Hull: Options, Futures and Other Derivatives, Ninth Edition
Chapter 15: The Black-Scholes-Merton Model
Multiple Choice Test Bank: Questions with Answers

1. Which of the following is assumed by the Black-Scholes-Merton model?
    A. The return from the stock in a short period of time is lognormal
    B. The stock price at a future time is lognormal
    C. The stock price at a future time is normal
    D. None of the above

    Answer: B

    Black-Scholes-Merton assumes that the return from a stock in a short period of time is normally distributed. This means that the stock price at a future time is lognormally distributed.

2. The original Black-Scholes and Merton papers on stock option pricing were published in which year?
    A. 1983
    B. 1984
    C. 1974
    D. 1973

    Answer: D

    The correct answer is 1973. By coincidence this is also the year that organized trading in call options started. Put option trading started a few years later.

3. Which of the following is a definition of volatility
    A. The standard deviation of the return, measured with continuous compounding, in one year
    B. The variance of the return, measured with continuous compounding, in one year
    C. The standard deviation of the stock price in one year
    D. The variance of the stock price in one year

    Answer: A

    Volatility when multiplied by the square root of Δt is the standard deviation of the return in a short period of time of length Δt. It is also the standard deviation of the continuously compounded return in one year.

4. A stock price is $100. Volatility is estimated to be 20% per year. What is an estimate of the standard deviation of the change in the stock price in one week?
    A. $0.38
    B. $2.77
    C. $3.02
    D. $0.76

Answer: B

The estimate is $100 \times 0.2 \times \sqrt{1/52} = \$2.77$

5. What does N(x) denote?
    A. The area under a normal distribution from zero to *x*
    B. The area under a normal distribution up to x
    C. The area under a normal distribution beyond x
    D. The area under the normal distribution between -*x* and x

    Answer: B

    The normal distribution runs from minus infinity to plus infinity. N(x) is the area under the distribution between minus infinity and x.

6. Which of the following is true for a one-year call option on a stock that pays dividends every three months?
    A. It is never optimal to exercise the option early
    B. It can be optimal to exercise the option at any time
    C. It is only ever optimal to exercise the option immediately after an ex-dividend date
    D. None of the above

    Answer: D

    When there are dividends it is sometimes optimal to exercise immediately before an ex-dividend date, but it is never optimal to exercise at other times. None of the first three answers are therefore correct.

7. What is the number of trading days in a year usually assumed for equities?
    A. 365
    B. 252
    C. 262
    D. 272

    Answer: B

    Analysts usually assume that there are 252 trading days in a year for equities.

8. The risk-free rate is 5% and the expected return on a non-dividend-paying stock is 12%. Which of the following is a way of valuing a derivative?
    A. Assume that the expected growth rate for the stock price is 17% and discount the expected payoff at 12%
    B. Assuming that the expected growth rate for the stock price is 5% and discounting the expected payoff at 12%
    C. Assuming that the expected growth rate for the stock price is 5% and discounting the expected payoff at 5%

D. Assuming that the expected growth rate for the stock price is 12% and discounting the expected payoff at 5%

Answer: C

Risk-neutral valuation shows that a derivative can be correctly valued by assuming that the stock grows at the risk-free rate and discounting the expected payoff at the risk-free rate. It follows that C is the correct answer.

9. When there are two dividends on a stock, Black's approximation sets the value of an American call option equal to which of the following
   A. The value of a European option maturing just before the first dividend
   B. The value of a European option maturing just before the second (final) dividend
   C. The greater of the values in A and B
   D. The greater of the value in B and the value assuming no early exercise

   Answer: D

   For Black's approximation we calculate a) the value of the option assuming no early exercise and b) the value of the option assuming that the exercise decision is made immediately before the final ex-dividend date. The value of the option is set equal to the greater of these two values.

10. Which of the following is measured by the VIX index
    A. Implied volatilities for stock options trading on the CBOE
    B. Historical volatilities for stock options trading on CBOE
    C. Implied volatilities for options trading on the S&P 500 index
    D. Historical volatilities for options trading on the S&P 500 index

    Answer: C

    The VIX index measures the implied volatilities of one-month options trading on the S&P 500 index.

11. What was the original Black-Scholes-Merton model designed to value?
    A. A European option on a stock providing no dividends
    B. A European or American option on a stock providing no dividends
    C. A European option on any stock
    D. A European or American option on any stock

    Answer: A

    The original Black-Scholes-Merton model was designed to value a European option on a stock paying no dividends .

12. A stock provides an expected return of 10% per year and has a volatility of 20% per year. What is the expected value of the continuously compounded return in one year?
    A. 6%

B. 8%
C. 10%
D. 12%

Answer: B

The expected value of the continuously compounded return per year is $\mu - \sigma^2/2$. In this case it is $0.1 - 0.2^2/2 = 0.08$ or 8%.

13. An investor has earned 2%, 12% and -10% on equity investments in successive years (annually compounded). This is equivalent to earning which of the following annually compounded rates for the three year period.
    A. 1.33%
    B. 1.23%
    C. 1.13%
    D. 0.93%

    Answer: D

    Over the three year period \$100 grows to $100 \times 1.02 \times 1.12 \times 0.9 = \$102.816$. This corresponds to an annually compounded return per year of $\sqrt[3]{1.02816} - 1 = 0.0093$ or 0.93%. One plus the return is the geometric average of 1.02, 1.12, and 0.90.

