Exam 8
Investments and Financial Analysis

April 26, 2007

INSTRUCTIONS TO CANDIDATES

1. This 80 point examination consists of 39 problem and essay questions.

2. For the problem and essay questions, the number of points for each full question and each 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 dark pencil or ink. Do not use multiple colors.

   • Write your Candidate ID number and the examination number, 8, at the top of each answer sheet. Your name, or any other identifying mark, must not appear.

   • Do not answer more than one question on a single sheet of paper. Write only on the front lined side of the paper – DO NOT WRITE ON THE BACK OF THE PAPER. Be careful to give the number of the question you are answering on each sheet. If your response cannot be confined to one page, please use additional sheets of paper as necessary. Clearly mark the question number on each page of the response in addition to using a label such as “Page 1 of 2” on the first sheet of paper and then “Page 2 of 2” on the second sheet of paper.

   • The answer should be concise and confined to the question as posed. When a specified number of items are requested, do not offer more items than requested. For example, if you are requested to provide three items, only the first three responses will be graded.

   • In order to receive full credit or to maximize partial credit on mathematical and computational questions, you must clearly outline your approach in either verbal or mathematical form, showing calculations where necessary. Also, you must clearly specify any additional assumptions you have made to answer the question.

3. Do all problems until you reach the last page of the examination where "END OF EXAMINATION" is marked.

CONTINUE TO NEXT PAGE OF INSTRUCTIONS

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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. **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. **Do not remove this label.** Keep a record of your Candidate ID number for future inquiries regarding this exam.

6. **Candidates must remain in the examination center until two hours after the start of the examination.** The examination starts after the reading period is complete. You may leave the examination room to use the restroom with permission from the supervisor. To avoid excessive noise during the end of the examination, **candidates may not leave the exam room during the last fifteen minutes of the examination.**

7. **At the end of the examination, place all answer sheets in the Examination Envelope.** Please insert your answer sheets in your envelope in question number order. Insert a numbered page for each question, even if you have not attempted to answer that question. Nothing written in the examination booklet will be graded. **Only the answer sheets will be graded.** Also place any included reference materials in the Examination Envelope. **BEFORE YOU TURN THE EXAMINATION ENVELOPE IN TO THE SUPERVISOR, BE SURE TO SIGN IT IN THE SPACE PROVIDED ABOVE THE CUT-OUT WINDOW.**

8. If you have brought a self-addressed, stamped envelope, you may put the examination booklet and scrap paper inside and submit it separately to the supervisor. It will be mailed to you. **Do not put the self-addressed stamped envelope inside the Examination Envelope.**

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

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

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

9. **Candidates must not give or receive assistance of any kind during the examination.** Any cheating, any attempt to cheat, assisting others to cheat, or participating therein, or other improper conduct will result in the Casualty Actuarial Society and the Canadian Institute of Actuaries disqualifying the candidate's paper, and such other disciplinary action as may be deemed appropriate within the guidelines of the CAS Policy on Examination Discipline.

10. The exam survey is available on the CAS Web Site in the “Admissions/Exams” section. Please submit your survey by May 14, 2007.

END OF INSTRUCTIONS
1. (1.5 points)

You are given the following information:

- A risky portfolio has an expected return of 16% and a standard deviation of 25%.
- The T-bill rate is 6%.

a. (0.5 point)

Suppose you invest 60% of your funds in the risky portfolio and 40% in a T-bill money market fund. Calculate the expected value and the standard deviation of the rate of return of the portfolio.

b. (1 point)

Determine the equation of the Capital Allocation Line (CAL) of the risky portfolio and graph the CAL. Plot the position of the overall portfolio on the CAL graph. Label all items properly.

SHOW ALL WORK.
2. (2.5 points)

Available securities include two risky stock funds, X and Y, and T-bills. Data for the securities follows:

<table>
<thead>
<tr>
<th></th>
<th>Expected Return</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fund X</td>
<td>8%</td>
<td>22%</td>
</tr>
<tr>
<td>Fund Y</td>
<td>27%</td>
<td>70%</td>
</tr>
<tr>
<td>T-bills</td>
<td>6%</td>
<td>0%</td>
</tr>
</tbody>
</table>

The correlation coefficient between funds X and Y is -0.15.

a. (1.5 points)

Determine the expected return and the standard deviation of the optimal risky portfolio.

b. (1 point)

"A" is the index of an investor's risk aversion. Calculate how much an investor with a risk aversion index of 4 will invest in each of funds X and Y and in T-bills.

SHOW ALL WORK.
3. (1 point)

Some financial advisors assert that time diversification reduces risk.

Explain why you either agree or disagree.
4. (1 point)
   
a. (0.5 point)
   Briefly explain the effect of survivorship bias on measurements of risk premium.

b. (0.5 point)
   Identify two factors on which the degree of survivorship bias is dependent.
5. (2 points)
   a. (0.5 point)
   Briefly describe the semi-strong version of the efficient market hypothesis.

   b. (1.5 points)
   Fundamental analysis has revealed patterns of stock returns that appear to contradict the semi-strong version of the efficient market hypothesis.

   Identify and briefly describe three of these anomalies.
6. (1.5 points)

a. (0.5 point)

Briefly describe the steps involved in the two-stage procedure used by Miller and Scholes to test the Capital Asset Pricing Model (CAPM).

b. (0.5 point)

Briefly explain how the results of this procedure compared to those predicted by the CAPM.

c. (0.5 point)

Briefly describe two concerns about the validity of the test conducted by Miller and Scholes.
7. (2.25 points)
   a. (1.5 points)
      Briefly describe three types of information processing biases that can lead investors to make forecast errors in the financial markets.
   b. (0.75 point)
      Identify a market anomaly associated with each.
8. (1.5 points)

A U.S. Treasury bond with a face value of $100,000 has a quoted price of 92:15 on October 13, 2006. The bond has a 10% coupon and matures on December 1, 2010.

Calculate the cash price of this bond. Use actual/actual as the day counting convention.

SHOW ALL WORK.
9. (1 point)

Consider a 30-year bond that pays an annual coupon of $80 and has a par value of $1,000. At the end of the first year, the bond's yield to maturity is 8.5%.

Calculate the one-year pre-tax holding-period return.

SHOW ALL WORK.
10. (2 points)

Company X has entered into a forward rate agreement with Company Y with a principal amount of $2,000 at an interest rate of 5%. The agreement is for 6 months incepting January 1, 2007. The forward LIBOR interest rate between January 1, 2007 and July 1, 2007 is 5.2%. The actual LIBOR interest rate observed in the market at January 1, 2007 for the period January 1, 2007 to July 1, 2007 is 4.8%.

a. (0.75 point)

Calculate the payoff to Company X.

b. (1.25 points)

Calculate the value of the forward rate agreement assuming continuous compounding.

SHOW ALL WORK.
11. (2 points)

The total value of a population of bonds was $250,000 as of January 1, 2004. You are given the following information about this population of bonds:

<table>
<thead>
<tr>
<th></th>
<th>2004</th>
<th>2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value of bonds called</td>
<td>$25,000</td>
<td>$15,000</td>
</tr>
<tr>
<td>during year:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Value of bonds maturing</td>
<td>35,000</td>
<td>25,000</td>
</tr>
<tr>
<td>during year:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Value of bonds defaulting</td>
<td>10,000</td>
<td>14,000</td>
</tr>
<tr>
<td>during year:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Calculate the cumulative mortality rate as of December 31, 2005 for this population of bonds.

SHOW ALL WORK.
12. (1.5 points)

You are given the following information about a one-year coupon bond:

- The principal is $1,000
- The coupon rate is 5%
- The market price is $875
- The probability of default is 10%

The principal and the coupon are to be paid in one year. In the event of default, however, neither the principal nor the coupon will be paid. The yield on default-free government bonds is 8%.

Assume interest rates are compounded annually.

Calculate the default premium on the one-year coupon bond.

SHOW ALL WORK.
13. (1.5 points)

You are given the following table of average cumulative default rates for corporate bonds:

<table>
<thead>
<tr>
<th>Bond Type</th>
<th>Term (Years)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Aaa</td>
<td>0.00</td>
</tr>
<tr>
<td>Baa</td>
<td>0.15</td>
</tr>
<tr>
<td>Caa</td>
<td>25.00</td>
</tr>
</tbody>
</table>

a. (0.5 point)
Calculate the unconditional default probability for the 3rd year for the Baa bond.

b. (0.5 point)
Calculate the default intensity for the 3rd year for the Caa bond. Assume no earlier default.

c. (0.5 point)
Calculate the average default intensity between year 0 and year 5 for the Aaa bond, based on the historical cumulative default rates.

