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Exam 7

Estimation of Policy Liabilities, Insurance Company Valuation, and ERM

INSTRUCTIONS TO CANDIDATES

1. This 63.75 point examination consists of 27 problem and essay questions.
2. For the problem and essay questions the number of points for each full question or part of a question is indicated at the beginning of the question or part. Answer the questions on the lined sheets provided in your Examination Envelope. Use dark pencil or ink. Do not use multiple colors or correction fluid.
 - Write your Candidate ID number and the examination number, 7, at the top of each answer sheet. Your name, or any other identifying mark, must not appear.
 - Do not answer more than one question on a single sheet of paper. Write only on the front lined side of the paper – DO NOT WRITE ON THE BACK OF THE PAPER. Be careful to give the number of the question you are answering on each sheet. If your response cannot be confined to one page, please use additional sheets of paper as necessary. Clearly mark the question number on each page of the response in addition to using a label such as "Page 1 of 2" on the first sheet of paper and then "Page 2 of 2" on the second sheet of paper.
 - The answer should be concise and confined to the question as posed. When a specific number of items is requested, do not offer more items than requested. For example, if you are requested to provide three items, only the first three responses will be graded.
 - In order to receive full credit or to maximize partial credit on mathematical and computational questions, you must clearly outline your approach in either verbal or mathematical form, showing calculations where necessary. Also, you must clearly specify any additional assumptions you have made to answer the question.
3. Do all problems until you reach the last page of the examination where "END OF EXAMINATION" is marked.
4. Prior to the start of the exam you will have a **fifteen-minute reading period** in which you can silently read the questions and check the exam booklet for missing or defective pages. A chart indicating the point value for each question is attached to the back of the examination. Writing will NOT be permitted during this time and you will not be permitted to hold pens or pencils. You will also not be allowed to use calculators. The supervisor has additional exams for those candidates who have defective exam booklets.

CONTINUE TO NEXT PAGE OF INSTRUCTIONS

5. Your Examination Envelope is pre-labeled with your Candidate ID number, name, exam number, and test center. Do not remove this label. Keep a record of your Candidate ID number for future inquiries regarding this exam.
6. Candidates must remain in the examination center until two hours after the start of the examination. The examination starts after the reading period is complete. You may leave the examination room to use the restroom with permission from the supervisor. To avoid excessive noise during the end of the examination, candidates may not leave the exam room during the last fifteen minutes of the examination.
7. At the end of the examination, place all answer sheets in the Examination Envelope. Please insert your answer sheets in your envelope in question number order. Insert a numbered page for each question, even if you have not attempted to answer that question. Nothing written in the examination booklet will be graded. Only the answer sheets will be graded. Also place any included reference materials in the Examination Envelope. BEFORE YOU TURN THE EXAMINATION ENVELOPE IN TO THE SUPERVISOR, BE SURE TO SIGN IT IN THE SPACE PROVIDED ABOVE THE CUT-OUT WINDOW.
8. If you have brought a self-addressed, stamped envelope, you may put the examination booklet and scrap paper inside and submit it separately to the supervisor. It will be mailed to you. Do not put the self-addressed stamped envelope inside the Examination Envelope.

If you do not have a self-addressed, stamped envelope, please place the examination booklet in the Examination Envelope and seal the envelope. You may not take it with you. Do not put scrap paper in the Examination Envelope. The supervisor will collect your scrap paper.

Candidates may obtain a copy of the examination from the CAS Web Site.

All extra answer sheets, scrap paper, etc., must be returned to the supervisor for disposal.

9. Candidates must not give or receive assistance of any kind during the examination. Any cheating, any attempt to cheat, assisting others to cheat, or participating therein, or other improper conduct will result in the Casualty Actuarial Society and the Canadian Institute of Actuaries disqualifying the candidate's paper, and such other disciplinary action as may be deemed appropriate within the guidelines of the CAS Policy on Examination Discipline.
10. The exam survey is available on the CAS Web Site in the "Admissions/Exams" section. Please submit your survey by May 14, 2014.

END OF INSTRUCTIONS

EXAM 7 – SPRING 2014

1. (2 points)

Given the following information:

Cumulative Losses (\$000,000)

<u>Accident Year</u>	<u>Reported at 24 Months</u>	<u>Ultimate Loss</u>
2008	12	18
2009	10	16
2010	14	20
2011	12	18
2012	21	

An insurer writes annual policies that incept on January 1. Exposure and coverage levels were constant for 2008 through 2011. On January 1, 2012, policy coverage was expanded and pricing actuaries estimated the following:

- Loss amounts will increase by 25% due to the expanded coverage.
- 75% of ultimate losses are expected to be reported by 24 months, with a standard deviation of 8% of estimated ultimate loss.
- Standard deviation of accident year 2012 ultimate loss will be \$3 million.

a. (1.5 points)

Calculate the projected accident year 2012 ultimate loss using Bayesian credibility methods.

b. (0.5 point)

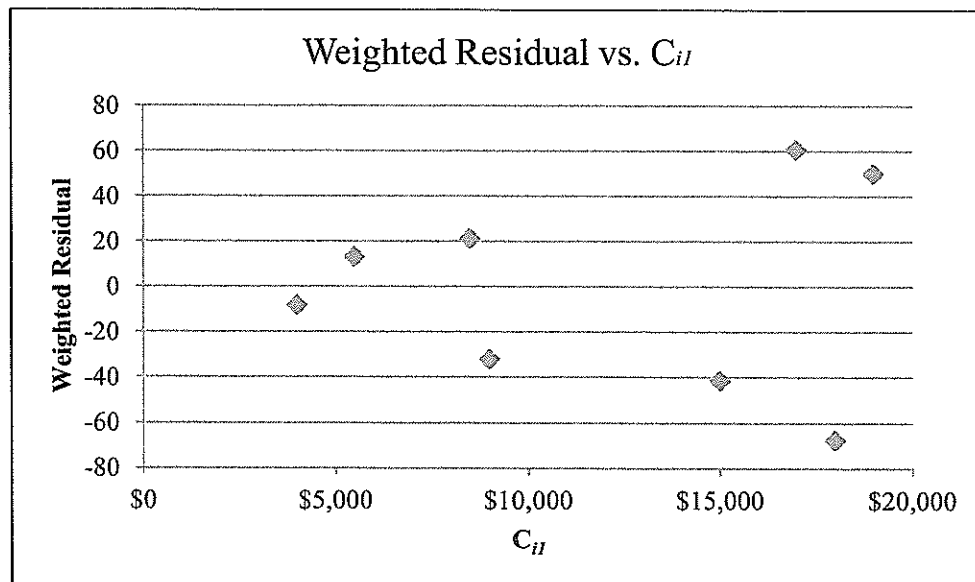
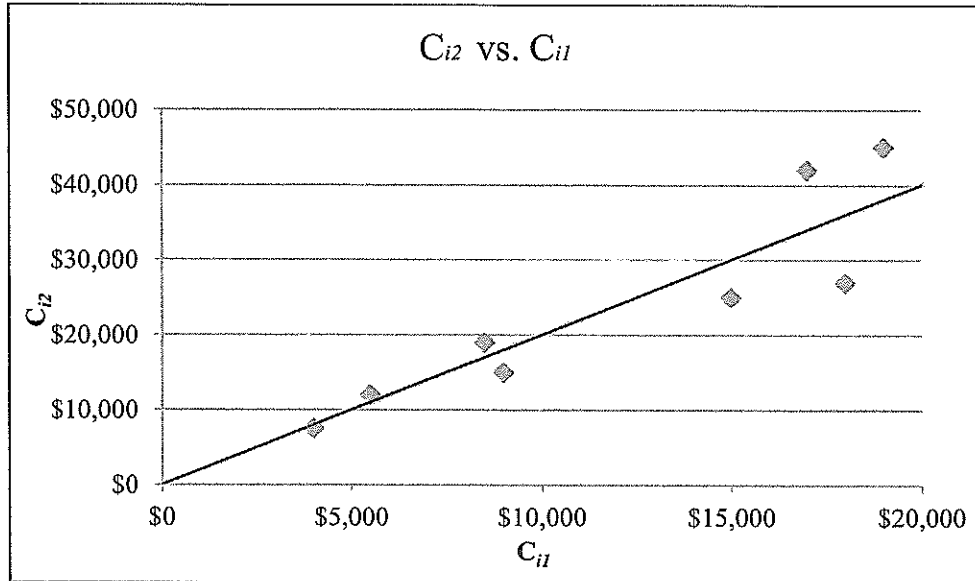
Explain why the least squares method is not appropriate for calculating the accident year 2012 ultimate loss.

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EXAM 7 – SPRING 2014

2. (1 point)

Given the following output from a company's reserving software:



- C_{i1} : Loss evaluated at 12 months for accident year i (\$000)
- C_{i2} : Loss evaluated at 24 months for accident year i (\$000)

Based on the two charts above, explain whether the chain-ladder method is appropriate for estimating ultimate loss.

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EXAM 7 – SPRING 2014

3. (1.25 points)

Given the following data for a Cape Cod reserve analysis:

Actual Incremental Reported Losses (\$000)

Accident Year	12 <u>Months</u>	24 <u>Months</u>	36 <u>Months</u>
2010	100	255	180
2011	120	280	
2012	120		

Expected Incremental Reported Losses (\$000)

Accident Year	12 <u>Months</u>	24 <u>Months</u>	36 <u>Months</u>
2010	80	300	200
2011	80	320	
2012	100		

The parameters of the loglogistic growth curve (ω and θ) and the expected loss ratio (ELR) were previously estimated, resulting in a total estimated reserve of \$1,500,000. The parameter standard deviation of the total estimated reserve is \$350,000.

Calculate the standard deviation of the reserve due to parameter and process variance combined.

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EXAM 7 – SPRING 2014

4. (3.75 points)

Given the following loss information:

<u>Cumulative Reported Losses (\$000)</u>						
<u>Year</u>	<u>12 Months</u>	<u>24 Months</u>	<u>36 Months</u>	<u>48 Months</u>	<u>60 Months</u>	<u>72 Months</u>
2008	200	1,000	1,500	1,800	2,100	2,100
2009	400	800	1,000	1,500	1,800	
2010	800	1,500	2,000	2,200		
2011	1,200	2,000	2,200			
2012	400	1,800				
2013	200					

<u>t-statistic for 0.90 at Various Degrees of Freedom (DF)</u>							
<u>DF</u>	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>
<u>t-statistic</u>	3.08	1.89	1.64	1.53	1.48	1.44	1.42

- Assume $T = r [(n - 2) / (1 - r^2)]^{1/2}$ is t -distributed with $n - 2$ degrees of freedom where r is the sample correlation coefficient.

a. (3.25 points)

Evaluate whether the triangle above meets the assumption that the age-to-age factors are independent from 12 months to 36 months, using a 10% t -statistic significance standard.

b. (0.5 point)

State two other basic chain-ladder assumptions needed for least squares optimality.

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EXAM 7 – SPRING 2014

5. (3.25 points)

An insurance company has 1,000 exposures uniformly distributed throughout the accident year. The a priori ultimate loss is \$800 per exposure unit.

The expected loss payment pattern is approximated by the following loglogistic function where G is the cumulative proportion of ultimate losses paid and x represents the average age of reported losses in months.

- $G(x) = \frac{x^\omega}{x^\omega + \theta^\omega}$
- $\omega = 2.5$
- $\theta = 24$

a. (1 point)

Calculate the expected losses paid in the first 36 months after the beginning of the accident year.

b. (0.75 point)

Assume the actual cumulative paid losses at 36 months after the beginning of the accident year are \$650,000. Estimate the ultimate loss for the accident year using assumptions based upon the Cape Cod method.

c. (0.5 point)

Estimate the ultimate loss for the accident year based on the loglogistic payment model and the actual payments through 36 months, disregarding the a priori expectation.

d. (1 point)

Calculate a reserve estimate for the accident year by credibility-weighting the two estimates of ultimate loss in parts b. and c. above using the Benktander method.

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EXAM 7 – SPRING 2014

6. (1 point)

Given the following information from an insurance company's portfolio of policies with a \$500,000 deductible:

Age-to-Age Loss and ALAE Development Factors

	<u>12-24</u>	<u>24-36</u>	<u>36-48</u>	<u>48-60</u>
Unlimited	1.912	1.316	X	1.077
Limited to \$500,000	1.900	1.300	1.125	1.050

Limited Severity Relativities (R^L)

<u>12</u>	<u>24</u>	<u>36</u>	<u>48</u>	<u>60</u>
0.980	0.974	0.962	0.944	0.920

a. (0.5 point)

Calculate the missing value, X, from the table above.

b. (0.5 point)

Calculate the excess of \$500,000 36-48 month development factor.

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EXAM 7 – SPRING 2014

7. (2 points)

Identify four common data issues associated with applying an over-dispersed Poisson bootstrap model and provide one adjustment for each.

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EXAM 7 – SPRING 2014

8. (4.5 points)

Given the following information as of December 31, 2013:

- An insurer had written only homeowners insurance until it began writing workers compensation on January 1, 2012.
- Five independent models were run for workers compensation and one independent model was run for homeowners, producing the following modeled coefficients of variation for accident year ultimate loss:

	<u>Model 1</u>	<u>Model 2</u>	<u>Model 3</u>	<u>Model 4</u>	<u>Model 5</u>
Homeowners	5%	-	-	-	-
Workers Compensation	21%	9%	45%	N/A	38%

- Model 4 failed to produce valid predictors for workers compensation.
- The claims adjusting process for homeowners has recently become automated.
- The company uses a third party to adjust medical claims for workers compensation. Claim information is received from the third party on a quarterly basis.
- In-house homeowners claims staff meet regularly with the valuation actuary.

a. (1.5 points)

Identify and define the three main components of internal systemic risk when determining liability risk margins for a book of business.

b. (1.5 points)

Identify one potential risk indicator for each line of business under each risk component listed in part a. above.

c. (1.5 points)

Briefly discuss whether each indicator in part b. above would receive a more or less favorable score on a balanced scorecard.

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EXAM 7 – SPRING 2014

9. (2 points)

Given the following output (\$000) from a paid chain-ladder generalized linear model:

<u>Accident Year</u>	<u>Mean Unpaid</u>	<u>Standard Error</u>	<u>Coefficient Of Variation</u>
2008	\$63	\$35	0.556
2009	632	260	0.411
2010	2,130	641	0.301
2011	4,721	1,265	0.268
<u>2012</u>	<u>7,011</u>	<u>2,825</u>	<u>0.403</u>
Total	14,557	4,024	0.276

Use four diagnostic tests to evaluate the model for reasonableness.

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EXAM 7 – SPRING 2014

10. (1 point)

a. (0.5 point)

Within the context of a stochastic framework for loss reserving, briefly describe two types of expert opinion that can be used to override the calculated parameters in a predictive reserving model.

b. (0.5 point)

Given the following parameters and means of three Gamma distributions:

α_i	β_i	<u>Mean</u>
30,000	12.00	2,500
3,000	1.20	2,500
300	0.12	2,500

Discuss how the β_i value influences the trade-off between the chain-ladder and Bornhuetter-Ferguson estimates in a Bayesian model.

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EXAM 7 – SPRING 2014

11. (2.25 points)

For each of the following external systemic risks, give an example of a line of business for which the risk would be important, and explain why it is important for that line of business.

a. (0.75 point)

Legislative risk

b. (0.75 point)

Event risk

c. (0.75 point)

Latent claim risk

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EXAM 7 – SPRING 2014

12. (1.75 points)

A single retrospectively rated policy has the following adjustments:

<u>Adjustment</u>	<u>Incremental Losses</u>	<u>Incremental Premium</u>
1	\$100,000	\$150,000
2	50,000	25,000
3	15,000	0
4	20,000	5,000
5	5,000	-1,250

a. (0.5 point)

Discuss why incremental premium can be greater than incremental losses at the first adjustment.

b. (0.5 point)

Explain how a positive fourth adjustment to the incremental premium could follow a third adjustment of \$0.

c. (0.75 point)

Explain how the observed premium development to loss development (PDL) ratio could become negative for the fifth adjustment.

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EXAM 7 – SPRING 2014

13. (2 points)

Describe four aspects of reinsurance loss reserving that make it somewhat more difficult than primary loss reserving.

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EXAM 7 – SPRING 2014

14. (2 points)

Given the following reinsurance company data (\$000) evaluated as of December 31, 2013:

Calendar/ Accident <u>Year</u>	Earned Risk <u>Pure Premium</u>	Adjusted <u>Premium</u>	Aggregate Reported <u>Loss</u>
2010	5,000	5,000	3,000
2011	4,500	5,500	2,500
2012	5,000	6,000	2,500
<u>2013</u>	<u>6,500</u>	<u>6,500</u>	<u>1,500</u>
Total	20,000	23,000	9,500

Reported Loss Development
Factors to Ultimate

12 months	2.50
24 months	2.00
36 months	1.60
48 months	1.25
60 months	1.00

- Adjusted premium incorporates changes in primary rates, underwriting, and exposure affecting the loss potential.

