CFE FD Model Solutions
Spring 2014

1.   **Learning Objectives:**
5.   The candidate will understand how to identify and recommend appropriate risk assessment and monitoring techniques for financial risk management.

Learning Outcomes:
(5b)   Describe the types of models and the sources of model risk.

(5c)   Assess the methods and process for quantifying and managing model risk within a financial institution.

Sources:
LO5-FC-T138-13 Dowd, Measuring Market Risk 2nd ed, Ch. 16

LO5-FC-N120-13 Kalberer & Ravindran, Variable Annuities, Ch. 8

LO5-FC-N121-13 Kalberer & Ravindran, Variable Annuities Ch. 9

Commentary on Question:
This question aims to test candidate's understanding on limitations of the Black-Scholes lognormal mode, as well as related issues on model risk. Candidates did moderately well on this question.

Solution:
(a)   Describe four reasons why using the Black-Scholes lognormal model to value the guarantee is inappropriate.

Commentary on Question:
Most candidates were able to answer two valid reasons on this analysis question. General comments simply saying that policyholder behavior cannot be modeled was counted as one valid reason. Other reasons than those shown below were also counted as valid. Comments regarding the Black-Scholes model being used in a risk-neutral setting were not counted as valid by themselves.

- The Black-Scholes lognormal model (B-S) is sensitive to changes in volatility but volatility cannot be directly observed.
- B-S cannot handle early exercise of an American option, e.g. policyholder behavior.
- B-S is not path dependent, resulting in some product features that cannot be priced properly

# 1.	Continued

*	B-S ignores transactions costs.

(b)	Describe four model risks, specific to valuing the guarantee, which remain even when an appropriate model is used.

Commentary on Question:
While most candidates were able to recall general model risk issues in this analysis question, many did not consider how they specifically applied to valuing the guarantee, resulting in partial credit. Other answers than those shown below were also given credit.

*	An insufficient number of scenarios may cause the value of the guarantee to be significantly different from its expected value
*	Data problems may produce an inappropriate value
*	Incorrect calibration of parameters may produce an inappropriate value
*	A poor random number generator may produce biased results

(c)	List four ways to protect against model risk.

Commentary on Question:
Candidates did fairly well on this retrieval question. Other answers than those shown below were also given credit.

*	Be aware of the limitations of the models they use
*	Identify, evaluate and check key assumptions
*	Test the models against known problems
*	Do not ignore small problems

2. **Learning Objectives:**
   3.   The candidate will understand how and when to apply various stochastic
          techniques to situations which have uncertain financial outcomes.

Learning Outcomes:
(3c)   Recommend the use of techniques to reduce the computational demand when
       applying stochastic methodology.

Sources:
LO3-FC-T120-13 Huynh, Lai, Soumare, Wiley, Stochastic Simulation and Applications
in Finance, Ch. 8

LO3-FC-T128-13 Dowd, Measuring Market Risk 2nd ed, Ch.8

LO3 FC-T123-13Huynh, Lai, Soumare, Wiley, Stochastic Simulation and Applications in
Finance Ch. 14

LO3-FC-T121-13 Huynh, Lai, Soumare, Wiley Stochastic Simulation and Application in
Finance Ch. 10

Commentary on Question:
*Candidates generally did quite poorly on this question. Failure to correctly identify and
use the inputs and information given in the question led candidates to attempt
unnecessary computations. Answers were not clearly laid out, making it difficult for
graders to follow the computations.*

Solution:
(a)   Calculate, analytically, the VaR(95%) of the payoff at maturity for Option A,
      given an expected payoff of 4.38. Show your work.

      Commentary on Question:
      *Most candidates did not use the formula for the stochastic price of the underlying
      stock on this analysis question. Some candidates failed to correctly identify the
      mean as being equal to the risk-free rate plus the risk premium and also
      misinterpreted other information and inputs given.*

      The analytical stochastic price of the underlying stock index S_T is:

      $S_T = S_0 e^{(\mu - 0.5\sigma^2)T + \sigma(T^{0.5})Z}$

      $S_0 = 100$
      $K = 100$
      $\mu = 0.01 + 0.09 = 0.1$
      $\sigma = 0.2$
      $T = 2$

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2. **Continued**

The analytical S_T at 95% downside, where $Z = -1.64$, is:

$S_T(95\%) = 100e^{(0.1 - (0.5)(0.2)^\wedge 2)(2) + (0.2)(2^\wedge 0.5)(-1.64)} = 73.80$

The 95% loss for option A is therefore:

$\text{Max}[0, K - S_T(95\%)] = \max[0, 100 - 73.80] = 26.20$

The VaR(95%) for option A is therefore:

$\text{VaR}_A(95\%) = \text{Loss at 95\%} - \text{Expected Payoff} = 26.20 - 4.38 = 21.82$

(b) Calculate the simulated VaR(95%) of the payoff at maturity for Option A, assuming the simulated expected payoff for Option A is 3.99. Show your work.

Commentary on Question:
Most candidates attempted this comprehension question. Some, however, did not use the formula for the simulated stock price using the Euler scheme, even though it was provided in the question.

Simulated price at time T=2, using Euler scheme with $\Delta t = 1$ and $\Delta W_k = Z * \Delta t^\wedge 0.5$

$S_1 = S_0 + \mu * S_0 * \Delta t + \sigma * S_0 * Z_1 * \Delta t^\wedge 0.5$
$\quad = 100 + 0.1 * 100 * 1 + 0.2 * 100 * (-1.5) * 1^\wedge 0.5$
$\quad = 80$

$S_2 = S_1 + \mu * S_1 * \Delta t + \sigma * S_1 * Z_2 * \Delta t^\wedge 0.5$
$\quad = 80 + 0.1 * 80 * 1 + 0.2 * 80 * (-0.75) * 1^\wedge 0.5$
$\quad = 76$

The 95% loss for option A is therefore:
$\text{Max}(0, K - S_2) = \max(0, 100 - 76) = 24$

The VaR(95%) for option A is therefore:
$\text{VaR}_A(95\%)_{SIM} = \text{Loss at 95\%} - \text{Expected Payoff} = 24 - 3.99 = 20.01$

(c) Calculate the simulated VaR(95%) of the payoff at maturity for Option B, assuming the simulated expected payoff for Option B is 3.38. Show your work.

Commentary on Question:
Most candidates who did not score well in this comprehension question did not realize that the payoff of the Asian option is the average of the stock price at time 1 and time 2 calculated in part (b).

2. **Continued**

The 95% scenario is the same for both option A and option B. Using the result from part (b): Average Price (annual) = $(S_1 + S_2) / 2 = (80 + 76) / 2 = 78$

The 95% loss for option B is $\text{Max}(0, K - (S_1 + S_2)/2) = \max(0, 100 - 78) = 22$

The VaR(95%) for option B is $\text{VaR}_B(95\%)_{SIM} = 22 - 3.38 = 18.62$

(d) Apply the control variate technique to improve the VaR(95%) of the payoff at maturity for Option B, using the results above. Show your work.

Commentary on Question:
Overall, candidates did relatively better in this comprehension question, as many showed understanding of the general concept, though some struggled to apply it using the answers of the first three parts.

The simulated VaR(95%) for option B with control variates, using results from all above:

$$\text{VaR}_{B'}(95\%)_{CV} = \text{VaR}_B(95\%)_{SIM} + \text{VaR}_A(95\%) - \text{VaR}_A(95\%)_{SIM}$$
$$= 18.62 + 21.82 - 20.01 = 20.43$$

(e) Evaluate whether using a control variate is appropriate in this situation.

Commentary on Question:
Candidates did all right with this knowledge utilization question. As an alternative to the answer below, candidates who identified that the two options were correlated but stated the control variate estimate would be more appropriate if using a different option that is more highly correlated with the Asian option received full credit.

The payoffs of option A and option B should be reasonably highly correlated as they have the same underlying stock index, same strike and same term, and similar payoff structure. This reduces the simulation variance of simulated value given the same number of simulations.

Therefore, the Control Variate technique is appropriate in this case.

3. **Learning Objectives:**
1. The candidate will understand how a business enterprise funds its activities with considerations for its business model, and the cost and constraints of the sources of capital.

