CFE FD Model Solutions
Fall 2018

1. Learning Objectives:

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

Learning Outcomes:

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

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

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

Sources:

F-123-15 How Do CFOs Make Capital Budgeting and Capital Structure Decisions?

F-113-14 Securitization, Insurance, and Reinsurance

F-121-15 Is the Company Using Its Capital Wisely?

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

Commentary on Question:

Candidates were tasked with evaluating capital considerations for Blue Ocean, as an insurer, with respect to its position in the RPPC conglomerate. Overall, candidates demonstrated knowledge on the subject matter, including when securitization might be more appropriate than reinsurance for transferring risk, or why an insurer's hurdle rate should be higher than the overall cost of capital, but they struggled to connect their answers to Blue Ocean and RPPC specifically.

1. Continued

Solution:

(a)

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

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

Commentary on Question:
For part i) most candidates were able to point to a correlation or a negative skew, some failed to mention insurance company-specific risks. Credit was given (but not required) for mentioning systematic risk associated with beta. For part ii) candidates did well, showing that Blue Ocean's hurdle rate was higher than RPPC's cost of capital, but supporting the reason was sometimes lacking.

(i) An insurance company may have several correlated risks on its books, thus causing the potential for capital depletion to increase which would drive up the cost of raising new capital. Secondly, losses from non-life insurance companies tend to be negatively-skewed, resulting in similar negative consequences to the company's capital, increasing the cost of raising capital to capture these risks.

(ii) RRPC's WACC = 60% x (0.14) + 40% x (.08 x [1 -35%]) = 10.48%. Blue Ocean's hurdle rate is 12% which is higher than RPPC's overall cost of capital. This is appropriate as Blue Ocean is an insurance company that likely has correlated risks and negatively-skewed losses. Also, each project within Blue Ocean would carry its own hurdle rate to reflect its unique risks, and the option to wait.

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

Commentary on Question:
Candidates struggled to provide examples of frictional costs, especially examples that would be appropriate for Blue Ocean's lines of business. Several frictional costs were appropriate with valid reasoning (regulatory, agency, moral hazard, tax rates, adverse selection, etc.)

1. Continued

Two frictional costs that Blue Ocean should consider in its capital plan are Regulatory Costs and Moral Hazard/Policyholder Behavior Costs. Regulators could provide strict oversight on reserving methodologies for solar personal energy, potentially increasing capital requirements for Blue Ocean. There is Policyholder Behavior to consider in this project's capital plan as purchasers may have no incentive to keep their panels operating at peak performance because of their guarantee, raising costs for Blue Ocean.

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

Commentary on Question:
Candidates seemed to struggle referencing the material from KPMG, Is the Company Using Its Capital Wisely? *The intent was to evaluate the overall allocation framework rather than what impacts any individual allocation decision. Candidates also struggled to connect the factors to RPPC as they evaluate Blue Ocean's capital allocation.*

Has the long-term strategy been considered when allocating capital? If the desire is to expand into the Renewable Energy sector, is less capital being deployed to other business lines?
Relative returns on capital should be considered. For example, Blue Ocean appears to be getting the lowest return on capital from its Marine business.
Is the capital allocation in-line with the risk appetite? The link to the strategy is clear, but entering a new business line should be carefully examined as the new risks might not fit the profile of the company.
Are we sensitive to biases in the allocation process? Are there biases in Blue Ocean's management that may impact their capital allocation process and pull it away from the overall strategy (e.g.: anchoring, agency problem, etc.)

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

Commentary on Question:
Candidates succeeded in highlighting the benefits of securitization in general however, for full credit, it was important to link the reasons back to Blue Ocean's Marine Line and explain why ILS is better than reinsurance. For example, many candidates mentioned Blue Ocean being large so ILS was more attainable, but that doesn't mean it's necessarily better in this situation.

1. Continued

Insolvency Risk – because extreme losses are largest relative to mean losses for marine claims, reinsurers have a higher potential for default, potentially putting the liability back on Blue Ocean. The ILS doesn't carry this same risk.
Pricing – ILS is likely to be cheaper than reinsurance for two reasons: reinsurance risks are likely correlated with the Blue Ocean risks, and negatively skewed, raising the premium costs. Second, ILS investors are unlikely to be correlated with marine losses, so securitization provides investors a diversification benefit, lowering the price demanded.
Market Size to Free-up Capital – with 200M being held under the (VaR99 – VaR95) requirement, compared with 25M for Pet and 13M for Travel, reinsurers may have limited capacity. The ILS market is massive, allowing Blue Ocean to securitize its largest line of business as much as it wishes.

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

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

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

Commentary on Question:
Many candidates did well on this section by referencing the homemade dividend or explaining the transactions in part i) and commenting on signaling in part ii)

(i) In perfect capital markets, taxes and transaction costs are removed so a share repurchase, and a dividend payment are zero-NPV transactions. When a dividend is paid, the value of the shares decreases by the amount of the dividend and there is no tax advantage. Additionally, investors can create a homemade dividend by selling shares.

(ii) Blue Ocean's management may have concern with dividend payments because it sets a precedent that positive financial results will continue. If the dividend ever were to decrease, it could be interpreted as a signal by the market of negative future earnings results, likely causing a drop in share price.

2. 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:

Sherman, Raising Capital, Ch. 3, 4, 6, 9, and 11

F-119-15 Capital Management: Banking's New Imperative

F-120-15 Creating Value Through Best-In-Class Capital Allocation

F-122-15 The Cross Section of Hurdle Rates for Capital Budgeting

Commentary on Question:

This question tested candidates' knowledge of capital sources and criteria used in determining appropriate deployment of limited resources. Successful candidates were able to identify private placement as a better means of raising capital, clearly communicate Frenz's advantages of exclusivity and an already-established brand, and recognize Frenz-specific benefits of a corporate CVCD. Responses that did not tie to the case study did not receive full credit.

Solution:

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

(i) Angel investors

(ii) Private placement

Commentary on Question:

Generally, candidates were able to successfully assess that Frenz is too mature for angel investors, but the potentially larger amounts of available capital and greater expertise from private placement investors was more appropriate.

2. Continued

(i) Angel investors would be inappropriate for two main reasons:
1. They invest in the start-up phase of companies, but Frenz is far more mature than that.
2. The required $100m is significantly more than angels invest.

(ii) Private placement is more appropriate than angel, as there are no restrictions on how much capital can be raised if Frenz follows Rule 506.

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

Commentary on Question:
This is an open-ended question with many possible responses. The key for successful candidates was to relate their answers to Frenz and the Vietombia project rather than discuss generic business plans.

(i) We do not know expansion will be successful, as there are many supply-chain risks linked to commodity prices and an uncertain political climate. However, this risk is priced into the financial projections by using a cost of capital of 20%, far greater than the 8% Frenz typically uses. Appropriate risk management and oversight from an experienced Frenz board can help mitigate these risks.

