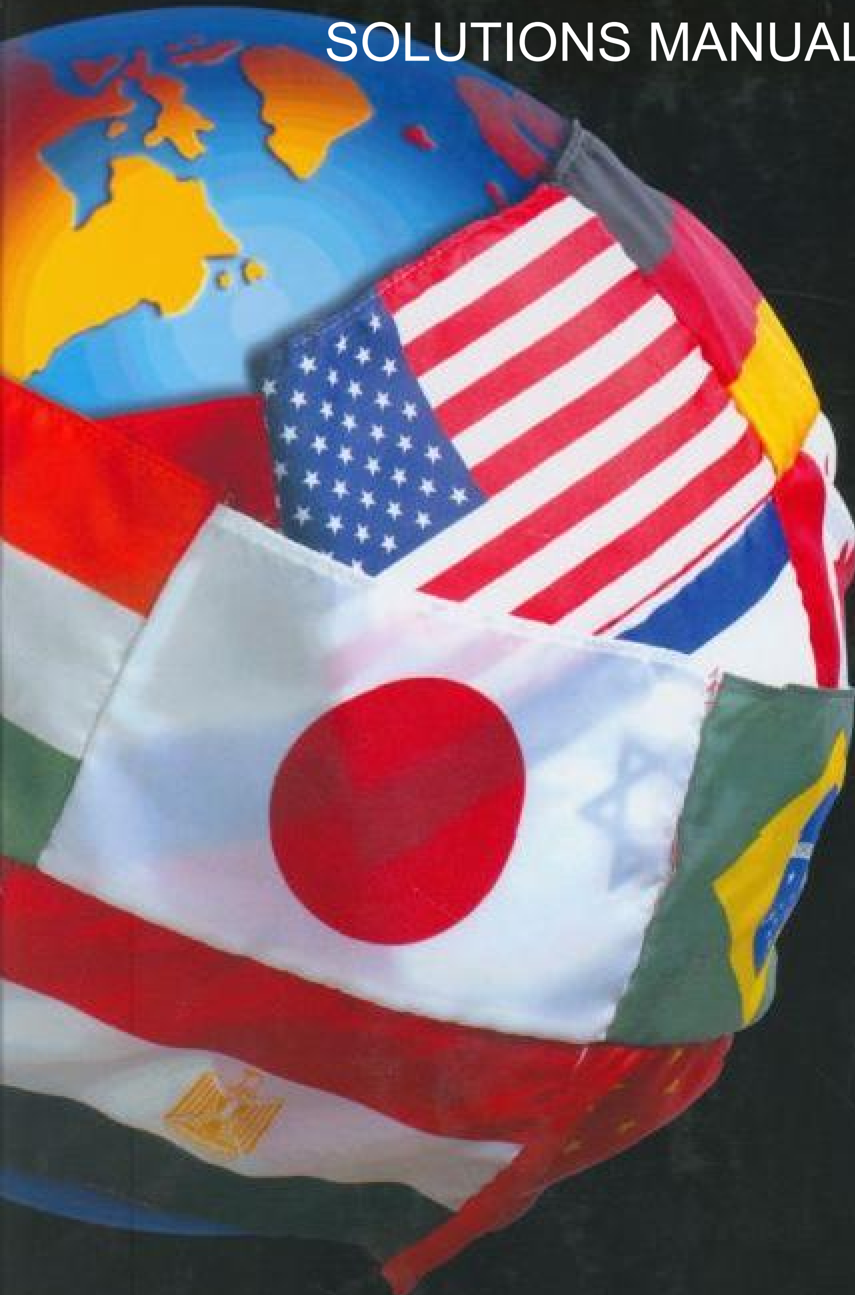
SOLUTIONS MANUAL



BREALEY MYERS ALLEN

PRINCIPLES of CORPORATE FINANCE

CHAPTER 2
Present Value and the Opportunity Cost of Capital

Answers to Practice Questions

1. Let INV = investment required at time t = 0 (i.e., INV = $-C_0$) and let x = rate of return. Then x is defined as:

   $x = (C_1 – INV)/INV$

   Therefore:

   $C_1 = INV(1 + x)$

   It follows that:

   $NPV = C_0 + \{C_1/(1 + r)\}$

   $NPV = -INV + \{[INV(1 + x)]/(1 + r)\}$

   $NPV = INV \{[(1 + x)/(1 + r)] – 1\}$

   a. When x equals r, then:

      $[(1 + x)/(1 +r)] – 1 = 0$

      and NPV is zero.

   b. When x exceeds r, then:

      $[(1 + x)/(1 + r)] – 1 > 0$

      and NPV is positive.

2. The face value of the treasury security is $1,000. If this security earns 5%, then in one year we will receive $1,050. Thus:

   $NPV = C_0 + [C_1/(1 + r)] = -1000 + (1050/1.05) = 0$

   This is not a surprising result, because 5 percent is the opportunity cost of capital, i.e., 5 percent is the return available in the capital market. If any investment earns a rate of return equal to the opportunity cost of capital, the NPV of that investment is zero.

3. NPV = -$1,300,000 + ($1,500,000/1.10) = +$63,636

Since the NPV is positive, you would construct the motel.

Alternatively, we can compute r as follows:

r = ($1,500,000/$1,300,000) – 1 = 0.1538 = 15.38%

Since the rate of return is greater than the cost of capital, you would construct the motel.

4.

Investment	NPV	Return
1)	$-10{,}000 + \dfrac{18{,}000}{1.20} = \$5{,}000$	$\dfrac{18{,}000 - 10{,}000}{10{,}000} = 0.80 = 80.0\%$
2)	$-5{,}000 + \dfrac{9{,}000}{1.20} = \$2{,}500$	$\dfrac{9{,}000 - 5{,}000}{5{,}000} = 0.80 = 80.0\%$
3)	$-5{,}000 + \dfrac{5{,}700}{1.20} = -\$250$	$\dfrac{5{,}700 - 5{,}000}{5{,}000} = 0.14 = 14.0\%$
4)	$-2{,}000 + \dfrac{4{,}000}{1.20} = \$1{,}333.33$	$\dfrac{4{,}000 - 2{,}000}{2{,}000} = 1.00 = 100.0\%$

a. Investment 1, because it has the highest NPV.

b. Investment 1, because it maximizes shareholders' wealth.

5. a. NPV = (-50,000 + 30,000) + (30,000/1.07) = $8,037.38

b. NPV = (-50,000 + 30,000) + (30,000/1.10) = $7,272.73

Since, in each case, the NPV is higher than the NPV of the office building ($7,143), accept E. Coli's offer. You can also think of it another way. The true opportunity cost of the land is what you could sell it for, i.e., $58,037 (or $57,273). At that price, the office building has a negative NPV.

6. The opportunity cost of capital is the return earned by investing in the best alternative investment. This return will not be realized if the investment under consideration is undertaken. Thus, the two investments must earn *at least* the same return. This return rate is the discount rate used in the net present value calculation.

7. a. NPV = -\$2,000,000 + [\$2,000,000 × 1.05)]/(1.05) = \$0

b. NPV = -\$900,000 + [\$900,000 × 1.07]/(1.10) = -\$24,545.45

The correct discount rate is 10% because this is the appropriate rate for an investment with the level of risk inherent in Norman's nephew's restaurant. The NPV is negative because Norman will not earn enough to compensate for the risk.

c. NPV = -\$2,000,000 + [\$2,000,000 × 1.12]/(1.12) = \$0

d. NPV = -\$1,000,000 + (\$1,100,000/1.12) = -\$17,857.14

Norman should invest in either the risk-free government securities or the risky stock market, depending on his tolerance for risk. Correctly priced securities always have an NPV = 0.

8. a. Expected rate of return on project =

$$\frac{\$2{,}100{,}000 - \$2{,}000{,}000}{\$2{,}000{,}000} = 0.05 = 5.0\%$$

This is equal to the return on the government securities.

b. Expected rate of return on project =

$$\frac{\$963{,}000 - \$900{,}000}{\$900{,}000} = 0.07 = 7.0\%$$

This is less than the correct 10% rate of return for restaurants with similar risk.

c. Expected rate of return on project =

$$\frac{\$2{,}240{,}000 - \$2{,}000{,}000}{\$2{,}000{,}000} = 0.12 = 12.0\%$$

This is equal to the rate of return in the stock market.

d. Expected rate of return on project =

$$\frac{\$1{,}100{,}000 - \$1{,}000{,}000}{\$1{,}000{,}000} = 0.10 = 10.0\%$$

This is less than the return in the equally risky stock market.

9. $\text{NPV} = -\$2{,}600{,}000 + \left[\frac{\$1{,}100{,}000 + (\$1{,}600{,}000 \times 1.12)}{1.12}\right] = -\$17{,}857.14$

The rate at which Norman can borrow does not reflect the opportunity cost of the investments. Norman is still investing $1,000,000 at 10% while the opportunity cost of capital is 12%.

10. a. This is incorrect. The cost of capital is an opportunity cost; it is the rate of return foregone on the next best alternative investment of equal risk.

b. Net present value is not "just theory." An asset's net present value is the net gain to investors who acquire the asset. The concept of "maximizing profits" is the fuzzy concept here. For example, this goal does not make it clear whether it is appropriate to try to increase profits today if it means sacrificing profits tomorrow. In contrast to the objective of maximizing profits, the net present value criterion correctly accounts for the timing of returns from an investment.

Note that "maximize profits" is an unsatisfactory objective in other respects as well. It does not take risk in to account, so that it is not possible to determine whether it is worth trying to increase (average) profits if, in the process, risk is also increased. It is also unclear which accounting figure should be maximized because the profit figure depends on the accounting methods chosen. It is cash flow that is important, not accounting profit. Cash flow can be spent or invested, while accounting profit is a number on a piece of paper which can change with changes in accounting methods.

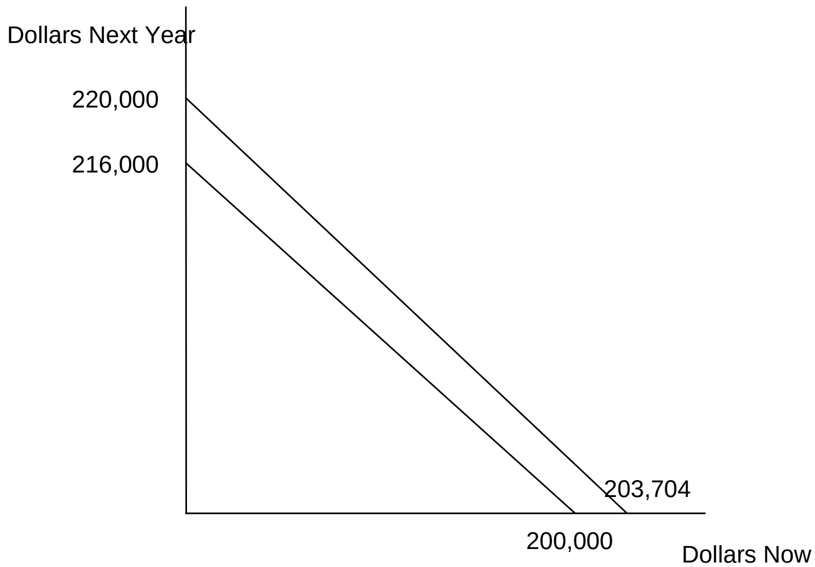
c. The comment can be interpreted in two ways:

1. The manager may try to boost stock price temporarily by disseminating a deceptively rosy picture of the firm's prospects. This possibility is not considered in this chapter. However, it is difficult to imagine how a manager can act in the stockholders' best interests by deceiving them.

2. The manager may sacrifice present value in order to achieve the "gently rising trend." This is not in the stockholders' best interests. If they want a gently rising trend of wealth or income, they can always achieve it by shifting wealth through time (i.e., by borrowing or lending). The firm helps its stockholders most by making them as rich as possible now.

11. The investment's positive NPV will be reflected in the price of Airbus common stock. In order to derive a cash flow from her investment that will allow her to spend more today, Ms. Smith can sell some of her shares at the higher price or she can borrow against the increased value of her holdings.

12.



a. Let x = the amount that Casper should invest now. Then ($200,000 – x) is the amount he will consume now, and (1.08 x) is the amount he will consume next year.

Since Casper wants to consume exactly the same amount each period:

$200{,}000 - x = 1.08\,x$

Solving, we find that x = $96,153.85 so that Casper should invest $96,153.85 now, he should spend ($200,000 - $96,153.85) = $103,846.15 now and he should spend (1.08 × $96,153.85) = $103,846.15 next year.

b. Since Casper can invest $200,000 at 10% risk-free, he can consume as much as ($200,000 × 1.10) = $220,000 next year. The present value of this $220,000 is: ($220,000/1.08) = $203,703.70, so that Casper can consume as much as $203,703.70 now by first investing $200,000 at 10% and then borrowing, at the 8% rate, against the $220,000 available next year. If we use the $203,703.70 as the available consumption now, and again let x = the amount that Casper should invest now, we can then solve the following for x:

$\$203{,}703.70 - x = 1.08\,x$

$x = \$97{,}934.47$

Therefore, Casper should invest $97,934.47 now at 8%, he should spend ($203,703.70 – $97,934.47) = $105,769.23 now, and he should spend ($97,934.47 × 1.08) = $105,769.23 next year. [Note that this approach leads to the result that Casper borrows $203,703.70 at 8% and then invests $97,934.47 at 8%. We could simply say that he should borrow ($203,703.70 - $97,934.47) = $105,769.23 at 8% against the $220,000 available next year. This is the amount that he will consume now.]

c. The NPV of the opportunity in (b) is: ($203,703.70 - $200,000) = $3,703.70

13. "Well functioning" means investors all have *free* and *equal* access to *competitive* capital markets. Maximizing value may not be in all shareholders' interest if different shareholders are taxed at different rates, or if they do not or can not receive important information at the same time (due to differences in costs or abilities), or if they have different access to the capital markets.