Calculate the Stanard-Bühlmann (Cape Cod) ultimate loss ratio for 2011.

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EXAM 7 – SPRING 2014

15. (1.5 points)

A publicly traded insurer writes three product lines: workers compensation, commercial property, and commercial auto. The following table presents financial data (\$000) for the insurer for 2013.

	<u>Workers Compensation</u>	<u>Commercial Property</u>	<u>Commercial Auto</u>
Earnings	636	318	297
Book Value	8,350	5,860	2,210

Three peer companies have been selected for each product line. These peer companies are monoline insurers that operate in the associated product line only.

<u>Workers Compensation Peer</u>	<u>Price-Earnings Ratio</u>	<u>Commercial Property Peer</u>	<u>Price-Earnings Ratio</u>
Peer 1	21.9	Peer 1	16.4
Peer 2	18.5	Peer 2	19.7
Peer 3	19.6	Peer 3	17.9

<u>Commercial Auto Peer</u>	<u>Price-Earnings Ratio</u>
Peer 1	13.9
Peer 2	17.2
Peer 3	14.8

Calculate the Price to Book Value ratio for the insurer based on relative valuation using multiples.

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EXAM 7 – SPRING 2014

16. (2 points)

Given the following information for a publicly traded corporation:

Market risk premium:	6.0%
Return on 90-day T-Bills:	2.5%
Beta for this corporation:	1.25

The corporation's dividend payments have been projected as follows:

<u>Calendar</u> <u>Year</u>	<u>Dividend</u> <u>Payment</u>
2014	\$450,000
2015	500,000
2016	675,000

After 2016, the corporation's dividend payments are expected to grow at 5% a year.

Estimate the value of this corporation as of December 31, 2013, using the dividend discount model.

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EXAM 7 – SPRING 2014

17. (1.5 points)

Given the following financial data for an insurer:

	2014	2015	2016
Beginning U.S. GAAP Equity	\$3,000,000		
Forecasted Net Income	\$420,000	\$500,000	\$550,000

In order for the insurer to maintain its A+ Rating, it must meet a minimum capital requirement for each year equal to 5% above the beginning U.S. GAAP equity for the given year.

a. (1 point)

Calculate the Free Cash Flow to Equity (FCFE) for 2016.

b. (0.5 point)

Explain why the FCFE valuation is unaffected by whether the insurer's loss and loss adjustment expense reserves increased in 2014.

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EXAM 7 – SPRING 2014

18. (4 points)

a. (0.5 point)

Define market risk and credit risk.

b. (1.5 points)

Identify and briefly describe three types of market risk that an insurer may face.

c. (1 point)

Briefly describe how market risk and credit risk each affect the value of both invested assets and insurance liabilities.

d. (1 point)

Given the following amounts (in \$000,000) for each risk factor:

Market risk of assets:	100
Credit risk of assets:	40
Market risk of liabilities:	40
Credit risk of liabilities:	10

Assuming non-negative correlations, calculate a range for total risk from these factors.

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EXAM 7 – SPRING 2014

19. (2.25 points)

A U.S.-domiciled insurance company is holding the following bonds:

- Bonds issued by a U.S.-based bank with credit rating of AA valued at \$15 million. The mean time to maturity is five years.
- Bonds issued by a technology company located in the U.S. with credit rating of BBB valued at \$20 million. The mean time to maturity is 10 years.

There are no other bonds held by the company.

Identify and briefly describe three key drivers of credit risk for the insurance company and briefly comment on how they relate to the insurer's bond portfolio.

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EXAM 7 – SPRING 2014

20. (1.5 points)

a. (1 point)

Describe an example where two lines of insurance that are typically uncorrelated become correlated during a stressed or extreme event.

b. (0.5 point)

Describe a method to account for increasing correlation in the tails of the loss distributions of typically uncorrelated risks.

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EXAM 7 – SPRING 2014

21. (5 points)

Given the following data:

<u>Class</u>	<u>Frequency</u>	<u>Severity</u>
1	0.20	\$15,000
2	0.05	25,000
3	0.40	5,000
4	0.25	3,000
5	0.10	12,000

a. (1.5 points)

Calculate the Pearson product-moment correlation coefficient between the frequency and severity.

b. (1.5 points)

Calculate the Kendall τ statistic between the frequency and severity.

c. (1 point)

Identify and briefly describe two potential weaknesses of the Pearson product-moment correlation coefficient as a measure of dependency.

d. (0.5 point)

Briefly describe whether the use of the Kendall τ statistic would address the weaknesses identified in part c. above.

e. (0.5 point)

Briefly describe one advantage and one disadvantage of using a scatterplot to evaluate dependency instead of using the Kendall τ statistic or the Pearson product-moment correlation coefficient.

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EXAM 7 – SPRING 2014

22. (3.25 points)

An insurer has decided to calculate risk-based performance metrics for its two lines of business. It has chosen a risk capital metric of 99th percentile VaR. Below is a summary of results (\$000,000) for the two lines of business.

<u>Line of Business</u>	<u>Expected Annualized Profit</u>	<u>Coefficient of Variation</u>
A	50	300%
B	9	250%

- $\Phi^{-1}(0.99) = 2.326$
- Income follows a normal distribution.
- The lines of business are independent.

a. (0.75 point)

Determine which line of business performs better using return on risk-adjusted capital.

b. (0.75 point)

Calculate the return on risk capital and the risk-adjusted performance metric for the portfolio as a whole.

c. (0.5 point)

Allocate the risk capital to both portfolios using the proportional allocation method.

d. (1.25 points)

Calculate the allocation of capital using an incremental marginal approach and discuss an advantage this approach has over the proportional allocation method.

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EXAM 7 – SPRING 2014

23. (2.5 points)

a. (1 point)

Discuss two reasons why the relationship between shareholders and debtholders often makes it worthwhile for a firm to minimize a specific diversifiable risk, regardless of whether the firm is an insurer.

b. (1 point)

Describe two ways the relationship between shareholders and debtholders differs for insurance firms and non-insurance firms.

c. (0.5 point)

Explain how the differences in part b. above could affect the amount of risk an insurance firm might want to retain relative to a non-insurance firm.

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EXAM 7 – SPRING 2014

24. (4 points)

The following information (\$000,000) is available for an insurer:

Earned premium	1,000
Expected losses	200
Acquisition expenses	150
Beginning surplus	2,000
Risk-free rate	3%
Investment rate of return	5%

The insurer is considering a reinsurance program for accident year 2015:

	<u>No Reinsurance</u>	<u>Reinsurance</u>
Reinsurance premium	0	450.0
Reinsurance commission	0	67.5
Expected recovery	0	110.0
Probability of distress	3.00%	0.40%

Assume the following:

- All premiums are collected at the beginning of the year.
- Losses are paid in full at the end of the year.
- All expenses are paid at the beginning of the year.
- There is no growth or change in the insured portfolio.
- The insurer cannot operate in a financially distressed state.
- Regulatory considerations are negligible.
- The firm value is the risk-adjusted present value of all future earnings.

a. (1.5 points)

Calculate the insurer's expected underwriting profit both with and without reinsurance.

b. (2.5 points)

Calculate the change in firm value of the insurer at the beginning of 2015 if the insurer purchases the reinsurance program.

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EXAM 7 – SPRING 2014

25. (2.5 points)

a. (1 point)

Define “bridging model” in the context of the loss ratio planning process and describe an operational problem created when a bridging model is used.

b. (1.5 points)

Identify two aspects of effective cycle management and describe how focusing on these aspects can help mitigate operational risks through underwriting cycles.

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EXAM 7 – SPRING 2014

26. (2 points)

a. (0.5 point)

Define the following:

- i. Economic capital level
- ii. Rating agency capital

b. (0.5 point)

Discuss why a firm might calibrate the capital model for the economic capital level instead of the rating agency capital level.

c. (0.5 point)

Define the following:

- i. Economic impairment earnings
- ii. Protection of franchise value

d. (0.5 point)

Discuss why a firm might calibrate the capital model to the economic impairment earnings level instead of the protection of franchise value level.

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EXAM 7 – SPRING 2014

27. (2 points)

a. (1 point)

Describe one benefit and one drawback of using a probability density function to model a company's capital when building an internal model for Solvency II.

b. (1 point)

Discuss one alternative to using a probability density function to model a company's capital when building an internal model for Solvency II and describe one advantage of this approach.

END OF EXAMINATION

Exam 7

Estimation of Policy Liabilities, Insurance Company Valuation, and ERM

QUESTION	POINT VALUE OF QUESTIONS	(a)	(b)	(c)	(d)	(e)	(f)	(g)
1	2	1.5	0.5					
2	1	1						
3	1.25	1.25						
4	3.75	3.25	0.5					
5	3.25	1	0.75	0.5	1			
6	1	0.5	0.5					
7	2	2						
8	4.5	1.5	1.5	1.5				
9	2	2						
10	1	0.5	0.5					
11	2.25	0.75	0.75	0.75				
12	1.75	0.5	0.5	0.75				
13	2	2						
14	2	2						
15	1.5	1.5						
16	2	2						
17	1.5	1	0.5					
18	4	0.5	1.5	1	1			
19	2.25	2.25						
20	1.5	1	0.5					
21	5	1.5	1.5	1	0.5	0.5		
22	3.25	0.75	0.75	0.5	1.25			
23	2.5	1	1	0.5				
24	4	1.5	2.5					
25	2.5	1	1.5					
26	2	0.5	0.5	0.5	0.5			
27	2	1	1					
TOTAL	63.75							

SAMPLE ANSWERS AND EXAMINER'S REPORT

GENERAL COMMENTS:

- Candidates should note that the instructions to the exam explicitly say to show all work; graders expect to see enough support on the candidate's answer sheet to follow the calculations performed. While the graders made every attempt to follow calculations that were not well-documented, lack of documentation may result in the deduction of points where the calculations cannot be followed or are not sufficiently supported.
- Incorrect responses in one part of a question did not preclude candidates from receiving credit for correct work on subsequent parts of the question that depended upon that response.
- Candidates should try to be cognizant of the way an exam question is worded. They must look for key words such as "briefly" or "fully" within the problem. We refer candidates to the Future Fellows article from December 2009 entitled "The Importance of Adverbs" for additional information on this topic.
- Some candidates provided lengthy responses to a "briefly describe" question, which does not provide extra credit and only takes up additional time during the exam.
- Generally, candidates were well prepared for this exam.

EXAM STATISTICS:

- Number of Candidates: 300
- Available Points: 63.75
- Passing Score: 47.25
- Number of Passing Candidates: 173
- Raw Pass Ratio: 57.67%
- Effective Pass Ratio: 58.84%

SAMPLE ANSWERS AND EXAMINER'S REPORT

QUESTION 1	
TOTAL POINT VALUE: 2	LEARNING OBJECTIVE: A1: Calculate unpaid claim estimates using credibility models.
SAMPLE ANSWERS	
Part a: 1.5 points	
<p><i>Sample Answer 1</i></p> <p>X= loss reported at 24 months Y= Ultimate losses $L(x)=Z(x/d)+(1-Z)E[Y]$ $Z=\frac{VHM}{VHM+EVPV}$ $VHM=(E[D]\cdot\sigma(y))^2=(.75)(3)^2=5.0625$ $EVPV=Var(D)[Var(y)+E[y]^2]=(0.08)^2[3^2+[(1.25)(\frac{18+16+20+18}{4})]^2]=3.2976$ $Z=\frac{5.0625}{5.0625+3.2976}=.606$</p> <p>$L(x)=(.606)(21/.75)+(1-.606)(22.5)=25.833$ million</p> <p><i>Sample Answer 2</i></p> <p>Y= ultimate losses $Z=\frac{VHM}{VHM+EVPV}$</p> <p>$\sigma_y=3M$ $d=.75$ $\sigma_d=.08$ $VHM=d^2 \sigma_y^2$ $EVPV= \sigma_d^2[\sigma_y^2+E(y)^2]$ $E[y]=1.25 \times 18=22.5M$ $VHM=.75^2 3^2=5.0625$ $EVPV=.08^2[3^2+22.5^2]=3.2976$ $Z=\frac{5.0625}{5.0625+3.2976}=.6055$</p> <p style="text-align: center;">Ultimate =.6055(21/.75)+(1-.6055)(22.5)=25.83M</p>	
Part b: 0.5 point	
<p><i>Sample 1</i></p> <p>The least squares method is appropriate when the distribution of loss is not changing year over year. Given the coverage expansion and change in 2012 loss distribution, we cannot use the least squares method.</p> <p><i>Sample 2</i></p> <p>Least squares method is appropriate when year to year fluctuation is mainly caused by randomness. However, in this case, there is a systematic shift in losses. As a result, we cannot use least squares.</p>	

SAMPLE ANSWERS AND EXAMINER'S REPORT

EXAMINER'S REPORT

Part a

The candidate is expected to know

- a. Application of credibility
- b. Mechanics of the method

To get full credit, the candidate has to get the final calculation right. Candidates did not score very well on this part. Only 36% received full credit. Part of the reason is that it involved a lot of calculation. Some candidates had difficulty calculating $E[y]$.

Common errors include using EVPV (VHM) formula for VHM (EVPV), missing 25% increase in $E(y)$, using LDF to calculate x/d or $E(y)$, using standard deviation instead of variance in calculation. Some candidates used formula involving LDF for Z.

Part b

The candidate is expected to know strengths and weaknesses of the method.

To get full credit, the candidate has to mention Least Squares method assumptions and why is it not the case in this question. Candidates performed well on this question; 90% of candidates received full credit.

One common error was mentioning only part of the two components (least squares relies on stable patterns, major change in coverage distorts stable pattern).

SAMPLE ANSWERS AND EXAMINER'S REPORT

QUESTION 2	
TOTAL POINT VALUE: 1	LEARNING OBJECTIVE: A2: Estimate parameters and unpaid claims using claims development models related to loss reserving methods such as: <ul style="list-style-type: none">• Chain ladder• Cape Cod• Chain ladder plus calendar-year effects• Bornhuetter-Ferguson
SAMPLE ANSWERS	
<i>Sample Answer 1</i> <p>The graph shows Ci_2 & Ci_1 has linear relationship and the line goes through the origin. It supports one of the CL assumptions; expected incremental loss is proportional to losses reported to date. Graph 2 shows that residuals are increasing as losses increase. This violates the variance assumption. Overall I think CL method is not appropriate.</p>	
<i>Sample Answer 2</i> <p>The first chart shows an estimate using CL approach (a linear fit with origin at zero). Overall this appears to be a pretty good fit, with the variance increasing in proportion to losses to date. This is also shown by the residuals. Overall, there is not a trend in the residuals up or down, but they do expand at the right tail. Since these are weighted residuals that could mean the proportion is not constant, but not enough evidence. Overall residuals are even around zero for any loss size, overall CL is a good fit.</p>	
<i>Sample Answer 3</i> <p>The graph of Ci_2 v Ci_1 is a straight line through the origin and appears to be a decent fit. This indicates that the CL method is appropriate. The second graph appears to show that the residuals are scattered around 0, however the variance appears to be larger as losses become larger. In order to determine if the CL method is appropriate for ultimate, we would need to see the graphs for other ages as well.</p>	
EXAMINER'S REPORT	
<p>The candidate was expected to understand the assumptions of the CL method and apply the knowledge to a simple example. In order to receive full credit the candidate was required to address both charts and demonstrate how they support or violate the Mack CL assumptions. Candidates that only stated the points fit the line well for the top chart lost credit. Candidates that rejected the approach due to larger errors for larger AY losses in top chart also lost credit. A common misinterpretation of the bottom chart was that candidates did not realize that the weighted residuals are adjusted for size of AY loss and that there should not be a pattern based on</p>	

SAMPLE ANSWERS AND EXAMINER'S REPORT

size of loss if CL assumptions hold. About half the candidates received full credit and over 85% received at least .75 points.

