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(a) (3 points) Assume an effective annual discount rate of 5%.
If someone invest $550 in a project today, and then receives $800 three years later from the investment, what is the profitability index of this investment?

- **Answer:**

\[ PI = \frac{800}{(1.05^2/550) = 1.25649} \]

(b) (4 points) A zero-coupon bond has a face value of $600 to be paid 3.25 months from today. If the yield to maturity is 5% (as an effective annual interest rate), what is the current price of the bond?

- **Answer:**

\[ PV = \frac{600}{1.05^{3.25/12}} = $592.12 \]
(c) (4 points) In the fictional country of Itway, from 1932-2010, the standard deviation of large-company stocks was 15.1%. The average rate of return for large-company stocks was 9.3%. The average return on short-term government bonds in Itway (assumed to be risk-free) was 4.2%. What is the Sharpe ratio for Itway from 1932-2010?

**Answer:**

\[
\text{Sharpe Ratio} = \frac{\text{risk premium}}{\text{s.d. of stocks}} = \frac{9.3\% - 4.2\%}{15.1\%} = 0.3375
\]

(d) (5 points) Madison’s Construction has just signed a new contract. She receives a $5,000 deposit from the customer today. She has to pay $10,000 in construction costs one month from today, and receives a final $5,000 payment from the customer two months from today. Find at least one monthly internal rate of return for this project.

**Answer:** in $1000’s,

\[
5 - \frac{10}{(1 + IRR)} + \frac{5}{(1 + IRR)^2} = 0
\]

\[
5 * (1 + IRR)^2 - 10 * (1 + IRR) + 5 = 0
\]

\[
(1 + IRR)^2 - 2 * (1 + IRR) + 1 = 0
\]

\[
((1 + IRR) - 1)((1 + IRR) - 1) = 0
\]

\[
(1 + IRR) = 1 \rightarrow IRR = 0
\]
(e) (5 points) 95.44% of the probability distribution is within 2 standard deviations of the mean of a normal distribution. The historical equity risk premium is 9.3%, and the standard deviation of the equity risk premium is 13.4%. 100 years of data were used to make these estimates. Find a 95.44% confidence interval of the historical equity risk premium.

Answer:

\[ CI = 9.3\% \pm 2 \frac{13.4\%}{\sqrt{(100)}} \]

\[ CI = (6.62\%, 11.98\%) \]
(a) (7 points) Aubrey’s Waffles only has $100,000 of stock issued, with no bonds. The current cost of equity is 8%. If the company sells $20,000 of bonds and uses this money to purchase $20,000 worth of stock, what is the new cost of equity? Assume that the cost of debt is 4% and that there are no other securities issued by Aubrey’s Waffles. You can also assume that the weighted average cost of capital is constant.

**Answer:**

Before

\[ R_{WACC} = R_S = 8\% \]

After

\[
R_{WACC} = \frac{B}{B+S} R_B + \frac{S}{B+S} R_S
\]

\[ 8\% = \frac{2}{10} 4\% + \frac{8}{10} R_S \]

\[ 8\% = 0.8\% + 0.8\% R_S \]

\[ 7.2\% = 0.8\% R_S \]

\[ 9\% = R_S \]
(10 points) Today, Avery bought a share of Aviairways and sold a call option with an exercise price of $65 per share. The expiration date of all of these options is six months from now. Each option is for one share. For simplicity in this problem, you can assume that the discount rate is 0%. Draw a well-labeled graph that shows the value of a combination of buying a stock and selling a call at expiration. The vertical intercept should have this combination, while the horizontal axis should have the value of the stock on the expiration date.
Answer:

- **Answer:**
(7 points) There are 3 states of the world, each with one-third probability of occurring: Hip, Jip, and Pip. In the Hip state of the world, Stock A has a return of 6% and stock B has a return of 3%. In the Jip state of the world, stock A has a return of 8% and stock B has a return of 10%. In the Pip state of the world, stock A has a return of 10% and stock B has a return of 20%. What is the correlation coefficient of stocks A and B?
Answer:

\[
E(R_A) = \frac{6\% + 8\% + 10\%}{3} = 8\%
\]

\[
E(R_B) = \frac{3\% + 10\% + 20\%}{3} = 11\%
\]

\[
Cov(A, B) = \frac{1}{3} \left[ (.06 - .08)(.03 - .11) + (.08 - .08)(.1 - .08) \\
+ (.1 - .08)(.2 - .11) \right] = .0011\bar{3}
\]

\[
Var(A) = \frac{1}{3} \left[ (.06 - .08)^2 + (.08 - .08)^2 + (.1 - .08)^2 \right] = .00002\bar{6}
\]

\[
\sigma_A = 0.0163299
\]

\[
Var(B) = \frac{1}{3} \left[ (.03 - .11)^2 + (.1 - .11)^2 + (.2 - .11)^2 \right] = .0048\bar{6}
\]

\[
\sigma_B = 0.0697615
\]

\[
Corr(A, B) = \frac{Cov(A, B)}{\sigma_A \sigma_B} = \frac{.0011\bar{3}}{0.0163299 \times 0.0697615} = 0.994849
\]
(12 points) Quincy’s Quarters is a successful military-themed furniture store. They pay out dividends every 3 months, with the next dividend payment three months from now. The next 4 dividend payments will be $0.25 each per share. After the next year, each dividend payment will be 12.5% higher than the dividend payment made one year before. If we assume that this company will pay dividends forever, what is the present value of this stock if the effective annual discount rate is 25%?

**Answer:**
Quarterly rate = $4\sqrt{1.25} - 1 = 5.73713\%$

PV of 1st year’s dividends:

$$\frac{0.25}{1.25^{\frac{1}{4}}} + \frac{0.25}{1.25^{\frac{1}{2}}} + \frac{0.25}{1.25^{\frac{3}{4}}} + \frac{0.25}{1.25} = $0.871516$$

PV of dividends is equivalent to receiving $0.871516 this year and receiving 12.5% more each subsequent year.

$$PV = $0.871516 + \frac{$0.871516(1.125)}{.25 - .125} = $8.71516$$
(8 points) Jack is taking out a $10,000 loan, and is required to pay off equal amounts of principal each year for 4 years. Assume that 4 payments are made in total, once per year starting one year from today. How much will each payment be if the effective annual discount rate is 12%?

Answer:

1st payment : $2500 + $10,000(.12) = $3700
2nd payment : $2500 + $7500(.12) = $3400
3rd payment : $2500 + $5000(.12) = $3100
4th payment : $2500 + $2500(.12) = $2800
(8 points) Albert Columbia Inc. stock currently sells for $60 per share. Roberta buys a European option to buy one share of stock at $67 one year from today. There is one interesting feature about the Albert Columbia stock. The price always stays the same, except once every 3 months, the price goes up or down by $3, each with 50% probability. The next change in the stock’s price will occur two months from today. If the effective annual discount rate is 10%, what is the present value of the option?

- **Answer:** For the value 1 year from now to be greater than $67, the stock must go (up, up, up, up), implying a price of $72.

\[
Pr(up, up, up, up) = \left(\frac{1}{2}\right)^4 = \frac{1}{16}
\]

\[
PV \text{ of option} = \frac{1}{16} \frac{(72 - 67)}{1.1} = \$0.2841
\]