(ii) Vietombia has offered exclusive rights to the beans, so nobody else is using this strategy at the moment. However, given the uncertain political climate, we do not know how long these rights will last.

(iii) Frenz has a strong name brand that will help reach a global client base. Exclusive rights to an alternative that costs significantly less than current premium beans will help Frenz differentiate itself on price.

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

There is significant upside in this project, as the cost of capital used to price the project (20%) is much higher than the rate Frenz typically uses (8%). However, the NPV of this project is -$50m, which would harm shareholder value.

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

2. Continued

Commentary on Question:
Candidates who did well in this section identified benefits that were specific to Frenz. Describing general benefits to RPPC (e.g. diversification into completely new business segments that lowers RPPC's overall risk profile) did not receive any credit. Simply identifying the CVCD as another capital source did not receive full credit, since this is not a specific benefit to Frenz but all of RPPC.

1. RPPC can invest in firms that bring new technologies to the coffee production process, bringing in new operational efficiencies.
2. Frenz can engage in joint product development of new drinks with newly-acquired firms.
3. Frenz can establish new distribution channels through the new acquisitions.

(e)

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

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

Commentary on Question:
Candidates tended to focus solely on Vietombia in this section. While candidates were still able to receive full credit for three good answers, there are significantly more capital allocation topics candidates could have identified for Frenz.

(i) 1. Risk-adjusted ROC
2. Revenue growth
3. Size of business

(ii) 1. Products/projects that return a risk-adjusted ROC greater than Frenz's cost of capital should receive further investment. Vietombia, with a 20% cost of capital, qualifies.
2. Regions that have the opportunity for significant growth may warrant further investment than cash cows. Frenz's focus on growth in Asia rather than sustained investment in Europe is an example.
3. Conversely, larger businesses (ex: coffee houses) or regions (ex: Europe) could benefit by receiving additional investment to ensure steady cash flows and profits remain intact.

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

2. Continued

Commentary on Question:
Some candidates explained why Frenz's cost of capital might be higher than Blue Jay Tire's cost of capital (such as investing in riskier projects like Vietombia) rather than address the differences in hurdle premium. Candidates who noted Blue Jay Tire had a higher cash-to-asset ratio than Frenz, and therefore had a higher option to wait, could still receive full credit.

Frenz has higher growth prospects than Blue Jay Tire. Because high-growth companies can afford to be picky about their investment opportunities, they are likely to wait for higher-NPV projects. This option to wait results in a higher hurdle premium than mature companies like Blue Jay Tire.

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.

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

Sources:

Corporate Finance, Berk and Demarzo, Chapter 27 Short Term Financing

Corporate Finance, Berk and Demarzo, Chapter 29 Corporate Governance

Raising Capital, Sherman, Chapter 2

Algorithms to Live By, Christian, and Griffiths, Chapter 11

F-132-17 Capital structure, executive compensation, and investment efficiency

Commentary on Question:

This question tested a candidate's ability to evaluate financing methods and catastrophe management. To receive full credit, candidates needed to support recommendations with strong justifications. For recall questions, more detailed answers often received more points. Over the entire exam, candidates seemed to write too little to demonstrate mastery and did not receive full credit.

3. Continued

Solution:

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

(i) Floating lien

(ii) Trust receipt

(iii) Warehouse arrangement

Commentary on Question:
Many candidates did well on this recall question. Candidates who included a description of the relative advantages or disadvantages of each type of loan received full credit.

Floating lien - the inventory secures the loan. It has a higher interest rate because it is riskier for lenders; in the event of financial distress, the company may attempt to sell the inventory without paying the loan.

Trust receipt - inventory is held in a trust as security for the loan. As inventory is sold, the firm remits proceeds to repay the loan. The lender will often send a representative to check on inventory.

Warehouse arrangement - inventory used to secure the loan is stored in a warehouse. This is the least risky for the lender. Warehouse arrangements are expensive due to the cost of operating the warehouse.

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

Commentary on Question:
Most candidates did well on this question. The most common error was to use the APR as a compound instead of a simple rate. Partial credit was awarded in many cases.

Interest rate over three months = 12% / 4 = 3%

Total payment due at end of loan = \$3,200,000 * (1.03) + 40,000 = \$3,336,000

Actual interest rate paid over three months = 3,336,000 / 3,200,000 = 4.25%

Effective annual interest rate = $(1.0425)^4 - 1 = 18.11\%$

3. Continued

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

Commentary on Question:
A variety of recommendations and justifications were accepted for full credit. Many candidates suggested appointments from Blue Ocean P&C based on their catastrophe modeling and pricing experience. The best answers included at least one appointment with specific operational risk experience rather than simply financial risk management.

Geoff Olive, the CRO of Blue Ocean P&C – Mr. Olive has experience working with property catastrophe coverage and modeling. He will bring a strong understanding of catastrophe occurrence and management.

Jack Tavares, CRO of Blue Jay Tire – Mr. Tavares has experience working with supply chain and political risk management, both of which could be helpful in managing catastrophes like the Vietombia earthquake. Mr. Tavares also has experience managing reputational risk after a crisis.

(d)

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

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

Commentary on Question:
Some candidates suggested that a difference between the company leverage ratio and compensation leverage ratio is a conflict of interest. To receive full credit, a candidate needed to explain that a misalignment of incentives could encourage excessive risk-taking. Other candidates made recommendations to reduce conflicts of interest that also eliminated any retention benefit; these adjustments were not awarded credit.

(i) This type of stock option compensation may encourage executives to manipulate the stock price in order to maximize option value.

It also may encourage them to overinvest in risky projects with higher catastrophic risk because their incentives are not more closely aligned with stockholders

3. Continued

(ii) Spot bonus - cash compensation would avoid any stock manipulation concerns

Extend the vesting period – offer a certain percentage of compensation after six months, an additional amount after one year, etc. This would make it harder to manipulate the stock price over a longer period of time and may have a stronger impact on retention

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

Commentary on Question:
Many candidates discussed both over- and underuse of unlimited vacation days. Full credit required discussion of the game theory view that employees will take fewer days overall.

Frenz could gain a reputational boost by offering unlimited vacation time.

Some employees could take advantage of the benefit and take so much time off that their work suffers.

Game theory suggests that the most likely outcome is that employees will want to take fewer days than their colleagues, which will lead to a race to the bottom. The Nash equilibrium in this case is that no employees take any vacation days.

4. 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.

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:

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

(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.

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

Sources:

SOA, Model Validation for Insurance Enterprise Risk and Capital Models

ASB, Proposed ASOP on Modeling

Hubbard, How to Measure Anything, Ch 7

Tetlock and Gardner, Superforecasting, Ch 5

Dowd, Measuring Market Risk 2nd ed, Ch 15

Dowd, Measuring Market Risk 2nd ed, Ch 16

Commentary on Question:

The question tests a Candidate's understanding of sources of model risks and mitigation techniques. It is important to explain an answer rather than simply listing the answer, because there is often more than one unique correct answer.

