Chapter 13

1. Stock / Option

(*a*) $\dfrac{84-80}{80}=+5\%$ $\quad$ $\dfrac{0-2}{2}=-100\%$

(*b*) $\dfrac{80-80}{80}=0\%$ $\quad$ $\dfrac{0-2}{2}=-100\%$

(*c*) $\dfrac{78-80}{80}=-2.5\%$ $\quad$ $\dfrac{2-2}{2}=0\%$

(*d*) $\dfrac{76-80}{80}=-5\%$ $\quad$ $\dfrac{4-2}{2}=+100\%$

(*e*) \$78, from part (*c*) above

(*f*) $TVP = P - IVP = 2 - 0 = \$2$

2. (*a*) $IVC = S - E = 100 - 98 = \$2$

(*b*) $TVC = C - IVC = 6 - 2 = \$4$

(*c*) $IVP = \$0$ since $S \geq E$

(*d*) $TVP = P - IVP = 2 - 0 = \$2$

3. Profit position = − Cost of \$40 call + Cost of \$45 call
+ Value of \$40 call − Value of \$45 call

(*a*) $-3+1+0-0=-\$2$

(*b*) $-3+1+0-0=-\$2$

(*c*) $-3+1+2.50-0=\$.50$

(*d*) $-3+1+5-0=\$3$

(*e*) $-3+1+10-5=\$3$

4. See answers to the Exercises on p. 623.

5. (*a*) Break-even stock prices = $E+C+P$ and $E-C-P$.

(*b*) Largest amount of loss = $C+P$

6. (*a*) The shorter-term option should sell for a lower price than the longer-term option. Thus, sell one \$5 option and buy one \$4 option. Adjust position in 6 months.

   (*b*) If $S \le 50$ in 6 months, profit is:

   \$1 if $S = 48$ in one year.

   \$1 if $S = 50$ in one year.

   \$3 if $S = 52$ in one year.

   If $S > 50$ is 6 months, profit is:

   \$3 if $S = 48$ in one year.

   \$1 if $S = 50$ in one year.

   \$1 if $S = 52$ in one year.

7. See answers to the Exercises on p. 623.

8. *P* increases as *S* decreases, the opposite of calls.

   P increases as *E* increases, the opposite of calls.

   P increases at *t* increases, since longer-term options are more valuable than shorter-term options.

   P increases as σ increases, since all option values increase as volatility increases.

   P increases as *i* decreases, the opposite of calls. The replicating transaction for calls involves lending money, while the replicating transaction for puts involves borrowing money.

9. Figure 13.5 provides the explanation.

10. (*a*) 0 from Figure 13.5.

    (*b*) $S - Ee^{-\delta n}$ from Figure 13.5.

    (*c*) *S*, since the call is equivalent to the stock.

    (*d*) 0, since the option is far "out of the money."

    (*e*) $S - E,$ if $S \ge E$

    0, if $S < E,$ the *IVC*.

    (*f*) *S* from Figure 13.5.

11. Using put-call parity, we have

$$S + P = v^t E + C \quad \text{or} \quad C = S + P - v^t E.$$

In the limit as $S \to \infty,\ P \to 0,$ so that

$$C = S + 0 - v^t E = S - v^t E.$$

12. Using put-call parity, we have

$$S + P = v^t E + C$$

$$49 + P = \left(1 + \frac{.09}{12}\right)^{-3}(50) + 1 \text{ and } P = \$.89.$$

13. Buy the call. Lend \$48.89. Sell the stock short. Sell the put. Guaranteed profit of $-1 + 48.89 + 49 + 2 = \$1.11$ at inception.

14. See Answers to the Exercises on p. 624.

15. (*a*) At $S = 45,$ profit is

$$(2)(4) - 3 - 6 + 0 + 0 + 0 = -\$1$$

At $S = 50,$ profit is

$$(2)(4) - 3 - 6 + 5 + 0 + 0 = +\$4$$

At $S = 55,$ profit is

$$(2)(4) - 3 - 6 + 10 - (5)(2) + 0 = -\$1$$

(*b*) See Answers to the Exercises on p. 624.