2. The candidate will understand how an enterprise's structure and policies allow its management to prioritize and select among projects or business activities that are competing for scarce capital resources.

Learning Outcomes:
(1a) Describe the steps to procuring capital funding (treasury function).

(1b) Assess the various features and implications of various sources of capital funding and recommend the optimal approach for funding.

(2a) Evaluate how the legal form of an organization, corporate governance and/or compensation dynamics impact decision-making on projects or business activities.

Sources:
LO1-FC-T104-13 Jonathan Berk and Peter Demarzo, Coporate Finance, 2011, Second Edition, Ch. 23

LO1-FC-T105-13 Jonathan Berk and Peter Demarzo, Coporate Finance, 2011, Second Edition, Ch. 24

LO2-FC-T111-13 Jonathan Berk and Peter Demarzo, Coporate Finance, 2011, Second Edition, Ch. 16

Commentary on Question:
This question tested candidates' understanding of the costs and benefits of a company going public vs. remaining private. The focus is on the firm's investors and not necessarily on the firm itself. The investors gain liquidity by going public, but there may be a large "cost" for doing so in terms of the underwriting fee and underselling of the IPO. The benefits of the IPO are contrasted with the benefits of remaining private and issuing debt to raise capital.

Solution:
(a) Describe three ways an underwriter can take a firm public through an IPO.

   Commentary on Question:
   Most candidates received full credit for this comprehension question.

   - Firm commitment – the underwriter guarantees the sale of the issued stock at the agreed-upon price

3. **Continued**

- Best efforts – the underwriter agrees to sell as many shares as possible at the agreed-upon price
- Auction – the price of the offering is set after taking in all bids and determining the highest price at which the total offering can be sold

(b)   Assuming the CFO is correct:

(i)   Calculate the impact to the underwriter. Show your work

(ii)   Calculate the impact to the IPO investors. Show your work

Commentary on Question:
About half of the candidates received full credit for this comprehension question. A common mistake was in part (i), where some candidates thought the underwriter directly benefits from the large gain in the first day of trading.

(i)   The underwriter benefits by the underwriting fee of 7% * $16 * 5,000,000 = $5.6 million

(ii)   Investors benefit by the first day gain of ($32 - $16) * 5,000,000 = $80 million

(c)   Calculate the pre-IPO fair market value per share, assuming the CFO is correct. Show your work.

Commentary on Question:
Only a handful of candidates answered this analysis question correctly. Another handful was close, missing the underwriting fee, and received partial credit. Most candidates did not grasp what the question was asking for.

V = current market value of business before IPO.

Assuming CFO is correct,
$32 = (V + 93% * $16 * 5,000,000) / 10,000,000
V = $245,600,000

Market value per share is V divided by number of shares
= 245,600,000 / 5,000,000 = $49.12

(d)   Explain why the existing investors may still desire the IPO despite the potentially high cost

3. **Continued**

Commentary on Question:
A high percentage of candidates answered this analysis question correctly or received partial credit for an answer in the right direction. A common mistake was to answer the question from the viewpoint of the firm itself and not the firm's investors.

The IPO creates liquidity, providing a market for existing shares and allowing shareholders to redeem their investment and diversify their wealth.

(e) Describe how each of the following would impact the price of the individual bonds:
   (i) Higher call price, for a callable bond
   (ii) Higher conversion ratio, for a convertible bond
   (iii) Bond covenants

Commentary on Question:
Candidates struggled to answer this comprehension question correctly and completely. Common mistakes included answering how the yield is impacted rather than the price as well as answering how callable or convertible bonds differ from vanilla bonds without answering how a change in call price or conversion ratio impacts the price of the security.

   (i) A higher call price reduces the value of the bond issuers' call option and increases the price of the bond.
   (ii) A higher conversion ratio allows the bondholder to trade in the security for more shares and increases the price of the bond.
   (iii) More or stronger bond covenants limit the risk the firm can take and increase the price of the bond.

(f) Identify, in general, two advantages and two disadvantages of a debt issuance as compared to an IPO.

Commentary on Question:
The average candidate received half credit for this retrieval question. Other answers than those below also received full credit. Common answers that were not given credit include that debt issuance is cheaper and that debt generates agency costs.

Advantages:
- Debt creates a tax shield
- Investors retain control of the firm

Disadvantages:
- The investor's shares remain illiquid
- Potential distress costs increase

3. **Continued**

    (g)   Recommend whether to take Jessica's or Nick's recommendation, from the perspective of each of the following. Justify your recommendation.

        (i)   Angel Investors

        (ii)   CFO, who does not own any shares

Commentary on Question:
With recommendation questions it is not always clear what the best recommendation is. The justification for the recommendation is always at least as important as the recommendation itself. With this knowledge utilization question, there are tradeoffs with both funding methods. However, it is believed there is a better recommendation in this scenario given the facts and circumstances, and only partial credit was given for an incorrect recommendation. Roughly half of the candidates made correct recommendations.

        (i)   Angel Investors: Do the IPO (Jessica's recommendation), as our shares gain liquidity, we can know the market value of the shares, and we can sell shares and diversify.

        (ii)   CFO: Issue Debt (Nick's recommendation), as we will benefit from the tax shield, and encounter less regulatory costs. An IPO is expensive, and we retain the option to do the IPO later.

4. **Learning Objectives:**

3. The candidate will understand how and when to apply various stochastic techniques to situations which have uncertain financial outcomes.

Learning Outcomes:

(3a) Explain the mathematical foundation of stochastic simulation.

Sources:

LO3-FC-F116-13 Huynh, Lai, Soumare, Wiley, Stochastic Simulation and Applications in Finance, Ch. 1-4 (background)

LO3-FC-F123-13 Huynh, Lai, Soumare, Wiley, Stochastic Simulation and Applications in Finance, Ch. 14

LO3-FC-F120-13 Huynh, Lai, Soumare, Wiley, Stochastic Simulation and Applications in Finance, Ch. 8

Commentary on Question:

This question tested the basic understanding of stochastic calculus with applications within a Monte-Carlo simulation framework.

Solution:

(a) Show, by applying Ito's Lemma for $d(\ln X)$, that the solution of the equation above is:

$$X(T) = X(0)\exp\left[\left(\mu_X - \tfrac{1}{2}\sigma_X^2\right)T + \sigma_X\sqrt{T}Z\right]$$

where $T > 0$ and $Z \sim N(0,1)$

Commentary on Question:

This comprehension question was relatively straightforward. The candidates either knew the answer or did not. Most candidates did a good job answering it. While the answer below is somewhat formal, as long as the candidate demonstrated an understanding of the mathematical derivation, full credit could be earned. Some candidate did not show the integration of dlnX and lost a few marking points.

Ito's lemma:

$$dY = \left(\frac{\partial g}{\partial t} + a(X(t),t)\frac{\partial g}{\partial x} + \frac{1}{2}b^2(X(t),t)\frac{\partial^2 g}{\partial x^2}\right)dt + b(X(t),t)\frac{\partial g}{\partial x}dW$$

where $Y(t) = g(t,X(t))$

Let $Y = \ln X$, $a = \mu_X$ and $b = \sigma_X$, then

4. **Continued**

$$dY = d\ln X = \left(0 + \mu_X X\left(\frac{1}{X}\right) + \frac{1}{2}\sigma_X^2 X^2\left(-\frac{1}{X^2}\right)\right)dt + \sigma_X X\left(\frac{1}{X}\right)dW$$

$$d\ln X = \left(\mu_X - \frac{1}{2}\sigma_X^2\right)dt + \sigma_X dW$$

Integrating from 0 to T,

$$\int_0^T d\ln X = \int_0^T \left(\mu_X - \frac{1}{2}\sigma_X^2\right)dt + \sigma_X dW$$

Since W is a Weiner process:

$$\ln X(T) - \ln X(0) = \left(\mu_X - \frac{1}{2}\sigma_X^2\right)T + \sigma_X\sqrt{T}Z, \qquad where\ T > 0\ and\ Z\sim N\,(0,1)$$

$$\ln\left(\frac{X(t)}{X(0)}\right) = \left(\mu_X - \frac{1}{2}\sigma_X^2\right)T + \sigma_X\sqrt{T}Z$$

$$X(t) = X(0)\exp\left(\left(\mu_X - \frac{1}{2}\sigma_X^2\right)T + \sigma_X\sqrt{T}Z\right)$$

(b) Describe how to generate the correlated random variates Z_U and Z_f from independently generated standard normal variates Z_1 and Z_2.

