CFE FD Model Solutions
Spring 2019

1.

Learning Objectives:

5. The candidate will understand how and when to apply various advanced techniques to evaluate non-hedgeable risk or uncertainty in any business enterprise, especially non-financial organizations.

Learning Outcomes:

(5a) Apply cost of capital frameworks for risk evaluation in business decisions.

Sources:

F-107-13: A Market Cost of Capital Approach to Market Value Margins

Down But Not Out: A Cost of Capital Approach to Fair Value Risk Margins

Commentary on Question:

Commentary listed underneath question component.

Solution:

(a)

(i) Describe the difference between the MCoC approach and the Percentile approach.

(ii) Provide four reasons why the CRO Forum recommends the MCoC approach.

(iii) Explain how to apply the MCoC approach to Frenz.

Commentary on Question:

For this section candidates are expected to make connections between two capital calculation approaches and understand the key difference. For the part (iii) full credit was given when the steps showed how they apply to Frenz instead of simply listing the steps.

(i) The key difference between the MCoC and Percentile approaches is as below

a. The Percentile approach takes the perspective that sufficient capital is needed to ensure that the liabilities can be met with a predefined confidence level. The percentile is set based on either expert judgment or the risk appetite of the company.
b. MCoC approach takes the perspective that sufficient capital is needed to be able to run-off the business.

1. Continued

(ii) The CRO forum recommends MCoC approach because:

a. It provides a more appropriate reflection of risk, both in terms of risk type and between product groups. Therefore, it supports appropriate risk management actions
b. It allows for simplifying assumptions, which makes this approach easy to implement
c. It is transparent, easily verifiable and readily understandable by the supervisor and other constituencies
d. It ensures a better response to a potential crisis in the insurance industry

(iii) Under MCoC, MVM is calculated for non-hedgeable risks only. Therefore, Frenz needs to first identify their non-hedgeable risks. The key non-hedgeable risks for Frenz include Supply Chain risks, Political instability risks etc.

For each non hedgeable risk the MVM procedure is:

a. Calculate the SCR (Solvency Capital Requirement) using internal models
b. Run off the SCR,
c. Multiply by the Cost of Capital,
d. Discount at the risk free rate to calculate the MVM

(b) Calculate the MVM for the Vietombia project using the MCoC approach. Show your work.

Commentary on Question:
This is a straightforward quantitative question. Candidates are expected to identify the components and correctly apply them to the calculation.

Under MCoC approach the MVM can be calculated as below

	t=0	t=1	t=2	t=3	t=4
	SCR	Run-off SCR			
Run-off	60	48	36	24	12
*CoC		9.6	7.2	4.8	2.4
Discount		9.14	6.53	4.15	1.97
MVM	21.79				

Step 1. Run-off SCR uniformly over 5 years.
Step 2. Multiply by CoC, 20% (as per case study) for that project.
Step 3. Discount at risk free rate, 5%

The MVM of the project is 21.79M

1. Continued

(c)

(i) Describe the "Down but not Out" concept.

(ii) Provide three examples of events that could put Frenz into a "Down but not Out" situation. Justify your response.

Commentary on Question:
This is again a straightforward question. Part ii must reference the case study in providing three events related to Frenz that would cause the company to loose a large sum without actually going out of business.

(i) The Down but not Out concept talks about level of resilience of the company. If a 1 in N year event wipes out the economic capital of a risk enterprise, there should still be enough risk margin on the balance sheet that the company can either attract a new investor to replace the lost capital or, equivalently, pay a similar healthy enterprise to take on its obligations.

(ii) Three examples of a Down but Not out situation for Frenz are:
   a. Vietombia government decides to impose a huge tax on foreign companies such as Frenz
   b. A catastrophic weather event wipes out Frenz's coffee supply
   c. Large shipments of coffee contain mold which sickens customers and leads to lawsuit for medical costs and bad press coverage.

2. Learning Objectives:

3. The candidate will understand why and when to apply stochastic techniques to develop risk profiles and assess the techniques' efficacy.

4. The candidate will understand how to identify and recommend appropriate model risk assessment and vetting techniques for risk management models.

Learning Outcomes:

(3a) Assess the appropriateness of a given stochastic technique to quantify market and non-market risk exposures.

(3b) Recommend the use of techniques that balance resource constraints versus model accuracy and appropriateness when applying stochastic techniques.

(3c) Assess the results of a given application of stochastic modelling.

(3d) Explain what risk exposures are or are not identified with a given risk metric, assess the implications, and recommend further action.

(4a) Assess methods and processes for quantifying and managing model risk within any business enterprise.

(4b) Design and evaluate stress-testing and back-testing processes.

Sources:

Hubbard, *How to Measure Anything*, Ch 6

Christian, *Algorithms to Live By*, Ch 7

Tetlock, *Superforecasting: The Art and Science of Prediction*, Ch 5

Commentary on Question:

Commentary listed underneath question component.

Solution:

(a) Analyze the results of the coffee price risk analysis shown in the Case Study Section 4.3, Exhibit 5b.

Commentary on Question:

Most candidates failed to do any analysis beyond reduction of losses. Stronger candidates explored multiple risk aspects and did a simple quantification of the potential loss reduction.

2. Continued

The simple analysis may result in understated tail risk of the Vietombia Deal.
The current Frenz supplier model was not built to include coffee production, just sourcing coffee.
As the exclusive buyer of Vietombia coffee, Frenz will be exposed to different risks than when it sourced Arabica coffee
The results of the analysis indicate that losses are reduced 40% throughout the tail with the Vietombia Deal.
This appears to be a simple assumption that losses will be reduced 40%

(b) Describe four risk exposures specific to the Vietombia Proposal that are not captured in the coffee price risk analysis.

Commentary on Question:
Most candidates did well on this question. Successful candidates described multiple risks related to Frenz's analysis of the Vietombia deal.

Model does not include risks specific to Vietombia (political and monetary banking system).
Model does not consider risks involved in setting up an exclusive production facility in Vietombia
Model is simple and does not consider interrelationships
Model does not consider the risk of recruiting and retaining qualified personnel in Vietombia, which has only 30% adult literacy
Model does not include risks related to weather, political and economic conditions of Vietombia, etc.
Model does not consider the increased operational risks and business disruptions in executing Vietombia Project

(c) Outline how to estimate the risk of political instability in Vietombia.

Commentary on Question:
Candidates generally did well on this question. Successful candidates used a fermi-style approach to decompose the problem/risks and then used measuring techniques to estimate the uncertainty. A lot of candidates failed to break down the initial question with more specific questions and describe impact of sub-questions. A few candidates failed to describe risks and just listed them.

What causes political instability?
Possible factors:

- unstable government,
- economic instability,
- organized labor,
- education level

2. Continued

How stable is the current government?
Not stable: Vietombia was overthrown 2 years ago; current government has corrupt officials and weak laws.
=> High Risk of political instability

How stable is Vietombia's economic environment?
Unstable: Vietombia pegged its currency and then deflated it; banking system is fluffy.
=> High Risk of political instability

How organized are workers?
Not organized - Vietombia has no "association of coffee providers" and no trade unions
=> Medium Risk of political instability

Is the population educated?
Lack of education - 30% adult literacy, average school level of coffee workers is Grade 6
=> Medium Risk of political instability

How to measure the loss if political instability occurs?
Design a Monte Carlo simulation using a range of production levels, sunk costs, varying expenses, and medium to high probabilities of political uprising to estimate losses in event.

(d)

(i) Explain why a better fit of available data may not justify increased model complexity.

(ii) Describe a technique to reduce model complexity.

Commentary on Question:
Candidates generally did well on this question. Successful candidates mentioned overfitting and described how overfitting impacts the accuracy of future predictions. Some candidates did not relate this to the Vietombia data. For the second part, successful candidates were able to name one of the methods and describe how it works.

(i) A model with too many factors may be overfitted.

A model that's too complicated becomes oversensitive to the particular data points that we happened to observe.
Too many factors can lead us to optimize or model the wrong thing

2. Continued

The 3-month Vietombia government rate, Vietombia unemployment rate, and Vietombia GDP should have limited impact on the Rubiaceae value because Vietombia has pegged its currency to that of its neighbors.

