Exam 9

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CASUALTY ACTUARIAL SOCIETY AND THE

CANADIAN INSTITUTE OF ACTUARIES



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Exam 9

Financial Risk and Rate of Return

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4 HOURS

INSTRUCTIONS TO CANDIDATES

- 1. This 58.75-point examination consists of 27 problem and essay questions.
- 2. For the problem and essay questions, the number of points for each full question and part of a question is indicated at the beginning of the question or part. Answer these questions on the lined sheets provided in your Examination Envelope. Use <u>dark</u> pencil or ink. Do not use multiple colors.
 - Write your Candidate ID number and the examination number, 9, 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. <u>When a specific number</u> <u>of items is requested</u>, do not offer more items than the number requested. For example, if three items are requested, only the first three responses will be graded.
 - <u>In order to receive full credit</u> or to maximize partial credit on mathematical and computational questions, you must clearly outline your approach in either verbal or mathematical form, <u>showing calculations</u> where necessary. Also, you must clearly <u>specify any additional</u> <u>assumptions</u> 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.

CONTINUE TO NEXT PAGE OF INSTRUCTIONS

- 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.
 - Verify that the table of the Normal Distribution is attached to the examination after the last question.
- 5. Your Examination Envelope is pre-labeled with your Candidate ID number, name, exam number and test center. <u>Do not remove this label.</u> Keep a record of your Candidate ID number for future inquiries regarding this exam.
- 6. <u>Candidates must remain in the examination center until two hours after the start of the</u> <u>examination</u>. 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, <u>candidates may not leave the exam room during the last</u> <u>fifteen minutes of the examination</u>.
- 7. <u>At the end of the examination, place all answer sheets in the Examination Envelope.</u> 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. <u>Only the answer sheets will be graded</u>. Also place any included reference materials in the Examination Envelope. <u>BEFORE YOU TURN THE EXAMINATION ENVELOPE IN TO THE SUPERVISOR, BE SURE TO SIGN IT IN THE SPACE PROVIDED ABOVE THE CUT-OUT WINDOW.</u>
- 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. Interoffice mail is not acceptable.

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. <u>Do not put</u> 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 15, 2015.

END OF INSTRUCTIONS

Given the information below describing a three-security financial market, one rational investor's complete portfolio and investors' utility:

| Security | Expected Return | Standard Deviation | Portfolio Allocation |
|----------|-----------------|--------------------|----------------------|
| Х | 4% | 0% | 43% |
| Y | 10% | 20% | 30% |
| Z | 15% | 30% | 27% |

- Investors assign utility to their portfolios by the formula: $U = E(r) \frac{1}{2}A\sigma^2$.
- a. (0.5 point)

Describe the interpretation of the risk aversion index when A < 0.

b. (0.75 point)

Calculate the correlation coefficient of the returns of securities Y and Z.

c. (1 point)

Calculate the value of A for the investor.

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Given the following information about the universe of available risky securities:

- Annual stock returns are identically normally distributed.
- The expected annual return for each stock is 12%.
- The standard deviation for each stock is 40%.
- The correlation coefficient between annual returns of any pair of stocks is 0.35.
- An equally weighted risky portfolio of 30 stocks has a total value of \$10 million.

a. (0.5 point)

Calculate the minimum number of stocks necessary for the standard deviation of a portfolio composed of the stocks specified above to be less than or equal to 24%.

b. (1.5 points)

The given portfolio of 30 stocks is diversified such that only systematic risk remains. Calculate the amount, in dollars, of the 90% 1-year Value at Risk (VaR) that has been eliminated.

3. (1.5 points)

Given the following information:

| Stock | Capitalization (\$) | Alpha | Beta | Expected Return | Standard Deviation |
|-------|---------------------|-------|------|-----------------|--------------------|
| A | 2500 | 1.0% | 0.9 | 7.3% | 30% |
| В | 4700 | 0.0% | 0.3 | 2.1% | 10% |
| С | 2800 | -0.5% | 1.7 | 11.4% | 40% |

• An index of stocks A, B and C is used as the market index for a single-index model.

- The standard deviation of the market index portfolio is 20%.
- a. (0.25 point)

Calculate the covariance between stock A and the index portfolio.

b. (0.25 point)

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Calculate the covariance between stock A and stock B.

c. (0.5 point)

Calculate the systematic and firm-specific components of the variance of stock C.

d. (0.5 point)

Assume 100 stocks are added to this financial market. Briefly describe two disadvantages of using the Markowitz model rather than the single-index model in this case.

Given the following information:

• The variance-covariance matrix:

| | Stock A | Stock B | Market Portfolio |
|------------------|---------|---------|------------------|
| Stock A | 0.16 | | |
| Stock B | -0.48 | 1.44 | |
| Market Portfolio | -0.0108 | 0.252 | 0.09 |

- Stock A and Stock B are perfectly negatively correlated.
- The risk-free rate is 3%.
- The market portfolio has an expected return of 8%.
- Portfolio P consists of:
 - o 75% invested in Stock A.
 - o 25% invested in Stock B.
- a. (1.5 points)

Using CAPM, calculate the expected return of Portfolio P.

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b. (1.25 points)

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Construct an arbitrage strategy using the risk-free rate and some combination of Stock A and Stock B.

5. (1.5 points)

Given the following information:

| | | Market's | Minimum- |
|------|-----------|-----------|-----------|
| | Market | Zero-Beta | Variance |
| | Portfolio | Portfolio | Portfolio |
| E(r) | 8% | Not Given | 6% |
| σ | 14% | 14% | 10% |

- The risk-free rate is 3%.
- The covariance of Security A and the market portfolio is 0.0392.
- The minimum-variance frontier is symmetric around the minimum-variance portfolio.
- a. (1 point)

Calculate the expected return for Security A using the zero-beta extension of CAPM.

b. (0.25 point)

Identify the assumption that is relaxed under the zero-beta extension of CAPM.

c. (0.25 point)

State the correlation between the market portfolio and the market's zero-beta portfolio.

Given the following information:

| Firm | Book Value (\$000,000) | Market Value (\$000,000) | CAPM Beta |
|------|---------------------------|-----------------------------|-----------|
| A | 625 | 500 | 1.2 |
| В | 350 | 500 | 1.2 |
| С | 1,250 | 1,000 | 1.2 |

a. (1.25 points)

Use the principles underlying the Fama & French 3-Factor Model to evaluate which firm would be expected to have the highest future rate of return.

b. (1 point)

Assume that the firm identified in part a. above does produce the highest rate of return over a future period.

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Describe two behavioral explanations that could explain the superior performance.

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| | Average Risk- Free Rate | Average Portfolio Return | Average Dividend Yield | Average Dividend Growth Rate |
|-----------|----------------------------|--------------------------------|---------------------------|------------------------------------|
| 1955-1974 | 4.1% | 9.5% | 6.6% | 3.0% |
| 1975-1994 | 3.8% | 9.1% | 4.9% | 4.0% |
| 1995-2014 | 4.3% | 12.6% | 5.6% | 3.5% |

An investor has held the same portfolio of stocks since 1955.

Using the dividend discount model (DDM), evaluate whether the high returns in the most recent period can be expected to persist into the future.

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| Bond | Par Value | Time to Maturity (in years) | Annual Coupon Rate | Bond Price |
|------|-----------|-----------------------------|-----------------------|---------------|
| 1 | \$100 | 1 | 2% | \$97.89 |
| 2 | \$100 | 2 | 4% | Not Given |
| 3 | \$100 | 3 | 4% | Not Given |
| 4 | \$100 | 4 | 0% | \$81.34 |

Given the following information about bonds with annual coupon payments:

| Forward Rate Agreement | Lending Period Begins | Term | Principal | Annual Effective Interest Rate | Value (to Lender) |
|------------------------------|-----------------------------|--------|-------------|--------------------------------------|-------------------------|
| A | in 2 years | 1 year | \$1,000,000 | 6.4% | \$6,000 |
| В | in 3 years | 1 year | \$2,000,000 | 7.5% | \$26,000 · |

Calculate the price of Bond 3.

A company entered into a 10-year currency swap.

Given the following information:

- The company receives 10% per annum in Mexican Pesos.
- The company pays 6% per annum in US Dollars.
- LIBOR = 5.0% United States Dollar (USD).
- LIBOR = 8.0% Mexican Peso (MXN).
- LIBOR Rates are per annum with continuous compounding.
- The principals are 10 million in US Dollars and 120 million in Mexican Pesos.

There are four years left on the swap and the current exchange rate is 1 USD to 11.5 MXN.

Determine the value of the swap in US Dollars.

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Given the following information for a monoline Workers' Compensation insurance company as of 12/31/2014:

| Accident Year | Written Premium | Indemnity Reserve | Medical Reserve | Total Reserve |
|------------------|--------------------|----------------------|--------------------|------------------|
| 2013 | 10,000,000 | 3,450,000 | 50,000 | 3,500,000 |
| 2014 | 9,500,000 | 3,900,000 | 100,000 | 4,000,000 |

In order to fund these liabilities, the following investments are available:

| Investment Vehicle | Expected Investment Income |
|-----------------------------|----------------------------|
| Long-term bonds | 5% |
| Short-term commercial paper | 2% |

The insurer currently invests all of its reserves in short-term commercial paper. The insurer anticipates that their reserves will be paid over the next ten years. There are no transaction costs.

a. (1.25 points)

Fully assess the insurer's strategy to invest solely in short-term commercial paper, including a recommendation for an alternative strategy, if appropriate.

b. (1 point)

On 1/1/2015, the insurer increases the reserves by \$10 million as shown below:

| Indemnity Reserve | Medical Reserve | Total Reserve |
|-------------------|-----------------|---------------|
| \$1 million | \$9 million | \$10 million |

These reserves are also expected to be paid out over ten years.

Describe how the insurer's investment strategy should change as a result of this reserve increase.

Insurer ABC has a long history of projecting interest rates into the future and acting on those predictions in order to increase its surplus. Insurer ABC has forecasted a decrease in interest rates for the next 10 years.

Insurer XYZ does not project interest rates into the future and relies on underwriting results in order to increase its surplus.

Both insurers have a reserve of \$5 million which will be paid in a single payment in 5 years.

In order to fund this liability, the following assets are available:

| Bond | Maturity (years) | Par Value (millions) | Annual Coupon | Duration | Price (millions) |
|------|---------------------|----------------------------|------------------|-----------|---------------------|
| Α. | 5 | 5.0 | 0% | 5.00 | 4.53 |
| В | 5 | 4.0 | 4.8% | Not Given | Not Given |
| С | 7 | 4.5 | 2.1% | 6.58 | 4.53 |

The current interest rate is 2%.

a. (0.5 point)

Calculate the duration and price for bond B.

b. (1 point)

Determine which asset Insurer ABC would purchase and fully explain the reasoning behind their decision.

c. (0.75 point)

Determine which asset Insurer XYZ would purchase and fully explain the reasoning behind their decision.

Given the following information about two companies in different industries:

- ABC is in an industry that is expected to become more competitive.
- XYZ has a business plan that relies on the successful development of a new product.
- One company has Ba-rated debt, and the other B-rated debt.
- B-rated and Ba-rated debt have expected cumulative default rates described in the table below:

| Term (years) | 5 | 10 | 15 |
|--------------|-----|-----|-----|
| Ва | 10% | 20% | 30% |
| B | 30% | 50% | 58% |

a. (1 point)

Evaluate which bond rating more accurately describes the expected change in probability of default as a function of time for Company XYZ.

b. (1 point)

Assuming both companies are still in business in 10 years, use the table of default rates to determine which company is expected to have better credit-worthiness.

a. (1 point)

Describe a collateralization agreement and explain why it may not fully protect a financial institution from credit risk.

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b. (1 point)

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Describe a downgrade trigger and explain why it may not fully protect a financial institution from credit risk.

14. (3.5 points)

A country recently began allowing financial institutions to package catastrophe (CAT) bonds into collateralized debt obligations (CDO) that allowed tranches to be constructed based on the performance of the underlying CAT bonds.

Critics objected that allowing CAT bond CDO tranches with AAA ratings could lead to a repeat of the subprime mortgage crisis.

a. (1.5 points)

Discuss three ways the risks associated with CAT bond CDOs differ from the collateralized mortgage obligations constructed before the subprime financial crisis.

b. (1 point)

Discuss two potential challenges arising from widespread construction and investment in the CAT bond CDOs that could contribute to a future financial crisis.

c. (1 point)

Propose and briefly explain two possible regulations for construction or rating of the new CAT bond CDOs that could help alleviate some of the challenges in part b. above, without greatly discouraging innovation and investment.

An insurance company is considering investing in only one new line of business. The company will base its decision on one of two risk measures: either the economic profit or the risk-adjusted return on capital (RAROC). The options are summarized in the table below:

| | Line A | Line B |
|------------------|--------------|-------------|
| Premium | \$10,000,000 | \$8,000,000 |
| Expense Ratio | 10% | 15% |
| Loss Ratio | 80% | 75% |
| Required Capital | \$9,500,000 | \$4,500,000 |

- Investment return is 6.5%.
- Premium is collected immediately.
- Expenses are paid immediately.
- Capital is released at the end of the year.
- Losses are paid at the end of the year.
- a. (1.5 points)

Demonstrate which line would be preferred for each of the risk measures.

b. (0.5 point)

Calculate the additional premium that would need to be charged for line A to make its risk-adjusted return on capital equal to line B. Assume the required capital for line A does not change.

The tables below describe the possible outcomes for a company's losses and asset values.

| Losses | Probability | Assets | Probability |
|----------|-------------|----------|-------------|
| \$15,000 | 50% | \$18,000 | 50% |
| \$20,000 | 30% | \$25,000 | 30% |
| \$30,000 | 20% | \$35,000 | 20% |

Assume the losses and assets are independent.

The company will be changing the investment of its assets so that the assets are invested in risk-free securities that would guarantee an asset value of \$19,000.

Determine the additional required capital for the company to maintain the same Expected Policyholder Deficit (EPD) ratio following this investment change.

A well-capitalized reinsurance company allocates its risk capital into the following three risk categories:

- Premium risk
- Reserve risk
- Interest rate risk

The company writes only the following two lines of business, which have similar expected losses:

- Line A: Short-tailed property catastrophe reinsurance
- Line B: Long-tailed casualty reinsurance

The company wants to further allocate the capital for each of those three risks sources to Line A and Line B.

a. (1.5 points)

Explain which line of business (A or B) should receive a higher allocation of capital for each of premium, reserve, and interest rate risk.

b. (0.75 point)

Discuss how the choice of risk measure between value at risk (VaR) and conditional tail expectation (CTE) is expected to impact the allocated capital to line A.

An insurance company writes three lines: Auto Liability (AL), Auto Physical Damage (PD) and Workers' Compensation (WC).

- The total required capital is \$5,000,000.
- Capital is allocated based on a Co-CTE risk measure.
- The expense ratio is 27% for each line of business.
- The interest rate for discounting is 2.5%.
- The cost of capital is 15%.
- Expenses are paid at the beginning of the year and losses are paid at the end of each year.

| Line | Premium | Undiscounted Loss Ratio | Loss Reserve Duration | 99.5% Co-CTE |
|-------|------------|----------------------------|--------------------------|-----------------|
| AL | 5,000,000 | 70.0% | 2.5 | 2,275,000 |
| PD | 2,000,000 | 62.5% | 0.8 | 1,625,000 |
| WC | 8,000,000 | 77.5% | 3.5 | 2,600,000 |
| Total | 15,000,000 | 73.0% | 2.8 | 6,500,000 |

Determine whether the Workers' Compensation line of business adds value to the company on a risk-adjusted basis.

The actuarial department of a property and casualty insurer is reviewing two potential growth opportunities, referred to as Option A and Option B. Given the following information about these options:

- Policies are in-force for one year.
- Premium is collected at the beginning of the policy period.
- Variable expenses equal to 25% of the premium are paid at policy inception.
- Both options are expected to achieve an 85% loss ratio.
- Equal loss amounts are expected to be paid out at the end of each year over a twoyear period for both options.
- The company allocates capital in a way that results in a reserve-to-surplus ratio of 2:1 for Option A and 3:1 for Option B.
- Initial required surplus is set to the loss portion of the unearned premium reserve.
- Supporting capital can be invested at a 10% rate of return.
- The cost of capital is 8% per year.
- Investment income is earned at the end of a given policy year.
- There are no taxes.

Calculate the internal rate of return (IRR) and net present value (NPV) for each growth opportunity.

Below is information about a large property and casualty insurer that writes Homeowners' and Workers' Compensation business.

- The insurer expects to write \$1 billion of business over the next year, equally split between its Homeowners' and Workers' Compensation lines of business.
- The expected loss ratio is the same for both products.
- Each product is expected to earn \$25 million in underwriting income over the course of the year.
- \$500 million of surplus is held between these two products.
- The average duration between occurrence and payment of a claim is one year for Homeowners' and three years for Workers' Compensation.
- There is no investment income.
- a. (1 point)

Using two allocation methods, calculate the return on equity for each line of business. Assume a steady state environment.

b. (1 point)

For each allocation method above, briefly explain how the above return on equity figures would change if the Workers' Compensation line of business has been growing at a faster pace than the Homeowners' line of business for the past several years.

The Basic Equation for Total Return on Equity can be expressed as follows:

T/S = I/A (1 + R/S) + U/P * P/S

Where:

T = Total after-tax return to the insurer

I = Investment gain or loss (after appropriate tax charges)

U = Underwriting profit or loss (after appropriate tax charges)

P = Premium income

A = Total assets

R = Reserves and other liabilities (excluding equity in unearned premium reserves)

S = Stockholders' equity (capital, surplus, and equity in unearned premium reserve)

Identify which term in the above equation is the "insurance leverage factor" and explain the purpose of this factor in the calculation of total return on equity.

The explanation should address all of the following (assume all else being equal, i.e., this factor was not recently affected by any forces outside management control):

- What is being leveraged?
- What is the impact on total return on equity of changes to this leverage factor?
- What is a potential problem of this factor being too high?
- What is a potential problem of this factor being too low?

The chief actuary of a small monoline P&C carrier writing coverage in one state files rates that are 10% higher than they were in the prior year. To support the filing, the chief actuary claims that investors are demanding higher rates of return than what the company has historically achieved. Additionally, the chief actuary notes that competitors have been achieving higher rates of return on equity.

a. (1 point)

Evaluate whether the chief actuary's justification for the rate increase is reasonable from the regulator's perspective.

b. (1 point)

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Identify and briefly describe two additional items the regulator may wish to consider when evaluating whether the proposed rates of **any** insurer are acceptable.

A consulting actuary has been tasked with evaluating a stock company's methodology for selecting an appropriate underwriting profit provision. Company management has historically favored using the Calendar Year Investment Income Offset Method to determine the required profit provision. Increased awareness of the changing macroeconomic environment and stronger regulatory oversight has prompted management to place greater emphasis on reflecting risk within the model. Information on the company's historical profile is provided below.

| Calendar Year | Combined Ratio | Earned Premium at Year End | Estimate of Portfolio Yield | Actual Realized Portfolio Yield |
|------------------|-------------------|-------------------------------|--------------------------------|------------------------------------|
| 2010 | 98% | 50 million | 8% | 4% |
| 2011 | 101% | 53 million | 7% | 11% |
| 2012 | 103% | 72 million | 9% | 5% |
| 2013 | 103% | 90 million | 6% | 9% |
| 2014 | 104% | 105 million | 8% | 5% |
| 2015 | 107% | 120 million | 8% | Not available |

Calendar Year 2015 data reflects company projections for year end results.

Using the current management's viewpoint along with the historical company profile above, discuss three items the actuary should consider in using each of the following alternate methods in the selection of the underwriting profit provision.

a. (0.75 point)

Present Value Offset Method

b. (0.75 point)

Calendar Year Return on Equity Method

c. (0.75 point)

Risk-Adjusted Discounted Cash Flow Model

d. (0.75 point)

Internal Rate of Return on Equity Flow Model

For two stock companies:

| | Company A | Company B |
|-----------------------|--------------|-------------|
| Beginning Surplus | \$10,000,000 | \$5,000,000 |
| Ending Surplus | \$15,000,000 | \$6,000,000 |
| Stockholder Dividends | \$1,000,000 | \$300,000 |
| Capital Paid-In | \$3,000,000 | \$100,000 |
| Market to Book Value | 0.90 | 2.00 |

a. (0.75 point)

Calculate the market rates of return for each of company A and company B.

b. (0.5 point)

Briefly compare the investors' view of the future for each company.