SAMPLE ANSWERS AND EXAMINER'S REPORT

QUESTION 3																	
TOTAL POINT VALUE: 1.25	LEARNING OBJECTIVE: A3: Calculate the moments and percentiles of unpaid claim distributions implied by the models.																
SAMPLE ANSWERS																	
<p><i>Sample Answer 1</i></p> $\sigma^2 = \frac{1}{n - p} \sum \frac{(\text{Actual} - \text{Expected})^2}{\text{Expected}}$ <p>n = Number of points=6 p=# parameters=2+1=3</p> $\sigma^2 = \frac{1}{6 - 3} \left(\frac{(100 - 80)^2}{80} + \dots + \frac{(180 - 200)^2}{200} \right)$ $= \frac{1}{3} * 42.75 = 14.25$ $14.25 * 1000 = 14,250$ $\text{Process Var} = \sigma^2 * \text{Reserve} = 14,250 * 1,500,000 = 2.1375 \times 10^{10}$ $\text{Total SD} = \sqrt{2.1375 * 10^{10} + 350000^2} = 379,309$ <p><i>Sample Answer 2</i></p> <p>R= 1,500,000 Parameter variance = (350,000)²</p> $\sigma^2 = \frac{1}{n - p} \sum \frac{(c - \mu)^2}{\mu}$ <p>n =6 p=3</p> <table style="margin-left: auto; margin-right: auto;"> <tr> <td style="text-align: center;"><u>AY</u></td> <td style="text-align: center;"><u>12</u></td> <td style="text-align: center;"><u>24</u></td> <td style="text-align: center;"><u>36</u></td> </tr> <tr> <td style="text-align: center;">10</td> <td style="text-align: center;">5</td> <td style="text-align: center;">6.75</td> <td style="text-align: center;">2</td> </tr> <tr> <td style="text-align: center;">11</td> <td style="text-align: center;">20</td> <td style="text-align: center;">5</td> <td></td> </tr> <tr> <td style="text-align: center;">12</td> <td style="text-align: center;">4</td> <td></td> <td></td> </tr> </table> $\sigma^2 = \frac{1}{3} * 42.75 = 14.25$ $14.25 * 1000 = 14,250$ $\text{st dev} = \sqrt{1500000(14,250) + 350,000^2} = 379,309$		<u>AY</u>	<u>12</u>	<u>24</u>	<u>36</u>	10	5	6.75	2	11	20	5		12	4		
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<p>Candidates generally performed well with the most common deduction for not reflecting the 1000's in the triangles. Some candidates used erroneous formulas for σ^2 or did not calculate the inputs correctly.</p>																	

SAMPLE ANSWERS AND EXAMINER'S REPORT

QUESTION 4																															
<p>TOTAL POINT VALUE: 3.75</p>	<p>LEARNING OBJECTIVE: A2: Estimate parameters and unpaid claims using claims development models related to loss reserving methods such as:</p> <ul style="list-style-type: none"> • Chain ladder • Cape Cod • Chain ladder plus calendar-year effects • Bornhuetter-Ferguson 																														
SAMPLE ANSWERS																															
<p>Part a: 3.25 points</p>																															
<p><i>Sample Answer 1</i></p> <p>Use Pearson's Correlation:</p> $r = \frac{E[XY] - E[X] \times E[Y]}{\sigma_X \times \sigma_Y}$ <table style="margin-left: 40px; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left; padding: 2px;"><u>AY</u></th> <th style="text-align: left; padding: 2px;"><u>12-24 LDF's</u></th> <th style="text-align: left; padding: 2px;"><u>24-36 LDF's</u></th> </tr> </thead> <tbody> <tr> <td style="padding: 2px;">08</td> <td style="padding: 2px;">5.000</td> <td style="padding: 2px;">1.500</td> </tr> <tr> <td style="padding: 2px;">09</td> <td style="padding: 2px;">2.000</td> <td style="padding: 2px;">1.250</td> </tr> <tr> <td style="padding: 2px;">10</td> <td style="padding: 2px;">1.875</td> <td style="padding: 2px;">1.333</td> </tr> <tr> <td style="padding: 2px;">11</td> <td style="padding: 2px;">1.667</td> <td style="padding: 2px;">1.100</td> </tr> </tbody> </table> <table style="margin-left: 40px; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left; padding: 2px;"><u>AY</u></th> <th style="text-align: left; padding: 2px;"><u>X-Values</u></th> <th style="text-align: left; padding: 2px;"><u>Y-Values (LDF's -1)</u></th> </tr> </thead> <tbody> <tr> <td style="padding: 2px;">08</td> <td style="padding: 2px;">4.000</td> <td style="padding: 2px;">0.500</td> </tr> <tr> <td style="padding: 2px;">09</td> <td style="padding: 2px;">1.000</td> <td style="padding: 2px;">0.250</td> </tr> <tr> <td style="padding: 2px;">10</td> <td style="padding: 2px;">0.875</td> <td style="padding: 2px;">0.333</td> </tr> <tr> <td style="padding: 2px;">11</td> <td style="padding: 2px;">0.667</td> <td style="padding: 2px;">0.100</td> </tr> </tbody> </table> <p style="margin-left: 40px;"> $\Sigma XY = 2.606$ $E[XY] = 2.606/4 = .651$ </p> $r = \frac{0.651 - 1.636 \times 0.295}{1.37 \times .144}$ <p style="margin-left: 40px;">= 0.854</p> <p style="margin-left: 40px;"> $T = 0.854 \times ((4 - 2)/(1 - .854^2))^{1/2} = 2.321$ Use D.F. = 4-2 = 2 → Compare to 1.89 from table 2.321 > 1.89, so assumption of independence from 12-36 months fails. </p>		<u>AY</u>	<u>12-24 LDF's</u>	<u>24-36 LDF's</u>	08	5.000	1.500	09	2.000	1.250	10	1.875	1.333	11	1.667	1.100	<u>AY</u>	<u>X-Values</u>	<u>Y-Values (LDF's -1)</u>	08	4.000	0.500	09	1.000	0.250	10	0.875	0.333	11	0.667	0.100
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SAMPLE ANSWERS AND EXAMINER'S REPORT

Sample Answer 2

Use Pearson's Correlation:

$$r = \frac{\sum \{[X - E[X]] \times [Y - E[Y]]\}}{\sqrt{\sum [X - E[X]]^2} \sqrt{\sum [Y - E[Y]]^2}}$$

<u>AY</u>	<u>12-24 LDF's</u>	<u>24-36 LDF's</u>
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11	0.667	0.100

$$E[X] = 1.635$$

$$E[Y] = .2958$$

$$r = \frac{0.673}{2.74 \times .289}$$

$$= 0.849$$

$$T = r \times ((n - 2)/(1 - r^2))^{1/2}$$

$$T = 0.849 \times ((4 - 2)/(1 - .849^2))^{1/2} = 2.28$$

$$T_{4-2} = 1.89$$

2.28 > 1.89 – Using a 10% t statistic this assumption is not met.

Part b: 0.5 point

Sample Answer 1

Assumes losses in the next period are equal to a factor based on age times cumulative losses to date

Assumes variance of incremental losses is proportionate to cumulative losses and a factor based on age.

SAMPLE ANSWERS AND EXAMINER'S REPORT

Sample Answer 2

This formula is from Venter the above tests that the accident year losses are independent.

Two other assumptions are:

$E\{q(w,d+1) | \text{data to } w + d\} = f(d)c(w,d)$ – next period's losses are losses reported to date times a factor that depends on age

$\text{Var}\{q(w,d+1) | \text{data to } w + d\} = a(d, c(w,d))$ – variance is proportional to losses reported to date and a factor that varies by age.

EXAMINER'S REPORT

Overall, many candidates performed very well on this question. Based on the knowledge statements candidates should know key assumptions of the chain ladder models and how to test these assumptions. The core of the question is determining whether the age-to-age factors are independent. This implies correlation and the candidate should know the formula for correlation as well as how to calculate it and the value of "n".

Part a

In order to receive full credit candidates needed to calculate link ratios at 12-24 months as well as 24-36 months and calculate the correlation coefficient based on the Pearson's correlation formula. Based on the correlation and the appropriate t statistic, candidates were expected to make the appropriate conclusion that the null hypothesis is rejected and age to age are correlated at the 10% level of significance.

Some candidates did not receive full credit for a variety of reasons:

Some candidates failed to calculate the degrees of freedom correctly (D.F. = n-2).

Other candidates chose a rank correlation approach. Although the idea is correct, rank correlation is appropriate for sets of data where there are no ties between the items being tested. These ties were present in the data being tested and therefore this approach is incorrect.

Other candidates incorrectly relied on the actual losses rather than link ratios.

Part b

Many candidates stated the independence of accident years which was the assumption being tested in part a. However the question asked for two other assumptions. Full credit was given to those candidates who understood that future expected incremental losses are proportional to cumulative losses to date and that the variance of future incremental losses are also proportional to cumulative losses to date.

SAMPLE ANSWERS AND EXAMINER'S REPORT

QUESTION 5	
TOTAL POINT VALUE: 3.25	LEARNING OBJECTIVE: A1: Calculate unpaid claim estimates using credibility models. A2: Estimate parameters and unpaid claims using claims development models related to loss reserving methods such as: <ul style="list-style-type: none"> • Chain ladder • Cape Cod • Chain ladder plus calendar-year effects • Bornhuetter-Ferguson
SAMPLE ANSWERS	
Part a: 1 point	
<i>Sample Answer 1</i>	
<p>The average age of AY losses at 36 months = 36 – 6 = 30 $G(x) = x^w / [x^w + \theta^w] = 30^{2.5} / [30^{2.5} + 24^{2.5}] = 0.636$ We would expect 1,000 × \$800 × 0.636 = \$508,800 to be paid by 36 months</p>	
<i>Sample Answer 2</i>	
<p>Time = 36 Months Average Age = 30 months $G(x) = 30^{2.5} / [30^{2.5} + 24^{2.5}] = 0.636$ Expected losses after 36 months = \$800 × 0.636 × 1,000 = \$508,800</p>	
Part b: 0.75 point	
<i>Sample Answer 1</i>	
<p>Ultimate = Paid + Expected Unpaid Ultimate = 650,000 + (1 - 0.636) × 800,000 = \$941,200</p>	
<i>Sample Answer 2 (using truncation)</i>	
<p>Test for Truncation --> $g(66) = .926$ --> Need to truncate at twice 3 years = 6 years Ultimate = 650,000 + (.926 - .636) × 800,000 = \$882,000</p>	
Part c: 0.5 point	
<i>Sample Answer 1</i>	
<p>Ultimate = 650,000 / 0.636 = \$1,022,013</p>	

SAMPLE ANSWERS AND EXAMINER'S REPORT

Sample Answer 2 (using truncation)

$$\text{Ultimate} = 650,000 \times (.926 / .636) = \$946,384$$

Part d: 1 point

Sample Answer 1

The credibility weight (z) for the Benktander method is $G(30) = 0.636$

$$U_{GB} = U_{LDF} \times z + (1 - z) \times U_{CC}$$

$$U_{GB} = 1,022,013 \times 0.636 + (1 - 0.636) \times 941,200 = 992,597$$

$$R_{GB} = 992,597 - 650,000 = \$342,597$$

Sample Answer 2

$$R_{GB} = R_{LDF} \times z + (1 - z) \times R_{CC}$$

$$R_{GB} = (1,022,013 - 650,000) \times 0.636 + (1 - 0.636) \times (941,200 - 650,000) = \$342,597$$

Sample Answer 3

$$R_{GB} = (1 - z) \times U_{CC} = (1 - .636) \times (941,200) = \$342,597$$

Sample Answer 4 (using truncation)

$$R_{GB} = (1 - z) \times U_{CC} = (.926 - .636) \times (882,000) = \$255,780$$

EXAMINER'S REPORT

In general, candidates scored well on this question.

Part a

The candidate was expected to know the average age of the losses, the initial ultimate loss estimate, and the application of the two to calculate estimated paid losses.

The most common mistake was candidates inappropriately calculating the average age.

Part b

The candidate was expected to know to how to calculate the estimated unpaid loss, and add the actual paid losses to this amount to arrive at the ultimate.

The most common mistake was candidates using the wrong initial Ultimate loss.

SAMPLE ANSWERS AND EXAMINER'S REPORT

Part c

The candidate was expected to know to divide the actual paid loss by the estimated percent paid to date, which ignores the a-priori loss estimate.

Part d

The candidate was expected to appropriately weight the ultimate loss estimates from parts a. and b., per the Benktander method.

The most common mistake made on this part of the question was not subtracting paid loss from ultimate loss in order to determine the reserve estimate.

Some candidates used a different method that produced the correct answer, but did not utilize the answers in parts b and c, as the question specified. Credit was not awarded for these responses.

SAMPLE ANSWERS AND EXAMINER'S REPORT

QUESTION 6	
TOTAL POINT VALUE: 1	LEARNING OBJECTIVE: A4: Estimate unpaid claims for various layers of claims.
SAMPLE ANSWERS	
Part a: 0.5 point	
<i>Sample Answer 1</i>	
$\text{LDF}_t^L = \text{LDF}_t \times R_{t+1} / R_t$ $1.125 = \text{LDF}_t \times (.944/.962)$ $\text{LDF}_t = 1.146$	
<i>Sample Answer 2</i>	
$1.125 = X \times .944/962$ $X = 1.146$	
Part b: 0.5 point	
<i>Sample Answer 1</i>	
$\text{LDF}_t = \text{LDF}_t^L \times R_t + (1-R_t) \times \text{XSLDF}$ $1.146 = 1.125 \times .962 + (1-.962) \times \text{XSLDF}$ $\text{XSLDF} = 1.690$	
<i>Sample Answer 2</i>	
$1.146 \times (1-.944)/(1-.962) = 1.6895$	
EXAMINER'S REPORT	
<p>Candidates generally scored well, with almost 75% receiving full credit of 1.0 and less than 10% received 0.25 point or less. On average, candidates had similar success with a. and b. The most common mistake was selecting an incorrect limited severity relativity, be it simple column reference error or just misunderstanding the formula/concept.</p>	
Part a	
<p>The candidate was expected to provide a correct solution, but not via one and only one formula. The most common mistake was selecting an incorrect limited severity relativity, be it simple column reference error or just misunderstanding the formula/concept.</p>	

SAMPLE ANSWERS AND EXAMINER'S REPORT

Part b

The candidate was expected to provide a correct solution, but not via one and only one formula. The most common mistake was using an incorrect age for the LDF/relativity relationship.

SAMPLE ANSWERS AND EXAMINER'S REPORT

QUESTION 7	
TOTAL POINT VALUE: 2	LEARNING OBJECTIVE: A8: Identify data issues and related model adjustments for reserving models.
SAMPLE ANSWERS	
<i>Sample Answer 1</i>	
<ul style="list-style-type: none">○ Negative incremental value: limit incremental losses to zero○ Missing values/incomplete data: estimate missing values using surrounding values○ Heteroscedasticity: stratified sampling is accomplished by organizing the development periods by group with homogeneous variance within each group and then sampling with replacement only from the residuals in each group○ Exposures that have changed dramatically over the years: modify data to get pure premiums and multiply the residuals by the exposures by year after the process variance step	
<i>Sample Answer 2</i>	
<ul style="list-style-type: none">○ Non-zero sum of residuals: add a single constant to all residuals so that the sum of the adjusted residuals is zero○ Outliers/extreme values: exclude outliers from the average age-to-age factors and residual calculations, but re-sample the corresponding incremental when simulating triangles○ Heteroecthesious data/misshapen data/partial year/interim evaluation dates: project future incremental values before applying model; need to annualize then de-annualize results○ Lack of residuals to sample from/lack of extreme residuals: need to parameterize a distribution from which to sample from	
<i>The following data issues/adjustments were also accepted:</i>	
<ul style="list-style-type: none">○ Negative incremental value: remove the row from the triangle if it is causing extreme results and doesn't improve the parameterization of the model; use $-\ln(\text{abs}(q(w,d)))$ for $q(w,d) < 0$, when total of all incremental values in a development column is positive; when column(s) sum to a negative value, add the absolute value of the largest negative (either among the sums of development columns or incremental values in the triangle) to every incremental value in the triangle, solve the GLM, and reduce each fitted incremental value by the largest negative; when simulating from a negative incremental value $m(w,d)$ using the gamma distribution:	

SAMPLE ANSWERS AND EXAMINER'S REPORT

use $\text{Gamma}(\text{abs}(m(w,d)), \text{phi} \times \text{abs}(m(w,d))) + 2 \times m(w,d)$, since this will have mean $m(w,d)$ while remaining skewed to the right; discussion in 4.1.1 contains other alternatives

- Missing values/incomplete data: modify loss development factors to exclude the missing value (in which case there will not be a corresponding residual for this missing value)
- Outliers/extreme values: remove them and deal with them like missing values; exclude outliers from the average age-to-age factors and residual calculations, but re-sample the corresponding incremental when simulating triangles
- Heteroscedasticity: sort development periods into groups with homogeneous variances, multiply each residual in each group by a hetero-adjustment factor $(\text{max}(\text{st.dev.}(r_i))/\text{st.dev.}(r_i))$, sample with replacement among all residuals, and divide each residual by the hetero-adjustment factor when the residuals are resampled

EXAMINER'S REPORT

Candidates were expected to provide four data issues and briefly identify a solution for each. While the solution was required to be complete and correct, the candidate was not required to recall specific formulas or equations. As an example, if the candidate's adjustment for negative incremental values required subtracting the largest negative, the candidate was also required to mention that this adjustment needs to be removed after solving the GLM. Credit would not be given if the candidate's adjustment required adding the largest negative with no mention of using the absolute value.

