

# E120: Principles of Engineering Economics

Final Exam

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## Part 1: Concepts. (20 points)

1. Circle the only correct answer.

1.1 Which of the following statements is FALSE?

- a. It is never optimal to exercise American call options before the expiration date.
- b. Buying a call option at the money and selling a put option at the money is equivalent to buying a forward contract.
- c. *It is never optimal to exercise American put options before the expiration date.*
- d. There is an arbitrage opportunity if the put-call parity does not hold.
- e. An American put option has a higher value than a European put option for the same stock at the same strike price.

1.2 Stock ownership can be replicated by:

- a. Buying call options on a stock and writing put options on a stock.
- b. Buying call options on a stock and borrowing at the risk-free interest rate.
- c. Buying put options on a stock and borrowing at the risk-free interest rate.
- d. Buying put options on a stock, lending funds at the risk-free interest rate, and writing call options.
- e. *Buying call options on a stock, borrowing (should be lending) funds at the risk-free interest rate, and writing put options.*

1.3 The amount of systematic risk present in a particular risky asset, relative to the systematic risk present in an average risky asset, is called the particular asset's:

- a. *Beta coefficient*
- b. Reward to risk ratio
- c. Law of One Price
- d. Diversifiable risk
- e. Profitability Index

1.4 Which of the following describes a portfolio that plots above the security market line?

- a. The security is overvalued.
- b. *The security's reward to risk ratio is too high.*
- c. The security is providing a return that is less than expected.
- d. The security's beta is too high.
- e. The security provides a return that is less than the average return on the market.

1.5 Which of the following would be considered an example of systematic risk?

- a. Intel reports record sales.
- b. Quarterly profit for GM equals expectations.
- c. Lower quarterly sales for IBM than expected.
- d. *Greater new jobless claims than expected.*
- e. Fed leaves interest rates unchanged, as expected.

- 1.6 If you exercise a put option prior to expiration,
- You are obligated to buy the asset underlying the option contract at the option strike price.
  - You must have been the “writer” (or provider) of the option when it was created.
  - You will always receive more than you would if you let the option run to maturity.
  - You have behaved in a rational manner if the market price exceeds the strike price.
  - It must be an American option.*

1.7 A(n) \_\_\_\_\_ contract is a legally binding agreement between two parties calling for the purchase/sale of an asset in the future at an agreed-upon price today?

- forward contract*
- future contract
- swap contract
- option contract
- cross contract

1.8 In which of the following arrangements, does money NOT change hands (i.e. from one contracting party to another) when the contract is written.

- Future contracts
  - Option contracts
  - Forward contracts
- I only
  - II only
  - III only
  - I and II only
  - I and III only*

1.9 A perfect hedge in one that results in a completely flat risk profile. Which of the following describes a perfect hedge?

- On net, the hedger can only make money if prices change.
- On net, the hedger can only lose money if prices change.
- On net, the hedger can either make or lose money if prices change.
- On net, the hedger will neither make nor lose money if prices change.*
- None of the above.

1.10 An increase in which of the following, all else the same, leads to an increase in call option value?

- Exercise price
  - Stock price
  - Time to expiration
  - Volatility
- I and III only
  - II and IV only
  - I, II, and III only
  - I, II and IV only
  - II, III and IV only*

## Part 2: Calculations.

2. (21%) A project requires an initial investment of \$5000, straight-line depreciable to zeros over 5 years. The discount rate is 12%. The tax bracket is 35% and you receive a tax credit for negative earnings in the year in which the loss occurs. Additional information for variables with forecast error is shown below.

	<b>Base Case</b>	<b>lower bound</b>	<b>upper bound</b>
Unit sales	2000	1200	2800
Price/unit	\$15	\$13	\$17
Variable cost/unit	\$10	\$8	\$12
Annual fixed costs	\$4000	\$3250	\$4750

a. What is the base case NPV for the project?

**Base Case**

*Unit sales* 2000  
*Price/unit* \$15  
*Variable cost/unit* \$10  
*Annual fixed costs* \$4000

$$OCF = [(P-V) * Q - FC](1-T) + DT = [(15-10) * 2000 - 4000](1-0.35) + (5000/5)(0.35)$$

$$= 4250$$

$$NPV = -5000 + 4250[1 - 1/1.12^5]/0.12 = 10320.30$$

b. What is the best case OCF for the project?

**Best Case**

*Unit sales* 2800  
*Price/unit* \$17  
*Variable cost/unit* \$8  
*Annual fixed costs* \$3250

$$OCF = [(P-V) * Q - FC](1-T) + DT = [(17-8) * 2800 - 3250](1-0.35) + (5000/5)(0.35)$$

$$= 14617.5$$

c. Find the sensitivity of NPV to unit price for the base case.

Suppose  $P = \$16$  in the base case.

$$OCF = [(P-V) * Q - FC](1-T) + DT = [(16-10) * 2000 - 4000](1-0.35) + (5000/5)(0.35)$$

$$= 5550$$

$$NPV = -5000 + 5550[1 - 1/1.12^5]/0.12 = 15006.51$$

$$\text{Sensitivity of NPV to unit price change} = (15006.51 - 10320.30)/(16 - 15) = 4686.21$$

d. For the base case, what are the account, cash and financial break-even points? Ignore taxes.