Commentary on Question:
Candidates did very well on this comprehension question. The question called for a description of how to generate correlated random variables given the correlation matrix. Full marks were also given to candidates that wrote out the two-variable Cholesky decomposition and applied it correctly.

To generate the correlated random variables, use a Cholesky decomposition, which decomposes the correlation matrix of the two variables Λ as $\Lambda = LL^T$, where L is a lower triangular matrix. Then, generate the correlated random variates by multiplying the lower triangular matrix from the factorization of the correlation matrix by the vector of uncorrelated variates.

(c) Given a portfolio P where 200 A\$ is invested in the K\$-denominated index U at time 0 with the starting exchange rate $f(0) = 2$ A\$/K\$:

(i) Determine, at time 0, the value of P in terms of K\$.

(ii) Determine, at time T, the expression for P in terms of K\$.

(iii) Determine, at time T, the expression for f in terms of A\$/K\$.

4. **Continued**

      (iv)   Determine, at time *T*, the expression for P in terms of A$.

      Commentary on Question:
      This comprehension question was relatively straightforward and candidates
      either knew how to answer the question or they did not.

      (i) $P_0 = 200A\$ = 200\ A\$/(2\ A\$/K\$) = 100K\$$

      (ii) $P(T) = U_0 \exp\ [(\mu_u - \frac{1}{2}\ \sigma_u^2)T + \sigma_u\ \sqrt{T}\ Z_u]$
              $= 100 \exp\ [(\mu_u - \frac{1}{2}\ \sigma_u^2)\ T + \sigma_u\ \sqrt{T}\ Z_u]$

      (iii) $f(T)\ = f_0 \exp[(\mu_f - \frac{1}{2}\ \sigma_f^2)\ T + \sigma_f\ \sqrt{T}\ Z_f] = 2 \exp[(\mu_f - \frac{1}{2}\ \sigma_f^2)\ T + \sigma_f\ \sqrt{T}\ Z_f]$

      (iv) $P(T)f(T) = 200 \exp[(\mu_u - \frac{1}{2}\ \sigma_u^2)\ T + \sigma_u\ \sqrt{T}\ Z_u]\ \exp[(\mu_f - \frac{1}{2}\ \sigma_f^2)\ T + \sigma_f\ \sqrt{T}\ Z_f]$
              $= 200 \exp[(\mu_u + \mu_f - \frac{1}{2}\ \sigma_f^2 - \frac{1}{2}\ \sigma_u^2)\ T + \sigma_u\ \sqrt{T}Z_u + \sigma_f\ \sqrt{T}\ Z_f]$

5. **Learning Objectives:**
1.   The candidate will understand how a business enterprise funds its activities with considerations for its business model, and the cost and constraints of the sources of capital

2.   The candidate will understand how an enterprise's structure and policies allow its management to prioritize and select among projects or business activities that are competing for scarce capital resources.

Learning Outcomes:
(1b)   Assess the various features and implications of various sources of capital funding and recommend the optimal approach for funding.
(2g)   Evaluate human behavioral biases in the decision making processes.

Sources:
LO2-FC-N106-13 Financial Decision Making, a Behavioral Perspective

LO2-FC-T110-13 Jonathan Berk and Peter Demarzo, Corporate Finance, 2011, Second Edition, Ch. 15

Commentary on Question:
The question focused on taxes as a capital market imperfection, testing candidates' understanding of how a firm can enhance its value by using leverage to minimize the taxes it (and its investors) pay. Candidates were expected to discuss the reasons why some companies choose to pay dividends despite material advantages of share repurchases.

Solution:
(a)   Explain how leverage would change the value of Maidenhair.

   Commentary on Question:
   Most candidates answered this comprehension question correctly. Alternative answers stating that after-tax WACC is less than the pre-tax WACC due to the interest tax shield received full credit.

   With taxes being the only market imperfection, interest payments on debt are tax-deductible. This reduces taxes paid by the company, increasing company value.

(b)   Complete the market value balance sheet below. Show your work.

   Commentary on Question:
   Most candidates had no issues completing at least part of the balance sheet for this analysis question. However, many candidates calculated the interest tax shield for one period only, not recognizing the fact that the present value of all shielded earnings needed to be taken into account.

5. **Continued**

In addition, many candidates lost points for not recognizing increase in cost of equity following debt issue, and not including value of tax shield in calculating levered WACC.

PV(Interest Tax Shield) = TaxRate * Debt = 0.35 * $500 million = $175 million

V(levered) = V(unlevered) + PV(InterestTaxShield) = $1000 million + $175 million = $1175 million

Market Value Balance Sheet	Before Debt Issue	After Debt Issue
Cash from Issue		$500 million
Original Assets	$1000 million (Given)	$1000 million
Tax Shield		$175 million
Total Assets	**$1000 million**	**$1675 million**
Debt	$0 million (Given)	$500 million
Total Liabilities	**$0 million (Given)**	**$500 million**
Equity = Assets - Liab	$1000 million	$1175 million
Fair Price per Share (Calc below)	$20 (Given)	$23.50
WACC (Calc below)	15%	14.30%

Price per Share (levered) = V(levered) / Shares Outstanding = $1175 million / 50 million = $23.50/share

WACC(unlevered) = Cost of Equity = r_U = 15%

After debt issue, E increases from $1000M to $1175M due to interest tax shield. D = $500M. Cost of Equity after debt issue: $r_E = r_U + D/E * (r_U - r_D)$

r_E = 15% + ($500 million / $1175 million) * (15% - 6%) = 18.8%

WACC(levered) = $E/(D+E) * r_E + D/(D+E) * r_D * (1 - TaxRate)$ =

= $1175 million / ($1175 million + $500 million) * 18.8% + $500 million / ($1175 million + $500 million) * 6% * (1 - 35%)
= 14.30%

(c)

    (i)   Calculate the average benefit per share if the bond proceeds are used to pay a one-time special dividend. Show your work.

    (ii)   Calculate the average benefit per share if the bond proceeds are used to repurchase shares. Show your work.

5. Continued

(iii)   Identify shareholder behavior considerations that affect the choice of paying a one-time special dividend or repurchasing shares.

(iv)   Recommend whether Maidenhair should pay a one-time special dividend or repurchase shares in order to maximize shareholder value. Justify your recommendation.

Commentary on Question:
For part (i) of this analysis question, very few candidates recognized the fact that price per share drops following dividend payment. The majority of people stopped at calculating dividend per share. Those who assumed the shareholder could benefit from deducting capital losses after one-time dividend is paid were not penalized. For part (ii), many candidates calculated after-tax realized capital gain for repurchased shares, but did not take into account unrealized capital gains for remaining shares and lost minor points for that. Some candidates conceptually knew that a share repurchase should result in a greater benefit, and had attempted to force the answer to be greater than the dividend per share they had calculated in part (i). No points were given in such situations. For part (iii) many people provided valid considerations involving irrational shareholder expectations; other answers were also accepted. Part (iv) was answered reasonably well by most candidates; partial credit was given for those recommending the divided and citing behavior considerations.