SHOW ALL WORK.
14. (2.25 points)

You are given the following financial statement information (in millions of dollars) for two companies in the same industry:

<table>
<thead>
<tr>
<th></th>
<th>Company A</th>
<th>Company B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash Flow</td>
<td>$25</td>
<td>$45</td>
</tr>
<tr>
<td>Interest Obligations</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Current Liabilities</td>
<td>60</td>
<td>130</td>
</tr>
<tr>
<td>Total Assets</td>
<td>145</td>
<td>255</td>
</tr>
<tr>
<td>Debt</td>
<td>15</td>
<td>30</td>
</tr>
<tr>
<td>Earnings (before interest payments and taxes)</td>
<td>9</td>
<td>15</td>
</tr>
<tr>
<td>Current Assets</td>
<td>100</td>
<td>190</td>
</tr>
<tr>
<td>Equity</td>
<td>40</td>
<td>60</td>
</tr>
</tbody>
</table>

a. (1.5 points)

For each company, calculate the following financial ratios used by bond rating agencies: times-interest-earned ratio; current ratio; and return on assets.

SHOW ALL WORK.

b. (0.75 point)

For each ratio calculated in part a. above, briefly explain which company has a higher risk of default.
15. (1.5 points)

Identify and briefly describe three protective covenants that can be included in a bond indenture to protect the rights of the bondholder.
16. (1.5 points)

Briefly discuss three reasons Altman gives for excess historical default premiums for bonds.
17. (1 point)

You are given the following information:

- An investor holds 25,000 shares of the stock for XYZ Company
- The market price of XYZ’s stock is $45 per share
- The S&P index is 1,200
- Each S&P futures contract is for delivery of $50 times the index
- The beta of XYZ is 0.8

Determine the strategy the investor should follow to hedge against movements in the market using S&P futures.

SHOW ALL WORK.
18. (1.5 points)

You are given the following information about interest rates for Company A and Company B:

<table>
<thead>
<tr>
<th></th>
<th>Company A</th>
<th>Company B</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S. dollars (floating rate)</td>
<td>LIBOR + 1.5%</td>
<td>LIBOR + 2.5%</td>
</tr>
<tr>
<td>Canadian dollars (fixed rate)</td>
<td>7.5%</td>
<td>10.0%</td>
</tr>
</tbody>
</table>

- Company A wants to borrow U.S. dollars at a floating rate of interest.
- Company B wants to borrow Canadian dollars at a fixed rate of interest.
- To arrange a swap that is equally attractive to both Company A and B, a financial institution requires a spread of 25 basis points.

Determine the rates of interest Company A and Company B will each pay.

SHOW ALL WORK.
19. (2 points)

A financial institution pays 6-month LIBOR and receives 7% per year with semiannual compounding on a swap with notional principal of $50 million. The remaining payment dates are in 4, 10, and 16 months.

The LIBOR rates with continuous compounding for 4, 10, and 16 month maturities are 8%, 8.5%, and 9%, respectively.

The 6-month LIBOR rate at the last payment date was 8.8% with semiannual compounding.

Calculate the value of the swap to the financial institution.

SHOW ALL WORK.
20. (1.5 points)  

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You are given the following information:

- Strike price is $30  
- Current stock price is $29  
- Dividends of $1.50 are expected to be paid after 3, 5, and 7 months  
- Continuously compounded risk-free interest rate is 10% per annum  
- Price of 6-month European call with a strike price of $30 is $2  

Calculate the price of a European put option that expires in 6 months. 

**SHOW ALL WORK.**
21. (2 points)

You have created a bear spread from call options with strike prices of $20 and $25 that cost $4 and $1, respectively. The call options expire on the same day.

Draw the profit diagram for the bear spread. Completely and clearly label all components and values.
22. (3 points)

Consider a 2-year American put option with a strike price of $63 on a stock with a current price of $60. Assume that the stock price moves proportionately up or down by 10% each year. The risk-free interest rate is 3% per annum with continuous compounding.

Calculate the value of the put.

SHOW ALL WORK.
23. (3 points)

Consider a European call option on the S&P 500 that is 2 months from maturity in addition to the following information.

- Current value of index is 1,000
- Exercise price is 950
- Risk-free interest rate is 5% per annum
- Volatility of the index is 25% per annum
- Dividend yields of 0.1% and 0.2% are expected in months 1 and 2, respectively

Calculate the price of one index option contract.

SHOW ALL WORK.
24. (3 points)

You own a 3-year bond that is callable at par ($100) beginning in year 1. You are given the following information about a binomial interest rate tree:

- Current interest rate is 3.95%
- The lower one-year rate one year forward is 4.25%
- The lowest one-year rate two years forward is 4.85%
- The volatility of the one-year rate is 15%
- The bond’s annual coupon rate is 5.25%

Calculate the price of the bond if there were no call feature.

SHOW ALL WORK.
25. (3 points)

Company XYZ has 2 million shares worth $70 each and is considering issuing 1 million warrants each of which gives the holder the right to buy one share with a strike price of $120 in 4 years. The interest rate is 6% per annum, and the volatility is 30% per annum. The company pays no dividends.

a. (2 points)

Calculate the change in XYZ’s stock price today if it announces the issuance of 1 million warrants at $120 in 4 years.

b. (1 point)

Instead of warrants, the company issues 1 million executive stock options with a strike price of $70 and executable in 4 years. In 4 years, the stock price is $125 immediately before the stock options are executed.

Determine the change in XYZ’s stock price once the stock options are executed and explain your answer.

SHOW ALL WORK.
26. (1 point)

You are given the following information:

- An American investor purchases 1,000 shares of a Canadian company on January 1, 2006 for $27.50 Canadian (CAD) per share
- This investor sells all shares for $30 CAD on December 31, 2006
- The exchange rate was 1.10 CAD per U.S. dollar (USD) on January 1, 2006
- The exchange rate was 1.20 CAD per USD on December 31, 2006

Calculate the investor's rate of return in U.S. funds on December 31, 2006.

SHOW ALL WORK.
27. (2.5 points)

You are given the following information about a property-casualty insurance company:

<table>
<thead>
<tr>
<th>Assets</th>
<th>Market Value</th>
<th>Duration in Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Common Stocks</td>
<td>$2,000</td>
<td>26.5</td>
</tr>
<tr>
<td>Taxable Bonds</td>
<td>$4,000</td>
<td>5.4</td>
</tr>
<tr>
<td>Money Market</td>
<td>$500</td>
<td>1.0</td>
</tr>
<tr>
<td>Tax-exempt Bonds</td>
<td>$1,000</td>
<td>11.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Liabilities</th>
<th>Market Value</th>
<th>Duration in Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loss Reserves</td>
<td>$5,000</td>
<td>6.0</td>
</tr>
</tbody>
</table>

The current booked value for loss reserves is $7,500.

a. (2 points)

Calculate the duration gap of economic leverage for this company.

b. (0.5 point)

Briefly explain a condition under which a firm’s economic leverage is immunized against changes in interest rates.

SHOW ALL WORK.
28. (3 points)

You are given the following loss payout pattern for a property-casualty insurance line of business for a given accident year:

<table>
<thead>
<tr>
<th>Development Year</th>
<th>Payout Pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>47.2%</td>
</tr>
<tr>
<td>2 through 6</td>
<td>0.0%</td>
</tr>
<tr>
<td>7</td>
<td>52.8%</td>
</tr>
</tbody>
</table>

- The risk free interest rate is 4%
- The yield on the company's investable assets is 9%
- All loss payouts are made mid-year
- The environment for cash flow from these insurance losses is non-inflationary

a. (1 point)

Calculate the liability duration of the loss reserves for this line of business.

b. (2 points)

For each of the following bond portfolios, demonstrate why or why not the portfolio would be appropriate to duration match the loss reserve for this line of business.

- Portfolio #1 consists of coupon bonds with a coupon of 1% per quarter and a yield of 1.5% per quarter. The bonds mature in 2 years.
- Portfolio #2 consists of level annuities with a 5% yield per year, paid annually, for 5 years.

SHOW ALL WORK.
29. (3 points)

You are given the following information about an insurance company:

- Policyholder surplus as of December 31, 2005 = $100
- Premium of policies written January 1, 2006 = $100
- Expected losses on January 1, 2006 policies = $80
- Expenses on January 1, 2006 policies = $25
- Risk-free rate = 4.0%
- 2007 client retention rate = 95%
- 2008 client retention rate = 80%
- 2009 client retention rate = 0%

Assume expenses are paid when the policy is written and losses are certain and paid at the end of the year.

a. (1 point)

Calculate the current economic value of this firm on January 1, 2006.

b. (1 point)

Calculate the total economic value of this firm on January 1, 2006.

c. (1 point)

Suppose a rating agency determines that the duration of the total economic value is high and is considering lowering the insurance company’s rating.