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Given the following information for a Company,

As a % of surplus for 2014:

- 5% Expense and claims inflation:
- Increase in demand for insurance: 4%
- Increase in the aggregate reserves: 3% 12%
- Retained return on capital:
- Stockholders dividends:
- Additional paid-in capital: 3%

Given also the following information about the Company and the industry:

| | | | С | ompany | | | | |
|--|------|------|------|--------|--------------------|------|--------------|--------|
| (a) (b) (c) (d) Market to Book Value Earnings per Share P/E Ratio Return of | | | | | | | d) Irn on | |
| 2013 | 2014 | 2012 | 2013 | 2014 | 2015 (Estimate) | 2014 | Book | Market |
| 1.76 | 1.15 | 9.14 | 9.41 | 9.55 | 9.10 | 8 | 15% | 13% |

5%

| | | | Industr | y Informatio | on | | | |
|---------------------------|------------------|---------------------------|---------|--------------|--------------------|------------------|------------------|--------|
| (Market to | a) Book Value | (b) Earnings per Share | | | | (c) P/E Ratio | (d) Return on | |
| 2013 | 2014 | 2012 | 2013 | 2014 | 2015 (Estimate) | 2014 | Book | Market |
| Top Quartile | e Companies | | | | | | | |
| 2.16 | 1.78 | 11.76 | 12.13 | 12.07 | 12.87 | 14 | 16% | 9% |
| Bottom Quartile Companies | | | | | | | | • |
| 0.67 | 0.60 | 3.87 | 3.21 | 3.24 | 3.31 | 7 | 6% | 10% |

a. (0.5 point)

Calculate the required rate of return.

b. (1.5 points)

Discuss the Company's performance and outlook for the future relative to the industry using financial characteristics (a) through (d) above.

A reinsurer is pricing a high excess layer with the following attributes:

- The mean loss, μ_L , for the treaty is \$0.
- The target investment return is 12%.
- The cost per dollar of investment protected for a put option is 2%.
- The risk-free rate is 3%.
- The mean of the investment return is 10%.
- The safety level is equal to the limit of the treaty.
- a. (1.5 points)

Calculate the Rate On Line (ROL) the reinsurer would charge.

b. (0.75 point)

State whether the swap technique or put option technique usually produces a smaller Rate On Line. Describe why.

c. (0.25 point)

State an underwriter's justification for a minimum rate on line.

A property catastrophe insurer writes one portfolio with exposures in State X, and another portfolio with exposures in State Y, and is considering using the Shapley method to calculate the renewal risk loads for the portfolios.

The following information is given:

- 99th percentile loss modeled for State X Earthquake is \$300 million.
- 99th percentile loss modeled for State Y Earthquake is \$100 million.

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- The variance for X is \$50 million.
- The variance for Y is \$25 million.
- a. (0.5 point)

Explain whether the Shapley method provides equitable risk loads for the two states.

b. (0.5 point)

Based on the information given above, propose an alternate risk load method that accounts for the deficiency in the Shapley method.

c. (2 points)

Calculate the risk loads for State X and State Y using the method proposed in b. above. Assume the covariance between State X and State Y is \$15 million and the appropriate risk load multiplier is 0.00025.

Exam 9 Financial Risk and Rate of Return

POINT VALUE OF QUESTIONS

| | VALUE | SUB-PART OF QUESTION | | | | | | |
|----------|------------|----------------------|------|------|------|-----|-----|-----|
| QUESTION | OF QUESTON | (a) | (b) | (c) | (d) | (e) | (f) | (g) |
| 1 | 2.25 | 0.50 | 0.75 | 1.00 | | | | |
| 2 | 2.00 | 0.50 | 1.50 | | | | | |
| 3 | 1.50 | 0.25 | 0.25 | 0.50 | 0.50 | | | |
| 4 | 2.75 | 1.50 | 1.25 | | | | | |
| 5 | 1.50 | 1.00 | 0.25 | 0.25 | | | | |
| 6 | 2.25 | 1.25 | 1.00 | | | | | |
| 7 | 1.25 | 1.25 | | | | | | |
| 8 | 2.75 | 2.75 | | | | | | |
| 9 | 2.00 | 2.00 | | | | | | |
| 10 | 2.25 | 1.25 | 1.00 | | | | | |
| 11 | 2.25 | 0.50 | 1.00 | 0.75 | | | | |
| 12 | 2.00 | 1.00 | 1.00 | | | | | |
| 13 | 2.00 | 1.00 | 1.00 | | | | | |
| 14 | 3.50 | 1.50 | 1.00 | 1.00 | | | | |
| 15 | 2.00 | 1.50 | 0.50 | | | | | |
| 16 | 2.00 | 2.00 | | | | | | |
| 17 | 2.25 | 1.50 | 0.75 | | | | | |
| 18 | 2.25 | 2.25 | | | | | | |
| 19 | 2.25 | 2.25 | | | | | | |
| 20 | 2.00 | 1.00 | 1.00 | | | | | |
| 21 | 2.00 | 2.00 | | | | | | - |
| 22 | 2.00 | 1.00 | 1.00 | | | | | |
| 23 | 3.00 | 0.75 | 0.75 | 0.75 | 0.75 | | | |
| 24 | 1.25 | 0.75 | 0.50 | | | | | |
| 25 | 2.00 | 0.50 | 1.50 | | | | | |
| 26 | 2.50 | 1.50 | 0.75 | 0.25 | | | | |
| 27 | 3.00 | 0.50 | 0.50 | 2.00 | | | | |
| 28 | 0.00 | | | | | | | |
| 29 | 0.00 | | | | | | | |
| 30 | 0.00 | | | | | | | |
| 31 | 0.00 | | | | | | | |
| 32 | 0.00 | | | | | | | |
| 33 | 0.00 | | | | | | | |
| 34 | 0.00 | | | | | | | |
| 35 | 0.00 | | | | | | | |
| 36 | 0.00 | | | | | | | |
| 37 | 0.00 | | | | | | | |
| 38 | 0.00 | | | | | | | · |
| 39 | 0.00 | | | | | | | |
| 40 | 0.00 | | | | | | | |
| 41 | 0.00 | | | | | | | |
| 42 | 0.00 | | | | | | | |
| 43 | 0.00 | | | | | | | |
| 44 | 0.00 | | | | | | | |
| 40 | 0.00 | | | | | | | |

TOTAL

٤

58.75

Tables of the Normal Distribution

| | Probability Content from -∞ to Z | | | | | | | | | | | |
|---|--|--|--|--|--|--|--|--|--|--|--|--|
| Z | 0.00 | 0.01 | 0.02 | 0.03 | 0.04 | 0.05 | 0.06 | 0.07 | 0.08 | 0.09 | | |
| 0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0 2.1 2.2 2.3 2.4 2.5 2.6 | 0.5000 0.5398 0.5793 0.6179 0.6554 0.7257 0.7580 0.7257 0.7580 0.7881 0.8159 0.8413 0.8643 0.8643 0.8849 0.9032 0.9192 0.9332 0.9192 0.9332 0.9452 0.9554 0.9554 0.9713 0.9772 0.9821 0.9821 0.9893 0.9918 0.9938 0.9953 | 0.5040 0.5438 0.5832 0.6217 0.6591 0.6950 0.7291 0.7611 0.7910 0.8186 0.8438 0.8665 0.8869 0.9049 0.9049 0.9207 0.9345 0.9463 0.9564 0.9719 0.9778 0.9826 0.9864 0.9896 0.9920 0.9940 0.9955 | 0.5080 0.5478 0.5871 0.6255 0.6628 0.6985 0.7324 0.7642 0.7642 0.7939 0.8212 0.8461 0.8686 0.9222 0.9357 0.9474 0.9573 0.9656 0.9726 0.9783 0.9830 0.9888 0.9888 0.9922 0.9941 0.9956 | 0.5120 0.5517 0.5910 0.6293 0.6664 0.7019 0.7357 0.7673 0.7967 0.8238 0.8485 0.8708 0.8907 0.9082 0.9236 0.9370 0.9484 0.9582 0.9664 0.9732 0.9788 0.9834 0.9871 0.9901 0.9925 0.9943 0.9957 | 0.5160 0.5557 0.5948 0.6331 0.6700 0.7054 0.7054 0.7054 0.7095 0.8264 0.8508 0.8729 0.8925 0.9099 0.9251 0.9382 0.9495 0.9591 0.9671 0.9738 0.9793 0.9838 0.9793 0.9838 0.9875 0.9904 0.9927 0.9959 | 0.5199 0.5596 0.5987 0.6368 0.7088 0.7422 0.7734 0.8023 0.8289 0.8531 0.8749 0.8944 0.9115 0.9265 0.9394 0.9505 0.9599 0.9678 0.9744 0.9798 0.9842 0.9878 0.9906 0.9929 0.9946 0.9960 | 0.5239 0.5636 0.6026 0.6406 0.6772 0.7123 0.7454 0.7764 0.8051 0.8315 0.8554 0.8770 0.8962 0.9131 0.9279 0.9406 0.9515 0.9608 0.9686 0.9750 0.9803 0.9846 0.9881 0.9909 0.9931 0.9948 0.9961 | 0.5279 0.5675 0.6064 0.6443 0.6808 0.7157 0.7486 0.7794 0.8078 0.8340 0.8577 0.8790 0.8980 0.9147 0.9292 0.9418 0.9525 0.9616 0.9693 0.9756 0.9808 0.9850 0.9884 0.9911 0.9932 0.9949 0.9962 | 0.5319 0.5714 0.6103 0.6480 0.6844 0.7190 0.7517 0.7823 0.8106 0.8365 0.8599 0.8810 0.8997 0.9162 0.9306 0.9429 0.9535 0.9625 0.9625 0.9699 0.9761 0.9812 0.9854 0.9887 0.9913 0.9934 0.9951 0.9963 | 0.5359 0.5753 0.6141 0.6517 0.6879 0.7224 0.7549 0.7852 0.8133 0.8389 0.8621 0.8830 0.9015 0.9177 0.9319 0.9441 0.9545 0.9633 0.9706 0.9767 0.9817 0.9857 0.9857 0.9890 0.9916 0.9936 0.9952 0.9964 | | |
| 2.7 2.8 2.9 3.0 | 0.9965 0.9974 0.9981 0.9987 | 0.9966 0.9975 0.9982 0.9987 | 0.9967 0.9976 0.9982 0.9987 | 0.9968 0.9977 0.9983 0.9988 | 0.9969 0.9977 0.9984 0.9988 | 0.9970 0.9978 0.9984 0.9989 | 0.9971 0.9979 0.9985 0.9989 | 0.9972 0.9979 0.9985 0.9989 | 0.9973 0.9980 0.9986 0.9990 | 0.9974 0.9981 0.9986 0.9990 | | |

| Values | ofz | for | selected | values | of Pr(Z <z)< td=""></z)<> |
|--------|-----|-----|----------|--------|---------------------------|

| Z | 0.842 | 1.036 | 1.282 | 1.645 | 1.960 | 2.326 | 2.576 |
|--|-------|-------|-------|-------|-------|-------|-------|
| Pr(Z <z)< th=""><td>0.800</td><td>0.850</td><td>0.900</td><td>0.950</td><td>0.975</td><td>0.990</td><td>0.995</td></z)<> | 0.800 | 0.850 | 0.900 | 0.950 | 0.975 | 0.990 | 0.995 |

ANSWERS AND EXAMINER'S REPORT EXAM 9

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 welldocumented, 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 depend 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 additional credit, but takes up additional time during the exam.
- Many candidates also shared a concern that question seven was not on the exam 9 syllabus. This question was closely reviewed both prior to and subsequent to the exam administration, and the question is a question about material on the exam 9 syllabus, and is directly related to a learning objective from the syllabus. For more specific information on this question, please refer to the section of this Examiner's Report on question seven.

EXAM STATISTICS:

| • | Number of Candidates: | 458 |
|---|-------------------------------|-------|
| • | Available Points: | 58.75 |
| • | Passing Score: | 40.75 |
| • | Number of Passing Candidates: | 185 |
| • | Raw Pass Ratio: | 40.4% |
| • | Effective Pass Ratio: | 42.0% |

| QUESTION 1 | | | | |
|---|--|--|--|--|
| TOTAL | POINT VALUE: 2.25 LEARNING OBJECTIVE: A1, A5 | | | |
| SAMPLE ANSWERS | | | | |
| Part a: 0.5 point | | | | |
| 1. | When A < 0, the investor is considered to be "risk-seeking", meaning he seeks to invest for risk, regardless of expected return and therefore does not care for optimizing his mean variance | | | |
| | return. | | | |
| 2. | A is a measure of investors' risk appetite. When A < 0, it means this investor is risk seeking. His utility increases by taking on more risk. | | | |
| Part b: 0.75 point | | | | |
| 1. | . Given WY = 30% and WZ = 27% . | | | |
| | The weight of the risky portfolio is: $y = 30\% + 27\% = 57\%$ | | | |
| | Y's weight in the risky portfolio is: $\frac{30\%}{57\%} = \frac{10}{19}$ | | | |
| | We also know the portion of Y in the risky assets should be: | | | |
| | $WY = \frac{R_Z \sigma z^2 - R_Z \sigma y z}{1 - R_Z \sigma y z}$ | | | |
| | $R_{Y \sigma z^{2} + R_{Z} \sigma Y^{2} - (RY + RZ) \sigma yz}$ | | | |
| | Given $rt = r_x = 4\%$ | | | |
| | $R_y = 6\%$ $R_z = 11\%$ | | | |
| | $\sigma_y^2 = 0.2^2 \qquad \sigma_z^2 = 0.3^2$ | | | |
| | $\frac{10}{19} = \frac{0.06 \times 0.3^{2} - 0.116 yz}{0.06 \times 0.3^{2} + 0.11 \times 0.2 - (0.06 + 0.11) \sigma yz}$ | | | |
| | Solve for $\sigma YZ \rightarrow \sigma yz = 0.0118$ | | | |
| $0.0118 = \text{Pyz} * \sigma \text{y} * \sigma \text{z} \rightarrow \text{Pyz} = \frac{\sigma yz}{\sigma y \sigma z} = 0.1966$ | | | | |
| 2. | Risk portfolio = $\frac{r_p r_f}{A r_p^2} = 0.57 = \frac{.123704}{A \sigma_p^2}$ | | | |
| | $r_p = (\frac{.5}{.57} * .1) + (\frac{.27}{.57} * .15) = .1237$ | | | |
| | Correlation coeff of Y,Z => Cov (Y,Z) = $D_{rz} r_r r_z$ = D(.2)(.3) | | | |
| | $r_{ZE}^{2}(R_{y}) - E(R_{z})Cov(Z,Y) = -3^{2}(.06) - (.11)Cov(Z,Y)$ | | | |
| | $-\frac{1}{(3^{2}*.06)+(.2^{2}*.11)-(.11+.06)Cov(Y,Z)} - \frac{1}{(3^{2}*.06)+(.2^{2}*.11)-(.11+.06)Cov(Y,Z)}$ | | | |
| | $.5263 = \frac{.005411Cov(Z,Y)}{.009817Cov(Z,Y)} 0.00516 - 0.0895Cov = .005411Cov *Cov(Z,Y) = 0.0117$ | | | |
| Deute | 0.0117 = D(.2)(.3) => Corr Coeff = 0.195 | | | |
| Part c: | $E(r_{m})$ | | | |
| 1. | To maximize utility, we invest $y^* = \frac{-(rp)-r}{A\sigma p^2}$ in risky assets. | | | |
| | $E(r_p) = \frac{1}{57} + 0.1 + \frac{1}{57} + 0.15 = 0.1237$ | | | |
| | $\sigma_p^2 = w_y^2 \sigma_y^2 + W_z^2 \sigma_z^2 + 2w_y w_z \sigma_{yz}$ | | | |
| | $\sigma_p^2 = \left(\frac{30}{57}\right)^2 * 0.2^2 + \left(\frac{27}{57}\right)^2 * 0.3^2 + 2 * \frac{30}{57} * \frac{27}{57} * 0.1966 * 0.2 * 0.3 = 0.0372$ | | | |
| | $\mathbf{Y^*} = \frac{57}{100} = \frac{0.1237 - 0.04}{A * 0.00372}$ | | | |

→ A = 3.95

2. $\sigma_p^2 = w_y^2 r_y^2 + w_z^2 \sigma_z^2 + 2 \operatorname{Cov}(Z,Y) w_y w_z = 5.265^2 + .2^2 + .3^2 + .4737^2 + 2(.5263)(.4737)$ Cov = 0.037108

 $0.57 = \frac{.1237 - .04}{A * .037108} \quad A = 3.957$

EXAMINER'S REPORT

Majority of candidates scored well.

Part a

Candidate was expected to be able to interpret the meaning of different values for A. They needed to mention that the investor is "risk seeking" or "risk lover" to obtain full credit.

Part b

Candidates were expected to know the formula for the weight of securities in the optimal risky portfolio and determine the correlation coefficient. The most common errors were due to miscalculation.

Part c

Candidates were expected to know the formula for the optimal weight of the risky portfolio. They were expected to be able to calculate the value of A given the correlation coefficient calculated in part b. The most common errors were due to misinterpreting the formula and miscalculation.

| QUESTION 2 | | | | |
|---|--|--|--|--|
| TOTAL | POINT VALUE: 2 | LEARNING OBJECTIVE: A2, A4 | | |
| SAMPLE ANSWERS | | | | |
| Part a: 0.5 point | | | | |
| a) | $E(r) = .12 \sigma = 4 p = .35 n = 30$ | | | |
| | Avg σ^2 = .4 ² = .16 | | | |
| | Avg cov = .35(. 4 ²) = .056 | | | |
| | $\sqrt{\frac{1}{n}(.16) + \frac{n-1}{n}(.056)} \le .24$ | | | |
| | $\frac{.16}{n} + .056 - \frac{.056}{n} \le .0576$ | | | |
| | $\frac{.104}{n} \le .0016 \Rightarrow n \ge 65$ | | | |
| Part b | 1.5 points | | | |
| b) | Systematic = .056 => s + dev = .2366 | | | |
| | Original = $\sqrt{\frac{16}{30} + \frac{29}{30}(.056)} = .2439$ | | | |
| | Z(.1) = -1.282 | | | |
| | Original VaR = 10,000,000 (.12 – 1.282(.248 | 9)) = -1,926,798 | | |
| | Diversified VaR = 10,000,000 (.12-1.282(.23 | 64)) = -1,833,212 | | |
| | Amount eliminated = -1,833,212 – (-1,926,7 | 98) = 93,586 | | |
| b) | The systematic risk = $6_p^2 = (\frac{1}{n} 6_i^2 + \frac{n-1}{n} \text{Cov}) =$ | : Cov = 0.056 | | |
| | Mean = Mp = 0.12, 6p = $\sqrt{0.056}$, Z = N (0.90 | 0) = 1.282 | | |
| | VaR diversified = 10M * (Mp + Z 6p) = 10M Without diversification | 0.12 + 1.282 * $\sqrt{0.056}$) = 4,233,766 | | |
| | Mean = Mp = 0.12, $6_p^2 = \frac{1}{20} * 24^2 + \frac{29}{20} * 0.056$ | = 0.059467 | | |
| | VaR undiversified = 10M (Mp + Z 6p) = 10M The VaR eliminated = 4,326,258 – 4,233,766 | (0.12 + 1.282 √0.059467) = 4,326,258 5 = 92,492 | | |
| b) | $6_{current} = \left(\frac{0.4^2}{30} + \left(1 - \frac{1}{30}\right) * 0.056\right)^{\frac{1}{2}} = 0.24386$ 1 ⁻¹ (0.90) = 1.28 | Systematic = $\sqrt{0.056}$ | | |
| | Amount diversified away = 10,000,000*1.28 | *(0.24386 - $\sqrt{0.056}$) = 92,375.15 | | |
| EXAMINER'S REPORT | | | | |
| Part a | | | | |
| For part A, the candidate was expected to know how to set up the relationship between the | | | | |
| portfolio variance and the number of stocks in the portfolio. The majority of candidates received | | | | |
| full credit on part A. Common errors were algebra errors and failure to take the square of 0.24 (to | | | | |
| get the variance). | | | | |
| Part b | | | | |
Part B was more challenging. The candidate was expected to know how to calculate the formula for the portfolio variance. To receive full credit, the candidate would have correctly calculated the portfolio variance of the 30-stock portfolio as well as the variance of the portfolio that is diversified in such a way that only the systematic risk remains. The remaining points for part B were awarded for calculating the VaR of the two different portfolios and taking the difference to show the amount that was diversified away. Alternatively, the candidate could recognize a shortcut and calculate the amount of VaR that was diversified away without individually calculating the VaRs (see the various sample solutions). Common errors for part B included:

- Using (n-1) / n * Cov for the systematic risk instead of just the Cov
- Only calculating one VaR
- Comparing a diversified portfolio to a single stock portfolio
- Using the variance instead of the standard deviation in the VaR formula

| QUESTION 3 | |
|--|------------------------|
| TOTAL POINT VALUE: 1.5 | LEARNING OBJECTIVE: A5 |
| SAMPLE ANSWERS | |
| Part a: 0.25 point | |
| Sample 1 | |
| $\frac{Cov(ri,rm)}{2} = \beta i$ | |
| G^{-m} Cov (ri, rm) = βi σ^2 m | |
| $= .9 * .2^2 = .036$ | |
| | |
| Sample 2 | |
| $COV_{A,Mkt} = \beta_A * \beta_M * \sigma_M^2 = .9 * 1.0 * .2^2 = .036$ | |
| | |
| Sample 3 | |
| Cov $(r_A, r_M) = B_A \sigma_M^2 = .9(.2)^2 = .036$ | |
| Part b: 0.25 point | |
| Sample 1 | |
| Cov $(r_A, r_B) = B_A B_B \sigma_M^2 = .9(.3)(.2)^2 = .0108$ | |
| Part c: 0.5 point | |
| Sample 1 | |
| $\sigma_{C}^{2} = B_{C}^{2} \sigma_{M}^{2} + \sigma^{2}(e_{C})$ | |
| Systematic: $B_C^2 \sigma_M^2 = 1.7^2 (.2)^2 = .1156$ | |
| Firm specific: $\sigma^2(e_c) = \sigma_c^2 - R_6^2 \sigma_M^2 = .4^21$ | 156 = .0444 |
| Sample 2 | |
| $\frac{\text{sample } z}{\sigma^2 - \rho^2 \sigma^2} \qquad \qquad$ | |
| $O_C - \rho_C O_M + O_C (e)$ | ic |
| J. | |
| $4^2 = 1.7^2 * .2^2 + \sigma_c^2$ (e) σ_c^2 (e) = 04 | 44 |
| $\beta_c^2 \sigma_M^2 = \text{Systematic} = .1156$ | |
| Part d: 0.5 point | |
| Sample 1 | |
| 1. Markowitz model requires a large numbe | r of parameters. |
| $\frac{n^2-n}{n}$ COV variances in expected returns, and | d n std deviations |
| | ג וו זנע עכיוענוטווז. |

2. Due to the large number of parameters, the Markowitz model is subject to estimation errors which can produce nonsensical results. These errors are magnified due to the large number of parameters (as opposed to the small number in index model, this smaller estimation error risk).