(i)   After-tax dividend per share = (1- DivTaxRate) * Total Dividend / Num of Shares
= (1 - 0.3) * $500 million / 50 million = $7 per share

Value per share after dividend paid = [V(levered) - Dividend Paid] / 50 million shares = [$1175 million - $500 million] / 50 million = $13.50 per share

Per-share benefit of issuing debt and using proceeds to pay one-time dividend:

After-tax Dividend + Value per share - Start value
= $7 + $13.50 - $20.00 = $0.50 per share

(ii)   Value of shares after issuing debt (from part b) = Purchase price = $23.50 per share

After-tax Realized Capital Gain = (1 - 15%) x ($23.50 - $20.00) = $2.975 per share

Unrealized Capital Gain = ($23.50 - $20.00) = $3.50 per share

5. Continued

> # Shares repurchased = $500 million / $23.50 per share = 21.28 million shares
> # Shares outstanding after purchase: 50 million - 21.28 million = 28.72 million
>
> Average Per-Share Benefit of Issuing Debt and Buying Back Shares:
>
> (# Shares Bought x Benefit per Share + # Shares Outstanding x Benefit per Share) / Total Beginning Shares
> = (21.28 million x $2.975 + 28.72 million x $3.50) / 50 million = $3.28 per share

(iii)   Dividends are immediate cash, while stock price might be perceived uncertain

Explained by mental accounting, people tend to savor dividends when the stock price rises and consider them a silver lining when the stock price drops.

(iv)   Recommend share repurchase, since this maximizes the shareholder after-tax benefit, due to the tax rate on dividends being higher than that on realized capital gains.

6. **Learning Objectives:**
2. The candidate will understand how an enterprise's structure and policies allow its management to prioritize and select among projects or business activities that are competing for scarce capital resources.

5. The candidate will understand how to identify and recommend appropriate risk assessment and monitoring techniques for financial risk management.

Learning Outcomes:
(2f) Design a risk management plan to optimize the risk reward trade off of capital employed.

(5a) Evaluate the methods and processes for measuring and monitoring market risk positions.

Sources:
LO3-FC-N109-13 Ho & Lee, Oxford Guide to Financial Modeling, Ch 6

LO3-FC-N110-13 Ferrera & Nezzamoddini, Interest Rate Swap - Exposed

Commentary on Question:
This question tested candidates' basic understanding of interest rate derivatives, their valuation, and their practical application in the current regulatory context.

Solution:
(a) Determine the cash flows each party would receive or pay each year by completing the table below for the given LIBOR projection:

Commentary on Question:
Very few candidates received full credit for this comprehension question. Common mistakes were around the number and timing of cash flows.

Year	2014	2015	2016	2017	2018
Hen Wallow CF	0	0	+50,000	+200,000	-100,000
Glencannon CF	0	0	-50,000	-200,000	+100,000

(b) Define swaption.

Commentary on Question:
Most candidates received full credit for this retrieval question.

A swaption is an arrangement in which the holder of the swaption has the right, but not the obligation, to enter into a swap agreement.

(c) Complete the following table for the swaption, including definitions and values based on the Black model.

6. Continued

Item	Definition	Value
R_F	Forward swap rate	7%
R_X	Strike rate of underlying swap	8%
σ	Volatility of forward swap rate	25%
T	Time to maturity of swaption	1 year
L	Notional value of swap	$10 million
A	Annuity factor	2.86
X	Value of swaption	$142,000

(d) Recommend, from the perspective of each of the following, whether Hen Wallow
should exercise the swaption or replicate the swap cash flows using bond
derivatives. Justify your recommendation.

Chief Actuary: Replicate cash flows
Dodd-Frank dictates swaps companies are to be cleared through central
counterparties (CCP's), which may demand collateral to be posted by Hen
Wallow, lessening liquidity.

CFO: Exercise the swaption
Prefer to enter the swap and use a CCP to reduce counterparty risk and also
reduce the increased capital that would be required under Dodd-Frank if OTC
derivatives were used.

7. **Learning Objectives:**
3.   The candidate will understand how and when to apply various stochastic techniques to situations which have uncertain financial outcomes.

5.   The candidate will understand how to identify and recommend appropriate risk assessment and monitoring techniques for financial risk management.

Learning Outcomes:
(3e)   Interpret the results of a given application of stochastic modeling and the impact of the chosen calibration process used.

(5a)   Evaluate the methods and processes for measuring and monitoring market risk positions.

Sources:
LO5-FC-T127-13 Dowd, Measuring Market Risk 2nd ed, Ch 4

LO5-FC-T133-13 Dowd, Measuring Market Risk 2nd ed, Ch 7

Commentary on Question:
This question tested candidates' ability to explain historical simulation approaches and their advantages and disadvantages. Candidates did moderately well on most parts.

Solution:
(a)   List four advantages and four disadvantages of using non-parametric models for calculating VaR.

   Commentary on Question:
   Alternative advantages (such as easy to implement, eliminate the need to estimate parameters, easy to produce confidence intervals and data being readily available) and disadvantages (such as difficulty adjusting to market shifts, selection of sample size and bin size is subjective, result is constrained by largest loss in sample) were also accepted on this retrieval question.

   Advantages:
   1. Intuitive and conceptually simple
   2. Can accommodate fat tails, skewness, and other non-normal features
   3. Can accommodate any type of position (including derivatives)
   4. Results are easy to report and communicate

   Disadvantages
   1. Dependent on historical data
   2. Extreme losses that are unlikely to recur can dominate the estimates
   3. Subject to ghost/shadow effects where extreme observations move in or out of the period, creating volatility in the VaR estimate
   4. No allowance for plausible events that did not occur in the sample period

7. Continued

(b) Describe two issues with using a long sample period for the historical simulation.

Commentary on Question:
Other acceptable disadvantages for this comprehension question were:
A longer sample period is less responsive to changes in market conditions
Greater potential for data collection problems

Aged data may not be relevant
Potential distortion from past events that are unlikely to recur

(c) Recommend a modification that will alleviate their concerns. Justify your recommendation.

Commentary on Question:
Some candidates answered volatility-weighted simulation for this knowledge utilization question, earning full credit when properly supported.

Recommendation: Age-Weighted Simulation
Slowly decreases the relative importance (and weight) of older events, recognizing that they are not as relevant but still retain some value

(d) Explain how volatility-weighted historical simulation could improve sensitivity to changes between stable and more volatile market conditions.

Commentary on Question:
On this comprehension question, some candidates described the volatility-weighted method but failed to explain how it could improve sensitivity to market changes, hence only earning partial credit.

Volatility-weighted historical simulation is more sensitive to changes in markets because it adjusts historical returns for the relative difference between historical and current volatility, producing risk estimates that are appropriately sensitive to current volatility estimates.

(e) Recommend an approach for calculating the confidence interval for VaR. Justify your recommendation.

Commentary on Question:
Candidates who recommended "order statistics" as an approach to calculate the confidence interval with appropriate justification received full credit on this knowledge utilization question. Many candidates, rather than justifying why it would be appropriate to use, described how to implement the recommended method, earning no points for the justification.

7. **Continued**

<u>Bootstrap Resampling</u>:
Works well for non-parametric approaches, simple to explain and implement, and does not force confidence interval to be symmetric around the point estimate.

8.　**Learning Objectives:**

4.　　The candidate will understand how to critique the appropriateness of advanced risk assessment methods for a given situation.

Learning Outcomes:

(4e)　Explain how to quantify risk when there is limited data.

Sources:

LO4-FC-N116-13 Manistre, Static Control Model

Commentary on Question:

This question tested the Yield Curve Extension and Static Control models discussed in Manistre's paper. Candidates were required to demonstrate their ability to reproduce some of the calculations referred to in the study note and to directly compare the two.

Solution:

(a)　Calculate the present value of the liability cash flows using a simple monopole assuming a continuous forward rate of 4.0% for all durations greater than 30. Show your work.

Commentary on Question:

To receive full credit on this comprehension question, candidates needed to successfully identify the appropriate rates and apply them continuously to the correct cash flows to execute the simple monopole strategy. Many candidates were able to recognize this and receive full credit. Common errors included applying the rates discretely or using a single rate altogether.

Monopole static hedge is analogous to buying a 30-year zero coupon bond of a size equal to the PV beyond that point. This requires using the observable 30-year rate (3.9%) and a forward rate (4.0%) thereafter.

$PV = \exp(-i_{spot} * t) * \Sigma\ CF_i\ x \exp(-i_{forward} * (j - t))$ for all $j > t$

$PV = \exp(-0.039 * 30) * [\ 100{,}000 + 300{,}000 * \exp(-0.04 * 5) + 500{,}000 * \exp(-0.04 * 10) + 100{,}000 * \exp(-0.04 * 15)]$

$PV = 228{,}325$

(b)　Describe the standard static control model.