Discuss the aspects of the dilemma created if the insurance company uses traditional duration-matching to manage its interest rate risk.

SHOW ALL WORK.
30. (2.5 points)

An investor is holding a short position in 3,000 European call options on silver futures. The call options mature in 3 months.

You are given the following information:

- The exercise price of the options is $10
- The risk-free interest rate is 5% per annum
- The volatility of silver is 10% per annum
- There are no storage costs for silver
- The current price of the futures contract underlying the option is $10 per ounce
- The futures contract matures in six months

Calculate the initial position in silver that is necessary to delta hedge the investor’s call options.

SHOW ALL WORK.
31. (2 points)

You are given the following information about a portfolio:

- The portfolio consists of 5000 shares of Stock X and 2000 shares of Stock Y
- Stock X share price is $100
- Stock Y share price is $150
- Daily price volatility for Stock X is 1%
- Daily price volatility for Stock Y is 2%
- The returns on the two shares have a bivariate normal distribution with a coefficient of correlation between the two stocks of 0.30

a. (1 point)

Calculate the 15-day, 99% Value at Risk for the portfolio.

b. (1 point)

Calculate the benefit of diversification on the portfolio.

SHOW ALL WORK.
32. (1.5 points)

You are given the following one-year ratings transition matrix and information regarding an individual bond:

<table>
<thead>
<tr>
<th>Initial Rating</th>
<th>Aaa</th>
<th>Aa</th>
<th>A</th>
<th>Baa</th>
<th>Ba</th>
<th>B</th>
<th>Caa</th>
<th>Default</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aaa</td>
<td>92.07%</td>
<td>7.15%</td>
<td>0.75%</td>
<td>0.00%</td>
<td>0.02%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.01%</td>
</tr>
<tr>
<td>Aa</td>
<td>1.16%</td>
<td>90.76%</td>
<td>7.72%</td>
<td>0.27%</td>
<td>0.07%</td>
<td>0.01%</td>
<td>0.00%</td>
<td>0.01%</td>
</tr>
<tr>
<td>A</td>
<td>0.05%</td>
<td>2.34%</td>
<td>91.79%</td>
<td>5.16%</td>
<td>0.50%</td>
<td>0.13%</td>
<td>0.01%</td>
<td>0.01%</td>
</tr>
<tr>
<td>Baa</td>
<td>0.05%</td>
<td>0.24%</td>
<td>5.19%</td>
<td>88.46%</td>
<td>4.90%</td>
<td>0.80%</td>
<td>0.16%</td>
<td>0.19%</td>
</tr>
<tr>
<td>Ba</td>
<td>0.01%</td>
<td>0.05%</td>
<td>0.49%</td>
<td>5.38%</td>
<td>85.05%</td>
<td>7.18%</td>
<td>0.54%</td>
<td>1.29%</td>
</tr>
<tr>
<td>B</td>
<td>0.01%</td>
<td>0.03%</td>
<td>0.13%</td>
<td>0.42%</td>
<td>6.49%</td>
<td>83.24%</td>
<td>3.00%</td>
<td>6.68%</td>
</tr>
<tr>
<td>Caa</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.57%</td>
<td>1.70%</td>
<td>4.15%</td>
<td>67.79%</td>
<td>25.78%</td>
</tr>
<tr>
<td>Default</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>100.00%</td>
</tr>
</tbody>
</table>

Assume you have the sample of two variables from normal distributions:

- Current rating of the bond = A
- Sampled random variable = 1.14

a. (1 point)

Using the *CreditMetrics* approach for calculating credit VaR, based on the sampled random variables, calculate the simulated year-end rating of the bond.

SHOW ALL WORK.

b. (0.5 point)

Briefly describe one advantage and one disadvantage of the *CreditMetrics* approach for calculating credit VaR.
33. (2.5 points)

You are given the following observations regarding the price of stocks A and B:

<table>
<thead>
<tr>
<th>Day</th>
<th>Stock A</th>
<th>Stock B</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>55.00</td>
<td>45.00</td>
</tr>
<tr>
<td>1</td>
<td>56.10</td>
<td>45.45</td>
</tr>
<tr>
<td>2</td>
<td>54.98</td>
<td>43.18</td>
</tr>
<tr>
<td>3</td>
<td>52.23</td>
<td>41.88</td>
</tr>
<tr>
<td>4</td>
<td>54.84</td>
<td>43.98</td>
</tr>
<tr>
<td>5</td>
<td>57.03</td>
<td>44.86</td>
</tr>
<tr>
<td>6</td>
<td>55.32</td>
<td>43.06</td>
</tr>
<tr>
<td>7</td>
<td>52.00</td>
<td>42.63</td>
</tr>
<tr>
<td>8</td>
<td>57.20</td>
<td>43.91</td>
</tr>
<tr>
<td>9</td>
<td>54.34</td>
<td>44.79</td>
</tr>
<tr>
<td>10</td>
<td>53.80</td>
<td>42.55</td>
</tr>
</tbody>
</table>

Assume that your portfolio consists of 1,000 shares of each stock.

Estimate the 1-day VaR for an 80% confidence level using the historical simulation methodology.

SHOW ALL WORK.
34. (1 point)

Briefly explain two ways that hedging can be a value-adding strategy for firms that have chosen to concentrate equity ownership within their management.
35. (4.5 points)

The CEO of your company has asked you for assistance in determining which lines of business written by the company are value-adding and which are value-detraacting, as evaluated on a rate-of-return basis.

a. (1 point)

Briefly describe four possible measures of capital that could be used in the denominator of the rate-of-return calculation.

b. (0.5 point)

Briefly explain how your recommended capital measure might differ based on whether your company is publicly owned or is a mutual company.

c. (1 point)

Briefly describe two possible risk measures that could be used to assess the risk associated with a given line of business.

d. (1.5 points)

Briefly describe three methods to allocate capital to a given line of business once the appropriate risk measure has been selected.

e. (0.5 point)

The CEO would like to use the company's cost of capital, as derived from the Capital Asset Pricing Model, as the hurdle rate to which each line's rate of return should be compared.

Explain why this may or may not be appropriate.

CONTINUED ON NEXT PAGE
36. (2.5 points)

You are given the following information:

- Assets = $1,000
- Liabilities = $1,196
- Risk-free rate (continuously compounded) = 6%
- Time to payment = 1 year
- Risk parameter (continuously compounded) = 10%

Calculate the Expected Policyholder Deficit.

SHOW ALL WORK.
37. (3 points)

You are given the following information from XYZ Company’s Annual Statement:

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earned Premium</td>
<td>$104,000</td>
</tr>
<tr>
<td>Loss and Loss Adjustment Expense Incurred</td>
<td>$78,000</td>
</tr>
<tr>
<td>Commissions</td>
<td>$10,400</td>
</tr>
<tr>
<td>Acquisition Expenses</td>
<td>$5,200</td>
</tr>
<tr>
<td>Other Underwriting Expenses</td>
<td>$2,000</td>
</tr>
<tr>
<td>Depreciation</td>
<td>$840</td>
</tr>
<tr>
<td>Debt outstanding</td>
<td>$10,000</td>
</tr>
</tbody>
</table>

You are also given the following information for XYZ:

- To sustain its targeted 5% annual growth rate in perpetuity, XYZ must invest 25% of its pretax cash flow each year
- Depreciation is expected to remain constant
- XYZ’s tax rate is 35%
- XYZ has determined its appropriate leveraged market capitalization rate to be 8% and its unleveraged market capitalization rate to be 11%

a. (2 points)

Calculate the value of XYZ’s equity using the free cash flow method. Ignore interest expense on debt as well as any tax savings resulting from the deductibility of the interest expense.

b. (0.5 point)

XYZ has determined that they need $2,000 of additional capital to maintain their rating.

Describe the impact on XYZ’s free cash flow.

c. (0.5 point)

Calculate the equity value assuming that XYZ retains the additional capital required to maintain XYZ’s current rating.

SHOW ALL WORK.

CONTINUED ON NEXT PAGE

37
38. (2 points)

XYZ Company is maturing and production capacity is sufficient to meet market demand, so the company has decided to decrease investment into research and development and increase its dividend payout ratio.

You are given the following information:

- XYZ will pay out a dividend of $1.20 at December 31, 2007
- XYZ plans to increase its dividend by 10% for the next 3 years before the dividend growth rate is expected to level off in the fourth year
- XYZ expects to increase its dividend payout ratio to 60% by December 31, 2010
- XYZ targets an ROE of 12%
- The market rate of return is 10.5%
- The current market price per share of XYZ’s stock is $25

a. (1.5 points)

Calculate the intrinsic value of XYZ’s stock as of January 1, 2007.