Most candidates were successful in identifying at least 3 data issues with appropriate adjustments (whether it was directly from the list or a description of one of the items). For example, several candidates did not use the term "heteroecthesious data", but they were able to give an accurate description of the term. Per CAS exam rules, only the first 4 identified responses were graded in instances where candidates identified more than 4 items.

Common errors:

- Candidates were not given credit for providing multiple aspects for what essentially is the same data issue. For instance, if candidates listed multiple data issues associated with Negative Incremental Values only the first of these responses was accepted.
- Some candidates mismatched appropriate adjustments between two different data issues. For instance, the paper mentions that it is common for outliers to form the first row of the data triangle and that removing the first row is an appropriate solution in this instance. However, this was sometimes listed as an adjustment for missing values, which isn't mentioned in the paper (the paper lists an example in which the oldest diagonals are missing). Credit for identifying the data issue was still given in these cases.
- Incomplete responses were sometimes given. Often an adjustment required applying a constant or factor, but the solution was missing the removal of this constant or factor after fitting or sampling. Credit for identifying the data issue was still given in these cases.

SAMPLE ANSWERS AND EXAMINER'S REPORT

QUESTION 8	
TOTAL POINT VALUE: 4.5	LEARNING OBJECTIVE: A5: Describe the various sources of risk and uncertainty that are associated with the determination of reserves. Calculate risk margins that consider these sources of risk and uncertainty.
SAMPLE ANSWERS	
Part a: 1.5 points	
<i>Sample Answer 1</i>	
<p>Specification error – reflects the fact that it is not possible to precisely model the insurance process</p> <p>Parameter selection error –reflects the fact that it is not possible to perfectly estimate linear predictors or, in general, that model parameters are incorrect</p> <p>Data error – risk that there is an inadequate amount of data to build a model and/or that there is a lack of knowledge regarding pricing and underwriting practices</p>	
<i>Sample Answer 2</i>	
<p>Specification error – this is the risk of error in our inability of perfectly modelling the insurance process</p> <p>Parameter selection error – this is the uncertainty of selecting the best predictors or trends to describe the insurance process</p> <p>Data error – this is the risk that comes with inaccurate data or the lack of knowledge of our portfolio</p>	
Homeowners Specification (b and c): .25 (b) .25 (c) point	
<i>Sample Answer 1</i>	
<p>The number of model and simulations used to model the policy liabilities: not favorable since only uses one independent model instead of several</p> <p>Number of models run: less favorable – prefer to run more than one for homeowners to capture event/cat risk as well as provide check on first model validity</p> <p>Only one model was run, so could indicate difficulty specifying models: less favorable. Only 1 model gives less comfort model specifies correctly, since cannot compare results</p>	

SAMPLE ANSWERS AND EXAMINER'S REPORT

Sample Answer 2

Are our predictors stable over time: not favorable because claims adjusting process recently changed thus creates some uncertainty for the future

Meet with actuary: favorable since meeting regularly to share insights, beneficial to both parties

Meeting w/ claims staff regularly, could get expert opinion on parameters: more favorable – meeting with claims staff regularly helps get expert opinion, better estimates of parameters, lower risk of parameter error

Sample Answer 3

Is the data timely, reliable and consistent?: favorable since valuation actuary seems to meet regularly with claims staff and so seems to have a good knowledge and understanding of the portfolio.

Claim system automation: middle – probably favorable going forward for standard data process, but may be unfavorable as all parties adjust to new system

The claims process is automated, could lower data errors: more favorable – automated claims systems give less chance of data input errors

Workers Compensation Specification (b and c): .25 (b) .25 (c) point

Sample Answer 1

Since WC is a long tail coverage, do we have confidence in our testing of the model, has it been tested thoroughly to make sure it is appropriate? Stable model over model?: not favorable since the results of the independent model are very variable. Thus need to account for this with a higher risk margin.

Number of models run: favorable – multiple models provide balance and checks on one another

4 Models were run: more favorable – w/ 4 working models because they can compare results to test reasonability

Sample Answer 2

Have we selected the best predictors and trends to use in our model: not favorable since this is a new line of business and predictors are likely not yet perfect. Need some experience before this can be favorable.

SAMPLE ANSWERS AND EXAMINER'S REPORT

Amount of data (history) + level of experience in line of business: less favorable – new line for this company, may be some lacking knowledge thus far, good to use 4 models to balance this

High variance of CoV and one model failed to produce valid predictors. Could indicate parameter selection error: less favorable – the high CoV could indicate high parameter variance, showing more risk to parameter selection error

Sample Answer 3

Since insurer receives data quarterly, is the information received timely and reliable?: not favorable since this is a new line of business and the insurer does not have a very good knowledge of portfolio yet. Also receives claims information on a quarterly basis which may not be timely. Should also verify model 4 to see if error was not due to underlying data.

Claim information source: less favorable – good that data is received quarterly, but third party introduces risks with handoffs and quality

Third party claims staff, less direct control of data/tests: less favorable – third party claims staff gives less control over data/data checks, could result in errors

EXAMINER'S REPORT

Candidates were expected to be able to list the 3 main components of internal systemic risk. A vast majority of candidates were able to do this successfully.

Parts b and c required candidates to tie the facts given in the problem to each of the main components of internal systemic risk. While none of the line/component combinations individually were difficult to provide, it was challenging for many candidates to find specific and relevant examples for all 6 combinations. Candidates were expected to make some of these connections. Familiarity with the potential risk indicators enabled those candidates with higher scores in providing clear and comprehensive responses.

A significant number of candidates attempted to support their given risk indicator with facts not stated in the problem. This is considered a mistake under part c; however, in this situation the applicable part b solution would be acceptable if the candidate stated a general risk indicator listed in the paper even if that general risk indicator was unable to be supported with the given facts.

Part a

SAMPLE ANSWERS AND EXAMINER'S REPORT

With respect to identifying the risk types, Model or Specification error was acceptable however "Process error" was not an acceptable answer.

Also, for the Data error (Data accuracy) risk type, defining data error as solely the risk of having little data or low credibility was not acceptable; however, candidates were not penalized for the inclusion of this statement as a part of a broader explanation.

Parts b and c (Homeowner Specification)

There wasn't a common mistake in these parts. Most candidates correctly identified the number of models tested as an appropriate risk indicator.

Candidates who used the meetings with the claims staff as part of their response needed to state what the benefit of the meetings has from a parameter error perspective. Simply stating "meetings with claims staff" under part b with a more favorable score under part c was not an acceptable response

Another common mistake in this section was using the "long history of the line" as a risk indicator. This is a weak argument for a favorable score on its own and furthermore wasn't a stated fact in the problem.

Similarly, candidates who used the claims adjusting process as a risk indicator needed to support their response. See the rubric for examples.

Parts b and c (Workers Compensation Specification)

There wasn't a common mistake in these parts and most candidates correctly identified one of the possible risk indicators.

Interactions with the third party administrator (TPA) were not stated in the problem, so using the expertise or knowledge sharing of the TPA as support for a risk indicator would be a mistake under part c. As stated above however, acceptable answers under part b would include anything that discusses "best indicators", stable parameters, the value of the parameters selected, etc.

A common mistake was using the volume of workers compensation data as a risk indicator. Merely stating that the data was not credible due to the limited time the company had written the WC line was not sufficient for these parts. Instead candidates needed to discuss the potential for data coding errors and untimely data receipts from the TPA and/or a lack of complete knowledge of the portfolio and consequent misunderstanding of data as potential risk indicators.

SAMPLE ANSWERS AND EXAMINER'S REPORT

QUESTION: 9	
TOTAL POINT VALUE: 2	LEARNING OBJECTIVE: A9: Test assumptions underlying reserve models.
SAMPLE ANSWERS	
<i>Sample Answer 1</i>	
<p>Standard Error should increase over time, oldest to youngest; it does. This is due to the larger reserve values at more recent years Standard error is increasing over time – this is reasonable</p>	
<i>Sample Answer 2</i>	
<p>Coefficient of variation decreases as AY increases, except for the most recent AY. This is good. It decreases since the variability is measured against a higher mean. The last AY has higher coefficient of variation because the parameter uncertainty overpowers process uncertainty. Does CV decrease as AY becomes less mature? In general yes. Also it is reasonable to see an uptick for the most recent year because sometimes the parameter variance increases enough to overpower the generally declining CV ratio</p>	
<i>Sample Answer 3</i>	
<p>CV should decrease in more recent AYs due to influence of incremental claim payments. This test is not passed as CV for AY 2012 is greater than CV for AY's 2010 and 2011 CV should be lower for more recent AY's – but $.403 > .268$, so the model is not reasonable in this sense</p>	
<i>Sample Answer 4</i>	
<p>Standard error of the total reserve should be larger than any individual year, and it is The total standard error should be greater than the standard error for any one period</p>	
<i>Sample Answer 5</i>	
<p>CV of the total reserve should be less than any individual year, and it is not (it is larger than 2011). This should be investigated further CV total should be lower compared to CV in any individual AY. 2011 violates this</p>	
<i>Sample Answer 6</i>	
<p>The mean reserve should show an increasing pattern down the column, which it does Mean unpaid → should increase as we move down the AY's. This occurs, so passes.</p>	

SAMPLE ANSWERS AND EXAMINER'S REPORT

EXAMINER'S REPORT

The candidate was expected to know the diagnostic tests, then apply them to the data.

Relatively few candidates received full credit. Common errors fell into the following four buckets

- Diagnostic tests that weren't accepted as valid response, some common ones:
 - The total standard error should be less than the sum of the individual standard errors: this is expected to be true of the output of the model, but it will also be true of the output of an unreasonable model.
 - Similar responses to prior bullet, but discussing coefficient of variation or sum of squared errors, were also not accepted
 - There were several variations of the following response: "compare the standard deviation to the mean, in general we want the mean to be at least two times the standard deviation." However, a symmetric normal distribution may not be a good approximation to the true distribution of the reserves. This diagnostic would only assess whether the distribution of reserves in the model can be reasonably described as normal, not assess the reasonableness of the model itself.
- No assessment of a correctly described diagnostic test
- Incorrect assessment of a correctly described diagnostic test: one surprising example was related to accepted response 5. The correct diagnostic was described, but failure of AY 2011 not noted
- Diagnostic tests not appropriately described: most common for Accepted Response3: "CV should be high in early accident years and latest year" this response did not describe whether the expectation is to have a decreasing or increasing CV

This question was challenging from the standpoint of synthesizing the tests and applying it to the data, in addition to clearly stating what the diagnostic tests were.

SAMPLE ANSWERS AND EXAMINER'S REPORT

QUESTION 10	
TOTAL POINT VALUE: 1	LEARNING OBJECTIVE: A8: Identify data issues and related model adjustments for reserving models.
SAMPLE ANSWERS	
Part a: 0.5 point	
<i>Sample Answer 1</i>	
<ul style="list-style-type: none">- Can incorporate an a priori opinion regarding the expected ultimate level of losses => this could come from an underwriter (expert), based on his or her knowledge about a change in the quality of risks written (expect experience to be better or worse than in the past).- Could incorporate a prior opinion regarding the loss development factors => here claims manager may be the expert, as he or she may have knowledge about a change to the claims process that would make selected LDFs more appropriate than those calculated in the model.	
<i>Sample Answer 2</i>	
<ul style="list-style-type: none">- The LDF for a certain year and development period can be over-ridden based on expert opinion regarding recent claim process changes.- The LDF along a diagonal can be overridden based upon expert opinion regarding a calendar year effect such as legislative changes impacting all claims after a certain calendar date.	
<i>Sample Answer 3</i>	
<ul style="list-style-type: none">- Can apply expert opinion on a column parameter such as an LDF. Can judgementally pick higher or lower factor based on known changes, such as change in claims philosophy.- Can apply expert opinion on row parameters such as the predicted ultimate loss. Can pick higher or lower estimate based on known changes within the company.	
<i>Other accepted answers:</i>	
<ul style="list-style-type: none">- Actuarial can override LDF factors if not reflective of current exposure set or add additional trend factors if change in inflation, trend, claim litigation will arise in the future.	
Part b: 0.5 point	
<i>Sample Answer 1</i>	
<p>For a gamma distribution, the variance is α/β^2. Choose a small β, get high variance, less weight to B-F estimate and more to chain ladder. Choose a large β, get low variance, more weight to B-F estimate and less to chain ladder.</p>	

SAMPLE ANSWERS AND EXAMINER'S REPORT

Sample Answer 2

The credibility factor Z that gets applied to the chain ladder method is $Z = P/(\beta\phi + P)$. With B being in the denominator, large values of β will lead to small values of Z , and thus less reliance on the chain ladder method. So the first distribution will rely more on the BF than the second, and the second more than the third.

EXAMINER'S REPORT

Part a

The candidate was expected to identify two types of expert opinion that could be used to modify model results.

In order to achieve full credit, the candidate had to identify an issue that an expert may have commentary on (e.g., a claims manager might have input on claim process changes) and how that opinion would/could impact the model (e.g., judgmentally select an LDF rather than relying on model output.)

Many candidates received only partial credit because they did not clearly identify the expert/expert's view but limited their answer to what model parameter would change (e.g., "Could make manual adjustments to empirical age-to-age factors.")

Part b

The candidate was expected to understand the relationship between the β parameter and the relative weight given to the BF vs. Chain-ladder methodologies.

The majority of candidates received full credit for this part.

Generally, candidates who did not receive full credit either had the relationship reversed or simply failed to attempt the question. There were a few candidates who discussed the β parameter and its relationship to credibility and/or variance but did not state the final effect on the weighting of the BF and Chain Ladder.

SAMPLE ANSWERS AND EXAMINER'S REPORT

QUESTION 11	
TOTAL POINT VALUE: 2.25	LEARNING OBJECTIVE: A5: Describe the various sources of risk and uncertainty that are associated with the determination of reserves. Calculate risk margins that consider these sources of risk and uncertainty.
SAMPLE ANSWERS	
Part a: 0.75 points	
Sample LOB: <ul style="list-style-type: none">• Workers Compensation• Liability• Auto• Medical Malpractice	
<i>Sample Answer 1</i> <p>Legislative risk is important for Workers Compensation because law changes can affect benefit levels. If you don't account for this risk, you may not be able to handle increased exposure higher benefit levels.</p>	
<i>Sample Answer 2</i> <p>Workers Comp – there might be changes to benefit limits or items requiring coverage, which could effect in process or prior cases as well as future causing high variability in the reserves.</p>	
<i>Sample Answer 3</i> <p>Legislative risk is important for long-tail line such as Workers Comp. A change in benefit level could significantly impact the pricing/reserving of workers comp and such benefit change could be initiated by the state legislature.</p>	
<i>Sample Answer 4</i> <p>Legislative risk is very important for workers compensation. WC claims are very long tailed and can take a long time to pay out (possibly the life of a person.) Legislative changes to workers comp benefits may affect all open claims, even claims that occurred a long time ago, so reserves for many AYs could increase all at once.</p>	

SAMPLE ANSWERS AND EXAMINER'S REPORT

Sample Answer 5

Medical Malpractice --> Court awards are often limited by caps set by law --> If there is tort reform, could change the cap, which would impact all open claims --> Thus the potential impact is huge. Also, the tort reform could have to do with the statute of limitations for a medical malpractice claims --> if the statute of limitations is extended, could mean more claims.

Part b: 0.75 points

Sample LOB:

- Property
- Homeowners
- Auto
- Earthquake

Sample Answer 1

Event risk (such as cats) is important for private passenger auto (property coverage) since event risk can impact many exposures at once. These risks may be highly correlated in tails between other lines and may be geographical correlated. If not diversified or properly capitalized, this can lead to insolvency.

Sample Answer 2

Property – important because an event like a catastrophe could have a significant impact on premium liabilities and on the solvency of the insurer. This type of risk can be modeled with external cat models for events like earthquake, hurricanes, etc.

Sample Answer 3

Homeowners – Event Risk. Homeowners writers can have many properties in a dense geographical area where one large weather event can affect all properties in the area. Thus, this is an important risk for the HO writers to consider.

Part c: 0.75 points

Sample LOB:

Several LOBs were accepted, the most common were:

- Workers Compensation
- Medical Malpractice
- Liability

Sample Answer 1

WC would be greatly impacted by latent claim risk. Since latent claims take a while to be discovered & WC is a long tailed line of business something like asbestos could be found to make ppl sick & the WC pol would have to pay even though didn't know this risk existed

SAMPLE ANSWERS AND EXAMINER'S REPORT

when policy was written.