A better fit for available data does not necessarily mean a better prediction; rather it may make predictions dramatically worse.

(ii) Regularization is a technique to reduce model complexity that could cause the overfitting problem.

Regularization uses a complexity penalty so that more complex models or models with higher number of factors have to do a significantly better job to justify their complexity.

(e) Propose a stress scenario for the Vietombia Proposal that addresses the concerns of Kaplan, Jansen, Jacobs, and Pirot.

Commentary on Question:
Most candidates were able to propose valid stress scenarios however some just proposed doing more stress scenarios without explaining why they would be useful. Successful candidates covered multiple stress scenarios and one stress scenario where risks were combined.

Continued economic instability leads to increased support for the political party that was in power 2 years ago.
The strengthened party overthrows the current political regime. (Political risk)

The political turmoil forces the Rubiaceae off its peg which results in wild currency fluctuations. (Currency risk)

The worsening economic conditions lead to increased business costs forcing Frenz to increase its coffee prices (Coffee price risk)

The three risks are covered in one stress scenario

3. Learning Objectives:

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

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 especially when opposing factors are key decision criteria.

Learning Outcomes:

(1a) Identify and critique the available funding sources of any business at its different stages and business of various risk profiles and durations.

(2a) Evaluate how the legal form of an organization, corporate governance, compensation dynamics and other market frictions impact business decisions.

(2b) Recommend an optimal capital structure and how to implement the structure for a business strategy.

(2d) Assess the impact of behavioral factors in capital budgeting methods and capital structure policies.

Sources:

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

Fan, Titman & Twite, An International Comparison of Capital Structure and Debt Maturity Choices

Jonathan Berk and Peter Demarzo, Corporate Finance, Third Edition, Ch 17: Payout Policy

Jonathan Berk and Peter Demarzo, Corporate Finance, Third Edition, Ch 18: Capital Budgeting and Valuation with Leverage

Jonathan Berk and Peter Demarzo, Corporate Finance, Third Edition, Ch 26: Working Capital

Jonathan Berk and Peter Demarzo, Corporate Finance, Third Edition, Ch 27: Short Term Financing

Jonathan Berk and Peter Demarzo, Corporate Finance, Third Edition, Ch 29 Corporate Governance

3. Continued

Sherman, Raising Capital, Ch. 1, 7

Handbook of Economics of Finance, Ch5: Baker & Wurgler, Behavioral Corporate Finance: An Updated Survey

Commentary on Question:
Commentary listed underneath question component.

Solution:

(a) Identify four agency costs to Frenz of retaining cash.

Commentary on Question:
Most candidates earned full or near full credit on this part. Full credit required listing four distinct agency costs of retaining cash. Candidates earning partial credit usually listed fewer than four agency costs, and on rare occasion listed the same agency cost from slightly different angles (restated differently, but same issue).

(1) Managers may use cash to fund perks that do not add value to shareholders, such as corporate jets
(2) Managers may invest in sub-optimal projects to build an empire
(3) There are tax inefficiencies to holding cash – pay tax on cash investment earnings and do not get the benefit of a tax shield from debt
(4) Governments, unions, and other external entities may try to take advantage of Frenz's "deep pockets"

(b) Compare and contrast the benefits to Frenz of funding projects with cash vs. debt.

Commentary on Question:
Candidates answered this question satisfactorily (not great, not poor). Many candidates listed four or more pros and cons regarding funding a project from either cash or debt; totaling eight items (four each source). Partial credit was awarded regarding how deeply candidates understood the pros and cons for each. Candidates that performed poorly on this either:

a) did not demonstrate an understanding of the issues (e.g. an answer of "pecking order says use cash first" was not a satisfactory benefit)
b) Focused too much on cash as negative debt without demonstrating the implications of this in terms of actually funding a project
c) listed few to no benefits for one or both sides

3. Continued

Debt:
(i) Preferential treatment of debt (tax shield)
(ii) Debt holders provide monitoring of the agency at a lower cost to shareholders
(iii) Preserve cash on-hand for flexibility to invest in projects or other reasons as they arise
(iv) Need to evaluate the return on a project vs. the cost of the funds used to finance the project

Cash:
(i) Lower distress costs compared to bonds
(ii) No interest payments to keep up with
(iii) Preserves credit rating and likelihood of default
(iv) Reduces liquidity which could cause issues in the event of market crisis or earnings short-falls

(c) Calculate the return on the Vietombia project to shareholders if it is funded with $100 million of Frenz's accumulated cash assuming the equity cost of capital is 14%. Show your work.

Commentary on Question:
Majority of candidates got full or near full credit on this question. Candidates who did not perform well generally either:
a) did not attempt to answer it
b) failed to recognize it was a perpetuity, did the calculation the hard way, and ended up making formulaic errors
c) forgot to deduct the upfront cost of the project from the PV of future earnings

Use the Free Cash-flow to Equity method since there is no debt to worry about in this scenario from the case-study:
Net of $10-million per year, return on equity of 14% => PV of FCFE = 10/.14 = 71.4 million
Less initial outlay of 100 million => NPV = -28.6 million

(d) Calculate the return on the Vietombia project to shareholders if it is funded with a 5-year $100 million interest-only loan. Show your work.

Commentary on Question:
Nearly all candidates left this problem blank and earned little to no credit for it. This was surprising considering all that was necessary was to add the value of the Tax Shield to part (c).

3. Continued

Part (c) had a Unlevered Value of the Project = -28.6 million
Interest due on loan per year = $7 million, tax rate = 21%, so tax deduction is 1.47 million per year for five years
Discounting tax deductions at 20% provides a tax shield of $4.4 million
Leveraged Value of Project = Unlevered + Tax Shield = -28.6 + 4.4 = -24.2 million

(e) Explain additional considerations for the loan in part (d) if the borrower were a Frenz subsidiary, based in Vietombia, instead of Frenz.

Commentary on Question:
Most candidates provided extremely brief explanations such as "get a bank loan"; a prompt of "explain" requires further description and detail to demonstrate candidate comprehension of the underlying issues. Additionally, as a case study question, it is important to tie the response back to the situation presented in the case study.

If the borrower is a subsidiary in Vietombia consideration needs to be given to:
(i) The higher risk of Vietombia in terms of politics, operations, and currency
(ii) Vietombia's political and banking environment may impact what funding sources are available or preferential
(iii) A subsidiary's credit rating will be lower than that of Frenz at inception
(iv) Frenz may not step in if the subsidiary experiences financial distress
(v) All these factors will impact the terms of the debt/equity issuance and availability of capital raised

(f) Describe how dividends may impact the value of management stock options.

Commentary on Question:
Most candidates focused primarily on the general aspects of dividends, such as ex-dividend dates and signaling theory, but failed to go a step further and relate these to management stock options as requested by the question. The key is that unexercised options do not receive dividend payments.

At the ex-dividend date, the value of a stock falls by approximately the present value of the dividend to be paid.
Shareholders are no worse off before or after the ex-dividend date because the value of the stock + the dividends they will receive remains equal holding all else constant
However, because the stock price drops, management options will be exercised at the new lower share price and therefore hold less value to management.
Ultimately this reduces the value of management options and results in more pronounced earnings management when the timing of dividends and earnings impact management compensation.

3. Continued

(g) Frenz announces a plan to pay a one-time special dividend of $2 to shareholders in six months.

(i) Describe how this plan is expected to impact Frenz's share price over the next six months.

(ii) Explain how the special dividend may impact Frenz's share price in the long-term.

Commentary on Question:
Most candidates did well on part ii, correctly describing signaling and the nuances of this being a one-time special dividend rather than a recurring one. For part i, candidates often referenced the differences in shareholder tax rates to influence supply and demand and be the primary driver of the changes in stock price due to the dividend. Stock price is essentially the Present Value of Earnings Per Share, and a one-time unexpected dividend is additional money to be received by shareholders that was not expected in the stock value prior to announcement.

(i) At the declaration date the share price will increase by the PV of the additional $2 dividend. This will grade up to the value of the dividend at the ex-dividend date. On the ex-dividend date, the stock will fall by the value of the additional dividend because new shareholders will not receive the dividend.