*Accounting break-even level:  $NI=0 \Rightarrow OCF = NI + D = D$*

$$Q = (FC + OCF)/(P - V) = (4000 + 1000)/(15 - 10) = 1000$$

*Cash break-even level:  $OCF=0$*

$$Q = (FC + OCF)/(P - V) = 4000/(15 - 10) = 800$$

*Financial break-even level:  $NPV = 0 \Rightarrow -5000 + OCF[1 - 1/1.12^5]/0.12 = 0; OCF = 1387$*

$$Q = (FC + OCF)/(P - V) = (4000 + 1387)/(15 - 10) = 1077.4 \approx 1078$$

3. (12%) The manager of GoldenBears Inc. plans to manufacture engine blocks for classic cars from the 60s era. They expect to sell 250 blocks annually for the next 5 years. The necessary foundry and machining equipment will cost a total of \$800,000 and will be depreciated on a straight-line basis to zero over the projects' life. The firm expects to be able to dispose the manufacturing equipment for \$150,000 at the end of the project. The project also needs a one-time investment in net working capital of \$50,000. Labor and materials costs total \$500 per engine block, fixed costs are \$125,000 per year. Assume a 35% tax rate and a 12% discount rate.

a. What is the expected after-tax cash flow to the firm when the equipment is sold in year 5?

$$\text{After-tax salvage value} = 150,000 - (150,000 - 0)(0.35) = 150,000(1 - 0.35) = 97,500$$

b. What is the minimum price the firm should set for the blocks if they don't want to lose money?

Find  $P$  such that  $NPV = 0$ .

$$0 = -800,000 - 50,000 + OCF[1 - 1/1.12^5]/0.12 + 97,500/1.12^5 + 50,000/1.12^5$$

$$\Rightarrow 212,580.34 = OCF = [(P - 500)(250) - 125,000](1 - 0.35) + (800,000/5)(0.35)$$

$$\Rightarrow P = 1,963.57$$

4. (15%) Using the following information to answer questions

Security	Expected return	Standard deviation	Beta
A	16%	20%	1.2
B	12%	25%	0.8

a. Which of A and B has least total risk, systematic risk and unsystematic risk? Why?

*Total risk is measured by the variance.*

$\Rightarrow A$  has the least total risk.

*Systematic risk is measured by the beta coefficient.*

$\Rightarrow B$  has least systematic risk.

*Unsystematic risk is the difference between total risk and systematic risk.*

$\Rightarrow A$  has the least unsystematic risk.

b. What are the expected market return and the risk-free rate?

By CAPM:  $0.16 = R_F + 1.2(R_M - R_F)$   
 $0.12 = R_F + 0.8(R_M - R_F)$

$$\Rightarrow R_M = 0.14; R_F = 0.04$$

c. What is the portfolio expected return and the portfolio beta if you invest 35% in A, 45% in B and 20% in the risk-free asset?

$$E[R_p] = 0.35(0.16) + 0.45(0.12) + 0.2(0.04) = 0.118$$

$$\text{Beta} = 0.35(1.2) + 0.45(0.8) + 0.2(0) = 0.78$$

5. (12%) using the following information

Orange Juice(CTN) 15,000 lbs.; cents per lb.

May 12, 2002

	Open	High	Low	Settle	change	Lifetime High	Lifetime Low	Open interest
July	80.00	86.10	79.90	85.20	+4.70	128.50	73.00	37,832
Sept	84.75	88.50	84.50	88.00	+3.00	121.30	77.10	16,379
Nov	89.25	93.20	89.00	92.75	+3.00	115.50	79.80	13,149
Jan03	91.00	94.80	90.80	94.50	+3.00	109.75	82.75	5,397

- a. Suppose you are interested in purchasing the September futures contract. What is the future price of 15,000 lbs. of orange juice for September delivery?

$$\$0.88 * 15,000 = \$13,200$$

- b. Suppose that yesterday you purchased one July futures contract at the settle price. At the close of business today, how much is your contract worth, e.g. the value changed?

*The settlement price has increased by 4.7 cents per lb.*

*For the long position in futures contract, it's a gain since you "settled" on a lower price yesterday.*

$$\text{Value of the contract} = \$0.047 * 15,000 = \$705$$

- c. How many orange juice futures contracts for delivery in 2002 ONLY were outstanding at the end of the trading day?

*July 37,832*

*Sept 16,379*

$$\text{Nov 13,149} \quad \text{Total} = 37,832 + 16,379 + 13,149 = 67,360$$

6. (20%) A firm has stock outstanding with a current price of \$28 per share. The price in one year is expected to be either \$30 or \$39. A call option is available with the strike price of \$25. The risk-free rate is 10%,

- a. What will you pay for the call options?

*The option will finish in the money for sure.*

$$C = S - PV(E) = 28 - 25/1.1 = 5.27$$

- b. What is the value of a put option with the same strike price? Given an intuition for the value of the put option.

*The value of the put option with the same strike price should be zero since the put option is worthless at the time the option matures.*

- c. Show that you can be replicated the stock with a bond and call options with a strike price of \$36?

*Suppose we have a portfolio of buying one call (E:36) and investing 30/1.1 in bond*

$S_T$	From bond	From call	Total payoffs
30	$(30/1.1)(1.1) = 30$	0	30
39	$(30/1.1)(1.1) = 30$	$39 - 36 = 3$	33

$\Rightarrow$  *Need 3 call options to replicate the stock when  $S_T = 39$ .*

*Therefore, buying 3 call options with strike price of \$36 and investing 30/1.1 in bond now can replicate the value of the stock a year from now.*

- d. What is the value of a call option with strike price of \$36? What is the value of the put option with the same strike price?

$$\text{From part d, } C = (28 - 30/1.1)/3 = 0.24$$

$$\text{From put-call parity, } P = C - S + PV(E) = 0.24 - 28 + 36/1.1 = 4.97$$