SHOW ALL WORK.

b. (0.5 point)

Briefly explain what an investor should do to capitalize on the discrepancy between its intrinsic value and current market price.
39. (2.5 points)

You are given the following information about XYZ Insurance Company:

<table>
<thead>
<tr>
<th>Year</th>
<th>GAAP Equity (Beginning of Year)</th>
<th>Net Income</th>
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</thead>
<tbody>
<tr>
<td>2007</td>
<td>$100,000</td>
<td>$10,000</td>
</tr>
<tr>
<td>2008</td>
<td>105,000</td>
<td>11,000</td>
</tr>
<tr>
<td>2009</td>
<td>110,000</td>
<td>12,000</td>
</tr>
<tr>
<td>2010</td>
<td>115,000</td>
<td>13,000</td>
</tr>
<tr>
<td>2011</td>
<td>120,000</td>
<td>14,000</td>
</tr>
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</table>

- Risk-free rate is 3%
- Expected market return is 5%
- Beta of 2.0
- Abnormal earnings will decline linearly over the 6-year period after 2011

Assume that the growth in book value does not require additional capital contributions.

Calculate the total equity value of the insurance company using the abnormal earnings method.

SHOW ALL WORK.
### Tables of the Normal Distribution

#### Probability Content from $-\infty$ to $Z$

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</tbody>
</table>
Solution 1

a. Expected return = .6(16) + .4(6) = 12%.

Standard deviation = $\sigma = .6(25) = 15\%$

b. 

![Graph showing the relationship between expected return and standard deviation.](image)

CAL: $E(r) = r_f + \frac{[E(r_p) - r_f]}{\sigma_p} \sigma_c = 6\% + 0.4\sigma_c$
Solution 2

A) \[ w_x = \frac{[E(r_x) - r_f] \sigma^2_x - [E(r_y) - r_f] \text{Cov}(r_x, r_y)}{[E(r_x) - r_f] \sigma^2_x + [E(r_y) - r_f] \sigma^2_y - [E(r_x) - r_f + E(r_y) - r_f] \text{Cov}(r_x, r_y)} \]

\[ \text{Cov}(r_x, r_y) = \rho \sigma_x \sigma_y \]

\[ w_x = \frac{(8 - 6)(70)^2 - (27 - 6)(-15)(22)(70)}{(8 - 6)(70)^2 + (27 - 6)(22)^2 - (8 - 6 + 27 - 6)(-15)(22)(70)} = \frac{14651}{25277} = 0.58 \]

\[ w_y = 1 - w_x = 1 - 0.58 = 0.42 \]

\[ E(r_p) = w_x E(r_x) + w_y E(r_y) = 0.58(8) + 0.42(27) = 4.64 + 11.34 = 15.98 \]

\[ \sigma_p^2 = w_x^2 \sigma_x^2 + w_y^2 \sigma_y^2 + 2w_x w_y \text{Cov}(r_x, r_y) \]

\[ = (0.58)^2 (22)^2 + (0.42)^2 (70)^2 + 2(0.58)(0.42)(-0.15)(22)(70) = 162.82 + 864.36 - 112.54 = 914.64 \]

\[ \sigma_p = \sqrt{914.64} = 30.24 \]

B) Suppose utility function \( y = E(r) - 0.005 \sigma^2 \)

\[ y = \frac{E(r_p) - r_f}{.01 A \sigma_p^2} = \frac{15.98 - 6}{.01(4)(914.64)} = \frac{9.98}{36.585} = 0.27 \] in the risky portfolio

Stock Fund X \( 0.27(0.58) = 15.66 \)
Stock Fund Y \( 0.27(0.42) = 11.34 \)
T-bills \( 1 - 0.27 = 73.00 \)
Solution 3

Time diversification only reduces the average return per year over a certain investment horizon $\rightarrow \sigma / t^{0.5}$

However, over time, the total return over this investment horizon will be more variable, i.e., risk will increase. The riskiness of the dollar return over the period will increase with time $\rightarrow \sigma \times t^{0.5}$

So, I don’t agree.
Solution 4

a. If only markets that survived are included in measurements of risk premium, you are excluding the markets that failed, which would have had a lower risk premium. Thus your calculation of risk premium will be biased upward.

b. Possible responses:
   - Time periods used (e.g., if you used a time period of a depression, then there would be more defaults)
   - Time horizon used
   - Selection of equity markets used to compute the risk premium (e.g., if only the US market is used, vs using up to 60 markets from around the world, as has been done in some papers to illustrate the survivorship bias in the US market)
   - Relative size of markets that are used or not used in the analysis
   - The return on those companies that did not default compared to those that did
   - Number of defaulting companies
   - Success of the market (The more successful, the fewer defaulting companies)
   - Market volatility – if market has been very volatile, more funds will have gone out of business
   - Interest rates
   - Business cycle
   - The pool of companies that are being analyzed
   - How the companies are treated when they leave the pool
   - How companies are weighted in an index
   - Regulations taking over poor performing firms
   - Whether failed funds are returns are being used in measurements
   - Cut off rate
Solution 5

a. Semi-strong says that stock prices reflect all publicly available information about stocks including past movements and fundamentals.

b. Momentum: In market sectors exhibiting either the best or worst recent returns, this good or bad recent performance of particular stocks continues over time. They conclude that while the performance of individual stocks is highly unpredictable, portfolios of the best-performing stocks in the recent past appear to outperform other stocks with enough reliability to offer profit opportunities.

Reversal Effect: Suggests that the stock market overreacts to relevant news. After the overreaction is recognized, extreme investment performance is reversed. This phenomenon would imply that a contrarian investment strategy---investing in recent losers and avoiding recent winners---should be profitable.

P/E Ratio: Portfolios of low price-earnings ratio stocks have higher returns than do high P/E portfolios. This holds up even if returns are adjusted for portfolio beta.

Small-Firm-in-January Effect: Average annual returns are consistently higher on the small firm portfolios even when returns are adjusted for risk and it occurs virtually entirely in the first two weeks in January.
- Small Firm Effect
- January Effect

Neglected-Firm Effect: Small firms, whose operations have not been researched by large institutional investors earn higher returns possibly reflecting the additional risk associated with lack of information.

Liquidity Effect: Small firms that are less liquid earn higher returns due to the risk associated with the lack of liquidity.

Book to Market Ratio: Firms with high book to market ratios provide a higher return.

Post-Earnings-Announcement Price Drift: The apparently sluggish response of stock prices to firms' earning announcements. The cumulative abnormal returns of positive-surprise stocks continue to rise - in other words, exhibit momentum - even after the earnings information becomes public, while the negative-surprise firms continue to suffer negative abnormal returns. The market appears to adjust to the earnings information only gradually, resulting in a sustained period of abnormal returns.
Solution 6

a. Use a two-step regression to estimate $\gamma_0$, $\gamma_1$ and $\beta$ in the following equation:

$$ E(r_m) - r_f = \gamma_0 + \gamma_1 \times \beta $$

Step 1: take N stocks over M time interval. Regress each of the N stocks over time to produce an estimate of $\beta$ for each stock.

Step 2: regress on the output from Step 1 to produce an estimate of $\gamma_0$ and $\gamma_1$ for the group of N stocks

b. Predicted: $\gamma_0 = 0$

$$ \gamma_1 = E(r_m) - r_f $$

Results: $\gamma_0$ greater than expected

$\gamma_1$ less than expected

c. 1. The N-stock portfolio does not represent the entire market

2. The error in the $\beta$ estimates from Step 1 is enough to invalidate the results in Step 2
Solution 7

Forecasting Errors: people give too much weight to recent experience compared to prior beliefs when making forecasts, and tend to make forecasts that are too extreme given the uncertainty inherent in their information. An example is the P/E effect, which can be explained by earnings expectations that are too extreme.

Overconfidence: people tend to overestimate the precision of their beliefs or forecasts and they tend to overestimate their abilities. An example is the prevalence of active versus passive investment management, since high trading activity is highly predictive of poor investment performance.

Conservatism: investors are too slow to update their beliefs in response to recent evidence. An example is post-earnings-announcement drift which gives rise to momentum in stock market returns.

