1. **Learning Objectives:**
   1. The candidate will understand how a company optimizes its corporate finance decisions based on its business objectives.

**Learning Outcomes:**
(1a) Recommend an optimal capital structure for given business objectives and the competitive environment.

(1b) Compare and contrast methods to determine the value of a business or project, including the impact on capital budgeting and allocation decisions.

**Sources:**
Corporate Finance, Fourth Edition, Jonathan Berk and Peter Demarzo, Chapter 18: Capital Budgeting and Valuation with Leverage


Hurdle Rates, Cost of Capital & Capital Structure: CFO Spotlight

**Commentary on Question:**
*The key for this question was to set it up correctly. Candidates who had a good approach but made some calculation or logical error could still receive a lot of credit. Some candidates would have benefited from doing a reasonableness check of their answers to see if they were on the right track.*

**Solution:**
(a) Critique the following statements pertaining to Capital Budgeting:

(i) Blue Jay Air’s CFO, says, “I am excited to announce our 2018 non-repatriated earnings in our Canadian unit has yielded pre-tax income of 100M USD, on which we will pay 45M USD of Canadian income tax. Due to the lower U.S. corporate tax rate of 21%, we have overpaid the tax due on our foreign income and will receive a tax credit of 24M USD to our domestic book.”
1. Continued

(ii) John Feather, CEO of Blue Jay Air, stated, “Our WACC approach follows industry standards as we identify risk and look at our cost of capital on a total company basis. RPPC believes best practice is to manage risk at the RPPC level in a way that takes into account diversification across projects while leveraging our lower company-wide cost of capital.”

(iii) Jim Peters, CRO of Blue Jay Air, says, “We evaluate our investment opportunities using the Adjusted Present Value Capital Budgeting Methodology. It is easier to apply than the WACC method when the firm does not maintain a constant debt-equity ratio, and it provides managers with an explicit valuation of the tax shield itself.”

Commentary on Question:
Candidates were expected to identify the veracity of the statement and explain why the statement is true/false to receive full credit. In general, candidates scored well on this part.

(i) The statement is false.

For any non-repatriated earnings, there are no US tax implications until such dividends are distributed back onshore to the US.

If the income was re-patriated, to the extent the foreign tax rates are higher than US tax rates, US taxes paid on domestic business cannot be offset by the additional tax burden from the offshore taxes.

(ii) The statement is false.

Best practice is to manage systematic risk by basing the WACC on projects with a similar risk profile. Additionally, any project specific risks should be reflected inherently in the cash flows.

Using a company-wide WACC on projects that do not have a similar risk profile as the firm, will result in accepting projects with high risk, and rejecting projects with low risk.

(iii) The statement is true.

The WACC assumes the project will maintain a similar cost of capital risk level relative to the entirety of the company.

Managers will have an easier time applying this to their project evaluations.
1. Continued

(b) Calculate the salvage value at the end of five years, in USD, of the D.2 fleet expansion proposal. Show your work.

**Commentary on Question:**
*It is important that candidates understand how to approach problems like this. Even with an incorrect salvage value, candidates could receive credit for:*

1) Setting this up in a logical way (table, formulas, etc.).
2) Correct use of the current spot rate.
3) Calculating the second forward rate

<table>
<thead>
<tr>
<th>End of Year</th>
<th>Risk Free Rate US</th>
<th>Risk Free Rate JPY</th>
<th>Current Spot Rate</th>
<th>Forward Spot Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.009</td>
<td>0.0090</td>
</tr>
<tr>
<td>1</td>
<td>3.00%</td>
<td>2.00%</td>
<td></td>
<td>0.0091</td>
</tr>
<tr>
<td>2</td>
<td>3.06%</td>
<td>2.02%</td>
<td></td>
<td>0.0092</td>
</tr>
<tr>
<td>3</td>
<td>3.12%</td>
<td>2.04%</td>
<td></td>
<td>0.0093</td>
</tr>
<tr>
<td>4</td>
<td>3.18%</td>
<td>2.06%</td>
<td></td>
<td>0.0094</td>
</tr>
<tr>
<td>5</td>
<td>3.25%</td>
<td>2.08%</td>
<td></td>
<td>0.0095</td>
</tr>
</tbody>
</table>

Sale Price in Yen = 232B
Salvage Value in $ = Sale Price x 5th Forward Spot Rate = 2.201M

(c) Calculate the NPV of the D.2 fleet expansion proposal using the Adjusted Present Value Method. Show your work.

**Commentary on Question:**
*This is a challenging calculation under exam conditions. Partial credit was awarded if the candidate set-up the problem correctly and had the appropriate considerations on the following:*

1) Development of the unlevered free cash flow including the correct treatment of depreciation and the imposition of income taxes
2) Development of the free cash flows
3) Development of the interest tax shield including interest paid
4) Calculation of the correct unlevered cost of capital
5) Ultimate NPV calculation

*Most candidates received partial credit on this part.*
1. Continued

Purchase Proposal for International Plane Fleet

<table>
<thead>
<tr>
<th>Year</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenue</td>
<td>270</td>
<td>270</td>
<td>270</td>
<td>270</td>
<td>270</td>
<td></td>
</tr>
<tr>
<td>Annual Projected Maintenance Costs</td>
<td>-2</td>
<td>-2</td>
<td>-2</td>
<td>-2</td>
<td>-2</td>
<td></td>
</tr>
<tr>
<td>Additional Annual Expenses</td>
<td>-60</td>
<td>-60</td>
<td>-60</td>
<td>-60</td>
<td>-60</td>
<td></td>
</tr>
<tr>
<td>Depreciation</td>
<td>-100</td>
<td>-100</td>
<td>-100</td>
<td>-100</td>
<td>-100</td>
<td></td>
</tr>
<tr>
<td>EBIT</td>
<td>0</td>
<td>108</td>
<td>108</td>
<td>108</td>
<td>108</td>
<td>108</td>
</tr>
<tr>
<td>Income tax at 21%</td>
<td>0</td>
<td>-22.68</td>
<td>-22.68</td>
<td>-22.68</td>
<td>-22.68</td>
<td>-22.68</td>
</tr>
<tr>
<td>Unlevered Net Income</td>
<td>0</td>
<td>85.32</td>
<td>85.32</td>
<td>85.32</td>
<td>85.32</td>
<td>85.32</td>
</tr>
</tbody>
</table>

Free Cash Flow

| Plus: Depreciation | 100 | 100 | 100 | 100 | 100 |     |
| Less: Purchase Price | -1750 |     |     |     |     |     |

FCF = -1750, 185.32, 185.32, 185.32, 185.32, 219

Discount Rate: 

\[ \text{Discount Rate}_{\text{a}} = 1 \times 89.9\% \times 80.9\% \times 72.7\% \times 65.4\% \times 58.8\% \]

Discount Rate: 

\[ \text{Discount Rate}_{\text{WACC}} = 1 \times 90.613\% \times 82.106\% \times 74.399\% \times 67.414\% \times 61.086\% \]

Debt Capacity

| FCF         | 1,750.00 | 185.32 | 185.32 | 185.32 | 185.32 | 2,196.18 |
| Leverage Value | 1,924.45 | 1,938.50 | 1,954.01 | 1,971.12 | 1,990.01 | 0.00 |
| Debt Capacity | 769.78   | 775.40  | 781.60  | 788.45  | 796.00  | 0.00 |

Interest Tax Shield

| Debt Capacity | 769.78 | 775.40 | 781.60 | 788.45 | 796.00 | 0.00 |
| Interest Paid | 76.98 | 77.54 | 78.16 | 78.84 | 79.60 |     |
| Interest Tax Shield | 16.17 | 16.28 | 16.41 | 16.56 | 16.72 |     |
1. Continued

<table>
<thead>
<tr>
<th>After Tax Salvage Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchase Price</td>
</tr>
<tr>
<td>Accumulated Depreciation</td>
</tr>
<tr>
<td><strong>Book Value</strong></td>
</tr>
</tbody>
</table>

| Sale Price | 2,201 |
| Book Value | 1250  |
| **Gain on Sale** | **951.0716** |

\[ V^L = APV = V^U + PV \text{ (Interest Tax Shield)} \]

\[ V^U \text{ is discounted using the project's cost of capital if it were financed without leverage} \]

<table>
<thead>
<tr>
<th>Unlevered Cost</th>
<th>WACC</th>
</tr>
</thead>
<tbody>
<tr>
<td>[ r_u = \frac{E}{E + D} * r_e + \frac{D}{E + D} * r_d ]</td>
<td>[ r_u = \frac{E}{E + D} * r_e + \frac{D}{E + D} * r_d (1- \text{tax}) ]</td>
</tr>
<tr>
<td>Debt to Value Ratio</td>
<td>40%</td>
</tr>
<tr>
<td>rd of RPPC Dynasty</td>
<td>10%</td>
</tr>
<tr>
<td>re of RPPC Dynasty</td>
<td>12%</td>
</tr>
<tr>
<td>( V^u )</td>
<td>114.1446</td>
</tr>
<tr>
<td>PV (Interest Tax Shield)</td>
<td>60.3025</td>
</tr>
<tr>
<td>( V^L )</td>
<td>\text{Check}</td>
</tr>
</tbody>
</table>

\[ V^L \text{ using WACC} = 174.4471 \]

(d)

(i) Recommend in which proposal (D.1 or D.2) management should invest. Justify your recommendation.