Sample Answer 2

Latent – WC – think asbestos or WC occupational hazard type claims. Asbestos claims in particular over past 20 years have shown that have low freq but very very high severity claims have a large impact on estimating WC unpaid claim reserve. So important to capture latent risk for WC else would be missing key component risk.

Sample Answer 3

Latent claim risk is important for workers compensation. For asbestos for example, or other on the job work hazards, it can take years for health effects to be discovered. Insurers must consider the risk of latent claims for WC because the worker will be covered even if exposure to the substance happened a long time ago.

EXAMINER'S REPORT

- Candidates generally scored well with 50% receiving full or nearly full credit.
- Less than 10% had a point or more deducted.

Part a

- The candidate was expected to know **legislative** risk, what LOBs were sensitive, and why legislative risk is important.
- To obtain full credit, candidates were expected to respond with variations of:
 - Legislatures make law which determines what is compensable and statutorily-defined benefits, and thus impact claim/loss frequency, severity, loss cost.
 - Long-tail LOBs are more vulnerable to these changes, as the longer a claim's duration, the longer a claim's frequency, severity, and loss cost can be impacted by legislative change.
 - Legislatures *can* apply changes in statutory benefits that apply retroactively, and thus impact an array of open claims and AYs, which poses additional risk to the insurer.
- Common error made by candidates:
 - Confusing legislative risk with judicial, regulatory, or other government bodies. Legislatures make law and statutes; hence, statutory benefits. The judiciary interprets law and regulators implement law, but they are not the same as legislature.

Part b

- The candidate was expected to know **event** risk, what LOBs were sensitive, and why event risk is important.
- To obtain full credit, candidates were expected to respond with variations of:
 - A single event can trigger insurance coverage on a large number of policies all at once.
 - Property/Auto risks are typically independent (not correlated), but an event can trigger

SAMPLE ANSWERS AND EXAMINER'S REPORT

correlated claims and losses across a range of policies.

- Geographic concentration of risks can generate high frequency (when low frequency is the expectation).

- An event falls in the tail of distribution: low frequency and high severity.

- Consultation of risk models and subject matter experts is wise to consider exposure to event risk.

- Common error made by candidates:
 - Simply using "catastrophe" to define an event.
 - In and of itself, a large loss is not an event.

Part c

- The candidate was expected to know **latent claim** risk, what LOBs were sensitive, and why latent claim risk is important.
- To obtain full credit, candidates were expected to respond with variations of:
 - At policy inception, latent risks are unknown. These risks are not explicitly priced for and contract language is not explicitly aware of the exposure risk.
 - Latent risks take a long time to be discovered.
 - Latent risks are low frequency and typically emerge with high severity.
 - If a company is not adequately pricing and reserving for latent risks, then the company could be in adverse financial position.
- Common error made by candidates:
 - "Asbestos" is not a LOB.
 - Asbestos is an example of latent claim risk, but "asbestos" is not sufficient to explain why latent claim risk is important.
 - Just because a claim takes time to be reported does not mean that it is "latent".

SAMPLE ANSWERS AND EXAMINER'S REPORT

QUESTION 12	
TOTAL POINT VALUE: 1.75	LEARNING OBJECTIVE: A14: Forecast Premium Reserves.
SAMPLE ANSWERS	
Part a: 0.5 point	
<p>Several reasons were accepted. For full credit, the candidate could either list and briefly describe at least 2 items, or list 1 item with a more detailed explanation. Partial credit was provided for only listing 1 item without a detailed explanation.</p> <p>We accepted:</p> <ul style="list-style-type: none">- Tax Multiplier- Loss Conversion Factor- Basic Premium- Fact that few of the losses are already capped by the first adjustment period <p><i>Sample Answer 1</i></p> <p>Premium at the first adjustment includes the basic premium, which is the amount charged even if no losses emerge. Also, losses are not capped as much at the first adjustment, so multiplying by the loss conversion factor and tax multiplier can cause the PDL ratio to be greater than 1.0.</p> <p><i>Sample Answer 2</i></p> <p>In the first incremental period the premium includes an amount related to expenses and insurance charges (Basic Premium) in excess of the amount driven by losses. The effects of the Tax Multiplier and Loss Conversion Factor also contribute to the incremental premium being greater than the incremental losses at this point.</p>	
Part b: 0.5 point	
<p>We awarded credit for describing what could be causing 0 incremental premium at the 3rd adjustment, and also for explaining what would have been different about the 4th adjustment to cause the positive incremental premium.</p> <p>The most common answer was to say that the loss development at the 3rd adjustment was on a loss that had already reached the per accident limit, and the loss at the 4th adjustment was either on a new claim or one that had not yet reached the limit. We also accepted alternative solutions, including changes to the terms of the policy.</p> <p><i>Sample Answer 1</i></p> <p>It is possible that the 15,000 incremental loss in the 3rd adjustment is for a claim that has already breached the per-accident limit, so it generates 0 capped loss at the 3rd adjustment, and thus 0 incremental premium.</p>	

SAMPLE ANSWERS AND EXAMINER'S REPORT

The loss in the 4th adjustment could be from another claim which has not breached the per-accident limit, and so it will generate incremental premium.

Sample Answer 2

If all development in the third period occurred out of the loss limits, it is possible for the incremental premium to equal 0. For the incremental premium to be greater than 0 in the 4th period, it means that the development in the 4th period was within the loss limits.

Part c: 0.75 point

There were 3 main points that were needed to get full credit.

- Losses on claims below the cap decreased
- Losses on claims above the cap increased
- The increase in loss above the cap was greater than the decrease in loss below the cap, which caused the incremental premium to drop despite the fact that incremental losses were positive.

Sample Answer 1

Some incremental loss amount greater than 5k that was already outside plan parameters offset by slightly lesser negative incurred development on claims still inside the plan parameters, which would bring negative premium development. In short, losses in total increased but capped losses decreased.

Sample Answer 2

By the 5th adjustment, we may be seeing positive development only in losses that have been capped already, whereas claims at lower levels may be settling at amounts below what had previously been reserved. Therefore there is upward loss development outside of loss limits, and downward, but lower, loss development within limits. This would cause negative premium for the loss within the cap and no additional premium for loss above the cap.

EXAMINER'S REPORT

Candidates struggled a bit with this question and ran into trouble when they did not provide complete explanations, or where they ignored details given in the problem (by providing explanations that were not possible based on the numbers given).

Part a

Candidates did best on this part of the question. Candidates needed to know how the incremental premium is calculated at the 1st adjustment, and be able to explain how portions of that calculation could cause the PDL ratio to be above 1.0 at that point. To get full credit, the candidate needed to either go into detail on one of the potential reasons, or briefly describe more than one. The most common error was just naming one element of the formula, without discussing what it is or why it contributes to PDL ratio being greater than 1.0.

SAMPLE ANSWERS AND EXAMINER'S REPORT

Part b

Candidates struggled a bit on this part. Candidates needed to understand the various limits that could prevent the incremental losses from influencing the premium. To get full credit, the candidate needed to provide an explanation both of what could be causing the phenomenon at the 3rd adjustment, and what would have changed about the 4th adjustment. The most common error was not explaining the 4th adjustment at all.

Part c

Candidates performed worst on this part. The required understanding for this part was very similar to what was needed for part b. To get full credit, the candidate needed to explain which types of loss (relative to the caps) were increasing, and which were decreasing. They also needed to point out the relationship between the two types (which was greater). One of the more common errors was not pointing out that the increases had to outweigh the decreases. We accepted many ways of stating or even implying this relationship, but some candidates did not point it out at all. Other candidates ignored the caps completely, only stating that "losses went down, so premium was returned."

SAMPLE ANSWERS AND EXAMINER'S REPORT

QUESTION 13	
TOTAL POINT VALUE: 2	LEARNING OBJECTIVE: A11: Compare and contrast reinsurance and primary reserving procedures.
SAMPLE ANSWERS	
<p>The question requested candidates to provide 4 items, which for the most part came from a textbook list of 7 options. The sample answers below blend various candidate responses together in order to obtain the different possible solutions that were observed:</p>	
<p><i>Sample Answer 1</i></p> <ul style="list-style-type: none">• Report lags are longer – Claim will not be reported to reinsurer until it reaches a certain size threshold. Also, claims must go through insurers' processing systems, may be through an intermediary, and the input to the reinsurers' system all of which can add delay.• Reporting patterns are not homogeneous – Reinsurance can cover many lines of business, at different attachment points, plus there are a wide variety of contract types (treaty, XS, quota share) and terms (loss corridors, different treatment of ALAE) so getting a homogenous exposure group is often difficult.• Industry statistics are not very helpful due to heterogeneity – Schedule P "excess casualty" line includes many lines of business and is inconsistent across companies, also includes a blend of attachment points.• Persistent upward development – Due to (1) primary companies tend to under reserve for LAE; and (2) severity trends impact XS layers more.	
<p><i>Other sample solutions for one of the four items:</i></p> <ul style="list-style-type: none">• Lack of knowledge about the exposures – The reinsurer is less knowledgeable about the exposures than the cedants. Often times, reinsurers are only provided summary reporting detail containing loss and premium information, but lacking other details.• IT and coding system issues – Harder to code reinsurance data since there is such a variety. In addition, the nature of what needs to be coded usually changes more rapidly than the IT and coding systems are updated.• The reserve to surplus ratio for reinsurers is very high and it may be hard to convince management of the level of reserves required.	
EXAMINER'S REPORT	
<p>The question was worded nearly identically to Learning Objective A11, "Compare and contrast reinsurance and primary reserving procedures." In addition, the text included for this section specifically listed 7 items and explanations.</p> <p>The question requested candidates to briefly describe four ways that reinsurance reserving is more challenging than primary reserving. Approximately 65% of candidates received full credit, and for the most part provided model solutions very similar to the items listed in the textbook.</p> <p>Candidates were expected to provide four items, and as detailed above the majority of candidates</p>	

SAMPLE ANSWERS AND EXAMINER'S REPORT

received full credit. Candidates were expected not only to simply list the item, but also provide a brief description of how or why it is relevant.

In general, when points were deducted it was due to either: (a) showing less than four items; (b) candidate only providing a brief overview of the item and not providing an additional description; or (c) candidate providing two items and descriptions that were essentially the same.

SAMPLE ANSWERS AND EXAMINER'S REPORT

QUESTION 14	
TOTAL POINT VALUE: 2	LEARNING OBJECTIVE: A13: Calculate ceded loss reserves using appropriate methods.
SAMPLE ANSWERS	
<i>Sample Answer 1</i>	
Step 1 – Calculate the reporting lags	
Report Lags:	
2010 = $1/1.25 = 80\%$	
2011 = $1/1.60 = 62.5\%$	
2012 = $1/2.00 = 50\%$	
2013 = $1/2.50 = 40\%$	
Step 2 – Calculating the Cape Cod ELR	
Cape Code ELR = Total <u>Aggregate</u> Reported Loss / sumproduct of <u>Adjusted Premium</u> multiplied by <u>lag pattern</u>)	
Cape Code ELR = $9,500 / (5,000 \times 0.80 + 5,500 \times 0.625 + 6,000 \times 0.50 + 6,500 \times 0.40) = 72.9\%$	
Step 3 – Calculate the IBNR	
IBNR = ELR \times ARPP \times (1 – Report Lag)	
2011 IBNR = $0.729 \times 5,500 \times 0.375 = 1,504$	
Step 4 – Calculate the loss ratio	
2011 Loss Ratio = $(\text{Aggregate Reported Loss}_{2011} + \text{IBNR}_{2011}) / \text{Earned Risk Pure Premium}_{2011}$	
2011 Loss Ratio = $(2,500 + 1,504) / 4,500 = 89.0\%$	

SAMPLE ANSWERS AND EXAMINER'S REPORT

Sample Answer 2

AY	Adjusted Premium (1)	CLDF (2)	% Reported (3) = 1/(2)	Used Up Premium (4)=(1)×(3)	Reported Loss (5)
2010	5,000	1.25	80.0%	4,000.0	3,000
2011	5,500	1.60	62.5%	3,437.5	2,500
2012	6,000	2.00	50.0%	3,000.0	2,500
2013	6,500	2.50	40.0%	2,600.0	1,500
Total	23,000			13,037.5	9,500

Expected Loss Ratio = Reported Loss / Used Up Premium = 9,500 / 13,037.5 = 72.9%

AY 2011 Ultimate Loss Ratio

= (Reported Loss + Adjusted Premium × ELR × (1.00 - % Reported)) / Earned Risk Pure Premium

= (2,500 + 5,500 × .729 × (1.00 - .625)) / 4,500 = 89.0%

Sample Answer 3

Expected Loss Ratio = Reported Loss / Used Up Premium

= 9,500 / (6,500/2.50 + 6,000/2.00 + 5,500/1.60 + 5,000/1.25) = 72.9%

AY 2011 Ultimate Loss

= Reported Loss + Adjusted Premium × ELR × (1.00 - 1/LDF)

= 2,500 + 5,500 × .729 × (1.00 - 1/1.60)

= 4,002.9

AY 2011 Ultimate Loss Ratio = AY 2011 Ultimate Loss / Earned Risk Pure Premium

= 4,002.9 / 4,500 = 89.0%

EXAMINER'S REPORT

The average score for this question was quite high. Approximately 77% of the candidates received full or nearly full credit.

Common mistakes:

- Using the wrong premium base when calculating the ultimate loss ratios. Many candidates used the Adjusted Premium instead of the Earned Risk Pure Premium.
- Candidates calculated the expected loss ratio correctly but then used an expected loss ratio method instead of the Bornhuetter-Ferguson approach (Note: This produces a very similar ultimate loss ratio as the correct answer but it is just by coincidence. $ELR \times \text{Adjusted Premium} = 72.9\% \times 5,500 = 4,007.7$ which translates into an 89.1% ultimate loss ratio $[4,007.7 / \text{Earned Risk Pure Premium}]$.)
- Candidates calculated an all accident year loss ratio instead of just accident year 2011.

SAMPLE ANSWERS AND EXAMINER'S REPORT

QUESTION 15	
TOTAL POINT VALUE: 1.5	LEARNING OBJECTIVE: B3: Value the equity of a firm using comparative or relative valuation methods based on multiples of selected financial variables obtained from either peer companies or from underlying fundamentals.
SAMPLE ANSWERS	
<i>Sample Answer 1 (MEAN):</i>	
Step 1: Calculate average P-E ratios based on peer companies by product line	
WC: P-E ratio = $(21.9 + 18.5 + 19.6) / 3 = 20.0$	
CP: P-E ratio = $(16.4 + 19.7 + 17.9) / 3 = 18.0$	
CA: P-E ratio = $(13.9 + 17.2 + 14.8) / 3 = 15.3$	
Step 2: Calculate the price of each segment for the company.	
Price = P-E Ratio \times Latest Fiscal Year Earnings	
WC: Price = $20.0 \times 636 = \$12,720K$	
CP: Price = $18.0 \times 318 = \$5,724K$	
CA: Price = $15.3 \times 297 = \$4,544K$	
Step 3: Calculate total price of the company	
Price = $12,720 + 5,724 + 4,544 = \$22,988K$	
Step 4: Calculate Total Book Value	
Total Book value = $8,350 + 5,860 + 2,210 = 16,420$	
Step 5: Calculate Price to Book Value Ratio	
Price to Book Value Ratio = $22,988 / 16,420 = 1.40$	
<i>Sample Answer 2 (MEDIAN):</i>	
Step 1: Select median P-E ratio of peer companies by product line	
WC: P-E ratio = 19.6	
CP: P-E ratio = 17.9	
CA: P-E ratio = 14.8	

SAMPLE ANSWERS AND EXAMINER'S REPORT

Step 2: Calculate the price of each segment for the company.

Price = P-E Ratio \times Latest Fiscal Year Earnings

WC: Price = $19.6 \times 636 = \$12,466\text{K}$

CP: Price = $17.9 \times 318 = \$5,692\text{K}$

CA: Price = $14.8 \times 297 = \$4,396\text{K}$

Step 3: Calculate total price of the company

Price = $12,466 + 5,692 + 4,396 = \$22,554\text{K}$

Step 4: Calculate Total Book Value

Total Book value = $8,350 + 5,860 + 2,210 = 16,420$

Step 5: Calculate Price to Book Value Ratio

Price to Book Value Ratio = $22,554 / 16,420 = 1.37$

EXAMINER'S REPORT

Candidates performed very well on average. Candidates needed to know how to value the firm using financial information from peer companies. Some candidates calculated the P-BV of each 3 lines separately and then summed them to get to the company P-BV. A few others had difficulty figuring out how to use the data given (P/E ratios of competitors) to get to the P/BV of the firm.