Commentary on Question:

Many candidates performed well on this comprehension question. Several were able to identify the two-bucket nature of this model. Full credit was awarded to candidates who were able to extend that description further to identify how the buckets were used within the framework of the model.

8. **Continued**

The static control model aims to use available market instruments to match the hedgeable component of the risk while taking a total return approach to the unhedgeable risk.

Model the total return liability vehicle with a process such as a standard lognormal. Through that modeling, build a yield curve of derived discount factors called the Marginal Cost Yield Curve, which is a function of both the cash flows and the risk measure.

Match cash flows for the first 30 years using bonds and use the total return approach to replicate cash flows beyond the horizon of available market instruments.

(c) Calculate the implied forward rate for the static control model, assuming the total return vehicle is a standard normal process with an expected return of 7% and volatility of 16%. Show your work.

Commentary on Question:
The intent of the question is to calculate the implied forward rate assuming a standard lognormal process, rather than the standard normal process in the text of the question. Due to the ambiguity in the question, all candidates receive full marks for this part. With the intent of the comprehension question in mind, the successful candidates were expected to recall the parameters of the standard lognormal process and grasp the concept behind the short example discussed in the reading.

Total return vehicle is assumed to be a standard lognormal process, and μ and σ are calibrated for an expected return of 7% and volatility of 16%. For a lognormal model, this means $\sigma = 16\%$ and $\exp(\mu + \sigma^2 / 2) = 7\%$, and solving for μ yields $\mu = 0.05486$

The expected discount factor for a standard lognormal is $\exp(-\mu + \sigma^2 / 2)$
Using the results above, this yields $\exp(-0.05486 + 0.16^2 / 2) = 0.95881$

Forward rate is found by taking the inverse of that $= 1/.095881 = 1.04296$
Therefore, the forward rate is 4.30%

(d)
(i) Describe the advantages of a simple monopole.

(ii) Describe the advantages of a static control model.

(iii) Recommend whether Rainbow Falls should use a simple monopole or the static control model. Justify your recommendation.

8. **Continued**

Commentary on Question:
Because this comprehension and knowledge utilization question was asking for advantages of the models, credit was not awarded for noting disadvantages of the model in parts (i) and (ii). To receive full credit for part (iii), the candidate had to consider the advantages and disadvantages of each model and apply them to the situation that was given. Rather than restating the advantages in parts (i) and (ii), the more successful candidates were able justify the choice for reasons specific to Rainbow Fall's situation. While the solution below supports the simple monopole, many candidates were also successfully able to recommend and justify the static control model.

(i)   Advantages of the Simple Monopole:
- Very simple approach

(ii)   Advantages of the Static Control Model
- Hedging Strategies implied from the model are more realistic.
- Provides a market consistent result

(iii)   Recommend the use of the simple monopole. The question notes that Rainbow Falls is a small insurance company. It is likely that a small company would have limited resources, which supports the use of a framework that is much simpler to implement and explain.

9. **Learning Objectives:**
5. The candidate will understand how to identify and recommend appropriate risk assessment and monitoring techniques for financial risk management.

Learning Outcomes:
(5e) Interpret the results of back-testing.

Sources:
LO5-FC-T137-13 Dowd, Measuring Market Risk 2nd ed, Ch. 15

Commentary on Question:
This question tested candidates' ability to apply several backtesting concepts from the syllabus reading to a specific situation.

Solution:
(a) Determine for each model, whether it passes the basic frequency backtest (Kupiec) assuming a 95% confidence level and a two-sided alternative hypothesis. Show your work.

Commentary on Question:
This comprehension question specifically asked candidates to show their work. Credit was not awarded for merely stating "pass" or "fail" for each model without providing support. Successful candidates were able to state the null and alternative hypotheses, recognize the two rejection regions in a two-sided test and arrive at the acceptance region.

Null Hypothesis: H(0): p = 0.05
Alternative Hypothesis: H(1): p <> 0.05

The two sided frequency test carries two rejection regions, the lower 2.5% and the upper 97.5% tails. Observances that carry a cumulative binomial probability within these ranges would result in rejecting the null hypothesis. Based on the table provided, the acceptance region is [4, 16].

Model #1: 9 within [4, 16], accept the null hypothesis, passes backtest
Model #2: 9 within [4, 16], accept the null hypothesis, passes backtest
Model #3: 10 within [4, 16], accept the null hypothesis, passes backtest
Model #4: 3 outside [4, 16], so reject the null hypothesis, fails backtest

(b) Evaluate each of the four models as a good, medium, or poor fit, using both visual inspection and the results from part (a). Support each evaluation.

Commentary on Question:
This analysis question specifically asked for both visual inspection and reliance on the backtest results.

9. Continued

Successful candidates were able to include their results from part (a) and to make a sound justification for why the visual fit appeared to result in this being a well fit model. Incorrect conclusions in part (a) were not penalized as long as candidates made a reasonable conclusion using said result.

Model #1 is a good fit: passes the backtest in part (a), and visual inspection suggests that the positions are being updated daily

Model #2 is a medium fit: passes the backtest in part (a), but there appears to be significantly more volatility than the other models

Model #3 is a medium fit: passes the backtest in part (a), but VaR does not vary, suggesting that the positions are not being updated daily

Model #4 is a poor fit: fails the backtest in part (a), and VaR level visually appears to be much higher than other models…only outliers are being included, which is not suitable for a 95% confidence interval.

(c)   Recommend two improvements to the backtesting analysis. Justify your recommendations.

Commentary on Question:
In addition to recommending some improvements to the backtesting exercise, successful candidates were able to apply those recommendations to this situation to explain why it would be an improvement over the current approach, receiving full marks on this knowledge utilization question. The following are two examples of these improvements; other reasonable answers also received full credit. These included but were not limited to backtesting with alternative positions, conditional testing to assess clustering, and bootstrapping techniques to provide more data.

Recommend acquiring more data. 200 days is not a very long period to capture extreme events. By testing over a longer period we could evaluate whether the models properly fit several market periods and not just this one.

Consider severity of losses. Our current quantitative test only considers the frequency of exceedences, not the severity. This is potentially valuable information. Using a test that considered this detail (i.e. Berkowitz) could provide a stronger assessment on fit.

10. **Learning Objectives:**
2.   The candidate will understand how an enterprise's structure and policies allow its management to prioritize and select among projects or business activities that are competing for scarce capital resources.

Learning Outcomes:
(2b)   Describe the factors impacting short-term capital needs.

Sources:
LO2-FC-T112-13 Jonathan Berk and Peter Demarzo, Corporate Finance, 2011, Second Edition, Ch. 26

LO2-FC-T113-13 Jonathan Berk and Peter Demarzo, Corporate Finance, 2011, Second Edition, Ch. 27

Case Study

Commentary on Question:
In general, candidates did well on parts (a), (b), and (c) but not on part (d) of this question testing candidates' understanding and application of short-term capital and cash considerations.

Solution:
(a)   Provide two reasons, other than meeting day-to-day needs, why a company holds cash.

Commentary on Question:
Most candidates are able to give two reasons why a company may want to hold cash in this retrieval question. Answers other than those below were also accepted for full credit.

1. To counter the uncertainty associated with its cash flows
2. To satisfy bank requirements

(b)
(i)   Describe the cash conversion cycle.

(ii)   Calculate the cash conversion cycle for Blue Jay Tire for 2012. Show your work.