14. If a firm does not have a reputation for honesty and fair business practices, then customers, suppliers, and investors will not want to do business with the firm. The firm, by acting in such a fashion, will not be able to maximize the value of the firm and shareholders will start to sell and the stock price will fall. The further the stock price falls, the easier it is for another group of investors to buy control of the firm and to replace the old management team with one that is more responsive to its stockholders.

Challenge Questions

1. The two points raised in the question do not invalidate the NPV rule.

   a. As long as capital markets do their job, all members of the community, wealthy or poor, have the same rate of time preference, because they all adjust to the same borrowing-lending line. The government acts in the best interests of all of its citizens by choosing only investments having positive NPV when discounted at the market interest rate.

   b. The "longer horizon" argument, to the extent it is valid, requires a lower discount rate. It does not require discarding the NPV concept. But should the government ever use a lower discount rate? Note that the rate of return on incremental real investment in the private sector equals the market rate of interest. Why should the government divert resources into public investments offering a lower rate of return? Lowering the discount rate for public investment means allowing the government to invest resources at a lower rate of return. That would not help future generations.

      There are some cases where a lower discount rate might be justified, however. For example, NPV analysis might indicate that a wilderness mountain meadow should be torn up in order to create a copper mine, but We the People might decide to make it a national park instead. In part, this decision reflects the difficulty of capturing intangible benefits of the park in an NPV calculation. Even if the intangibles could be expressed as dollar values, there is a case for discounting at a relatively low rate: People's time preferences for wilderness recreation may not fully adjust to capital market rates of return.

2. a. 1 + r = 5/4 so that r = 0.25 = 25 percent

   b. \$2.6 million – \$1.6 million = \$1 million

   c. \$3 million

   d. Return = (3 – 1)/1 = 2.0 = 200 percent

   e. Marginal rate of return = rate of interest = 25 percent

   f. PV = \$4 million – \$1.6 million = \$2.4 million

   g. NPV = -\$1.0 million + \$2.4 million = \$1.4 million

   h. \$4 million (\$2.6 million cash + NPV)

   i. \$1 million

   j. \$3.75 million

3. a-d. See Figure 2.1a on page 10.

e. $NPV = C_0 + C_1/(1 + r)$

$\$2 \text{ million} = -\$6 \text{ million} + C_1/(1 + 0.10)$

$C_1 = \$8.8$ million

f. The marginal rate of return equals the interest rate, 10 percent.

g. After the firm has announced its investment plans, the firm's PV is equal to the amount of cash initially available ($10 million) plus the PV of the investment ($2 million). Thus, the firm's PV after the announcement is $12 million.

h. After the company pays out $4 million, the shareholders have $4 million in cash plus shares worth $8 million. (We know the shares are worth $8 million because the PV of their total investment is $12 million.) In order to spend as they desire, they must borrow $2 million. The interest rate is 10 percent.

i. Next year, they will have the cash flow at t = 1, which is $8.8 million, but they will also have to repay the loan (plus interest, of course):

$\$8.8 \text{ million} – (\$2 \text{ million} \times 1.1) = \$6.6 \text{ million}$

4. a. Expected cash flow = ($8 million + $12 million + $16 million)/3 = $12 million

b. Expected rate of return = ($12 million/$8 million) – 1 = 0.50 = 50%

c. Expected cash flow = ($8 + $12 + $16)/3 = $12

Expected rate of return = ($12/$10) – 1 = 0.20 = 20%

The net cash flow from selling the tanker load is the same as the payoff from one million shares of Stock Z in each state of the world economy. Therefore, the risk of each of these cash flows is the same.

d. NPV = -$8,000,000 + ($12,000,000/1.20) = +$2,000,000

The project is a good investment because the NPV is positive. Investors would be prepared to pay as much as $10,000,000 for the project, which costs $8,000,000.

5. a. Expected cash flow (Project B) = ($4 million + $6 million + $8 million)/3

Expected cash flow (Project B) = $6 million

Expected cash flow (Project C) = ($5 million + $5.5 million + $6 million)/3

Expected cash flow (Project C) = $5.5 million

b. Expected rate of return (Stock X) = ($110/$95.65) –1 = 0.15 = 15.0%

Expected rate of return (Stock Y) = ($44/$40) –1 = 0.10 = 10.0%

Expected rate of return (Stock Z) = ($12/$10) –1 = 0.20 = 20.0%

c.

	Percentage Differences	
	Slump v. Normal	Boom v. Normal
Project B	4/6 = 66.67%	8/6 = 133.33%
Project C	5/5.5 = 90.91%	6/5.5 = 109.09%
Stock X	80/110 = 72.73%	140/110 = 127.27%
Stock Y	40/44 = 90.91%	48/44 = 109.09%
Stock Z	8/12 = 66.67%	16/12 = 133.33%

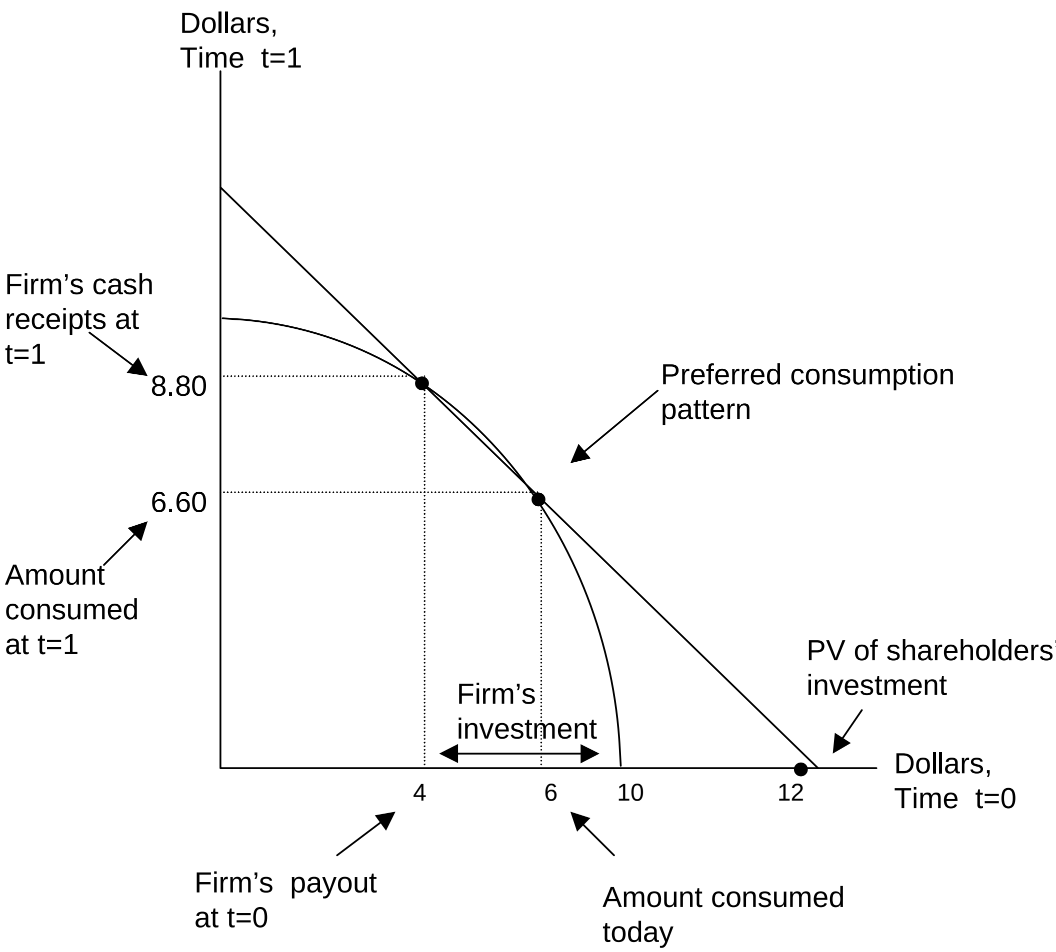
Project B has the same risk as Stock Z, so the cost of capital for Project B is 20%. Project C has the same risk as Stock Y, so the cost of capital for Project C is 10%.

d. NPV (Project B) = -$5,000,000 + ($6,000,000/1.20) = 0

NPV (Project C) = -$5,000,000 + ($5,500,000/1.10) = 0

e. The two projects will add nothing to the total market value of the company’s shares.

Figure 2-1a
(Dollar amounts are in millions)



CHAPTER 3
How to Calculate Present Values

Answers to Practice Questions

1.

a. PV = \$100 × 0.905 = \$90.50

b. PV = \$100 × 0.295 = \$29.50

c. PV = \$100 × 0.035 = \$ 3.50

d. PV = \$100 × 0.893 = \$89.30

PV = \$100 × 0.797 = \$79.70

PV = \$100 × 0.712 = \$71.20

PV = \$89.30 + \$79.70 + \$71.20 = \$240.20

2.

a. PV = \$100 × 4.279 = \$427.90

b. PV = \$100 × 4.580 = \$458.00

c. We can think of cash flows in this problem as being the difference between two separate streams of cash flows. The first stream is \$100 per year received in years 1 through 12; the second is \$100 per year paid in years 1 through 2.

The PV of \$100 received in years 1 to 12 is:

PV = \$100 × [Annuity factor, 12 time periods, 9%]

PV = \$100 × [7.161] = \$716.10

The PV of \$100 paid in years 1 to 2 is:

PV = \$100 × [Annuity factor, 2 time periods, 9%]

PV = \$100 × [1.759] = \$175.90

Therefore, the present value of \$100 per year received in each of years 3 through 12 is: (\$716.10 - \$175.90) = \$540.20. (Alternatively, we can think of this as a 10-year annuity starting in year 3.)

3. a. $DF_1 = \frac{1}{1+r_1} = 0.88 \Rightarrow$ so that r_1 = 0.136 = 13.6%

b. $DF_2 = \frac{1}{(1+r_2)^2} = \frac{1}{(1.105)^2} = 0.82$

c. $AF_2 = DF_1 + DF_2 = 0.88 + 0.82 = 1.70$

d. PV of an annuity = C × [Annuity factor at r% for t years]

Here:

$24.49 = $10 × [$AF_3$]

$AF_3 = 2.45$

e. $AF_3 = DF_1 + DF_2 + DF_3 = AF_2 + DF_3$

$2.45 = 1.70 + DF_3$

$DF_3 = 0.75$

4. The present value of the 10-year stream of cash inflows is (using Appendix Table 3): ($170,000 × 5.216) = $886,720

Thus:

NPV = -$800,000 + $886,720 = +$86,720

At the end of five years, the factory's value will be the present value of the five remaining $170,000 cash flows. Again using Appendix Table 3:

PV = 170,000 × 3.433 = $583,610

5. a. Let S_t = salary in year *t*

$$PV = \sum_{t=1}^{30} \frac{S_t}{(1.08)^t} = \sum_{t-1}^{30} \frac{20{,}000\,(1.05)^{t-1}}{(1.08)^t} = \sum_{t=1}^{30} \frac{(20{,}000/1.05)}{(1.08/1.05)^t} = \sum_{t-1}^{30} \frac{19{,}048}{(1.029)^t}$$

$$= 19{,}048 \times \left[\frac{1}{0.029} - \frac{1}{(0.029)\times(1.029)^{30}}\right] = \$378{,}222$$

b. PV(salary) x 0.05 = $18,911.

Future value = $18,911 x $(1.08)^{30}$ = $190,295

c. Annual payment = initial value ÷ annuity factor

20-year annuity factor at 8 percent = 9.818

Annual payment = $190,295/9.818 = $19,382

6.

Period	Discount Factor	Cash Flow	Present Value
0	1.000	-400,000	-400,000
1	0.893	+100,000	+ 89,300
2	0.797	+200,000	+159,400
3	0.712	+300,000	+213,600
		Total = NPV =	$62,300

7. We can break this down into several different cash flows, such that the sum of these separate cash flows is the total cash flow. Then, the sum of the present values of the separate cash flows is the present value of the entire project. All dollar figures are in millions.

- Cost of the ship is $8 million
  PV = -$8 million

- Revenue is $5 million per year, operating expenses are $4 million. Thus, operating cash flow is $1 million per year for 15 years.
  PV = $1 million × [Annuity factor at 8%, t = 15] = $1 million × 8.559
  PV = $8.559 million

- Major refits cost $2 million each, and will occur at times t = 5 and t = 10.
  PV = -$2 million × [Discount factor at 8%, t = 5]
  PV = -$2 million × [Discount factor at 8%, t = 10]
  PV = -$2 million × [0.681 + 0.463] = -$2.288 million

- Sale for scrap brings in revenue of $1.5 million at t = 15.
  PV = $1.5 million × [Discount factor at 8%, t = 15]
  PV = $1.5 million × [0.315] = $0.473

Adding these present values gives the present value of the entire project:
PV = -$8 million + $8.559 million - $2.288 million + $0.473 million
PV = -$1.256 million

8. a. PV = $100,000

b. PV = $\$180{,}000/1.12^5$ = $102,137

c. PV = $11,400/0.12 = $95,000

d. PV = $19,000 × [Annuity factor, 12%, t = 10]

PV = $19,000 × 5.650 = $107,350

e. PV = $6,500/(0.12 - 0.05) = $92,857

Prize (d) is the most valuable because it has the highest present value.

