

## Chapter 22 Real Options

### Multiple Choice Questions

1. The following are the main types of real options:

- (I) The option to expand if the immediate investment project succeeds
  - (II) The option to wait (and learn) before investing
  - (III) The option to shrink or abandon a project
  - (IV) The option to vary the mix of output or the firm's production methods
- A) I only
  - B) I and II only
  - C) I,II, and III only
  - D) I, II, III, and IV only

Answer: D Type: Easy Page: 597

2. The opportunity to invest in a project can be thought of as a three-year real option, which is worth \$500 million with an exercise price of \$800 million. Calculate the value of the option given that,  $N(d_1) = 0.3$  and  $N(d_2) = 0.15$ . Assume that the interest is 6% per year.

- A) \$150 million
- B) \$49.25 million
- C) Zero
- D) None of the above.

Answer: B Type: Medium Page: 599

Response:  $C = 500(0.3) - (0.15)(800) / (1.06^3) = 49.25$

3. The opportunity to invest in a project can be thought of as a two year option or an asset which is worth \$400 million (PV of the cash flows from the project) with an exercise price of \$600 million (investment needed). Calculate the value of the option given that  $N(d_1) = 0.6$  and  $N(d_2) = 0.4$  and interest rate is 6%.

- A) \$26.4 million
- B) Zero
- C) \$200 million.
- D) None of the above.

Answer: A Type: Medium Page: 599

Response:  $C = 400(0.6) - (0.4)(600) / (1.06^2) = 26.4$

4. The DCF approach must be:

- A) Augmented by added analysis if there are no imbedded options.
- B) Augmented by added analysis if a decision has significant imbedded options.
- C) Jettisoned if there are any embedded options.
- D) Computed carefully to identify the options.

Answer: B Type: Medium Page: 599



5. The following are examples of expansion options:

(I) A mining company may acquire rights to an ore body that is not worth developing today but could be profitable if product prices increase

(II) A film producing company acquiring the rights to a novel to produce a film based on the novel in the future

(III) A real estate developer may acquire a parcel of land that could be turned into a shopping mall

(IV) A pharmaceutical company may acquire a patent to market a new drug

A) I only

B) I and II only

C) I, II, and III only

D) I, II, III, and IV

Answer: D Type: Easy Page: 601

6. The opportunity to defer investing to a later date may have value because:

(I) The cost of capital may increase in the near future.

(II) Uncertainty may be increased in the future.

(III) Investment costs fluctuate over time.

(IV) Market conditions may change and increase the NPV of the project.

A) I only

B) I and II only

C) III only

D) IV only

Answer: D Type: Difficult Page: 602

Use the following to answer questions 7-9:

Petroleum Inc. owns a lease to extract crude oil from sea. It is considering the construction of a deep-sea oil rig at a cost of \$50 million ( $I_0$ ) and is expected to remain constant. The price of oil  $P$  is \$40/bbl and the extraction costs are \$25/bbl. The quantity of oil  $Q = 300,000$  bbl per year forever. The risk-free rate is 6% per year and that is also the cost of capital (Ignore taxes).

7. Calculate the NPV to invest today.

A) + 40 million

B) +75 million

C) +25 million

D) None of the above

Answer: C Type: Difficult Page: 603

Response:  $NPV \text{ today} = [(40 - 25)(300,000)]/(0.06) - 50,000,000 = + 25,000,000 = 25 \text{ million}$

8. Suppose the oil price is uncertain and can be \$50/bbl or \$30/bbl next year, then expected NPV of the project if postponed by one year is:

- A) + 25 million
- B) -25 million
- C) +35.4 million
- D) None of the above

Answer: B Type: Difficult Page: 603

Response:  $NPV(\text{oil price} = \$50/\text{bbl}) = (50-25)(300,000)/0.06 - 50,000,000 = +75,000,000$