(ii) The market could interpret this one-time dividend to "signal" that Frenz plans to increase the dividends paid out in the future which would increase the value of the stock. Conversely, the market could interpret this as a "signal" that Frenz no longer has valuable projects to invest in, leading to a reduction in stock price due to a reduction in expected future growth of Frenz.

4. Learning Objectives:

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

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 especially when opposing factors are key decision criteria.

Learning Outcomes:

(1a) Identify and critique the available funding sources of any business at its different stages and business of various risk profiles and durations.

(1b) Evaluate capital budgeting approaches and structure policy for insurance and non-insurance organizations.

(2a) Evaluate how the legal form of an organization, corporate governance, compensation dynamics and other market frictions impact business decisions.

(2c) Design a risk management plan to optimize the risk reward tradeoff of employed capital.

Sources:

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

Jagannathan, Meier, & Tarhan, The Cross Section of Hurdle Rates for Capital Budgeting

Fan, Titman & Twite, An International Comparison of Capital Structure and Debt Maturity Choices

Jonathan Berk and Peter Demarzo, *Corporate Finance,* Third Edition, Ch 18: Capital Budgeting and Valuation with Leverage

Jonathan Berk and Peter Demarzo, *Corporate Finance,* Third Edition, Ch 25: Leasing
Sherman, *Raising Capital*, Ch. 7

Commentary on Question:

This question tested candidates' understanding of how business's risk profile affects its funding and the appropriateness of its capital budget allocation method. To receive full credit, candidates needed to support their arguments with facts from the case study. Responses that did not tie to the case study did not receive full credit.

4. Continued

Solution:

(a)

(i) Evaluate four elements with regards to Blue Jay Air that will affect Big Ben's decision.

(ii) Evaluate each of the three fleet upgrade proposals for its impact on the loan decision, given the information available.

(iii) Identify additional information for each proposal that would help with Big Ben's decision. Justify your response.

Commentary on Question:
Overall, candidates were able to successfully identify some of the elements with regard to Blue Jay Air and the proposals. Most candidates were also able to identify the additional information for each proposal. However, on average, candidates failed to elaborate their arguments comprehensively with reference to case study material.

(i)

1. Industry Competitiveness
If BJA is unable to compete in the industry, Big Ben probably should not provide the loan. Therefore, it's important to understand where the borrower is in the business cycle, growth and profitability compared to peers, outlook for growth compared to peers.

The most recent year's net income is only $79 million which is lower than the loan amount. This is concerning from Big Ben's perspective.

2. Management Capacity
Management sets the strategic direction of BJA. Without good management, the risk of default goes up.

Blue Jay Air has been in the industry since the 1970s and has weathered several business cycles. In addition, the new CEO is also a veteran in the airline industry. The new CEO has a good vision for the airline's long-term growth and they established a risk management committee with a well-known risk manager. These are positive factors from Big Ben's perspective

4. Continued

3. BJA's risk management
How BJA is going to manage the risk of this project is also an influencing factor. Since BJA doesn't have strong financials, the risk of default is a concern. Even though they have the debt guarantee from RPPC, the loan document should reflect these clauses to help protect Big Ben's interests.

4. Collateral for the transaction
Even with a sound risk management practice, the bottom-line for risk mitigation is collateral for the transaction. Given BJA does own a large amount of physical property and equipment, this is a positive factor.

(ii) **Lease**: Usually, in the event of bankruptcy, the lessor is more senior than the loan lender. As a result, new planes can't be used as collateral.

Purchase: The purchase price is $1.75 Billion. There probably exists a number of creditors which may hinder Big Ben's ability to make claims in case of bankruptcy.

Upgrade: This proposal doesn't increase revenue as much. However, it requires the smallest outlay of money. It could be the safest proposal for Big Ben to consider.

(iii) **Lease**: Type of lease (sales lease, direct lease, etc.) and other lease terms such as buy back amount.

Purchase: plan of financing for the remaining funding needed

Upgrade: BJA's plan if it ends up in an unfavorable state

(b) Describe two covenants Big Ben should include in the loan document to mitigate default risk.

Commentary on Question:
Almost all candidates demonstrated their understanding of covenants relevant to BJA.

1. BJA to provide Audited financial statements annually
2. BJA should not pay dividends without Big Ben's approval

Other examples:
3. Prevent Blue Jay Air from incurring any additional debt
4. Prevent Blue Jay Air from engaging in any business not related to its current business

4. Continued

(c) Assess the appropriateness of Big Ben's 15% hurdle rate for each of the three projects.

Commentary on Question:
Candidates who did well in this section provided analysis relevant to the case study facts. Analysis should focus on the projects *instead of the* companies. *In addition, some candidates failed to assess the appropriateness of the hurdle rate for BJA*

Blue Jay Air: If BJA selects the purchase plan, there will be a lot of uncertainty with regard to additional funding and as a result increase the risk for the project. Therefore, the hurdle rate should probably be higher than 15%. On the other hand, selecting a different plan could change the risk profile and lower the hurdle rate accordingly.

Frenz: The Vietombia project has a lot of risk due to political and economical factors. In addition, Frenz is evaluating it at a 20% cost of capital. These all indicate that a 15% hurdle rate may not be enough.

Blue Ocean securitization: Big Ben is just performing a service for a fee and the risk of Blue Ocean's business itself shouldn't have much impact. It's reasonable to measure using Big Ben's hurdle rate.

(d) Critique the CRO's suggestion.

Commentary on Question:
Candidates struggled to explain the consequence of adopting the 20% hurdle rate for all divisions. Most candidates were able to identify that hurdle rates should vary based on various factors. For full credit, candidates need to describe how the hurdle rate should be set as well as the consequences following to the CRO's suggestion.

Companies should allocate capital based on the economic value of each investment opportunity and associated risk adjusted returns. The cost of capital used should be adjusted for risk and also for the time period of the project.

On the other hand, hurdle rates are expected returns without risk adjustments. By allocating capital only based on hurdle rates and searching for high returns, it will allow the divisions to ignore their strategic objectives and pursue riskier projects which may lead to failure.

4. Continued

Increasing the hurdle rate from 15% to 20% will further exacerbate this trend. It will not make the company more risk-averse; rather, it will achieve the opposite effect.

In addition, Big Ben will be at disadvantage to its competitors assuming competitors use a more appropriate discount rate.

Therefore, Big Ben should not require all divisions to use the same standard.

5. Learning Objectives:

3. The candidate will understand why and when to apply stochastic techniques to develop risk profiles and assess the techniques' efficacy.

4. The candidate will understand how to identify and recommend appropriate model risk assessment and vetting techniques for risk management models.

Learning Outcomes:

(3a) Assess the appropriateness of a given stochastic technique to quantify market and non-market risk exposures.

(3c) Assess the results of a given application of stochastic modelling.

(3d) Explain what risk exposures are or are not identified with a given risk metric, assess the implications, and recommend further action.

(4b) Design and evaluate stress-testing and back-testing processes.

Sources:

Case Study Sections 5.1.4-8

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

Dowd, *Measuring Market Risk*, 2nd ed, Ch 13

Commentary on Question:

This question was intended to test candidates' understanding of various capital frameworks as well as how stress testing can be a valuable capital management tool for Blue Ocean. Overall, candidates demonstrated knowledge of capital considerations, however, many candidates failed to apply the specifics of the case study to the questions themselves. Additionally, where candidates lost points was their inability to calculate capital levels as support for statement critiques and a detailed breakdown of the statements themselves. Candidates generally scored lower in parts a and b, and more favorably in parts c and d.

Solution:

(a) Critique Olive's statement.

Commentary on Question:

Very few candidates were able to identify, with mathematical support from the case study, that the required capital levels did not actually cover the tail risks. Only a select few identified that not only were tail risks not covered, but the current capital regime did not sufficiently cover even 50% of the tail risk.

5. Continued

Required capital for each line of business is calculated as VaR 99 - VaR 95

	Marine Claims	Pet Claims	Travel Claims
VaR 99	1,000	150	163
VaR 95	800	125	150
Required Capital	200	25	13

In fact, Blue Ocean's required capital calculation does not cover most of the tail. It does not even cover the 50%-ile Expected Loss

	Marine Claims	Pet Claims	Travel Claims
VaR 50	250	52	90

(b) Critique Grey's statement.