Sample Size Neglect and Representativeness: people tend to infer a pattern too quickly based on a small sample and tend to extrapolate apparent trends too far into the future. An example is evidence that stocks with the best recent performance show reversals in the few days surrounding earnings announcements suggesting that the correction occurs just as investors learn that their initial beliefs were too extreme.
Solution 8

Coupons are semi annual because this is a U.S. Treasury Bond
Quoted price is relative to $100 par value and number after dash in quote is to 32nds

Actual days elapsed to actual number of days in period between coupon payments
June 1 to October 13 = actual days elapsed = 134
June 1 to December 1 = actual days between coupon payments = 183
134/183 = 0.7322

Coupon payment = 0.10/2 * $100 = $5

Accrued interest = 0.7322 * $5 = $3.661

Quoted price = $92 + $15/32 = $92.46875

Cash price = Quoted price + accrued interest since last coupon date
= $92.46875 + $3.661 = $96.12975

The cash price of a $100,000 bond is $96.12975 * $1,000 = $96,129.75
Solution 9

SAMPLE 1

Assume this bond was purchased at par

P1: 
   \( N = 29 \)
   \( y = 8.5\% \)
   \( PMT = 80 \)
   \( FV = 1000 \)
   \( PV = 946.70 \)

\[
HPR = \frac{80 + (P1 - 1000)}{1000} = \frac{80 + (946.70 - 1000)}{1000}
\]

\[
HPR = 2.67\%
\]

SAMPLE 2

Assume YTM at sale is also 8.5%

Original price = 946.27
Price at end of year 1 = 946.70

Holding period return = \( \frac{80 + 946.70 - 946.27}{946.27} = 8.5\% \)
Solution 10

L: $2,000
R_K: 5.0%
R_M: 4.8%
R_F: 5.2%
T_1: 0.0
T_2: 0.5

a) Payoff = \[\frac{L(R_K-R_M)(T_2-T_1)}{1+R_M(T_2-T_1)}\]
= \[\frac{(2,000)(0.05-0.048)(0.5-0.0)}{1+0.048(0.5-0.0)}\]
= $1.95

b) \(R_2\) = continuously compounded zero rate
\(R_2 = m \times \ln(1 + R_m/m)\)
m = 2
\(R_m = 0.048\)
\(R_2 = 2 \times \ln(1 + 0.048/2) = 0.474\%

\(V_{FRA} = L(R_F - R_K)(T_2 - T_1)e^{-R_2T_2}\)
= \[2,000*(0.052-0.050)*(0.5-0.0)*e^{-0.0474*0.5}\]
= $1.953
Solution 11

$CMR_t = 1 - [\prod SR_t$]

$SR_t = 1 - MMR_t$

$MMR_t = \text{Marginal Mortality Rate at time } t = \frac{\text{value of bonds defaulting in year } (t)}{\text{value of population at start of year } (t)}$

$CMR = 1 - [(1 - 10000/250000) * (1 - 14000/180000)] = 0.1147$
Solution 12

$875 = (1000 + 50) / (1 + x) \Rightarrow x = 20\%$

Default premium = 20\% - 8\% = 12\%
Solution 13

a.)  Unconditional Default Probability for Year 3 = 
Q(3) – Q(2) = 1.00% - 0.45% = 0.55%

b.)  Default intensity for Year 3 = 
\[
\frac{Q(3) - Q(2)}{1 - Q(2)}
\]
\[= \frac{50.0\% - 40.0\%}{100\% - 40\%}\]
\[= \frac{10\%}{60\%} = 16.67\%
\]

c.)  \[Q(t) = 1 - \epsilon^{\mu(t) t}\]
\[Q(5) = .0015 = 1 - \epsilon^{-\mu(t) 5}\]
\[.9985 = \epsilon^{-\mu(t) 5}\]
\[\ln (.9985) = -\mu(t) * 5\]
\[-1/5 * \ln (.9985) = \mu(t)\]
\[\mu(t) = 0.0003\]
Solution 14

a)  
Times-interest-earned Ratio:  
Company A: $9 / 1 = 9$  
Company B: $15 / 5 = 3$

Current Ratio:  
Company A: $100 / 60 = 1.67$  
Company B: $190 / 130 = 1.46$

Return on Assets Ratio:  
Company A: $9 / 145 = 0.062$  
Company B: $15 / 255 = 0.059$

b)  
Times-interest-earned Ratio: Company B’s has a higher default risk because its interest obligations are a greater proportion of its earnings. If earnings decline company B may have difficulty meeting these obligations.

Current Ratio: Company B has a higher default risk. If its asset values decline it may not be able to meet its current liabilities.

Return on Assets Ratio: Company B has a higher default risk. It is generating a lower return on its assets suggesting inefficiencies or other problems that may signal difficulties.
Solution 15

Any three and only three of the following

- Sinking funds – firm spreads the payment burden of the par value at the end of the bonds life through the issuing firm repurchasing some bonds in the open market each year or the repurchasing at a special call price associated with the sinking fund provision
- Subordination of Debt – clause that restricts the amount of additional borrowing and may require additional debt to be subordinated in priority to existing debt
- Dividend Restrictions – limits dividends a firm is allowed to pay
- Collateral – bonds issued with specific assets behind them that bondholders received if the firm defaults on the bond
- “Netting” – if one contract defaults, they all default
- Downgrade Trigger – if credit rating of issuer falls below a specified value, bond immediately becomes due in full
Solution 16

SAMPLE 1

1. Illiquidity of corporate bonds, especially low-grade bonds. Because they are more difficult to trade, investors will require an additional liquidity premium to invest in corporate bonds compared to liquid government bonds.
2. Upon default, the retention/recovery value of the bonds can vary greatly around its average of around 40%. This additional uncertainty of final payment may cause investors to demand an additional risk premium.
3. Some regulatory restrictions on what types of bonds that corporation can hold may be artificially suppressing demand for corporate bonds, especially the low-grade speculative “junk” bonds. This will cause these bond prices to be artificially lower, raising their average return.

SAMPLE 2

1. Liquidity risk – some bonds may not be as liquid as investors would like, so investors demand extra compensation in the form of a risk premium
2. Market inefficiency – these bonds have simply been mispriced due to lack of information
3. Investment restrictions – reduced demand due to investment restrictions means certain bonds are offered at more favorable prices
Solution 17

Since I have the stock, I want to be protected against a decrease in price. I should short hedge future contract.

A short position in \( 0.8 \times \frac{25,000 \times 45}{1200 \times 50} \) = 15 contracts
Solution 18

SAMPLE 1

The differential between U.S. Dollar floating rates is 1.0%.
The differential between Canadian Dollar fixed rates is 2.5%.

The total potential gain to all parties is the difference between these differentials, or 1.5%. Since the financial institution requires 0.25%, A and B can each be made 0.625% better off.

Company A has comparative advantage in fixed; Company B has comparative advantage in floating.

Arrange the swap so A can borrow at USD at LIBOR + 0.875% and B can borrow CAD at 9.375% per annum.

SAMPLE 2

Company A borrows using LIBOR + 1.5%.

25 basis points = 0.25%

Since the floating rate for Company A is lower than that for Company B, A has no incentive to make the swap unless they get a benefit.

Benefit to A =

<table>
<thead>
<tr>
<th>What they would pay on their own</th>
<th>LIBOR + 1.5%</th>
</tr>
</thead>
<tbody>
<tr>
<td>- what they would pay with Co. B</td>
<td>- LIBOR + 2.5%</td>
</tr>
<tr>
<td>- 25 basis point fee</td>
<td>- 0.25%</td>
</tr>
<tr>
<td>+ benefit</td>
<td>+ X</td>
</tr>
</tbody>
</table>

= X - 1.25%

Benefit to B =

<table>
<thead>
<tr>
<th>What they would pay on their own</th>
<th>10%</th>
</tr>
</thead>
<tbody>
<tr>
<td>- what they would pay with Co. A</td>
<td>- 7.5%</td>
</tr>
<tr>
<td>- 25 basis point fee</td>
<td>- 0.25%</td>
</tr>
<tr>
<td>+ benefit</td>
<td>+ X</td>
</tr>
</tbody>
</table>

= 2.25% - X

The benefits must be equal, so X = 1.75% and therefore:

Company A pays LIBOR + 2.5% + 0.25% - 1.75% = LIBOR + 1.0%
Company B pays 7.5% + 0.25% + 1.75% = 9.5% fixed
Solution 19

SAMPLE 1

\[ k = \frac{0.07}{2} \times 50M = 1.75M \]
\[ k^* = \frac{0.088}{2} \times 50M = 2.2M \]

\[ B_{\text{fix}} = 1.75e^{-0.08 \times 4/12} + 1.75e^{-0.085 \times 10/12} + 51.75e^{-0.09 \times 16/12} = 49.23M \]
\[ B_{\text{float}} = 2.2e^{-0.08 \times 4/12} + 50e^{-0.08 \times 4/12} = 50.83M \]

\[ V_{\text{swap}} = B_{\text{fix}} - B_{\text{float}} = 49.23M - 50.83M = -1.6M \]

SAMPLE 2

At \( t = 4 \) mo: \( e^{(0.085 \times 0.3333)} = e^{(0.08 \times 0.3333)} \times e^{(R \times 0.5)} \rightarrow R = 8.833\% \) cont