Sample 2

a) 1. Single factor model uses less parameters; less parameter risk.

2. Separating systematic (macroeconomic) and firm-specific risk allows for specialization in securities analysis / decisions.

Sample 3

1. Markowitz will be very time intensive. Must calculate expected return and variance for 100 stocks along with the covariance between each of these stocks. Single index model won't take

as long since less calcs and cov is calculated through β of each stock and market variance. 2. Single index model splits out firm specific and systematic risk where Markowitz doesn't. This is important since return is based only on systematic risk and firm specific risk can be diversified away.

EXAMINER'S REPORT

Candidates were expected to be able to compute variances and covariances for the single-index model of security prices and compare the single-index model with the Markowitz model. Performance was generally good on this question, with many candidates obtaining full credit. The most common errors were in the formulas for the covariances and variances.

Part a

The candidate needed to recall and apply the correct formula for the covariance between the stock and the index in a single-index model.

Common errors made by candidates included use of B_A^2 instead of B_A in the formula for the covariance, use of Sigma_M instead of Sigma_M^2 in the formula, and calculation of B_M as a capitalization-weighted average of the B_A, B_B, B_C.

Part b

The candidate needed to recall and apply the correct formula for the covariance between an individual security and the index for the single-index model.

A common error made by candidates was the use of Sigma_M instead of Sigma_M^2 in the covariance formula.

Part c

The candidate needed to recall and apply the correct formula for expressing the total variance of an individual stock in the single-index model as a sum of the systematic variance and firm-specific variance.

Common errors made by candidates included use of B_C instead of B_C^2 in the systematic component of the variance and plugging in the total variance (Sigma_C^2) as the firm-specific variance (Sigma(E_C)^2). The latter mistake was the most common across all of question 3.

Part d

The candidate was expected to express two distinct disadvantages of the Markowitz model as compared to the single-index model. Since the question condition involved a significant increase in the number of stocks in the financial market, the candidates were originally expected to give disadvantages related to this new information {e.g. much more work involved due to the large number of parameter estimates; greater potential error associated with the large number of parameter estimates and especially the need to estimate covariances between numerous potentially unrelated securities}. However, the wording in the question did not specifically rule out more general disadvantages of the Markowitz model, so we accepted answers such as:

- Markowitz model makes it more difficult for analysts to specialize in particular industries because it requires estimating pairwise covariances across all securities in the financial markets.
- Markowitz model does not provide any guidance on how to forecast risk premiums
- Markowitz model does not differentiate between macroeconomic and firm-specific influences on security risk



upfront.

Since A & B negatively correlated, can have variance of zero. For p = -1 $W_A = \frac{\sigma_B^2 + \sigma_A \sigma_B}{\sigma_A^2 + \sigma_B^2 + 2 \sigma_A \sigma_B} = \frac{\sigma_B (\sigma_A + \sigma_B)}{(\sigma_A \sigma_B)^2} = \frac{\sigma_B}{\sigma_A \sigma_B}$ $= \frac{\sqrt{1.44}}{\sqrt{0.16} + \sqrt{1.44}} = \frac{1.2}{0.4 + 1.2} = 0.75$ $W_B = 1 - 0.75 = 0.25$ Check: $\sigma^2 = 0.75^2 * 0.16 + 0.25^2 * 1.44 + 2(-1) (\sqrt{0.16}) (\sqrt{1.44}) (0.75) (0.25)$ = 0Since $\sigma = 0$, that means the return calculated in part a) is "risk-free". \Rightarrow Borrow at risk free rate \Rightarrow Use borrowed money to purchase portfolio in part a) with 75% in A and 25% in B (Portfolio P) \Rightarrow Use proceeds from Portfolio P to pay back loan and still have 6.05% - 3%

= 3.05% of risk free return.

EXAMINER'S REPORT

Part a

In this part, the candidate was expected to calculate the expected return of a portfolio of two assets using CAPM.

In order to obtain full credit, the candidates needed to calculate the beta, and expected returns for both A and B and then weight with the correct portfolio weights in order to calculate the expected return of the portfolio. Alternatively, the candidate could weigh the betas for A and B to calculate the beta of the portfolio and then calculate the expected return of the portfolio.

Common mistakes included:

- calculating Betas Using Std Dev of Market instead of Variance
- squaring portfolio variance assuming that std dev was provided

Part b

In this part, candidates were expected to construct a portfolio with zero variance, and explain how to exploit an arbitrage opportunity using the zero-variance portfolio and a risk-free security.

In order to obtain full credit, candidates needed to calculate the weights of A and B that would result in a zero variance portfolio and, using these weights, calculate the expected return on such a portfolio. Candidates then needed to recognize that an arbitrage opportunity existed between the zero-variance portfolio and the risk free

security, and outline an investment strategy with no up-front costs that borrowed at the lower risk free rate and invested the proceeds in the zero variance portfolio (which had a higher return).

Overall, most candidates had difficulty obtaining full credit on Part b. The majority of candidates seemed to understand the concept of an arbitrage strategy, but struggled to identify the arbitrage opportunity that existed within the problem.

Common mistakes included:

- explaining an arbitrage exploitation strategy that had up-front costs
- assuming a 50-50 weighting of A and B for the zero variance portfolio
- constructing a portfolio of A & B with a beta of 0 and outlining an arbitrage strategy between this portfolio and the risk-free security (these portfolios have the same return, so no arbitrage opportunity exists)
- constructing a portfolio of A & B with beta of 1 and outlining an arbitrage strategy between this portfolio and the market portfolio (these portfolios have the same return, so no arbitrage opportunity exists

ANSWERS AND EXAMINER'S REPORT EXAM 9

| QUESTION 5 | |
|------------|---|
| | _ |

TOTAL POINT VALUE: 1.5 SAMPLE ANSWERS

LEARNING OBJECTIVE: A6, A7

Part a: 1 point

Part a required candidates to calculate the expected value of Security A using the zero-beta extension of CAPM. Only one numeric final answer was accepted (+12%), which can be reached through the following steps:

- $E(r_A) = E(r_z) + \beta_A(E(r_M) E(r_z))$
- $\beta_A = \text{Cov}(r_A, r_M) / \text{Var}(r_M) = .0392 / (.14)^2 = 2$
- Given that the minimum-variance frontier is symmetric around the minimum-variance portfolio, the zero-beta portfolio will be the same distance away from the minimum-variance portfolio as the market portfolio on the inefficient side of the frontier. That is:
 - $\circ \quad E(r_z) = E(r_{minvar}) (E(r_M) E(r_{minvar}))$
 - \circ E(r_z) = .06 (.08 .06) = .04
- E(r_A) = .04 + 2(.08 .04) = .12

Candidates could have solved for $E(r_z) = .04$ various ways, including:

- Numerically (as above).
- Visually, by drawing the efficient frontier and labeling the points corresponding to the market portfolio and the market's zero-beta portfolio.
- Verbally, by explaining how one can infer the vertical position of the zero-beta portfolio given the symmetry of the efficient frontier and information given in the problem.
 - E.g. Given that the minimum variance frontier is symmetric around the minimum variance portfolio, the zero-beta portfolio will be the same distance away from the minimum variance portfolio as the market portfolio on the inefficient side of the frontier.

Sample 1:

a) E (r_A) = E (r_Z) + (E (r_M) - E (r_Z)) β_A

min-variance frontier is symmetric around min-variance portfolio.

 $E(r_Z) = (8\% - 6\%) + 6\%$ = 4% $\beta_A = \frac{Cov(r_A, r_M)}{\sigma_M^2}$ = $\frac{0.0392}{0.14^2}$ = 2 $E(r_A) = 4\% + (8\% - 4\%) * 2$ = 12%



| Part c: 0.25 point |
|---|
| Responses that received full credit for this subpart include: |
| • ρ = 0 |
| • 0 |
| The portfolios are uncorrelated. |
| |
| No credit was given for describing that the two portfolios were on opposite sides of the efficient |
| frontier, unless candidates further stated that the portfolios are also uncorrelated. |
| |
| Sample 1: |
| They are <u>NOT</u> correlated. |
| |
| Sample 2: |
| $\operatorname{Cov}(r_z, r_m) = \rho_{z,m} \sigma_z \sigma_m$ |
| $\operatorname{Cov}(r_z, r_m) = 0$ |
| $p_{Z,m} = 0$ Mkt & zero-beta portfolio are uncorrelated |
| FXAMINER'S REPORT |
| Part a |
| The candidate was expected to know the equation for the zero-beta extension of CAPM and to use |
| the fact that the efficient frontier is symmetric to calculate $F(r_2)$. Most candidates were able to |
| state the equation that they needed to solve for $F(r_{\lambda})$ and most were further able to calculate β_{λ} |
| |
| Common errors included: |
| • not using the information about the symmetry of the efficient frontier to calculate $E(r_{A})$ |
| incorrectly stating that the expected return for portfolio A was a function of actual returns |
| on the zero-beta and market portfolios |
| • using the risk free rate instead of $F[r_2]$ in the zero-beta equation |
| • using the minimum-variance portfolio sigma in calculating β_{A} instead of the market |
| portfolio sigma |
| Part b |
| Candidates generally performed well on this subpart and accurately noted that the ability to freely |
| borrow and lend at the risk-free rate is relaxed in the zero-beta extension of CAPM. |
| |
| Examples of responses that did not receive full credit: |
| • listing another CAPM assumption such as "All investors are mean-variance optimizers" |
| • stating that investors faced "restrictions on borrowing" under the zero-beta extension but not |
| specifying the assumption asked for in the question |
| • stating that investors have to or do not have to borrow/lend at the risk-free rate. The CAPM |
| assumption pertains to the ability to borrow/lend at r _f . |
| Part c |
| Candidates were expected to know that portfolios on the efficient frontier have a companion |
| portfolio on the inefficient half of the frontier with which they are uncorrelated (known as the |
| zero-beta portfolio). The candidates should therefore note that the market portfolio and its zero- |
| beta portfolio are uncorrelated. |

Common errors included listing correlations other than 0, such as:

- 1 (perfectly positively correlated)
- -1 (perfectly negatively correlated)
- other numeric value, calculated by trying to back into β_z using the original form of the CAPM equation: $E[r_z] = r_f + \beta_z(E[r_M] r_f)$. Note though that this was the very assumption relaxed in the zero-beta extension.

Other responses that did not receive credit:

- stating the relationship between the zero-beta portfolio and market portfolio e.g. that they lie on opposite sides of the efficient frontier without specifying the correlation
- leaving an answer in equation form. For instance, $\rho = \frac{Cov(r_M, r_z)}{\sigma_M \sigma_z}$

Candidates generally performed well on this subpart.

ANSWERS AND EXAMINER'S REPORT EXAM 9

| QUESTION 6 | | |
|--|---|--|
| TOTAL POINT V | ALUE: 2.25 | LEARNING OBJECTIVE: A11 |
| SAMPLE ANSW | ERS | |
| Part a: 1.25 poi | nts | |
| Firm Book to | Market CAPM Beta | Market Value Rank (low to high) |
| A 1.25 | 1.2 | 1 |
| B 0.7 | 1.2 | 1 |
| C 1.25 | 1.2 | 2 |
| A&C have highe Between A and larger cap firms | est book to market ratio C, A will have the highe →Firm A. | s (tied) so they'll be expected to have higher returns than B. r return, since small cap firms expected to outperform |
| Part b: 1 point | | |
| Sample Answer | #1 | |
| Small fi would r smaller Forecas bid up a B/M rat till go b | The tends to be neglected equire higher return due firms had higher return. t Error – investor place is and overpriced \rightarrow lead to io are undervalued, late ack up. | d by large investors, because of regret avoidance. Investors e to less information and its unconventional choice, so more weight in recent performance that glamour firm got o low B/M ratio, on the other hand, other firms with high er on, investor correct their errors, so high B/M value return |
| Sample Answer Regret A "uncon- thus wil Sample pattern price fo to M ra | #2 Avoidance → investors w ventional" or out of favo I require to have higher size neglect and represe /trend and extrapolating r these low book to mar tio firms → excessive pr | will demand higher returns for stocks that are or. High B to M ratio firms are considered out of favor and returns entativeness → investors tend to infer too quickly on pricing g price of low book to market ratio firms too high → higher rket ratio firms end up generating lower returns than high B ice represents excessive investor optimism |
| Sample Answer | #3 | |
| Affect – such as Conserv bought | firm A could have some being a green energy co vatism – investors were it, producing high return | ething that makes investors feel good about themselves ompany. This draws investors to buy A and drive up return. slow to accept new info, they saw A was attractive and ns. |
| EXAMINER'S R | PORT | |
| The candidates and use them t on this part, wi | were expected to be ab o evaluate the expected th many full credit answ | ble to identify the three factors in the Fama French model I return on the firms. The candidates generally scored well vers. |
| Part a | | |
| The candidates and use them t | were expected to be ab o evaluate the expected | ble to identify the three factors in the Fama French model I return of the firms. |

Common mistakes included suggesting that the LOWER B/M firm should have higher expected returns and failing to identify size (either failing to mention at all or not knowing that market value rather than book value should be used) as a factor to consider when selecting the firm.

Part b

The candidates were expected to describe two behavioral explanations that explain the superior performance of the firm identified in part a. Full credit is given when the candidate correctly described the behavioral explanation and explained how this behavior relates to superior performance.

We gave partial credit for all Behavioral Finance explanations mentioned in the text – Forecast error, Regret Avoidance, Overconfidence, Conservatism, Affect, Sample Size, Framing/Mental Framing, Mental Accounting and Disposition. Most of these were described in chapter 12 of the text. Please note that we did NOT allow credit for Prospect Theory even though it is described in the chapter 12 list of Behavioral Finance explanations. This is because Prospect Theory is an alternative to the standard indifference curve rather than a "Behavioral" – characterized by investor failure to process information correctly or failure to act on information leading to sub-optimal decisions.

There appeared to be a certain amount of confusion of the part of some of the candidates. In addition to the "Behaviorals", chapters 11 - 13 of the text also included explanations for various efficient market anomalies such as the Small Firm in January effect, the Neglected Firm effect, among many. Consequently, many responses pertained to these other (incorrect) explanations.

Even when the response was nominally in the direction of one of the Behavioral Finance explanations, there were additional mistakes. These included:

- labeling vs. description. A number of candidates labeled an explanation a certain way but then provided a different description. Given how the exam question was worded, we relied on the description – sometimes giving credit when the label would have been incorrect and vice versa.
- insufficient description to identify a Behavioral Finance explanation.
- described the behavioral explanation, but failed to relate it to the firm identified in part a, or how this behavior led to superior performance.
- identified firm or stock behavior instead of investor behavior.

ANSWERS AND EXAMINER'S REPORT EXAM 9

| QUESTION 7 | | | | |
|--|--|--|--|--|
| TOTAL POINT VALUE: 1.25 | LEARNING OBJECTIVE: A12 | | | |
| SAMPLE ANSWERS | | | | |
| Sample 1: | | | | |
| 1955 – 1974: Expected Return = Div Yield + Div Grov | vth = 9.6% vs. 9.5% Actual | | | |
| 1975 – 1994: 4.9% + 4.0% = 8.9% vs. 9.1% Actual | | | | |
| 1995 – 2014: 5.6% + 4.3% = 9.9% vs. 12.6% Actual | | | | |
| Assuming Portfolio Returns in the future will be app | roximately equal to the sum of Dividend Yield % | | | |
| and Dividend Growth % (as seen from 1955-1994), t | he high returns will likely not persist. | | | |
| | | | | |
| Sample 2: | | | | |
| Expected return (avg divided yield + avg divided gro | wth rate) | | | |
| 1955 - 1974 $6.6 + 3 = 9.6$ | | | | |
| 1975 - 1994 $4.9 + 4 = 8.9$ | | | | |
| 1995 - 2014 $5.6 + 3.5 = 9.1$ | | | | |
| Excess return (actual – expected) | | | | |
| 1955 - 1974 = 9.5 - 9.6 = -0.1% | | | | |
| 1975 - 1994 = 9.1 - 8.9 = 0.2% | | | | |
| 1995 - 2014 = 12.0 - 9.1 = 3.5% | veges return in recent period may be driven by | | | |
| more than expected "capital gains" | cess return in recent period may be driven by | | | |
| Based on DDM it doesn't seem like dividend vield a | nd growth in dividend vield will increase by 3 5% to | | | |
| match the actual | | | | |
| Based on DDM, it doesn't seem like high returns wil | l persist in the future. | | | |
| EXAMINER'S REPORT | | | | |
| Partial credit was given to candidates who approa | ached the problem using an excess return | | | |
| calculation, which was often incomplete. | | | | |
| | | | | |
| Also partial credit was given to candidates who pr | resented non-quantitative arguments based on | | | |
| the data presented in the problem (ie. trends, car | pital gains). | | | |
| ···· ···· ··· ··· ··· ··· ··· ··· ··· | | | | |
| In order to receive partial credit for stating "retur | ns would not persist", candidates needed to | | | |
| provide at least a minimal supporting argument. A large variety of reasonable supporting | | | | |
| arguments were accepted. even though they did | not specifically address the DDM. Partial credit | | | |
| was not given to responses that stated "returns would not persist" absent any supporting | | | | |

The challenge of this question is that it did not explicitly state that it was related to the Equity Premium Puzzle, which is contained in the knowledge statements and found within the required reading. Candidates were thus expected to recognize this problem's context within the syllabus

argument. A significant number of candidates failed to provide any response whatsoever.

based on the data given and its similarity to an example presented in the text.