Commentary on Question:
The statement by Andrew Grey was incorrect as VaR90 increases the required capital, thus reduces ROEs. Many candidates assumed that Grey suggested to substitute VaR95 with VaR90 in the capital calculation. In fact, the question clearly states that VaR90 is the actual capital amount, and so candidates did not receive credit if they calculated Required Capital as VaR95- VaR90. Second, many candidates missed credit for suggesting VaR90 is a lower capital level than the current regime, and thus, Grey was correct that ROEs increase.

Setting the required capital at VaR 90 will increase the required capital.

	Marine Claims	Pet Claims	Travel Claims
Required Capital	200	25	13
VaR 90	550	100	130

Since Blue Ocean defines its ROE as Expected Profit/Required Capital, the ROE will decline when required capital is increased.

	Marine Claims	Pet Claims	Travel Claims
Projected Profit	25	5	17
ROE w current Required Capital	13%	20%	131%
ROE w Var 90 Required Capital	5%	5%	13%

(c)

(i) Calculate Blue Ocean's required capital as suggested by Green. Show your work.

(ii) Recommend an improvement to Blue Ocean's required capital calculation. Justify your recommendation.

5. Continued

Commentary on Question:
Part c)i) was answered well in general. Most candidates were able to properly dissect the required capital for each line of business prior to aggregating at the VaR99.5 level. Candidates received credit if they disaggregated the business lines even if they did not calculate the VaR99.5% levels correctly.

Part c) ii) was also well done. Where candidates missed in part ii) was the inability to clearly justify their recommendation.

(i)

Blue Ocean calculates the required capital for each line of business separately.

At VaR 99.5, the required capital is 1490

	Marine Claims	Pet Claims	Travel Claims	Sum
VaR 99.5	1150	165	175	**1490**

(ii)

Instead of calculating required capital (RC) for each line of business separately, Blue Ocean could calculate the required capital in an integrated model.

Since Marine, Pet, and Travel insurance claims are not likely to be highly correlated, the RC calculated with an integrated approach will likely be less than the simple sum from 3 separate models.

The diversification benefit implied by the integrated approach provides insight on how the underlying risk drivers interact.

With the implementation of an integrated model, economic benefits arise with the reduction of capital, resulting in higher distributable income, and effectively, higher IRR/ ROE.

(d)

(i) Describe four ways in which stress testing can provide valuable information that may not be available with a VaR analysis.

(ii) Propose an appropriate stress test for Blue Ocean. Justify your proposal.

5. Continued

Commentary on Question:
The majority of candidates scored well on part d overall. Candidates scored better in part i) than in part ii). Where candidates missed in part ii) was their inability to tie together the various parts of the business that would be affected given a stress event. Many candidates suggested a general stress approach, rather than a specific stress test that actually applied to Blue Ocean.

(i) Stress events are usually unlikely, the chances are that the data used to estimate VaR will not reveal much about them.

The holding period often used for VaR will likely be too short to reveal the full impact of a stress event, so it is important to carry out stress events on longer holding periods.

If stress events are rare, they are also likely to fall in the VaR tail region, and VaR will tell us nothing about them.

Assumptions that help to value non-linear positions in normal times might be wide of the mark in a stress situation, so a stress test with full revaluation could reveal considerably more than a second-order VaR.

A stress test could take account of the unusual features of a stress scenario (e.g., such as radicalized correlations, etc.) and so help reveal exposures that a VaR procedure would often overlook.

(ii) Develop a stress test scenario with seven Atlantic hurricanes in one season and claims two standard deviations above expected. Assume those storms impact 5,000 airline flights which increase claims for Blue Ocean's travel insurance division. Finally, include morbidity assumptions 25% above average in the Pet Insurance line to stress that division.

6. Learning Objectives:

3. The candidate will understand why and when to apply stochastic techniques to develop risk profiles and assess the techniques' efficacy.

5. The candidate will understand how and when to apply various advanced techniques to evaluate non-hedgeable risk or uncertainty in any business enterprise, especially non-financial organizations.

Learning Outcomes:

(3a) Assess the appropriateness of a given stochastic technique to quantify market and non-market risk exposures.

(3b) Recommend the use of techniques that balance resource constraints versus model accuracy and appropriateness when applying stochastic techniques.

(3c) Assess the results of a given application of stochastic modelling.

(5b) Assess business opportunities when information is limited or sample size is small.

Sources:

Christian, Algorithms to Live By, Ch 2, 6 and 11

Commentary on Question:

Commentary listed underneath question component.

Solution:

(a)

(i) Identify the most desirable country and the least desirable country for expansion based on the market survey results and the provided Gittins Index. Justify your answer.

(ii) Analyze whether the most desirable country in (i) would change if Taylor had a lower cost of capital assumption.

(iii) Assess the appropriateness of using a Gittins Index to support this decision.

(iv) Recommend an alternative decision-making approach for Taylor. Justify your recommendation.

Commentary on Question:

Candidates did well in analyzing the survey results to identify the correct Gittins Index. Many candidates did not understand the implication of a lower cost of capital in part ii). Below are sample responses; candidates received credit for other responses that were appropriate and supported by proper justification.

6. Continued

(i) Using the market survey data, Country C has the highest Gittins Index (0.7439) and Country A has the lowest Gittins Index (0.6279). Therefore, Country C is the most desirable and Country A is the least desirable.

(ii) Lower cost of capital increases the value of exploring since exploration will be less risky. Taylor may be open to more uncertainty under a lower discount rate.

Country D may be the most desirable due to the lack of market survey being conducted. Country A has the same number of success but more failures, and Country B has the same number of failures but less success, such that Country A and B will never be more attractive than Country C.

(iii) Gittins Index is inappropriate to support the decision to expand into a new country.
Gittins Index assumes a constant probability of success where Taylor assumes the probability of success would change with additional market data. Also, Gittins Index does not consider the cost of switching the investment if initial results are poor.

(iv) Taylor can create a confidence bound around the likelihood of success in each country using market survey data.

Taylor should conduct additional market survey to collect enough data. The data can be used to determine a threshold for the upper and/or lower bounds to guide decision making. Taylor will be able to limit its risk and maximize the likelihood of success by choosing the highest upper bound within the options that the lower bound for the probability of success is at least 30%.

(b)

(i) Define the price of anarchy.

(ii) Evaluate the CRO's statement.

Commentary on Question:
Candidates did well in defining the price of anarchy. Most candidates were able to point out that the price of anarchy will not be infinite, however, fewer candidates were able to make the connection to Taylor's stated competitive advantage in the market.

6. Continued

(i) The price of anarchy measures the cost that results from parties competing rather than cooperating.

(ii) The CRO is incorrect.

The price of anarchy will not be infinite, and given Taylor's exclusive access to unique ingredients, they can differentiate themselves in the high-end liquor market to avoid a price war, thus reduce the price of anarchy.

(c)

(i) Recommend the number of stages and length of each stage Taylor should use assuming the first stage is four years long. Justify your recommendation.

(ii) Assess whether the recommended staged investment approach for Country A would be appropriate for Taylor in its domestic market.

Commentary on Question:
Some candidates failed to identify the increase-in-length investment strategy and proposed the decrease-in-length investment strategy. No candidate made the connection to reference some type of distribution in part i). Candidates who did well in part i) also tended to do well in part ii) and vice versa.

(i) Multiple stage investments can identify and manage risks in the early stages which allows the later stages to have a higher chance of success. Since early stages are riskier, we should invest less in the early stages. After the early stages are successful, we can then make larger investments in later stages to earn a higher return on capital.

This phenomenon is consistent with the multiplicative Rule (and a Power-law Prior).

Since the first stage is 4 years and Taylor should invest in longer stages after, an appropriate multiple stage investment scenario could be $4 + 5 + 6 + 9 = 24$ years.

(ii) The staged investment approach is not appropriate for Taylor in its domestic market.

Taylor already has a dominant market position in the domestic market which implies that Taylor should have a higher chance of success in domestic market. Taylor's past success in the domestic market is likely to increase the chance of success in the future.