(ii) Describe two limitations of your recommendation.

**Commentary on Question:**

*Candidates generally scored well in this part. For (d.i), candidates were expected to clearly state the recommendation itself and provide justification to support their recommendation. For (d.ii) candidates had to describe the limitations rather than merely identify them.*

(i) Simply based on the NPV analysis performed, Blue Jay Air management should invest in the Purchase Proposal for an International Plane Fleet.

However, due to the potential large sensitivity in the assumptions made within the purchase proposal, the additional value created does not warrant the risk introduced in the pricing exercise.
1. Continued

Therefore ultimately, I would recommend the lease proposal as there is less uncertainty around assumptions made at a slightly lower NPV.

(ii) Results are sensitive to the financing structure we have assumed in our analysis. If the financing structure of Blue Jay Air deviates from that of RPPC, the WACC will likely change, shifting value from the purchase option to the lease option.

Results are also sensitive to the expected sale price of the existing fleet at the end of 5 years. Changes in that assumption could undermine our initial analysis.

A second assumption made by management is that the salvage value is expected to be higher than the original purchase price of the plane fleet. If the actual figure deviates from the expected value, the purchase option NPV could quickly fall. In fact, the break-even point for an NPV = 0, would be a sales price of 1.7B.
2. **Learning Objectives:**

3. The candidate will understand how to apply and recommend appropriate ERM framework, principles and strategies to manage, evaluate, analyze and mitigate risk exposures faced by an entity and to ensure operational excellence in any industry.

5. The candidate will understand advanced techniques to evaluate and manage non-hedgeable risks in financial and non-financial organizations.

**Learning Outcomes:**

(3a) Assess the potential impact of risks faced by an entity in any industry.

(3b) Recommend best practices in risk measurement, modeling, and management of various financial and non-financial risks.

(3c) Develop an appropriate risk mitigation or risk transfer strategy for any given situation.

(3d) Recommend best practices to achieve operational excellence.

(5a) Apply frameworks or methods to evaluate non-hedgeable risks for both financial and non-financial organizations.

(5c) Evaluate the efficacy of different approaches to managing non-hedgeable risks, including risk capital positions, operational risk management practices, risk mitigation and transfer strategies.

**Sources:**

Enterprise Risk Management Models, Olsen and Wu, Chapter 5 pages 55-73

How to Measure Anything, Hubbard, Chapter 13

Managing Supply Chain Disruptions, Vakharia and Yenipazarli, Sections 2-5

**Commentary on Question:**

The question tested candidate’s understanding of both supply chain risk and stochastic modeling as a tool for risk mitigation. Candidates continue to struggle to describe a Monte Carlo process although it has been asked on several past CFE FD exams.

**Solution:**

(a)

(i) Evaluate whether the push or pull supply chain is more appropriate for each company. Justify your response.

(ii) Evaluate whether a reliable or robust supply chain is more appropriate for each company. Justify your response.
2. Continued

Commentary on Question:
This is an open-ended question looking for logical buildup rather than an objective answer. The systems can be justified either way and credit was awarded for sound justification.

(i) As per the case study, Blue Jay Tire surpasses its sales targets each year and hence it can be inferred that they can sell as much as they can produce. Moreover, it is difficult to change production process for tires due to the complexity and usually certain quantities are produced in a given time frame. Therefore, the Push system is more optimal for Blue Jays Tire.

Frenz's coffee production process is relatively simple. Therefore, it can easily customize its production quantity in accordance with end customer demand. It is optimal for Frenz to follow a Pull supply chain system.

(ii) Frenz Corporation should follow a high cost but reliable supplier strategy because
a. It is very important that coffee beans are of high quality as Frenz is popular as premier coffee brand. Frenz should have reliable suppliers who can provide same quality products with the same characteristics.
b. There should be absolutely no compromise on the health aspect of the coffee beans. Since this is a food product, any health-related scare could be disastrous to the brand reputation. Therefore, Frenz should have a very reliable set of suppliers.

Blue Jay Tire should follow a cost-effective robust supply chain strategy due to the following reasons
a. In case of supply price rise, BJT will not be able to pass on the cost due to long-term contracts with car manufacturers. Therefore, they need to keep the supply chain cost effective.
b. BJT has maintained the same suppliers for a long time. This increases supply chain disruption risks. To effectively manage the disruptions, BJT should follow a robust supply chain strategy.

(b) Describe the benefits of using a Monte Carlo model to manage a supply chain.

Commentary on Question:
Many candidates gave a generic Monte Carlo description. For full credit, candidates needed to relate the model to supply chain risk mitigation.
2. Continued

The benefits of using a Monte Carlo model to manage a supply chain are
1. The supply chain risks can be evaluated on a wide spectrum of possibilities producing clear trade-offs.
2. The variability in the supply chain factors can be implemented.
3. The correlation between supply factors can be evaluated.
4. The simulation can identify the relative level of impact and variability for each of the risk factors.

(c)
(i) Identify three stochastic supply chain variables to use in the BJT model. Justify your response.

(ii) Identify three deterministic supply chain variables to use in the BJT model. Justify your response.

(iii) Outline the steps of a Monte Carlo inventory simulation model.

Commentary on Question:
Many candidates failed to link their responses to the specifics given in the Case Study and instead gave short, generic responses that did not receive full credit. For part (c.iii) very few candidates were able to outline the steps of a Monte Carlo model in a coherent way.

(i) The variables which are likely to change frequently for Blue Jay Tire's supply chain should be modeled as stochastic variables. These variables are harder to accurately predict but might have a significant impact on supply chain risks. The variables can be:
   a. Customer Demand - number of tires per order/number of orders per day
   b. Price of rubber
   c. Foreign currency exchange rates

(ii) The variables which are unlikely to change frequently for Blue Jay Tire's supply chain should be modeled as deterministic variables. Since these variables don't fluctuate, they are not likely to have a significant impact on supply chain risks. The variables can be:
   a. Sale Price - As per the Case Study the prices are contractual with the car manufacturers.
   b. Storage cost per tire
   c. Production time
2. Continued

(iii) Steps for building a Monte Carlo inventory simulation model
a. Identify the variables: The first step is to identify the variables. The variables with a high level of uncertainty should be modeled as stochastic variables. The variables which are unlikely to change should be modeled as deterministic variables.
b. Identify the distributions for stochastic variables: identify the probability distribution models suitable for the variables which are modeled as stochastic and values (constant) for deterministic variables. These can be either standalone or interconnected. If interconnected, we need to determine correlation factors as well.
c. Build the inventory model: using factors identified in step a, the inventory model should be implemented within the software.
d. Simulate the model: simulate the stochastic variables based on the distributions from step b to create a distribution for the inventory.
e. Metrics: from the simulation, key metrics such as min, max, average, certain percentiles, standard deviation etc. should be calculated. Comparing these metrics with stochastic variables will present the risk-reward trade-offs for the inventory system.

(d) Propose three ways that BJT can better align third parties in its total supply chain without acquiring them. Support your proposals.

Commentary on Question:
Part (d) was very open-ended and aimed at examining a candidate’s understanding of efficiency improvement in supply chains. Some candidates struggled to find improvements that didn’t take outright control.

BJT can better align third parties in their supply chain without acquiring each party in the supply chain by doing the following:

a. Data: Provide rubber suppliers with sales forecasts so they can align on rubber distribution to meet production demands.
b. Inventory: Maintain an inventory of rubber so tires can still be produced and distributed to the independent dealers even if there's a disruption from the suppliers in Malaysia.
c. Monitoring Changes: Receive feedback from the tire distributors on what products are selling best, what new demands are emerging, competitive intelligence, etc. so BJT can adapt its production capabilities to meet new market demands.
3. **Learning Objectives:**

1. The candidate will understand how a company optimizes its corporate finance decisions based on its business objectives.