SAMPLE ANSWERS AND EXAMINER'S REPORT

QUESTION 16																					
TOTAL POINT VALUE: 2	LEARNING OBJECTIVE: B2: Value the equity of a P&C insurer based on its expected future dividends, its free cash flow to equity, or its expected abnormal earnings																				
SAMPLE ANSWERS																					
<i>Sample Answer 1</i>																					
$g = 0.5$ $r_f = 0.25$ $k = r_f + \beta(E(r_m) - r_f)$ $= 0.25 + 1.25 \times 0.06$ $= 0.1$ $\text{Terminal value} = \frac{2016 \text{ dividend} \times (1 + g)}{k - g} = \frac{675,000 \times 1.05}{0.1 - 0.05} = 14,175,000$ $\text{Total Value} = \frac{450,000}{1 + k} + \frac{500,000}{(1 + k)^2} + \frac{675,000}{(1 + k)^3} + \frac{\text{Terminal Value}}{(1 + k)^3}$ $= 409,091 + 413,223 + 507,137 + 10,649,887$ $= 11,979,338$																					
<i>Sample Answer 2</i>																					
$k = r_f + \beta(r_m - r_f) = 0.025 + 1.25(0.06) = 0.1$ $g = 0.05$ <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;">CY</th> <th style="text-align: left;">DIV</th> <th style="text-align: left;">PV Factor</th> <th style="text-align: left;">PV(DIV)</th> </tr> </thead> <tbody> <tr> <td>2014</td> <td>450,000</td> <td>1/1.1=0.9091</td> <td>409,091 = 450,000 × 0.9091</td> </tr> <tr> <td>2015</td> <td>500,000</td> <td>1/1.1²=0.8264</td> <td>413,223</td> </tr> <tr> <td>2016</td> <td>675,000</td> <td>0.7513</td> <td>507,137</td> </tr> <tr> <td>Total</td> <td></td> <td></td> <td>1,329,451</td> </tr> </tbody> </table> $TV = \frac{DIV_{16}(1 + g)}{k - g} = \frac{675,000(1 + 0.05)}{0.1 - 0.05} = 14,175,000$ $PV(TV) = \frac{14,175,000}{1.1^3} = 10,649,887$ $\text{Total Value} = 10,649,887 + 1,329,451 = 11,979,338$		CY	DIV	PV Factor	PV(DIV)	2014	450,000	1/1.1=0.9091	409,091 = 450,000 × 0.9091	2015	500,000	1/1.1 ² =0.8264	413,223	2016	675,000	0.7513	507,137	Total			1,329,451
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Total			1,329,451																		
EXAMINER'S REPORT																					
<p>This question is a commonly asked question that stems directly from Learning Objective B2, Knowledge Statement (a) – “Dividend Discount Model.” Approximately 82% of candidates received full credit, and for the most part provided model solutions very similar to the items listed in the textbook.</p> <p>While the large majority scored perfect, the minor mistakes that we did see occur were: rounding errors, no labeling of \$000's, and calculation errors.</p>																					

SAMPLE ANSWERS AND EXAMINER'S REPORT

In addition, there was a common error where candidates calculated an incorrect discount rate using the CAPM formula of 6.875% instead of the correct 10.0%. In nearly all of these cases the remainder of the solution was correct and the candidates received only a minor deduction for the initial error.

SAMPLE ANSWERS AND EXAMINER'S REPORT

QUESTION 17																										
TOTAL POINT VALUE: 1.5	LEARNING OBJECTIVE: B1: Calculate the effect of loss and expense reserve requirements and regulatory or rating agency capital requirements on the free cash flow to equity for a P&C insurer																									
SAMPLE ANSWERS																										
Part a: 1 point																										
<i>Sample Answer 1</i>																										
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	<p>For 2016 Beg Equity = $3,000,000 \times (1.05)^2 = 3,307,500$ Increase in Required Capital = $3,307,500 \times (.05) = 165,375$ FCFE = Net Income - Increase in Capital = $550,000 - 165,375 = 384,625$</p>																									
<i>Sample Answer 2</i>																										
	<table border="1"> <thead> <tr> <th>Yr</th> <th>Beg Req(000s)</th> <th>Req Cap↑(000s)</th> <th>NI(000s)</th> <th>FCFE=NI↑Cap</th> </tr> </thead> <tbody> <tr> <td>14</td> <td align="right">3,000</td> <td></td> <td></td> <td></td> </tr> <tr> <td>15</td> <td align="right">3,150</td> <td></td> <td></td> <td></td> </tr> <tr> <td>16</td> <td align="right">3,307.5</td> <td align="right">165.375</td> <td align="right">550</td> <td align="right">384.625</td> </tr> <tr> <td>17</td> <td align="right">3,472.875</td> <td></td> <td></td> <td></td> </tr> </tbody> </table>	Yr	Beg Req(000s)	Req Cap↑(000s)	NI(000s)	FCFE=NI↑Cap	14	3,000				15	3,150				16	3,307.5	165.375	550	384.625	17	3,472.875			
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17	3,472.875																									
Part b: 0.5 point																										
<i>Sample Answer 1</i>																										
	<p>The formula for Free Cash Flow to Equity (FCFE) = Net Income + Non-cash Charges – Net Working Capital (NWC)I – Increase in Required Capital + Net Borrowing</p> <p>The reserves would appear in both the Non-cash charges and Increase in Required Capital. These are offsetting, so the loss and LAE reserves do not impact the FCFE.</p>																									
<i>Sample Answer 2</i>																										
	<p>The change in loss and LAE reserves are accounted for twice. It is accounted for in the Net Income originally and then in the capital requirement increase, which both offset each other. Thus changes in reserves do not affect FCFE.</p>																									
EXAMINER'S REPORT																										

SAMPLE ANSWERS AND EXAMINER'S REPORT

Part a

The candidate is expected to know Free Cash Flow to Equity for a P&C insurer.

To get full credit, the candidate has to assume all free cash flow is paid to shareholders. In general, candidates performed well in this part with 78% receiving full credit. Some candidates calculated beginning equity based on previous years beginning equity plus net income.

Part b

The candidate is expected to know FCFE formula and show how Loss and LAE reserves are reflected in the formula.

To get full credit, the candidate has to mention the offsetting effect in different parts of the formula. Over half of the candidates received full credit. Some candidates misinterpreted the question and stated that Net income for 2016 is forecasted so reserve change in 2014 has no impact.

Errors included referencing that increase in reserves only affected certain calendar years, referencing reserves as debt, referencing reserves being charged twice in the FCFE formula, and determining net income was based on a forecast.

SAMPLE ANSWERS AND EXAMINER'S REPORT

QUESTION 18	
TOTAL POINT VALUE: 4	LEARNING OBJECTIVE: C1: Demonstrate how insurance and financial risk can be analyzed quantitatively. C4: Demonstrate the properties of various risk measures and their limitations.
SAMPLE ANSWERS	
Part a: 0.5 point	
<i>Sample Answer 1</i>	
<p>Market Risk is the risk of loss due to changing asset and liability values as a result of changing market prices. Credit risk is the risk of loss due to a change in credit quality (downgrade or default) of a counterparty.</p>	
<i>Sample Answer 2</i>	
<p>Market risk – the risk that changes in financial variables such as interest rate will change the value of assets and liabilities. Credit risk – the risk that a party will be unable to fulfill its financial obligations.</p>	
Part b: 1.5 points	
<i>Sample Answer 1</i>	
<p>Concentration Risk – lots of assets w/same issuers (think 100% Disney bonds) or same quality (all BBB); Reinvestment Risk – risk that when principal is paid, will not earn target return on new money (i.e. bonds with 6% yield mature and now rate for bonds of same quality is 2%); Equity/Property Risk – Risk of change or fluctuations in value of stocks & property (stock market crash '08 and housing crisis)</p>	
<i>Sample Answer 2</i>	
<p>Interest Rate Risk – the risk due to fluctuation of interest rates; Basis risk – the risk due to yields on different debt instruments not moving together; Assets/Liabilities Mismatch Risk – the risk due to the mismatch of the timing of the assets cash flow and the liabilities cash flow.</p>	
Part c: 1 point	
<i>Sample Answer 1</i>	
<p>Market/Asset – market risk due to reduction in value of financial instruments (e.g. equity); Market/Liability – market risk if insurance liability is discounted (e.g. using risk-free rate), then movement in risk-free rate would impact liabilities; Credit/Asset – credit risk could affect value of corporate/government bonds if the issuer defaults or gets downgraded; Credit/Liability –reinsurance recoverables may not be recoverable if reinsurer defaults, thus increasing net liability.</p>	

SAMPLE ANSWERS AND EXAMINER'S REPORT

Sample Answer 2

Market risk affects stock prices and bond prices, which are assets held, but also affects liabilities through inflation. Credit risk affects bonds held (will company forego coupon payment or default on all obligations) but also affects liabilities in that insureds may not be able to pay the portion ceded to them (primary insurer is then liable).

Part d: 1 point

Sample Answer 1

Assuming complete independence (0% correlation): $\sigma_{\text{total}}^2 = \sum \sigma_{\text{factor}}^2$ so total risk = $(100^2 + 40^2 + 40^2 + 10^2)^{0.5} = 115.326$. Assuming 100% correlation: $\sigma_{\text{total}}^2 = (\sum \sigma_{\text{factor}})^2$ so total risk = $[(100 + 40 + 40 + 10)^2]^{0.5} = 190$. Total range = [115.326, 190]

Sample Answer 2

The range for total risk would be from zero correlation to perfect correlation. Min risk = $(100^2 + 40^2 + 40^2 + 10^2)^{0.5} = 115.326$. Max risk = $100 + 40 + 40 + 10 = 190$. Range is (115.3, 190)

Sample Answer 3

Total independent = $(100^2 + 40^2 + 40^2 + 10^2)^{0.5} = \115.33M . Total dependence = $100 + 40 + 40 + 10 = \$190\text{M}$. Between ($\115.33M, $\$190\text{M}$)

EXAMINER'S REPORT

Part a

The candidate was expected to be able to describe types of insurer risks. Most candidates received full credit and those that didn't usually stated that there was a risk that the value of assets and liabilities would change but failed to provide a reason for the change (e.g., financial variables).

Part b

The candidate was expected to be able to describe types of market risk. The majority of candidates received full credit. Those that lost partial credit did so because they used examples of another insurer risk (e.g., credit risk, underwriting risk), forgot to identify the market risk, or duplicated the description of Equity/Property risk.

Part c

This question required the candidate to take a learning objective and be able to apply it with a real world example. The candidate was expected to provide four specific items: an example of both an asset and a liability, and a description of the direct impact from both a market risk and a credit risk. Although many candidates were able to use their answer from part b. to help identify a real world example, other candidates simply stated that market risk would change the value of assets and liabilities but failed to provide an actual example or reason why they would change. Another common error was a candidate citing asset/liability mismatch risk but this was not an acceptable answer as it does not have a direct impact to the value of liabilities.

Part d

The candidate was expected to recognize that the maximum risk assumes full

SAMPLE ANSWERS AND EXAMINER'S REPORT

correlation/dependency between all of the risks and that the minimum risk would occur when the risks have no correlation or are independent of each other. Most candidates had some difficulty with this question. One common error was a candidate using the more conservative equation IAA provided in Appendix E, section 8.18, where IAA specifically assumed the best diversification can be approximated by a correlation coefficient of 0.5. Another common error was a candidate offsetting the risks which was not a valid approach since the question clearly stated "assuming non-negative correlations".

SAMPLE ANSWERS AND EXAMINER'S REPORT

QUESTION 19	
TOTAL POINT VALUE: 2.25	LEARNING OBJECTIVE: C1: Demonstrate how insurance and financial risk can be analyzed quantitatively
SAMPLE ANSWERS	
<u>Credit quality</u> (also accepted counterparty risk, default risk, and credit rating)	
<i>Sample Answer 1</i>	
<p>Credit quality of an investment or an enterprise refers to the probability that the issuer will meet all contractual obligations. This assessment normally occurs at both the initial investment and at each renewal point. One of the common measurements used in assessing credit quality is the rating assigned to the issuer. A variety of ratings agencies provide these assessments to the public, giving the investor a perceived level of confidence in the issuer's ability to make good on the repayment schedules to which it is committed.</p>	
<i>Sample Answer 2</i>	
<p>The credit risk from credit quality is higher for the technology company bonds according to the credit ratings.</p>	
<u>Maturity</u> (also accepted time horizon or duration)	
<i>Sample Answer 1</i>	
<p>The longer the term to maturity of an investment, the longer even a high quality issuer has to potentially deteriorate.</p>	
<i>Sample Answer 2</i>	
<p>The credit risk from maturity is higher for the bank bonds since they have a longer maturity.</p>	
<u>Concentration by industry</u> (also accepted concentration by type)	
<i>Sample Answer 1</i>	
<p>Conditions that trigger credit events have a tendency to impact on the entire economy simultaneously. Within this general characteristic, however, the impact of economic development often varies between sectors of the economy. Within a sector, however,</p>	

SAMPLE ANSWERS AND EXAMINER'S REPORT

there tends to be uniformity between the entities participating in that sector. Degrees of separation within a sector will exist, but these are on a smaller scale than those that normally occur between sectors.

Sample Answer 2

The credit risk from concentration by industry is reduced by choosing bonds from companies in two unrelated industries.

Concentration by geography (also accepted concentration by region/country)

Sample Answer 1

Credit risk has been shown to carry a large degree of contagion. Periods of relatively few credit events are followed by periods where default experience is extremely high. Similarly, economically depressed regions tend to produce high levels of default experience in comparison with more prosperous areas. That these regions can and do change over time creates a challenge to the process of credit risk analysis.

Sample Answer 2

There is some credit risk from concentration by geography since all of the bonds are from American companies. OR The credit risk from concentration by geography is reduced by investing in bonds from a national rather than regional bank.

Size of expected loss

Sample Answer 1

The size of loss due to a credit event can vary widely, from loss of some or all of the return on an investment to loss of some, or all, of the inherent principal. Losses can also occur from a delay in the timing of a scheduled payment, causing either a loss of return during the deferral period, a reduction in available reinvestment rate during the deferral period, or both. When a scheduled payment is delayed for any reason, there is also the potential for an associated loss if the payment were needed to match a scheduled outflow. The investor would then be required to make good on its obligation by borrowing or selling other assets. They might need to delay payment of their own scheduled obligation, possibly incurring a penalty.

SAMPLE ANSWERS AND EXAMINER'S REPORT

Sample Answer 2

There is not enough information to determine the amount of credit risk from size of expected loss.

EXAMINER'S REPORT

- Candidates were expected to identify, briefly describe, and comment on the application of three key drivers of credit risk to the bond portfolio.
- Most candidates were successful in identifying, describing, and commenting on at least 2 key drivers. Many candidates successfully identified and commented on 3 key drivers, with the descriptions of the drivers being absent or insufficient.
- Additional common responses and remarks:
 - Downgrade risk was a very common incorrect response. Partial credit was given when the response included an appropriate discussion of maturity.
 - While not explicitly identified in the reading, credit was granted for responses describing lack of diversification with respect to the number of issuers.
 - Some candidates listed sovereign risk as a key driver, and this was considered an incorrect response. However, partial credit was given if this response included an appropriate discussion relating to being concentrated in the US.
 - Settlement risk was another incorrect response given by some candidates. Partial credit was given when the response included an appropriate discussion of maturity. Payment lag was not acceptable. Discussions of interest rate or liquidity risk were not accepted since this is a separate issue from credit risk.
 - Descriptions and comments for “size of expected loss” pertaining to the size of the bond values were not accepted, as this pertains more to portfolio concentration risk with respect to lack of diversification.