6. Continued

Taylor could invest in longer stages in the domestic market to earn higher return on capital. And the stages can be equal in length given the higher chance of success for Taylor in domestic market already. An appropriate scenario could be 12 + 12 = 24 years.

(d)

(i) Determine the optimal strategy for Taylor.

(ii) Determine the optimal strategy for Perry.

(iii) Explain whether Taylor and Perry achieve the optimal outcome based on the optimal strategies determined in (i) and (ii).

Commentary on Question:
Almost all candidates were able to determine the optimal strategy. Some candidates failed to distinguish between the optimal outcome vs the Nash equilibrium.

(i) Optimal strategy for Taylor is large investment. Taylor earns more profit under large investment no matter which strategy Perry chooses.

(ii) Optimal strategy for Perry is also large investment. Perry earns more profit under large investment no matter which strategy Taylor chooses.

(iii) Based on their optimal strategy, they achieve their Nash equilibrium outcome of (100, 100) which is 100 profit for Taylor and Perry each. This is not the optimal outcome, the optimal outcome is (250, 250) which is 250 profit for Taylor and Perry each. The optimal outcome can be achieved if both Taylor and Perry chose the small investment.

(e) Describe how the equilibrium outcome will change with the import quota limitation.

Commentary on Question:
Almost all candidates were able to identify the new optimal strategy is a small investment, and most candidates recognized that the equilibrium outcome is now the same as the optimal outcome.

With the import quota, both Taylor and Perry's optimal strategy will be changed to small investments. The outcome is (250, 250) which is 250 profit for each. The equilibrium outcome now equals the optimal outcome.

7. Learning Objectives:

4. The candidate will understand how to identify and recommend appropriate model risk assessment and vetting techniques for risk management models.

Learning Outcomes:

(4a) Assess methods and processes for quantifying and managing model risk within any business enterprise.

(4b) Design and evaluate stress-testing and back-testing processes.

(4c) Interpret stress-testing and back-testing results.

Sources:

Dowd, Measuring Market Risk, 2nd ed, Ch 15

Commentary on Question:

Commentary listed underneath question component.

Solution:

(a)

(i) State the null hypothesis and alternative hypothesis for the test.

(ii) Determine whether the null hypothesis should be accepted or rejected. Show your work.

Commentary on Question:

Candidates were expected to perform an exceedance test. Exceedance tests follow a binomial distribution and when the size of sample is large enough it converges to a normal distribution. Candidates were expected to clearly mention the one-sided test to receive full credit. Most candidates received partial credit for this question.

(i)

H0: exceedance/frequency of tail loss is equal 5%
H1: exceedance/frequency of tail loss is over 5%

(ii)

# of expected exceedance: 5% x 2,300 = 115
(130-115)/sqrt(5%*95%*2300) = 1.43509, follows N(0,1)1.43509 is around 92.4% < 95% (or 1.43509 < 1.645)
Therefore, accept H0

7. Continued

(b) Critique the product manager's comment.

Commentary on Question:
Very few candidates were able to link to Type I error and Type II error in their critique. Most candidates received partial credit for this question.

The Product Manager's statement is incorrect
Increasing the confidence level to 99% does not increases our confidence that the model itself is correct.

Increasing the confidence level can reduce the likelihood of rejecting the true model (i.e. reduce Type I error) since it is harder to reject the null hypothesis. However, it also increases the likelihood that an incorrect model is accepted (i.e. Type II error) since the null hypothesis is now more likely to be accepted.

(c) Identify two drawbacks of an exceedance test.

Commentary on Question:
Candidates were expected to list two correct drawbacks to receive full credit. Candidates generally scored well on this straightforward question.

Exceedance test typically requires large sample sizes to overcome their limitations.
Exceedance test ignores any information about the temporal pattern of exceedances.
Exceedance test ignores size of exceedances.

(d) Interpret the results of the additional analysis.

Commentary on Question:
Candidates were expected to understand the purpose of the back-testing options but did not need to comment on the actual calculation. In general, candidates scored well for this question.

Passing Christofferson indicates the exceedance has
- the correct unconditional coverage ("correct" number frequency of exceedance)
- does not exhibit clustering ("auto-correlations" or lack of independence)

Failing backtesting based on the Rosenblatt Transformation.
- means that exceedances are not distributed evenly
- the tail is either too thin or too thick

8. Learning Objectives:

4. The candidate will understand how to identify and recommend appropriate model risk assessment and vetting techniques for risk management models.

Learning Outcomes:

(4a) Assess methods and processes for quantifying and managing model risk within any business enterprise.

(4b) Design and evaluate stress-testing and back-testing processes.

(4c) Interpret stress-testing and back-testing results.

Sources:

SOA, Model Validation for Insurance Enterprise Risk and Capital Models

Dowd, Measuring Market Risk 2nd ed, Ch 13, 16

Commentary on Question:

Commentary listed underneath question component.

Solution:

(a) Explain the difference between reporting risk and output risk.

Output risk: The technical issue of whether the outputs are correct and can be interpreted in the context of their intended application.

Reporting risk: The risk that the representation of the output for the business users is incomplete or misleading; risk has much to do with effective communication with the decision makers.

Commentary on Question:

Candidates did well on this very straightforward question.

(b) Critique Adam's statement.

Commentary on Question:

Candidates who did well on this question went into detail about <u>why</u> Adam's comments are not correct and how different risks have serious and broad organizational consequences rather than simply listing out different types of model risks from a more technical perspective.

Adam's comment is not correct. Even with the correct model concept, the model is still prone to other risks, and the best practices are model documentation and understanding model limits.

8. Continued

For larger organizations, it is likely that the validation process stretches with various levels of intensity across several reporting intervals and includes temporary approval from regulators or management.

Embedding validation in the risk management control cycle and proposing how transparency can be increased to reduce the problems of validating a moving target. For all these reasons it is important that the validation process is clearly structured and documented to ensure that a common standard is being kept and that there is no gap in the process for reporting risk.

Adam's comment to compare to real world scenarios is a form of model validation but is insufficient by itself as an incorrect model could still produce reasonable results.

(c)

(i) Interpret the results of the consultant's work.

(ii) State four questions that Adam should ask to validate his model in light of the consultant's information.

Commentary on Question:
Candidates who did well on this question recognized that the VaR increases significantly in the tail scenarios as correlation increases. In general, most candidates scored well on part ii as long as their responses were relevant to the model and business decisions presented.

(i) The baseline and moderate scenarios indicate a low correlation between A and B. Therefore, the risk can be reasonably estimated.

There is lots of tail risk in extreme scenarios, which may or may not be an issue with the model.

(ii) What do the modeled scenarios represent?
Is the extreme scenario legitimate or otherwise validated?
Are there other model risks than just A and B that weren't checked?
Is the model output metric the appropriate metric for the business?

(d) Critique the CFO's statement on stress testing.

8. Continued

Commentary on Question:
Candidates who did well on this question provided more detail around pros and cons to stress testing as a metric. Candidates who stated the CFO's comment is incorrect without properly supporting the argument (for example- because the scenarios can be realistic, understood by management, and reveal hidden risks) generally did not receive full credit.

The comment that stress testing is subjective is true, but this does not make them useless.

Stress testing can only have a limited number of scenarios, the likelihood of any one scenario is impossible to estimate so it is not a probability-weighted distribution.

Stress testing has its limitations. There is usually no right or wrong in the scenarios.

Stress testing gives a lot of information about the bad states and is a natural complement (not replacement) to probabilistic risk measures like VaR and CTE.

Loss estimates from the stress testing can be regarded as bona fide risk measures and can be useful as a coherent risk measure.

9. Learning Objectives:

3. The candidate will understand why and when to apply stochastic techniques to develop risk profiles and assess the techniques' efficacy.

Learning Outcomes:

(3a) Assess the appropriateness of a given stochastic technique to quantify market and non-market risk exposures.

(3b) Recommend the use of techniques that balance resource constraints versus model accuracy and appropriateness when applying stochastic techniques.

(3c) Assess the results of a given application of stochastic modelling.