9. a. Present value per play is:

$$PV = 1{,}250/(1.07)^2 = \$1{,}091.80$$

This is a gain of 9.18 percent per trial. If x is the number of trials needed to become a millionaire, then:

$$(1{,}000)(1.0918)^x = 1{,}000{,}000$$

Simplifying and then using logarithms, we find:

$$(1.0918)^x = 1{,}000$$

$$x\ (\ln 1.0918) = \ln 1000$$

$$x = 78.65$$

Thus the number of trials required is 79.

b. $(1 + r_1)$ must be less than $(1 + r_2)^2$. Thus:

$$DF_1 = 1/(1 + r_1)$$

must be larger (closer to 1.0) than:

$$DF_2 = 1/(1 + r_2)^2$$

10. Mr. Basset is buying a security worth $20,000 now. That is its present value. The unknown is the annual payment. Using the present value of an annuity formula, we have:

$$PV = C \times [\text{Annuity factor, 8\%, } t = 12]$$

$$20{,}000 = C \times 7.536$$

$$C = \$2{,}654$$

11. Assume the Turnips will put aside the same amount each year. One approach to solving this problem is to find the present value of the cost of the boat and equate that to the present value of the money saved. From this equation, we can solve for the amount to be put aside each year.

$$PV(\text{boat}) = 20{,}000/(1.10)^5 = \$12{,}418$$

$$PV(\text{savings}) = \text{Annual savings} \times [\text{Annuity factor, 10\%, } t = 5]$$

$$PV(\text{savings}) = \text{Annual savings} \times 3.791$$

Because PV(savings) must equal PV(boat):

Annual savings × 3.791 = $12,418

Annual savings = $3,276

Another approach is to find the value of the savings at the time the boat is purchased. Because the amount in the savings account at the end of five years must be the price of the boat, or $20,000, we can solve for the amount to be put aside each year. If x is the amount to be put aside each year, then:

$$x(1.10)^4 + x(1.10)^3 + x(1.10)^2 + x(1.10)^1 + x = \$20{,}000$$
$$x(1.464 + 1.331 + 1.210 + 1.10 + 1) = \$20{,}000$$
$$x(6.105) = \$20{,}000$$
$$x = \$\ 3{,}276$$

12. The fact that Kangaroo Autos is offering "free credit" tells us what the cash payments are; it does not change the fact that money has time value. A 10 percent annual rate of interest is equivalent to a monthly rate of 0.83 percent:

$$r_{monthly} = r_{annual}/12 = 0.10/12 = 0.0083 = 0.83\%$$

The present value of the payments to Kangaroo Autos is:

$$\$1000 + \$300 \times [\text{Annuity factor, } 0.83\%, t = 30]$$

Because this interest rate is not in our tables, we use the formula in the text to find the annuity factor:

$$\$1{,}000 + \$300 \times \left[\frac{1}{0.0083} - \frac{1}{(0.0083) \times (1.0083)^{30}}\right] = \$8{,}938$$

A car from Turtle Motors costs $9,000 cash. Therefore, Kangaroo Autos offers the better deal, i.e., the lower present value of cost.

13. The NPVs are:

at 5 percent $\Rightarrow \text{NPV} = -\$150{,}000 - \dfrac{\$100{,}000}{1.05} + \dfrac{\$300{,}000}{(1.05)^2} = \$26{,}871$

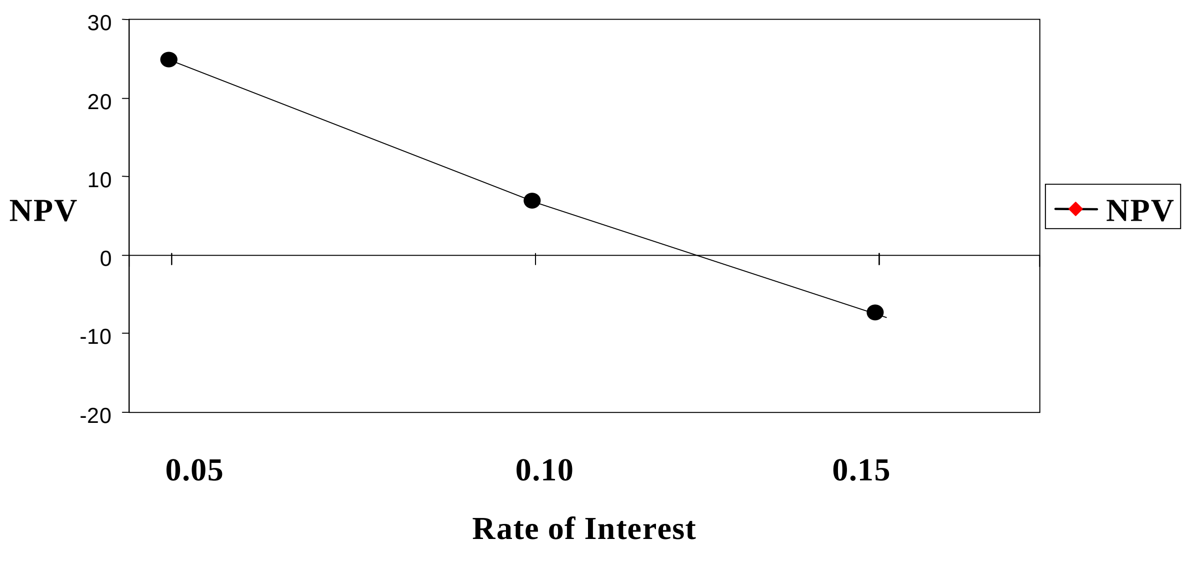
at 10 percent $\Rightarrow \text{NPV} = -\$150{,}000 - \dfrac{\$100{,}000}{1.10} + \dfrac{300{,}000}{(1.10)^2} = \$7{,}025$

at 15 percent $\Rightarrow \text{NPV} = -\$150{,}000 - \dfrac{\$100{,}000}{1.15} + \dfrac{300{,}000}{(1.15)^2} = -\$10{,}113$

The figure below shows that the project has zero NPV at about 12 percent.

As a check, NPV at 12 percent is:

$$\text{NPV} = -\$150{,}000 - \frac{\$100{,}000}{1.12} + \frac{300{,}000}{(1.12)^2} = -\$128$$



14. a. Future value = \$100 + (15 × \$10) = \$250

b. FV = \$100 × $(1.15)^{10}$ = \$404.60

c. Let x equal the number of years required for the investment to double at 15 percent. Then:

$$(\$100)(1.15)^x = \$200$$

Simplifying and then using logarithms, we find:

$$x\ (\ln 1.15) = \ln 2$$

$$x = 4.96$$

Therefore, it takes five years for money to double at 15% compound interest. (We can also solve by using Appendix Table 2, and searching for the factor in the 15 percent column that is closest to 2. This is 2.011, for five years.)

15. a. This calls for the growing perpetuity formula with a negative growth rate (g = -0.04):

$$PV = \frac{\$2\text{ million}}{0.10 - (-0.04)} = \frac{\$2\text{ million}}{0.14} = \$14.29\text{ million}$$

b. The pipeline's value at year 20 (i.e., at t = 20), assuming its cash flows last forever, is:

$$PV_{20} = \frac{C_{21}}{r - g} = \frac{C_1(1+g)^{20}}{r - g}$$

With C_1 = \$2 million, g = -0.04, and r = 0.10:

$$PV_{20} = \frac{(\$2\text{ million}) \times (1 - 0.04)^{20}}{0.14} = \frac{\$0.884\text{ million}}{0.14} = \$6.314\text{ million}$$

Next, we convert this amount to PV today, and subtract it from the answer to Part (a):

$$PV = \$14.29\text{ million} - \frac{\$6.314\text{ million}}{(1.10)^{20}} = \$13.35\text{ million}$$

16. a. This is the usual perpetuity, and hence:

$$PV = \frac{C}{r} = \frac{\$100}{0.07} = \$1,428.57$$

b. This is worth the PV of stream (a) *plus* the immediate payment of $100:

PV = $100 + $1,428.57 = $1,528.57

c. The continuously compounded equivalent to a 7 percent annually compounded rate is approximately 6.77 percent, because:

$e^{0.0677} = 1.0700$

Thus:

$$PV = \frac{C}{r} = \frac{\$100}{0.0677} = \$1,477.10$$

Note that the pattern of payments in part (b) is more valuable than the pattern of payments in part (c). It is preferable to receive cash flows at the start of every year than to spread the receipt of cash evenly over the year; with the former pattern of payment, you receive the cash more quickly.

17. a. PV = $100,000/0.08 = $1,250,000

b. PV = $100,000/(0.08 - 0.04) = $2,500,000

c. $$PV = \$100,000 \times \left[\frac{1}{0.08} - \frac{1}{(0.08) \times (1.08)^{20}}\right] = \$981,800$$

d. The continuously compounded equivalent to an 8 percent annually compounded rate is approximately 7.7 percent , because:

$e^{0.0770} = 1.0800$

Thus:

$$PV = \$100,000 \times \left[\frac{1}{0.077} - \frac{1}{(0.077) \times e^{(0.077)(20)}}\right] = \$1,020,284$$

(Alternatively, we could use Appendix Table 5 here.) This result is greater than the answer in Part (c) because the endowment is now earning interest during the entire year.

18. To find the annual rate (r), we solve the following future value equation:

$$1{,}000\ (1 + r)^8 = 1{,}600$$

Solving algebraically, we find:

$$(1 + r)^8 = 1.6$$

$$(1 + r) = (1.6)^{(1/8)} = 1.0605$$

$$r = 0.0605 = 6.05\%$$

The continuously compounded equivalent to a 6.05 percent annually compounded rate is approximately 5.87 percent, because:

$$e^{0.0587} = 1.0605$$

19. With annual compounding: FV = $\$100 \times (1.15)^{20} = \$1{,}637$

With continuous compounding: FV = $\$100 \times e^{(0.15)(20)} = \$2{,}009$

20. One way to approach this problem is to solve for the present value of:
(1) $100 per year for 10 years, and
(2) $100 per year in perpetuity, with the first cash flow at year 11
If this is a fair deal, these present values must be equal, and thus we can solve for the interest rate, r.

The present value of $100 per year for 10 years is:

$$PV = \$100 \times \left[\frac{1}{r} - \frac{1}{(r) \times (1+r)^{10}}\right]$$

The present value, as of year 10, of $100 per year forever, with the first payment in year 11, is: $PV_{10} = \$100/r$

At t = 0, the present value of PV_{10} is:

$$PV = \left[\frac{1}{(1+r)^{10}}\right] \times \left[\frac{\$100}{r}\right]$$

Equating these two expressions for present value, we have:

$$\$100 \times \left[\frac{1}{r} - \frac{1}{(r) \times (1+r)^{10}}\right] = \left[\frac{1}{(1+r)^{10}}\right] \times \left[\frac{\$100}{r}\right]$$

Using trial and error or algebraic solution, we find that r = 7.18%.

21. Assume the amount invested is one dollar.
Let A represent the investment at 12 percent, compounded annually.
Let B represent the investment at 11.7 percent, compounded semiannually.
Let C represent the investment at 11.5 percent, compounded continuously.
After one year:

$FV_A = \$1 \times (1 + 0.12)^1 = \$1.120$

$FV_B = \$1 \times (1 + 0.0585)^2 = \$1.120$

$FV_C = \$1 \times (e^{0.115\times1}) = \$1.122$

After five years:

$FV_A = \$1 \times (1 + 0.12)^5 = \$1.762$

$FV_B = \$1 \times (1 + 0.0585)^{10} = \$1.766$

$FV_C = \$1 \times (e^{0.115\times5}) = \$1.777$

After twenty years:

$FV_A = \$1 \times (1 + 0.12)^{20} = \$9.646$

$FV_B = \$1 \times (1 + 0.0585)^{40} = \$9.719$

$FV_C = \$1 \times (e^{0.115\times 20}) = \$9.974$

The preferred investment is C.

22. $1 + r_{nominal} = (1 + r_{real}) \times (1 + \text{inflation rate})$

Nominal Rate	Inflation Rate	Real Rate
6.00%	1.00%	4.95%
23.20%	10.00%	12.00%
9.00%	5.83%	3.00%

23. $1 + r_{nominal} = (1 + r_{real}) \times (1 + \text{inflation rate})$

Approximate Real Rate	Actual Real Rate	Difference
4.00%	3.92%	0.08%
4.00%	3.81%	0.19%
11.00%	10.00%	1.00%
20.00%	13.33%	6.67%

24. The total elapsed time is 113 years.

At 5%: $FV = \$100 \times (1 + 0.05)^{113} = \$24{,}797$

At 10%: $FV = \$100 \times (1 + 0.10)^{113} = \$4{,}757{,}441$

25. Because the cash flows occur every six months, we use a six-month discount rate, here 8%/2, or 4%. Thus:

$PV = \$100{,}000 + \$100{,}000 \times$ [Annuity Factor, 4%, t = 9]
$PV = \$100{,}000 + \$100{,}000 \times 7.435 = \$843{,}500$

26. $PV_{QB} = \$3$ million $\times$ [Annuity Factor, 10%, t = 5]

$PV_{QB} = \$3$ million $\times$ 3.791 = \$11.373 million

$PV_{RECEIVER} = \$4$ million + \$2 million $\times$ [Annuity Factor, 10%, t = 5]

$PV_{RECEIVER} = \$4$ million + \$2 million $\times$ 3.791 = \$11.582 million

Thus, the less famous receiver is better paid, despite press reports that the quarterback received a "$15 million contract," while the receiver got a "$14 million contract."

27. a. Each installment is: $9,420,713/19 = $495,827

$PV = \$495{,}827 \times$ [Annuity Factor, 8%, t = 19]

$PV = \$495{,}827 \times 9.604 = \$4{,}761{,}923$

b. If ERC is willing to pay $4.2 million, then:

$\$4{,}200{,}000 = \$495{,}827 \times$ [Annuity Factor, x%, t = 19]

This implies that the annuity factor is 8.471, so that, using the annuity table for 19 times periods, we find that the interest rate is about 10 percent.