| QUESTION 8 | |
|--|--|
| TOTAL POINT VALUE: 2.75 | LEARNING OBJECTIVE: B2 |
| SAMPLE ANSWERS | |
| Sample 1: | |
| f_t is forward rate from t to t+1. | |
| 97.89 = $\frac{102}{(1+r_1)}$ => $r_1 = 4.2\%$; 81.34 = $\frac{100}{(1+r_4)^2}$ | $r_4 = 5.3\%$ |
| $26,000 = \frac{2,000,000 \times (.075 - f_3) \times (4 - 3)}{(1 + r_4)^4} = \frac{2,000,000 \times (.075 - 4)}{(1 + .053)^4}$ $f_3 = 5.9\%$ | $(f_3)x(1)$ |
| $(1 + r_4)^4 = (1 + r_3)^3 (1 + f_3)$ (1 + .053) ⁴ = (1 + r_3)^3 (1 + .059) r_3 = 5.1% | |
| $6,000 = \frac{1,000,000 \times (.064 - f_2) \times (3 - 2)}{(1 + r_3)^3} = \frac{1,000,000 \times (.064 - f_2)}{(1 + .051)^3}$ $f_2 = 5.7\%$ | <u>2)x (1)</u> |
| $(1 + r_3)^3 = (1 + r_2)^2 (1 + f_2)$ (1 + .051) ³ = (1 + r_2)^2 (1 + .057) r_2 = 4.8% | |
| Bond 3 = $\frac{4}{(1+r_1)} + \frac{4}{(1+r_2)^2} + \frac{104}{(1+r_3)^3} = \frac{4}{(1+.042)} + \frac{4}{(1+.042)}$ Bond 3 = \$97.06 | $\frac{4}{.048)^2} + \frac{104}{(1+.051)^3}$ |
| Sample 2: | |
| 97.89 = $\frac{102}{(1+r_1)}$ => $r_1 = 4.2\%$; 81.34 = $\frac{100}{(1+r_4)^2}$ | $r_4 = 5.3\%$ |
| $26,000 = \frac{2,000,000 \times (f_3075) \times (4 - 3)}{(1 + r_4)^4} = \frac{2,000,000 \times (f_3075) \times (4 - 3)}{(1 + .053)^4}$ $f_3 = 9.1\%$ | <u>75)x (1)</u> |
| $(1 + r_4)^4 = (1 + r_3)^3 (1 + f_3)$ (1 + .053) ⁴ = (1 + r_3) ³ (1 + .091) r_3 = 4.06% | |
| $\begin{vmatrix} 6,000 = \frac{1,000,000 \text{ x } (f_2064) \text{ x } (3 - 2)}{(1 + r_3)^3} = \frac{1,000,000 \text{ x } (f_2064)}{(1 + .0406)^3} \\ f_2 = 7.08\% \end{vmatrix}$ | <u>)x (1)</u> |
| $(1 + r_3)^3 = (1 + r_2)^2 (1 + f_2)$ $(1 + .0406)^3 = (1 + r_2)^2 (1 + .0708)$ | |

$$\begin{split} & r_2 = 2.58\% \\ & \text{Bond } 3 = \frac{4}{(1+r_1)} + \frac{4}{(1+r_2)^2} + \frac{104}{(1+r_3)^3} = \frac{4}{(1+.042)} + \frac{4}{(1+.0258)^2} + \frac{104}{(1+.0406)^3} \\ & \text{Bond } 3 = \$99.94 \\ \hline & \text{Sample 3:} \\ & 97.89 = \frac{102}{(1+r_1)} \Rightarrow r_1 = 4.20\% ; \\ & 26,000 = \frac{2.000,000 \times (075 - f_3) \times (4-3)}{(1+f_3)} = \frac{2.000,000 \times (075 - f_3) \times (1)}{(1+f_3)} \\ & f_3 = 6.12\% \\ & 6,000 = \frac{1.000,000 \times (064 - f_2) \times (3-2)}{(1+f_2)} = \frac{1.000,000 \times (064 - f_2) \times (1)}{(1+f_2)} \\ & f_2 = 5.77\% \\ & 100 = 81.34 * (1+r_1)(1+f_1) (1+f_2)(1+f_3) \\ & 100 = 81.34 * (1+r_0)(1+f_1) (1+f_2)(1+f_3) \\ & 100 = 81.34 * (1+0.420)(1+f_1)(1+f_1)(1+f_2) = \frac{4}{(1+.0420)} + \frac{4}{(1+.0420)(1+.0512)} + \frac{104}{(1+.0420)(1+.0512)} \\ & \text{Bond } 3 = \frac{4}{(1+r_1)} + \frac{4}{(1+r_1)(1+f_1)} + \frac{104}{(1+r_1)(1+f_1)(1+f_2)} = \frac{4}{(1+.0420)} + \frac{4}{(1+.0420)(1+.0512)} + \frac{104}{(1+.0420)(1+.0512)} \\ & \text{Bond } 3 = \$97.26 \\ & \text{Sample 4:} \\ & 97.89 = \frac{102}{(1+r_1)} \Rightarrow r_1 = 4.20\% ; \\ & 26,000 = 2,000,000 * (.064 - f_2) * (3-2) \\ & f_3 = 6.20\% \\ & 100 = 81.34 * (1+r_1)(1+f_1) (1+f_2)(1+f_3) \\ & 100 = 81.34 * (1+r_1)(1+f_1) (1+f_2)(1+f_3) \\ & 100 = 81.34 * (1+r_0)(1+f_1)(1+f_1)(1+f_0)(1+f_0) \\ & 100 = 81.34 * (1+r_0)(1+f_1)(1+f_1)(1+f_0)(1+f_0) \\ & 100 = 81.34 * (1+r_0)(1+f_1)(1+f_0)(1+f_0) \\ & 100 = 81.34 * (1+r_0)(1+f_0)($$

| Sam | nl | - E. |
|-----|-----|----------|
| Sam | pig | <u> </u> |

| 97.89 = $\frac{102}{(1+r_1)}$ => $r_1 = 4.2\%$; 81.34 = $\frac{100}{(1+r_4)^4}$ => $r_4 = 5.3\%$ |
|--|
| $f_2 = 6.4\%$ (given) $f_3 = 7.5\%$ (given) |
| $\frac{(1 + r_4)^4}{\frac{(100/_{81.34})}{1.075}} = (1 + r_3)^3$ $r_3 = 4.575\%$ |
| $(1 + r_3)^3 = (1 + r_2)^2 (1 + f_2)$ $(1 + .04575)^3 = (1 + r_2)^2 (1 + .064)$ $r_2 = 3.67\%$ |
| Bond 3 = $\frac{4}{(1+r_1)} + \frac{4}{(1+r_2)^2} + \frac{104}{(1+r_3)^3} = \frac{4}{(1+.042)} + \frac{4}{(1+.0367)^2} + \frac{104}{(1+.04575)^3}$ |
| Bond 3 = \$98.50 |

EXAMINER'S REPORT

The candidate was expected to understand how to calculate a spot rate, forward rate, and bond price. Demonstrating how to apply the spot and forward rates correctly was required. As a general rule it was expected that the candidate be familiar with valuing a forward rate agreement. However, this was not required for full credit (see sample solution 5). Either annual or continuous compounding was deemed appropriate.

Many candidates had difficulty applying or interpreting the rates correctly throughout the problem. In particular, many candidates used the forward rate incorrectly in place of the spot rate and many used the wrong discount rate in the forward rate agreement. Another common error was overlooking the \$2M nominal rate in FRA B and using \$1M instead. Some candidates added a fourth term to "Bond 3".

This question was challenging due to the number and length of computations required. Many candidates had trouble applying or interpreting the output of each calculation.

A variety of answers were accepted as the question could be interpreted multiple ways. Some common methodologies that were accepted include:

- evaluation of FRA done from different company perspective
- candidate treated the given FRA value as at the beginning of FRA period
- candidate treated the given FRA value as at the end of FRA period
- candidate treated the given effective interest rates as forward rates

| QUE | STION 9 | | | | | | | |
|--|------------------------|--------------------------|-------------------|-----------------|----------|--------------|-------------|-----------|
| TOTAL POINT VALUE: 2 LEARNING OBJECTIVE: B3 | | | | | | | | |
| SAM | PLE ANSWE | RS | | | | | | |
| MET | HOD 1: | | | | | | | |
| | | | | | | | | |
| | Payments | Discount | Discounted | Re | ceives | Discount | Discounte | d |
| (t) | USD (\$M) | at 5.0% | Payments | M | XN(M) | at 8.0% | Payments | (MXN) |
| 1 | \$0.6 | 0.9512 | \$570,738 | | 12 | 0.9231 | 11,07 | 7,396 |
| 2 | \$0.6 | 0.9048 | \$542,902 | | 12 | 0.8521 | 10,22 | 25,725 |
| 3 | \$0.6 | 0.8607 | \$516,425 | | 12 | 0.7866 | 9,43 | 9,534 |
| 4 | \$10.6 | 0.8187 | \$8,678,546 | | 132 | 0.7261 | 95,85 | 51,673 |
| | Total | | \$10,308,611 | | | | 126,59 | 4,329 |
| | | | | | | | | |
| The o | company rec | eives the M | XN Pesos and pa | ays out in dol | lars. | | | |
| | | | | | | | | |
| The o | current value | to the com | ipany is 126,594 | ,329 / 11.5 - : | \$10,308 | 3,611 = \$69 | 9,592. | |
| Whe | re 11.5 is the | current ex | change rate. | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| MET | HOD 2: Payn | nents show | n in Millions, nu | mbers showr | are un | rounded. | | |
| | | | | | | | | |
| (1) | (2) | (3) | (4) | (5) | | (6) | (7) | |
| | | | | Receives in | Ν | let | | |
| | Payments | Receives | Pesos | (\$) | Payn | nent(\$) [| Discount | |
| (t) | USD | MXN | Conv Fact | (3) * (4) | (5) | - (2) | \$ at 5% | |
| 1 | 0.6 | 12 | 0.084387 | 1.012639 | 0.42 | L2639 0 | .392514 | |
| 2 | 0.6 | 12 | 0.081893 | 0.982711 | 0.38 | 32711 0 | .346291 | |
| 3 | 0.6 | 12 | 0.079472 | 0.953667 | 0.35 | 53667 0 | .304404 | |
| 4 | 10.6 | 132 | 0.077124 | 10.180304 | -0.4 | 19696 -0 |).343618 | |
| | | | | | | | | |
| | | | | | Tota | l (\$M) 0 | .699592 | |
| Col (| $4) = e^{((.0508)*t)}$ | ⁾ / 11.5, fac | tor to convert C | ol (3) from Pe | sos to l | Dollars. | | |
| | | | | | | | | |
| | | | | | | | | |
| Due | to different r | ounding me | ethods in interm | ediate steps, | differe | nt final val | ues would b | e arrived |
| at, and accepted as correct, given the rounding used. The range of answers receiving full credit | | | | | | | | |
| were | \$695,000 to | \$710,000 | | | | | | |
| FXA | MINER'S REP | ORT | | | | | | |

The candidates were expected to lay out the future payment patterns, discount at the appropriate rates, and convert the pesos into dollars from the company's perspective.

Candidates did well overall with most candidates obtaining full credit or making one error.

Common mistakes included:

- misinterpreting the payment patterns to go from t = 0-3, 0-4, 1-10 or 7-10
- missing the final exchange of principal at t=4
- not using continuous compounding to discount
- miscalculating the payment patterns
- calculating the final step backwards from the Company's perspective, and getting -699,592
- calculation errors

In doing Method 2 above:

- miscalculating column (4), usually getting the exponent (.05-.08) backwards
- not discounting by 5% as a final step (Col 7, above)

QUESTION 10

TOTAL POINT VALUE: 2.25

LEARNING OBJECTIVE: B5

SAMPLE ANSWERS

Part a: 1.25 points

Choosing to solely invest in short-term commercial papers will help reduce some interest rate risk since property & casualty reserves can be inflation sensitive. However, most of these reserves are indemnity, which for work comp is typically payments for lost wages & are set in a schedule, so inflation may be less of an issue. Also the insurer is taking a huge cut in expected investment income. I would suggest instead shift to more long-term bonds being including and keeping a smaller portion as short-term commercial paper. Additional premiums paid in should help cover claim cost so inflation isn't a big worry and the long term bonds will provide more interest income.

Part b: 1 point

This reserve increase dramatically shifts the book towards medical reserves, which are very inflation sensitive. Given this, the approach of carrying short-term commercial papers will help reduce the interest risk that comes from inflation changes. The investment could still have some long term bonds to help improve the expected investment, but not as long of a shift as recommended in part A.

EXAMINER'S REPORT

This question was written in a way to try to isolate a discussion about how to invest differently based on liabilities' inflation-sensitivity. As such, we tried to take other variables largely out of the mix by limiting investment options to only two assets (Short-Term Commercial Paper and Long Term Bonds) and taking away transaction costs. However, a lot of candidates listed transaction costs as a reason to not invest in Short Term Commercial Paper and made a final recommendation to invest in stocks. These candidates would have spent their exam time more wisely by constraining their answers to the parameters set up within the question.

Part a

We were looking for 5 different points to be made:

- most of the reserves are indemnity
- indemnity reserves are not as inflation sensitive
- short term commercial paper is better than long term bonds for inflation sensitive reserves
- long term bonds are a better option due to a better duration match
- long term bonds are a better option due to a higher yield

We generally gave credit for the above items even if they appeared in the discussion of the Part b section of the response.

We observed that:

- most candidates were able to recognize short term commercial paper was inappropriate due to the low yields and lack of duration matching
- some candidates had trouble recognizing the large difference of indemnity reserves compared to medical reserves and struggled to understand the impact of inflation on these reserves
- recognizing the impact of inflation on both kinds of reserves was key to understanding the distribution of assets that should be invested in. Many candidates did not discuss inflation at all. A few candidates attempted to assume a non-inflationary environment, which was not an acceptable assumption for this question.

Part b

We were looking for 4 different points to be made:

- the reserves had shifted to have a higher percent of medical
- the shift resulted in there being about a 50-50 split between medical and indemnity reserves (almost any discussion about a need to have a mix of assets because of the mix of liabilities resulted in credit for this subpart.)
- medical reserves are more inflation sensitive than indemnity reserves
- the company should invest in more Commercial Paper because of the increase in medical reserves

We generally gave credit for the above items even if they were discussed in the Part a section of the response.

We observed that many candidates did not discuss the increase in medical reserves. It was unclear whether these candidates did not notice the relative increase or if the candidates did not perceive differences in assets needed to back reserves in medical vs. indemnity.

| QUESTIO | N 11 | | |
|-------------------------|------------------|----------------------------|---|
| TOTAL POINT VALUE: 2.25 | | E: 2.25 | LEARNING OBJECTIVE: B5 |
| SAMPLE A | ANSWERS | | |
| Part a: 0.5 | 5 point | | |
| Т | PMT | PV | |
| | | | * assume interest rate in annually compounded |
| 1 | 0.192 | 0.1882 | |
| 2 | 0.192 | 0.1845 | |
| 3 | 0.192 | 0.1809 | $D = \sum T.PV$ |
| 4 | 0.192 | 0.1774 | $D = \frac{1}{\sum PV}$ |
| 5 | 4.192 | 3.7970 | |
| | | 4 5200 | |
| | | 4.5280 | D 4 503 |
| . · | 6 4 5 2 | | D = 4.593 |
| Price = | \$ 4.53 m | illion | D = 4.502 |
| Part b: 1 | point | | |
| a. If | there is a c | aecrease in in | terest rates, bond values increase. The impact in greater on |
| longer ter | m bonds | alast band C | here we adress on reter would have the greatest impact on its |
| D. Al | | | because a drop on rates would have the greatest impact on its |
| price. This | s is pecaus | | easons stated above |
| C. IV | | ally, $\Delta P = -D^{-1}$ | Δy. Since they all have the same price and C has the highest |
| reinvest | a drop will | give C the lai | gest donar increase. When in rates drop, they can sen it and |
| Part c: 0.7 | 75 point | | |
| XYZ Woul | d Select Bo | ond A because | e the duration equals their liabilities duration and the value |
| equals the | e future pa | yment value. | Since they don't predict interest rates, this will immunize them |
| to small c | hanges | | |
| EXAMINE | R'S REPOR | т | |
| Candidate | es were exp | pected to be a | able to calculate the price of a bond, its duration, the relationship |
| between | bond's pric | e and interes | t rate movements, and understand the concept of immunization. |
| Most can | didates did | well on part | a and c, but about half of the candidates did struggle on part b. |
| Part a | | | |
| Overall th | is part was | s well answer | ed by candidates. Some candidates treated the bond as if there |
| were only | 4 coupon | payments to | be made, while there were 5. Some candidates calculated the |
| duration | but forgot | to calculate tl | ne price. |
| Part b | | | |
| Some can | didates dio | d not understa | and that the company specifically wanted to make profit from |
| interest ra | ate movem | ients, and rat | her talked about immunization. Some candidates, while they |
| showed u | nderstand | ing between l | bond's price, duration and interest rates, treated the question |
| from an ii | mmunizatio | on point of vie | ew. |
| Part c | | | |
| Overall th | is part was | s well answer | ed by candidates. For the most part, candidates that did not get |
| full marks | incorrectl | y assumed th | at because XYZ does not forecast interest rates and relies only on |
| underwrit | ting results | to increase p | rotits, it means that XYZ is not concerned about duration |
| matching | their asset | s and liabilitie | es. Rather, they discussed investment choices of XYZ from other |

considerations such as transactions costs, maximum investment yield, or investing in stock to hedge inflation. In relying only on underwriting results, XYZ needs to remove/reduce the impact of investment risk from its results, hence the need for immunization.

| QUEST | ON 12 | | | | | |
|--|--|---|---|---|--|--|
| TOTAL | POINT VALUE: 2 | LE | ARNING OBJECTIVE: | C1 | | |
| SAMPL | E ANSWERS | | | | | |
| Part a: | 1 point | | | | | |
| <u>Descrip</u> | tive Answer: | | | | | |
| a) | ABC is already establish grows, it will be more lil increases. $Q_5 = 10\%$ | ed. It is not likely to def kely to default. This is n | ault in the near future eflected in Ba since the | . However, as competition e conditional profit default | | |
| | $Q_5 = \frac{20 - 10}{100 - 10} = 11.1\%$ | $Q_5 = \frac{30 - 10}{1 - 20} = 12$ | 2.5% | | | |
| | XYZ is unlikely to survive the new product is succ longer. This is reflective | e the next couple years, essful and XYZ survives in the decreasing cond | , since the new produc the next years, it is m itional default Pr of B. | t would fail. However, if ore likely to survive | | |
| <i>Q</i> ₅ = 30 | % $Q_{20} = \frac{50 - 30}{1 - 2070} = 2$ | 28.1% $Q_{P5} = \frac{58-50}{100-50} =$ | 16% | | | |
| <u>Unconc</u> | litional Probability calc: | _ | | | | |
| a) | Change in prob default | as a function of time | t | | | |
| | | 5-10 yrs | 10-1 | 5 yrs | | |
| | А | 20-10=10% 30-20=10% | | | | |
| | В | 50-30=20% | 58-5 | 0=8% | | |
| Bond rating B more accurately reflects expected change in prob of default as a function of time for XYZ. Since this requires successful development of a new product, the earlier years of development are the most critical and should see the greatest change in default probability. | | | | | | |
| | Once the company has survived that initial period and the new product is successful, it shouldn't see major changes in default prob. | | | | | |
| This is b better t <u>Hazard</u> a) | est shown by B, since 20 o ASBC, being in an indu <u>Rate calc:</u> Default intensity given s | 0% > 8% (while A shows stry & country competi survival. | steady decline 10% = tive. | 10 yrs), which may relate | | |
| | | | | | | |
| | Ba | 01 | 0 111 | 0.125 | | |
| | B | 03 | 0.286 | 0.16 | | |
| | L - | | | | | |

As seen above the default intensify $\lambda(t)$ decreases for the B rated., which matches the XYZ company. Some of it depends on successful development of a new product, making it right short term (70% on 5 yrs) but if they survived, chance of default in the next 5 yrs as shown above. And the trends go on for 10-15 yrs as well. So again, B. Also make note that ABC's rate goes up as a competitive environment. Part b: 1 point a) Calculate hazard rate for yr 15 (ABC) Ba $\rightarrow = \frac{.3-.2}{1-.2} = 12.5\%$ (XYZ) B $\rightarrow = \frac{.58 - .5}{1 - .5} = 16\%$ Since the Ba rated bond (ABC) has a lower hazard rate, they are more credit worthy. **EXAMINER'S REPORT** Part a Candidates were expected to recognize that a company that was reliant on a new product would have a period with a high probability of default followed by declining hazard rates if the product is successful. By far, the most common error was not including any discussion about the declining hazard rate portion of the pattern. Other errors were generally of the form where candidates argued that the Ba-rated bond with the constant hazard rate was more appropriate. Part b Most of the errors for part b were using the change in the unconditional probability instead of using the hazard rates to make a decision on which company would have better creditworthiness. Since the question asked under the condition that both companies survived, the answer needed to use the conditional probability or hazard rates. Most other deductions were caused by calculation errors.