Sources:

Heavy Models, Light Models, and Proxy Models

Dardis, Layering Your Own Views into a Stochastic Simulation, SOA Risks and Rewards, August 2013

Commentary on Question:

This question tested the concept of statistical fit and of using proxy models instead of larger, more resource intensive models. The question also tested candidates' ability to evaluate the suitability of certain modeling techniques and measures of goodness of fit given the objectives and intended model use. Candidates needed to fully justify their evaluations and recommendations in order to receive full credit. Candidates generally scored better on the earlier question parts than later parts.

Solution:

(a) Describe two statistical tests that can measure the quality of fit for this proxy model.

Commentary on Question:

Candidates needed to describe two tests applicable for a hedge program focused on preventing tail losses. Statistical tests other than those listed below could receive credit, but some candidates did not describe the statistical tests and their applicability for this particular application.

The following tests can be used to measure quality of fit of this proxy model:

- QQ Plots
- PP Plots

These tests are visual aids to assess the goodness of fit across percentiles and are useful when considering specific regions of the distribution.

9. Continued

(b) Describe three criteria, other than quality of fit, to consider in designing the proxy model.

Commentary on Question:
Many candidates recieved full credit on this part by fully describing other criteria to consider.

Ease of implementation and cost

The calibration phase may require a high volume of fitting points to be generated from the heavy models, which can make initial implementation costs significant. Higher initial costs may be offset by reduced on-going costs through increased efficiency in proxy models.

Model stability

Small changes in heavy model results must not cause large changes in proxy model results. Additionally, proxy models should be stable over time. For example, if the proxy models are calibrated annually but used quarterly, then the method of calibration must ensure that quarterly re-calibrations would be stable if performed.

Intuitiveness

Management acceptance of results will depend on the understandability and intuitiveness of results. The ease at which information from the model can be converted in to a form that can be used for management decisions must be considered.

(c) Evaluate the proxy model fit with respect to the CFO's goals for hedging in:

(i) low interest rate environments.

(ii) high interest rate environments.

Commentary on Question:
This part tested whether the candidate can correctly identify suitable measures of goodness of fit, given the hedge objectives of covering expected losses beyond the 95th percentile. Candidates needed to note that the model may be appropriate to use given these objectives, even though some of the measures of goodness of fit fall outside of the criteria (within 0.5% of heavy model fit).

9. Continued

(i) low interest rate environments.

Maximum error and root mean square are not ideal for risk management purposes.
95% CTE is within the 0.5% limit and therefore indicates an acceptable fit. This is sufficient for hedging since the hedge covers expected losses beyond the 95th percentile.

However, the fit is volatile in the tails, 99% CTE is well above the required limit of 0.5%.

(ii) high interest rate environments.
The maximum error and root mean square errors indicate a better fit in high interest rate scenarios compared to low interest rate scenarios.
The 95% and 99% CTEs both are above the required limit of 0.5%, which indicates the model is not suitable to be used for hedging.

(d) Recommend four improvements to the proxy model calibration to obtain a better fit. Justify your recommendation.

Commentary on Question:
Candidates needed to suggest recommendations and justify those recommendations. Many candidates did not fully support their recommendations through their impact on the model.

Use precise interpolation with just 11 calibration points since there are only 11 parameters to estimate. This requires fewer runs from the heavy ALM model.

Use interpolation with roots of Legendre Polynomials as the calibration scenarios instead of regression to achieve the best estimate of the best possible fit.

Optimize each component separately, achieving a good fit in both high rate and low rate environments.

Increase the number of out-of-sample tests in the tails of the distribution. In this case, distribution accuracy is more important for CTE than for strict scenario accuracy.

(e)

(i) Describe how the actuary would apply the entropy technique.

(ii) Evaluate the appropriateness of this approach.

9. Continued

Commentary on Question:
Candidates needed to describe the entropy technique as well as evaluating why the approach would or would not be applicable for the proposed use of evaluating a hedging program with an imposed projected yield of 2%. Many candidates performed poorly in describing the appropriateness of the technique.

(i) Assign weights to scenarios so that the expected 10-year rate is at the target rate of 2%. The weights can be assigned by maximizing the entropy function:

$$S = -\sum_{i=1}^{N} w_i \ln w_i$$

The optimization algorithm favors solutions where the weight is evenly distributed without over-weighting any particular scenarios, thus retaining features of the original probability distribution.

(ii) The approach is appropriate due to the following reasons

- No need to recalibrate scenarios
- Given the current average is 3% in one year, a large portion of scenarios probably have rates around 2%, allowing for low information loss

The approach may not be appropriate due to the following reasons

- The technique is more effective for metrics close to the central estimate. May not be appropriate for evaluating hedging using CTE (95)

10. 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 and when to apply various advanced techniques to evaluate non-hedgeable risk or uncertainty in any business enterprise, especially non-insurance organizations.

Learning Outcomes:

(3d) Explain the differences and implications of the use of real-world and market-consistent constructs for risk assessment.

(5b) Apply cost of capital frameworks for risk evaluation in business decisions.

(5c) Assess the appropriateness of Applied Information Economics (AIE) concepts for risk management.

Sources:

Hubbard, How to Measure Anything, Ch 9, 11, 12

Christian, Algorithms to Live By, Ch 1

Commentary on Question:

Commentary listed underneath question component.

Solution:

(a) Rank the performance of engineers A, B, C and D, according to the curve. Justify your response.

Commentary on Question:

Most candidates were able to recognize the utility curve measures to the performance of engineers. However, a small number of candidates did not understand the evaluation chart; and tried to use the completion rate and error free rate trade-off.

D>B=C>A

Both B and C fall on the utility curve so their performance is equally strong.

D outperforms B and C.
A's performance is not as strong according to Paisley's expectation standards.

10. Continued

(b) Estimate the minimum GPA requirement (round to the nearest .1) for a candidate to receive an interview.

(i) Using the "mathless approach." State your reasoning.

(ii) Using statistical models. Show your work.

Commentary on Question:
This question tested candidates' understanding of the basic concepts of statistical testing for risk analysis. Many candidates did not receive credit for part i because they tried to use a statistical method to estimate the minimum GPA.

(i) 4.5
With a sample of 5, the lower bound of mathless 90% CI is the smallest value in the sample.

(ii) Average GPA = 4.68
SD of the estimate of the mean = SQRT(Variance of BCD/3)= SQRT (0.017/5) = 0.058
Use t-stat since this is a small sample size
Sample error = SD of the estimation of mean*t-stats @90% = 0.058 * 2.13 = 0.12

Minimum GPA requirement = 4.68 - 0.12 = 4.56 (4.6 rounded to the nearest 0.1)

(c)

(i) Explain whether 10 interviews is the optimal strategy to find the best candidate.

(ii) Explain whether 50 interviews is the optimal strategy to find the best candidate.

Commentary on Question:
Most candidates applied the 37% rule and made correct recommendations. However, some candidates merely stated that 10 is too few and 50 is too many without explaining their reasoning.

"37% rule. With 100 applicants, take the best applicant after 37 (37%).
Look at the first 37% of the candidates, choosing none, then be ready to leap for anyone better than all those we've seen so far." Paisley will need more than 37 interviews to find the best candidate.

10. Continued

(i) no. because there is a high probability that HR hasn't interviewed the best candidate yet

(ii) no. you have wasted time with another 13 interviews and there is a possibility that the best candidate has taken another job

(d) Develop a strategy for Paisley's leadership to find the new hire using the test performance and the start date criteria.

Commentary on Question:
Most candidates were able to use the two-step approach. First, HR should set a high threshold at the beginning of the interviewing. Second, HR should lower the threshold after an extended period. A few candidates were able to recognize the first step but not the second.

Use threshold rule when there is full information. HR would use the test results to set a threshold, i.e. accept an applicant if he/she is above a certain percentile. Paisley will accept the candidate (out of the 100 applications) who scored the highest percentile if he/she is above the threshold. Otherwise, open the application again and be prepared to hire anyone who is above the threshold.

Lower the standards/threshold as time passes by but never hire someone who is below the average unless you are totally out of options.

(e) Develop a method for Paisley's leadership to estimate the percentage of employees who discussed personal development with their managers last month.

Commentary on Question:
Most candidates were able to recognize the random sampling method. However, a few candidates used other approaches, such as setting numerical sampling size, (eg. 20% sample size within the pool of employees having a discussion with managers). Those are valid responses and received full credit.