4 mo to 10mo: \( e^{0.08833} = (1 + R/2)^2 \rightarrow R = 9.031\% \)

16 mo: \( e^{(0.09 \times 1.3333)} = e^{(0.085 \times 0.8333)} \times e^{(R \times 0.5)} \rightarrow R = 9.833\% \)
\[ e^{0.09833} = (1 + R/2)^2 \rightarrow R = 10.079\% \]

\( T = 4 \) mo: pay 4.4% \( \times 50m = 2.2m \); receive 3.5% \( \times 50m = 1.75m \) \( \rightarrow \) net pay = 0.45m

\( T = 10 \) mo: pay 9.031% \( \times 0.5 \times 50m = 2.25783m \); receive 1.75m \( \rightarrow \) net pay 0.50783m

\( T = 16 \) mo: pay 10.079% \( \times 0.5 \times 50m = 2.51977m \); receive 1.75m \( \rightarrow \) net pay 0.76977m

Value = \(-[0.45 \times e^{(-0.08 \times 4/12)} + 0.50783 \times e^{(-0.08 \times 10/12)} + 0.76977 \times e^{(-0.09 \times 16/12)}]\) = -1.59398m
Solution 20

Use put-call parity for European options that pay dividends

\[ p + S - PV(\text{divs}) = c + Ke^{-rT} \]

Divs in months 3 and 5 only, the third is after expiration
\[ D = PV(\text{Divs}) = 1.5e^{.10(3/12)} + 1.5e^{.10(5/12)} = 2.90 \]

\[ p = c + Ke^{-rT} - S + D \]
\[ = 2 + 30e^{-10(.5)} - 29 + 2.90 \]
\[ = 1.54 + 2.90 \]
\[ = $4.44 \]
Solution 21

Bear spread
buy call @ $k = 25$ for $\$1$, sell call @ $k = 20$ for $\$4 \rightarrow$ gain of $\$3$

<table>
<thead>
<tr>
<th>$k$</th>
<th>Long call (25)</th>
<th>Short call (20)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>$S_T &gt; 25$</td>
<td>$S_T - 25$</td>
<td>$-(S_T - 20)$</td>
<td>$-5 + 3$</td>
</tr>
<tr>
<td>$20 &lt; S_T &lt; 25$</td>
<td>$0$</td>
<td>$-(S_T - 20)$</td>
<td>$-(S_T - 20) + 3$</td>
</tr>
<tr>
<td>$S_T &lt; 20$</td>
<td>$0$</td>
<td>$0$</td>
<td>$+3$</td>
</tr>
</tbody>
</table>

![Graph showing profit against $S_T$ with long and short call lines](image)
Solution 22

\[ p = \frac{e^{rT} - d}{u - d} \]
\[ p = \frac{e^{-0.03(T)} - 0.9}{1.1 - 0.9} \]
\[ p = 0.6523 \]

Node A
Stock Price = $60
\[ f_u = e^{-0.03(T)}(0.6523*1.2147 + (1-0.6523)*3.60) \]
\[ f_u = 1.2147 \]
The put is worth $0 at this point. Therefore, it is not optimal to exercise the put at this time and the option value = 1.2147

If we exercise the put at this point, it is worth $63 - $60 = $3. Therefore, it is not optimal to exercise the put at this time and the option value = $3.81.

Node B
Stock Price = $66
\[ f_u = e^{-0.03(T)}(0.6523*0 + (1-0.6523)*3.60) \]
\[ f_u = 3.8057 \]

Node C
Stock Price = $54
\[ f_u = e^{-0.03(T)}(0.6523*3.60 + (1-0.6523)*14.40) \]
\[ f_u = 7.1378 \]
But if we exercise the put at this point, it is worth $63 - $54 = $9. Therefore, it is optimal to exercise the put at this time and the option value = $9.

Stock Price = $72.60
Option Value = $0

Stock Price = $59.40
Option Value = $3.60

Stock Price = $48.60
Option Value = $14.40

Stock Price = $72.60
Option Value = $0
Solution 23

c = S_0 e^{qT} N(d_1) - K e^{-rT} N(d_2)

d_1 = \left[ \ln(S_0/K) + (r - q + \sigma^2 / 2)T \right] / \left[ \sigma \sqrt{T} \right]

d_2 = \left[ \ln(S_0/K) + (r - q - \sigma^2 / 2)T \right] / \left[ \sigma \sqrt{T} \right] = d_1 - \sigma \sqrt{T}

annualized dividend yield \( q = (0.1\% + 0.2\%) \times 6 = 1.8\% \) per annum

d_1 = \left[ \ln(1000/950) + (0.05 - 0.018 + 0.252 / 2)(2/12) \right] / \left[ 0.25((2/12)^{1/2}) \right]

d_1 = 0.6059

N(d_1) = 0.7257 + 0.59(0.7291 - 0.7257)

N(d_1) = 0.7277

N(d_2) = 0.6915 + 0.38(0.6950 - 0.6915)

N(d_2) = 0.6928

\[ c = 1000 e^{-0.018(2/12)} (0.7277) - 950 e^{-0.05(2/12)} (0.6928) \]

\[ c = 72.82 \]

Therefore, one index option contract costs 72.82 (100) = $7,282.
Solution 24

\[ r_H = r_L e^{2\sigma} \]
\[ r_{HL} = r_{LL} e^{2\sigma} \]
\[ r_{HH} = r_{LL} e^{4\sigma} \]

\[ r_H = 0.0574 \]
\[ r_{HL} = 0.0655 \]
\[ r_{HH} = 0.0884 \]

\[ V_{LL} = \frac{105.25}{1.0485} = 100.38 \]
\[ V_{HL} = \frac{105.25}{1.0655} = 98.78 \]
\[ V_{HH} = \frac{105.25}{1.0884} = 96.70 \]

Assume equal probability

\[ V_L = \frac{(100.38 + 5.25 + 98.78 + 5.25)/2}{1.0425} = 100.56 \]
\[ V_H = \frac{(96.70 + 5.25 + 98.78 + 5.25)/2}{1.0574} \text{ or } 100 = 97.40 \]

\[ V = \frac{(100.56 + 5.25 + 97.40 + 5.25)/2}{1.0395} \]

Value of an optionless bond = 100.27
Solution 25

a) Value of the Call Option:

Where $S_0 = $70 \quad K = $120 \quad r = 6\% \quad \sigma = 30\% \quad T = 4$

\[
d_1 = \frac{\ln\left(\frac{70}{120}\right) + \left(0.06 + \frac{0.30^2}{2}\right) \cdot 4}{0.30 \cdot \sqrt{4}} = -0.1983
\]

\[
d_2 = \frac{\ln\left(\frac{70}{120}\right) + \left(0.06 - \frac{0.30^2}{2}\right) \cdot 4}{0.30 \cdot \sqrt{4}} = -0.7983
\]

$N(-0.1983) = 0.4214 \quad N(-0.7983) = 0.2123$

\[
C = 70 \cdot 0.4214 - 120 \cdot e^{-0.06 \cdot 4} \cdot 0.2123 = 9.46
\]

The value of each warrant is: (where $N = 2,000,000$ and $M = 1,000,000$)

\[
$9.46 \cdot \frac{2,000,000}{2,000,000 + 1,000,000} = 6.306667
\]

$1,000,000$ warrants $\Rightarrow$ $6,306,667$

Adjusted Price $\frac{6,306,667}{2,000,000}$ Shares $= 3.15$ per share decline in price.

b) SAMPLE 1

For Executive Stock options the price of the stock at the exercise date already anticipates the exercise of the Stock Options. So no further adjustments are needed.

When markets are efficient the impact of dilution from executive stock options is reflected in the stock price as soon as they are announced and does not need to be taken into account again when the options are valued.