2. The candidate will understand how to gauge a company’s performance through an evaluation of its financial reports.

**Learning Outcomes:**

(1d) Assess the impact of business strategies such as acquisitions, divestitures, and/or restructurings.

(2a) Analyze the interrelationships between the income statement, cash flow statement, and balance sheet, in order to measure a corporation’s financial performance.

**Sources:**

Corporate Finance, Fourth Edition, Jonathan Berk and Peter Demarzo, Chapter 28: M&A

Damodaran on Valuation, Aswath Damodaran, Chapter 15: The Value of Synergy

International Financial Statement Analysis, Robinson et al., Chapters 4, 7 and 17

**Commentary on Question:**

Candidates were asked to provide their analysis of financial statements, specifically common-size statements, and understand the benefits of a potential merger beyond just the financial transaction.

**Solution:**

(a)

(i) Describe the two common categories of financial analysis for a company

(ii) Explain why each of the common categories from (i) should be considered in BJA’s acquisition analysis.

**Commentary on Question:**

Very few candidates answered this correctly, often confusing common-size statement analysis as one of the categories of financial analysis; candidates needed to apply the types of analysis to the BJA situation for full credit.

(i) Equity Analysis: focuses on the ability to generate and grow earnings and cash flows over time; Credit Analysis: focuses on a company’s ability to pay its debts and cover its risks

(ii) BJA is trying to evaluate the ability of SEA to generate earnings, cash flow and growth for the company, while maintaining its BBB credit rating
3. Continued

(b) 

(i) Describe how a common-size analysis works.

(ii) Describe two benefits, specific to BJA’s acquisition analysis, of using a common-size analysis.

Commentary on Question:
Candidates did well on this part, however some failed to mention two benefits specific to the BJA acquisition scenario.

(i) Common size analysis involves expressing elements of financial statements not as absolute values but as a ratio of a common measure such as total revenue (income statement) or assets (balance sheet) which allows for a comparison of the source of income/assets between two companies.

(ii) A common-size analysis is valuable since BJA and SEA are very different in size. Common-size still allows for a direct comparison of their performance over time. The common-size analysis also removes the impact of different currencies (CAD vs USD), allowing for comparison between SEA and BJA.

(c) 

(i) Describe four observations from the common-size statements relevant to BJA’s acquisition analysis.

(ii) Describe three financial aspects that BJA should consider in its acquisition analysis that are not observable from the common-size analysis.

Commentary on Question:
Candidates did well at analyzing the statements and were able to comment on trends for both companies, but often struggled to provide three financial aspects that are not observable from the common-size analysis. A complete answer would comment on the fact that the common-size analysis only looks at ratios and doesn’t provide a picture of liquidity, solvency, or even why there is a difference in ratios.

(i) Fuel costs have been increasing for SEA but flat for BJA; SEA has been trending more to passenger revenues while BJA has had consistent revenue sources over the past three years; SEA spends much more of its earnings on maintenance than BJA; BJA has had flat net operating income.
3. Continued

(ii) The common-size statement doesn’t give an indication of the liquidity or solvency of SEA. The ratios don’t explain how the business models differ, only where the earnings are sourced and costs are allocated. BJA should consider tax obligations, particularly considering the foreign currency and foreign tax laws applicable to SEA, when analyzing the acquisition.

(d) Describe four synergy benefits to BJA that would justify paying more for the acquisition of SEA than its status-quo valuation.

Commentary on Question:
Candidates struggled to identify items that would cause BJA to pay more than the valuation price. For example, economies of scale would be present in almost every acquisition but that would not be considered in paying more than the valuation price.

- Booking system: because BJA was looking to upgrade its booking system, it could save money by building on SEA’s system.
- New Market Entry: BJA is too expensive for the NW market, but with acquisition of SEA it would allow for easy entry.
- Insurance: SEA could offer BJA insurance to its customer base for an additional source of revenue.
- Maintenance Crew: Acquiring SEA’s specialized staff and crew could help BJA save costs in their other operations.

(e) Explain how the synergy benefits you provided in (d) impact the following financial items in the short-term and long-term.

(i) Operating Expenses

(ii) Profit Margin

Commentary on Question:
Candidates did well on this part for synergies that were valid in part d. For full credit candidates, must comment on both short and long-term impacts.

Booking System: Operating expenses should increase in the short term as it’s an investment in the new system, however this will reduce Op Ex in the long-run by reducing staff costs. The profit margin will decrease in the short term but increase in the long run (inverse to the operating expenses).

New Market Entry: This will increase operating expenses in the short-term because it accelerates BJA’s expansion, but operating expenses will decrease in the long-run because of existing SEA infrastructure. Profit margin should decrease in the short-term but increase and stabilize over time as more revenues are realized.
3. Continued

Travel Insurance: Operating expenses would increase in the short and long term as there are new expenses with running an insurance business with new clients; profit margin could increase or decrease depending how the customers accept the insurance business and how profitable it can be run (risks occurring, etc.)

Maintenance Crew: Operating expenses will increase in the short term with new staff but decrease in the long-run as planes will be treated better and no need to outsource maintenance; profit margin will decrease initially with higher staffing costs, but the benefits will result in long-term profit margin increases
4. Learning Objectives:
3. The candidate will understand how to apply and recommend appropriate ERM framework, principles and strategies to manage, evaluate, analyze and mitigate risk exposures faced by an entity and to ensure operational excellence in any industry.

Learning Outcomes:
(3a) Assess the potential impact of risks faced by an entity in any industry.
(3c) Develop an appropriate risk mitigation or risk transfer strategy for any given situation.
(3d) Recommend best practices to achieve operational excellence.

Sources:
Enterprise Risk Management Models, Olsen and Wu, Chapters 1 and 3

Commentary on Question:
The goal was for candidates to demonstrate an understanding of the risks faced by BJT, especially with respect to the cost of goods sold to produce their main product. A related concept was evaluating strategies to mitigate or transfer these risks.

Solution:
(a) 
(i) Identify four sources of uncertainty related to Blue Jay Tire’s (BJT) rubber supply. (Case Study Section 3.2)
(ii) Describe a possible consequence associated with each uncertainty in (i).

Commentary on Question:
Most candidates correctly identified four sources of uncertainty and related consequence(s), receiving full credit. Risks that had little or no relationship to the rubber supply and BJT received minimal credit.

Weather
• Weather may suddenly and unexpectedly reduce the supply of natural rubber. This could lead to a rise in cost of materials.

Political climate
• The company has a geographical concentration of the suppliers in Malaysia. Unfavorable political relations could lead to tariffs on rubber.

Currency fluctuations
• A stronger Malaysian currency relative to the dollar would make it more expensive to purchase the rubber needed for tire production.
4. Continued

Supplier relationship
- A stable 30+ year relationship with the same supplier has resulted in volume discounts for rubber. If the relationship soured those discounts may vanish.

(b) 
(i) Recommend a new rubber supplier based on the SMART analysis. Show your work.

(ii) Identify a weakness of BJT’s SMART analysis.

Commentary on Question: 
Most candidates correctly solved for the missing SMART scores and recommended the largest such score, Supplier D, receiving full credit for part (i). Few candidates identified a weakness of BJT’s SMART analysis, and instead received only partial credit in (ii) for identifying a general weakness of the methodology.

Change the Rating into the proportions needed for the weighted average
Proportion = Rating / Sum of all Ratings = Rating / 3
Cost Per Unit = (1.00) / (3) = .33
Quality = (.60) / (3) = .20
Transportation Cost = (.40) / (3) = .13
Scalability = (.20) / (3) = .07
Agility = (.80) / (3) = .27

Calculate SMART scores using the proportions
A: 0.75*0.33+0.80*0.20+0.80*0.13+0.30*0.07+0.90*0.27 = 0.777 given
B: 1.00*0.33+1.00*0.20+0.50*0.13+0.70*0.07+0.50*0.27 = 0.780
C: 0.55*0.33+0.90*0.20+0.60*0.13+0.40*0.07+0.70*0.27 = 0.657
D: 0.90*0.33+0.70*0.20+0.90*0.13+0.60*0.07+0.80*0.27 = 0.813

Recommend Supplier D since SMART score D > B > A > C

Agility has a high weighting (~27%) yet is a somewhat subjective measure. Supplier B, which had the second highest SMART score overall, appears to be especially penalized in BJT’s SMART analysis having received the lowest (subjective) Agility score.

(c) BJT’s CFO states “We need to protect against potentially rising rubber costs. If we pursue Almond Bank’s offer (Case Study Section 3.2.1), we can hedge our risk, which is much more important than the cash outlay today.”