28. This is an annuity problem with the present value of the annuity equal to $2 million (as of your retirement date), and the interest rate equal to 8 percent, with 15 time periods. Thus, your annual level of expenditure (C) is determined as follows:

$\$2{,}000{,}000 = C \times$ [Annuity Factor, 8%, t = 15]

$\$2{,}000{,}000 = C \times 8.559$

$C = \$233{,}672$

With an inflation rate of 4 percent per year, we will still accumulate \$2 million as of our retirement date. However, because we want to spend a constant amount per year in real terms (R, constant for all t), the nominal amount (C_t) must increase each year. For each year t:

$$R = C_t /(1 + \text{inflation rate})^t$$

Therefore:

$$PV\ [\text{all } C_t] = PV\ [\text{all } R \times (1 + \text{inflation rate})^t] = \$2{,}000{,}000$$

$$R \times \left[\frac{(1+0.04)^1}{(1+0.08)^1} + \frac{(1+0.04)^2}{(1+0.08)^2} + \ldots + \frac{(1+0.04)^{15}}{(1+0.08)^{15}} \right] = \$2{,}000{,}000$$

$$R \times [0.9630 + 0.9273 + \ldots + 0.5677] = \$2{,}000{,}000$$

$$R \times 11.2390 = \$2{,}000{,}000$$

$$R = \$177{,}952$$

Thus C_1 = (\$177,952 × 1.04) = \$185,070, C_2 = \$192,473, etc.

29. First, with nominal cash flows:

a. The nominal cash flows form a growing perpetuity at the rate of inflation, 4%. Thus, the cash flow in 1 year will be \$416,000 and:

$$PV = \$416{,}000/(0.10 - 0.04) = \$6{,}933{,}333$$

b. The nominal cash flows form a growing annuity for 20 years, with an additional payment of \$5 million at year 20:

$$PV = \left[\frac{416{,}000}{(1.10)^1} + \frac{432{,}640}{(1.10)^2} + \ldots + \frac{876{,}449}{(1.10)^{20}} + \frac{5{,}000{,}000}{(1.10)^{20}} \right] = \$5{,}418{,}389$$

Second, with real cash flows:

a. Here, the real cash flows are \$400,000 per year in perpetuity, and we can find the real rate (r) by solving the following equation:

$$(1 + 0.10) = (1 + r) \times (1.04) \Rightarrow r = 0.0577 = 5.77\%$$

$$PV = \$400{,}000/(0.0577) = \$6{,}932{,}409$$

b. Now, the real cash flows are $400,000 per year for 20 years and $5 million (nominal) in 20 years. In real terms, the $5 million dollar payment is:

$\$5{,}000{,}000/(1.04)^{20} = \$2{,}281{,}935$

Thus, the present value of the project is:

$$PV = \$400{,}000 \times \left[\frac{1}{(0.0577)} - \frac{1}{(0.0577)(1.0577)^{20}}\right] + \frac{\$2{,}281{,}935}{(1.0577)^{20}} = \$5{,}417{,}986$$

[As noted in the statement of the problem, the answers agree, to within rounding errors.]

30. Let x be the fraction of Ms. Pool's salary to be set aside each year. At any point in the future, t, her real income will be:

$(\$40{,}000)(1 + 0.02)^{t}$

The real amount saved each year will be:

$(x)(\$40{,}000)(1 + 0.02)^{t}$

The present value of this amount is:

$$\frac{(x)(\$40{,}000)(1+0.02)^{t}}{(1+0.05)^{t}}$$

Ms. Pool wants to have $500,000, in real terms, 30 years from now. The present value of this amount (at a real rate of 5 percent) is:

$\$500{,}000/(1 + 0.05)^{30}$

Thus:

$$\frac{\$500{,}000}{(1.05)^{30}} = \sum_{t=1}^{30} \frac{(x)(\$40{,}000)(1.02)^{t}}{(1.05)^{t}}$$

$$\frac{\$500{,}000}{(1.05)^{30}} = (x)\sum_{t=1}^{30} \frac{(\$40{,}000)(1.02)^{t}}{(1.05)^{t}}$$

$\$115{,}688.72 = (x)(\$790{,}012.82)$

$x = 0.146$

31. $$PV = \sum_{t=1}^{5} \frac{\$600}{(1.048)^t} + \frac{\$10,000}{(1.048)^5} = \$10,522.42$$

$$PV = \sum_{t=1}^{10} \frac{\$300}{(1.024)^t} + \frac{\$10,000}{(1.024)^{10}} = \$10,527.85$$

32. $$PV = \sum_{t=1}^{5} \frac{\$600}{(1.035)^t} + \frac{\$10,000}{(1.035)^5} = \$11,128.76$$

$$PV = \sum_{t=1}^{10} \frac{\$300}{(1.0175)^t} + \frac{\$10,000}{(1.0175)^{10}} = \$11,137.65$$

33. Using trial and error:

At r = 12.0% $\Rightarrow PV = \sum_{t=1}^{2} \frac{\$100}{(1.12)^t} + \frac{\$1,000}{(1.12)^2} = \$966.20$

At r = 13.0% $\Rightarrow PV = \sum_{t=1}^{2} \frac{\$100}{(1.13)^t} + \frac{\$1,000}{(1.13)^2} = \$949.96$

At r = 12.5% $\Rightarrow PV = \sum_{t=1}^{2} \frac{\$100}{(1.125)^t} + \frac{\$1,000}{(1.125)^2} = \$958.02$

At r = 12.4% $\Rightarrow PV = \sum_{t=1}^{2} \frac{\$100}{(1.124)^t} + \frac{\$1,000}{(1.124)^2} = \$959.65$

Therefore, the yield to maturity is approximately 12.4%.

Challenge Questions

1. a. Using the Rule of 72, the time for money to double at 12 percent is 72/12, or 6 years. More precisely, if x is the number of years for money to double, then:

$$(1.12)^x = 2$$

Using logarithms, we find:

$$x\ (\ln 1.12) = \ln 2$$

$$x = 6.12 \text{ years}$$

b. With continuous compounding for interest rate r and time period x:

$$e^{r\,x} = 2$$

Taking the natural logarithm of each side:

$$r\,x = \ln(2) = 0.693$$

Thus, if r is expressed as a percent, then x (the time for money to double) is: x = 69.3/(interest rate, in percent).

2. Spreadsheet exercise

3. Let P be the price per barrel. Then, at any point in time t, the price is:

$$P\ (1 + 0.02)^t$$

The quantity produced is: $100{,}000\ (1 - 0.04)^t$

Thus revenue is:

$$100{,}000P \times [(1 + 0.02) \times (1 - 0.04)]^t = 100{,}000P \times (1 - 0.021)^t$$

Hence, we can consider the revenue stream to be a perpetuity that grows at a negative rate of 2.1 percent per year. At a discount rate of 8 percent:

$$PV = \frac{100{,}000P}{0.08 - (-0.021)} = 990{,}099P$$

With P equal to $14, the present value is $13,861,386.

4. Let c = the cash flow at time 0
g = the growth rate in cash flows
r = the risk adjusted discount rate

$$PV = c(1 + g)(1 + r)^{-1} + c(1 + g)^2(1 + r)^{-2} + \ldots + c(1 + g)^n(1 + r)^{-n}$$

The expression on the right-hand side is the sum of a geometric progression (see Footnote 7) with first term: $a = c(1 + g)(1 + r)^{-1}$
and common ratio: $x = (1 + g)(1 + r)^{-1}$
Applying the formula for the sum of n terms of a geometric series, the PV is:

$$PV = (a)\left[\frac{1 - x^N}{1 - x}\right] = c(1+g)(1+r)^{-1}\left[\frac{1-(1+g)^n(1+r)^{-n}}{1-(1+g)(1+r)^{-1}}\right]$$

5. The 7 percent U.S. Treasury bond (see text Section 3.5) matures in five years and provides a nominal cash flow of $70.00 per year. Therefore, with an inflation rate of 2 percent:

Year	Nominal Cash Flow	Real Cash Flow
2002	70.00	$70.00/(1.02)^1 = 68.63$
2003	70.00	$70.00/(1.02)^2 = 67.28$
2004	70.00	$70.00/(1.02)^3 = 65.96$
2005	70.00	$70.00/(1.02)^4 = 64.67$
2006	1,070.00	$1070.00/(1.02)^5 = 969.13$

With a nominal rate of 7 percent and an inflation rate of 2 percent, the real rate (r) is:

$$r = [(1.07/1.02) - 1] = 0.0490 = 4.90\%$$

The present value of the bond, with nominal cash flows and a nominal rate, is:

$$PV = \frac{70}{(1.07)^1} + \frac{70}{(1.07)^2} + \frac{70}{(1.07)^3} + \frac{70}{(1.07)^4} + \frac{1070}{(1.07)^5} = \$1,000.00$$

The present value of the bond, with real cash flows and a real rate, is:

$$PV = \frac{68.63}{(1.0490)^1} + \frac{67.28}{(1.0490)^2} + \frac{65.96}{(1.0490)^3} + \frac{64.67}{(1.0490)^4} + \frac{969.13}{(1.0490)^5} = \$1,000.00$$

6. Spreadsheet exercise.

CHAPTER 4
The Value of Common Stocks

Answers to Practice Questions

1. Newspaper exercise, answers will vary

2. The value of a share is the discounted value of all expected future dividends. Even if the investor plans to hold a stock for only 5 years, for example, then, at the time that the investor plans to sell the stock, it will be worth the discounted value of all expected dividends from that point on. In fact, that is the value at which the investor expects to sell the stock. Therefore, the present value of the stock today is the present value of the expected dividend payments from years one through five plus the present value of the year five value of the stock. This latter amount is the present value today of all expected dividend payments after year five.

3. The market capitalization rate for a stock is the rate of return expected by the investor. Since all securities in an equivalent risk class must be priced to offer the same expected return, the market capitalization rate must equal the opportunity cost of capital of investing in the stock.

4.

	Expected Future Values		Present Values		
Horizon Period (H)	Dividend (DIV_t)	Price (P_t)	Cumulative Dividends	Future Price	Total
0		100.00		100.00	100.00
1	10.00	105.00	8.70	91.30	100.00
2	10.50	110.25	16.64	83.36	100.00
3	11.03	115.76	23.89	76.11	100.00
4	11.58	121.55	30.51	69.50	100.00
10	15.51	162.89	59.74	40.26	100.00
20	25.27	265.33	83.79	16.21	100.00
50	109.21	1,146.74	98.94	1.06	100.00
100	1,252.39	13,150.13	99.99	0.01	100.00

Assumptions

1. Dividends increase by 5% per year compounded.
2. The capitalization rate is 15%.

5. a. Using the growing perpetuity formula, we have:

$P_0 = Div_1/(r – g)$

$73 = 1.68/(r - 0.085)$

$r = 0.108 = 10.8\%$

b. We know that:

Plowback ratio = 1.0 – payout ratio

Plowback ratio = 1.0 - 0.5 = 0.5

And, we also know that:

dividend growth rate = g = plowback ratio × ROE

$g = 0.5 \times 0.12 = 0.06 = 6.0\%$

Using this estimate of g, we have:

$P_0 = Div_1/(r – g)$

$73 = 1.68/(r - 0.06)$

$r = 0.083 = 8.3\%$

6. Using the growing perpetuity formula, we have:

$P_0 = Div_1/(r – g) = 2/(0.12 - 0.04) = \$25$

7. $$P_A = \frac{DIV_1}{r} = \frac{\$10}{0.10} = \$100.00$$

$$P_B = \frac{DIV_1}{r - g} = \frac{5}{0.10 - 0.04} = \$83.33$$

$$P_C = \frac{DIV_1}{1.10^1} + \frac{DIV_2}{1.10^2} + \frac{DIV_3}{1.10^3} + \frac{DIV_4}{1.10^4} + \frac{DIV_5}{1.10^5} + \frac{DIV_6}{1.10^6} + \left(\frac{DIV_7}{0.10} \times \frac{1}{1.10^6}\right)$$

$$P_C = \frac{5.00}{1.10^1} + \frac{6.00}{1.10^2} + \frac{7.20}{1.10^3} + \frac{8.64}{1.10^4} + \frac{10.37}{1.10^5} + \frac{12.44}{1.10^6} + \left(\frac{12.44}{0.10} \times \frac{1}{1.10^6}\right) = \$104.50$$

At a capitalization rate of 10 percent, Stock C is the most valuable.

For a capitalization rate of 7 percent, the calculations are similar. The results are:

$P_A = \$142.86$
$P_B = \$166.67$
$P_C = \$156.48$

Therefore, Stock B is the most valuable.

8. a. We know that g, the growth rate of dividends and earnings, is given by:

$$g = \text{plowback ratio} \times \text{ROE}$$

$$g = 0.40 \times 0.20 = 0.08 = 8.0\%$$

We know that:

$$r = (DIV_1/P_0) + g$$

$$r = \text{dividend yield} + \text{growth rate}$$

Therefore:

$$r = 0.04 + 0.08 = 0.12 = 12.0\%$$

b. Dividend yield = 4%. Therefore:

$$DIV_1/P_0 = 0.04$$

$$DIV_1 = 0.04 \times P_0$$

A plowback ratio of 0.4 implies a payout ratio of 0.6, and hence:

$$DIV_1/EPS_1 = 0.6$$

$$DIV_1 = 0.6 \times EPS_1$$

Equating these two expressions for DIV_1 gives a relationship between price and earnings per share:

$$0.04 \times P_0 = 0.6 \times EPS_1$$

$$P_0/EPS_1 = 15$$

Also, we know that:

$$\frac{EPS_1}{P_0} = r \times \left[1 - \frac{PVGO}{P_0}\right]$$

With $(P_0/EPS_1) = 15$ and r = 0.12, the ratio of the present value of growth opportunities to price is 44.4 percent. Thus, if there are suddenly no future investment opportunities, the stock price will decrease by 44.4 percent.

c. In Part (b), all future investment opportunities are assumed to have a net present value of zero. If all future investment opportunities have a rate of return equal to the capitalization rate, this is equivalent to the statement that the net present value of these investment opportunities is zero. Hence, the impact on share price is the same as in Part (b).