ANSWERS AND EXAMINER'S REPORT EXAM 9

| QUESTION 13 |
|--|
| TOTAL POINT VALUE: 2 LEARNING OBJECTIVE: C2 |
| SAMPLE ANSWERS |
| Part a: 1 point |
| A collateralization agreement requires a company to post cumulative collateral equal to the difference between the total value of its agreements with a counterparty and a given threshold amount/specific event/condition if the total value exceeds the threshold. |
| a collateralization agreement provides collateral from the counterparty in a derivatives transaction. Collateral is typically the percentage of the value of a derivative to the party collecting collateral. |
| A collateralization agreement will not eliminate credit risk because: the threshold or line of credit amount is not protected the counterparty may stop responding to posting requests if in financial difficulty the counterparty may not be able to post collateral the assets posted may not be safe or may decrease in value |
| Sample Candidate Responses: If the value of a contract of a counterparty increases above a certain threshold, the counterparty will be required to post collateral for the difference between the value and the threshold. However, if a company is in financial distress, they may not respond to the collateral calls. |
| • A collateralization agreement provides collateral from the counterparty in a derivatives transaction. Collateral is typically a percentage of the value of a derivative to the party collecting collateral. It may not offer full protection because if the counterparty were to very suddenly face severe distress they would likely not have an opportunity to post collateral (some agreements only require collateral based on perceived credit worthiness). |
| • Collateralization agreements requires collateral to be posted either at initiation or upon a triggering event. If the collateral required is not equal to the exposure or the collateral cannot be provided upon triggering event, the financial institution can suffer a loss. Collateral value can also be impacted if securities (vs. cash or letter of credit) are used. |
| Part b: 1 point |
| A downgrade trigger is a clause that allows a financial institution to close out all outstanding agreements at market value with a company whose credit rating has dropped to or below a certain level. |
| A downgrade trigger may not provide sufficient protection in a scenario where a company's credit rating drops dramatically company has downgrade triggers established with several financial institutions, i.e. not all institutions may be able to collect on the change in credit rating |

- may default before credit rating reaches threshold/too late
- impairment is severe

Sample Candidate Responses:

- A downgrade trigger gives a party the option to close out a contract if the counterparty's rating drops below a certain level. However, this does not protect against large rating downgrades and if the counterparty has a lot of contracts with downgrade triggers, it could force them into premature bankruptcy and the company won't get its money.
- A downgrade trigger may require the closing of a position in the event of a counterparty has their credit rating downgraded by a rating agency. If the counterparty were to have several of these agreements then the sudden downgrade may trigger multiple contracts and the counterparty may not be able to close them all for full value.
- A downgrade trigger permits the closeout of the obligation if there is a downgrade to a
 party's credit rating. If there is a delay or long period between credit rating updates, the
 party being downgraded may not have the ability to meet its obligation → trigger is too
 late.

EXAMINER'S REPORT

Part a

Candidates were expected to know that collateral needed to be posted and determined based on threshold amount and to understand the risk that was not protected from this arrangement such as amount of threshold not being protected and/or party may not respond to requests. Candidates generally scored well. Candidates lost credit for not mentioning threshold.

Part b

Candidates were expected to know when a downgrade trigger would go into effect along with understanding what each party would do during the event (i.e. close out contract) and to understand the risk that was not protected from this arrangement such as when there is a sudden ratings downgrade. Candidates generally scored well. Candidates lost credit for not mentioning that contracts would be closed out.

ANSWERS AND EXAMINER'S REPORT EXAM 9

QUESTION 14

TOTAL POINT VALUE: 3.5

LEARNING OBJECTIVE: C6, C7

SAMPLE ANSWERS Part a: 1.5 points

1. Much larger market for subprime than for CAT bonds – more integral or "financially important" to economy.

Example answer: CAT reinsurance market is small compared to the overall financial market. Therefore the CAT bond market is likely to be easily absorbed by the market. This is unlike the massive size of the CMO market before it collapsed.

2. Correlations among the component bonds

- a. The defined triggers of CAT bonds allow more transparency in correlation between bonds
- b. Low correlations among different natural catastrophes

Example answer: The CAT bonds underlying the CDO can be selected to cover different geographical areas and therefore won't suffer from the geographical concentration that made estimation of correlation difficult for CMOs.

3. Correlation with the economy

a. Low correlation between natural catastrophes and economic collapse, except in the case of extremely large (i.e. the Big One in So Cal) events.

- b. Default on Cat bonds does not depend on credit worthiness or credit events.
- c. MBS = Systematic Risk, Cat bond = diversifiable risk

Example answer: CAT bonds are not correlated with market returns, so they should not drop in value during market downturn.

4. Strength of CAT bond collateralization

a. Cat bonds are collateralized with high quality securities, while MBS are collateralized by real estate.

b. No credit risk in CAT bond CDO.

Example answers:

- CAT bonds are collateralized (fully) therefore are not subject to credit risk like mortgages are.
- CAT bond CDOs are different because the underlying asset is fully collateralized, unlike mortgages, which were affected by fire sales.

5. Individual bonds can be individually scrutinized, as opposed to individual mortgages making up an MBS, or individual MBS's making up a CDO².

Example answer: CAT bonds have a credit rating provided, where individual subprime mortgages did not. Therefore, when CAT bonds are packaged into a CDO, we have a better idea of the risk of individual CAT bonds. CMOs packaged together ABS of mortgages.

6. No prepayment risk on the CAT CDOs.

Example answer: No prepayment risk. Mortgages can be prepaid, while CAT bonds can only be called after they have breached a certain trigger.

7. Recovery rate assumptions are not an issue with CAT CDOs, because the assumption should just be a total loss of principal.

Example answer: The CAT bonds are essentially all or nothing, unlike mortgages; they don't have the risk of overestimating recovery.

8. Cat bonds have LOWER moral hazard because of parametric trigger, as opposed to mortgage borrowers who have incentive to abandon loan.

Example answers:

- Banks could pass almost all mortgage risk to investors via mortgage CDOs. Insurers write single policies that cover both CAT and XCAT risk, therefore, less likelihood of deterioration in underwriting standards since insurer retains all CAT risk.
- Less moral hazard: CAT bonds are typically structured with index triggers to increase transparency regarding whether and how much is paid/lost from the bond. This reduces moral hazard of insurer triggering invalid payment. CMOs relied on the underlying homeowner to act with the same interests as the CDO investor (i.e. not default), even when default on a home that was under water may have been in his/her best interests.

9. CMOs themselves encouraged riskier mortgages

10. Insurers selling cat bonds maintain lower layers of cat exposure; thus there is no "pass through" risk (i.e. less moral hazard than for mortgage lenders)

Example answer: The insurers selling CAT bonds usually maintain exposure to the CAT events and the bonds can be independently priced so there is no parallel to the pass-through risk issuer with CMOs.

11. Subprime profusion was driven by government intervention; CAT bonds are not.

Example answer: CAT bonds already access the capital market without government intervention. The subprime crisis was partly fueled by government Fannie May guidance and encouragement from the government to provide cheap credit.

12. Cat bonds compete directly against traditional reinsurance, which will keep prices in line. MBS were the only market for transferring mortgage risk.

Example answer: CAT bonds have a competitive industry to benchmark against (reinsurance) so there is less risk prices will get out of whack.

13. Much lower interest rate risk for the CAT CDO (due to the swap)

Example answer: With a CAT bond the investor is shielded from interest rate risk (since there is a swap fixed for floating).

14. Cat bonds are shielded by the special purpose reinsurer from the business risk of the insurers (which is correlated with the broader economy)

Example answer: An SPR is formed in CAT bond arrangements to protect the investor from the business risk of the insurance company. In the CMOs, there was not medium like this to protect investors from risks associated with the mortgage holders.

Part b: 1 point

1. Unforeseen correlation between or increased frequency of cat events such as due to effects like global warming or fracking

Example answer: Global warming may cause flood more frequently occurs, if CAT bond focus on flood exposures, then it would increase the correlation.

2. Complications with multiple triggers within the same CDO prevent investors from understanding what they are buying

Example answer: Some CAT bonds use indemnity trigger & others can use index trigger (or even hybrid). The trigger used incorporates different risk (e.g. basis risk with index trigger & moral hazard with indemnity trigger) means CAT bonds less homogenous and payment of tranche harder to determine.

3. If CDOs are constructed with CAT bonds that have overlapping triggers; this could lead to heavy correlation between the packaged CAT bonds and could make the CAT CDOs much riskier than they initially appear.

Example answer: CATs can be highly correlated. For instance, a CAT hurricane loss is not independent of a CAT loss in South Carolina. It is possible that multiple CAT bonds could be in the CDO for the SAME region!

4. Model Risk

Example answer: It is very difficult to model CAT events. So there is modeling error associated with the estimated probability of a CAT event happening, & triggering a CAT bond payment.

5. Complexity and specialization of the CAT CDO would make it hard for rating agencies and investors to understand the risks they are assuming.

Example answer: CATS risk being passed to investors may pose challenges, as they may not truly understand the risk they'd be taking on, just like the CDO mortgage investors did not fully understand.

6. Securities laws prevent certain information (such as default probabilities) from being reported on CAT bond transactions. This would cause mispricing of the security.

Example answer: SEC only have CAT bond traded in private market. This limit the ability of noninvestors and researchers to study CAT bond and CAT bond market. Without fully understanding and advanced knowledge of CAT bond and CAT bond market, it'll be difficult to detect any problems before it's too late.

7. Similar to the proliferation and then securitization of non-conforming mortgages, standards on the quality of cat bonds and their securitization could be relaxed, such as requiring full collateralization of limits.

Example answer: Relax the UW standards for CAT bond and not invest funds in highly-rated securities.

8. AAA ratings could again be misconstrued as safe, since investors will assume "naming convention discipline" would have been created.

Example answer: Investors may misinterpret the "AAA" rating on CAT bond CDOs which could lead

them to underestimating the risk of default that could be caused by even one large catastrophe.

9. If they become more widespread, Cat reinsurance will become very cheap, leading to a decline in U/W standards and concentration monitoring at the primary insurer. This is a valid version of the moral hazard argument.

Example answer: Reinsurance company have to be competitive to sell CAT coverage in the market, this will drive down the RI price and eventually CAT bond CDO prices, then the yield of CAT bond CDO may seem attractive and follow the path of the subprime financial crisis.

10. CAT CDOs could become subject to speculative investment (particularly by means of Credit Default Swaps) by investors with no underlying Cat risk, similar to what happened in the financial crisis.

Example answer: Synthetic CDO can be forced by selling the CDS allowing for investors to take bets on CDO far greater than the total size of the CAT bond market.

11. There are not enough definable cat hazards to truly create a diversified bond.

Example answer: There are only so many potential CATs so diversification could be difficult. Also, only so many reinsurers. Hard to diversify CATs and reinsurers so if market grows quickly it might not be diversified.

12. The success of the market could stimulate market appetite for instruments linked to higher frequency events (i.e. with higher probability of default).

Example answer: If CAT bonds have probability of CAT occurring increase – write CAT bond on more common occurrences like tornadoes in Midwest or floods in flood prone areas.

Part c: 1 point

1. Require correlations in the model to be conservative

Example answer: Regulators could thoroughly review rating agency's models, and mandate they put in some conservative reduction in its ratings to account for the greater level of uncertainty.

2. Require all bonds to have the same easily understood type of trigger (i.e. index trigger), making risk more transparent and accurate.

Example answer: The underwriting of CAT bonds must be maintained to ensure likelihood of default doesn't increase and that for [the issue of complications from multiple triggers] that all CAT bonds in a single financial package have same trigger so investors know what trigger is used and can have CAT bond packages they want (either index or industry).

3. Limit the number or percent of CAT bonds underlying the CDOs that can have overlapping payment triggers; this would limit the correlation of default between the CAT bonds since the vast majority of catastrophes are uncorrelated

Example answer: CAT CDOs cannot cover the same risk groups. Each CAT must be unique / different, either different_ region or loss cause hurricane vs. tornado, etc.

4. Regulate the CAT modeling underlying individual bonds, alleviate some of the concerns

about the accuracy of the ratings given to the CDOs and allow for more investor confidence. Example answer: Regulators could put greater scrutiny on the underlying assumptions used to rate the bonds and to determine default rates. This could lead to more transparency around the uncertainty and the risk that these assumptions are wrong.

5. Loosen current securities reporting laws. This could help stakeholders estimate default probabilities more accurately.

Example answer: Rating can be regulated by government agencies who can build / import expertise to calculate the default probabilities and rating agencies won't have perverse incentives to provide false rating when they lack expertise.

6. Ensure that requirements on the quality of trust investments are not loosened

Example answer: Regulate where the investment can be put for the CAT bond funds.

7. Change naming conventions on CAT bond ratings.

Example answer: The AAA ratings should be assigned more carefully and perhaps be re-rated with a provision for how this risk is different from that of a single rating. There could be different scales developed for these risks compared to rating scales for individual firms.

8. Set limits on the amount of CAT bond CDOs that certain investors can hold.

Example answer: Put limits in place on how much investors could use CAT bond CMOs in their portfolios.

9. Dual or index trigger to solve moral hazard.

Example answer: Could use an industry loss index as a trigger to avoid the moral hazard of insurers inflating losses.

10. Have investors pay for ratings.

Example answer: CDOs should be rated by independent rating agencies, not those hired by the insurers / SPVs (issuers of CDOs) since this presents a conflict of interest.

11. Regulate U/W for cat-prone primary insurance.

Example answer: Federal oversight of companies U/W criteria in CAT prone areas could limit relaxing of guidelines.

12. Limit the use of Credit Default Swaps.

Example answer: Limit use of CDS on CAT bonds or have minimum capital requirements to be posted as collateral.

13. Limit the number of rebundlings (i.e. CDO³)

Example answer: Maximum number of "compounding iterations", i.e., max number of times you can bundle CDOs are re-split into tranches.

14. More investment in climate/hazard research.

Example answer: Regulation should encourage more research can be done for the improvement of CAT models by facilitating reporting of losses, or by making more of the current CAT bond market more open to academics for study. This is especially important as most rating agencies have little experience modeling tail risks like CAT events.

15. Ensure transparency in the nature of the underlying bonds (i.e. issuer, trigger) Example answer: Make the construction of CAT bond CDO's transparent. Investors need to know whether, for instance, they are investing too much on Mexico City hurricane risk.

16. <u>Limit</u> CDO^2 .

Example answer: Restrict the construction of CDO² / CDO when the market are still learning / understanding these complex instruments. Apply higher standards when rating the CAT bond CDOs.

17. Prohibit CDO² from being used as collateral in any other transactions.

Example answer: Make CAT bonds unavailable to use as collateral, despite the AAA rating. This would minimize the downward spiral that occurs after a potential downgrade.

18. Restrict triggering events to "well known" cat perils / lower frequency events.

Example answer: CAT bonds must be based on CAT events that have low probabilities of occurrence. Could model losses and if probability of loss is below a threshold can include CAT bond in CAT bond CDO.

19. Establish requirements for the quality of CAT bonds to be packaged.

Example answer: CAT bonds packaged into CDOs must meet certain criteria, or be "conforming" in order to be packaged into the asset backed securities.

20. Allow only institutional investors to purchase CAT bond CDOs.

Example answer: Investors in CAT bonds must be institutional investors to ensure that the full risks are understood. This would likely have little impact on the market since most ILS is hedge funds and institutional investors, like pension funds.

21. Improve quality of index to reduce moral hazard

Example answer: For the construction of CAT bonds, regulation should encourage the industry to establish better CAT event indexes so that both the investor and insurer will face lower risks.

EXAMINER'S REPORT

The candidate was expected to know some basic features of both cat bonds and mortgage backed securities, the risks underlying each, and some major drivers of the subprime financial crisis. Examples of these are:

- Cat bonds: Single Purpose Reinsurer, collateralization of principal in safe assets, covered risks (i.e. specific perils and regions for a (re)insurer)
- MBS: bundling of mortgages, pass-through securitization, involvement of government through Fannie Mae and Freddie Mac.
- drivers of crisis: extreme sensitivity of structured instruments to correlation assumptions, unrealistic assumptions and overconfidence in models, decline in standards for securitization (i.e. allowing non-conforming loans to be packaged).

Candidates achieved mixed results on this question. Those who obtained full credit generally highlighted correlation between bonds as the fundamental strength of Cat CDOs, as well as a possible issue, and listed at least one solution that would prevent correlation between bond

defaults from being an issue for the CDO.

Some candidates identified issues with Cat bonds in general, such as the balance between morale hazard associated with indemnity triggers and basis risk associated with index or model triggers. We felt that, while these are truly valid issues, correlation between bonds is the fundamental issue, and these other problems would be characterized as idiosyncratic and diversifiable.

Some candidates expressed confidence in the quality of cat modeling compared to that of the modeling underlying MBS creation. While there can be legitimate points made that the modeling is of very good quality, we felt that model risk is still a very valid concern with cat bonds.

A few candidates expressed confidence in various ways that regulators, rating agencies, investors, and other parties have "learned their lesson" from the subprime crisis and will price, underwrite, and rate Cat bond CDOs appropriately. In general, candidates did not adequately defend this optimism.

This was a challenging question, requiring synthesis of syllabus material involving structured finance generally, and the subprime crisis and cat bonds specifically. It required creativity and critical thinking

Part a

Candidates were expected to demonstrate an understanding of the basic features of both CAT bonds and the collateralized mortgage obligations that fueled the subprime financial crisis and be able to identify differences between the two to refute the critic's objections mentioned in the question.

In order to receive full credit, the candidate had to list 3 separate differences that helped refute critic's objections to CAT bond CDOs

Responses that listed literal differences but had no explanation of how these differences would inhibit another financial crisis did not receive credit (for example: CMOs involved individuals while CAT CDOs involve insurers).

Another common response that did not receive credit was arguing CAT bond CDOs could actually be riskier than CMOs.

Part b

Candidates were expected to identify potential issues with CAT bond CDOs and potential widespread construction. In order to receive full credit, the candidate had to identify two separate issues with either the CAT bond CDOs or challenges related to widespread construction.

The most common error was the candidate discussing an issue with the CAT bond itself (i.e. moral hazard or basis risk resulting from the selection of trigger). These did not receive credit because, while they are true issues for the insurance company behind the bond, they do not specifically relate to a challenge for the financial markets.

Another common error was candidates not listing responses that were inherently different from

each other. For example, listing complications from correlation of underlying geographic location and correlation from underlying type of event would only receive credit for one issue not two. **Part c**

Candidates were expected to come up with reasonable and not overly general solutions to the issues listed in part b.

Candidates did receive full credit for a reasonable solution to an unaccepted challenge listed in part b (for example, even though moral hazard was not accepted as a challenge in part b, a solution in part c of requiring a dual trigger to reduce moral hazard would receive full credit).

Candidates received only partial credit for giving solutions that were too general (for example as a solution to the problem that the bonds may be difficult to rate – "have the ratings be provided by the right experts". To receive full credit this would have had to give more detail on the experts, for example require multiple CAT modelers to be involved in the rating process).

Candidates also received only partial credit if they listed a valid solution, but it was to a problem that was not listed in part b. In order to receive the partial credit in this case, however, the problem the solution was solving needed to be clearly defined as part of the answer.

Candidates did not receive credit for solutions that were too restrictive as the question clearly stated "without greatly discouraging innovation or investment". For example, as a solution to the challenge of synthetic CAT bond CDOs, "do not allow the creation of synthetic CAT bond CDOs" would not receive credit.