Critique the CFO’s statement.
4. Continued

Commentary on Question:
Many candidates received only partially credit for outlining a general approach (e.g., cost benefit analysis) to assess the financial tradeoffs of hedging vs. a cash outlay today. Candidates that addressed the effectiveness (measured against goals stated in the Case Study) and cost of the proposed hedge received full credit.

The proposed hedge is likely to be ineffective as it mitigates rubber costs rising 15% and only covers a single year. BJT has concerns about annual rate increases starting at 10%. More generally, being over-hedged at the tail may be too costly and a poor tradeoff depending on the rubber cost volatility.

(d) Recommend two other mitigation strategies, aside from hedging, that BJT could implement to manage its rubber price exposure. Justify your recommendation.

Commentary on Question:
Most candidates recommended and justified two appropriate mitigation strategies.

Expand / diversify rubber suppliers
- Having a single source for a commodity gives BJT few options should the supply and/or price change. BJT should explore diversifying its rubber supply into multiple sources.

Buffers / safety stock / excess inventory
- BJT could keep an excess supply of rubber - purchasing at opportune times from their one supplier when prices were reasonable - to act as a buffer against future supply and/or price changes.
5. **Learning Objectives:**

4. The candidate will understand the application of quantitative methods with a risk management focus to business problems.

5. The candidate will understand advanced techniques to evaluate and manage non-hedgeable risks in financial and non-financial organizations.

**Learning Outcomes:**

(4c) Evaluate the impact of risk mitigation methods including risk hedging and insurance.

(5a) Apply frameworks or methods to evaluate non-hedgeable risks for both financial and non-financial organizations.

(5c) Evaluate the efficacy of different approaches to managing non-hedgeable risks, including risk capital positions, operational risk management practices, risk mitigation and transfer strategies.

**Sources:**

The Costs and Benefits of Reinsurance - Cummins et al.,

Empirical Evaluation of Selected Hedging Strategies for Cattle Feeders - Gorman et al.,

An Analysis of Delta Air Lines' Oil Refinery Acquisition - Manuela, Rhoades, & Curtis

CRO Forum, Market Cost of Capital Approach to Market Value Margins

Managing Supply Chain Disruptions, Vakharia and Yenipazarli, Sections 2-5

Walmart's Response to Hurricane Katrina: Striving for a Public-Private Partnership, Harvard Kennedy School of Government


**Commentary on Question:**

*This question tested candidates’ understanding of hedgeable vs. non-hedgeable risks.*

**Solution:**

(a) Jane Smith, Darwin’s CRO, states, “Reinsurance goes through cycles of hard and soft markets all the time. All we have to do is wait a bit and reinsurance will be cheap again.”

Critique Smith’s statement.
5. Continued

Commentary on Question:
Most candidates understood that reinsurance goes through pricing cycles and that there is no guarantee that reinsurance will be cheap again. However, few candidates identified that the loss is due to an LTC assumption miss or mentioned that Darwin is a relatively new carrier so reinsurers may be more cautious on pricing.

Reinsurance does go through pricing cycles.

Shortage of capital following large reinsurer losses could cause prices to increase (hard market). Reinsurers could be re-evaluating their participation after suffering losses. The agency issue between direct writers and reinsurers is a friction that also increases the cost. In addition, Darwin is a relatively unknown, reinsurers may be more cautious.

Reinsurance is a global market and generally, capital is redeployed over time to bring prices back down. But there is no guarantee that reinsurance will be "cheap" only that it will likely be available

(b) Explain why Darwin might be willing to pay more than the actuarial present value of expected chronic care rider claims for the reinsurance.

Commentary on Question:
Generally, candidates did well on this part. However, many candidates failed to link their response to Darwin’s situation as presented in the Case Study and instead gave generic responses which did not merit full credit. Few candidates described the benefit of the convex structure of the tax code or the reduction of insolvency risk.

The reinsurance allows Darwin to gain access to a reinsurer's expertise (could include product development, claims evaluation and risk management) since Darwin is new to this business and has no prior data, a reinsurer could be invaluable.

Reinsurance reduces the variance of results. Darwin's loss ratio on this business can be more stable and that could reduce the need for large amounts of economic capital to back the business. It also limits the possibility for Darwin to have large losses and reduces the underwriting cycle. The reinsurance can further help Darwin decrease expected taxes by exploiting the convex structure of tax code.

Reinsurer has a profit (loading fees) built into the price to cover its cost of capital.
5. Continued

It also reduces insolvency risk and makes Darwin's products more attractive to consumers. Since Darwin is new to this risk, customers could be worried about its viability. Reinsurance would calm those concerns.

(c) Since reinsurance is so expensive, Tim Jones, Darwin’s hedge manager, suggests buying a chain of nursing homes to offset the risk of future performance on the block. He says, “If longevity assumptions are understated, longer nursing home stays would generate gains to cover the insurance losses.”

Critique Jones’ statement.

Commentary on Question: 
Many candidates were able to identify that a nursing home is not a perfect hedge for Darwin’s future LTC claims. However, most candidates only provided very brief explanations to demonstrate their point. A prompt of “Critique” requires further description and elaboration for full credit.

Nursing home operations could potentially be a partial hedge; but, would not be a perfect hedge for future LTC claims. First, LTC policyholders probably aren't the same people who are the nursing home residents. Second, LTC offers other elements that aren't related to nursing home care.

This is not really a vertical integration strategy since nursing home care isn't an input into the LTC claim costs. Darwin's goal should be to manage the incidence of LTC benefit payments not the cost of care which insureds would use their LTC benefit payments to purchase.

Cost of providing nursing home services will still expose Darwin to LTC benefit risk. Nursing home operations entail additional risk, such as expense risk, legal risk, etc. which are not present in Darwin’s LTC contract.

It is not clear that a hedge of this type would be successful. Darwin could have losses on both nursing homes and the LTC rider. Darwin should focus on Darwin's core competencies and maximize those to increase profits/reduce risk. Darwin should stick to what it knows.

However, even if it is not a great hedge for Darwin's risks, it may be perceived as such by investors. That would help Darwin even if there is no actual LTC claim offset from the nursing homes.
5. Continued

(d)

(i) Identify two other non-hedgeable risks in Darwin’s chronic care rider.

(ii) Explain how Darwin would mitigate the risks identified in (i).

Commentary on Question:
Candidates performed poorly on this part and struggled to understand what is a non-hedgeable risk. Below are sample responses. Other reasonable and well supported responses received full credit.

Non-hedgeable risk is one that has no deep and liquid market to observe/estimate the risk of loss.

Risk: a data breach which causes customers' personal information to be released publicly. The ensuing fallout to Darwin's reputation is a non-hedgeable risk. Mitigation: design a risk mitigation plan which envisions Darwin's response to such an event. It could combine that with the purchase of a cyber risk insurance policy which covers some of the event's elements.

Risk: policyholder anti-selection when it comes to purchasing LTC coverage that is different than priced for. Mitigation: have a team (build a reporting system) that monitors the important information as sales come in. The team should be able to manage the producers (the supply chain) such that they must bring in a spectrum of clients and cannot specialize in only selling to senior citizens for example.

Risk: operation errors/problems/shortfalls caused by a third-party supplier result in Darwin being unable to pay customer claims or respond to customer inquiries. Mitigation: work on the supply chain to evaluate the suppliers and test their abilities from time to time. Darwin should develop quick response capabilities in order to minimize the impact.

Risk: claims paid based on inability to perform activities of daily living is a self-reported standard subject to manipulation by the policyholder. Mitigation: redesign policy provisions so that insured must have certification by a licensed doctor that confirms they cannot perform the necessary activities. Additionally, build some cost sharing into the policy design so that the insured has less incentive to make a claim when not truly necessary.
6. **Learning Objectives:**

2. The candidate will understand how to gauge a company’s performance through an evaluation of its financial reports.

**Learning Outcomes:**

(2a) Analyze the interrelationships between the income statement, cash flow statement, and balance sheet, in order to measure a corporation’s financial performance.

(2b) Identify and analyze the impact of unusual accounting practices on the quality of earnings and assets of a corporation, including analyzing the signs of questionable accounting.

**Sources:**

International Financial Statement Analysis, Robinson et al., Chapter 11 - Financial Reporting Quality

International Financial Statement Analysis, Robinson et al., Chapter 17 - Evaluating Quality of Financial Reports

**Commentary on Question:**

The question tests the candidates’ ability to evaluate management decisions and the impact of those decisions on financial reports.

**Solution:**

(a) The auditor is reviewing BJA’s financials (Case Study Section 2.6). The auditor identified the following three items to be investigated:

I. Accounts receivable

II. Accounts payable

III. Advance ticket sales

Explain why the auditor would pick these items.