9. Internet exercise; answers will vary depending on time period.

10. Internet exercise; answers will vary depending on time period.

11. Using the concept that the price of a share of common stock is equal to the present value of the future dividends, we have:

$$P=\frac{DIV_1}{(1+r)}+\frac{DIV_2}{(1+r)^2}+\frac{DIV_3}{(1+r)^3}+\left[\frac{1}{(1+r)^3}\times\frac{DIV_4}{(r-g)}\right]$$

$$50=\frac{1}{(1+r)}+\frac{2}{(1+r)^2}+\frac{3}{(1+r)^3}+\left[\frac{1}{(1+r)^3}\times\frac{(3\times 1.06)}{(r-0.06)}\right]$$

Using trial and error, we find that r is approximately 11.1 percent.

12. There are two reasons why the corresponding earnings-price ratios are not accurate measures of the expected rates of return.

First, the expected rate of return is based on future expected earnings; the price-earnings ratios reported in the press are based on past actual earnings. In general, these earnings figures are different.

Second, we know that:

$$\frac{EPS_1}{P_0}=r\left[1-\frac{PVGO}{P_0}\right]$$

Hence, the earnings-price ratio is equal to the expected rate of return only if PVGO is zero.

13. a. An Incorrect Application. Hotshot Semiconductor's earnings and dividends have grown by 30 percent per year since the firm's founding ten years ago. Current stock price is $100, and next year's dividend is projected at $1.25. Thus:

$$r=\frac{DIV_1}{P_0}+g=\frac{1.25}{100}+0.30=0.3125=31.25\%$$

This is *wrong* because the formula assumes perpetual growth; it is not possible for Hotshot to grow at 30 percent per year forever.

A Correct Application. The formula might be correctly applied to the Old Faithful Railroad, which has been growing at a steady 5 percent rate for decades. Its EPS_1 = \$10, DIV_1 = \$5, and P_0 = \$100. Thus:

$$r = \frac{DIV_1}{P_0} + g = \frac{5}{100} + 0.05 = 0.10 = 10.0\%$$

Even here, you should be careful not to blindly project past growth into the future. If Old Faithful hauls coal, an energy crisis could turn it into a growth stock.

b. An Incorrect Application. Hotshot has current earnings of \$5.00 per share. Thus:

$$r = \frac{EPS_1}{P_0} = \frac{5}{100} = 0.05 = 5.0\%$$

This is too low to be realistic. The reason P_0 is so high relative to earnings is not that r is low, but rather that Hotshot is endowed with valuable growth opportunities. Suppose PVGO = \$60:

$$P_0 = \frac{EPS_1}{r} + PVGO$$

$$100 = \frac{5}{r} + 60$$

Therefore, r = 12.5%

A Correct Application. Unfortunately, Old Faithful has run out of valuable growth opportunities. Since PVGO = 0:

$$P_0 = \frac{EPS_1}{r} + PVGO$$

$$100 = \frac{10}{r} + 0$$

Therefore, r = 10.0%

14. $$\text{Share price} = \frac{EPS_1}{r} + \frac{NPV}{r - g}$$

Therefore:

$$P_\alpha = \frac{EPS_{\alpha 1}}{r_\alpha} + \frac{NPV_\alpha}{(r_\alpha - 0.15)}$$

$$P_\beta = \frac{EPS_{\beta 1}}{r_\beta} + \frac{NPV_\beta}{(r_\beta - 0.08)}$$

The statement in the question implies the following:

$$\frac{NPV_\beta}{(r_\beta - 0.08)} \Bigg/ \left(\frac{EPS_{\beta 1}}{r_\beta} + \frac{NPV_\beta}{(r_\beta - 0.08)} \right) > \frac{NPV_\alpha}{(r_\alpha - 0.15)} \Bigg/ \left(\frac{EPS_{\alpha 1}}{r_\alpha} + \frac{NPV_\alpha}{(r_\alpha - 0.15)} \right)$$

Rearranging, we have:

$$\frac{NPV_\alpha}{(r_\alpha - 0.15)} \times \frac{r_\alpha}{EPS_{\alpha 1}} < \frac{NPV_\beta}{(r_\beta - 0.08)} \times \frac{r_\beta}{EPS_{\beta 1}}$$

a. $NPV_\alpha < NPV_\beta$, everything else equal.

b. $(r_\alpha - 0.15) > (r_\beta - 0.08)$, everything else equal.

c. $\frac{NPV_\alpha}{(r_\alpha - 0.15)} < \frac{NPV_\beta}{(r_\beta - 0.08)}$, everything else equal.

c. $\frac{r_\alpha}{EPS_{\alpha 1}} < \frac{r_\beta}{EPS_{\beta 1}}$, everything else equal.

15. a. Growth-Tech's stock price should be:

$$P = \frac{0.50}{(1.12)} + \frac{0.60}{(1.12)^2} + \frac{1.15}{(1.12)^3} + \left(\frac{1}{(1.12)^3} \times \frac{1.24}{(0.12 - 0.08)} \right) = \$23.81$$

b. The horizon value contributes:

$$PV(P_H) = \frac{1}{(1.12)^3} \times \frac{1.24}{(0.12 - 0.08)} = \$22.07$$

c. Without PVGO, P_3 would equal earnings for year 4 capitalized at 12 percent:

$$\frac{2.49}{0.12} = \$20.75$$

Therefore: PVGO = \$31.00 - \$20.75 = \$10.25

d. The PVGO of \$10.25 is lost at year 3. Therefore, the current stock price of \$23.81 will decline by:

$$\frac{10.25}{(1.12)^3} = \$7.30$$

The new stock price will be \$23.81 - \$7.30 = \$16.51

16. Internet exercise; answers will vary depending on time period.

17. Internet exercise; answers will vary.

18. Internet exercise; answers will vary.

19. a. Here we can apply the standard growing perpetuity formula with DIV_1 = \$4, g = 0.04 and P_0 = \$100:

$$r = \frac{DIV_1}{P_0} + g = \frac{4}{100} + 0.04 = 0.08 = 8.0\%$$

The \$4 dividend is 60 percent of earnings. Thus:

EPS_1 = 4/0.6 = \$6.67

Also:

$$P_0 = \frac{EPS_1}{r} + PVGO$$

$$100 = \frac{6.67}{0.08} + PVGO$$

PVGO = \$16.63

b. DIV_1 will decrease to: $(0.20 \times 6.67) = \$1.33$

However, by plowing back 80 percent of earnings, CSI will grow by 8 percent per year for five years. Thus:

Year	1	2	3	4	5	6	7, 8 . . .
DIV_t	1.33	1.44	1.56	1.68	1.81	5.88	Continued growth at
EPS_t	6.67	7.20	7.78	8.40	9.07	9.80	4 percent

Note that DIV_6 increases sharply as the firm switches back to a 60 percent payout policy. Forecasted stock price in year 5 is:

$$P_5 = \frac{DIV_6}{r - g} = \frac{5.88}{0.08 - 0.04} = \$147$$

Therefore, CSI's stock price will increase to:

$$P_0 = \frac{1.33}{1.08} + \frac{1.44}{1.08^2} + \frac{1.56}{1.08^3} + \frac{1.68}{1.08^4} + \frac{1.81 + 147}{1.08^5} = \$106.22$$

20. Formulas for calculating $PV(P_H)$ include the following:

a. $PV(P_H) = (EPS_H/r) + PVGO$
where EPS_H is the firm's earnings per share at the horizon date.
(This formula would be the easiest to apply if PVGO = 0.)

b. $PV(P_H) = EPS_H \times (P/E)_C$
where $(P/E)_C$ is the P/E ratio for comparable firms.
(This formula would be a good choice if comparable firms can be readily identified.)

c. $PV(P_H) = BV_H \times (MV/BV)_C$
where BV_H is the firm's book value per share at the horizon date, and $(MV/BV)_C$ is the market-book ratio for comparable firms.
(This formula would be a good choice if comparable firms can be readily identified.)

d. $PV(P_H) = C_{H+1}/(r - g)$
where C_{H+1} is the firm's cash flow in the subsequent time period.
(This formula would be a good choice if the assumption of growth at a constant rate g for the foreseeable future is a reasonable assumption.)

21. a.

	Year									
	1	2	3	4	5	6	7	8	9	10
Asset value	10.00	11.50	13.23	15.21	17.49	19.76	22.33	23.67	25.09	26.60
Earnings	1.20	1.38	1.59	1.83	2.10	2.37	2.68	2.84	3.01	3.20
Investment	1.50	1.73	1.98	2.28	2.27	2.57	1.34	1.42	1.51	1.60
Free cash flow	-0.30	-0.35	-0.39	-0.45	-0.17	-0.20	1.34	1.42	1.50	1.60
Earnings growth	20.0%	20.0%	20.0%	20.0%	20.0%	13.0%	13.0%	6.0%	6.0%	6.0%

The present value of the near-term flows (i.e., years 1 through 6) is -$1.38

The present value of the horizon value is:

$$PV(P_H) = \frac{1}{(1.10)^6} \times \frac{1.34}{(0.10 - 0.06)} = \$18.91$$

Therefore, the present value of the free cash flows is:

($18.91-$1.38) = $17.53

The present value of the near term cash flows increases because the amount of investment each year decreases. However, the present value of the horizon value decreases by a greater amount, so that the total present value decreases.

b. With one million shares currently outstanding, price per share is:
($17.53 million/1 million shares) = $17.53
The amount of financing required is $1.38 million, so the number of shares to be issued is: ($1.38 million/$17.53) = 79,000 shares (approximately)

c. (i) $17.53 million/1 million shares = $17.53 per share
(ii) previously outstanding shares/total shares =
1 million/1.079 million = 0.9268
$0.9268 \times \$18.91 = \$17.53$

22. The value of the company increases from $100 million to $200 million.
The value of each share remains the same at $10.

23.

	Expected Future Values		Present Values		
Horizon Period (H)	Dividend (DIV_t)	Price (P_t)	Cumulative Dividends	Future Price	Total
0		100.00		100.00	100.00
1	15.00	100.00	13.04	86.96	100.00
2	5.00	110.00	16.82	83.18	100.00
3	5.50	121.00	20.44	79.56	100.00
4	6.05	133.10	23.90	76.10	100.00
10	10.72	235.79	41.72	58.28	100.00
20	27.80	611.59	62.63	37.37	100.00
50	485.09	10,671.90	90.15	9.85	100.00
100	56,944.68	1,252,782.94	98.93	1.07	100.00

In order to pay the extra dividend, the company needs to raise an extra $10 per share in year 1. The new shareholders who provide this cash will demand a dividends of $0.50 per share in year 2, $0.55 in year 3, and so on. Thus, each old share will receive dividends of $15 in year 1, ($5.50 – $0.50) = $5 in year 2, ($6.05 – $0.55) = $5.50 in year 3, and so on. The present value of a share at year 1 is computed as follows:

$$PV = \frac{\$15}{1.15} + \left(\frac{\$5}{0.15 - 0.10} \times \frac{1}{1.15}\right) = \$100.00$$

Challenge Questions

1. There is something of an inconsistency in Practice Question 11 since the dividends are growing at a very high rate initially. This high growth rate suggests the company is investing heavily in its future. Free cash flow equals cash generated net of all costs, taxes, and positive NPV investments. If investment opportunities are abundant, free cash flow can be negative when investment outlays are large. Hence, where do the funds to pay the increasing dividends come from?

   At some point in time, competition is likely to drive ROE down to the cost of equity, at which point investment will decrease and free cash flow will turn positive.

2. From the equation given in the problem, it follows that:

$$\frac{P_0}{BVPS} = \frac{ROE \times (1-b)}{r - (b \times ROE)} = \frac{1-b}{(r / ROE) - b}$$

   Consider three cases:

   $ROE < r \Rightarrow (P_0/BVPS) < 1$

   $ROE = r \Rightarrow (P_0/BVPS) = 1$

   $ROE > r \Rightarrow (P_0/BVPS) > 1$

   Thus, as ROE increases, the price-to-book ratio also increases, and when ROE = r, price-to-book equals one.

3. Assume the portfolio value given, \$100 million, is the value as of the end of the first year. Then, assuming constant growth, the value of the contract is given by the first payment (0.5 percent of portfolio value) divided by (r – g). Also:

   r = dividend yield + growth rate

   Hence:

   r - growth rate = dividend yield = 0.05 = 5.0%

   Thus, the value of the contract, V, is:

$$V = \frac{0.005 \times (\$100\text{ million})}{0.05} = \$10\text{ million}$$

CHAPTER 5
Why Net Present Value Leads to Better Investment Decisions Than Other Criteria

Answers to Practice Questions

1. a. $NPV_A = -1000 + \dfrac{1000}{(1+0.10)} = -\$90.91$

$$NPV_B = -2000 + \frac{1000}{(1.10)} + \frac{1000}{(1.10)^2} + \frac{4000}{(1.10)^3} + \frac{1000}{(1.10)^4} + \frac{1000}{(1.10)^5} = +\$4{,}044.73$$

$$NPV_C = -3000 + \frac{1000}{(1.10)} + \frac{1000}{(1.10)^2} + \frac{1000}{(1.10)^4} + \frac{1000}{(1.10)^5} = +\$39.47$$

b. $Payback_A$ = 1 year
$Payback_B$ = 2 years
$Payback_C$ = 4 years

c. A and B.

2. The discounted payback period is the number of periods a project must last in order to achieve a zero net present value. It is marginally preferable to the regular payback rule because it uses discounted cash flows, thereby overcoming the criticism that all cash flows prior to the cutoff date have equal weight. However, the discounted payback period still does not account for cash flows occurring after the cut-off date.

3. Book rate of return uses the accounting definition of income and investment (i.e., book value of assets). Both of these accounting concepts differ from cash flow measures. In addition, book rate of return does not recognize the time value of money. Hence, decisions based on book rate of return can, and often do, lead to choices that are unacceptable when analyzed on a net present value basis.