ANSWERS AND EXAMINER'S REPORT EXAM 9

| QUESTION 15 | |
|---|---|
| TOTAL | POINT VALUE: 2 LEARNING OBJECTIVE: C7 |
| SAMPLE ANSWERS | |
| Part a: | 1.5 points |
| Econom | nic Profit = Premium (1-Expense Ratio) x (1+ Investment Return) – Premium x Loss Ratio |
| Economic Profit for A=\$10M x (11) x 1.065 – \$10M x .8 = \$1.575M | |
| Economic Profit for B=\$8M x (115) x 1.065 – \$10M x .75 = \$1242M | |
| A is preferred as it has a higher economic profit. | |
| RORAC=Economic Profit/Required Capital | |
| RORAC for A = \$1.575M/\$9.5M = 16.7% | |
| RORAC for B = \$1.242M/\$4.5M = 27.6% | |
| B is preferred as it has a higher RAROC. | |
| It was also acceptable to calculate Economic Profit as Underwriting Income and Investment Income separately, i.e. Premium (1-Expense Ratio-Loss Ratio)+ Premium (1-Expense Ratio)x Investment Return. | |
| a) | Economic profit = Premium – Expense – PV (Loss) + Investment income Assume loss ratio is discounted loss ratio |
| | A = [10M - 10M*10% - 80% * 10M] + 0.065 [10M - 10% (10M)] = 1.585M |
| | B = [8M – 8M * 15% - 75% * 8M] + 0.065 [8M – 15% (8M)] = 1.242M |
| | Line A is preferred under economic profit measure |
| | $RAROC = \frac{Economic profit}{C}$ |
| | A = 1.585M / 9.5M = 0.167 |
| | B = 1.242M / 4.5M = 0.276 |
| | |
| | Line B is preferred under RAROC measure |
| h) | $\frac{1.585M + (1 - 10\% - 80\%)P + 0.065[(1 - 10\%)P]}{100} = 0.276$ |
| | 9.5M - 0.270 |
| | r – 0.341VI |
| Part b. | 0.5 point |
| Sample 1: All fixed: $(\$10M \times (1-1) + P) \times 1.065 \cdot \$10M \times 81/\$9.5M = 276 \text{ implies } P=\$0.974M$ | |
| | |
| a) | Economic profit |
| , | $A \rightarrow = (p - \varepsilon) (in) - PVL$ |
| | = 10000 (.9) (1.065) - 10000 (.8) = \$1,585,000 |
| | B → 8000 (.85) (1.065)75 (8000) = \$1,242,000 |

Since A has a higher economic profit, it would be preferred based on this metric. RAROC $A \rightarrow = \frac{\varepsilon c Pr}{\text{Req Cap}} = \frac{1585}{9500} = 16.68\%$ $B \rightarrow = \frac{1242}{4500} = 27.6\%$ B has a higher RAROC, would be preferred. b) $.276 = \frac{(10000)(.9)(1.065) + \pi(1.065) - 10000(.8)}{0500}$ 9500 <u>π = 973,709</u> Sample 2: Fixed losses, variable expenses: ((\$10M+P) x (1-.1)) x 1.065-\$10Mx.8)/\$9.5M=.276 implies P=\$1.082M a) Economic profit \Rightarrow Assume given LR is discounted LR for both Line A: 10M * (1-10%) * (1.065) – 10M * 0.8 = 1.585M Line B: 8M * (1-15%) * (1.065) - 8M * 0.75 = 1.242M \Rightarrow A is preferred RAROC Line A: $\frac{1.585}{\text{Capital}_{A}} = \frac{1.585\text{M}}{9.5\text{M}} = 16.68\%$ Line B: $\frac{1.242}{\text{Capital}_{B}} = \frac{1.242\text{M}}{4.5\text{M}} = 27.6\%$ \Rightarrow Line B is preferred b) Line A: Addition X premium (0.276) * 9.5M = (10M + X) * (1-10%) * (1.065) - 10M * 0.82.622M = 9.585M + 0.9585X - 8M 1.037M = 0.9585X X = 1.0819M
Sample 3: All variable: ((\$10M+P) x (1-.1) x 1.065-(\$10M+P)x.8)/\$9.5M=.276 implies P=\$6.540M a) Economic profit A = 10M (1-0.1) 1.065 - 10M\$ * 0.8 = 1.585 M\$ B =8M (1-0.15) 1.065 - 8M\$ * 0.75 = 1.242M\$ Under economic profit Line A is better. $A = \frac{1.585}{9500} = 16.7\%$ RAROC $B = \frac{1.242}{4.5} = 27.6\%$ RAROC Under risk adjusted return on capital Line B is preferable. b) 27.6% * 9.5 = (10+x)(1-0.1) * 1.065 - (10+x) * 0.8In order to have a RAROC = 27.6% the additional premium required is 6.543M\$ 2.622 = 9.585 - 8 + 0.9585X - 0.8X X = 6.543M\$ Sample 4: It was also acceptable to calculate directly as a required change in premium, i.e. (.276 x \$9.5M - \$1.575M)/1.065=\$0.974M a) Econ Profit = Prem - Expn + Inv Incom - PVCL RAROC = Econ Profit / Begin Capital A: Econ Profit = (10 - 10*.1) * 1.065 - 10 * .8 = 1.585 M RAROC = $\frac{1.585M}{9.5}$ = 16.68% B: Econ Profit = (8 - 8 * .15) * 1.065 - 8 * .75 = 1.202M RAROC = $\frac{1.202M}{4.5}$ = 27.6% Econ Profit \Rightarrow A higher $RAROC \Rightarrow B$ higher b) $\frac{1.585 + R \times 1.065}{9.5} = .276$ R = .974 M

EXAMINER'S REPORT

Candidates generally performed well on this question. For both parts, candidates were expected to understand RAROC, calculate it, and apply it.

Part a

For full credit, a candidate was expected to demonstrate knowledge of and correctly calculate the economic profit and RAROC.

Candidates were also expected to understand what economic profit is, know how to calculate economic profit, and select the preferred line based on the measures.

Candidates generally performed well on this part, especially for RAROC. Common errors included:

- subtracting cost of capital from profit to get the economic profit
- discounting losses to the beginning of the year but investing net premium to the end of the year
- ignoring investment income

Some candidates only calculated RAROC and missed the instructions to calculate both measures. It was also important to clearly identify which line was preferred and why.

Part b

For full credit, a candidate was expected to calculate the additional premium to reach the target RAROC.

Candidates were expected to know how to adjust the premium to reach the target RAROC.

Candidates performed very well on this part. Common errors included subtracting cost of capital, or providing the total premium instead of the additional premium.

| QUESTION 16 | QUESTION 16 | | | | |
|--|----------------------------|--------------------------|------------------------------------|---|--|
| TOTAL POINT | VALUE: 2 | | | LEARNING OBJECTIVE: C7 | |
| SAMPLE ANS | SAMPLE ANSWERS | | | | |
| Prob | Assets | Losses | Deficit | | |
| .5*.5=.25 | 18,000 | 15,000 | - | | |
| .5*.3=.15 | 25,000 | 15,000 | - | | |
| .5*.2=.1 | 35,000 | 15,000 | - | | |
| .3*.5=.15 | 18,000 | 20,000 | 2,000 | | |
| .3*.3=.09 | 25,000 | 20,000 | - | | |
| .3*.2=.06 | 35,000 | 20,000 | - | | |
| .2*.5=.1 | 18,000 | 30,000 | 12,000 | | |
| .2*.3=.06 | 25,000 | 30,000 | 5,000 | | |
| .2*.02=.04 Sums to 1 | 35,000 | 30,000 | - | | |
| (Full credit was also given for those who just showed the relevant rows with deficits.) | | | | | |
| E[L] = .25*15,000 + .15*15,000 + = 19,500 EPD = 2,000*.15+12,000*.1+5,000*.06 = 1,800 EPD Ratio = 1,800/19,500 = .0923 | | | | | |
| New A = $19,000$.2*(30,000 - x)/19,500 = 0.0923 x = 21,000 Since this is greater than the next lowest loss, 21,000. Additional capital = 21,000 - 19,000 = 2,000 | | | | | |
| Alternate Sol #1 after finding EPD Ratio: Keep same EPD of 1,800, since losses don't change (30,000 – (19,000+c))*.2 = 1,800 c = 2,000 | | | | | |
| EXAMINER'S | REPORT | | | | |
| Candidates we distribution, d | ere expect eficit in ea | ed to know ch scenari | / how to calcul o, the EPD, and | ate the expected loss, the joint probability I remember its relationship to the EPD ratio. | |

With the investment switch, the candidate was expected to figure out that only the \$30K loss will produce a deficit in order for the EPD to remain the same.

After that, the candidate was expected to calculate the additional capital to hold directly, or through finding the deficit, total assets required, and then the required additional capital.

Candidates in general scored well, with a majority of candidates receiving full credit.

Some candidates incorrectly calculated the EPD based on an incorrect probability distribution, such as not creating a joint distribution.

Some candidates used (Expected Assets – Expected Losses) as the capital rather than calculating the additional capital needed to maintain the EPD ratio. For example, some candidates calculated the additional capital as 21,000 - E[L] rather than 21,000 minus the guaranteed assets of 19,000.

Some candidates assumed a deficit for both the 20,000 and 30,000 case, but did not go back and verify after calculating their additional capital that the 20,000 case would not have a deficit, thereby disproving their assumption.

Some candidates made minor calculation mistakes.

QUESTION 17

TOTAL POINT VALUE: 2.25

LEARNING OBJECTIVE: C8

SAMPLE ANSWERS

Part a: 1.5 points Premium Risk

Model solution 1

Line A b/c greater chance of mispricing. Line A has catastrophe risk which is very volatile and difficult to predict. Reinsurance can be priced for the "average" year of experience based on models. However, in most years there will be very little losses but infrequently there will be years with very large losses (when a hurricane hits, for example). Also, there is model risk involved b/c catastrophe models are likely used due to lack of historical experience, so that introduces additional pricing risk.

Model solution 2

Prem risk is expected risk that expected prem collected won't be enough to pay for expected losses for those corresponding policies. A needs higher allocation since it covers CAT loss, which has a fat tail and can be really volatile.

Reserve Risk

Model solution 1

B receives more because it will have more reserves due to its longer payout pattern.

Model solution 2

Reserve risk: short-tail property CAT claims are settled & paid out quickly even for reinsurers, while latent long term claims can take years before hitting reinsurance layers & being reported to the reinsurer. This makes reserving very difficult & risky for the long-tailed casualty reinsurance & so it should get a higher capital allocation B.

Interest Rate Risk

Model solution 1

Interest Rate Risk \rightarrow Line B should receive more capital because it is longer tailed so the investments supporting the reserves need to have a longer duration, and are therefore more dependent on changes in interest rate.

Model solution 2

Interest Rate Risk: Line B because it is long tailed so supporting capital & premiums are invested for longer: subject to changes in value as interest rates fluctuate. Line A is shorter tailed so invest in low risk, short term investments that aren't subject to interest rate fluctuations.

Part b: 0.75 point

VaR allocates capital to achieve a given percentile threshold (exceedance probability). The severity of losses above the threshold has no impact on the allocation. However CTE looks at the average severity above the threshold. A would get more allocated capital using CTE due to the low frequency, high-severity losses of the CAT exposed line, which would impact CTE but would not impact VaR as much.

EXAMINER'S REPORT

This question required candidates to apply their knowledge to a hypothetical reinsurance company and a basic set of assumptions. Candidates generally received partial credit on the question as a whole, due to difficulty with part a. In part a, candidates lost credit for restating information given in the question as the solution, rather than providing an explanation about why the information drove the capital allocation.

Part a

Part A tested the candidate's knowledge of basic insurance and financial risks, as well as their ability to discuss allocating capital to the sources of those risks. These are core concepts within financial risk management and we expect candidates to have comfort applying these to a simple model of a reinsurance company.

The main differentiator between getting credit and not seemed to come from candidates being able to articulate how the attributes of a certain line of business drove its capital allocation. For each of the three subparts, candidates received full credit for identifying which line should receive the bulk of the allocation and explaining why.

The most common error came from candidates simply restating information given in the question without any explanation about why that drove the capital allocation (example "because it is long-tailed"). Other common mistakes included explanations which were indeed properties of the line of business, but did not relate to the risk being discussed.

Part b

Part B tested the candidate's knowledge of VAR and CTE metrics and their ability to apply them (conceptually, not numerically) in allocating capital to the two sources of risk. These are basic metrics of risk measurement and we expected all candidates to be able to apply them. The candidate received full credit by explaining the difference between the risk measures, as well the expected behavior of the risk measure when applied to catastrophe loss distributions.

Candidates overall scored very well on this part. Partial credit was given for demonstrating a clear understanding of VAR versus CTE but failing to apply it correctly to the model at hand. The most common error came from candidates confusing the short-tail or long-tail attribute for light-tail or heavy-tailed loss distributions.

| QUESTION 18 | |
|---|---|
| TOTAL POINT VALUE: 2.25 | ARNING OBJECTIVE: C9, C10 |
| SAMPLE ANSWERS | |
| Discounted loss ratio as LossRatio / (1+Interest)^(durat | ion) |
| • WC: 0.775/(1.025)^3.5 = 0.7108 | |
| | |
| Net profit as (1 – DiscountedLossRatio – ExpenseRatio) | * Premium |
| • WC: (1-0./108-0.2/) * 8,000,000 = 153,238 | |
| Capital allocated as (Co-CTE / Total Co-CTE) * CapitalRe | quired |
| • WC: (2,600/6,500) * 5,000,000 = 2,000,000 | |
| | |
| RAROC as (NetProfit/ CapitalAllocated) | |
| • WC: 153,238/2,000,000 = 7.7% | |
| Alternate solution is to calculate the cost of capital in d | ollars , |
| • WC: 2,000,000*(0.15) = 300,000 | |
| • EVA = 153,238 - 300,000 = - 146,762 | |
| | |
| | |
| 7.7% < 15% WC: Does not odd value hearves DADOC is law. | an them exact of equital |
| WC: Does not add value because RAROC IS lower | er than cost of capital |
| Alternate, $E_{1/4} < 0 (146.762.40)$ | |
| EVA < 0 (-140,702 < 0) W(C: Does not add value because EVA is lower to | han cost of canital |
| FXAMINER'S REPORT | |
| To receive full credit, the candidate was expected to | know how to calculate BABOC at the correct |
| point in time and make the appropriate comparison | and conclusion regarding whether the line |
| adds value. | |
| | |
| Generally, the candidates scored favorably. Common | n errors included: |
| bringing all values to t = 1 when it should be to | t = 0 |
| not explicitly stating the comparison that brir | ngs them to the conclusion of adding value |
| inclusion of investment income in profit calculation | ulation |
| • not calculating the allocating capital at all or | using duration to allocate the capital |
| Less frequent errors included inappropriate discount | ing of losses and contemplating duration in |
| the cost of capital | |

| QUESTION 19 | | | | | | |
|--|-------------------------|---------------|-----------------|---------------------|---------------------------|----------------------------|
| TOTAL POINT VALUE: 2.25 | | | | LEARNING OBJE | CTIVE: D1 | |
| SAMPLE ANSWEP | RS | | | | | |
| Note : Five model | solutions | are prov | ided as example | s, but graders gav | e full credit t | to other solutions, |
| depending on assu | umptions | made by | the candidate r | egarding balance s | sheet items a | and investment |
| income. | | | | | | |
| | | | | | | |
| | | | | | | |
| <u>Sample 1:</u> | | | | | | |
| | | | 0 | 1 | | 2 |
| Prem | | $\frac{0}{D}$ | $\frac{1}{0}$ | | $\frac{2}{0}$ | |
| Expense | | | 25P | 0 | | 0 |
| Loss | | | 0 | .425P | | .425P |
| | | | | | | |
| RSV | .85 | P | .425P | 0 | | |
| A Surplus | .425 | 5P | .2125P | 0 | $\leftarrow \frac{RS}{2}$ | <u>SV</u> |
| D. Currelue | 207 | 90 | 141070 | 0 | , RS | <u>,</u> SV |
| B Surpius | .283 | 5P | .14107P | 0 | | } |
| • | | | | | | |
| A | 1 275 | D | 1 4025 | 70125 | D | |
| Asset Pre | 5250 | ٢ | 1.4025 | .70125 | ٢ | |
| Asset Post | 1 275 | P | 6375P | 0 | | \leftarrow RSV + surplus |
| Distrib | | | .34P | .27625 | Р | |
| 2.00.10 | | | | | · | <u> </u> |
| В | | | | | | |
| Asset Pre | 1.133 | Р | 1.2463P | .62333 | 7 | |
| Contrib | .383P | | | | | ← .383P = |
| | | | | | | 1.133P-(P25P) |
| Asset Post | 1.133 | Р | .56667P | 0 | | |
| Distrib | | | .25463P | .19833 | 7P | \leftarrow = .62337P - 0 |
| | | | | | | 423P |
| 100 | | | | | | |
| <u>IKK</u> | .27625P | | | | | |
| A:525P + $\frac{1}{1+R_A}$ + | $\frac{1}{(1+R_A)^2} =$ | 0 | | | | |
| $IRR_{A} = 11.819\%$ | | | } divide by F | & it cancels at sin | $ce \frac{0}{p} = 0$ | |
| B:383P + $\frac{.25463P}{$ | + .198337F | -=0 | | | 1 | |
| $1+R_B$ | $(1+R_B)^2$ | - | | | | |
| $IKK_B = 12.31\%$ | | | | | | |
| NPV | | | | | | |
| Δ : - 525P + $\frac{.34P}{+}$ + $\frac{.2}{2}$ | 2 <u>7625P</u> _ ∩ | 267P | | | | |
| 1.08 | 1.08 ² 0 | 2071 | _ | | | |
| B: $383P + \frac{.101001}{1.08} + \frac{.100001}{1.08^2} = .0228P$ | | | | | | |

| Option A | 0 | 1 | 2 | |
|--|---|---|--|--|
| Premium | Р | 0 | 0 | |
| Expenses | 25P | 0 | 0 | |
| Losses | 0 | 425P | 425P | |
| | L | | | |
| UEPR | Р | 0 | 0 | |
| Loss Portion | .85P | 0 | 0 | |
| Loss Rsrvs | 0 | .425P | 0 | |
| Total Rsrvs | Р | .425P | 0 | |
| Required Surp | .85P | .2125P | 0 | |
| Required Assets | 1.85P | .6375P | 0 | |
| | | · | | |
| Beginning Assets | Р | 2.035P | .70125P | |
| Payments | 25P | 425P | 425P | |
| Remaining | .75P | 1.61P | .27625P | |
| Required | 1.85P | .6375P | 0 | |
| Δ Equity | 1.1P | 9725P | 27625P | |
| Investment inc NPV based on f | come earned on all as | sets. not just surplus. | | |
| | 8% COSE OF CADILAT. | | | |
| Option B | | 1 | 2 | |
| Option B Premium | 0 P | 1 0 | 2 | |
| Option B Premium Expenses | 0 P 25P | 1 0 0 | 2 0 0 | |
| Option B Premium Expenses Losses | 0 P 25P 0 | 1 0 0 425P | 2 0 0 425P | |
| Option B Premium Expenses Losses | 0 P 25P 0 | 1 0 0 425P | 2 0 0 425P | |
| Option B Premium Expenses Losses VEPR | 0 P 25P 0 P | 1 0 0 425P | 2 0 0 425P | |
| Option B Premium Expenses Losses VEPR Loss Portion | 0 P 25P 0 P .85P | 1 0 0 425P 0 0 | 2 0 0 425P 0 0 | |
| Option B Premium Expenses Losses VEPR Loss Portion Loss Rsrv. | 0 P 25P 0 P .85P 0 | 1 0 0 425P 0 0 .425P | 2 0 0 425P 0 0 0 0 | |
| Option B Premium Expenses Losses VEPR Loss Portion Loss Rsrv. Total Rsrv. | 0 P 25P 0 P .85P 0 P | 1 0 0 425P 0 0 .425P .425P .425P | 2 0 0 425P 0 0 0 0 0 0 0 | |
| Option B Premium Expenses Losses VEPR Loss Portion Loss Rsrv. Total Rsrv. Required Surplus | P 25P 0 P .85P 0 P .85P 0 P .85P | 1 0 0 425P 0 0 .425P .425P .425P .142P | 2 0 0 425P 0 0 0 0 0 0 0 0 0 0 | |
| Option B Premium Expenses Losses VEPR Loss Portion Loss Rsrv. Total Rsrv. Required Surplus Requi8red Total | 0 P 25P 0 P .85P 0 P .85P 1.85P 1.85P | 1 0 0 425P 0 0 0 .425P .425P .425P .425P .142P .567P | 2 0 0 425P 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 | |
| Option B Premium Expenses Losses VEPR Loss Portion Loss Rsrv. Total Rsrv. Required Surplus Requi8red Total | 0 P 25P 0 P .85P 0 P .85P 1.85P | 1 0 0 425P 0 0 .425P .425P .425P .142P .567P | 2 0 0 425P 0 0 0 0 0 0 0 0 0 0 0 0 0 | |
| Option B Premium Expenses Losses VEPR Loss Portion Loss Rsrv. Total Rsrv. Required Surplus Requi8red Total Beginning Assets | 0 P 25P 0 P .85P 0 P .85P 1.85P P | 1 0 0 425P 0 0 .425P .425P .425P .425P .142P .567P 2.035P | 2 0 0 425P 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 | |
| Option BPremiumExpensesLossesVEPRLoss PortionLoss Rsrv.Total Rsrv.Required SurplusRequi8red TotalBeginning AssetsPayments | 0 P 25P 0 P .85P 0 P .85P 1.85P 1.85P 25P 25P | 1 0 0 425P 0 0 .425P .425P .425P .425P .142P .567P 2.035P 425P | 2 0 0 425P 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 | |
| Option BPremiumExpensesLossesVEPRLoss PortionLoss Rsrv.Total Rsrv.Required SurplusRequi8red TotalBeginning AssetsPaymentsRemaining | 0 P 25P 0 P .85P 0 P .85P 1.85P P .25P 25P 0 P .85P 0. P .85P 1.85P 25P 25P | 1 0 0 425P 0 0 .425P .425P .425P .425P .142P .567P 2.035P 425P 1.61P | 2 0 0 425P 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 | |
| Option B Premium Expenses Losses VEPR Loss Portion Loss Rsrv. Total Rsrv. Required Surplus Requi8red Total Beginning Assets Payments Remaining Required | 0 P 25P 0 P .85P 0 P .85P 1.85P P 25P .85P 0 P .85P 1.85P 25P 75P 1.85P | 1 0 0 425P 0 0 .425P .425P .425P .425P .142P .567P 2.035P 425P 1.61P .567P | 2 0 0 425P 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 | |

| IRR: 0 = -1.1P + $\frac{1.048P}{1+IRR}$ + $\frac{1}{(1)}$ NPV: P(-1.1 + $\frac{1.043}{1.08}$ + $\frac{1.98}{1.08}$ | $\frac{1987P}{+IRR)^2} \Rightarrow IRR = 11.08\%$ $\frac{37}{3^2} = 0.0361P$ | | |
|---|---|----------------------------|---------|
| <u>Sample 3:</u> | | | |
| Option A: | | | |
| Т | 0 | 1 | 2 |
| Prem | Р | | |
| Expenses | .25P | | |
| Loss Reserve | .85P | .425P | |
| Loss Paid | 0 | .425P | .425P |
| Required Surplus (problem states = initial loss portion of UEP reserve) | .85P | $.2125P = \frac{.425P}{2}$ | 0 |
| Contr. By Inv. (P25P85P) +.85P = .95P Assuming at t=1, use capital ratio. | .95P | | |
| Inv. Income | | .17P | .06375P |
| Pre Dist. Assets | 1.7P | 1.87P | .70125P |
| Distr. To Inv. | 0 | .8075P (.852125)+.17 | .27625P |
| Needed Assets | 1.7P | .6375P | 0 |