**Commentary on Question:**

To receive full credit, the candidate had to identify the suspicious trends of these items from BJA’s financials. Some candidates failed to understand that auditors review financials for accuracy and do not evaluate the financial condition of the firm.
6. **Continued**

These 3 items are subject to management choices. Trends in BJA’s financial have shown suspicious activity:

I. Jump in accounts receivable may be a sign that BJA booked revenue that won’t ultimately be received.

II. Jump in accounts payable may be a sign that BJA paid suppliers slower in order to boost profitability in a year.

III. Jump in advance ticket sales may be a sign that BJA had a sale so that the 2018 revenue looks good.

(b) In response to the auditor’s inquiry, management has provided the following commentaries:

I. Accounts receivable: “We performed an experience study on uncollectable receivables. As a result, we are decreasing the uncollectable percentage assumption from 4% to 3% over the next five years.”

II. Accounts payable: “We have negotiated better financing terms with our major suppliers and are maximizing financing terms to better manage our overall costs.”

III. Advance ticket sales: “In order to meet the sales target for 2018, we offered discounts to clients in Q4 2018 for flights taken in 2019.”

Evaluate how each comment above (I-III) relates to the quality of BJA’s earnings.

**Commentary on Question:**

Candidates did well in evaluating advance ticket sales however, they struggled with accounts receivable and accounts payable. Many candidates confused financial performance with earnings quality (i.e. whether earnings were manipulated). In general, candidates should have been more skeptical of management’s responses and attempted to substitute facts for impressions.

I. Decreasing the % of uncollectable receivables will reduce the allowance for uncollectible expense reported for the period. Because the proof of the estimates is rarely available at the time the estimate is recorded, managers have a means to manipulate earnings. The experience study should be reviewed to ensure that managers have a legitimate justification to decrease the percentage of uncollectable.
6. Continued

II. Better financial terms with suppliers gives BJA better financial flexibility to manage cash flow. After the “better financial terms” has been fully utilized, cash outflow will increase as the accounts payable become due. There is no impact on actual earnings but liquidity may become a concern for management as the payments are due. Depending on the actual financial terms from suppliers, BJA’s earnings quality may improve or deteriorate.

III. BJA induced customers to buy flight tickets through discounts. This has the effect of inflating Q4 2018 results by pulling future sales in the present period (referred to as channel stuffing). Such practices exhibit poor quality earnings because the reported information does not provide a useful indication of the company’s true performance.

BJA is evaluating the upgrade of current fleet proposal (Case Study Section 2.6 – Exhibit D.3). Assume BJA has the flexibility to choose one of the following two accounting methods:

I. Capitalize the costs of the fleet upgrade

II. Treat the upgrade cost as an operational expense

(c) Explain the impact of the two accounting methods on the following financial statements:

(i) Income Statement

(ii) Balance Sheet

(iii) Statement of Cash Flow

Commentary on Question:
Candidates did well for income statement and balance sheet impacts. Most candidates failed to recognize that the cash position is neutral regardless of which accounting method is used.

(i) Income Statement
Capitalized: Depreciation of the cost allocated for each period will be subtracted from revenue.
Expensed: The whole cost will be subtracted from revenue in the period incurred with no further adjustments in later periods
6. Continued

(ii) Balance Sheet
   Capitalized: The whole cost will increase the value of the assets on BJA’s balance sheet in the period incurred. Asset value will be reduced in subsequent years as it is depreciated.
   Expensed: No impact on the balance sheet

(iii) Statement of Cash Flow
   Under both methods, the net change to cash flow statement would be zero because cash position is indifferent under both accounting methods.

(d)

(i) Describe three methods of depreciation.

(ii) Recommend the most appropriate depreciation method for BJA to use for its current fleet upgrade. Justify your response.

Commentary on Question:
Candidates did well in describing three methods of depreciation. Other recommendations were accepted for credit as long the justification uses the manner in which the planes are to be “consumed” as the driver for depreciation.

(i) Straight line basis: costs of fleet upgrade will depreciate each year with the same amount of depreciation expenses
   Acceleration method: costs of fleet upgrade will depreciate with greater depreciation in the earlier years but the depreciation will decline in each succeeding year based on a fixed rate
   Activity based method: costs of fleet upgrade will depreciate based on units of use or production (e.g. number of flights or days in service)

(ii) We need to consider which methods represent the way the cost of the fleet upgrade will be consumed over its expected economic life. We expect the life span for the costs of fleet upgrade to be consistent with the remaining life span for the current fleet. One can justify using the current depreciation method for BJA’s fleets.

BJA’s income statement shows that an increase in depreciation expense from 2016 to 2018. The increase is consistent with the increase in revenue from 2016 to 2018. This observed pattern between depreciation and revenue implies that BJA is using activity based depreciation method for its current fleet. Therefore, activity based depreciation method is the most suitable for the cost of fleet upgrade.
7. Learning Objectives:
5. The candidate will understand advanced techniques to evaluate and manage non-hedgeable risks in financial and non-financial organizations.

Learning Outcomes:
(5a) Apply frameworks or methods to evaluate non-hedgeable risks for both financial and non-financial organizations.

(5b) Assess strengths and biases of techniques to measure risks given limited information for a range of business situations.

Sources:


Commentary on Question:
The question allowed candidates to demonstrate and explain the differences/similarities between one traditional method used in statistics, the t-statistic, and some non-traditional methods that may be quicker and not so dependent on certain assumptions like how the data is distributed.

Solution:
(a) Calculate a 2-sided 90% confidence interval for the mean loss from the data above using the t-statistic (Case Study page 2). Show your work.

Commentary on Question:
Candidates did fairly well on this straightforward part. One suggestion would be to apply a reasonableness check...if your answers are way out of line, perhaps you made a calculation error.

\[
\begin{align*}
\bar{X} &= \frac{1}{5} \sum \text{losses} = \frac{174}{5} = 34.8 \\
\text{VAR}[X] &= \frac{1}{(5-1)} \sum (\text{loss} - \bar{X})^2 = (6-34.8)^2 + (12-34.8)^2 + (18-34.8)^2 + (42-34.8)^2 + (96-34.8)^2 = 1357.2 \\
\text{\Sigma of x bar} &= (\text{var/5})^{1/2} = 16.475 \\
90\% \text{ 2 sided } t_{5-1 \text{ d.f.}} &= 2.13 \\
\text{Confidence Interval is 34.8 plus or minus 14.475 x 2.13} &= (-0.3, 69.9)
\end{align*}
\]

(b)
(i) Describe the “Rule of Five” as stated by Hubbard.

(ii) Determine the mathless 90% confidence interval using all eleven events.
7. Continued

Commentary on Question:
Candidates could have done more to actually describe the approach but most received credit for this part.

As long as there are at least 5 observations, one can derive a reasonable 90% confidence interval for the median.

Where \( n = 11 \), take the 3rd smallest and 3rd largest observation to get a 90% confidence interval.

3rd smallest = 12  
3rd largest = 42  
90% mathless CI = (12, 42)

(c) Recommend either the t-statistic or mathless method for the presentation of this analysis. Justify your response.

Commentary on Question:
Candidates could receive credit for either t-statistic or mathless method as long as they defended their selection. Stronger candidates tied their response to the information given in the question.

I recommend the mathless method. The mathless is based on the median, not the mean. The t-statistic could be distorted by outliers. Mathless is good for non-convergent means, the mathless doesn’t make any assumptions about distributions, and mathless is simpler to apply.

(d)  
(i) Evaluate whether clustered sampling or stratified sampling is more appropriate for the survey. Justify your response.

(ii) Evaluate whether the Likert or open-ended method is more appropriate for the survey. Justify your response.

Commentary on Question:
Again, stronger candidates tied their response to the information given in the question.

(i) Stratified is more appropriate. Given that we plan to survey all departments, it would be good to take random samples from each department. This would allow us to test whether some departments manage risk better than others. It is better when there are some groups that vary widely from each other, but they are fairly homogeneous within a group. Clustering works where a collection of individuals is different within each group.
7. Continued

(ii) Likert is more appropriate. This forces respondents to state strongly agree, agree, neutral, disagree or strongly disagree. This will help standardize scores amongst the departments and give you a broad understanding across the company. Open ended could be too broad for this initial survey.

(e)

(i) Describe two ways to avoid response bias in a survey.

(ii) Revise the survey questions (I-III) to eliminate response bias.

Commentary on Question:
Almost all candidates got full credit for part (i). In part (ii) it was important to keep the information sought by the question similar but to eliminate the bias from the leading question structure.

