s profit from the LBO under the new terms.

8. Continued

(e) (2 points)

- (i) Calculate the share price of Lavendre after completion of the LBO takeover.
- (ii) Recommend whether the Consortium should pursue the takeover of Lavendre. Support your recommendation.

****END OF EXAMINATION****
Morning Session

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