 IRR_A : -.95P + $\frac{.8075P}{1+IRR}$ + $\frac{.27625P}{(1+IRR)^2}$ = 0 Using calculator, IRR = 11.16% (P cancels)

NPV: $-.95P + \frac{.8075P}{1.08} + \frac{.27625P}{1.08^2} = .0345P$

Option B: only thing that changes is required surplus @ t=1

| Т | 0 | 1 | 2 |
|-------------|------|---------------------------|---|
| Reg Surplus | .85P | $.1417P = \frac{.425}{3}$ | 0 |
| Need Assets | 1.7P | .5667P | 0 |

$$\begin{split} IRR_B: -.95\mathsf{P} + \frac{.8783P}{1+IRR} + \frac{.19837P}{(1+IRR)^2} \Rightarrow \mathsf{IRR} = 11.23\% \\ NPV_B: -.95\mathsf{P} + \frac{.8783P}{1.08} + \frac{.19837P}{(1+.08)^2} = .0333\mathsf{P} \end{split}$$

| | | I | |
|--|------------------|--------------------------|-------------|
| | 0 | 1 | 2 |
| Prem. | Р | 0 | 0 |
| VEPR | Р | 0 | 0 |
| Exp. | .25P | 0 | 0 |
| Loss Res. | 0 | .425P | 0 |
| Pd. Loss | 0 | .425P | .425P |
| Inv. Inc. | 0 | .1425P | .06375P |
| Req. Eq. | <u>.85P</u> 2 | .2125P | 0 |
| Equity Flow | 675P | .505P | .27625P |
| 3: | 0 | 1 | 2 |
| Prem. | Р | 0 | 0 |
| VEPR | Р | 0 | 0 |
| - | .25P | 0 | 0 |
| Exp. | 0 | .425P | .425P |
| Exp. Loss Res. | 0 | | .425P |
| Exp. Loss Res. Pd. Loss | 0 | .425P | |
| Loss Res. Pd. Loss Inv. Inc. | 0 | .425P .1283P | .0567P |
| Exp. Loss Res. Pd. Loss Inv. Inc. Req. Eq. | 0 0 .283P | .425P .1283P .142P | .0567P 0 |

 $.675P = \frac{.505P}{1+IRR} + \frac{.27625P}{(1+IRR)^2}$ 2 (.2765) X = 1.115 $IRR_A = 11.5\%$ $NPV_A = -.675P + \frac{.505P}{1.08} + \frac{.2765P}{1.08^2} = .0296P$ B: .533P = $\frac{.4193P}{1+IRR} + \frac{.1987P}{(1+IRR)^2}$ $IRR_B = 12\%$ $NPV_B = -.533P + \frac{.4193P}{1.08} + \frac{.1987}{(1.08)^2} = .0255P$

| Sample 5: | | | | |
|--|--------|---------|----------|--|
| Option A IRR | | | | |
| | 0 | 1 | 2 | |
| Prem. | Р | 0 | 0 | |
| Exp. | .25P | 0 | 0 | |
| Res. | Р | .425P | 0 | |
| Loss | 0 | .425P | .425P | |
| Req. Surpls | Р | .2125P | 0 | |
| Inv. Irc. | 0 | .2P | 0.06375P | |
| Asset Pre. | 2P | 2.2P | 0.70125P | |
| Equity | -1.25P | 1.1375P | 0.27625P | |
| Asset Post | 2P | 0.6575P | 0 | |
| Option B IRR | | | | |
| | 0 | 1 | 2 | |
| Prem. | P | 0 | 0 | |
| Exp. | .25P | 0 | 0 | |
| Res. | Р | .425P | 0 | |
| Loss | 0 | .425P | .425P | |
| Req. Surpls | Р | .142P | 0 | |
| Inv. Irc. | 0 | .2P | 0.0567P | |
| Asset Pre. | 2P | 2.2P | 0.6237P | |
| Equity | -1.25P | 1.208P | 0.1987P | |
| Asset Post | 2P | 0.567P | 0 | |
| Option A IRR $\Rightarrow 0 = -1.25P + \frac{1.1375P}{1+IRR} + \frac{0.27625P}{(1+IRR)^2}$ $1.25 = \frac{1.137}{1+IRR} + \frac{0.27625}{(1+IRR)^2}$ IRR = 10.924% Option A NPV = $-1.25P + \frac{1.1375P}{1.08} + \frac{0.27625}{1.08^2}$ = 0.04 P | | | | |
| Option B IRR $\Rightarrow 0 = -1.25P + \frac{1.208P}{1+IRR} + \frac{0.1987P}{(1+IRR)^2}$ IRR = 10.965% Option B NPV = $-1.25P + \frac{1.208P}{1.08} + \frac{0.1987P}{(1.08)^2}$ = 0.0389P | | | | |
| EXAMINER'S REPORT | | | | |

In order to obtain full credit candidates were expected to calculate the correct expenses, reserves, loss payments, and investment income in order to come up with the correct equity flows, from which the candidate would then calculate the correct IRR and NPV. This had to be done for BOTH option A and option B for full credit.

A very large proportion of the candidates got full credit or close to full credit. Common mistakes included:

- calculating the NPV of the premium, expense and loss payment cash flows only, i.e. NPV = $P 0.25P 0.425P/1.08 0.425P/1.08^2 = -0.0079P$.
- calculating the correct NPV, but inverting the sign, i.e. providing the correct answer but adding a negative sign in front when there should have been none.
- a few candidates set up the UPR at t = 0, but did NOT set up any subsequent loss reserve, hence giving a required surplus of 0 at t = 1.

| QUESTION 20 | | | | | |
|--|---|------------------------|--|--------|--|
| TOTAL POINT | TOTAL POINT VALUE: 2 LEARNING OBJECTIVE: D1 | | | | |
| SAMPLE ANSWERS | | | | | |
| Part a: 1 point | | | | | |
| Surplus allocated in proportion to premium | | | | | |
| 0 | Surplus to HO | : \$500M * 50% = \$2 | 50M | | |
| 0 | Surplus to WC | C: \$500M * 50% = \$25 | 50M | | |
| 0 | ROE _{но} = \$25N | 1 / \$250M = 10% | | | |
| 0 | ROE _{wc} = \$25N | 1 / \$250M = 10% | | | |
| Surplu | s allocated in p | roportion to reserves | | | |
| 0 | RatioBasis _{но} = | \$500M * 1 = \$500M | | | |
| 0 | RatioBasis _{wc} = \$500M * 3 = \$1,500M | | | | |
| 0 | % surplus to HO: \$500M / 2,000M = 25% | | | | |
| 0 | % surplus to WC: 75% | | | | |
| 0 | Surplus to HO: \$500M * 25% = \$125M | | | | |
| 0 | Surplus to WC: \$500M * 75% = \$375M | | | | |
| 0 | о ROE _{но} = \$25М / \$125М = 20% | | | | |
| • $ROE_{WC} = $25M / $375M = 6.67\%$ | | | | | |
| Surplu | • Surplus allocated based on policy inception through payment, assuming loss occurrence | | | | |
| happe | ns mid-term. | | | | |
| | | Period | Surplus | RoE | |
| НО | | .5 + 1 = 1.5 | $500\left(\frac{1.5}{1.5+3.5}\right) = 150 M | 16.67% | |
| WC | | .5 + 3 = 3.5 | \$350 M | 7.14% | |

Part b: 1 point

If surplus were allocated in proportion to premium, the above numbers would not change since the premium numbers are based on the current premium.

If surplus were allocated in proportion to reserves, more than 25% of the reserves would likely be held for the HO line of business and less than 75% of the reserves would likely be held for the WC line of business. The WC line would have progressively built up reserves as that business grew (faster growth rate for WC means lower historical reserves for WC than HO). As a result, ROE_{HO} would likely be less than 20% while ROE_{WC} would likely be more than 6.67%.

Alternative for allocation based on reserves: Assuming duration is unchanged then there is no impact on ROE for HO and WC.

EXAMINER'S REPORT

Learning Objective D1 states that the candidate is expected to be able to evaluate the internal rate of return framework and specifically on this question, understand the methods for allocating surplus and the impact on IRR. The first part of the question required basic allocations of surplus to calculate the ROE for each line of business, while the second part of the question required the candidate to evaluate the impact on the ROE and to briefly explain.

Part a

The vast majority of candidates scored well on this part, with the majority of candidates getting full credit. Most candidates responded with allocations using premium and reserves. Credit was granted to candidates using other allocation methods as long as it was well documented and assumptions were stated.

A common error resulting in partial credit was misinterpreting the given information as \$500 million of surplus for each line, not in total.

Part b

The candidate was expected to "evaluate" the rate of return and briefly explain the rationale, which effectively resulted in 4 pieces to their answer: the impact on the ROE for each line of business in part A and the rationale for each impact.

This part of the question appeared to be challenging for most candidates, with the majority of candidates only receiving partial credit. Common errors included:

- difficulty evaluating the impact from the growth in the WC line of business
- misinterpreting the information in part b as prospective growth, not growth over the past several years
- only mentioning the impact(s) on ROE with no corresponding rationale for the impact(s)

QUESTION 21

TOTAL POINT VALUE: 2

LEARNING OBJECTIVE: D2

SAMPLE ANSWERS Sample 1:

Insurance leverage factor = $1 + \frac{R}{s}$

The insurance leverage can be viewed as non-equity financing. It is the reserves borrowed from policy holders, and is available for investment. The key question in how much of this non-equity financing is optimal is how much it impacts the volatility of earnings. There is a cost associated with this non-equity capital, and unlike debt capital, the cost is variable, not fixed. The formula can also be written as:

$$\frac{T}{S} = \frac{I}{A} + \frac{R}{S} \left(\frac{I}{A} + \frac{U}{R} \right)$$

Which shows that $\frac{U}{R}$ is the interest "expense" paid for the use of the non-equity capital. If underwriting gains are positive, then this capital was "free", but if underwriting losses are experienced, this is a cost.

If $\frac{R}{s}$ is too high, then the firm may be unprofitable due to potential volatility in earnings.

If $\frac{\ddot{R}}{s}$ is too low, then firm may be overcapitalized.

Changing the $\frac{R}{s}$ factor results in uncertainty about the impact on total return due to the uncertainty around underwriting results.

Sample 2:

Insurance leverage factor = $\frac{R}{S}$ $\frac{T}{S} = \frac{I}{A} + \frac{R}{S} \left(\frac{I}{A} + \frac{U}{R}\right)$

Therefore, if $(\frac{I}{A} + \frac{U}{R}) > 0$, leverage factor will result in total $\frac{T}{S}$ to be higher.

The result of $\left(\frac{I}{A} + \frac{U}{R}\right)$ is being leveraged.

If $(\frac{I}{A} + \frac{U}{R}) > 0$, the effect on $\frac{T}{s}$ will be magnified due to $\frac{R}{s}$. Also if $(\frac{I}{A} + \frac{U}{R}) < 0$, $\frac{T}{s}$ will decrease more.

If too high it will cause the $\frac{T}{s}$ to be very volatile, also if $\frac{R}{s}$ high due to write more business, the more earning will increase firm value. At the same time, the volatility will decrease firm value; opposite effect.

If too low and $(\frac{I}{A} + \frac{U}{R})$ is positive, that means the firm is not efficiently using the non-equity financing strategy, since it can be viewed as borrow at $\frac{R}{s}$ with interest $\frac{U}{R}$.

EXAMINER'S REPORT

The candidate was expected to know what the insurance leverage factor is, its purpose in and impact on the calculation of total ROE, and issues with this factor not being at its optimal level.

Candidates generally scored well on the question as a whole, although the majority did not get full credit. Full credit was granted where the candidates showed an understanding of the multiple forces at work behind this leverage and how they impacted the total ROE. Simply stating directional impacts (i.e. if A goes up, then B goes up) did not demonstrate a full understanding.

Common reasons for deductions included:

- candidates not understanding what was being leveraged, i.e. the leverage affects the investment income contribution to ROE
- candidates not demonstrating understanding that the impacts on total ROE stemmed from the opposing forces of increased investment income and higher discount rate required by investors
- candidates stating only a directional impact on ROE of changes to the leverage factor, particularly if they do not account for the possibility of negative investment income being amplified by an increase in the factor

The question was challenging to the candidates in that the reasoning behind this factor's use was required for full credit, not simply showing the change in one factor based on another by simple recall of parts of the formula.

| QUESTION 22 | | | | |
|---|--|--|--|--|
| TOTAL POINT VALUE: 2 | LEARNING OBJECTIVE: D3 | | | |
| SAMPLE ANSWERS | | | | |
| Part a: 1 point | | | | |
| Sample 1 Firms with higher equity would have mean that insurer is not using capital Investors demanding higher ROE show protection is sufficient (no need to at Chief actuary justification may not be | lower ROE even if they are as profitable. It could efficiently. uld not be passed on to policyholder as long as surplus tract new capital). e reasonable. | | | |
| Sample 2 | | | | |
| While it may be appropriate for investit is not reasonable from the regulator and is probably comparing to multilin Capital allocation differs by company measure for the regulator to use is the surplus. | stors to compare rates of return between companies, or's perspective. Because this is a monoline insurer ne insurers, the comparisons are difficult to make. and cannot be done by line. A more appropriate ne profit provision as a percent of premium instead of | | | |
| Sample 3 | | | | |
| No, policyholders should not be subjeare not owners of capital (shareholdefrom return on surplus. Should not compare one company's rdifferent risk profile therefore needs Therefore, rate increase is NOT reaso | ect to the general investment risk of the insurer. They ers are) so they should not benefit or be penalized return on equity to another. Each company has a different amounts of surplus. onable. | | | |
| Part b: 1 point | | | | |
| Sample 1 | | | | |
| Return on sales – the return divided to similar to the concept of a markup and of insurance companies. Industry conditions – certain signals in inadequate such as an increasing size innovation, and dividends being paid | by the premium. This has intuitive appeal as it is not may not be distorted by the varying leverage ratios in the market may support the idea that rates are e of the residual market, reduced product diversity and out of the industry faster than capital is being paid in. | | | |
| Sample 2 | | | | |
| 1. The regulator can also consider if r insurers are profitable on the busines profits, i.e. prices are adequate. 2. The regulator can also consider ret allocating resources the best and offer insured. This protects society. | eturn on sales is appropriate. This helps ensure that ss they write and achieve acceptable underwriting curn on assets. This ensures that the insurer is ering products and services (meeting demand) of | | | |

Sample 3

Residual mkt → growth in the residual market usually means companies are not generating enough returns & so they are tightening underwriting standards / shrinking their books. This may signal to the regulators that rates need to be increased. Investor activity → is the insurance industry attracting investors? If so, the returns being earned must be adequate. If not, if investors are leaving the industry this may again signal to the regulators that rates need to be raised.

Sample 4

- If market structure says rates are too low:
 - \rightarrow Competitors are leaving market.
 - \rightarrow Diversity of products is decreasing.

Sample 5

• Besides profit loads, the regulator should examine rate indications. How does the historic loss experience look when compared to the rate. Rate indications are the #1 item considered by regulators when measuring rates and fairness.

Expenses \rightarrow are the expenses loaded into the rate reasonable? Some regulators can cap expenses at a certain level, some have their own expense assumptions.

To summarize, loss experience and expenses are two items the regulator could look at in addition to profit load.

EXAMINER'S REPORT

Candidates were expected to know the difference between the regulator's perspective and that of an investor and of the company itself. Candidates were also expected to describe the difficulties that exist in allocating surplus.

Most candidates answered this question and were able to describe issues related to surplus allocation in part a, and received partial credit. Most candidates answered part b for full credit.

Difficulties in this question arose from candidates providing general information that did not directly address the question.

Part a

The candidates were expected to explain that the regulator is unconcerned with investor demands, that regulatory focus is on rate equity not rate of return equity, and that ROE may be distorted by surplus allocation methods.

For full credit, both assertions made by the Actuary had to be addressed. Most candidates responded to the ROE assertion, but failed to address the justification related to investor demands. A common mistake was providing general knowledge that did not address the Actuary's statements from a regulatory perspective.

Part b

Many candidates received full credit on part b. Candidates mentioning a regulatory focus on return-on-sales and using market characteristics to determine overall rate adequacy received full credit. Responses such as the rate must not be excessive, inadequate, or unfairly discriminatory received partial credit.

Common mistakes included:

- answering with general information that was not directly related to both (1) the regulator's perspective and (2) ratemaking
- stating items that were appropriate to consider from an industry-wide perspective and applying them to the individual company

QUESTION 23 TOTAL POINT VALUE: 3 LEARNING OBJECTIVE: D5 SAMPLE ANSWERS Part a: 0.75 point Sample 1 • This method is not distorted by large changes in exposures or reserves -> the company has grown quite a bit over recent years This method takes into account investment income in a simple manner • No need to select a target return or allocate surplus • Sample 2 Line of business being evaluated. The PV offset method compares the line with a shorter • tailed reference line so a selection of reference line is necessary for this method • Traditional profit load (U_0) for the selected reference line. Again this is a required input for the method. This method does not require selecting a target return so it has a benefit there. But selecting discount rates are required Sample 3 Does not account for risk associated w/ the reference line, only for the extra investment • income associated w/ a longer lag in payments, so doesn't achieve goal of emphasis on risk

- Sensitive to selection of payout schedule & interest rates for discounting. Company has not needed either for CY Inv Inc Offset method (only prospective inv. Inc. rate), so especially payout schedules may not be available
- Requires comparison to a reference line, which doesn't appear to be mentioned and may not be readily available

Sample 4

- Discount rate to use actual or estimate
- What reference line to use
- Iterative nature of PLR and U

Part b: 0.75 point

Sample 1

٠

- This will be distorted by the current growth
- The output of this method will be comparable to a GAAP ROE metric and thus easier for management to interpret
- You will need to allocate surplus and select a target return

Sample 2

- Needs to select a target return on equity.
- Actual realized portfolio yield seem volatile may need to refer to estimated yields or other possible yields
- Calendar Yr used can be applied in CY ROE method now. Data is readily available

Sample 3

- Can select target ROE to reflect risk
- Can select leverage ratio to reflect desired risk
- CY data is not prospective -> may not be good since such strong growth

Sample 4

• This method reflects the risk through selected target ROE and surplus requirement. Need to consider: (1) what is the appropriate target ROE to be chosen; (2) how much surplus needs to be allocated to the line; (3) since this is based on CY data whether the large growth of volume in history will distort the results

Part c: 0.75 point

Sample 1

- Chief actuary need to select β for liability
- The surplus selection is not as important as other method
- Chief actuary doesn't need to select target rate of return

Sample 2

- You need to calculate a β for the loss payments (difficult)
- The CAPM only measures exposure to systematic (market) risk
- This method is arguably based more on financial theory and could be supported

Sample 3

- Betas are difficult to calculate for liability return calculation
- No market for liabilities, so difficult to calculate the expected return which is used to discount loss
- Calculates a 'fair premium' based on UW income and investment income (both after tax)
- The method is tied to modern financial theory

Sample 4

- Not distorted by growth
- Accounts for risk in risk-adjusted rates
- No need to select target return

Sample 5

- Sound basis in economic theory
- Requires a risk-adjusted discount rate for losses
- Requires assumptions about loss payment patterns

Sample 6

- Need a beta for liabilities which can be hard to calculate
- Need surplus to the extent that investment income is earned
- May be the best method as grounded in economic theory

Sample 7

- What value of beta should we use for liabilities
- Does the liability beta differ by line
- What is the market return and will that change over time

Sample 8

- Discount rate for losses use CAPM to select a risk-adjusted discount rate for losses
- Discount rate select discount rate to discount premium, expenses & taxes
- Investment return select investment return rate to get tax on Inv Income from surplus

Part d: 0.75 point

- Sample 1
 - Adequately accounts for both SAP & GAAP regulations
 - You will need to allocate surplus
 - It will not be distorted by the current growth

Sample 2

- What is the cost of capital you'll compare your IRR to?
- Do you have any reversals in your equity flows? If so, IRR will have more than one solution
- It is possible for your IRR to be positive, but the NPV to be negative. This could confuse regulators

Sample 3

- Need to allocate surplus & all surplus backs all lines so this is arbitrary
- Need to make assumptions about commitment & release of surplus
- Good if viewing from shareholders perspective as directly addresses shareholder's needs

Sample 4

- Understandable since IRR can be viewed as a rate on loan
- We can explicitly reflect accounting rules in the cash flows (GAAP or SAP)
- We will need to select a required surplus which reflects the risk of the line we are pricing

EXAMINER'S REPORT

Learning Objective D5 says the candidate should be able to "calculate and compare the provision for underwriting profit in property and casualty insurance rates." Each part of this question required the candidate to discuss three considerations related to a specific method to determine the profit provision, within a hypothetical insurance company scenario.