4. a. When using the IRR rule, the firm must still compare the IRR with the opportunity cost of capital. Thus, even with the IRR method, one must think about the appropriate discount rate.

b. Risky cash flows should be discounted at a higher rate than the rate used to discount less risky cash flows. Using the payback rule is equivalent to using the NPV rule with a zero discount rate for cash flows before the payback period and an infinite discount rate for cash flows thereafter.

5. In general, the discounted payback rule is slightly better than the regular payback rule. But, *in this case*, it might actually be worse: with the same cut-off period, fewer long-lived investment projects will make the grade.

6.

	r =	-17.44%	0.00%	10.00%	15.00%	20.00%	25.00%	45.27%
Year 0	-3,000.00	-3,000.00	-3,000.00	-3,000.00	-3,000.00	-3,000.00	-3,000.00	-3,000.00
Year 1	3,500.00	4,239.34	3,500.00	3,181.82	3,043.48	2,916.67	2,800.00	2,409.31
Year 2	4,000.00	5,868.41	4,000.00	3,305.79	3,024.57	2,777.78	2,560.00	1,895.43
Year 3	-4,000.00	-7,108.06	-4,000.00	-3,005.26	-2,630.06	-2,314.81	-2,048.00	-1,304.76
	PV =	-0.31	500.00	482.35	437.99	379.64	312.00	-0.02

The two IRRs for this project are (approximately): –17.44% and 45.27%. The NPV is positive between these two discount rates.

7. a. The figure on the next page was drawn from the following points:

	Discount Rate		
	0%	10%	20%
NPV_A	+20.00	+4.13	-8.33
NPV_B	+40.00	+5.18	-18.98

b. From the graph, we can estimate the IRR of each project from the point where its line crosses the horizontal axis:

IRR_A = 13.1% and IRR_B = 11.9%

c. The company should accept Project A if its NPV is positive and higher than that of Project B; that is, the company should accept Project A if the discount rate is greater than 10.7 percent and less than 13.1 percent.

d. The cash flows for (B – A) are:

C_0	C_1	C_2	C_3
0	-60	-60	$+140$

Therefore:

	Discount Rate		
	0%	10%	20%
NPV_{B-A}	+20.00	+1.05	-10.65

IRR_{B-A} = 10.7%

The company should accept Project A if the discount rate is greater than 10.7% and less than 13.1%. As shown in the graph, for these discount rates, the IRR for the incremental investment is less than the opportunity of cost of capital.

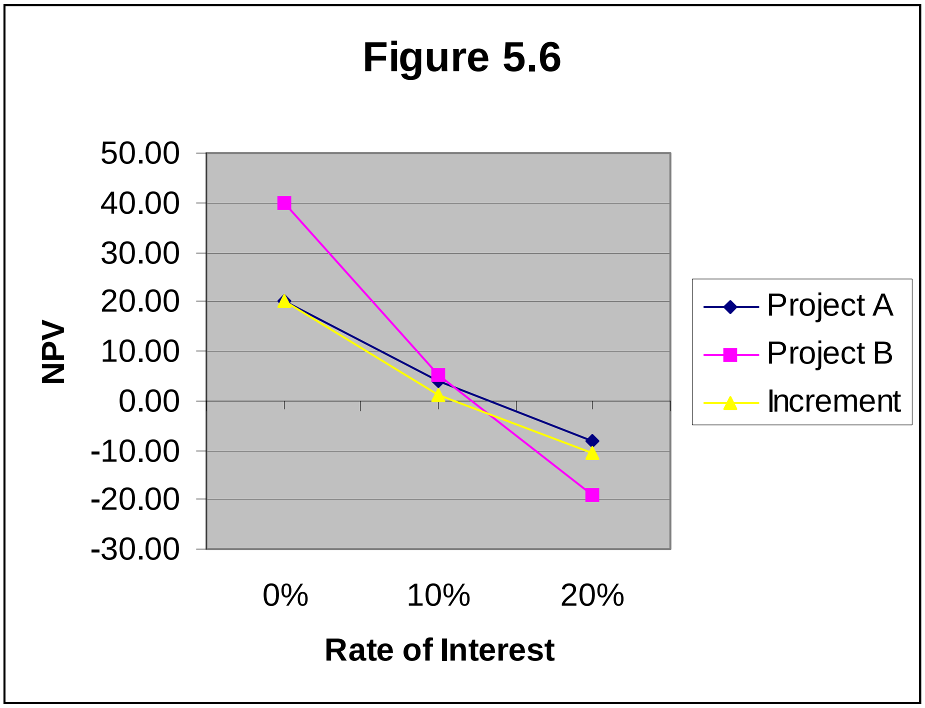


Figure 5.6
50.00
40.00
30.00
20.00
10.00
0.00
-10.00
-20.00
-30.00
NPV
0%
10%
20%
Rate of Interest
Project A
Project B
Increment

8. a. Because Project A requires a larger capital outlay, it is possible that Project A has both a lower IRR and a higher NPV than Project B. (In fact, NPV_A is greater than NPV_B for all discount rates less than 10 percent.) Because the goal is to maximize shareholder wealth, NPV is the correct criterion.

b. To use the IRR criterion for mutually exclusive projects, calculate the IRR for the incremental cash flows:

	C_0	C_1	C_2	IRR
A - B	-200	+110	+121	10%

Because the IRR for the incremental cash flows exceeds the cost of capital, the additional investment in A is worthwhile.

c.

$$NPV_A = -400 + \frac{250}{(1.09)} + \frac{300}{(1.09)^2} = \$81.86$$

$$NPV_B = -200 + \frac{140}{(1.09)} + \frac{179}{(1.09)^2} = \$79.10$$

9. Use incremental analysis:

	C_1	C_2	C_3
Current arrangement	-250,000	-250,000	+650,000
Extra shift	-550,000	+650,000	0
Incremental flows	-300,000	+900,000	-650,000

The IRRs for the incremental flows are approximately 21.13 *and* 78.87 percent. If the cost of capital is between these rates, Titanic should work the extra shift.

10. The statement is true because more immediate cash flows will be discounted less than cash flows that are further into the future. Hence, projects with quick paybacks and low investments will be preferred on an IRR basis, even though longer-term projects might have larger NPVs.

11. a.

$$PI_E = \frac{-10{,}000 + \dfrac{20{,}000}{1.10}}{-(-10{,}000)} = \frac{8{,}182}{10{,}000} = 0.82$$

$$PI_F = \frac{-20{,}000 + \dfrac{35{,}000}{1.10}}{-(-20{,}000)} = \frac{11{,}818}{20{,}000} = 0.59$$

b. Both projects have a Profitability Index greater than zero, and so both are acceptable projects. In order to choose between these projects, we must use incremental analysis. For the incremental cash flows:

$$PI_{F-E} = \frac{-10{,}000 + \dfrac{15{,}000}{1.10}}{-(-10{,}000)} = \frac{3{,}636}{10{,}000} = 0.36$$

The increment is thus an acceptable project, and so the larger project should be accepted, i.e., accept Project F. (Note that, in this case, the better project has the lower profitability index.)

12. Because there are three sign changes in the sequence of cash flows, we know that there can be as many as three internal rates of return. Using trial and error, graphical analysis, or solving analytically (the easiest way to solve for the IRR is with a spreadsheet program such as Excel), we can show that there is only one IRR, 5.24 percent.

A project with an IRR equal to 5.24 percent is not attractive when the opportunity cost of capital is 14 percent. (Alternatively, we can say that, with a discount rate of 14 percent, the project's NPV is -$2,443 so that the project is not attractive.)

13. Using the fact that Profitability Index = (Net Present Value/Investment), we find that:

Project	Profitability Index
1	0.22
2	-0.02
3	0.17
4	0.14
5	0.07
6	0.18
7	0.12

Thus, given the budget of $1 million, the best the company can do is to accept Projects 1, 3, 4, and 6.

If the company accepted *all* positive NPV projects, the market value (compared to the market value under the budget limitation) would increase by the NPV of Project 5 and the NPV of Project 7: ($7,000 + $48,000) = $55,000. Thus, the budget limit costs the company $55,000 in terms of its market value.

14. Maximize: $NPV = 6,700x_W + 9,000x_X + 0X_Y - 1,500x_Z$

subject to:

$10,000x_W + 0x_X + 10,000x_Y + 15,000x_Z \leq 20,000$

$10,000x_W + 20,000x_X - 5,000x_Y - 5,000x_Z \leq 20,000$

$0x_W - 5,000x_X - 5,000x_Y - 4,000x_Z \leq 20,000$

$0 \leq x_W \leq 1$

$0 \leq x_X \leq 1$

$0 \leq x_Z \leq 1$

Challenge Questions

1. The IRR is the discount rate which, when applied to a project's cash flows, yields NPV = 0. Thus, it does not represent an opportunity cost. However, if each project's cash flows could be invested at that project's IRR, then the NPV of each project would be zero because the IRR would then be the opportunity cost of capital for each project. The discount rate used in an NPV calculation is the opportunity cost of capital. Therefore, it is true that the NPV rule does assume that cash flows are reinvested at the opportunity cost of capital.

2. a.

$C_0 = -3{,}000$	$C_0 = -3{,}000$
$C_1 = +3{,}500$	$C_1 = +3{,}500$
$C_2 = +4{,}000$	$C_2 + PV(C_3) = +4{,}000 – 3{,}571.43 = 428.57$
$C_3 = -4{,}000$	MIRR = 27.84%

b. $$xC_1 + \frac{xC_2}{1.12} = \frac{C_3}{1.12^2}$$

$$(1.12^2)(x\ C_1) + (1.12)(x\ C_2) = C_3$$

$$(x)[(1.12^2)(C_1) + (1.12)(C_2)] = C_3$$

$$x = \frac{C_3}{(1.12^2)(C_1) + (1.12)(C_2)}$$

$$x = \frac{4{,}000}{(1.12^2)(3{,}500) + (1.12)(4{,}000)} = 0.45$$

$$C_0 + \frac{(1-x)C_1}{(1+IRR)} + \frac{(1-x)C_2}{(1+IRR)^2} = 0$$

$$-3{,}000 + \frac{(1-0.45)(3{,}500)}{(1+IRR)} + \frac{(1-0.45)(4{,}000)}{(1+IRR)^2} = 0$$

Now, find MIRR using either trial and error or the IRR function (on a financial calculator or Excel). We find that MIRR = 23.53%.

It is not clear that either of these modified IRRs is at all meaningful. Rather, these calculations seem to highlight the fact that MIRR really has no economic meaning.

3. A project with all positive cash flows has no IRR. For example:

$C_0 = 100$
$C_1 = 100$
$C_2 = 100$
$C_3 = 100$

4. Using Excel Spreadsheet Add-in Linear Programming Module:

Optimized NPV = $13,450

with $x_W = 1$; $x_X = 0.75$; $x_Y = 1$ and $x_Z = 0$

If the financing available at t = 0 is $21,000:

Optimized NPV = $13,500

with $x_W = 1$; $x_X = (23/30)$; $x_Y = 1$ and $x_Z = (2/30)$

Here, the shadow price for the constraint at t = 0 is $50, the increase in NPV for a $1,000 increase in financing available at t = 0.

In this case, the program viewed x_Z as a viable choice, even though the NPV of Project Z is negative. The reason for this result is that project Z provides a positive cash flow in periods 1 and 2.

If the financing available at t = 1 is $21,000:

Optimized NPV = $13,900

with $x_W = 1$; $x_X = 0.8$; $x_Y = 1$ and $x_Z = 0$

Hence, the shadow price of an additional $1,000 in t = 1 financing is $450.

5. a. The constraint in the second period would become:

$$-30x_A - 5x_B - 5x_C + 40x_D - (10 - 10x_A - 5x_B - 5x_C)(1 + r) \leq 10$$

b. The constraint in the first period would become:

$$10x_A + 5x_B + 5x_C + 0x_D + \text{COST OF HIRING \& TRAINING} \leq 10$$

CHAPTER 6
Making Investment Decisions with the Net Present Value Rule

Answers to Practice Questions

1. See the table below. We begin with the cash flows given in the text, Table 6.6, line 8, and utilize the following relationship from Chapter 3:

   Real cash flow = nominal cash flow/(1 + inflation rate)^t

   Here, the nominal rate is 20 percent, the expected inflation rate is 10 percent, and the real rate is given by the following:

$$(1 + r_{nominal}) = (1 + r_{real}) \times (1 + \text{inflation rate})$$
$$1.20 = (1 + r_{real}) \times (1.10)$$
$$r_{real} = 0.0909 = 9.09\%$$

   As can be seen in the table, the NPV is unchanged (to within a rounding error).

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Net Cash Flows/Nominal	-12,600	-1,484	2,947	6,323	10,534	9,985	5,757	3,269
Net Cash Flows/Real	-12,600	-1,349	2,436	4,751	7,195	6,200	3,250	1,678

   NPV of Real Cash Flows (at 9.09%) = $3,804

2. No, this is not the correct procedure. The opportunity cost of the land is its value in its best use, so Mr. North should consider the $45,000 value of the land as an outlay in his NPV analysis of the funeral home.

3. Unfortunately, there is no simple adjustment to the discount rate that will resolve the issue of taxes. Mathematically:

$$\frac{C_1}{1.10} \neq \frac{C_1/(1-0.35)}{1.15}$$

   and

$$\frac{C_2}{1.10^2} \neq \frac{C_2/(1-0.35)}{1.15^2}$$

4. Even when capital budgeting calculations are done in real terms, an inflation forecast is still required because:
   a. Some real flows depend on the inflation rate, e.g., real taxes and real proceeds from collection of receivables; and,
   b. Real discount rates are often estimated by starting with nominal rates and "taking out" inflation, using the relationship:

$$(1 + r_{nominal}) = (1 + r_{real}) \times (1 + \text{inflation rate})$$

5. Investment in working capital arises as a forecasting issue only because accrual accounting recognizes sales when made, not when cash is received (and costs when incurred, not when cash payment is made). If cash flow forecasts recognize the exact timing of the cash flows, then there is no need to also include investment in working capital.