SAMPLE 2

New price $= \frac{[1m \cdot 70 + 2m \cdot 125]}{[1m + 2m]} = 106.67$

Change in price $= -18.33$

The value of options is reflected at the time of announcement assuming market efficiency.
Solution 26

US funds required to purchase each share at January 1, 2006:
\[ \frac{27.50 \text{ CAD}}{1.10} = \$25.00 \text{ USD} \]

When the stock appreciates to $30 CAD per share, determine the value in USD using the December 31, 2006 exchange rate
\[ \frac{30.00 \text{ CAD}}{1.20} = \$25.00 \text{ USD} \]

Determine the rate of return
\[ \frac{25.00}{25.00} - 1 = 0\% \]
Solution 27

a.

\[ DG_{el} = D_{MVS} - D_{MVA} \]

\[ D_{MVS} = \frac{(D_{MVA} \times MVA) - (D_{MVL} \times MVL)}{MVS} \]

MVA = 2,000 + 4,000 + 500 + 1,000 = 7,500

MVL = 5,000

MVS = 7,500 – 5,000 = 2,500

\[ D_{MVA} = \frac{\sum D_{MVA_i} \times MVA_i}{\sum MVA_i} = \frac{[26.5 \times 2,000 + (5.4 \times 4,000) + (1.0 \times 500) + (11.5 \times 1,000)]}{2,000 + 4,000 + 500 + 1,000} \]

= 11.55

\[ D_{MVL} = \frac{\sum D_{MVL_i} \times MVL_i}{\sum MVL_i} = \frac{(6.0 \times 5,000)}{5,000} = 6.0 \]

\[ D_{MVS} = \frac{(11.55 \times 7,500) - (6.0 \times 5,000)}{2,500} \]

= 22.65

\[ DG_{el} = 22.65 - 11.55 \]

= 11.1

b. It is immunized when the duration of the surplus equals the duration of the assets, i.e. when the duration gap of economic leverage is 0.
Solution 28

A. 

\[
\text{Duration} = \frac{47.2 \times 0.5 \times \left( \frac{1}{1.09} \right)^{0.5} + 52.8 \times 6.5 \times \left( \frac{1}{1.09} \right)^{6.5}}{47.2 \times \left( \frac{1}{1.09} \right)^{0.5} + 52.8 \times \left( \frac{1}{1.09} \right)^{6.5}}
\]

= 2.90

B. 

Portfolio #1

Duration of coupon bond = \[
\frac{1 + y}{y} - \frac{(1 + y) + T(c - y)}{c \left[ (1 + y)^T - 1 \right] + y}
\]

where:
\[ c = .01 \]
\[ T = 8 \]
\[ y = .015 \]

= \[
\frac{1 + .015}{.015} - \frac{(1 + .015) + 8 \times (.01 - .015)}{.01 \left[ (1 + .015)^8 - 1 \right] + .015}
\]

= 7.72 quarters = 1.93 years

Portfolio #1 would not be appropriate to duration match the loss reserve liability, as the durations are not equal.

Portfolio #2

Duration of annuity = \[
\frac{1 + y}{y} - \frac{T}{(1 + y)^T - 1}
\]

where:
\[ T = 5 \]
\[ y = .05 \]

= \[
\frac{1 + .05}{.05} - \frac{5}{(1 + .05)^5 - 1}
\]

= 2.90

Portfolio #2 would be appropriate to duration match the loss reserve liability, as the durations are equal.
Solution 29

29a) Current Economic Value = $S + P - E - \left\lfloor \frac{L}{1+y} \right\rfloor$

\[ = 100 + 100 - 25 - \frac{80}{1.04} = 98.08 \]

29b) Total Economic Value = Current Economic Value + Franchise Value

2007 Franchise Value = \[P - E - \left\lfloor \frac{L}{1+y} \right\rfloor][d / (1 + d)]\]

\[ d = \frac{cr}{1 + y} \text{ if } cr \text{ is constant but it isn’t.} \]

\[ = \left[100 - 25 - \frac{80}{1.04}\right][0.95 / 1.04] = -1.76 \]

2008 Franchise Value = \[100 - 25 - \left(\frac{80}{1.04}\right)][(0.80 \times 0.95) / 1.04^2] = -1.35 \]

\[ \text{TEV} = 98.08 - 1.76 - 1.35 = 94.97 \]

29c) When the duration of franchise value is high, it is difficult to transform assets in order to match the durations. The duration of asset has to be near 0 or even negative. It would create rating agency and regulatory problems as they only see accounting numbers and they would see this strategy as increasing risk instead of decreasing it.
Solution 30

\[ d_1 = \frac{\ln(F_0/K) + \delta^2 T/2}{\delta x (T^{1/2})} \]

\[ F_0 = 10 \]
\[ K = 10 \]
\[ r = .05 \]
\[ \sigma = .10 \]
\[ T = 3/12 = .25 \]

\[ d_1 = \ln(10/10) + [.10^2 x (.25)]/2 = 0 + [(01)x(25)]/2 = .00125 = .025 \]

\[ N(d_1) = (.5080 + .5120) / 2 = .51 \]

Delta of Option: \[ e^{(-rT)} x N(d_1) = e^{(-.05 x .25)} x .51 = .9876 x .51 = .5037 \]

Delta of short position in 3,000 future options = \(-.5037)x(3000) = -1511.10 \]

Spot Delta of a six month futures contract = \[ e^{T} = e^{(.05 x .5)} = 1.0253 \]

Spot Delta of the option position is \(-1511.10) x (1.0253) = -1549.3 \]

Therefore, a long position in 1549.3 ounces of silver is necessary to hedge the option.
Solution 31

a) 15 day, 99% VaR of portfolio

\[ \sigma_x = 100 \times 5000 \times 0.01 = 5000 \]
\[ \sigma_x = 150 \times 2000 \times 0.02 = 6000 \]
\[ \sigma_p = \left[ (5000^2) + (6000^2) + (2 \times 0.3 \times 5000 \times 6000) \right]^{0.5} = 8888 \]

15 day, 99% VaR of portfolio = 8888 \times (15^{0.5}) \times 2.33 = 80208

b) SAMPLE 1

15 day, 99% VaR of Stock X = 5000 \times 2.33 \times (15^{0.5}) = 45120

15 day, 99% VaR for Stock Y = 6000 \times 2.33 \times (15^{0.5}) = 54144

Diversification benefit = (45120 + 54144) – 80208 = 19056

---

SAMPLE 2

\[ \rho = 1 \rightarrow \sigma_p = \sigma_x + \sigma_y = 11000 \]
\[ \text{VaR} = 2.33 \times (11000 \times 15^{0.5}) = 99065 \]

Benefit = reduction in VaR = 99065 – 80208 = 19057
Solution 32

a.

\[ N^{-1} [0.0005] = -3.00 \]
\[ N^{-1} [0.0005 + 0.0234] = -1.98 \]
\[ N^{-1} [0.0005 + 0.0234 + 0.9719] = 1.57 \]

Sampled rv of 1.14 is between -1.98 and 1.57, so rating stays at A

b.

SAMPLE 1

Pro: Credit losses are defined as those arising from credit downgrades as well as defaults.

Con: Likely to be computationally quite time intensive.

SAMPLE 2

1. advantage: based on historical default data
2. disadvantage: assumes normal distribution
Solution 33

Current value of the portfolio

<table>
<thead>
<tr>
<th></th>
<th>Stock A</th>
<th>Stock B</th>
<th>Portfolio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current</td>
<td>53.80</td>
<td>42.55</td>
<td>96,349</td>
</tr>
</tbody>
</table>

Calculate the 10 daily sample changes

<table>
<thead>
<tr>
<th>Day</th>
<th>Stock A</th>
<th>Stock B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.02</td>
<td>1.01</td>
</tr>
<tr>
<td>2</td>
<td>0.98</td>
<td>0.95</td>
</tr>
<tr>
<td>3</td>
<td>0.95</td>
<td>0.97</td>
</tr>
<tr>
<td>4</td>
<td>1.05</td>
<td>1.05</td>
</tr>
<tr>
<td>5</td>
<td>1.04</td>
<td>1.02</td>
</tr>
<tr>
<td>6</td>
<td>0.97</td>
<td>0.96</td>
</tr>
<tr>
<td>7</td>
<td>0.94</td>
<td>0.99</td>
</tr>
<tr>
<td>8</td>
<td>1.10</td>
<td>1.03</td>
</tr>
<tr>
<td>9</td>
<td>0.95</td>
<td>1.02</td>
</tr>
<tr>
<td>10</td>
<td>0.99</td>
<td>0.95</td>
</tr>
</tbody>
</table>

Simulated values for Day 11

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Stock A</th>
<th>Stock B</th>
<th>Portfolio Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>54.88</td>
<td>42.97</td>
<td>97,851</td>
</tr>
<tr>
<td>2</td>
<td>52.72</td>
<td>40.42</td>
<td>93,146</td>
</tr>
<tr>
<td>3</td>
<td>51.11</td>
<td>41.27</td>
<td>92,383</td>
</tr>
<tr>
<td>4</td>
<td>56.49</td>
<td>44.68</td>
<td>101,167</td>
</tr>
<tr>
<td>5</td>
<td>55.95</td>
<td>43.40</td>
<td>99,352</td>
</tr>
<tr>
<td>6</td>
<td>52.19</td>
<td>40.85</td>
<td>93,033</td>
</tr>
<tr>
<td>7</td>
<td>50.57</td>
<td>42.12</td>
<td>92,696</td>
</tr>
<tr>
<td>8</td>
<td>59.18</td>
<td>43.83</td>
<td>103,006</td>
</tr>
<tr>
<td>9</td>
<td>51.11</td>
<td>43.40</td>
<td>94,510</td>
</tr>
<tr>
<td>10</td>
<td>53.26</td>
<td>40.42</td>
<td>93,684</td>
</tr>
</tbody>
</table>

There are 10 scenarios - estimate the 80th %-ile as the 2nd lowest observation (scenario 7).