Solution:

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

4. Continued

Commentary on Question:
Candidates tended to provide too little support in answering this question. It is important to explain and describe rather than merely listing a response.

There are several sources of model risk in Blue Ocean's Solar Energy reserving model. Four of them are listed below:

1. Missing risk factors or parameters: As the travel insurance reserving model has been repurposed and only five risk factors are included, there is a possibility that this model is missing risk factors.
2. Incorrect Calibration: As the wind-farm data has been used to calibrate the parameters without using industry data, the Solar Energy model might have incorrectly calibrated parameters.
3. Programming Errors: Jay Brown is the only person who developed the solar energy reserving model by tweaking a travel insurance reinsurance model without much testing or peer review, this model might have programming errors.
4. Incorrect data feed: Since the model has been developed from a travel insurance reserving model, there is a possibility that right data feed or data fields are not being used for solar panel insurance reserve calculation.

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

Commentary on Question:
This is an extension of the answer of part (a). Ideally a candidate would provide risk mitigation techniques for each of the risks identified above.

Jay Brown should employ multiple risk mitigation techniques for the Solar Panel insurance reserving model. Four of these techniques are listed below:

1. The model should be validated by an independent model validation team who should check for model integrity, logic and formulas as well as coding errors.
2. The model should be peer reviewed by consultants who have expertise in the solar panel insurance industry and provide best practice information on the reserving methods employed by the industry.
3. Since Blue Ocean doesn't have much experience data on their own, they should seek industry data to calibrate parameters of the model.
4. The model has high level of key person dependence as Jay Brown is the only one who developed and knows about the model. The model should have proper documentation on methodology and user guide to reduce the key person dependency.

4. Continued

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

Commentary on Question:
On this open-ended question, the best candidates started with explaining what Fermi Style analysis means and then identified steps involved in applying that to the solar power estimate.

The basic principle of Fermi-style analysis is to break down a complex problem to smaller problems which are known and easier to answer. To estimate the amount of solar production lost when mechanical issues occur, we can break down the problem into the following parts:

- Common equipment issues and time to fix
  - Time to send a mechanic and time taken by the mechanic to identify/fix the issue
  - Cost to fix equipment failures
- Identify the parts which are prone to mechanical failures.
- Probability of the failure of the parts by observing the frequency distribution
- Time to replace a part when the failure occurs.
- Responsible party for the replacement and the cost
- Average output lost for one hour of downtime of the equipment.
- The total average cost includes
  - cost of repair mechanic payment
  - cost of replacement parts and
  - cost of output lost.

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

Commentary on Question:
Candidates should realize that this is an expected opportunity loss (EOL) question. The key is that there is a "loss" only in those situations where Blue Ocean makes the wrong choice. Many candidates were unsure how to apply the probability of increase with the amount of increase.

There is 30% probability that the reserve will increase by 10% where the project will be abandoned. We need to evaluate the reserve change for this case only.

The present value of impact of reserve change on income is shown below (using 5% return and 12% cost of capital given in the question)

4. Continued

Time	0	1	2	3	4	5
1. Reserve [R(t)]	1.08	1.62	2.43	3.65	5.47	0
2. Reserve Increase [R(t)-R(t-1)]	1.08	0.54	0.81	1.22	1.82	-5.47
3. Int. on Reserve [5%*R(t-1)]		0.05	0.08	0.12	0.18	0.27
4. Impact on Income [Line 3- Line 2]	-1.08	-0.49	-0.73	-1.10	-1.64	5.74
NPV of Impact on Income at 12%	(0.66)	in $M	Or (658,618) $			

As there is 30% chance of 10% increase in reserve,
the EOL = 30% X 10% X (658,618)
= 19,759

Therefore, the maximum amount that Blue Ocean should pay the consultant for a better estimate on solar production lost is $19,759.

5. 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.

Sources:

SOA, Model Validation for Insurance Enterprise Risk and Capital Models

ASB, Proposed ASOP on Modeling

Dowd, Measuring Market Risk 2nd ed, Ch 16

Commentary on Question:

Overall, candidates performed well on this question. This question was intended to have the candidate demonstrate an understanding of how compliance with the proposed ASOP can help mitigate model risk. It also was designed to test if candidates understood the different types of risk that would be posed by different types of models.

Solution:

(a)

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

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

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

Commentary on Question:

Candidates performed well on this question. Most candidates proposed a team structure that split the responsibility for building the model from testing the model. The strongest answers split modeling teams into three or more separate groups, to help mitigate additional risks that can arise during model design and model execution upon completing a model build.

(i) The model team structure should be designed to split the major model conversion responsibilities:
Team A – Model Specification / Design Team
Team B – Model Development / Build Team
Team C – Model Testing / Validation Team
Team D – Model Deployment / Execution / Implementation Team

5. Continued

(ii) The scope of responsibilities would be as follows:
Team A - This team is responsible for determining and documenting the requirements for the model. The work product from this team will be used to educate the Model Development team on what to build.
Team B - This team is responsible for constructing the model itself (whether coding the model from scratch or using a vendor system).
Team C - This team is responsible for testing the model that is built by the Development Team and ensuring the model is accurate and meets the requirements set out by the Design Team.
Team D - Once the model has been tested and validated, this team is responsible for moving the model into production, to be used as the official model going forward.

(iii) The teams have been structured this way to mitigate the following risks:
Team A - This team will mitigate the risk of incorrect model specification, specifically that the model is not built the way that the model owners desired / intended.
Team B - This team, along with the Model Testing / Validation Team will mitigate the "Risk of Programming Problems."
Team C - This team, along with the Model Development/Build Team will mitigate the "Risk of Programming Problems."
Team D - This team will mitigate the risk of Incorrect Model Application, by ensuring the model is used for its intended purpose, by only the intended users.

(b)

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

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

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

Commentary on Question:
Candidates did fairly well on this section. The strongest responses identified risks that would happen exclusively in a closed system. Responses that listed generic model risks without appropriately tying the nature of the risk back to the closed system did not receive full credit.

5. Continued

(i) The risk of programming problems is lower for a closed system, as the model builders do not have access to the underlying model code. Limiting access to the model code limits the ability to accidentally change the code or mis-program something. The risk of model implementation is lower for a closed system, as a closed model usually offers clear switches/toggles/indicators for specific actuarial implementation decisions (such as what discounting methodology to use).

(ii) The risk of incorrect model specification is higher for a closed system. Using a closed system prevents users from making changes to the model that may more accurately reflect product/company-specific nuances, and often involves using more simplifications. This increases the risk of a missing factor, product feature, relationship, etc. The risk of incorrectly applying the model is higher for a closed system. A closed system often is a "black box," which limits the model users understanding of the model. The lower the understanding the model, the higher the risk that the model will be applied to a use that it is not intended.

(iii) To reduce the risk of incorrect model specification, the modelers should develop an independent benchmark model and use that benchmark model to test the closed system, by comparing the results of the models. Differences can be identified and understood, even without access to the underlying code of the closed system.