16. (*a*) The percentage change in the stock value is $+10\%$ in an up move, and -10% in a down move. The risk-free rate of interest is $i = .06$. Let *p* be the probability of an up move. We have

$$p(.10) + (1 - p)(-.10) = .06$$

or $.20p = .16$ and $p = .8.$

(*b*) Using formula (13.12)

$$C = \frac{p \cdot V_U + (1 - p)V_D}{1 + i} = \frac{(.8)(10) + (.2)(0)}{1.06} = \$7.55.$$

17. (*a*) Using formula (13.8)

$$\Delta = \frac{V_U - V_D}{S_U - S_D} = \frac{10-0}{110-90} = \tfrac{1}{2}.$$

(*b*) Bank loan = Value of stock − Value of 2 calls = $100 - 2(7.55) = 84.906$ for 2 calls.
For one call the loan would be $\frac{84.906}{2} = \$42.45.$

18.

Year 1	Year 2	Probability	Stock Value
Up	Up	$(.8)(.8) = .64$	$100(1.1)^2 = 121$
Up	Down	$(.8)(.2) = .16$	$100(1.1)(.9) = 99$
Down	Up	$(.2)(.8) = .16$	$100(.9)(1.1) = 99$
Down	Down	$(.2)(.2) = .04$	$100(.9)^2 = 81$

We then have

$$C = \frac{(.64)(121-100)}{(1.06)^2} = \$11.96.$$

19. (*a*) Using the formula (13.7)

$$k = e^{\sigma\sqrt{h}} - 1 = e^{.3\sqrt{.125}} - 1 = .11190.$$

(*b*) Up move: $90(1+k) = 100.071$

Down move: $90(1+k)^{-1} = 80.943$

Now

$$100.071p + 80.943(1-p) = 90e^{.125(.1)} = 91.132$$

and solving, we obtain $p = .5327$.

(*c*) Applying formula (13.13) with the values of k and p obtained in parts (*a*) and (*b*) above together with $n = 8$, we obtain $C = \$10.78$. This, compare with the answer of $10.93 in Example 13.7.

20. Using formula (13.12) together with the stock values obtained in Exercise 18, $p = .8$ and $i = .06$ we obtain

$$P = \frac{(.16)(100-99) + (.16)(100-99) + (.04)(100-81)}{(1.06)^2} = \$.96.$$

21. The value of a put = 0 if $S(1+k)^{n-2t} \geq E = E - S(1+k)^{n-t}$ if $S(1+k)^{n-2t} < E$ or $\max\left[0, E - S(1+k)^{n-2t}\right]$. Thus, the value of an European put becomes

$$P = \frac{1}{(1+i)^n} \sum_{t=0}^{n} \binom{n}{t} p^{n-t} (1-p)^t \max\left[0, E - S(1+k)^{n-2t}\right].$$

22. We are asked to verify that formulas (13.14) and (13.16) together satisfy formula (13.5). We have

$$S + P = S + Ee^{-\delta n}\left[1 - N(d_2)\right] - S\left[1 - N(d_1)\right]$$
$$S + P = v^n E - Ee^{-\delta n} N(d_2) + SN(d_1)$$
$$= v^n E + C \text{ validating the result.}$$

23. Applying formula (13.16) directly, we have

$$P = 100e^{-.1}(1 - .4333) - 90(1 - .5525) = \$11.00.$$

The result could also be obtained using put-call parity with formula (13.5).

24. Applying formulas (13.14) and (13.15) repeatedly with the appropriate inputs gives the following:

(*a*) 5.76

(*b*) 16.73

(*c*) 8.66

(*d*) 12.58

(*e*) 5.16

(*f*) 15.82

(*g*) 5.51

(*h*) 14.88

25. We modify the final equation in the solution for Example 13.8 to obtain

$$C = (90 - 360e^{-.1})(.5525) - (100e^{-.1})(.4333) = \$8.72.$$

26. The price of the noncallable bond is $B^{nc}=100$ since the bond sells at par. The price of the callable bond can be obtained from formula (13.17) as

$$B^c = B^{nc} - C$$

Thus, the problem becomes one of estimating the value of the embedded option using the Black Scholes formula. This formula places a value of 2.01 on the embedded call. The answer is then $100.00-2.01=\$97.99$.

27. We modify the put-call parity formula to obtain

$$S - PV \text{ dividends } + P = v^t E + C$$

$$49 - .50a_{\overline{3}|.0075} + P = (1.0075)^{-3}(50) + 1$$

and solving for P we obtain

$$P = 2.37.$$

28. The average stock price is

$$\frac{10.10+10.51+11.93+12.74}{4} = 11.32$$

and the option payoff is $11.32-9=\$2.32$.