Avoid compound questions and
Avoid leading questions.

I. Do you think your department properly handles risk? What improvements would you suggest?

II. How does increased attention to operational risk impact the firm?

III. How have new regulations impacted your department?
8. **Learning Objectives:**

3. The candidate will understand how to apply and recommend appropriate ERM framework, principles and strategies to manage, evaluate, analyze and mitigate risk exposures faced by an entity and to ensure operational excellence in any industry.

**Learning Outcomes:**

(3a) Assess the potential impact of risks faced by an entity in any industry.

(3b) Recommend best practices in risk measurement, modeling, and management of various financial and non-financial risks.

**Sources:**

Enterprise Risk Management Models, Olsen and Wu, Chapter 8, pages 105-116

Enterprise Risk Management Models, Olsen and Wu, Chapter 9, pages 119-131

Fundamentals of Machine Learning for Predictive Analytics, Kelleher, Mac Namee, and D'Arcy, Chapter 9 - Case Study: Customer Churn

**Commentary on Question:**

*The question tests candidates’ understanding of how to apply an empirical process (DEA) to select an optimal choice among several alternatives based on a set of criteria.*

Candidates in general underperformed on this question, particularly in part (b), part (c), and part (e).

**Solution:**

(a) Explain four reasons why Data Envelopment Analysis (DEA) would help with your selection.

**Commentary on Question:**

*Credit was given for explaining each of the four reasons for the DEA concept and for connecting that reason to the stated information in the question.*

Candidates in general were able to explain DEA as a decision-making tool to choose between alternatives but had trouble explaining other reasons for the DEA concept.

DEA is used for efficient decision making such as vendor selection and choosing between alternatives/options based on a number of criteria. In this case, the selection choice is which bowler to sponsor with multiple differing criteria to consider.
8. Continued

DEA is also used in estimating an efficient frontier. Sponsoring a bowler is much like an investment with different considerations reflecting short-term and long-term risks and benefits.

Moreover, DEA is also effective in trading off multiple criteria, often including uncertain data. For instance, several bowlers may have nearly the same average score but one or two may be particularly popular with fans of the sport based on other factors which are difficult to understand and quantify.

Finally, DEA also effectively handles volatility that is typically a managerial assumption due to lack of sufficient historical data to calibrate the risk measure. In this case, the identified criteria other than perhaps bowling scores, do not have a starting basis but rather require expert judgment.

(b)

(i) Describe non-dominated alternatives in a DEA context.

(ii) Describe the steps of a linear programming model used to identify which bowlers are non-dominated.

Commentary on Question:
Credit was awarded for communicating each step of the linear programming model to identify which bowlers are non-dominated.

While most candidates were able to provide some high-level description of the modeling process, few articulated the specific objective function as well as its relevant components.

(i) Non-dominated alternatives are alternatives, which are at least as good on all criteria or strictly better on at least one criterion relative to all other alternatives.

(ii) First, we need to convert categorical (qualitative measures) to numerical measures with consistent direction (higher = better). Average bowling scores will be straightforward with higher being better. However, the scores of popularity, health, and performance under pressure will need to be converted. Using a consistent range (0 - 100) is helpful, though not necessary as the relative weightings will simply be more skewed.
8. Continued

We will then set up our linear programming model based on the following formula:

\[
\text{Max } \sum_{i=1}^{n} w_i y_i \\
\text{s.t. } \quad \sum_{i=1}^{n} w_i = 1 \\
\text{For each } j \text{ from } 2 \text{ to } m: \sum_{i=1}^{n} w_i y_{ij} \geq \sum_{i=1}^{n} w_i y_{ij} + 0.0001
\]

\[
\quad w_i \geq 0.0001
\]

Objective function is to maximize the sum-product of measure values multiplied by weights for each alternative in turn, subject to this function being strictly greater than each sum-product of measure values times weights for each of the other options.

We measure each alternative (bowler) separately with its own optimal weighting against the other solutions. Alternatives are shown as \( j \) from 1 to \( m \). There are 10 alternatives in this case.

Criteria are shown as \( i \) from 1 to \( n \). There are 4 criteria in this case. \( w \) represents the weighting of a criterion and \( y \) represents the alternative's score. Adding 0.0001 to the linear programming model would prevent any ties or otherwise, we may not identify strict dominance.

We would set up a table showing the optimal weighting for one alternative, the sum-product of its weighting and scores, and the resulting sum-product of each other alternative scores with the same weighting. If the alternative is non-dominated, then it will have the highest score. Otherwise, one or more alternatives with the same weighting are able to produce a higher score. We will perform this procedure for each measure.

(c) Explain how to modify the linear programming model in (b)(ii) to be stochastic, assuming bowlers' scores are normally distributed.

**Commentary on Question:**

While candidates are able to point out the need and the process to change the average score for the bowlers to be a random variable, most candidates did not communicate other aspects of the modification process. The response below is much more complete than would be expected on exam day.

Stochastic models construct production frontiers that incorporate both inefficiency and stochastic error. While incorporating average bowling score in the deterministic model is helpful, we can consider bowlers' performance as an investment's performance where there is variability. This approach will increase the technical efficiency relative to the deterministic model as outliers (scores) can be associated with the stochastic error term.
Compared to the deterministic linear programming model, the constant \( y(j) \) assigned to an option for each criterion potentially becomes a random variable. In this case, the random variable would be bowling score rather than using average score as the measure. We can estimate the mean and the variance of the modeling distribution based on the data set provided.

When a parameter or criterion is random (assuming normal distribution), a variance-covariance matrix is required between alternatives. The variance-covariance would correspond to the scores relative from one alternative (bowler) to another. Based on the data, the values for this matrix too can be estimated. Consequently, the formula will be updated as follows:

\[
\begin{align*}
\text{Max } & \sum_{i=1}^{n} w_i y_i \\
\text{s.t.} & \sum_{i=1}^{n} w_i = 1 \\
\text{For each } j \text{ from 2 to } m: \text{Prob}[\sum_{i=1}^{n} w_i y_{x1} \geq \sum_{i=1}^{n} w_i y_j + 0.0001] & \geq (1-\alpha) \\
\end{align*}
\]

Change from before is modifying the comparison of sum-products between alternatives such that alternative 1 is greater with probability \((1-\alpha)\) where \((1-\alpha)\) is commonly used in VaR to minimize expected losses to such a level, e.g. 95% where \(\alpha = 5\%). \text{Prob}\{L \leq \text{VaR}\} = 1 - \alpha.

Finally, the sum-product function will need to be updated to incorporate the variance in a bowler's scores as well as the covariance between that bowler's scores and each other bowler's scores in comparison:

\[
\begin{align*}
\text{w}_{score y_j score} - z & \sqrt{\text{Var}[y_j score]} + \sum_{i=2}^{n} w_i y_{x1} \geq \\
\text{w}_{score y_k score} & - z \sqrt{\text{Var}[y_k score] + 2\text{Cov}[y_j score, y_k score]} + \sum_{i=2}^{n} w_i y_k \\
\end{align*}
\]

(d) Explain two pros and two cons of using the deterministic linear programming model in (b)(ii) instead of the stochastic model in (c).

**Commentary on Question:**
Credit was awarded for each pro/con argument that tied to the stated information and demonstrated an understanding of tradeoffs between the two processes (deterministic vs. stochastic).

*Candidates performance on this part was generally good.*
8. Continued

First Pro - simplicity:
While the initial set up does involve an algorithm, it is easy to set up and explain. As each option has a list of criteria scores, the optimal weighting of each criteria is solved to test if a given option may be non-dominated. With a relatively simple set of data, this approach already brings a lot of rigor to the type of decision-making process which normally seems subjective based on multiple tradeoffs. The model and its results will be presented to a non-technical audience, and the method needs to be understandable and reasonable (not over-engineered) for the circumstance.

Second Pro - cost effectiveness:
While this is to be a sizable investment, it likely is not one of the largest risks the organization is facing (operational, strategic, and reputational) and therefore would be difficult to argue for the necessity of reflecting VaR and a production frontier that incorporates inefficiency and stochastic error.

First Con - range of outcomes:
Two bowlers with the same average score but one who consistently bowls the same score and the other who goes on exciting streaks of perfect games will be treated the same. The reading elaborates on the concept of VaR in financial risk management. Adopting a stochastic method would help the client to understand the decision, which could be viewed through the lens of risk taking (financial, reputational), bears a range of possible outcomes which they may not appreciate otherwise with the perceived simplicity of the linear approach. While the stochastic approach would be more difficult to communicate, explaining difficult mathematical concepts to non-technical leaders and experts is necessary to the profession.