Population proportion sampling: Random sample employees (managers) to see if they discussed personal development with their manager (employees) last month. If HR can observe X out of 100 random sampled employees discussed personal development with their manager in the past month, then they can conclude that X% employees discussed personal development with their managers last month.

11. Learning Objectives:

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

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 especially when opposing factors are key decision criteria.

3. The candidate will understand why and when to apply stochastic techniques to develop risk profiles and assess the techniques' efficacy.

5. The candidate will understand how and when to apply various advanced techniques to evaluate non-hedgeable risk or uncertainty in any business enterprise, especially non-financial organizations.

Learning Outcomes:

(1b) Evaluate capital budgeting approaches and structure policy for insurance and non-insurance organizations.

(2c) Design a risk management plan to optimize the risk reward tradeoff of employed capital.

(2d) Assess the impact of behavioral factors in capital budgeting methods and capital structure policies.

(3d) Explain what risk exposures are or are not identified with a given risk metric, assess the implications, and recommend further action.

(5b) Assess business opportunities when information is limited or sample size is small.

Sources:

Hubbard, How to Measure Anything, Ch 10, 14

Handbook of Economics of Finance, Ch5: Baker & Wurgler, Behavioral Corporate Finance: An Updated Survey

Berk and Demarzo, Corporate Finance, Third Edition, Ch 22: Real Options

Commentary on Question:

This question asked candidates to determine a solution to a problem with many uncertainties. The expectation was for candidates to understand the process for determining what to measure, how to measure, assess the value of new information with Bayes' Theorem, evaluate the project, and make a final recommendation.

11. Continued

Solution:

(a) Outline an Applied Information Economics (AIE) framework to address the investors' concerns.

Commentary on Question:
*Candidates were expected to describe and apply the four phases of the Applied Economic Framework, as found in **Hubbard's How to Measure Anything Ch. 14**. For full credit, candidates must provide examples of the framework application to the asteroid problem.*

Phase 0: Project Preparation
Initial research; expert identification; workshop planning
Example

- Decision: is the mission profitable?
- Experts: Small group representing different perspectives (scientists, engineers, geologists, economists, etc.)
- Variables: How much is available on the asteroid? How proportion can be extracted? How much can be transported back? What is platinum's expected selling price per ton? Would the payload be enough to shift the supply curve, lowering price?

Phase 1: Decision Modeling
Define the problem - investment boundary; model detail - list variables, cost/benefits, cashflows, ROI; initial calibrated estimates of variables with a 90% CI
Example

- Current state of uncertainty: calibrate experts to develop estimates for variables with 90% CI ranges (e.g. the concentration of platinum in a typical asteroid is 0.0001% to 0.003%).

Phase 2: Optimal Measurements
Value of information analysis (VIA); preliminary measurement method designs for variables with high info value; measurement methods for decomposed variables - random sampling, subjective-Bayesian, controlled experiments, Lens Models; updated decision model; final value of information analysis - can be multi-iteration.
Example

- Measure every very variable over the given range and determine some or most variables, perhaps the quantity that can be hauled back, are certain enough to not require further measurement.

11. Continued

Phase 3: Decision Optimization and the Final Recommendation
Risk/return analysis - Monte Carlo simulation of outcomes, risk/return relative to investment boundary; metrics procedure - tracking variables over the course of the project; decision optimization; final report & presentation
Example

- A select few variables with high information value need to be measured. A measurement method should be chosen that will provide information value much greater than the cost, often a lot less than perfect information but enough to inform the decision. For instance, the amount of platinum found on a particular asteroid would be very costly to measure directly, however, various smaller samples that have fallen to Earth could be measured to provide a narrower range with 90% CI.

(b) Assess the validity of the statistician's complaint.

Commentary on Question:
Candidates needed to recognize that the Bayesian approach uses a subjective prior, but it is not valid to state that the approach is subjective. The statistician's comments are false. For full credit, candidates must state they disagree, and provide justification for their response. Partial credit was awarded to candidates who agreed with the statistician and provided their reasoning.

The argument is false/misleading/inaccurate for the following reasons:

- Alternative methods that avoid a subjective prior still do not avoid subjectivity such as the significance level which is an arbitrary choice.
- Only way to get to the questions we need to answer like P(Claim | Observations).
- Attempting to avoid any priors results in answering a different question like P(Observations | ~Claim).
- Assuming total ignorance prior to any observation is not only subjective too, it's almost always false.
- Subjective estimators can be objectively measured, collecting copious data points on human experts.
- No rule in statistics against types of instruments including humans.

(c) Critique the CEO's statement.

Commentary on Question:
Candidates needed to recognize that while the existence of platinum cannot be ruled out, the probability of platinum being found is indeed reduced. For full credit, candidates must justify their response by applying Bayes' theorem. Behavior analysis responses were also accepted.

11. Continued

Applying Bayes' Theorem, the probability of the asteroid having platinum must be less after now knowing it hasn't been detected on the surface. Saying this information tells nothing is false. Similar to statement absence of evidence is not evidence of absence.

1. P(Platinum on asteroid | platinum detected on surface) = 1
2. P(Platinum on asteroid) = P(platinum on asteroid | platinum detected on surface) * P(platinum detected on surface) + P(platinum on asteroid | no platinum detected on surface) * P(no platinum detected on surface)
3. P(Platinum on asteroid) = P(platinum detected on surface) + P(platinum on asteroid | no platinum detected on surface) * P(no platinum detected on surface)
4. P(Platinum on asteroid) > P(platinum on asteroid | no platinum detected on surface)

The CEO is exhibiting anchoring bias: despite new information from the satellite imagery, his belief is biased towards the anchor; i.e. the existence and retrieval of platinum from the asteroid. The CEO is also showing overconfidence by stating his willingness to send a rocket despite the reduced probability of success.

(d) Design an approach to estimate how platinum deposits may be distributed below the asteroid's surface.

Commentary on Question:
The intent of this question was to test the candidate's ability to apply Bayes' Theorem for estimating means. Candidates needed to apply the process to the stated problem to receive full credit. Several other approaches were accepted as long as the process was well thought out, and the candidate applied their process to the stated problem.

This can be done by applying Bayes for estimates of means

Although the sample size is limited, after just a few samples a certain distribution assumption can become very unlikely. For instance, if none of the samples near the core return platinum but those near the crust do, then a sample with platinum would eliminate a distribution of "0" or a broad range of concentration the distribution assumed near the core becomes very unlikely.

Assign Priors
Two probable distributions have been chosen as priors. Prior probabilities need to be assigned to each. For example: 60% uniform and 40% increasing towards the core. The likelihood of each will get updated as samples are collected.

11. Continued

Sample Increments
Create a few subsets of increments to fit each sample into in terms of concentration or amount of platinum. If we're expecting a range of 0 - 10% for instance, then: 0-2.5%, 2.5-5%, 5%-7.5%, and 7.5-10%. Fit the prior distributions to these increments. Each sample's measurement will go into one of these subsets.

A simple graphical representation can be made of each subset relative to depth within the asteroid showing how the 10 samples appear relative to plots of uniform subsets and increasing (relative to depth) subsets.

Each sample, whether drawn near the surface or near the core, will slightly reduce uncertainty about how the platinum is truly distributed within the asteroid as the prior of each distribution's likelihood gets updated. With enough samples, the likelihood of one distribution will converge to 100% and the other to 0%.

(e)

(i) Determine the optimal order of development for these three projects. Show your work.

(ii) Calculate the NPV of the probe project given the order determined in (i).

Commentary on Question:
Part (i) is an application of Berk & Demarzo's Corporate Finance, Ch.22 Real Options. Candidates should take care to apply the formula correctly, taking the PV of success as the numerator, and recognize that the investment takes place right away, so it does not need to be discounted.
For both parts (i) and (ii), Candidates should also be mindful of the discount rate to be used. Candidates needed to use the risk-free-rate (10%), not the cost of capital (15%).