Commentary on Question:
Most candidates are able to identify and describe the cash conversion cycle correctly in this comprehension question. Many candidates, however, did not use the right figures from the case study to arrive the correct account receivable days and inventory days

10. Continued

The cash conversion cycle (CCC) is used to measure the length of time between when the firm pays cash to purchase its initial inventory and when it receives cash from the sale of the output produced from that inventory

CCC = Accounts Receivable Days + Inventory Days - Accounts Payable Days
Accounts Receivable Days = Accounts Receivable / Average Daily Sales
Inventory Days = Inventory / Average Daily Cost of Goods Sold
Accounts Payable Days = Accounts Payable / Average Daily Cost of Goods Sold

Average Daily Sales = $23,463 million / 365 = $64.28 million per day
Accounts Receivable = $2,095 million
Accounts Receivable Days = $2,095 million / $64.28 million per day
= 32.59 days

Average Daily Cost of Goods Sold = $15,753 million / 365
= $43.16 million per day
Inventory = $607 million
Inventory Days = $607 million / $43.16 million per day = 14.06 days

Accounts Payable = $109 million
Accounts Payable Days = $109 million / $43.16 million per day = 2.53 days

CCC = 32.59 days + 14.06 days - 2.53 days = 44.12 days

(c)   Blue Jay Tire's rubber supplier offers terms of 1/10, Net 15. Blue Jay Tire's current practice is to make payment on day 3.

   (i)   Assess Blue Jay Tire's current accounts payable practice.

   (ii)   Recommend an optimal accounts payable strategy. Justify your recommendation.

Commentary on Question:
Most candidates were able to identify Blue Jay Tire's current practice as suboptimal in this analysis question, but not all candidates gave full good reasons to justify this.

The terms include a 1% discount if payment occurs in the first 10 days. Blue Jay Tire is paying on day 3 and using the discount, a good practice, but it does not gain any benefit from paying before day 10, effectively lending its cash at zero interest between day 3 and day 10.

10. Continued

Blue Jay Tire should pay on day 10 to maximize the amount of time it can use its cash and still get the 1% discount. It is able to pay later without raising additional cash and earn an additional 7 days of interest on the cash.

(d)

   (i)   Calculate the effective annual rate of return for each of the three financing options. Show your work.

   (ii)   Describe one disadvantage for each of the three financing options.

   (iii) Recommend a financing option assuming the following environment: a steep yield curve, short-term rates unlikely to spike in the near future, and declining credit quality of Blue Jay Tire. Justify your recommendation.

Commentary on Question:
Candidates generally did not do very well on calculating effective annual rate of return for the three options on this knowledge utilization question, with many confusing it with annual percentage rate and some not knowing how to handle the compensating balance requirement. Most candidates were able to describe the disadvantages of the three forms of financing—other answers were also accepted for full credit. Most candidates were unable to select the option and give the right justification for the option they recommended, given the economic environment given in the question.

   (i)   Option I: ($10 million * (1 + 15%) − $1 million * (1 + 1%)) / $9 million − 1 = 16.56%
          Option II: ($10 million * (1 + 8% / 4) / ($10 million * (1 − 1%))^4 − 1 = 12.68%
          Option III: ($10 million / $9.7 million)^4 - 1 = 12.96%

   (ii)   I: Unsecured loans generally have higher costs and fees
          II: Secured financing risks loss of control of collateral
          III: Commercial paper is often only accessible to larger companies

   (iii) Blue Jay Tire should use option II, the secured loan. It is the cheapest, given the steep yield curve and the short-term nature of the loan. Blue Jay Tire's declining credit quality will have less impact on a secured loan compared to unsecured financing options. The violation of the matching principle is okay since short-term rates are unlikely to spike.

11. **Learning Objectives:**

1. The candidate will understand how a business enterprise funds its activities with considerations for its business model, and the cost and constraints of the sources of capital.

2. The candidate will understand how an enterprise's structure and policies allow its management to prioritize and select among projects or business activities that are competing for scarce capital resources.

Learning Outcomes:

(1g) Describe the methods of allocating risk capital.

(2e) Describe considerations for the risk borne by capital employed.

(2f) Design a risk management plan to optimize the risk reward trade off of capital employed.

Sources:

LO2-FC-T115-13 Jonathan Berk and Peter Demarzo, Corporate Finance, 2011, Second Edition, Ch. 30

Case Study

LO1-FC-N102-13 Capital Allocation in Financial Firms

Commentary on Question:

This question tests candidates' understanding of the differences between the risk management strategies of vertical integration and hedging. The candidate should apply that knowledge to the case study and articulate good reasons for pursuing their recommended strategy.

Solution:

(a) Calculate Frenz Corporation's change in internal required capital due to the reduction in its exposure to coffee bean price volatility if it enters the production agreement. Show your work.

Commentary on Question:

This is a straightforward calculation and most candidates did well on this comprehension question. Common mistakes were not multiplying by 2 or using the 95th percentile instead of 99th.

Capital requirement is 2 x 1-in-100 year tail event = 2 x 99th percentile
Current capital from risk without deal: 2 x 100 = 200
Potential capital from risk with deal: 2 x 60 = 120
Change in required capital: 120 – 200 = -80

11. Continued

(b) Explain why fully allocating Frenz's firm-wide risk capital across its businesses is likely to be suboptimal if Frenz enters the production agreement and considers the new Vietombia operation a separate business.

Commentary on Question:
Candidates did not do well on this analysis question. Candidates did not pick up diversification benefits and did not clearly articulate diversification of capital and risk.

The amount of risk capital for diversified firms is less than the sum of capital requirements for each of the businesses operated on a stand-alone basis. If Frenz enters the agreement and considers the Vietombia operation to be a separate business, it will not capture the diversification benefits in its capital allocation.

(c) Identify three other considerations when evaluating this production agreement.

Commentary on Question:
Most candidates received full or nearly full credit on this comprehension question. Answers other than those shown here could also receive full credit.

Investors can diversify risk more cheaply than Frenz can
Economic instability in Vietombia, with some risk of nationalization
Consumer preferences for this particular coffee bean may change

(d)

    (i) Describe two common mistakes to avoid when hedging commodity price risk.

    (ii) Assess the applicability of each mistake in part (i) to Frenz's situation.

    (iii) Recommend how Frenz can lessen the impact of each mistake in part (i). Justify each recommendation.

Commentary on Question:
Candidates did not do well on this analysis question, as they mixed the concepts of the purpose of hedging, its mistakes, and hedging operations. Answers other than those shown below were eligible for full credit.

One common mistake is liquidity risk, being able to maintain a margin account. This applies to Frenz, which has $138 million of cash on its balance sheet and expects coffee sales to provide a steady stream of cash flow. Liquidity risk is not a major risk for Frenz, but it could use debt financing for Vietombia project to protect liquidity.

11. Continued

Another common mistake is basis risk, the risk that the futures value is not perfectly correlated with the firm's exposure. In Frenz's case, the futures contract is on Arabica coffee beans, but Frenz sells different kinds of coffee, so basis risk is a concern. Frenz can mitigate this risk by limiting the hedge to cover only its Arabica coffee products, resulting in a better match.

(e)

    (i)   Contrast the two risk management strategies.

    (ii)   Recommend which risk management strategy Frenz should pursue. Justify your recommendation.

Commentary on Question:
Many candidates simply listed advantages/disadvantages of each strategy rather than drawing out specific contrasts between the two strategies on this knowledge utilization question. Some partial credit was given if there were relevant advantages and disadvantages. Other answers than those shown below were eligible for full credit. Either choice could be recommended for full credit, as long as the justification was strong and robust.

    (i)   The production agreement requires a $100 million initial investment, while futures have a low initial cash outlay. The production agreement gives exclusive access to high quality beans, an advantage not available with futures hedging. The futures allow for the size of commitment to be easily increased or decreased, while the production agreement is much less flexible.

    (ii)   Frenz should pursue the production agreement. While it does have some drawbacks, these are outweighed by the competitive advantage gained from the exclusive access to premium coffee beans. Frenz does have the cash on hand for the initial investment, and the strategy fits in well with RPPC's corporate conglomerate make-up. Other divisions of the company may be able to provide their expertise in production management to assist Frenz in this undertaking.

12. **Learning Objectives:**

   2.   The candidate will understand how an enterprise's structure and policies allow its management to prioritize and select among projects or business activities that are competing for scarce capital resources.

Learning Outcomes:

(2d)   Evaluate the capital efficiency of using reinsurance or securitizations for a given risk.

(2f)   Design a risk management plan to optimize the risk reward trade off of capital employed.