6. If the $50,000 is expensed at the end of year 1, the value of the tax shield is:

$$\frac{0.35 \times \$50{,}000}{1.05} = \$16{,}667$$

If the $50,000 expenditure is capitalized and then depreciated using a five-year MACRS depreciation schedule, the value of the tax shield is:

$$[0.35 \times \$50{,}000] \times \left(\frac{.20}{1.05} + \frac{.32}{1.05^2} + \frac{.192}{1.05^3} + \frac{.1152}{1.05^4} + \frac{.1152}{1.05^5} + \frac{.0576}{1.05^6}\right) = \$15{,}306$$

If the cost can be expensed, then the tax shield is larger, so that the after-tax cost is smaller.

7. a. $$NPV_A = -100{,}000 + \sum_{t=1}^{5} \frac{26{,}000}{1.08^t} = \$3{,}810$$

NPV_B = -Investment + PV(after-tax cash flow) + PV(depreciation tax shield)

$$NPV_B = -100{,}000 + \sum_{t=1}^{5} \frac{26{,}000 \times (1 - 0.35)}{1.08^t} +$$

$$[0.35 \times 100{,}000] \times \left[\frac{0.20}{1.08} + \frac{0.32}{1.08^2} + \frac{0.192}{1.08^3} + \frac{0.1152}{1.08^4} + \frac{0.1152}{1.08^5} + \frac{0.0576}{1.08^6}\right]$$

NPV_B = -$4,127

Another, perhaps more intuitive, way to do the Company B analysis is to first calculate the cash flows at each point in time, and then compute the present value of these cash flows:

	t = 0	t = 1	t = 2	t = 3	t = 4	t = 5	t = 6
Investment	100,000						
Cash In		26,000	26,000	26,000	26,000	26,000	
Depreciation		20,000	32,000	19,200	11,520	11,520	5,760
Taxable Income		6,000	-6,000	6,800	14,480	14,480	-5,760
Tax		2,100	-2,100	2,380	5,068	5,068	-2,016
Cash Flow	-100,000	23,900	28,100	23,620	20,932	20,932	2,016

NPV (at 8%) = -$4,127

b. $IRR_A = 9.43\%$
$IRR_B = 6.39\%$

$$\text{Effective tax rate} = 1 - \frac{0.0639}{0.0943} = 0.322 = 32.2\%$$

8. Assume the following:
a. The firm will manufacture widgets for at least 10 years.
b. There will be no inflation or technological change.
c. The 15 percent cost of capital is appropriate for all cash flows and is a real, after-tax rate of return.
d. All operating cash flows occur at the end of the year.

Note: Since purchasing the lids can be considered a one-year 'project,' the two projects have a common chain life of 10 years.

Compute NPV for each project as follows:

$$\text{NPV(purchase)} = -\sum_{t=1}^{10} \frac{(2 \times 200{,}000) \times (1 - 0.35)}{1.15^t} = -\$1{,}304{,}880$$

$$\text{NPV(make)} = -150{,}000 - 30{,}000 - \sum_{t=1}^{10} \frac{(1.50 \times 200{,}000) \times (1 - 0.35)}{1.15^t}$$

$$+ [0.35 \times 150{,}000] \times [\frac{0.1429}{1.15^1} + \frac{0.2449}{1.15^2} + \frac{0.1749}{1.15^3} + \frac{0.1249}{1.15^4} + \frac{0.0893}{1.15^5} +$$

$$\frac{0.0893}{1.15^6} + \frac{0.0893}{1.15^7} + \frac{0.0445}{1.15^8}] + \frac{30{,}000}{1.15^{10}} = -\$1{,}118{,}328$$

Thus, the widget manufacturer should make the lids.

9. a. *Capital Expenditure*

1. If the spare warehouse space will be used now or in the future, then the project should be credited with these benefits.
2. Charge opportunity cost of the land and building.
3. The salvage value at the end of the project should be included.

Research and Development

1. Research and development is a sunk cost.

Working Capital

1. Will additional inventories be required as volume increases?
2. Recovery of inventories at the end of the project should be included.
3. Is additional working capital required due to changes in receivables, payables, etc.?

Revenues

1. Revenue forecasts assume prices (and quantities) will be unaffected by competition, a common and critical mistake.

Operating Costs

1. Are percentage labor costs unaffected by increase in volume in the early years?
2. Wages generally increase faster than inflation. Does Reliable expect continuing productivity gains to offset this?

Overhead

1. Is "overhead" truly incremental?

Depreciation

1. Depreciation is not a cash flow, but the ACRS deprecation does affect tax payments.
2. ACRS depreciation is fixed in nominal terms. The real value of the depreciation tax shield is reduced by inflation.

Interest

1. It is bad practice to deduct interest charges (or other payments to security holders). Value the project as if it is all equity-financed.

Taxes

1. See comments on ACRS depreciation and interest.
2. If Reliable has profits on its remaining business, the tax loss should not be carried forward.

Net Cash Flow

1. See comments on ACRS depreciation and interest.
2. Discount rate should reflect project characteristics; in general, it is *not* equivalent to the company's borrowing rate.

b.
1. Potential use of warehouse.
2 Opportunity cost of building.
3. Other working capital items.
4. More realistic forecasts of revenues and costs.
5. Company's ability to use tax shields.
6. Opportunity cost of capital.

c. The table on the next page shows a sample NPV analysis for the project. The analysis is based on the following assumptions:

1. *Inflation*: 10 percent per year.
2. *Capital Expenditure:* $8 million for machinery; $5 million for market value of factory; $2.4 million for warehouse extension (we assume that it is eventually needed or that electric motor project and surplus capacity cannot be used in the interim). We assume salvage value of $3 million in real terms less tax at 35 percent.
3. *Working Capital*: We assume inventory in year t is 9.1 percent of expected revenues in year (t + 1). We also assume that receivables *less* payables, in year t, is equal to 5 percent of revenues in year t.
4. *Depreciation Tax Shield*: Based on 35 percent tax rate and 5-year ACRS class. This is a simplifying and probably inaccurate assumption; i.e., not all the investment would fall in the 5-year class. Also, the factory is currently owned by the company and may already be partially depreciated. We assume the company can use tax shields as they arise.
5. *Revenues*: Sales of 2,000 motors in 2000, 4,000 motors in 2001, and 10,000 motors thereafter. The unit price is assumed to decline from $4,000 (real) to $2,850 when competition enters in 2002. The latter is the figure at which new entrants' investment in the project would have NPV = 0.
6. *Operating Costs*: We assume direct labor costs decline progressively from $2,500 per unit in 2000, to $2,250 in 2001 and to $2,000 in real terms in 2002 and after.
7. *Other Costs*: We assume true incremental costs are 10 percent of revenue.
8. *Tax:* 35 percent of revenue less costs.
9. *Opportunity Cost of Capital*: Assumed 20 percent.

Practice Question 9

	1999	2000	2001	2002	2003	2004
Capital Expenditure	(15,400)					
Changes in Working Capital						
Inventories	(801)	(961)	(1,690)	(345)	(380)	(418)
Receivables – Payables		(440)	(528)	(929)	(190)	(209)
Depreciation Tax Shield		1,078	1,725	1,035	621	621
Revenues		8,800	19,360	37,934	41,727	45,900
Operating Costs		(5,500)	(10,890)	(26,620)	(29,282)	(32,210)
Other costs		(880)	(1,936)	(3,793)	(4,173)	(4,590)
Tax		(847)	(2,287)	(2,632)	(2,895)	(3,185)
Net Cash Flow	(16,201)	1,250	3,754	4,650	5,428	5,909

	2005	2006	2007	2008	2009	2010
Capital Expenditure					5,058	
Changes in Working Capital						
Inventories	(459)	(505)	(556)	(612)	6,727	
Receivables – Payables	(229)	(252)	(278)	(306)	(336)	3,696
Depreciation Tax Shield	310					
Revenues	50,489	55,538	61,092	67,202	73,922	
Operating Costs	(35,431)	(38,974)	(42,872)	(47,159)	(51,875)	
Other costs	(5,049)	(5,554)	(6,109)	(6,720)	(7,392)	
Tax	(3,503)	(3,854)	(4,239)	(4,663)	(5,129)	
Net Cash Flow	6,128	6,399	7,038	7,742	20,975	3,696

NPV (at 20%) = $5,991

10. The table below shows the real cash flows. The NPV is computed using the real rate, which is computed as follows:

$$(1 + r_{nominal}) = (1 + r_{real}) \times (1 + \text{inflation rate})$$
$$1.09 = (1 + r_{real}) \times (1.03)$$
$$r_{real} = 0.0583 = 5.83\%$$

	t = 0	t = 1	t = 2	t = 3	t = 4	t = 5	t = 6	t = 7	t = 8
Investment	-35,000.0								15,000.0
Savings		7,410.0	7,410.0	7,410.0	7,410.0	7,410.0	7,410.0	7,410.0	7,410.0
Insurance		-1,200.0	-1,200.0	-1,200.0	-1,200.0	-1,200.0	-1,200.0	-1,200.0	-1,200.0
Fuel		-526.5	-526.5	-526.5	-526.5	-526.5	-526.5	-526.5	-526.5
Net Cash Flow	-35,000.0	5,683.5	5,683.5	5,683.5	5,683.5	5,683.5	5,683.5	5,683.5	20,683.5
NPV (at 5.83%) =	$10,064.9								

11.

	t = 0	t = 1	t = 2	t = 3	t = 4	t = 5	t = 6	t = 7	t = 8
Sales		4,200.0	4,410.0	4,630.5	4,862.0	5,105.1	5,360.4	5,628.4	5,909.8
Manufacturing Costs		3,780.0	3,969.0	4,167.5	4,375.8	4,594.6	4,824.3	5,065.6	5,318.8
Depreciation		120.0	120.0	120.0	120.0	120.0	120.0	120.0	120.0
Rent		100.0	104.0	108.2	112.5	117.0	121.7	126.5	131.6
Earnings Before Taxes		200.0	217.0	234.9	253.7	273.5	294.4	316.3	339.4
Taxes		70.0	76.0	82.2	88.8	95.7	103.0	110.7	118.8
Cash Flow									
Operations		180.0	240.1	250.6	261.8	273.5	285.84	298.8	1,247.4
Working Capital	350.0	420.0	441.0	463.1	486.2	510.5	536.0	562.8	0.0
Increase in W.C.	350.0	70.0	21.0	22.1	23.2	24.3	25.5	26.8	-562.8
Rent (after tax)		65.0	67.6	70.3	73.1	76.0	79.1	82.2	85.5
Initial Investment	1,200.0								
Sale of Plant									400.0
Tax on Sale									56.0
Net Cash Flow	-1,550.0	180.0	240.1	250.6	261.8	273.5	285.8	298.8	1,247.4
NPV(at 12%) =	$85.8								

12. Note: There are several different calculations of pre-tax profit and taxes given in Section 6.2, based on different assumptions; the solution below is based on Table 6.6 in the text.

See the table on the next page. With full usage of the tax losses, the NPV of the tax payments is $4,779. With tax losses carried forward, the NPV of the tax payments is $5,741. Thus, with tax losses carried forward, the project's NPV decreases by $962, so that the value to the company of using the deductions immediately is $962.

Tax Cash Flows	t = 0	t = 1	t = 2	t = 3	t = 4	t = 5	t = 6	t = 7
Pretax Profit	-4,000	-4,514	748	9,807	16,940	11,579	5,539	1,949
Full usage of tax losses Immediately (Table 6.6)	-1,400	-1,580	262	3,432	5,929	4,053	1,939	682
NPV at 20%	$4,779							
Tax loss carry-forward	0	0	0	714	5,929	4,053	1,939	682
NPV (at 20%) =	$5,741							

13. (Note: Row numbers in the table below refer to the rows in Table 6.8.)

	t = 0	t = 1	t = 2	t = 3	t = 4	t = 5	t = 6	t = 7	t = 8
1. Capital investment	83.5								-12.0
4. Working capital	2.3	4.4	7.6	6.9	5.3	3.2	2.5	0.0	0.0
Change in W.C.		2.1	3.2	-0.7	-1.6	-2.1	-0.7	-2.5	0.0
9. Depreciation		11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
12. Profit after tax		-5.8	3.9	25.0	21.8	14.3	4.7	1.5	7.2
Cash Flow	-85.8	4.0	12.6	37.6	35.3	28.3	17.3	15.9	7.2
NPV (at 11.0%) =	$15.6								

14. In order to solve this problem, we calculate the equivalent annual cost for each of the two alternatives. (All cash flows are in thousands.)

Alternative 1 – Sell the new machine: If we sell the new machine, we receive the cash flow from the sale, pay taxes on the gain, and pay the costs associated with keeping the old machine. The present value of this alternative is:

$$PV_1 = 50 - [0.35(50 - 0)] - 20 - \frac{30}{1.12} - \frac{30}{1.12^2} - \frac{30}{1.12^3} - \frac{30}{1.12^4} - \frac{30}{1.12^5}$$

$$+ \frac{5}{1.12^5} - \frac{0.35\,(5 - 0)}{1.12^5} = -\$93.80$$

The equivalent annual cost for the five-year period is computed as follows:

$PV_1 = EAC_1 \times$ [annuity factor, 5 time periods, 12%]

$-93.80 = EAC_1 \times [3.605]$

$EAC_1 = -26.02$, or an equivalent annual cost of $26,020

Alternative 2 – Sell the old machine: If we sell the old machine, we receive the cash flow from the sale, pay taxes on the gain, and pay the costs associated with keeping the new machine. The present value of this alternative is:

$$PV_2 = 25 - [0.35(25-0)] - \frac{20}{1.12} - \frac{20}{1.12^2} - \frac{20}{1.12^3} - \frac{20}{1.12^4} - \frac{20}{1.12^5}$$

$$- \frac{20}{1.12^5} - \frac{30}{1.12^6} - \frac{30}{1.12^7} - \frac{30}{1.12^8} - \frac{30}{1.12^9} - \frac{30}{1.12^{10}}$$

$$+ \frac{5}{1.12^{10}} - \frac{0.35(5-0)}{1.12^{10}} = -\$127.51$$

The equivalent annual cost for the ten-year period is computed as follows:

$PV_2 = EAC_2 \times$ [annuity factor, 10 time periods, 12%]

$-127.51 = EAC_2 \times [5.650]$

$EAC_2 = -22.57$, or an equivalent annual cost of $22,570

Thus, the least expensive alternative is to sell the old machine because this alternative has the lowest equivalent annual cost.