14. Which of the following is NOT true?
    A. Risk-neutral valuation provides prices that are only correct in a world where investors are risk-neutral
    B. Options can be valued based on the assumption that investors are risk neutral
    C. In risk-neutral valuation the expected return on all investment assets is set equal to the risk-free rate
    D. In risk-neutral valuation the risk-free rate is used to discount expected cash flows

    Answer: A

    Risk-neutral valuation produces a valuation that is correct in all situations not just those where investors are risk-neutral. The expected return on all investments is assumed to be the risk-free rate and the risk-free rate is used to discount expected payoffs.

15. Which of the following is a way of extending the Black-Scholes-Merton formula to value a European call option on a stock paying a single dividend?
    A. Reduce the maturity of the option so that it equals the time of the dividend
    B. Subtract the dividend from the stock price
    C. Add the dividend to the stock price
    D. Subtract the present value of the dividend from the stock price

    Answer: D

    To value a European option we replace the stock price by the stock price minus the present value of all dividends that have ex-dividend dates during the life of the option.

16. When the Black-Scholes-Merton and binomial tree models are used to value an option on a non-dividend-paying stock, which of the following is true?
    A. The binomial tree price converges to a price slightly above the Black-Scholes-Merton price as the number of time steps is increased
    B. The binomial tree price converges to a price slightly below the Black-Scholes-Merton price as the number of time steps is increased
    C. Either A or B can be true
    D. The binomial tree price converges to the Black-Scholes-Merton price as the number of time steps is increased

    Answer: D

    The binomial tree valuation method and the Black-Scholes formula are based on the same set of assumptions. As the number of time steps is increased the answer given by the binomial tree approach converges to the answer given by the Black-Scholes-Merton formula.

17. When the non-dividend paying stock price is $20, the strike price is $20, the risk-free rate is 6%, the volatility is 20% and the time to maturity is 3 months which of the following is the price of a European call option on the stock
    A. 20N(0.1)-19.7N(0.2)
    B. 20N(0.2)-19.7N(0.1)
    C. 19.7N(0.2)-20N(0.1)
    D. 19.7N(0.1)-20N(0.2)

    Answer: B

    The formula for the option price is

$$S_0 N(d_1) - Ke^{-rT} N(d_2)$$

$$d_1 = \frac{\ln(S_0 / K) + (r + \sigma^2 / 2)T}{\sigma\sqrt{T}} \qquad \text{and} \qquad d_2 = d_1 - \sigma\sqrt{T}$$

    In this case $S_0 = K = 20$, $r = 0.06$, $\sigma = 0.2$, and $T = 0.25$ so that $Ke^{-rT} = 20e^{-0.06\times 0.25} = 19.7$. Also $d_1 = [\ln(1) + (0.06 + 0.04/2)\times 0.25]/(0.2\times 0.5) = 0.2$ and $d_2 = 0.2 - 0.2\times 0.5 = 0.1$.
    B is therefore the correct answer.

18. When the non-dividend paying stock price is $20, the strike price is $20, the risk-free rate is 5%, the volatility is 20% and the time to maturity is 3 months which of the following is the price of a European put option on the stock
    A. 19.7N(-0.1)-20N(-0.2)
    B. 20N(-0.1)-20N(-0.2)
    C. 19.7N(-0.2)-20N(-0.1)
    D. 20N(-0.2)-20N(-0.1)

    Answer: A

    The formula for the option price is

$$Ke^{-rT}N(-d_2) - S_0N(-d_1)$$

$$d_1 = \frac{\ln(S_0 / K) + (r + \sigma^2 / 2)T}{\sigma\sqrt{T}} \qquad \text{and} \qquad d_2 = d_1 - \sigma\sqrt{T}$$

In this case $S_0 = K$ =20, r = 0.06, σ=0.2, and T=0.25 so that Ke^{-rT}=20e$^{-0.06\times0.25}$=19.7. Also d_1 = [ln(1)+(0.06+0.04/2)×0.25]/(0.2×0.5) =0.2 and d_2=0.2 – 0.2×0.5=0.1.
A is therefore the correct answer.

19. A stock price is 20, 22, 19, 21, 24, and 24 on six successive Fridays. Which of the following is closest to the volatility per annum estimated from this data?
    A. 50%
    B. 60%
    C. 70%
    D. 80%

    Answer: D

    The price relative for the first week is 22/20 or 1.1. The natural log of the price relative is ln(1.1) or 0.09531. Similarly the ln of the price relatives for the other weeks are -0.1466, 0.1001, 0.1335, and 0. The standard deviation of 0.09531, -0.1466, 0.1001, 0.1335, and 0 is 0.1138. The volatility per week is therefore 11.38%. This corresponds to a volatility per year of 0.1138 multiplied by the square root of 52 or about 82%. The answer is therefore D.

20. The volatility of a stock is 18% per year. Which is closest to the volatility per month?
    A. 1.5%
    B. 3.0%
    C. 5.2%
    D. 6.3%

    Answer: C

    The volatility per month is the volatility per year multiplied by the square root of 1/12 . The square root of 1/12 is 0.2887 and 18% multiplied by this is 5.2%.