Sources:

LO2-FC-N105-13 Panjer with the Actuarial Foundation, Financial Economics with application to Investments, Insurance and Pension, Ch. 2.7-2.9

Case Study

Commentary on Question:
This question tested candidates' general understanding of ordinary stop-loss reinsurance and financial options as hedging techniques. Overall, candidates did satisfactorily on the question. Major errors from candidates in this question include: incorrectly defining the maximum payment of reinsurer in part (a), being unable to calculate the number of MCS contracts in part (b), and not contrasting reinsurance and options as stated in the question in part (c).

Solution:

(a)   Define the reinsurer's payment to Blue Ocean in terms of claim loss, maximum covered loss and deductible.

     Commentary on Question:
     About half of the candidates received full credit in this retrieval question. Some candidates incorrectly defined the maximum covered loss and maximum payment of reinsurer to be 2.25 billion and 1.25 billion respectively. Some candidates simply did not write down the correct formula. It is advised that these candidates verify their answer at various losses amount (e.g. reinsurance payment at $0, $1.1 billion, $2.5 billion).

     Reinsurer Payment = 0 if claim loss is < $1 billion.
     Reinsurer Payment = claim loss minus $1 billion if claims loss is between $1 billion and $1.25 billion.
     Reinsurer Payment = $250 million if claim loss is > $1.25 billion.

12. Continued

b) You construct a hedge strategy using call options that replicates the stop-loss reinsurance payment.

(i) Calculate the number of MCS option contracts needed. Show your work.

(ii) Calculate the cost of the strategy. Show your work.

Commentary on Question:
Very few candidates received full credit on this analysis question. Most candidates did not have correct scaling on the loss index using the information provided in the case study.

(i) Call options pay based on losses in the entire Atlantic Ocean region. Per case study, Blue Ocean has a 2% market share in the Atlantic Ocean region.
Scaling
Stop-loss deductible is $1 billion
- $1 billion of Blue Ocean losses is 2% of $50 billion regional losses
- $50 billion regional loss is an index value of 10.0 = $50 billion / $5 billion index value.

Maximum covered loss for stop-loss reinsurance is $1.25 billion
- $1.25 billion of Blue Ocean losses is 2% of $62.5 billion regional losses
- $62.5 billion regional loss is an index value of 12.5 = $62.5 billion / $5 billion index value.

Determine which options
Buy Call #1 to match stop-loss deductible at index value of 10.0 and sell Call #2 to match maximum covered loss at index value of 12.5

Determine number of options
# of options = maximum stop-loss payout / (option payout in index points / $200 per index point)
= $250,000,000 / [(12.5 - 10.0) / $200 per index point] = 500,000 calls

Therefore, buy 500,000 Call #1 Options and sell 500,000 Call #2 Options.

(ii) Cost of the strategy
Sum of (# of contracts for each option x option premium for the option x cost of a point)
500,000 x 2.10 x $200 - 500,000 x 1.99 x $200 = $11 million

12. Continued

(c)

    (i)   Contrast stop-loss reinsurance with hedging using traded call options.

    (ii)   Recommend an optimal hedge strategy. Support your recommendation.

Commentary on Question:
Candidates performed satisfactorily on this knowledge utilization question. The main reason candidates did not get full credit was that they provided a list of characteristics of reinsurance and options without contrasting them with each other. Candidate should contrast reinsurance with hedging using traded call options, as stated in the question. For part (ii), some candidates recommended hedging strategies other that reinsurance and options stated in the question. Full credit was given with reasonable justifications. Several candidates said that reinsurance cost more, which is not necessarily true – the reinsurance rate depends on company's own experience. If a company has good experience compared to the market, it is likely that the company gets better reinsurance rates.

(i)

	Reinsurance	Traded Options
Basis Risk	It is written on company's own portfolio/customized/payout depends on actual company losses. Therefore, there is no basis risk.	It is written on industry losses/not customized/payout depends on index. There is basis risk
Counterparty Risk	Reinsurer may not honor future payment and counterparty risk exists.	It is traded in exchange. There is no counterparty risk.
Transaction Services	Reinsurance is not tradable. Reinsurance may provide services and expertise to the insurer	It can be easily sold. No service is provided.
Privacy	Reinsurance is private transaction.	Traded options are more likely to de disclosed.

    (ii)   Blue Ocean should pursue stop-loss reinsurance, providing a private transaction with no basis risk and possible services and expertise from the reinsurer. The credit risk can be mitigated through treaty restrictions and monitoring the reinsurer's credit quality.

13. **Learning Objectives:**
1. The candidate will understand how a business enterprise funds its activities with considerations for its business model, and the cost and constraints of the sources of capital.

2. The candidate will understand how an enterprise's structure and policies allow its management to prioritize and select among projects or business activities that are competing for scarce capital resources.

Learning Outcomes:
(1a) Describe the steps to procuring capital funding (treasury function).

(1b) Assess the various features and implications of various sources of capital funding and recommend the optimal approach for funding.

(1d) Assess whether the risky return from a new project or ongoing business is sufficient to employ investor capital

(2c) Recommend an optimal capital structure and how to implement it for a given business or strategy.

Sources:
LO1-FC-T102-13 Jonathan Berk and Peter Demarzo, Corporate Finance, 2011, Second Edition, Ch. 18

Case Study

Commentary on Question:
This question tests candidates' understanding and ability to utilize capital budgeting and valuation methods. Candidates are expected to evaluate, calculate, re-level, and use various methods to value a project. It also tested candidates' knowledge of interest tax shields and sensitivities. In general, candidates scored well on parts (a), (b)(i), (b)(iii), and (c)(i). Very few candidates received full credit on parts (b)(ii) and (e).

Solution:
(a) You are preparing a report on the leasing plan for Blue Jay Air's CFO.

    (i) Identify the three main methods of valuing levered investments.

    (ii) Describe the most appropriate circumstance for using each method.

    (iii) Recommend the most flexible method for valuing the leasing plan. Justify your recommendation.

13. Continued

Commentary on Question:
In general, candidates scored well on this analysis question. No points were deducted for candidates who did not identify method names but were able to provide correct descriptions in (i). No points were deducted for candidates who answered that FTE is used to value payouts to equity associated with a project. Partial credit was given for recommending WACC with a proper justification in (iii).

(i)   1. The Weighted Average Cost of Capital (WACC) method
        2. The Adjusted Presented Value (APV) method
        3. The Flow to Equity (FTE) method

(ii)   WACC: Easiest to use when the firm will maintain a fixed debt to value ratio over the lifetime of the investments.
        APV: Usually the most straightforward approach for alternative leverage policies
        FTE: Typically used only in complicated settings for which the values of the securities in the firm's capital structure or the interest tax shield are themselves difficult to determine.

(iii)   Considering RPPC Dynasty is open to other leverage policies, recommend APV to provide the most flexibility.

(b)   Assume RPPC Dynasty will fund this project while maintaining its constant debt-to-value ratio.

(i)   Recommend the appropriate <u>debt</u> cost of capital for evaluating this project. Justify your recommendation.

(ii)   Recommend the appropriate <u>equity</u> cost of capital for evaluating this project. Justify your recommendation.

(iii) Calculate the value of the project to RPPC Dynasty. Show your work.

Commentary on Question:
Many candidates received full credit in part (i) and partial credit in part (iii) on this analysis question. Only a few candidates received any credit for part (ii). To get full credit in part (i), candidates needed to recommend the correct debt cost of capital and provide a supporting argument. To get full credit in part (ii), candidates needed to
- *Calculate the unlevered cost of capital using Omega Airline's cost of capital*
- *Recommend project's equity cost of capital using the same leverage as RPPC*
- *Provide a reasonable justification on the selections*

13. Continued

For part (iii), almost all candidates used WACC to calculate the value of the project. The APV and FTE methods could also be used to get the same result and full credit. To receive full credit, candidates needed to
- *Calculate the appropriate cash flows, with tax deducted*
- *Use appropriate discount rate for the selected valuation method;*
- *Perform correct NPV calculation, with initial capital in consideration*

(i)   Since the debt is originated from RPPC, the debt cost of capital should be the same as RPPC.
Debt cost of capital will be RPPC's : $r_D = 8\%$

(ii)   Unlevered cost of capital using Omega Airline's cost of capital and debt to-value ratio is: $r_U = 0.65 * 10\% + 0.35 * 12\% = 10.7\%$

RPPC maintains its current debt-to-value ratio means it will use same leverage for the project. Recommend equity cost of capital:
$r_E = 10.7\% + (0.4 / 0.6) * (10.7\% - 8\%) = 12.5\%$

Justification to use Omega Airline's cost of capital:

RPPC itself contains multiple lines of very different businesses. Blue Jay airline was newly acquired in 2010 and is a highly-leveraged, capital-intensive company. The risk and leverage of the project does not match those characteristics of RPPC as a whole. So we shouldn't be using RPPC's cost of capital for this project. The risk profile of this project should be closest to Omega Airline, using Omega's cost of capital information as the unlevered cost of capital for Blue Jay.