To reduce the risk of incorrectly applying the model, the modelers should limit access to the model, to make sure users do not obtain the model and use it without knowledgeable guidance. The modelers can try and ask for a complete specification of the model, but this is often not available (or the vendor is unwillingly to provide this), so limiting access is generally a more effective approach.

(c)

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

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

Commentary on Question:
Candidates generally did well on this question. Most candidates were able to identify that scenarios I and III were violations of the ASOP, while II and IV were not. Some candidates struggled with an approach to mitigate the issue for Scenario III, even once they had identified that it was a violation.

5. Continued

Scenario I - This is a violation of the proposed ASOP. Allowing people to access the model who should not have access to the model increases the risk of programming errors and of incorrect model application. To mitigate these risks, the access to the model should be restricted only to the modeling department.

Scenario II - This is not a violation of the Proposed ASOP. The ASOP notes that in the presentation of results, the actuary should explain any known limitations of the model which has been used, and the footnote in the year-end report would likely meet this disclosure requirement.

Scenario III - This is a violation of the proposed ASOP. The Proposed ASOP notes that an actuary should use assumptions and parameters that are appropriate in light of the model's intended purpose. Using an assumption that is different than the intended, documented assumption is a violation of the ASOP, increasing two model risks - incorrect calibration risk and data risk. To mitigate these risks, the model should be validated before it is run, using the "identify, evaluate, and check key assumptions" approach, to confirm that the model has all of the correct assumptions.

Scenario IV - This is not a violation of the Proposed ASOP. The ASOP notes that in checking model integrity, the actuary should test model projection results against historical actual results to verify that modeled results would bear a reasonable relationship to actual results over a given time period. However, a mere difference between the results does not necessarily indicate a model error. So, performing this model integrity check is in line with the ASOP, and failing the test is not a violation on its own.

6. 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.

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

Sources:

How to Measure Anything, Hubbard – Chapters 5, 6, & 8

Algorithms to Live By, Christian & Griffiths – Chapters 9 & 11

Measuring Market Risk 2nd Edition, Dowd – Chapter 15

Commentary on Question:

This question tested candidate's understanding of stochastic modeling including their ability to analyze results of an application and make recommendations based on that analysis. In addition, the question included game theory concepts to bring attention to human aspects not captured by models.

Solution:

(a)

(i) Explain which graph illustrates the correct simulation.

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

Commentary on Question:

Nearly all candidates correctly identified graph (b). However, few candidates provided appropriate justification (constant drift & increasing variance) for choosing graph (b) rather than graph (a) or graph (c).

(i) Graph (b) illustrates the correct simulation. At each point in time, k(t) can be written as $k(t) = k(0) + td + \Sigma e(i)$, which has a normal distribution with mean = $k(0) + td$, and variance = $t^2 * v$. Graph (b) is the only graph with a constant drift and increasing variance over time.

6. Continued

(ii) Graph (a) shows a constant variance over time, which is inconsistent with a normal distribution.

Graph (c) is not symmetrical, as the mean and midpoint of the 95% confidence interval differ. This is inconsistent with a normal distribution.

(b) Analyze the fit of the calibrated model for mortality rates.

Commentary on Question:
Candidates scores varied on part (b). Stronger candidates provided analysis for both graphs and reached the correct conclusions regarding the models' fit. Weaker candidates failed to consider both the number of outliers and their direction and/or provide appropriate conclusions.

Over a 40-year projection period, we would expect 2 points (40*5%) to fall outside a 95% confidence interval.

In the graph given for age 25, there are 2 points outside the 95% confidence interval, which is consistent with our expectation. In addition, there is 1 point above and 1 point below the confidence interval suggesting the confidence interval is not biased in a particular direction. The fit at age 25 appears appropriate.

In the graph given for age 50, there are 5 points outside the 95% confidence interval, and all 5 five points fall below the confidence interval. This indicates the model may be understating the size of the distribution's lower tail and may not capture the tail risk appropriately. The fit at age 50 is not suitable for Blake Corporation given the model's bias and Blake's target VA market (ages 40-65).

(c)

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

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

Commentary on Question:
Candidates scores varied considerably on part (c). Stronger candidates analyzed the impact of the war on the model fit, focused on differences in model fit by age group, and made a recommendation considering Blake's target market. Weaker candidates provided an elementary summary of the data provided and failed to discuss how the models being analyzed may or may not be useful for Blake's situation.

6. Continued

(i) Model 1 performed similarly using either calibration period, as the number of outliers and mean squared error (MSE) are similar between calibration periods. This suggests the war has limited impact on the model's fit. Model 2's is more sensitive to disruptions in the data (e.g. a war), as the number of outliers and MSE were significantly higher when calibrated from [Y-100, Y-40].

For either calibration period, model 1 performs better than model 2 for younger ages, as it has fewer outliers. For older ages, model 2 outperformed model 1 when the calibration period excluded the impact of the war. Given that Blake's target market is ages 40-65, Model 2 may be better suited for capturing Blake's unique risks.

(ii) Recommend Model 2 with calibration period [Y-80, Y-40]
The calibration period [Y-80, Y-40] is recommended, because Blake should exclude the impact of the war when fitting their model (assuming they do not expect a war in the future).

Model 2 is recommended as it performs better than Model 1 (as shown by fewer outliers) for the [Y-80, Y-40] calibration period at ages 40-65, which is Blake's target market for variable annuities.

(d)

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

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

Commentary on Question:
Candidates generally scored poorly on part (d).

Candidates often received no credit on part (i), as they failed to analyze the mortality assumptions in the context of term insurance or they discussed variable annuities. Note that part (i) does not make any reference to variable annuities.

Candidates largely failed to address modeling in part (ii). Most candidates only focused on potential differences between term and variable annuity mortality.

6. Continued

(i) The static assumptions for base mortality and mortality improvement are appropriate for Blake's 10-year term product.

Given the product's relatively short-term nature, Blake should expect less change in mortality over a policy's life, so using static assumptions to save time and effort is reasonable. Sensitivity testing the impact of a static change in mortality may help Blake evaluate more extreme outcomes.

Also, it may be difficult for Blake to derive an expected future mortality improvement assumption. Internal experience may be limited (one year provides only one data point) or of limited use, as mortality improvement may be expected to slow in the future.

(ii) The term mortality improvement assumption may not be suitable for variable annuities, as the target client bases may differ. Term may be sold to an unhealthier and younger population compared to variable annuities.

The recommended deterministic shocks are not appropriate. Variable annuities often require stochastic modeling to evaluate mortality risk due to the product's unique guarantees. Also, stochastic modeling will provide the probability or distribution of future mortality, which is helpful for risk analysis where there is policyholder optionality.

(e)

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

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

Commentary on Question:
Many candidates performed well on part (e).

Other answers from the game theory reading (beyond the answer shown below) were accepted with an appropriate explanation in part (i).