(i) We need to calculate (1-PV(success))/PV(investment)

Project A: (1-0.8/((1.1)^(0.5)))/20=0.0118615
Project B: (1-0.3/((1.1)^(1)))/50=0.0145455
Project C: (1-0.5/((1.1)^(1.5)))/100=0.005661
Based on this, we should develop project B first, A 2nd and C 3rd

(ii) NPV=-50-0.3*20/(1.10^(12/12))-0.3*0.8*100/(1.1^(18/12))=-76.2574 M or -0.07625 billion

11. Continued

(f)

(i) Identify the real option embedded in developing the probe.

(ii) Assess if FM should develop the probe or should attempt to extract immediately without first sending the probe.

Commentary on Question:
(i) Most candidates recognized the real option to be an option to abandon. It is not an option to delay because there is no added value from delaying the project.

(ii) Candidates approached this question by calculating and comparing either NPV or EOL. Full credit was given for either response as long as all permutations were considered.

(i) The option embedded in developing the probe is the option to abandon. If the probe detects no platinum, FMC doesn't have to spend more money on this project.

(ii) Assess if FMC should develop the probe or begin harvesting immediately without sending the probe.

"If they start harvest immediately without sending the probe ($1 billion cost for harvesting)"
NPV= 0.1*(8-1)-0.9*1 = -0.2 billion

"If they develop the probe…"
NPV= 0.1*(0.3*0.5*0.8*(8-1)+(1-0.3*0.8*0.5)*0-0.07625)-0.9*0.07625 = 0.00775 billion

Yes, they should send the probe.

12. Learning Objectives:

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

Learning Outcomes:

(1a) Identify and critique the available funding sources of any business at its different stages and business of various risk profiles and durations.

(1b) Evaluate capital budgeting approaches and structure policy for insurance and non-insurance organizations.

Sources:

Berk and Demarzo, *Corporate Finance,* Third Edition, Ch 8: Fundamentals of Capital Budgeting

Berk and Demarzo, *Corporate Finance,* Third Edition, Ch 18: Capital Budgeting and Valuation with Leverage

Sherman, Raising Capital, Ch. 7, 13

Jagannathan, Meier, & Tarhan, The Cross Section of Hurdle Rates for Capital Budgeting

Commentary on Question:

The goal was to have candidates demonstrate an understanding of various capital budgeting approaches and the limitations and appropriateness of the various sources of capital.

Solution:

(a)

(i) Calculate the NPV of Proposal A using the Weighted Average Cost of Capital (WACC) method. Show your work.

(ii) Calculate the NPV of Proposal B using the adjusted present value (APV) method. Show your work.

(iii) Recommend which proposal Swift should accept. Justify your recommendation.

Commentary on Question:

The majority of candidates knew both the NPV & APV methods; however, candidates often didn't apply tax correctly. The majority of candidates based their recommendation (part iii) on the correct analysis and received full credit, even when parts I & II were incorrect.

12. Continued

Proposal A

$$r_{wacc} = \frac{E}{E+D} r_E + \frac{D}{E+D} r_D (1 - \tau_c)$$

In this formula,

E = market value of equity

D = market value of debt (net of cash)

τ_c = marginal corporate tax rate

r_E = equity cost of capital

r_D = debt cost of capital

rwacc= 50%*10% + 50%*6%*(1-40%) = 6.8%

$$V_0^L = \frac{FCF_1}{1 + r_{wacc}} + \frac{FCF_2}{(1 + r_{wacc})^2} + \frac{FCF_3}{(1 + r_{wacc})^3} + \cdots$$

Year	0	1	2	3
Equipment	$12			
Upfront Cost	$4			
Tax on Upfront Cost	$1.60			
TOTAL EXPENSE	**$14.40**			
Earnings		$20	$20	$20
Tax on Earnings		$8.0	$8.0	$8.0
Depreciation		$4	$4	$4
TOTAL INCOME		**$16.0**	**$16.0**	**$16.0**
TOTAL	**($14.40)**	**$16.00**	**$16.00**	**$16.00**

Depreciation = 12M / 3 years = 4M
FCF= 20*(1-60%) + 4 = 16M
V = 16/1.068+16/1.068^2+16/1.068^3 = 42.14M
NPV = 42.14M-14.40M = 27.74M

12. Continued

Proposal B
r unlevered = 50%*10% + 50%*6% = 8%

The APV Formula

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

Value unlevered = present value of future cash flow = increase in FCF / (r - growth rate) = 4.56/(8%-3%) = 91.2M
Interest tax shield each year = interest rate * new debt * tax rate = 6%*60*40% = 1.44M
PV (interest tax shield) = 1.44/(8%-3%) = 28.8M
APV = value unlevered + PV (interest tax shield) = 91.2 + 28.8 = 120M
NPV = APV - purchase price = 120 - 100 = 20M

Recommendation
Proposal A should be recommended to Swift, since the NPV is higher.

(b) Evaluate the appropriateness of using WACC as the discount rate for capital budgeting decisions.

Commentary on Question:
Many candidates realized that a hurdle premium should be applied. Partial credit was awarded for a general discussion around risk. Candidates who had two reasons and tied their evaluation back to Swift's situation received full credit.

Swift should consider adding a hurdle premium to the weighted average cost of capital.
The hurdle premium accounts for the option to defer investments. This would allow Swift the financial flexibility to undertake future valuable projects, as it cannot undertake all positive net present value projects due to the limited availability of capital.
The option to wait is most valuable to firms with growth opportunities facing organizational capital constraints that limit their growth rate.

(c)

(i) Describe a method to calculate the shareholders' gain from the expansion based on the cash flow shareholders will receive.

(ii) Explain how this method impacts Swift's choice between Proposal A and Proposal B.

12. Continued

Commentary on Question:
Most candidates applied the free cash flow method, but struggled to truly describe it apart from stating that it calculated the free cash flows to shareholders.

(i)
Free Cash Flow to Equity Method (FTE):
FCFE = FCF – (1-τ_c)(Interest Payments) + (New Borrowing)
In the FTE valuation method, we explicitly calculate the cash flows available to equity holders after taking into account all payments to and from debt holders. The cash flows to equity holders are then discounted using the equity cost of capital
This method is a more transparent method of discussing a project's benefit to shareholders as this focuses on the cash flow that shareholders will receive.

(ii)
No impact as this method should generate the same results as the WACC and APV methods. Swift should still select proposal A.

(d) Recommend which type of commercial bank loan is most suitable. Justify your recommendation.

Commentary on Question:
To their detriment, candidates didn't focus on the goal of the proposal, but instead focused solely on the duration.

The most suitable type is an intermediate-term loan.
This type of loan is often used for acquiring other firms as Swift is looking to do. This type is almost always secured not only by assets being purchased with the loan proceeds, but also by the company's other assets (inventory, accounts receivable, equipment, real estate). In this case, Swift has enough unencumbered assets to secure the loan.

(e) Recommend one strategy, other than raising equity or debt capital, that Swift can use to expand into men's clothing. Justify your recommendation

Commentary on Question:
The majority of candidates were able to recommend and describe either a Joint Venture or Co-Branding arrangement. Candidates needed to have at least two applicable reasons to receive full credit.

12. Continued

Joint Venture

- Legal structure that offers another alternative to capital formation for a growing company such as Swift
- Good for developing new markets such as men's clothing
- Complementary technology (men's & women's clothing)
- Pool resources to develop a production and distribution facility
- Access a distribution network of sales & marketing capability
- The joint venture partner should already have in place capital, human resources and market relationships that will take years to develop on a standalone basis

Co-Branding

- A way to leverage the company's intangible assets (including brand awareness and consumer loyalty) by entering another product class (men's clothing)
- Provide added value in the form of consumer convenience and differentiation from competitors
- Easier and less risky than trying to build a strong brand, since that would require many internal and external impediments (corporate bias against innovation, short-term orientation, price pressures, competitive threats
- Gain marketplace visibility and create new customer interest (helps with branding)
- Change the perception of a brand - create new brand personality or update (current women's clothing)
- Help a company gain access to new product categories that otherwise would have involved a significant investment of time, money and resources to enter (men's clothing)
- Provide greater assurance about product quality as another firm is willing to stake its reputation on the product (both women and men's clothing)
- Reach a new customer base far more quickly than a new brand (men)
- Offer a way to target a key demographic audience (men)