Second Con – minimal variable cost:
The data necessary to determine variance and covariance is already utilized to develop averages. Furthermore, the deterministic model already sets up an algorithm where adopting stochastic would only involve some modifications. While Lemon Lu may value other risks as more costly, spending some more effort to make the process more robust (stochastic) may cause them to make a selection which would result in a better return on their investment.

(e) Explain the approach you would use to study a social media data set.

Commentary on Question:
Candidates tended to perform poorly as most focused on describing how and what to acquire for the social media data set but failed to describe and explain the process in how to model the data set itself.
8. **Continued**

We can train the model based on a subset of the data, 70% for instance. Once we trained the model, we can test our model using the remaining 30% of the data.

We can first define our dataset to create data types and data fields. We can then summarize our data using descriptive statistics (minima, maxima, means, medians, and quartiles). This is useful for a high-level understanding of the data or confirming its accuracy, also known as data cleanup. We can then compute correlation between variables.

Once we finish exploring the data, we can then select and train the appropriate model(s) (i.e. decision tree, regression, or neural network):

Decision tree splits data into bins and uses outcome counts to determine rules. It selects variables by various algorithms, often using entropy.

Regression can identify irrelevant and highly significant variables. Linear regression is a traditional method for fitting a statistical model to data whereas generalized linear models can address targets with non-normal distributions.

Neural network is a model that consists of multiple layers of neurons connected to each other. The network takes the numeric data and combines the numbers to produce a final answer. This is a less transparent process than the other tools.

Finally, we can improve the model fit by refining our model parameters over time as we acquire new data.
9. **Learning Objectives:**
4. The candidate will understand the application of quantitative methods with a risk management focus to business problems.

**Learning Outcomes:**

(4a) Assess methods and processes for quantifying and managing risk within any business enterprise.
   (i) Evaluate method and model tradeoffs between usefulness, resource constraints, timeliness, fidelity, and accuracy
   (ii) Evaluate processes for vetting models

(4b) Evaluate results of deterministic, stress-testing, stochastic and simulation methods and models.

**Sources:**
Fundamentals of Machine Learning for Predictive Analytics, Kelleher, Mac Namee, and D'Arcy, Chapter 10 - Case Study: Galaxy Classifications

Fundamentals of Machine Learning for Predictive Analytics, Kelleher, Mac Namee, and D'Arcy, Chapter 11 - The Art of Machine Learning for Predictive Data Analytics

**Commentary on Question:**
Most candidates did well on this question. The biggest issue was a failure to identify/describe the six phases of the CRISP-DM process in part (a), failure to identify what part (b) was requesting of the candidates, and the ability to understand more than just the technical aspects of the categorical models studied – which would have helped candidates better identify which model to use and support their answers in part (c.iii) and (d).

**Solution:**
(a) Describe the six phases of the CRISP-DM process.

**Commentary on Question:**
Candidates performed well on part (a), but the scores were widely distributed with the number of low scoring and high scoring. The answer to this question came from Chapter 11 of “Fundamentals of Machine Learning for Predictive Analytics”. It should be noted that the prompt was “Describe” and therefore simply listing the six components of the CRISP-DM process did not suffice for full credit. Low scoring candidates simply failed to answer the question or did not describe the process well enough to demonstrate they comprehended what the steps of the process entail/achieve. High scoring papers may have gotten the labels wrong, but they were able to describe the overall process well enough to demonstrate they comprehended the business purpose of the CRISP-DM process.
9. Continued

1) Business Understanding – What are we trying to accomplish? Understand the terminology, jargon, and context well enough to determine how this is an issue for the business and how a model could assist the business going forward.

2) Data Understanding – What data is available? How do these data sources relate to the business problem at hand? What does the data represent or inform on?

3) Data Preparation - How reliable is the data? Does it need scrubbing? Can it be updated and collected easily? Is it reproducible?

4) Data Modeling – What trends are in the data? What models could be used in this context? How do those models solve the business problem? What biases exist? How do we address over/under fitting?

5) Evaluation – What criteria will be used to evaluate the model/process? What performance issues exist with the models? Is the model appropriate for the business case?

6) Deployment – How will the model be monitored and evaluated going forward? How well does the model integrate into the organization? Does it provide the stakeholders with what they need to conduct their work?

(b)

(i) Identify two approaches to select the key features to include in the credit rating model.

(ii) Recommend which approach from (i) should be implemented. Justify your recommendation.

Commentary on Question:

Nearly all candidates missed part (b). Answers varied widely, and the few candidates who received credit for this question earned it on part (ii) for addressing model overfitting due to the use of too many risk-factors. Reducing the number of features would increase the efficiency of the model and make it more generalized, which would help with overfitting as well.

(i) Two approaches: Wrapper and Rank/Prune

(ii) Many features / risk-factors may be redundant with respect to building a predictive model. A predictive model should rely on the fewest features to achieve the highest predictive or explanatory power. A model with fewer features will run faster, be more efficient, and be highly predictive when the correct features are chosen. The goal with categorical models to map / predict risks is to maintain a high overall classification accuracy. I recommend the wrapper approach to feature selection, rather than the rank and prune approach, because the wrapper approach considers groups of features together and is therefore faster at identifying and eliminating redundant features.
9. Continued

(c)

(i) Calculate the classification accuracy and the average class accuracy of each model. Show your work.

(ii) Evaluate each model above in terms of accuracy.

(iii) Explain how to improve the performance of the models.

Commentary on Question:
Nearly all candidates earned full credit on part (i). Candidates who did not earn full credit either calculated one, but not both, of the average class accuracy and the overall accuracy, or they failed to calculate the metrics correctly. In part (ii) candidates generally did well, but the most commonly missed concept was tying back to the CRO’s requirement of 80% accuracy. Part (iii) was the most challenging piece for candidates; most candidates simply focused on the accuracy of the model rather than potential issues with the data. Running more data won’t help if the model isn’t working as intended.

(i) Average Class Accuracy is simply the average of how well the model sorts the categories correctly. In this case the average of how many of the actual defaults were predicted to be defaults and how many of the no-defaults were predicted to be default free.

Overall accuracy is how many of the actual events did model predict correctly out of all the actual data points in the sample.

Three models:
• K-nearest neighbor – Overall accuracy is 75.8%, Average Class Accuracy 62.4%
• logistic regression – Overall accuracy is 82.36%, Average Class Accuracy 67.5%
• support vector machine – Overall accuracy is 85.7%, Average Class Accuracy 70.9%

(ii) The Logistic Regression and Support Vector Machine satisfy the CRO’s requirement of 80% accuracy overall, but they fail to meet this accuracy requirement on average when looking at the individual classes into which the data points are sorted (the Average Class Accuracy). The SVM is the most accurate, followed by Logistic Regression, and finally the K-nearest neighbor is the least accurate of the three.
9. Continued

(iii) Categorical models are severely affected by target level imbalance. This is apparent by the significant drop in average class accuracy when compared to overall accuracy. The target level imbalance is due to the relative infrequent number of default data points compared to data points without defaults. This issue can be eliminated by generating a data sub-set that under samples the records without defaults. This new dataset would have a stronger emphasis on the records that defaulted, perhaps equal to the non-defaults.

(d) Recommend which model Adam should select. Justify your recommendation.

**Commentary on Question:**

*Candidates performed poorly on (d), “Recommend” requires that candidates support their recommendation. Many candidates simply said “I recommend x” without justifying it. Some candidates attempted to justify their model selection on the sole basis of model accuracy, but that does not demonstrate an understanding of the business case or the use case of the models studied in the readings. If you have a model that is 100% accurate, but takes 15-years to run, would you really recommend that model over one that is 90% accurate but takes 30-seconds to run?*

I recommend using the Logistic regression model to classify loan applications because:

- It is a fast model, and real-time approval decisions would generate more loans; K-nearest neighbor is slow due to the large number of point comparisons it makes in each case
- It is easy to interpret its results because it is based on a regression model; SVM is almost a black box in terms of ease of interpreting results
- While Logistic regression models are not easy to retrain on new datasets, it is unlikely the features used in loan decision making will vary or change materially at a rapid pace; so, the model will not need to be retrained frequently. Regression models typically need to be completely rebuilt, but logistic regression models allow for some corrections to live models.
10. **Learning Objectives:**
   1. The candidate will understand how a company optimizes its corporate finance decisions based on its business objectives.

**Learning Outcomes:**
(1a) Recommend an optimal capital structure for given business objectives and the competitive environment.

(1b) Compare and contrast methods to determine the value of a business or project, including the impact on capital budgeting and allocation decisions.