Common mistakes in part (ii) included failing to provide a clear recommendation, not making a connection to the game theory reading, or suggesting Blake "change the rules of the game" by (illegally!) price fixing.

6. Continued

(i) Information Cascade

It is possible that Blake's competitors are unsure about their modeling of variable annuity prices and looking to others for information. If one company is optimistic about future mortality improvement and prices variable annuities relatively low, other companies may be encouraged and believe their models are too conservative. To attempt to win business, these companies may lower prices, which signals more optimism in the market and encourages further price reductions. Eventually all companies may be pricing variable annuities at an unsustainable level.

(ii) Price variable annuities with an acceptable level of profitability based on Blake's model.

Pricing appropriately sends a signal to the market that may discourage others from lowering prices. Blake could consider design changes to their variable annuity to win customers by competing on a basis other than price or place greater focus on other products at this time.

7. 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-insurance organizations.

Learning Outcomes:

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

Sources:

Hubbard, How to Measure Anything, Ch 7,8 & 9

Commentary on Question:

This question tested candidate's knowledge of EVPI, what it means, is used for and how it can help companies make decisions. Candidate performance on this fairly easy question was poor. Many missed the basic concept from How to Measure Anything *that you don't always need more data to make valuable inferences.*

Solution:

(a)

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

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

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

Commentary on Question:

Candidate efforts on this question were weak. The key concept is that the EVPI framework evaluates the value of information that reduces the cost of being wrong. In situations where you are not wrong, there is no cost to avoid.

(i)

EVPI is the maximum amount of economic loss that can be avoided if you could eliminate uncertainty.
EVPI is the most you would ever pay to measure something new that would reduce uncertainty.

Alternate answers accepted for full credit:
The author suggests a good rule of thumb is that you could spend 10% of the EVPI to make new measurements.
EVPI therefore is a good way to judge whether or not to embark on an exercise that could reduce uncertainty but comes at a cost.
Expected value of information (EVI) = Expected opportunity loss (EOL) before new info - EOL after new info
EOL = chance of being wrong * economic value of being wrong
EVPI is EVI but with EOL after new info = 0.

7. Continued

(ii)

- The business decision is to either (1) hire 1,000 people at a fixed cost with the potential to add more revenue or (2) to not hire the people, not incur the expense but also does not have a chance to grow revenue.
- EVPI provides a cost ceiling on how much to pay for a measurement.
- The next steps would be to determine appropriate measurements that could be taken, determine the cost of taking these measurements, and using a rule of thumb (10% of EVPI, for example), to decide whether to proceed.

(iii)

The expected value of the proposal is an additional $44.5m of profit (revenue - expenses)

Outcome = {0, 25m, 100m, 200m} - 1,000 * 30,000 - 3m

$30m salary expense

$3m of flat HR expenses

Uncertainty is whether or not an additional $33m of revenue will be generated to offset the costs.

EVPI measures the economic benefit of reducing the uncertainty.

EVPI = (0-33m) * 20% + (25-33m) * 30% = 9m.

EVPI = -33m * 20% + -8m * 30% = 9m.

(b)

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

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

Commentary on Question:

Many candidates received partial credit for using a normal distribution rather than the t-distribution. In other respects, this question is a straightforward application, but it is critical for candidates to make a recommendation and to justify it based on their confidence interval calculations.

(i)

- Recognize that with limited samples, this will require a t-test CI rather than a standard normal test.
  - n = 10 and degrees of freedom = 9
  - t-statistic = 1.830
  - mean = 70,000
- sample variance = sum of (observation(i) - mean)^2 / (10 - 1)
- calculation simplification for numerator = sum of squares of observations - 2*mean*sum of observations + 10* mean^2

7. Continued

  - numerator = 70,400,000,000 - 2 * 70,000 * 700,000 - 10 * 70,000^2 = 21,400,000,000
  - sample variance = 21,400,000 / 9 = 2,377,777,778
  - standard deviation of the estimate of the mean = square root (2,377,777,778 / 10) = 15,420
- CI lower bound = 70,000 - 1.830 * 15420 = 41,781
- CI upper bound = 70,000 + 1.830 * 15420 = 98,219

(ii)
Recommendation: Move forward with the $33m investment to hire 1,000 Sales Assistants. Lower bound of the confidence interval is higher than the cost of adding a Sales Assistant.

Alternative response for full credit ……
Can extrapolate the CI to the whole project and show a lower bound of $41,781 * 1000 - $33m = $8.8m.
This is the profit that corresponds to the lower bound of the confidence interval.

(c)

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

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

Commentary on Question:
Most candidates did poorly on this question. The majority of candidates ignored the parameters of the pilot program and instead responded with a discussion about small sample size.

(i) *Sample answers below:*
- Cost and time-intensive.
- The experiment that produced the data for the problem suffers from one major weakness - time to complete.
- The business decision would likely need to take place sooner than the one-year time horizon of the experiment.
- The cost of the experiment, although acceptable, may be higher than alternatives.

7. Continued

(ii) *Sample answers below:*

- A monthly experiment could also incorporate the "Measure to a Threshold" method so that the data is collected over an indefinite amount of time but collection stops once there is enough data to conclude.
- The statistics for assessing a confidence interval will be a bit trickier with monthly figures, but it is possible.
- Another approach would be to decompose the problem further. Explore what activities an assistant can provide that results in increasing sales.
- Decomposing may come up with alternate items to measure, for example the opportunities missed because a Sales Representative is too busy follow-up on leads.
- It could result in finding a different factor / solution all together.

8. 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-insurance organizations.

Learning Outcomes:

(5c) Critique methods for determining long term discount rates beyond what is observable in the capital markets.

Sources:

F-130-15 Yield Curve Extrapolation

Manistre, A Risk Management Tool for Long Liabilities: The Static Control Model

Commentary on Question:

This question tested candidate understanding of:

- *Business considerations of extrapolating yield-curves beyond period of the deep-liquid market*
- *Why some stakeholders emphasize different aspects of extrapolating yield-curves*
- *The pros and cons of these different perspectives, and when each view is appropriate*
- *Which methods could be used to extrapolate yield-curves, and what view these methods most align with and support; and in the case of the Static Control Model, how the Contingent Tail Expectation selected can be used to support both a market consistent and stable value view point*

In general, candidates did well on this question; candidates struggled with some of the higher-level learning objective prompts to "compare and contrast" in part (b), and "critique" in part (c).

Solution:

(a) List the three parts of the yield-curve extrapolation problem that the "macroeconomic" / phased approach aims to address.

Commentary on Question:

The reference to the "macro-economic" approach prompted candidates to recall the list from Hibbert's reading, "Yield-Curve Extrapolation". In general, most candidates received full credit.

1 – Determine current market rates based on observable market prices within the longest reliable horizon / liquidity point (LHR / LLP)
2 – Determine an Ultimate Forward Rate (UFR) to use beyond the LHR/LLP
3 – Determine the speed and timing of transitioning from the current market rates to the UFR

8. Continued

(b)

(i) Describe the two views regarding the basic purpose of yield-curve extrapolation.