(iii)   The free cash flow based on the financials given is, in $ millions:

Year	0	1	2	3	4	5
Revenue		270.00	270.00	270.00	270.00	270.00
expense		(60.00)	(60.00)	(60.00)	(60.00)	(60.00)
EBIT		210.00	210.00	210.00	210.00	210.00
income tax at 35%		(73.50)	(73.50)	(73.50)	(73.50)	(73.50)
unleveled net income		136.50	136.50	136.50	136.50	136.50
capital expenditure	(500.00)					
Free Cash Flow	(500.00)	136.50	136.50	136.50	136.50	136.50

$r_{WACC} = 10.7\% - 0.4 * 0.35 * 8\% = 9.58\%$
The discount factor is $1 / (1 + 9.58\%) = 0.9126$
The value of the project, using a simple annuity factor, is
-$500 million + $136.50 million $* 0.9126 * (1 - 0.9126^5) / (1 - 0.9126)$
= $23 million

13. Continued

(c)
    (i)   Calculate the value of the interest tax shield using the fixed debt schedule. Show your work.

    (ii)   Calculate the value of the project using the fixed debt schedule. Show your work.

Commentary on Question:
For this comprehension question, many candidates were able to calculate the interest tax shield properly in part (i), but only some discounted the tax shield at the debt cost of capital. To successfully complete part (ii), candidates needed to use the APV calculation to determine the unlevered value of the project using the alternative leverage strategy, but very few candidates realized that. However, partial points were given for using the correct formula, i.e. Levered Value = Unlevered Value + Value of Interest Tax Shield.

    (i)   With a fixed debt schedule, the amount of the debt will not fluctuate. The tax shield is less risky than the project and should be discounted at the debt cost of capital, r_D of 8% .

Year	0	1	2	3	4	5
Debt	300.00	240.00	180.00	120.00	60.00	0.00
Interest Paid at 8%		24.00	19.20	14.40	9.60	4.80
Interest Tax Shield using 35% tax rate		8.40	6.72	5.04	3.36	1.68
Discount at 8%		7.78	5.76	4.00	2.47	1.14

    (ii)   The unlevered value of the project are the free cash flows in part (b) discounted at the unlevered discount rate of 10.7%, which, with a discount factor of $1 / (1 + 10.7\%) = 0.9033$, yields

-$500 million + $136.50 million * 0.9033 * $(1 – 0.9033^5) / (1 – 0.9033)$
= $8 million

The value of the levered project is then $8 million + $21 million
= $29 million

(d)   Evaluate which of the following is more sensitive to interest rate volatility.

    (i)   The constant debt-to-value leverage policy in part (b).

    (ii)   The fixed debt schedule leverage policy in part (c).

13. Continued

Commentary on Question:
Candidates struggled with this analysis question. Some candidates were able to provide a correct identification on which is more sensitive and thus received partial credit. Only a few candidates provided a well-developed reasoning to support the evaluation.

The policy in part b) will be more sensitive to interest rate volatility than c).

Blue Jay Air is a highly leveraged, capital intensive company. A volatile interest rate environment will increase the risk profile of Blue Jay Air and increase its unlevered cost of capital, decreasing the unlevered value of the project. Because the fixed debt schedule uses RPPC's cost of debt which will be impacted, the resulting impact on the value of the interest tax shield will be less sensitive with a fixed debt schedule.

(e)   Explain how the expected upgrade to the credit rating affects your current valuation of the project.

Commentary on Question:
Candidates did poorly on this analysis question. Most candidates analyzed how a credit rating upgrade would impact the project value as opposed to how funding occurring <u>before</u> the credit rating upgrade announcement would impact the project value. Successful candidates needed to provide the correct decision and a well-developed supporting argument to receive full credit.

The expected upgrade will **decrease** the value of the project.

The actual cost of debt will be higher than appropriate for the risk since funding for the project will occur before the announcement at a higher rate.

14. **Learning Objectives:**
5. The candidate will understand how to identify and recommend appropriate risk assessment and monitoring techniques for financial risk management.

Learning Outcomes:
(5a) Evaluate the methods and processes for measuring and monitoring market risk positions.

(5d) Design an appropriate stress-testing process and evaluate its limitations for a given risk position.

Sources:
LO5-FC-N122-13 Kalberer & Ravindran, Variable Annuities, Ch. 15

LO5-FC-N123-13 Kalberer & Ravindran, Variable Annuities, Ch. 16

LO5-FC-N124-13 Kalberer & Ravindran, Variable Annuities, Ch. 17

LO5-FC-T136-13 Dowd, Measuring Market Risk 2nd ed, Ch. 13

Commentary on Question:
This question tests candidates' understanding of measuring and monitoring VA hedge risk. While many candidates received partial credit here and there, few showed complete mastery of the topic.

Solution:
(a) Calculate the following for the VA liabilities. Show your work.

    (i) The contribution of the higher-order Greeks for the equity sensitivity

    (ii) The cross term between the equity and interest sensitivities

Commentary on Question:
Candidates did relatively well on this straightforward comprehension question on the attribution of Greeks.

    (i) Higher order equity Greek = Total change – delta component – gamma component = ($205 million - $200 million) - $4.1 million - $0.8 million = $0.1 million

    (ii) Cross term between equity and interest = Total change from both – change due to equity – change due to interest = ($207.8 million - $200 million) – ($205 million - $200 million) – ($203 million - $200 million) = $7.8 million - $5 million - $3 million = -$0.2 million

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14. Continued

(b)
    (i)   Evaluate each of the four approaches using each of Jones's three criteria.

    (ii)   Recommend an approach that Jones should use to measure hedge effectiveness. Justify your recommendation.

Commentary on Question:
This analysis question applies pros/cons of each of modeling approach to specific conditions. Candidates did relatively well and partial credit was given based on supporting items, including considerations for whether approaches based on historical data would include extreme real-world scenarios or not.

    (i)   Comparisons
- Computational intensity: Stochastic-on-stochastic is the most intensive, followed by VaR and stress testing; backtesting is the least intensive
- Extreme real-world scenarios: all approaches but backtesting look at extreme real-world scenarios
- Likelihood of a bad outcome: all approaches but stress testing provide the likelihood of a bad outcome

    (ii)   Jones should use VaR, as it is less computationally intensive, examines extreme real-world scenarios, and provides the likelihood of a bad outcome.

(c)   Describe two improvements for managing Darwin's VA risk, based on the information provided in the case study and in light of the lessons that VA writers learned from the 2007 – 2008 financial crisis.

Commentary on Question:
Candidates did not do well on this knowledge utilization question, which was looking for a higher level of business and management improvements from the latest market crisis rather than the narrow perspective on current business issues and improvements many candidates provided. Partial credit was given based on relevant supporting items. Answers other than those given below also received full credit.

First, invest in tools, infrastructure, and resources necessary to understand and manage the risks. The existing legacy systems and processes are insufficient to manage the business. For example, the hedge program should be integrated into other parts of the business (valuation, modeling, etc.). As such, the only assumption currently shared across functions is the static policyholder behavior assumption.

14. Continued

Second, practice prudent product development for future business, and make the product simple with a balanced risk-reward for all stakeholders as Darwin tries to expand its VA business. "Greatly extending the guarantee period" will entail detailed study; similarly, "offering a great diversity of mutual funds available for all IVA customers" may trigger unforeseeable results when the market moves unexpectedly.