**Sources:**
Handbook of Corporate Finance, Chapter 10: Payout Policy

Creating Value Through Best-In-Class Capital Allocation, JP Morgan

Capital structure, executive compensation, and investment efficiency, Journal of Banking and Finance

**Commentary on Question:**
*This is a simple question on capital deployment within a corporation.*

**Solution:**
(a) Explain the difference between options II and III above, assuming perfect capital markets.

**Commentary on Question:**
*This is a fairly basic concept and candidates generally did well on this part. Successful candidates were able to define Modigliani & Miller irrelevance proposition and draw conclusion based on it.*

According to Modigliani & Miller irrelevance proposition, under perfect markets, payout policy is irrelevant from the investor's perspective because any desired temporal pattern of payments can be replicated by appropriate purchases and sales of equity. Since investors can create "homemade" dividends, they will not pay a premium for a firm with a particular dividend policy. Therefore under perfect markets, there is no difference between options II and III.

(b) Assess which option (I-III) is the most advantageous for each stakeholder (A-C).

**Commentary on Question:**
*Most candidates were able to answer this question correctly with justification.*
10. Continued

Management with stock options will prefer one-time share repurchase (option I). A share repurchase has the effect of lowering the shares outstanding and increasing the earnings allocated to the remaining shares. Dividends would not benefit those with stock options if the dividends are paid before the options mature.

Employees with a defined benefit pension plan will prefer retaining the funds (option II). Pension benefits are similar to debt instruments from the company to the employee. To that end the employee is benefited if the employer is solvent and around to pay the pension benefits and would prefer the excess capital be retained to boost the company's solvency ratio.

Debtholders will prefer retaining the funds as well (option II). Debtholders will attempt to maximize the likelihood that they will be paid in full. So, it’s in their best interest to boost the company’s solvency ratio.

(c) Identify the additional information needed to assess which option is most advantageous to common stockholders. Justify your response.

Commentary on Question:

Few candidates answered part (c) correctly. Successful candidates identified the information needed and explained why that information would affect common stockholders’ decision making.

The missing information is the respective tax rates for dividends and capital gains. If the tax rate on dividends is lower for the respective stockholder vs. capital gains then dividends would be preferred, and vice versa.

(d) Calculate the impact to Raptor’s stock price for each of the following scenarios:

(i) The excess capital is used for share repurchases at the current share price.

(ii) The excess capital is used for the internal investment opportunity and returns are realized as expected and distributed to shareholders annually.

Show your work.

Commentary on Question:

Many candidates got this simple calculation. If an error was made it was generally in not reducing the number of shares outstanding in part d(i).
10. Continued

(i) Shares to be repurchased = $2B / $100 = 20M
Shares after repurchase = 1B-20M = 980M
Dividends are now distributed amongst 980M shares as opposed to 1B shares, which implies a price increase = 1B / 980M = 2.04%
New stock price = $100 * 1.0204 = $102.04
Impact: 102.04-100 = 2.04

(ii) After tax ROIC = 10% x $2B = $200M
PV of after tax ROIC = $200M / 0.16 = $1.25B
PV of dividends per share = $1.25B / 1B = $1.25
Stock price = $100 + $1.25 = $101.25
Impact: 101.25-100 = 1.25

(e)

(i) Critique Josh’s statement.

(ii) Calculate the MVA of the proposal. Show your work.

(iii) Recommend whether Raptor should proceed with the proposal, based on the result in (ii).

Commentary on Question:
Candidates generally did well on this part. Most were able to point out that Raptor should not proceed with the proposal due to the negative MVA. However, few candidates received full credit for part e(i) because they didn’t provide a critique (both why it is OK and why it isn’t).

(i) Josh’s statement is partially correct.
- Raptor should not invest in projects with negative MVA as it destroys value as opposed to creating value for the company.
- However, positive MVA projects may not properly reflect the risk of the project as hurdle rates are usually based on investment projects in the past. This will lead company to over-invest in risky projects.
- Companies should also evaluate MVA of this investment opportunity with other investment opportunities to make sure the best project is chosen.

(ii) EVA = (ROIC - WACC) x Invested Capital
EVA = (10% - 16%) x $2B = -$0.12B = -$120M
MVA = PV of all expected EVA
MVA = -$120M / 0.16 = -$750M

(iii) Since the MVA is actually negative, Raptor should not proceeded with the internal investment opportunity as it would destroy shareholder value.
11. Learning Objectives:
4. The candidate will understand the application of quantitative methods with a risk management focus to business problems.

Learning Outcomes:
(4a) Assess methods and processes for quantifying and managing risk within any business enterprise.
   (i) Evaluate method and model tradeoffs between usefulness, resource constraints, timeliness, fidelity, and accuracy
   (ii) Evaluate processes for vetting models

(4b) Evaluate results of deterministic, stress-testing, stochastic and simulation methods and models.

Sources:
Measuring Market Risk 2nd ed, Dowd, Chapter 9 - Applications of Stochastic Risk Measurement
Heavy Models, Light Models, and Proxy Models
Fundamentals of Machine Learning for Predictive Analytics, Kelleher, Mac Namee, and D'Arcy, Chapter 8 - Evaluations

Commentary on Question:
Candidates generally did well on this question. The objective was for a candidate to be able to evaluate a proxy model as well as describe the characteristics of an ideal interest rate stochastic process and the Cox-Ingersoll-Ross model. Credit was also awarded to candidates who recommended an alternate interest rate model as long as the advantages and drawbacks of using the model were stated correctly.

Solution:
(a) Describe two advantages of using a stochastic simulation model.

Commentary on Question:
Candidates did well on this part. Most could explain the advantages of using stochastic simulation models for fixed-income risks. Candidates who described advantages other than those listed below also received full credit.

1) Stochastic models are extremely flexible and powerful
2) Stochastic models are good at dealing with complicating factors such as path dependency, non-linearity, optionality, multidimensionality
11. Continued

(b)

(i) Recommend a stochastic process to model interest rates. Justify your selection.

(ii) Describe a limitation of the interest rate model you recommended in (i).

Commentary on Question:
Candidates generally did well in part (b.i), while performance on part (b.ii) was weak. Candidates who recommended a model other than Cox-Ingersoll-Ross (CIR) model also received partial credit if the justifications and limitations described were applicable to that specific model.

(i) Recommend using Cox-Ingersoll-Ross model because:
   a) mean-reversion: interest rates are typically prone to reverting to a long-term rate over a period of time (high rates tend downwards and low rates tend upwards), which is unlike stock prices which have an upwards drift
   b) interest rates are positive, which is what CIR models

(ii) CIR has the following limitations:
   a) Does not provide information about the spot rate term structure, which is needed to price fixed income positions.
   b) Does not provide information about the spot rate terminal volatility, which is needed to price interest rate options.

(c) Describe four factors that complicate the modelling of credit risk.

Commentary on Question:
Candidates generally did well on this part. Candidates received credit for other responses if those responses were indeed complications for credit risk and not just generic modeling complications.

a) The need to model default process, which is complex and non-normal
b) Default probability changes over time (not constant)
c) Recovery rates and credit rating upgrades/downgrades further complicate the modelling of credit risk
d) Institutional factors such as collateral and netting agreements significantly complicate the modelling of credit risk.
11.  Continued

(d)  Compare and contrast a light model with a heavy model.

**Commentary on Question:**
*Most candidates did very well on this section although some didn’t understand that a light model is built to replicate the heavy model’s outputs.*

Heavy models:
- a)  Model reality (risk factors)
- b)  More complex, slower, more accurate

Light models:
- a)  Model heavy model outputs
- b)  Simpler, faster, less accurate

(e)  Recommend which light model Toonie should select.  Justify your recommendation.

**Commentary on Question:**
*Candidates performance on this question was good. Successful candidates recommended the Replicating Portfolio (RP) and could clearly evaluate the trades-offs between the proxy models. Successful candidates also noted that VaR and CTE metrics were more important than any individual risk metrics, and RP performed better for those. Candidates received partial credit for evaluating the tradeoff for each statistic even if they didn’t recommend the RP.*

Recommend using the RP.

RP is closer to the stochastic model for VaR and CTE measures. Even though the Polynomial is closer for some specific metrics, the VaR and CTE measure is more important for the stated situation.

IR +/- 100bps, RP and polynomial are close
IR + 600bps, Polynomial does better but the difference is trivial
CD +10%, CD 2X, Polynomial is better
r-square, Polynomial is closer to 1 but it measures fit to a linear regression which is not credible in this case
K-S value, RP is higher so that shows better model fit
Polynomial has lower cost and faster speed. But the difference from RP is small so these are tradeoffs which can be accepted.