(ii) Compare and contrast the two views.

Commentary on Question:
For part (i), several candidates listed the two views without describing them; for part (ii) some candidates listed an aspect or two regarding the view, but few truly compared these items, especially regarding how the views and methods relate to one another.

(i)

Realist Transaction Price / Market Consistent / Fair Value View: focused on the discounted cash-flows from assets and liabilities tying to what would be the value in an arm's length transaction in a deep and liquid market.

Stabilized Price / Financial Reporting: seeks to minimize volatility in financial reporting, especially regarding market volatility from temporary hypes and sentiments that will on average cancel each other out over the life of the product / financial instrument.

8. Continued

(ii)

Fair Value	Stable Price	Comparison
Emphasis on fitting and replicating current market prices	Emphasis on a smooth yield curve to fit a broader framework	Fair Value may over-fit market price, rendering the yield curve unsuitable for use in real-world stochastic simulations. Stable value will produce a yield curve that can be used for a broader set of modeling efforts.
Slow grade to UFR	Quick grade to UFR	Fair value will increase volatility in prices with of assets/liabilities with long maturities; stable value will have lower volatility.
Longer Liquidity Horizon	Shorter Liquidity Horizon	Fair value may lead to using a longer horizon of available market data points to better fit more of the market, but these data points may have less credibility and be more prone to volatility due to the lack of depth and liquidity associated with them. This will increase volatility in financial reporting, whereas stable value would discard them and begin the grade to the UFR sooner – reducing volatility.
Larger Asset Bundle to Fit Yield Curve to	Smaller Asset Bundle to Fit Yield Curve to	Similar to the liquidity horizon, Fair Value may include more exotic assets with short tenors to better fit the entire market; these may not be deep and liquid enough of an asset class to satisfy someone with the stable price view and again increase volatility.

8. Continued

(c)

(i) Critique your boss' recommendation.

(ii) Critique the CFO's recommendation.

(iii) Recommend an appropriate approach to yield-curve extrapolation for the LTC valuation. Justify your recommendation.

Commentary on Question:
Most candidates did well on part (i), but few had strong critiques or recommendations for part (ii) and (iii).

(i) My boss' recommendation is the simple dipole strategy, where the ultimate forward rate is set to be the last observed forward rate. While this is a viable method to extrapolating a yield curve for long-tailed liabilities, it does not account for second order risks in the yield curve such as the convexity of the curve.

(ii) The CFO's recommendation of the Static Control Model with CTE(20) probably stems from the fact that the CFO would prefer to reduce volatility in financial reporting. When the Static Control Model uses a low CTE percentile, it accelerates the convergence to the UFR. While this is an appropriate view for a CFO, the fact that most of the liabilities are beyond the Longest Reliable Horizon leads me to believe that CTE(20) is too low, even for stable value. For financial reporting I would recommend a CTE(50), and for market consistent work I would use at least CTE(80) to better capture the market risk of so many cash-flows occurring so far in the future.

(iii) A Static Control model uses the total return approach for valuing liabilities beyond the LRH. It also calculates the marginal yield curve for the current market allowing for the easy derivation of a replicating portfolio / hedge strategy for cash-flows occurring prior to the LRH. I would recommend CTE(50) for financial reporting to better capture the risk of long-tailed cash-flows while remaining more stable than many other approaches, and CTE(95) for market consistent valuations because the high CTE will help better account for risk premia the market would charge for such long-tailed cash-flows.

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.

Sources:

Christian & Griffiths, Algorithms to Live By, Ch 1

F-131-16 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 tests candidate's understanding of approaches for balancing accuracy and complexity in stochastic modeling. Many candidates earned strong marks on this question. The best fully explained the tradeoffs between different approaches and justified their statements about when those approaches would or would not be suitable.

Solution:

(a)

(i) Describe how you would apply an optimal stopping strategy to select the ESG vendor.

(ii) Explain the rationale behind your strategy.

(iii) Explain the limitations of your strategy.

Commentary on Question:

Candidates generally scored well on this question. Any of the stopping strategies could be used. To earn full marks on parts (ii) and (iii), candidates had to describe how their strategy balanced the "exploring" and "exploiting" phases and the implications of the assumptions their strategy makes.

(i) (Threshold Rule) - We would immediately accept a vendor if they were above a certain threshold, where the threshold is based upon how the vendor would compare to a percentile. The threshold would start very high with so many vendors, and then decrease as our pool started to dwindle.

9. Continued

(ii) We balance exploring and exploiting, or taking time to gather information and acting on that information. If we stop too early, we may be acting on poor information, and if we stop too late, we may not have time to act on the information we have (we lack agency).

If we can place each vendor on the distribution of the population of vendors, we can use the threshold rule to quickly judge the chance that each vendor is the best in the set.

(iii) This strategy depends upon us having the ability to place vendors on a percentile of the available population. We also would assume we make offers immediately, have no chance of rejection, and there is no cost to searching – all of these are incorrect in this scenario.

(b) Compare the following two approaches to model the liabilities.

(i) Stochastic-on-stochastic modeling

(ii) Building proxy models that replicate the behavior of the liabilities

Commentary on Question:
Candidates generally scored well on this question. Candidates had to discuss the tradeoffs of each strategy to receive full credit.

(i) Stochastic on stochastic modeling involves modeling the risk drivers over a period of time (the outer loop) and then revaluing the balance sheet at each particular moment (the inner loop) by projecting the asset and liability cash flows associated with another set of stochastic scenarios.

This technique is the most accurate, however it is very computationally intensive. Companies will often have to increase computing capacity or optimize models in order to meet the technical demands.

(ii) A proxy model that replicates the behavior of the liabilities simplifies the cash flow model into something more easily calculated, such as a polynomial or a replicating portfolio of assets.

While the proxy model simplifies the calculation, it does sacrifice accuracy and does require significant validation and testing to set up.

9. Continued

(c) Evaluate the following proxy model options for the liabilities.

(i) Replicating polynomial

(ii) Replicating portfolio

Commentary on Question:
Candidates scored moderately well on this question. Stronger candidates discussed the pros and cons of using both the replicating polynomial and the replicating portfolio approach to proxy modeling.

(i) Replicating Polynomial –
A replicating polynomial involves fitting a polynomial based on the risk factors to the output of the liability cash flow model

The formula is often split into the individual risk components and non-linearity components, which can be helpful for risk managers to look at individual risks

The replicating polynomial is fairly simple and very easy to calculate, but they require many elements to model complex behavior, and can quickly become unintuitive

(ii) Replicating Portfolio –

A replicating portfolio is a pool of assets that mimics the market value changes for a pool of liabilities. Because they represent a pool of assets, these assets can be used to hedge or to inform hedging actions.

This approach is also very intuitive, especially for management with investment experience, and allows for comparison to guarantees in the marketplace. However, replicating portfolios do not handle non-market risks well, and thus can require recalibration as assumptions change.