$NPV(\text{oil price} = \$30/\text{bbl}) = (30-25)(300,000)/0.06 - 50,000,000 = -25,000,000$  (reject)

$NPV(\text{oil price} = \$30/\text{bbl}) = 0$

$\text{Expected NPV} = [(0.5)(0) + (0.5)(75,000,000)]/1.06 = 37,500,000/1.06 = 35.4$  million

9. Calculate the value of the option to wait for one year

- A) + 35.4 million
- B) +25 million
- C) +10.4 million
- D) None of the above

Answer: C Type: Difficult Page: 603

Response:  $\text{Value of the Option to Wait} = 35.4 - 25 = 10.4$  million

10. The value of a business that might suffer from declining profitability is equal to:

- (I) the value of the abandonment call option.
  - (II) the value of the business without the abandonment option.
  - (III) the value of the abandonment put option.
- A) I only
  - B) II only
  - C) III only
  - D) II and III only

Answer: D Type: Medium Page: 605

11. A project is worth \$12 million today without an abandonment options. Suppose the value of the project is \$18 million one year from today with high demand and \$8 million with low demand. It is possible to sell off the project for \$10 million if the demand is low. Calculate the value of the abandonment option if the discount rate is 5% per year. [Use the replicating portfolio method]

- A) \$1.03 million.
- B) \$2 million
- C) \$1.9 million.
- D) None of the above

Answer: A Type: Difficult Page: 605

Response:  $18A + 1.05B = 0$ ;  $0.8A + 1.05B = 2$   $A = -0.2$  or  $B = 3.42$   $P = -0.2(12) + 3.43 = 1.03$

12. A project is worth \$12 million today without an abandonment options. Suppose the value of the project is \$18 million one year from today with high demand and \$8 million with low demand. It is possible to sell off the project for \$10 million if the demand is low. Calculate the value of the abandonment option if the discount rate is 5% per year. [Use the risk-neutral valuation]

- A) \$1.03 million.
- B) \$2 million
- C) \$1.9 million.
- D) None of the above.

Answer: A Type: Difficult Page: 605

Response:  $12 = [(18)(X) + (8)(1-X)]/1.05$ ;  $X = 0.46$ ;  $(1-X) = 0.54$

$P = (2)(0.56)/1.05 = 1.03$

13. Petroleum Inc. owns a lease to extract crude oil from sea. It is considering the construction of a deep-sea oil rig at a cost of \$50 million ( $I_0$ ) and is expected to remain constant. The price of oil  $P$  is \$40/bbl and the extraction costs are \$25/bbl. The quantity of oil  $Q = 300,000$  bbl per year forever. The risk-free rate is 6% per year and that is also the cost of capital (Ignore taxes). The firm has constructed the oil rig and a year later the oil price has plummeted to \$20/bbl. The firm can cap the rig at a cost of \$10 million. The firm can restart pumping when oil price more favorable. Calculate the NPV of capping the rig (abandonment option).

- A) + \$25 million
- B) +\$10 million
- C) +\$15 million
- D) None of the above

Answer: C Type: Medium Page: 609

Response:  $PV(\text{continue to pump oil}) = (20 - 25)(300,000)/(0.06) = -25 \text{ million}$

$PV(\text{capping the rig}) = -10 \text{ million}$ ;  $NPV \text{ of capping} = +15 \text{ million}$

14. Rejecting an investment today forever might not be a good choice because:

- (I) The size of the firm will decline.
- (II) There are always errors in the estimation of the NPVs
- (III) The option value is negative.
- (IV) The company is foregoing future rights or the option to make the investment if economic and industry conditions change for the better

- A) I only
- B) II only
- C) I, II, and III only
- D) IV only

Answer: D Type: Difficult Page: 609

15. The option to build flexibility into production facilities.

- A) Typically is more expensive.
- B) Must consider the NPV of alternative uses.
- C) May be valuable by allowing the rearrangement to produce of goods or service with higher profit
- D) All of the above.