Candidates generally scored quite well on this question, with the bulk receiving a majority of the possible points. Some common errors that candidates made across all of the parts of the question included:

 incorrect conclusions related the recent performance of the hypothetical company and how it relates to specific methods (for example: concluding that the changing combined ratio made payment patterns unsuitable for some of the methods; describing past volatility in investment yields as a concern for methods that rely only on prospective new money yields). • incomplete responses For example:

| stating "premium growth consideration" without specifying whether a method recogneds well to growth or can be distorted by premium growth |
|--|
| stating "target return on equity" without specifying whether it is required in a |
| specific method or not |
| Part a |
| This part required the candidate to discuss considerations around the Present Value Offset procedure. A full credit response required three correct considerations. |
| Candidates generally performed well on this part, with a large majority of candidates providing at least two of three correct responses. |
| Common errors included: |
| making a general observation without connecting it to the method under consideration; for example, observing that the company has grown without discussion of whether the method is distorted by rapid growth. |
| assuming that the combined ratio deterioration shown in the company profile would affect the estimate of the permissible loss ratio used in this method, which is a prospective estimate |
| concluding that changing combined ratio or premium growth make payment patterns unsuitable for the method |
| stating that the method still relies on traditional underwing profit provision as the currently used CY II method (without specifying that the provision is needed for the reference line only) |
| suggesting that payout patterns reflect risk differences between lines of business, with a longer-tailed line being more risky. That is not always the case. |
| Part b |
| This part required the candidate to discuss considerations around the Calendar Year Return on Equity method. A full credit response required three correct considerations. |
| Candidates generally performed very well on this part, with a majority of candidates receiving full credit. |
| Common errors included: |
| making a general observation without connecting it to the method under consideration; for example, observing that the company has grown without discussion of whether the method is distorted by rapid growth. |
| assuming that the combined ratio deterioration shown in the company profile was due to reserve adequacy changes, which would distort this method, without acknowledging that the combined ratio changes could be due to higher expense spends or simply higher claim payments, and not necessarily due to any changes in reserves. |
| Part c |
| This was a second the second data to discuss a second data to second the Disl. A discted Discussed d |

This part required the candidate to discuss considerations around the Risk-Adjusted Discounted Cash Flow method. A full credit response required three correct considerations.

This part of the question was the most challenging to candidates, with a fairly even distribution of scores, but a significant number of candidates did receive full credit.

Common errors included:

- stating a need of a discount rate selection based on past investment returns in addition to the risk-adjusted rate derived using betas
- discussing difficulties with investment income calculation due to past volatility in investment returns (according to Robbin's paper, the method relies on prospective new money yield)
- concluding that changing combined ratio or premium growth make payment patterns unsuitable for the method
- stating that the method requires a target return assumption

Part d

This part required the candidate to discuss considerations around the Internal Rate of Return on Equity Flows method. A full credit response required three correct considerations.

Candidates generally performed well on this part, with a large number of candidates receiving full credit.

Common errors included:

- assuming that the combined ratio deterioration shown in the company profile was due to loss pressures, suggesting that the unprofitability would make it difficult to estimate future equity flows
- incorrectly describing an issue of internal rate of return misinterpretation and comparison to the cost of capital
- discussing difficulties with investment income calculation due to past volatility in investment returns (according to Robbin's paper, the method relies on prospective new money yield)

| QUESTION 24 | |
|---|--|
| TOTAL POINT VALUE: 1.25 | LEARNING OBJECTIVE: D6 |
| SAMPLE ANSWERS | |
| Part a: 0.75 point | |
| Sample 1: | |
| CO A | |
| $\Rightarrow \text{Actual ROR} = \frac{Send - S_{beg}}{S_{beg}} + \frac{S H \text{ Divid}}{S_{beg}} - \frac{Cap \text{ Paid In}}{S_{beg}}$ $= \frac{(15-10)}{10} + \frac{1}{10} - \frac{3}{10}$ | |
| = 0.3 | |
| \rightarrow Market ROR = $\frac{0.3}{MV:BV} = \frac{.3}{.9} = .333$ | |
| СОВ | |
| → Actual ROR = $\frac{(6-5)}{5} + \frac{0.3}{5} - \frac{0.1}{5}$ = .24% | |
| \rightarrow Market ROR = $\frac{2.4}{2} = 0.12$ | |
| Sample 2: | |
| Co A: $\frac{15M - 10M + 1M - 3M}{10M} * \frac{1}{0.9} = 33.33\%$ Co B: $\frac{1M - 5M + 300K - 100K}{5M} * \frac{1}{2} = 12\%$ | |
| Part b: 0.5 point | |
| Sample 1: | |
| Company A | Company B |
| Market : book 0.9 | 2.00 |
| Given that people are paying 2x the book v future must be good. | alue to own Co. B, their view of the companies' |
| Co. A's mkt value is .9 of the book value so stock. | investors must be less interested in owning Co. A |
| Sample 2: Currently Company B is trading at a premium to Boo the firm's prospects. | ok Value indicating investors are optimistic about |
| Company A on the other hand is trading at a discou optimistic about the firm's prospects. | nt to Book Value indicating investors are not |
| Sample 3: Company A's market to book value is far lower than And B's book value is half the market value. Investo | B ⇒ ors are positive about B's prospects. |

Sample 4:

Since Co A's market to book value is lower, the future earnings are expected to be lower than Co B's. Market value reflects the franchise value, thus future business.

EXAMINER'S REPORT

Candidates were expected to perform a series of calculations on the traditional rate of return before converting the answer to a market rate of return. Additionally, candidates needed to synthesize the historical information provided with regards to both firms in order to evaluate the future outlook, respectively.

Candidates tended to have difficulty decomposing the question (part b) in order to come up with a full credit solution. Overall, the candidates fared better on part a than part b. Some candidates who demonstrated knowledge of the material lost points on simple calculation errors.

The question proved to be challenging, with few candidates receiving full credit on both parts. Candidates who received full credit on part a often lost points on the analysis portion in part b. Additionally, some candidates produced full credit solutions for part b, but then lost points on part a by failing to calculate the "market" rate of return as opposed to the traditional rate of return.

Part a

Candidates were expected to understand how to calculate market rate of return from its basic building blocks. In order to obtain full credit, candidates were expected to correctly set up an equation to calculate the market rate of return and calculate the correct figures for both companies.

Candidates generally understood how to calculate the return on surplus but most did not correctly apply the MV/BV ratio to convert this figure to the market rate of return.

Common errors included:

- multiplying instead of dividing by the MV/BV ratio
- not converting the return on book value to a return on market value figure
- converting the wrong items to market value
- calculating the return on surplus as a dollar value instead of a rate of return, as the question directs
- dividing by ending surplus instead of beginning surplus

Part b

Candidates were expected to evaluate the historical information regarding the two firms in question, identify the appropriate metric(s) that would be most pertinent for highlighting the future outlook of each firm, and ultimately make a judgment on the outlook for each firm.

For full credit, candidates needed to select a metric(s) that was indicative of the future outlook for each firm from the point of an investor, describe what the metric entailed and then translate the result into an evaluation of future outlook of the two firms.

Most candidates who lost points on this part were unable to translate the selected performance metric to the future outlook of each firm. Many candidates were able to identify the MV/BV ratio as a key indicator for future performance, but subsequently lost points by failing to convey the

result with respect to each firm. Another common mistake came from misidentifying metrics that would be used by investors in evaluating future outlook and failing to understand the underlying concept behind the selected metric.

Some candidates referenced the Fama French 3-factor model in support of a more optimistic view with regards to the ability to earn excess return with Company A. Candidate responses which listed the relevant assumptions and then successfully identified the BV/MV trigger were awarded full credit.

| QUESTION 25 | | | |
|--|--|--|--|
| TOTAL POINT VALUE: 2 | LEARNING OBJECTIVE: D7 | | |
| SAMPLE ANSWERS | | | |
| Part a: 0.5 point | | | |
| Sample 1: | | | |
| Require rate of return = | Expense and claims inflation | | |
| | + increase in demand for insurance | | |
| | + Increase in aggregate reserves | | |
| | + Stockholders dividends | | |
| | - Additional paid-in capital | | |
| | = 5% + 4% + 3% + 5% - 3% = 14% | | |
| Sample 2: | | | |
| Assume increase in aggreg | ate reserves is excluding inflation but reflects increase in demand from | | |
| Assume increase in aggregate reserves is excluding initiation but reflects increase in demand from new business. [Assumption or formula must be stated for this answer to be acconted. Other | | | |
| assumptions are also accer | nted 1 | | |
| | Jean J | | |
| Require rate of return = | Expense and claims inflation | | |
| | + increase in demand for insurance | | |
| | + (Increase in aggregate reserves - increase demand for insurance) | | |
| | + Stockholders dividends | | |
| | - Additional paid-in capital | | |
| | = 5% + 4% + (3%-4%) + 5% - 3% = 10% | | |
| Sample 3: | | | |
| Required surplus change | = Expense and Claims inflation + increase in demand for insurance | | |
| | + increase in aggregate reserves | | |
| | = 5% + 4% + 3% = 12% | | |
| | | | |
| *Required rate of return : | Required surplus change + Stockholder dividends - Additional | | |
| | paid-in capital | | |
| | = 12% + 5% - 3% = 14% | | |
| | | | |
| * Required rate of return = | 12%+5%-3% is not an acceptable answer without accompanying | | |
| formula as 12% could represent Retained return on capital. | | | |
| | | | |
| Sample 4: | | | |
| Adjust reserve for increase in inflation. | | | |
| Require rate of return = | Expense and claims inflation | | |
| | + increase in demand for insurance | | |
| | + (Increase in aggregate reserves - increase inflation) | | |
| | + Stockholders dividends | | |
| | - Additional paid-in capital | | |
| | = 5% + 4% + (3%-5%) + 5% - 3% = 9% | | |

| Sample 5: | | |
|--|---|--|
| Adjust reserve for increase in inflation and increase in demand. | | |
| Require rate of return = | Expense and claims inflation | |
| | + increase in demand for insurance | |
| | + (Increase in aggregate reserves - increase inflation - increase | |
| | demand for insurance) | |
| | + Stockholders dividends | |
| | - Additional paid-in capital | |
| | = 5% + 4% + (3% - 5% - 4%) + 5% - 3% = 5% | |
| Sample 6: | 378 - 178 - (378 378 - 176) - 378 - 378 | |
| Adjusted demand for increase in inflation=4%-5%=-1%. | | |
| Adjusted reserves for increase in inflation and demand =3%-5%-(-1%)=-1% | | |
| | | |
| Require rate of return = | Expense and claims inflation | |
| | + increase in demand for insurance (adjusted) | |
| | + Increase in aggregate reserves(adjusted) | |
| | + Stockholders dividends | |
| | - Additional paid-in capital | |
| | = 5% +(-1%) + (-1%) + 5% - 3% = 5% | |
| Part b: 1.5 points | | |
| Market to Book Value - in | idicate company's financial performance | |
| Market/Book ratios between 1.0 and 2.0 (in-between top and bottom quartiles) | | |
| Market/Book ratios are falling for the company and industry | | |
| Market/Book ratios fell at a greater percentage than the market | | |
| Market/Book ratios above 1 | | |
| Market/Book ratios < 2 | | |
| average Market/E | Book Ratios | |
| Earnings per Share (EPS) - indicate company's financial performance | | |
| lower future earnings expected | | |
| EPS has been increasing and is much closer to the ton quartile than bottom | | |
| earnings forecast is down while industry forecast is trending un | | |
| EPS is between to | in and bottom quartile | |
| • EPS is between top and bottom quartile | | |
| | ne of steadily increasing | |
| • average EPS | | |
| P/E ratio - measure of investor confidence | | |
| low P/E ratios | | |
| P/E ratio is closer | to the bottom percentile | |
| | | |
| Return on book - measure | e of past performance & Return on market - rate of return which the | |
| investor is demanding in order to invest in the company | | |

investor is demanding in order to invest in the company

- required rate of return on book value (from part a) is being achieved since the return on book is 15%
- required rate of return on book value (from part a) is being achieved since the return on book is 17% (Retained return on capital + Stockholders dividends)
- high return on market value to compensate for earnings uncertainty
- the market believes the company is much riskier than the top companies as indicated by high return on market

Performance and outlook

- good performance and uncertain future
- good performance but investors may be losing confidence in the company
- financial characteristics suggest good returns will not continue in the future
- average performance and not a good outlook

EXAMINER'S REPORT

Part b was challenging given the analysis and evaluation involved. Candidates most often received only partial credit on part b as they did not know the four financial characteristics well enough to draw conclusions on the Company's performance and outlook.

Part a

The candidate was expected to calculate required rate of return which was a basic concept from the Roth paper.

Many candidates understood how to calculate the required rate of return but did not explicitly write out the formula to receive full credit. Without the formula, we were unable to tell if the candidate had the correct formula since 3% could mean increase in the aggregate reserves or additional paid-in capital. Candidates most often received partial credit on part a.

Common errors included:

- not providing formulas for calculation
- not subtracting additional paid-in capital
- calculating required surplus change only
- not listing out assumptions when adjusting for inflation and/or demand for insurance

Part b

The candidate was expected to know what each financial characteristic indicated or was a measure of and be able to analyze and evaluate the performance and outlook of the company given the financial characteristics of the company and industry.

In order to receive full credit for their analysis, candidates needed to use all four financial characteristics in their discussion and interpret the financial characteristics correctly. Candidates also needed to evaluate both the performance and outlook of the company. Many candidates only focused on the outlook.

Some candidates wrongly interpreted the low P/E ratio as a good outlook for this Company because low P/E ratio firms usually have higher returns or are undervalued. A low P/E ratio does not necessarily mean that a company is undervalued. P/E ratio is a measure of investor confidence in the company. Low P/E could mean the market believes the company is headed for trouble in the

near future which is supported by the lower future earnings expected. The high return on market value is to compensate for earnings uncertainty. In that aspect, many candidates misinterpreted high market return as a positive outlook for this company.

Financial characteristics (a), (b) and (c) from the question were generally discussed well. For P/E ratio (c), vague answers such as P/E ratio is between top and bottom quartile and average P/E ratio were not accepted because the candidate should recognize the P/E ratio is low and closer to the bottom quartile. For financial characteristic (d) from the question, only a few candidates were able to recognize that the required rate of return calculated in part (a) was required return on book value and evaluated whether the required return was achieved.



Sample 1: The put option technique since the mean return is usually greater than the risk-free rate. The Swap technique only earns the risk-free rate.

Sample 2: Option technique results in smaller rate on line because cost of put option is offset by investment income as compared to swap technique where investment income is lost by putting funds in risk free investment (hence resulting in higher rate to be charged).

Part c: 0.25 point

Sample 1: Min rate on line is the change for surplus and some level of expense.

Sample 2: Min ROL would be the risk load charged.

Sample 3: Minimum ROL needed to cover expenses .

Sample 4: If there is no minimum, then there would be the opportunity for free cover for very high limits.

EXAMINER'S REPORT

Candidates were expected to know how to calculate a Rate on Line (RoL) indication using the option and swap techniques and to select the more appropriate RoL from the two indications. The candidates were expected to be able to explain why one of the techniques tends to produce a lower indicated RoL than the other. They were also expected to demonstrate knowledge of how a minimum RoL could be justified in a real world situation.

Candidates had particular difficulty with parts a & b.

- in part a, candidates often were unable to produce the two formulas accurately or were unable to apply them correctly
- in part b, candidates had difficulty providing a complete explanation of the investment assumptions upon which the techniques are based

The question was challenging for the following reasons:

- candidates had to recall two complex formulas and apply them properly
- candidates had to demonstrate an understanding of assumptions underlying the techniques and draw conclusions based on this understanding

Part a

For full credit, a candidate was expected to demonstrate knowledge of and correctly solve the formulas for the swap and option techniques. A candidate also needed to indicate that the selected RoL should be the smaller of the two indications, and that the RoL reflects a relationship between reinsurance premium and limit (RoL = P/L), or some form thereof.

Common errors included:

- incorrect formulas or faulty parameterization of same
- using only one technique
- arithmetic errors
- selecting the larger of the two indications
- failure to state ROL=P/L

Part b

For full credit, a candidate was expected to:

- correctly state that option technique would usually produce smaller ROL
- discuss that swap technique assumes risk-free rate of return
- compare potential returns under the option technique relative to the risk-free rate

The most common error was the failure to discuss risk free assumption under the swap technique. **Part c**

For full credit, a candidate was expected to provide a reason that an underwriter would typically use to justify a minimum RoL even when the expected loss potential is remote or, as in this case, zero. A wide range of responses was accepted.

The most common error was a failure to answer the question as presented, discussing the selection of the lower RoL for competitive reasons.

| | QUESTION 27 | | |
|---|---|--|--|
| ľ | TOTAL POINT VALUE: 3 | LEARNING OBJECTIVE: D9 | |
| | SAMPLE ANSWERS | | |
| | Part a: 0.5 point | | |
| | Sample 1: No, it's not equitable. The Shapley method allocates the covariance to each risk equally. In this scenario, X has a higher Var.99, so it probably contributes more to the shared covariance, thus it should be allocated more when calculating the risk load. | | |
| | Sample 2: No. Shapley gives equal weights regarding covariance. This is not equitable as can be seen State X is more risky. | | |
| | Part b: 0.5 point | | |
| | Sample 1: Covariance Share approach. It allocate | s covariance in proportion to expected losses. | |
| | Sample 2: Covariance Share method. The insurer can allocate the covariance based on a selected percentile loss, i.e. weighted by 99 th ile modeled losses. | | |
| Sample 3: The Covariance Share method accounts for the deficiency because it allocates the aggregate covariance by proportions specified by the user to each risk, thus accounting for differences among risks. | | | |
| | Part c: 2 points | | |
| | Sample 1: CovShare X: $[300/(100+300)]^{2*15} = 22.5M$ CovShare Y: $[100/(100+300)]^{2*15} = 7.5M$ Renewal Risk Load: $R_L = \lambda[(\sigma_L)^2 + CovShare_L]$ Rx = .00025 (50+22.5)=\$18,125 Ry = .00025 (25+7.5) = \$8,125 | | |
| | Sample 2: allocated 2* covariance = $2x15=30M$, $var(x) = 50M$ Z _{.99} = 2.326 $300M = E[L_x]+2.326 \times SQRT(50M) \rightarrow E[L_x] = 283.6$ $100M = E[L_y]+2.326 \times SQRT(25M) \rightarrow E[L_y] = 88.37$ $E[L_{total}] = 371.97$ Risk Load X = .00025 [50 + (283.6/371.97)*30] = .(Risk Load Y = .00025 [25 + (88.37/371.97)*30] = .(| M, var(y) = 25M ; , 0182M 00803M | |
| | EXAMINER'S REPORT | | |
| ľ | Part a | | |
| | Candidates were expected to conclude that the S situation. The explanation needed to identify tha split equally between X and Y. State X was riskier portion of the covariance. Majority of the candid | hapley Method was not equitable in this t under the Shapley Method the covariance is than State Y and therefore should share a larger ates received full credit on this part. | |
| 1 | | | |

Credit was not given if candidates answered "not equitable" but followed with incorrect explanations which reflected incorrect understanding on this question. For example:

- candidates concluding that the Shapley Method was not equitable by attempting to prove the Shapley risk loads for States X and Y are not mathematically equal, i.e. Under Shapley Method, Var (x) + Covariance_{xy} ≠ Var (y) + Covariance_{xy}
- candidates concluding that the Shapley Method was equitable because it was renewal additive

Partial credit was given if candidates were able to give a correct conclusion but without fully covering all the key points in the explanations. For example:

- candidates identifying that State X was riskier, but failing to explain that the Shapley method assigns equal weight to covariance share and thus it was not equitable
- responses consisting of formulas without written explanation or conclusion

Part b

Candidates were expected to propose the Covariance Share method and supply a brief explanation of the method. Candidates did not have to explicitly name "Covariance Share" to receive full credit (as long as they had a sufficient explanation of their proposed method). Most candidates performed well on this part.

Common errors included only writing "Covariance Share" without any explanation. Partial credit was given in this case. This part asks candidates to "propose" a risk load method, which should have alerted the candidate that a brief explanation was required for full credit.

Part c

Candidates were expected to carry out the entire risk load calculation using the Covariance Share method, including the weights, covariance share, and risk load for States X and Y. Candidates generally demonstrated understanding of the Covariance Share method and scored well on this subpart.

Common errors included:

- the most common error was allocating 1x the covariance instead of 2x the covariance
- incorrectly calculating a covariance instead of using the \$15Million covariance given in Part c
- calculation errors