(d)

(i) Explain how re-weighting and the entropy statistic can be used to incorporate "own views" into a forecast.

(ii) Assess the suitability of this technique for the shocks listed above.

9. Continued

Commentary on Question:
Many candidates earned credit on part (i), but struggled to fully answer part (ii). Candidates had to discuss both how the shock and the measure affected the suitability of reweighting for each of the scenarios listed.

(i) An approach to incorporating your own views into a forecast is reweighting the scenarios so that the weighted-average scenario produces your result.

Essentially, we give more weight to scenarios that exhibit our view, and less weight to scenarios that differ from it, which prevents us from having to recalibrate and generate an entirely different set of scenarios.

The entropy statistic is used to judge how much information is lost with a reweighting and is higher the closer we are to an equal weighting.

(ii) Recalibration works best when the statistics are averages, when the scenario being chosen is in the scenario set, and when a single risk factor is being modeled

I. Interest rates remain level; average surplus

The reweighting approach is generally suitable for this shock, as the scenario chosen is in the distribution set and the statistic is an average measure

II. Interest rates drop 200 bps; average surplus

Recalibration is likely more appropriate for this scenario, as even though the statistic is an average, the scenario is likely not common in the scenario set, and reweighting may fail or depend on a small number of scenarios

III. Equities drop 15%; CTE 95 surplus

Reweighting may be less effective for this scenario, as it is focused on the tail. We may need additional testing to ensure results here are reasonable

10. 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 18: Capital Budgeting and Valuation with Leverage

Sherman, Raising Capital, Ch. 13

Commentary on Question:

This question tested the candidate's ability to recommend sources of financing for a medium sized company with aggressive growth goals. In general, candidates did well, but many candidates could have performed better if they had gone into more detail in their responses.

Solution:

(a) Explain why an alternative funding strategy would be advantageous to Dolly.

Dolly has two growth goals that may not be achievable in a reasonable timeframe with traditional funding sources because it is a medium-sized family owned business. An alternative funding strategy would allow them to get the necessary capital to accomplish their goals, as well as giving them an opportunity to gain synergies from additional personnel or knowledge, depending on the alternative funding strategy chosen.

(b) Evaluate whether each alternative funding strategy (I-IV) is appropriate for each of Dolly's growth goals.

Commentary on Question:

Candidates understood the funding strategies. Although many candidates did not evaluate the options for each of the two growth goals.

10. Continued

	Opening 10 more restaurants	Mass-producing bread
Licensing	Is not appropriate, since there isn't any proprietary knowledge or technology for Dolly to license.	Is appropriate; Dolly could license the bread recipe to a partner who would pay Dolly fees.
Franchising	Is appropriate; Dolly could allow a franchisee to use their name and systems to open a location.	Not appropriate, since Dolly doesn't already have the systems to produce the bread.
Joint Venture	Not appropriate. This goal is the core strategy of Dolly, and is something they already do well on their own. A Joint Venture is better served to for a new project, such as creating a new product or technology.	Is appropriate with the careful selection of a partner, such as a bakery who already has systems to produce the bread.
Cobranding	Not appropriate, for the same reason as the Joint Venture.	Is appropriate if rolled out in areas Dolly has brand recognition, and with a partner with similar brand recognition.

(c) Recommend, based on NPV, whether Dolly should self-fund the project or pursue the joint venture with Hill. Show your work.

Commentary on Question:
Most candidates did well on part c. Common mistakes revolved around missing the taxes and depreciation in the calculation.

Pursuing Project Independently:

Time	0	1	2	3	4
Revenue		200	200	200	200
Expenses	-45	-37	-37	-37	-37
Depreciation		-52.50	-52.50	-52.50	-52.50
Income Tax	9.45	-23.21	-23.21	-23.21	-123.21
Unlevered Net Income	-35.55	87.29	87.29	87.29	87.29
Plus: Depreciation		52.50	52.50	52.50	52.50
Less: Capital Expenditures	-370				
Free Cash Flow	-405.55	139.79	139.79	139.79	139.79

WACC = E/(D+E)*Re + D/(D+E)*Rd*(1 – t)
Use unlevered cost of capital (Ru) to solve for x = E/(D+E)
0.082 = x*0.09 + (1-x)*0.05 → x = 80%
WACC = 0.80*0.09 + 0.2*0.05*(1-0.21) = 7.99%

Free Cash Flows discounted @ WACC = $57.57

10. Continued

Joint Venture Option:

Time	0	1	2	3	4
Revenue		100	100	100	100
Expenses	-45	-22.20	-22.20	-22.20	-22.20
Income Tax	9.45	-16.34	23.21	23.21	23.21
Free Cash Flow	-35.55	61.46	61.46	61.46	61.46

No change to the discount rate under this option per assumption this project has similar risk to Dolly.

Free Cash Flows discounted @ WACC = $168.07

Dolly should pursue the project in a Joint Venture because the NPV is higher than pursuing the project independently.

(d)

(i) Identify which component in the calculation in part (c) would change based on the CFO's request.

(ii) Explain how to modify the component identified in part (i).

Commentary on Question:
Candidate performance was mixed on this part. Most candidates recognized that the WACC would need to be changed, but failed to explain how.

(i) To assume the risk of this project is different than that of Dolly as a whole, the project's free cash flows would need to be discounted at a different WACC.

(ii) The WACC can be altered by changing the unlevered cost of capital (Ru) and plugging into the formula: Rwacc = Ru – Rd*t*d
For pursuing the project independently, an appropriate assumption for Ru is an industry average of bread or bakery companies.
For a Joint Venture, it may be appropriate to assume the project is of similar risk to Hill as a whole, and utilize Hill's unlevered cost of capital.

(e) Describe two factors Dolly should consider in evaluating a joint venture with Hill.

Commentary on Question:
Most candidates did well on part e. Answers, other than as shown below were accepted for full credit.

The reputation of Hill, and whether Dolly wants to be associated with their brand.
Plans for ending the Joint Venture, including timelines and whether there are options to continue the venture or merge at that time.

11. 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 assess 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.

(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:

Superforecasting, Tetlock & Gardner, Chapters 2, 3 and 5

Commentary on Question:

This question allowed the candidate to apply forecasting methods when data is limited and results uncertain. The best candidates were able to apply the methods and explain the risks involved in making the forecast.

Solution:

(a) Critique Audrey's forecast from the perspective of a Superforecaster.

Commentary on Question:

Candidates need to provide valid arguments with good support and were expected to touch on at least 4 of the critiques below to receive full credit. Most candidates provided responses that were lacking detail and received partial credit on this question. Other answers than those shown below were accepted.

Audrey's forecast is simply from her "tip-of-the-nose" perspective. No considerations for the outside view or other perspectives.

Her forecast contains vague language and lacks details such as a timeline or likelihood estimate.

Confirmation bias. Audrey emphasizes cryptocurrencies' high volatility and failure rate, but ignored successful cryptocurrencies and done not touch on any specifics about RichCoin.