Answer: D Type: Difficult Page: 610

16. Which of the following conditions might lead a financial manager to delay a positive NPV project? Assume project NPV if undertaken immediately is held constant.

- A) The risk-free interest rate falls.
- B) Uncertainty about future project value increases.
- C) The first cash inflow generated by the project is lower than previously thought.
- D) Investment required for the project increases.

Answer: B Type: Medium Page: 610

17. Which of the following conditions might lead a financial manager to decide to expedite a positive Net Present Value investment project that previously he/she had decided to delay?

- A) The risk-free interest rate increases
- B) Uncertainty about future project value increases.
- C) The cash inflows generated by the project is lower than previously thought.
- D) Investment required for the project is expected to increase in the near future.

Answer: D Type: Medium Page: 610

18. In terms of a real option, the cash flows from the project play the same role as:

- A) The stock price.
- B) The exercise price
- C) The dividends
- D) The variance

Answer: C Type: Medium Page: 611

19. An example of a real option is:

- A) The option to make follow-on investments.
- B) The option to abandon a project.
- C) The option to wait before investing.
- D) all of the above.

Answer: D Type: Medium Page: 610

20. A rational manager may be reluctant to commit to a positive Net Present Value project when:

- A) The value of the option to abandon is high.
- B) The exercise price is high.
- C) The opportunity cost of capital is high.
- D) The value of the option to wait is high.

Answer: D Type: Medium Page: 611

21. Production facilities that are flexible in terms of possible raw materials used are most valuable when:

- A) Product demand is highly volatile
- B) Product price is highly volatile.
- C) Raw material prices are highly volatile.
- D) Labor costs are highly volatile.

Answer: C Type: Medium Page: 611



22. Consider an electric utility that may use either coal or natural gas to generate electricity. Under which of the following conditions would it be the least valuable to have co-firing equipment? Let  $a_c$  be the annual standard deviation of coal prices, and let  $a_n$  be the annual standard deviation of natural gas prices, and  $p$  the correlation between coal prices and natural gas prices.

- A)  $a_c$  high,  $a_n$  high,  $p$  low.
- B)  $a_c$  high,  $a_n$  low,  $p$  low.
- C)  $a_c$  low,  $a_n$  high,  $p$  low.
- D)  $a_c$  low,  $a_n$  low,  $p$  high.

Answer: D Type: Medium Page: 611

23. Consider an electric utility that may use either coal or natural gas to generate electricity. Under which of the following conditions would it be most valuable to have co-firing equipment? Let  $a_c$  be the annual standard deviation of coal prices, and let  $a_n$  be the annual standard deviation of natural gas prices, and  $p$  the correlation between coal prices and natural gas prices.

- A)  $a_c$  high,  $a_n$  high,  $p$  low.
- B)  $a_c$  high,  $a_n$  low,  $p$  low.
- C)  $a_c$  low,  $a_n$  high,  $p$  low.
- D)  $a_c$  low,  $a_n$  low,  $p$  high.

Answer: A Type: Medium Page: 611

24. A firm in the extraction industry whose major assets are cash, equipment and a closed facility may appear to have extraordinary value. This value can be primarily attributed to:

- A) The potential sale of the company.
- B) The low exercise price held by the shareholders.
- C) The option to open the facility when prices rise dramatically.
- D) All of the above.

Answer: C Type: Medium Page: 611

25. The difference between the NPV of the investment and the value of the option to invest is:

- (I) The value for the option to invest still have a positive value at high interest rates while the NPV could be negative.
- (II) The value of the option to invest has a negative value at low interest rates while NPV could have high positive value.
- (III) The value of the option to invest and the NPV of the project are unrelated.