SAMPLE ANSWERS AND EXAMINER'S REPORT

QUESTION 20	
TOTAL POINT VALUE: 1.5	LEARNING OBJECTIVE: C2: Describe the use of enterprise-wide risk modeling and aggregation techniques; and C3: Evaluate and select appropriate models to handle diverse risks, including stochastic approaches
SAMPLE ANSWERS	
Part a: 1 point	
<i>Sample Answer 1</i>	
<p>Auto and homeowners aren't typically correlated. If someone gets into an auto accident, the majority of the time it's with another car, not a house. However, during a hurricane, there will be many homes and cars destroyed, causing these two lines to be correlated.</p>	
<i>Sample Answer 2</i>	
<p>Mortgage insurance in Canada and Workers' Compensation in U.S. are uncorrelated in normal circumstances because the two lines are in different industries, claims are triggered by different events, and not in the same geographical area, facing different policyholders with minimal interaction.</p> <p>In the event of global economic recession, the unemployment rate goes up and hence mortgage defaults as well as increased claims on Workers' Compensation from workers avoiding layoffs and to get income.</p>	
Part b: 0.5 point	
<i>Sample Answer 1</i>	
<p>We could use a copula to join two marginal distributions into a joint distribution. Based on our selection of the copula, we can choose how we want the dependencies to vary across the entire distribution.</p>	
<i>Sample Answer 2</i>	
<p>Find a copula, such as the HRT, to combine the distribution of commercial property risks and the distribution of Workers' Compensation risks. This copula will account for high correlation in the tails but will not show much correlation in the middle of the distribution.</p>	
EXAMINER'S REPORT	
<p>Generally candidates performed well on this question. Most candidates were able to answer both parts well.</p>	
Part a	
<p>Most candidates were able to identify two uncorrelated lines of insurance and describe an event that would lead to correlation of the two lines of insurance.</p> <p>Candidates generally lost points when they did not describe how two lines are ordinarily uncorrelated. Some candidates lost points by not fully describing how an event can cause an increase in correlation. A minority of candidates also lost points when they wrote "catastrophe" or</p>	

SAMPLE ANSWERS AND EXAMINER'S REPORT

"extreme event", instead of specifying the event (e.g., earthquake).

Part b

Overwhelmingly, candidates responded with "copula". Candidates lost points on this part either by not fully describing a copula or by giving a wrong description of a copula.

SAMPLE ANSWERS AND EXAMINER'S REPORT

QUESTION 21

TOTAL POINT VALUE: 5

LEARNING OBJECTIVE: C2: Describe the use of enterprise-wide risk modeling and aggregation techniques; and C3: Evaluate and select appropriate models to handle diverse risks, including stochastic approaches

SAMPLE ANSWERS

Part a: 1.5 points

Sample Answer 1

$$\rho = \frac{\sum (X_i - \bar{X})(Y_i - \bar{Y})}{\sqrt{\sum (X_i - \bar{X})^2 \times \sum (Y_i - \bar{Y})^2}}$$

Frequency	Severity	$X_i - \bar{X}$	$Y_i - \bar{Y}$
0.2	15,000	0.00	3,000
0.05	25,000	-0.15	13,000
0.4	5,000	0.20	-7,000
0.25	3,000	0.05	-9,000
0.1	12,000	-0.10	0

\bar{X}	0.2
\bar{Y}	12,000
$\sqrt{\sum (X_i - \bar{X})^2}$	0.0750
$\sqrt{\sum (Y_i - \bar{Y})^2}$	308,000,000
$\sum (X_i - \bar{X})(Y_i - \bar{Y})$	-3,800

$$= \frac{-3,800}{\sqrt{0.0750 \times 308000000}} = -79\%$$

Sample Answer 2

$$\rho = \frac{\overline{XY} - \bar{X}\bar{Y}}{\sigma_X \sigma_Y}$$

- $\bar{X} = 0.2$
- $\bar{Y} = 12,000$
- $\overline{XY} = 1,640$
- $\sigma_X = 0.1225$
- $\sigma_Y = 7,848.57$

SAMPLE ANSWERS AND EXAMINER'S REPORT

$$\rho = \frac{1,640 - 0.2 \times 12,000}{0.1225 \times 7,848.57} = -79\%$$

Part b: 1.5 points

Sample Answer 1

$$\tau = 1 - \frac{4Q}{N \times (N - 1)}$$

Reordered		Rank (F)	Rank (S)	Swap 1	Swap 2	Swap 3	Swap 4	Swap 5	Swap 6	Swap 7	Swap 8	
0.05	25,000	1		5	3	3	3	3	3	3	1	1
0.1	12,000	2		3	5	4	4	4	1	1	3	2
0.2	15,000	3		4	4	5	1	1	4	2	2	3
0.25	3,000	4		1	1	1	5	2	2	4	4	4
0.4	5,000	5		2	2	2	2	5	5	5	5	5

Q	8
N	5
$(N - 1)$	4

$$= 1 - \frac{4 \times 8}{5 \times 4} = -60\%$$

Sample Answer 2

Frequency	Severity	Concordant	Ddiscordant
Rank	Rank		
1	5	1	3
2	3		3
3	4	1	1
4	1		1
5	2		
Total		2	8

$$\begin{aligned} \text{Tau} &= (\text{Concordant Pairs} - \text{Discordant Pairs}) / (\text{Concordant Pairs} + \text{Discordant Pairs}) \\ &= (2 - 8) / (2 + 8) = -0.6 \end{aligned}$$

Part c: 1.5 points

Sample Answer 1

It summarizes the dependence in a single number; as such, it doesn't "reveal dependencies that vary along the distributions, such as dependency in one or both tails but not in the middle of the distribution."

Sample Answer 2

It "is heavily influenced by outlying claims with large residuals", because it relates the values of the distributions with weights proportional to the squared residuals.

SAMPLE ANSWERS AND EXAMINER'S REPORT

Sample Answer 3

It depends on numerical values, not just the relation between the distributions, i.e. it is not an ordinal measure.

Sample Answer 4

It is not invariant under all monotone transformations. Applying certain nonlinear monotone functions to the underlying data will change the correlation statistic.

Part d: 0.5 point

Sample Answer 1

The Kendall statistic also summarizes the dependence in a single number, so it does not address this weakness of the Pearson correlation.

Sample Answer 2

The Kendall statistic weights by the number of swaps (not the square) – as such it isn't as heavily influenced by outlying data points

Sample Answer 3

It is ordinal, as opposed to cardinal; as such it relates the quantiles, not the values, of the distributions

Sample Answer 4

It is invariant under all monotone transformations, as these functions do not change the order of the data points.

Part e: 0.5 point

Advantage Sample Answer 1

Scatterplots show how dependency may change along the distribution, while the two analytical measures calculate dependency over the entire distribution.

Advantage Sample Answer 2

Displays the correlation at different points of the distribution, whereas Pearson's and Kendall's only generate one value for the entire distribution.

SAMPLE ANSWERS AND EXAMINER'S REPORT

Disadvantage Sample Answer 1

Scatterplots are subjective to the person viewing them – we may imagine relations where none exists, as our eyes see patterns in random dots.

Disadvantage Sample Answer 2

Viewers of scatterplots may confuse patterns from random fluctuation to be a dependency. Example, the ancient Greeks saw constellations among stars in the sky, joining random star positions into figures.

Disadvantage Sample Answer 3

Scatterplots of multivariate distributions portray the marginal distributions along with the dependency among the distributions. One might confuse the shape of marginal distributions with the type of dependency.

EXAMINER'S REPORT

This question requires candidates to calculate and understand basic correlation measures and concepts. Candidates scored very well on this question and generally demonstrated strong command of the material. Common mistakes were largely calculation errors or incomplete written explanations. There were common themes to understand for parts c through e. The majority of candidates demonstrated general understanding of the overall themes/concepts in these parts, whether or not they made a mistake in one or more of the parts.

Part a

Candidates were expected to correctly identify the formula, perform the intermediate calculations and provide the answer. Most mistakes were calculation errors. Some candidates mixed two different calculation methodologies within their response, leading to an incorrect result.

Part b

Candidates were expected to know the formula, understand the method for determining the number of swaps (or concordant/discordant pairs) and correctly perform the calculation. One common mistake was when candidates failed to set up the swap based on the order ranking of either severity or frequency.

Part c

This part requires the candidate to understand the most significant concepts behind the Pearson correlation. They were required to clearly identify two distinct weaknesses of Pearson and briefly describe why these weaknesses occur. The common mistakes were failing to give an incomplete explanation of the weakness and restating one weakness in an alternate manner.

Part d

Candidates were expected to understand the concepts underlying Kendall's Tau and how they compare to the Pearson correlation statistic. In order to receive full credit, candidates needed to identify whether Kendall's Tau addresses the weaknesses identified in part c and give a simple argument why or why not. A common mistake was to give insufficient explanation of why the weakness was or wasn't addressed.

SAMPLE ANSWERS AND EXAMINER'S REPORT

Part e

Candidates were expected to understand the role of using scatterplots in evaluating correlation. In order to receive full credit, the candidate needed to identify and clearly describe one advantage and one disadvantage to using scatterplots. This part was more difficult. A common error was to state something true about scatterplots that was not clearly a strength or a weakness in evaluating correlations.

SAMPLE ANSWERS AND EXAMINER'S REPORT

QUESTION 22	
TOTAL POINT VALUE: 3.25	LEARNING OBJECTIVE: C4: Demonstrate the properties of various risk measures and their limitations
SAMPLE ANSWERS	
Part a: 0.75 point	
<i>Sample Answer 1</i>	
<p>Standard dev A = $3 \times 50 = 150$; B = $2.5 \times 9 = 22.5$ VaRA = $50 + 2.326 \times 150 = 398.9$ $50/398.9 = 12.5\%$ B = VaR = $9 + 2.326 \times 22.5 = 61.34$ $9/61.34 = 14.7\%$; B has a higher return on risk adj capital; B better</p>	
<i>Sample Answer 2</i>	
<p>Use that sigma = cov \times mean, then use that capital required = $\sigma \times z$ $\sigma_A = 50 \times 3 = 150$; $\sigma_B = 9 \times 2.5 = 22.5$ capital_A = $150 \times 2.326 = 348.9$; capital_B = $22.5 \times 2.326 = 52.34$ return_A = $50/348.9 = 14.3\%$, return_B = $9/52.34 = 17.2\%$; return B better</p>	
<i>Sample Answer 3</i>	
<p>Line B performs better because it has a lower CV</p>	
Part b: 0.75 point	
<i>Sample Answer 1</i>	
<p>Standard dev = $(150^2 + 22.5^2) = 151.68$ VaR = $50 + 9 + 2.326 \times 151.68 = 411.81$ $59/411.81 = 14.3\%$</p>	
<i>Sample Answer 2</i>	
<p>$\sigma_{Total} = (150^2 + 22.5^2) = 151.68$ capital = $151.2 \times 2.326 = 352.8$ return = $59/352.8 = 16.7\%$</p>	
Part c: 0.5 point	
<i>Sample Answer 1</i>	
<p>Allocation to A = $411.81M \times (398.9/(398.9+61.335)) = 357M$ Allocation to B = $411.81M \times (61.335/(398.9+61.335)) = 55M$</p>	

SAMPLE ANSWERS AND EXAMINER'S REPORT

Sample Answer 2

Allocation to A = $352.8 \times (348.9 / (348.9 + 52.34)) = 306$

Allocation to B = $352.8 \times (52.34 / (348.9 + 52.34)) = 46$

Part d: 1.25 points

Sample Answer 1

Last in Marginal Allocation A = $411.81 - 61.335 = 350$

Allocate to A = $411.81 \times (350.475 / 363.385) = 397M$

B: $411.8 - 398.9 = 15$

Allocate to B = $411.81 \times (12.91 / 363.385) = 14.63M$

This method measures the marginal impact of the addition of each business unit treating it as the last one in. The method has the advantage of maintaining the financial principle of comparing marginal profits with marginal costs.

Sample Answer 2

RORAC = Expected Profit / Portfolio VaR where

	Portfolio VaR	LOB VaR	Inc. Marg. VaR	% Alloc	Marg. VaR
LOB A	352.8	348.9	300.5	99%	348.3
LOB B	352.8	52.3	3.9	1%	4.5
Total			304.4		352.8

Advantages of incremental marginal approach over the proportional allocation method:

- Maintains financial principle of comparing marginal profits with marginal costs
- Marginal allocation charges each unit with the additional capital it requires
- Suitable allocation, which means increasing business with highest ROE will increase ROE for entire company

EXAMINER'S REPORT

Based on the learning objective, the candidate needed to demonstrate understanding of the properties of VaR. Part d was more advanced, which was evident in that the majority of candidates did not receive full credit for this part and many did not attempt the calculation. The information that the candidate needed to successfully answer the question was based on multiple papers on the syllabus and required the candidate to draw from the various papers.

For solutions 1 and 2 above, it is necessary to calculate the allocated capital in order to compare the risk adjusted return. Two different calculations of allocated capital were accepted, resulting in the two different solutions. For solution 1 above the allocated capital was calculated as expected

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profit plus 2.326 standard deviations. For solution 2 the allocated capital was calculated as 2.326 standard deviations.

Part a

Over half of the candidates got full credit for this part. A number of candidates incorrectly calculated allocated capital resulting in a response with negative allocated capital.

Part b

A common error in part b was candidates calculating the portfolio allocated capital as a sum of the allocated capital for Lines A & B.

Part c

A common error in part c was candidates not using the allocated capital by line to allocate the portfolio risk capital.

Part d

Many candidates did not attempt the calculation. Very few candidates got full credit for this part.

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QUESTION 23	
TOTAL POINT VALUE: 2.5	LEARNING OBJECTIVE: C6: Describe the rationale for, methods for, and effect of managing insurance and financial risks
SAMPLE ANSWERS	
Part a: 1 point	
<i>Sample Answer 1</i> <p>(1) If shareholders (agents of debt holders) take risky gamble w/ debt holder's money, debt holders may demand higher yields & stricter bond covenants → firm should try to minimize agency issues. (2) If the firm becomes troubled, the shareholders may under invest in safer projects that provide a consistent, if lower, return ("underinvestment problem") which hurts the debt holders and the firm's viability. (The shareholders stake decreases when the firm is in distress but the bondholder's stake does not).</p>	
<i>Sample Answer 2</i> <p>Agency theory describes the conflict between shareholders and debt holders. (1) Outside of financial distress scenarios, there are conflicts between the primary goal of shareholders (optimize return on investment) and debt holders to minimize firm's default probability). As a result debt holders are risk averse. To appease debt holders, a firm may engage in risk transfer to minimize diversifiable risks that could lead to default. (2) In case of financial distress, the agency conflict heightens. Shareholders become less risk averse, as they want to take chances so that they can get some of their money out (debt holders have the first claim). Since shareholders have control of the firm's assets, this can lead to an underinvestment problem where the firm foregoes profitable investment opportunities that could benefit debt holders more. Engaging in risk reduction to reduce risk of distress helps avoid these issues.</p>	
Part b: 1 point	
<i>Sample Answer 1</i> <p>(1) In an insurance company the biggest "bond holders" are the policyholders. This is because the UEPR and Loss and LAE reserves dominate the balance sheet of an insurer. (2) Policyholders cannot diversify away their risk like a bondholder can by investing in multiple companies / municipalities/governments. A policyholder cannot purchase multiple policies and spread the risk.</p>	
<i>Sample Answer 2</i> <p>(1) Debt holders in insurance company can't diversify their risk (can't buy a personal accident policy from 3 insurers) → they are particularly risk averse [policyholders are also debt holders since they provide insurer liabilities of reserves & unearned premium]. Insurance Policy is a promise of future payment contingent on specific condition → policyholders who are also debtholders especially want the insurer to be stable. (2) Since the value of Liability and Unearned Premium Reserve is huge comparing to other forms of</p>	

SAMPLE ANSWERS AND EXAMINER'S REPORT

capital Debt holders are especially important. If lose them, will lose both customers and source of financing.
Part c: 0.5 point
<i>Sample Answer 1</i> An insurer may want to retain less risk since they may lose policyholders in the event of financial distress and w/ little recourse to set them back, since lowering rates will worsen distress.
<i>Sample Answer 2</i> As policyholders, who prefer to buy from stable insurers, play an important part in insurance company capital decision making (see part b), insurance company tend to retain less risk than non-insurers.
EXAMINER'S REPORT
This question tests the understanding of the differences in the relationship between shareholders and debt holders of insurance and non-insurance firms and how they influence risk management. Most candidates were able to get at least partial credit for this question. Some candidates failed to discuss the relationship between shareholders and debt holders. Many were not able to provide sufficient reasons to the differences in the relationship.
Part a
<ul style="list-style-type: none">• The candidate was expected to know that in spite of the inevitability of the conflict between shareholders and debt holders (pertaining to risk tolerance levels) there would be situations where it would be advantageous for the shareholders to adopt a risk-minimizing strategy under normal circumstances and a strategy of reducing the probability of financial distress.• The candidates needed to describe the relationships between shareholders and debt holders, describe the conflict situations, and describe the conflict resolution mechanism.• Many candidates mentioned that the interests are aligned. The divergence was not properly discussed. Many candidates made general statements instead of focusing on the relationship between shareholders and debt holders.
Part b
<ul style="list-style-type: none">• The candidate was expected to know that the policyholders are the primary debt holders for an insurance company. This situation leads to a Customer/Business relationship that supersedes shareholder/debt holder relationship. Hence, in order to retain their customer base, insurance companies have to manage the risk preferences of their customers. This situation does not become an issue for non-insurance companies.• Candidates needed to mention that policyholders/customers are the primary debt holders and how insurance companies have to consider their preferences.• Most candidates identified policyholders/customers as the primary debt holders of an insurance company. Many unnecessarily brought in the issue of mutual companies; this was not part of the question.
Part c
<ul style="list-style-type: none">• The candidate was expected to know that the debt holder/customer would be risk-averse and would expect the insurer to remain solvent to pay claims. This emphasis would force

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insurers to reduce risk much more than non-insurance companies.