1-Day VaR at 80% confidence level = current value – 2nd lowest =

96,349 – 92,696 = 3,655
Solution 34

a. Since management has a significant portion of their net worth in the company, decreasing volatility through hedging may lower the required compensation for management. They would require more pay to compensate them for the risk of if the company were extremely volatile.

b. If the company is too volatile, mgmt has less incentive to try to increase shareholder value since their efforts could be wiped out by the volatility. Hedging would lessen this chance and keep the manager focused on growing shareholder (and their own) value.
c. Solution 35

Part A – the following answers received full credit:

- Actual committed capital (or Book value of capital) – the actual cash capital provided to the company by its shareholders and used to generate income for the firm and its respective business units
- GAAP Equity – book value of capital using GAAP accounting principles
- Statutory Surplus – book value of capital using statutory accounting principles
- IASB Fair Value of capital – value of capital using IASB accounting principles
- Market value of equity – the committed capital measure adjusted to reflect market values of the assets and liabilities
- Regulatory required capital (or RBC) – the capital required to satisfy minimum regulatory requirements
- Rating agency required capital – the capital required to achieve a stated credit rating from one or more credit rating agencies (S&P, A.M. Best, Moody’s or Fitch)
- Economic capital – the capital required to ensure a specified probability (level of confidence) that the firm can achieve a specified objective over a given time horizon
- Risk capital – the amount of capital that must be contributed by the shareholders of the firm in order to absorb the risk that liabilities will exceed the funds already provided for in either the loss reserves or in the policyholder premiums

Part B – A publicly owned company would choose a different capital measure than a mutual due to differences in interests. Policyholder interests are more focused on solvency – paying claims. Shareholder interests are more focused on the company as a going concern and with maximizing firm value. Since policyholders own the mutual company, and shareholders own the public company, each will choose a different measure in line with those interests.

Part C – the following answers received full credit:

- Probability of Ruin – the (estimated) probability that losses exceed capital
- Value at Risk – the dollar amount that will not be exceeded in the next $N$ days with $\lambda$% certainty
- Expected Policyholder Deficit – looks at the expected difference between the amount the company is obligated to pay and the amount it actually pays to the oblige
- Conditional Tail Expectation – measures the average loss of the scenarios worse than the $X$% percentile
- Risk Based Capital – perform the NAIC RBC calculations for each line of business
- CAPM – decompose the beta coefficient to determine the betas by line of business
Part D – the following answers received full credit:

- Proportional allocation based on a risk measure – calculates standalone risk measures for each risk source and then allocates the total risk capital in proportion to the separate risk measures.
- Incremental Allocation – using a risk measure, measure the capital needed by the total firm and the capital for the firm excluding a single line of business. The capital allocation can either be the difference between these two numbers (Merton & Perold) or a proportional allocation based on the distribution of the differences for all lines of business.
- Marginal Allocation – using a risk measure, measure the capital needed by the total firm and the capital for the firm after making a small change in the risk exposure for a risk source (e.g. amount of assets, amount of reserves, premium volume). Allocate the total capital in proportion to these marginal changes in capital. (Myers & Read is an example of this).
- Co-Measures approach – establish the capital requirement using a particular conditional risk measure, such as VaR or CTE, and then calculate the Co-Measure for each business unit by calculating the comparable risk measure for the unit subject to the condition applied to the entire firm.
- Regulatory Risk-based Capital (RBC) – perform the NAIC RBC calculations for each line of business
- CAPM – decompose the beta coefficient to determine the betas by line of business
- Insolvency Put Option – model the policyholders’ claim on the company’s assets as a put option on the ratio of assets to liabilities with a strike price of 1.00

Part E – the following answers received full credit:

- The CAPM cost of capital is based on the market value of the company’s equity. The risk capital used in the rate of return calculations is most likely not market value of equity. Therefore, some sort of adjustment is likely needed.
- Each line of business has different amounts of risks and different amounts of surplus supporting it. Hence the same rate for all lines is not appropriate.
Solution 36

EPD ratio = expected shortfall / loss = put option / loss

EPD is equivalent to a put on the assets of the firm with $k = \text{PV} (\text{liabilities})$

Put option

\[ d_1 = \frac{\ln \left( \frac{1000}{1196} \right) + (0.06 + 0.5 \times 0.1^2)}{0.1} = -1.14 \]

\[ d_2 = -1.14 - 0.1 = -1.24 \]

\[ N(d_1) = 0.1271 \]

\[ N(d_2) = 0.1075 \]

\[ c = 1000 \times 0.1271 - 1126.35 \times 0.1075 = 6.02 \]

Put-call parity $\Rightarrow p = 6.02 + 1126.35 - 1000 = 132.37$
Solution 37

a. Before-tax CF from operations = 104000-78000-10400-5200-2000 = 8400
   Depreciation = 840
   Taxable income = 8400-840 = 7560
   Taxes = 7560*.35 = 2646
   After-tax CF from Operations = 8400 - 2646 = 5754
   New Investment = .25 * (7560+840) = 2100
   Free CF = 5754-2100 = 3654
   Value = 3654 / (.11 - .05) = 60900
   Equity = 60900 - 10000 = 50900

b. Free CF = 3,654 – 2,000
   = 1,654

c. Value = 1,654 / (.11 - .05)
   = 27,567
   Equity = 27,567 – 10,000
   = 17,567
Solution 38

a)  
\[ g = b \times \text{ROE} = (1-60\%) \times .12 = .048 \]

\[ D_{2007} = 1.20 \]
\[ D_{2008} = 1.32 \]
\[ D_{2009} = 1.45 \]
\[ D_{2010} = 1.60 \]

\[ V_{2006} = \frac{D_{2007}}{(1+k)} + \frac{D_{2008}}{(1+k)^2} + \frac{D_{2009}}{(1+k)^3} + \frac{(D_{2010}+P_{2010})}{(1+k)^4} \]

\[ P_{2010} = D_{2010} \times \frac{1+g}{k-g} = 1.60 \times \frac{1.048}{.105-.048} = 29.42 \]

\[ V_{2006} = \frac{1.20}{1.105} + \frac{1.32}{1.105^2} + \frac{1.45}{1.105^3} + \frac{(1.60+29.42)}{1.105^4} = 24.05 \]

b) Since the price of the stock is higher than its intrinsic value, an investor should sell or short the stock.
Solution 39

a. Required Return \( = r_f + \beta (r_m - r_f) \)
\[ = .03 + 2.0 (.05 - .03) \]
\[ = .07 \]

Assume interest rate is annual compounding

<table>
<thead>
<tr>
<th>Year</th>
<th>Net Inc.</th>
<th>Normal Earnings</th>
<th>Abnormal Earnings</th>
<th>PV Factor</th>
<th>PV</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>10,000</td>
<td>7,000</td>
<td>3,000</td>
<td>.935</td>
<td>2,804</td>
</tr>
<tr>
<td>2008</td>
<td>11,000</td>
<td>7,350</td>
<td>3,650</td>
<td>.873</td>
<td>3,188</td>
</tr>
<tr>
<td>2009</td>
<td>12,000</td>
<td>7,700</td>
<td>4,300</td>
<td>.816</td>
<td>3,510</td>
</tr>
<tr>
<td>2010</td>
<td>13,000</td>
<td>8,050</td>
<td>4,950</td>
<td>.763</td>
<td>3,776</td>
</tr>
<tr>
<td>2011</td>
<td>14,000</td>
<td>8,400</td>
<td>5,600</td>
<td>.713</td>
<td>3,993</td>
</tr>
<tr>
<td>2012</td>
<td></td>
<td>4,800</td>
<td></td>
<td>.666</td>
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<td>2013</td>
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<td>4,000</td>
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<tr>
<td>2014</td>
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<td>3,200</td>
<td></td>
<td>.582</td>
<td>1,862</td>
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<tr>
<td>2015</td>
<td></td>
<td>2,400</td>
<td></td>
<td>.544</td>
<td>1,305</td>
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<tr>
<td>2016</td>
<td></td>
<td>1,600</td>
<td></td>
<td>.508</td>
<td>813</td>
</tr>
<tr>
<td>2017</td>
<td></td>
<td>800</td>
<td></td>
<td>.475</td>
<td>380</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>27,322</td>
</tr>
</tbody>
</table>

Total Equity Value \( = PV(AE) + \text{Beg. BV} \)
\[ = 27,322 + 100,000 \]
\[ = 127,322 \]