- A) I only
- B) II only
- C) III only
- D) II and III only

Answer: A Type: Difficult Page: 614



26. If a project has implied options.

- A) The shorter the available life of the project the less valuable the option is.
- B) The longer the available life of the project the less valuable the option is.
- C) The shorter the available life of the project the more valuable the option is.
- D) Available project life does not change the value option

Answer: A Type: Medium Page: 614

27. Tech Com announces a major expansion into Internet services. This announcement causes the price of Tech Com stock to increase, but also causes an increase in price volatility of the stock. Which of the following correctly identifies the impact of these changes on the call option of Tech Com?

- A) Both changes cause the price of the call option to decrease
- B) Both changes cause the price of the call option to increase
- C) The greater uncertainty will cause the price of the call option to decrease. The higher price of the stock will cause the price of the call option to increase
- D) The greater uncertainty will cause the price of the call option to increase. The higher price of the stock will cause the price of the call option to decrease

Answer: B Type: Difficult Page: 614

### True/False Questions

T F 28. The option to make follow-on investment is a put option

Answer: False Type: Medium Page: 597

T F 29. The option to expand is a type of financial option

Answer: False Type: Easy Page: 597

T F 30. The option to wait is a type of real option.

Answer: True Type: Medium Page: 602

T F 31. In real options, required investment is considered the exercise price.

Answer: True Type: Medium Page: 603

T F 32. Adjusted present value of project = NPV (without abandonment option) + Value of abandonment option

Answer: True Type: Medium Page: 605

T F 33. The binomial method can be used for most abandonment options.

Answer: True Type: Medium Page: 606

T F 34. The first step in a real options analysis is to value the underlying asset using discounted cash flow (DCF) method.

Answer: True Type: Medium Page: 608

T F 35. An electric utility plant that may be designed to operate on either oil or natural gas is an example of flexibility in production.

Answer: True Type: Easy Page: 610

T F 36. Risk-neutral approach is same as certainty equivalent method

Answer: True Type: Medium Page: 614

### Essay Questions

37. What are the four main types of real options?

Type: Medium Page: 597

Answer:

- I) Option to expand if the immediate investment project is a success
- II) The option to wait (and learn) before investing
- III) The option to shrink or abandon a project
- IV) The option to vary the mix of output or the firm's production methods

38. How does an option to wait or postpone a project add value to the project?

Type: Medium Page: 602

Answer:

The option to wait or postpone a project is equivalent to owning a call option on the investment project. The option is exercised when the firm invests in the project. It is often preferable to defer the project in order to keep the call alive. Deferral is most attractive when uncertainty is large. Hence the value of the project is increase by the presence of the real option.

39. How does an abandonment option increase the value of a project?

Type: Easy Page: 605

Answer:

The option to abandon a project, a put option, provides partial insurance against failure and hence increases the value of a project

40. Explain the main difference between the Black-Scholes formula and the binomial method.

Type: Medium Page: 606

Answer:

The Black-Scholes formula is a continuous time model whereas the binomial method uses discrete time intervals. Therefore binomial method is more useful for evaluating real options. The binomial approach converges to the Black-Scholes method when the time interval is very small.

41. Explain the difference between the value of a project and the value of real options associated with project.

Type: Difficult Page: 614

Answer:

The value of a project is the present value of all the cash flows from a project. It is usually calculated using discounted cash flow method. The value of a real option on the project comes from the opportunity to change or modify the cash flow from the project.

42. Briefly explain the implied assumption when risk-neutral method is used for valuing real options.

Type: Medium Page: 614

Answer:

When risk-neutral method is used valuing a real option we implicitly assume that these options are traded in an efficient market. Risk-neutral method gives option values if it were to be traded in the efficient market. Conceptually, it is same as certainty equivalent method.

43. Briefly discuss three practical problems associated with real options analysis.

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Answer:

- I) Real options can be complex, and valuing them may be difficult and time consuming.
- II) Real options analysis applications to practical problems may be unstructured and solving these problems can get complicated quickly.
- III) Analyzing the real options applications when competitive firms can alter project payoffs may involve use of game theory.