- Most candidates were able to identify customers' needs with respect to risk reduction. However, many were unable to connect this situation with risk reduction for the firm.

SAMPLE ANSWERS AND EXAMINER'S REPORT

QUESTION 24	
TOTAL POINT VALUE: 4	LEARNING OBJECTIVE: C6.b: Describe the rationale for, methods for, and effect of managing insurance and financial risks
SAMPLE ANSWERS	
Part a: 1.5 points	
<i>Sample Answer 1</i>	
<p>w/o Reins: U/W Profit = EP – Loss – Expense = 1000 – 200 – 150 = 650 w/ Reins: U/W Profit = (1000 – 450) – (200 – 110) – (150 – 67.5) = 377.5</p>	
<i>Sample Answer 2</i>	
<p>Without Reinsurance: U/W Profit = 1000 – 200 – 150 = 650 M With Reinsurance: U/W Profit = 650 – 450 + 67.5 + 110 = 377.5 M</p>	
<i>Sample Answer 3</i>	
<p>Gross underwriting profit = EP – loss – expense = 1,000 -200 – 150 = 650 Cost of Reinsurance = Reinsurance Prem – commission – recovery = 450 – 67.5 – 110 = 272.5 UW Profit with Reinsurance = 650 – 272.5 = 377.5</p>	
Part b: 2.5 points	
<i>Sample Answer 1</i>	
<p>Without: Inv Inc = [2000 + (1000 – 150)] × 0.05 = 142.5 D = (1-d)/(1+r) = (1-.03)/(1+.03) = 0.942 V = E × D/(1-D) = (650 + 142.5)(0.942/(1-0.942)) = 12,821</p> <p>With: Inv Inc = (2000 + (1000 – 150 – 450 + 67.5)) × 0.05 = 123.4 D = (1 – 0.004)/1.03 = 0.967 V = (377.5 + 123.4)(0.967/(1 – 0.967)) = 14,678</p> <p>Value increased 14,678 – 12,821 = 1,807</p>	
<i>Sample Answer 2</i>	
<p>Without Reinsurance: E = 650 M + (2,000 + 1,000 – 150)(5%) = 792.5M D = (1-d)/(1+r) = (1-3%)/(1+3%) = 0.97/1.03 , M = D/(1-D) = 16.167 V = E × M = (792.5M)(16.167) = 12,812.08M</p> <p>With Reinsurance: E = 377.5M + (2,000 + 1,000 – 450 + 67.5 – 150)(5%) = 500.875M</p>	

SAMPLE ANSWERS AND EXAMINER'S REPORT

$$D = (1-0.4\%)/(1+3\%) = 0.996/1.03, M = D/(1-D) = 29.294$$

$$V = E \times M = (500.875)(29.294) = 14,672.69M$$

$$\text{Change in Firm Value} = 14,672.69M - 12,812.08M = 1,860.61M$$

Sample Answer 3

No Reinsurance - U/W Profit = 650

Investible Assets = Capital + Prem – Expense = 2000 + 1000 – 150 = 2850

2850(0.05) = 142.5

Total Earnings = 792.5

Reinsurance U/W Profit = 377.5

Investible Assets = Capital + Prem – Expense + Commission = 550 -150 +67.5 + 2000 = 2467.5

2467.5(0.05) = 123.4

Total Earnings = 377.5 + 123.4 = 500.9

Risk Adj PV

No Reins

$792.5(1 - 0.03)/(0.03 + 0.03) = 12,812$

Reins

$500.9(1 - 0.004)/(0.004 + 0.03) = 14,673$

$14,673 - 12,812 = 1,861$

Sample Answer 4

	W/O Reinsurance	With Reinsurance
d =	3%	0.4%
$D = (1 - d)/(1 + r)$	$0.97/1.03 = 0.9417$	$0.996/1.03 = 0.9670$
$K = (1 - D)/D$	0.0619	0.0341
Inv Assets (incl premium and expense)	2000 + 1000 – 150	2000 + 550 – 82.5
Investment Income	$(2000 + 1000 - 150) \times 0.05 = 142.5$	$(2000 + 550 - 82.5) \times 0.05 = 123.375$
Earnings	$650 + 142.5 = 792.5$	$377.5 + 123.375 = 500.875$
$V = E / k$	$792.5 / 0.0619 = 12,802.91$	$500.875 / 0.0341 = 14,688.42$

Change in firm value = 14,688.42 – 12,802.91 = 1855.51 increase in value due to reinsurance

Sample Answer 5

Investable assets

No Reinsurance = Surplus + EP – expense = 2000 + 1000 – 150 = 2,850

Reinsurance = 2850 – Reinsurance Prem + Commission = 2850 – 450 + 67.5 = 2,467.5

SAMPLE ANSWERS AND EXAMINER'S REPORT

	No Reinsurance	Reinsurance
UW Income	650	377.5
Investment Income = Inv Assets × 0.05	142.5	123.4
Earnings = UW Income + Inv Income	792.5	500.9
Prob distress d	3%	0.4%
$D = (1-d)/(1+r)$, r=3%	0.942	0.967
$M = D/(1-D)$	16.17	29.29
$E \times M$	12,815	14,671

Change in Firm Value = 14,671 – 12,815 = 1,856

Sample Answer 6

$$D = (1 - d) / (1 + r)$$

W/O Reinsurance

$$D = (1 - 0.03)/(1 + 0.03) = 1 / (1+k) \rightarrow k = 0.0619$$

$$\text{Earnings} = \text{U/w Income} + \text{Investment Income} = 650 + (2000 + 1000 - 150) \times 0.05 = 792.5$$

$$BV = E \times (1+g)/(k-g), \quad g=0$$

$$E/k = 792.5/0.0619 = 12,803$$

W/ Reinsurance

$$D = (1 - 0.004)/(1 + 0.03) = 1/(1+k) \rightarrow k = 0.0341$$

$$\text{Earnings} = \text{U/W Income} + \text{Investment Income} = 377.5 + (2000 + 1000 - 450 + 67.5 - 150) \times 0.05 = 500.875$$

$$BV = E/k = 500.875/0.0341 = 14,688$$

$$\text{Chg BV} = 14,688 - 12,803 = 1,866$$

EXAMINER'S REPORT

Question 24 tested the candidates' ability to calculate and compare firm value under two scenarios, with and without reinsurance. The problem was set up to use the risk-adjusted present value of future earnings method as described in Venter and Underwood "Value of Risk Reduction".

In general, the candidates scored well on this question. Over half the candidates received full credit and most received nearly full credit.

Part a

Candidates were expected to calculate underwriting profit with and without reinsurance. In order to obtain full credit, the candidate had to show the correct underwriting profit with and without reinsurance as well as the components of premium, expense/commission, and losses for the reinsurance portion. 76% of candidates received full credit on this part.

Common errors included the following:

- Including investment income in the underwriting profit (about 10% of candidates)

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- Calculation errors
- Discounting losses

Part b

Candidates needed to compare firm value with and without reinsurance, which required that the same calculations be performed for each scenario. Candidates needed to understand all the components of the method. Full credit required that they accurately show calculations for invested assets, investment income, total earnings, the discount and perpetuity factors, calculation of firm value using those components, and the difference in firm value for the two scenarios. 69% of candidates received full credit.

Common errors included the following:

- Calculation errors
- Incorrect calculation of invested assets (omitting surplus or another component)
- Use of an incorrect investment rate or risk-free rate in a particular calculation

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QUESTION 25	
TOTAL POINT VALUE: 2.5	LEARNING OBJECTIVE: C7: Describe operational risk and demonstrate possible mitigation and quantification methodology
SAMPLE ANSWERS	
Part a: 1 point	
<i>Sample Answer 1</i>	
<p>A bridging model uses mature prior year loss ratios, combined with loss cost and rate level changes, to project loss ratios for more recent years. This introduces significant autocorrelation between loss ratios in the planning process and older loss ratios...</p>	
<i>Sample Answer 2</i>	
<p>Bridging Model: loss ratios for older more mature years are used as expected losses for recent years, adjusting for inflation and trends. For recent years, a BF method is used to weigh actual experience and the expected loss using the older year ELR. Optimistic older LRs lead to optimistic plan LRs. An operational prob exists for a long tailed line, where deterioration in older year loss ratios gets carried forward to recent years, causing a reserve conflagration.</p>	
Part b: 1.5 points	
<i>Sample Answer 1</i>	
<ol style="list-style-type: none"> 1. Intellectual property: Includes investment in talent, systems and databases, and comprises majority of franchise value. Insurers should invest in intellectual property throughout the u/w cycle through investment in talent, systems, and databases. This mitigates risk of systems/databases becoming obsolete and talent leaving especially during a soft market. 2. Underwriter incentives – Underwriter incentives should be flexible and aligned to the goals of the portfolio. If market prices become inadequate during a soft market, underwriters should not be penalized for ceasing to write new business if this is in the portfolio's best interest. 	
<i>Sample Answer 2</i>	
<ol style="list-style-type: none"> 1. Firm's franchise values are mainly from intellectual property including experts in the underwriting, actuarial, etc., proprietary systems for policyholder information, forecasting systems, reputations, market relationship. To mitigate operational risk through cycle, firm needs to protect this intellectual property through retaining top talent, invest in systems, maintain presence in the core market so when the cycle goes back to favorable environment, the firm still has these assets to help create more value. 2. Owner's' education. Under bad market, premium won't increase as much while expense is still growing, these caused certain ratios such as expense ratios increase. Company's management and shareholders should have the perspective that this is due to the cycle so that they won't make wrong moves such as cutting premium to gain market share which 	

SAMPLE ANSWERS AND EXAMINER'S REPORT

will bring the firm to the vicious cycle that not able to retain future earnings. So a good understanding from owners will help mitigate the operational risks through the cycle.

EXAMINER'S REPORT

Part a

Candidates were expected to know the definition of a bridging model.

Many candidates recognized that a bridging model was an approach to estimate plan from historical loss ratios but did not give any details of the adjustments necessary in this process (for trend, rate level, etc.).

Some candidates incorrectly described a bridging model as a way to estimate reserves from the plan loss ratio, or else they related reserving to pricing.

Candidates received credit for the operational risk portion of the question if they related the risk to use of the bridging model. Generally, full credit answers identified the correlation between years that result from using a bridging model.

Part b

Candidates were expected to understand underwriting cycle management and know what companies should do to operate effectively through the cycle.

Candidates generally scored well on this section. Some candidates used two different examples of intellectual property. This was considered a duplicate answer and did not receive full credit. Some candidates identified an aspect of intellectual property but did not describe how it could help mitigate risk.

SAMPLE ANSWERS AND EXAMINER'S REPORT

QUESTION 26	
TOTAL POINT VALUE: 2	LEARNING OBJECTIVE: C8: Evaluate best practices in risk measurement, modeling, and management of various financial and non-financial risks faced by an entity
SAMPLE ANSWERS	
Part a: 0.5 point	
<i>Sample Answer 1</i>	
<p>A1) Economic Capital Level is the amount of capital needed to keep the probability of ruin under a certain threshold</p> <p>A2) Rating Agency Capital is the amount of capital needed to maintain certain rating may be developed by the models from rating agency</p>	
<i>Sample Answer 2</i>	
<p>A1) Amount of Capital needed to reduce risk of insolvency below a threshold</p> <p>A2) Amount of capital needed to reduce risk of a rating downgrade below a certain threshold</p>	
Part b: 0.5 point	
<i>Sample Answer 1</i>	
<p>Rating Agency Capital level is more or less dependent on the rating agency's activities. However, for a firm's economic capital level, it evaluates the risk of insolvency at a different threshold from rating agency capital level. Further, it might look at various or different types of risks.</p>	
<i>Sample Answer 2</i>	
<p>Calibrate to economic capital level to ensure solvency of the company based on the produced output. Rating Agency Capital level may not be high enough to endure a small probability of company failure</p>	
Part c: 0.5 point	
<i>Sample Answer 1</i>	
<p>C1: Economic impairment earnings is the amount of loss that would put the firm in a state of economic impairment</p> <p>C2: Protection of franchise value is the amount of capital required to keep the firm's franchise value (market- book) at a tolerable level</p>	
<i>Sample Answer 2</i>	
<p>C1: Economic Impairment Earnings → the amount of losses required to put a firm in economic impairment at a given threshold</p> <p>C2: Protection of Franchise Value: the amount of capital required to maintain the franchise value of the firm above a certain threshold with a given probability</p>	

SAMPLE ANSWERS AND EXAMINER'S REPORT

Part d: 0.5 point

Sample Answer 1

Firm might calibrate to EIEL instead of FVL because being impaired has more severe consequences than just losing franchise value. Company should be concerned with tail events that impact debt and policyholders not just the franchise value which mostly affects shareholders

Sample Answer 2

Economic impairment earnings level is often used to measure risk appetite rather than capital. The firm may be focused on measuring risk appetite as an input on decisions and maximizing its opportunities

EXAMINER'S REPORT

This question was meant to test the candidates' recollection of definitions and their ability to compare and contrast them. The majority of candidates were able to supply the requested definitions, however, they had trouble comparing and contrasting the terms.

Part a

- The candidates were expected to know the definitions and most candidates received full credit.
- The ECL should refer to probability of ruin or insolvency.
- Rating Agency Capital is required to achieve a certain rating; however, some candidates simply claimed it was required.

Part b

There were several different possibilities for answering the question, but some candidates only listed descriptions instead of answering why. About half of the candidates received full credit.

Part c

C1: Definition of Economic Impairment Earnings is a level of loss and not capital.

C2: The definition says we want to protect the franchise level from falling below a certain threshold. Many candidates said to protect from a decrease, or maintain the level, but they also needed to incorporate the concept of threshold

About half the candidates received partial credit, with the remainder split between full credit, and no credit.

Part d

Candidates referred to franchise value as difficult to value and this was not accepted. About 2/3 of the candidates received no credit on this response; most of these struggled with the definitions themselves.

SAMPLE ANSWERS AND EXAMINER'S REPORT

QUESTION 27	
TOTAL POINT VALUE: 2	LEARNING OBJECTIVE: C8: Evaluate best practices in risk measurement, modeling, and management of various financial and non-financial risks faced by an entity.
SAMPLE ANSWERS	
Part a: 1 point	
<u>Benefit</u>	
<i>Sample Answer 1</i>	
By calculating a few points of the distribution, you can fit a curve to find other values.	
<i>Sample Answer 2</i>	
It is easy to fit a pdf to a distribution of capital, even if only a few points in the distribution are available. The pdf can be used to smooth out the distribution and calculate interpolated or extrapolated quartiles, confidence intervals, etc.	
<u>Drawback</u>	
<i>Sample Answer 1</i>	
Does a poor job of representing the full range of possible real-world outcomes	
<i>Sample Answer 2</i>	
The selected probability density function may under fit the tail of the distribution which is the most important part for solvency purposes.	
<i>Sample Answer 3</i>	
It has difficulties in handling steps in the distribution, such as when reinsurance contracts are applied.	
Part b: 1 point	
<i>Sample Answer 1</i>	
Use the sampled capital values (from the individual risk capital distribution) to represent the distribution. A copula can then be used to combine the sampled capital values. Advantage: This avoids the need to approximate the distribution.	
<i>Sample Answer 2</i>	
A better approach would be to use a model that allows risks to vary stochastically. Advantage: This would allow for non-linear effects between risks and of the impact of risks in the capital required.	

SAMPLE ANSWERS AND EXAMINER'S REPORT

Sample Answer 3

You can use a bootstrap procedure to essentially come up with your own distribution based on your observed losses.

Advantage: you would no longer be tied to picking a known pdf for your losses.

EXAMINER'S REPORT

Candidates generally performed poorly on this question. There appears to be a large number of candidates confused by probability density functions, probability distribution functions, and cumulative distribution functions. Candidates are assumed to know the differences and relationships between these functions.

Part a

Candidates struggled to provide a benefit of using a probability density function for modeling capital. Candidates performed better when articulating the drawbacks of using density functions. A variety of responses received partial credit.

Part b

Candidates generally performed poorly on this part; a substantial number of candidates did not provide a true alternative to probability density functions. Instead, they provided methods that were improvements or modifications to density functions. These adjusted PDF methods received partial credit. Some candidates provided alternatives that were density functions without any modification and the difference was in name only; these responses received no credit. Some candidates lost points when they provided an alternative without describing it adequately.