11. Continued

Bad anchor. Audrey states she is extremely bullish about cryptocurrencies, but this bad anchor prevents her from considering other perspectives and produces a bad estimate.

Bait-and-Switch. Instead of focusing on the forecasting problem, Audrey answers a different question: "Will RichCoin increase or decrease in value?"

(b)

(i) Develop three questions to "Fermi-ize" the Brook Fund's forecasting question.

(ii) Describe "outside view" and "inside view."

(iii) Explain which questions in (i) are from an "outside view" and which are from an "inside view."

Commentary on Question:
Candidates scored well on this part in general. The solution below is only an example, candidates who provided reasonable questions in part (i) and justified their questions properly in part (iii) received full credit on these two parts.

(i) Are cryptocurrencies likely to continue to rise in the next six months?
How likely is it for a cryptocurrency to return more than 100% in a six-month period?
What is the impact of the new regulation on RichCoin?

(ii) The outside view, also called the "base rate" considers a generalization of the problem and should be the starting point in answering the forecasting question.

The inside view considers the specifics of the particular case. What hypothesis would have to hold for it to be true?

(iii) Are cryptocurrencies likely to continue to rise in the next six months? --> Outside View. This considers the whole market of cryptocurrencies and is not specific to RichCoin.

How likely is it for a cryptocurrency to return more than 100% in a six-month period? --> Inside View. This is very specific to the question.

What is the impact of the new regulation on RichCoin? → Inside View. This is focused on the impact to RichCoin itself.

11. Continued

(c) Approximate the likelihood that RichCoin will increase by at least 100% within the next 6 months using Fermi-style analysis and the data above.

Commentary on Question:
Most candidates received partial credit on this question. The answer below is merely illustrative. Any reasonable evaluation and data assumptions were acceptable for full credit as long as candidates were able to demonstrate a Fermi-style analysis, covering both inside view and outside view.

Base Rate 0-80%: Because cryptocurrencies will be regulated more strictly, limit the probability forecast to 80%

Adjust to 0-12%: Because only 15% of cryptocurrencies in the last six months returned more than 100% (80% * 15% = 12%)
Increase to 5-15%: Increased probability because RichCoin is backed by a successful tech entrepreneur, the likelihood of success for RichCoin in particular should be higher than other cryptocurrencies

Final Answer: There is a 10% chance RichCoin will return more than 100% in the next six months (Average of the range, (5% + 15%) / 2)

(d) Identify two additional steps you can take to improve your approximation.

Commentary on Question:
Candidates generally scored well on this open-ended question.

Consult other outside views

Consider second opinions from yourself

Employ additional data to calibrate the estimate.

12. 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) Describe the appropriateness of a given quantification of market and non-market risk exposures.

(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

ASB, Proposed ASOP on Modeling

Dowd, Measuring Market Risk 2nd ed, Ch 13

Commentary on Question:

Generally, candidates who provided more detail/support tended to do better on this question. Those candidates were able to express their reasoning and fully answer the question.

Solution:

(a) Critique the implementation process the IT programmer described.

Commentary on Question:

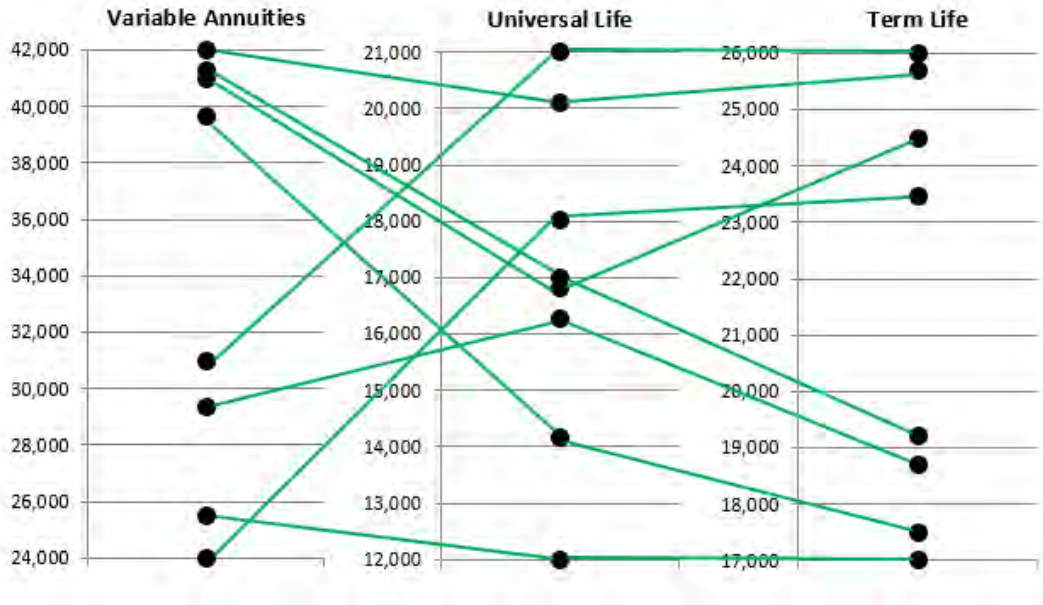
Critiquing does not imply that only faults should be presented. A critique can also point out was done well. Other, logical responses were accepted for full credit.

- Risk modeling experts should be involved in the selection of the algorithms that implement the modeling concepts, not just IT. Fastest doesn't mean best or most appropriate.
- Good decision to update the code documentation and consciously avoid confusion about versioning.
- A random selection of scenarios are not the best test cases for an economic capital model; should inspect the tail scenarios.
- Manual testing is okay, but it shouldn't replace automated test procedures; testing should be performed periodically.

12. Continued

- User acceptance testing has not been performed. IT should not be reviewing/testing this new model alone, the risk modelers should have input, too.
- What is the failure rate of the automated load; just because the failure rate is lower does not mean it should not be investigated further.

(b)



Interpret the graph.

Commentary on Question:
This is an open-ended question that allowed candidates to comment on correlation, range of outcomes, fitness for use, etc.

- The chart represents economic capital amounts for each product line under the various shocks.
- The range of EC results for Variable Annuity is much larger than the other two products.
- VA and Term results are clustered; UL does not show clustering
- Lines between UL and Term are horizontal for many scenarios; suggesting the EC results are correlated.

12. Continued

(c) Senior management believes the analysis above captures a sufficiently wide range of possible outcomes for the company's economic capital.

Evaluate senior management's belief.

Commentary on Question:
This is an open-ended question but the key is the information that this is being used for economic capital and the belief that the range of outcomes is sufficient. Candidates who addressed short-comings in this context scored higher.

- The number of scenarios is not adequate to calculate an economic capital amount which is a tail measure.
- There are other risks (such as lapses) which are not considered in the analysis.
- The amount and level of the shocks may not be adequate- suggest stochastic simulations.
- A one-year time horizon may not be appropriate.