One key assumption underlying this result is that, whenever the machines have to be replaced, the replacement will be a machine that is as efficient to operate as the new machine being replaced.

15. The current copiers have net cost cash flows as follows:

Year	Before-Tax Cash Flow	After-Tax Cash Flow	Net Cash Flow
1	-2,000	(-2,000 × .65) + (.35 × .0893 × 20,000)	-674.9
2	-2,000	(-2,000 × .65) + (.35 × .0893 × 20,000)	-674.9
3	-8,000	(-8,000 × .65) + (.35 × .0893 × 20,000)	-4,574.9
4	-8,000	(-8,000 × .65) + (.35 × .0445 × 20,000)	-4,888.5
5	-8,000	(-8,000 × .65)	-5,200.0
6	-8,000	(-8,000 × .65)	-5,200.0

These cash flows have a present value, discounted at 7 percent, of -$15,857. Using the annuity factor for 6 time periods at 7 percent (4.767), we find an equivalent annual cost of $3,326. Therefore, the copiers should be replaced only when the equivalent annual cost of the replacements is less than $3,326.

When purchased, the new copiers will have net cost cash flows as follows:

Year	Before-Tax Cash Flow	After-Tax Cash Flow	Net Cash Flow
0	-25,000	-25,000	-25,000.0
1	-1,000	(-1,000 × .65) + (.35 × .1429 × 25,000)	600.0
2	-1,000	(-1,000 × .65) + (.35 × .2449 × 25,000)	1,493.0
3	-1,000	(-1,000 × .65) + (.35 × .1749 × 25,000)	880.0
4	-1,000	(-1,000 × .65) + (.35 × .1249 × 25,000)	443.0
5	-1,000	(-1,000 × .65) + (.35 × .0893 × 25,000)	131.0
6	-1,000	(-1,000 × .65) + (.35 × .0893 × 25,000)	131.0
7	-1,000	(-1,000 × .65) + (.35 × .0893 × 25,000)	131.0
8	-1,000	(-1,000 × .65) + (.35 × .0445 × 25,000)	-261.0

These cash flows have a present value, discounted at 7 percent, of -$21,969. The decision to replace must also take into account the resale value of the machine, as well as the associated tax on the resulting gain (or loss). Consider three cases:

a. The book (depreciated) value of the existing copiers is now $6,248. If the existing copiers are replaced now, then the present value of the cash flows is:

$$-21{,}969 + 8{,}000 - [0.35 \times (8{,}000 - 6{,}248)] = -\$14{,}582$$

Using the annuity factor for 8 time periods at 7 percent (5.971), we find that the equivalent annual cost is $2,442.

b. Two years from now, the book (depreciated) value of the existing copiers will be $2,676. If the existing copiers are replaced two years from now, then the present value of the cash flows is:

$$(-674.9/1.07^1) + (-674.9/1.07^2) + (-21{,}969/1.07^2) +$$

$$\{3{,}500 - [0.35 \times (3{,}500 - 2{,}676)]\}/1.07^2 = -\$17{,}604$$

Using the annuity factor for 10 time periods at 7 percent (7.024), we find that the equivalent annual cost is $2,506.

c. Six years from now, both the book value and the resale value of the existing copiers will be zero. If the existing copiers are replaced six years from now, then the present value of the cash flows is:

$$-15{,}857 + (-21{,}969/1.07^6) = -\$30{,}496$$

Using the annuity factor for 14 time periods at 7 percent (8.745), we find that the equivalent annual cost is $3,487.

The copiers should be replaced immediately.

16. a.

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11
MACRS Percent	10.00%	18.00%	14.40%	11.52%	9.22%	7.37%	6.55%	6.55%	6.55%	6.55%	3.29%
MACRS Depr.	40.00	72.00	57.60	46.08	36.88	29.48	26.20	26.20	26.20	26.20	13.16
Tax Shield	15.60	28.08	22.46	17.97	14.38	11.50	10.22	10.22	10.22	10.22	5.13
Present Value (at 7%) = $114.57 million											

The equivalent annual cost of the depreciation tax shield is computed by dividing the present value of the tax shield by the annuity factor for 25 years at 7%:

Equivalent annual cost = $114.57 milliion/11.654 = $9.83 million

The equivalent annual cost of the capital investment is:

$34.3 million – $9.83 million = $24.47 million

b. The extra cost per gallon (after tax) is:

$24.47 million/900 million gallons = $0.0272 per gallon

The pre-tax charge = $0.0272/0.65 = $0.0418 per gallon

17. Since the growth in value of *both* timber and land is less than the cost of capital after year 8, it must pay to cut by that time. The table below shows that PV is maximized if you cut in year 8. Therefore, if we cut in year 8, the NPV of the offer is: $140,000 – 109,900 = $30,100

		Year 1	Year 2	Year 3	Year 4	Year 5
Future Value:	Timber	48.3	58.2	70.2	84.7	97.8
	Land	52.0	54.1	56.2	58.5	60.8
	Total	100.3	112.3	126.4	143.2	158.6
Present Value:		92.0	94.5	97.6	101.4	103.1

		Year 6	Year 7	Year 8	Year 9
Future Value:	Timber	112.9	130.3	150.5	162.7
	Land	63.3	65.8	68.4	71.2
	Total	176.2	196.1	218.9	233.9
Present Value:		105.1	107.3	109.9	107.7

18. a. $$PV_A = 40{,}000 + \frac{10{,}000}{1.06} + \frac{10{,}000}{1.06^2} + \frac{10{,}000}{1.06^3}$$

PV_A = \$66,730 (Note that this is a cost.)

$$PV_B = 50{,}000 + \frac{8{,}000}{1.06} + \frac{8{,}000}{1.06^2} + \frac{8{,}000}{1.06^3} + \frac{8{,}000}{1.06^4}$$

PV_B = \$77,721 (Note that this is a cost.)

Equivalent annual cost (EAC) is found by:

PV_A = $EAC_A \times$ [annuity factor, 6%, 3 time periods]
66,730 = $EAC_A \times 2.673$
EAC_A = \$24,964 per year rental

PV_B = $EAC_B \times$ [annuity factor, 6%, 4 time periods]
77,721 = $EAC_B \times 3.465$
EAC_B = \$22,430 per year rental

b. Annual rental is \$24,964 for Machine A and \$22,430 for Machine B. Borstal should buy Machine B.

c. The payments would increase by 8 percent per year. For example, for Machine A, rent for the first year would be \$24,964; rent for the second year would be (\$24,964 × 1.08) = \$26,961; etc.

19. Because the cost of a new machine now decreases by 10 percent per year, the rent on such a machine also decreases by 10 percent per year. Therefore:

$$PV_A = 40{,}000 + \frac{9{,}000}{1.06} + \frac{8{,}100}{1.06^2} + \frac{7{,}290}{1.06^3}$$

PV_A = \$61,820 (Note that this is a cost.)

$$PV_B = 50{,}000 + \frac{7{,}200}{1.06} + \frac{6{,}480}{1.06^2} + \frac{5{,}832}{1.06^3} + \frac{5{,}249}{1.06^4}$$

PV_B = \$71,613 (Note that this is a cost.)

Equivalent annual cost (EAC) is found as follows:

$$PV_A = EAC_A \times \text{ [annuity factor, 6\%, 3 time periods]}$$
$$61{,}820 = EAC_A \times 2.673$$
$$EAC_A = \$23{,}128, \text{ a reduction of 7.35\%}$$

$$PV_B = EAC_B \times \text{[annuity factor, 6\%, 4 time periods]}$$
$$71{,}613 = EAC_B \times 3.465$$
$$EAC_B = \$20{,}668, \text{ a reduction of 7.86\%}$$

20. With a 6-year life, the equivalent annual cost (at 8 percent) of a new jet is: ($1,100,000/4.623) = $237,941. If the jet is replaced at the end of year 3 rather than year 4, the company will incur an incremental cost of $237,941 in year 4. The present value of this cost is:

$$\$237{,}941/1.08^4 = \$174{,}894$$

The present value of the savings is: $\sum_{t=1}^{3} \frac{80{,}000}{1.08^t} = \$206{,}168$

The president should allow wider use of the present jet because the present value of the savings is greater than the present value of the cost.

Challenge Questions

1. a.

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Pre-Tax Flows	-14,000.0	-3,064.0	3,209.0	9,755.0	16,463.0	14,038.0	7,696.0	3,444.0
IRR = 33.3%								
Post-Tax Flows	-12,600.0	-1,630.0	2,381.0	6,205.0	10,685.0	10,136.0	6,110.0	3,444.0
IRR = 26.8%								
Effective Tax Rate = 19.5%								

b. If the depreciation rate is accelerated, this has no effect on the pretax IRR, but it increases the after-tax IRR. Therefore, the numerator decreases and the effective tax rate decreases.

If the inflation rate increases, we would expect pretax cash flows to increase at the inflation rate, while after tax cash flows increase at a slower rate. After tax cash flows increase at a slower rate than the inflation rate because depreciation expense does not increase with inflation. Therefore, the numerator of T_E becomes proportionately larger than the denominator and the effective tax rate increases.

c. $$T_E = \frac{\dfrac{C}{I(1-T_C)} - \dfrac{C(1-T_C)}{I(1-T_C)}}{\dfrac{C}{I(1-T_C)}} = \left[\frac{C}{I(1-T_C)} - \frac{C}{I}\right]\left[\frac{I(1-T_C)}{C}\right] = 1-(1-T_C) = T_C$$

Hence, if the up-front investment is deductible for tax purposes, then the effective tax rate is equal to the statutory tax rate.

2. a. With a real rate of 6 percent and an inflation rate of 5 percent, the nominal rate, r, is determined as follows:

$$(1 + r) = (1 + 0.06) \times (1 + 0.05)$$
$$r = 0.113 = 11.3\%$$

For a three-year annuity at 11.3 percent, the annuity factor (using the annuity formula from Chapter 3) is 2.4310; for a two-year annuity, the annuity factor is 1.7057.

For a three-year annuity with a present value of $28.37, the nominal annuity is: ($28.37/2.4310) = $11.67
For a two-year annuity with a present value of $21.00, the nominal annuity is: ($21.00/1.7057) = $12.31

These nominal annuities are not realistic estimates of equivalent annual costs because the appropriate rental cost (i.e., the equivalent annual cost) must take into account the effects of inflation.

b. With a real rate of 6 percent and an inflation rate of 25 percent, the nominal rate, r, is determined as follows:

$$(1 + r) = (1 + 0.06) \times (1 + 0.25)$$
$$r = 0.325 = 32.5\%$$

For a three-year annuity at 32.5 percent, the annuity factor (using the annuity formula from Chapter 3) is 1.7542; for a two-year annuity, the annuity factor is 1.3243.

For a three-year annuity with a present value of $28.37, the nominal annuity is: ($28.37/1.7542) = $16.17
For a two-year annuity with a present value of $21.00, the nominal annuity is: ($21.00/1.3243) = $15.86

With an inflation rate of 5 percent, Machine A has the lower nominal annual cost ($11.67 compared to $12.31). With inflation at 25 percent, Machine B has the lower nominal annual cost ($15.86 compared to $16.17). Thus it is clear that inflation has a significant impact on the calculation of equivalent annual cost, and hence, the warning in the text to do these calculations in real terms. The rankings change because, at the higher inflation rate, the machine with the longer life (here, Machine A) is affected more.

3. a. The cash outflow in Period 0 becomes -$10,426,000 and NPV = $5,693,684. The format is advantageous since it recognizes additional cash flows created by the tax-deductibility of depreciation. However, it may also be disadvantageous because several assumptions are made here. We are assuming:
1. The tax rate remains constant.
2. The depreciation method remains constant.
3. The company's ability to generate taxable income continues so the tax shield can be used.

b. Since the cash flows are relatively safe, they should probably be discounted at an after-tax borrowing or lending rate.

c. The discount rate for the other cash flows should not change since it must represent the opportunity cost of funds in a project of similar risk.

CHAPTER 7
Introduction to Risk, Return, and the Opportunity Cost of Capital

Answers to Practice Questions

1. Recall from Chapter 3 that:

   $(1 + r_{nominal}) = (1 + r_{real}) \times (1 + \text{inflation rate})$

   Therefore:

   $r_{real} = (1 + r_{nominal})/(1 + \text{inflation rate}) - 1$

   a. The real return on the S&P 500 in each year was:

1996:	19.2%
1997:	31.2%
1998:	26.6%
1999:	17.8%
2000:	-12.1%

   b. From the results for Part (a), the average real return was 16.5 percent.

   c. The risk premium for each year was:

1996:	17.9%
1997:	28.1%
1998:	23.7%
1999:	16.3%
2000:	-15.0%

   d. From the results for Part (c), the average risk premium was 14.2 percent.

   e. The standard deviation (σ) of the risk premium is calculated as follows:

$$\sigma^2 = \left(\frac{1}{5-1}\right) \times [(0.179 - 0.142)^2 + (0.281 - 0.142)^2 + (0.237 - 0.142)^2$$
$$+ (0.163 - 0.142)^2 + (-0.150 - 0.142)^2]$$

$$\sigma^2 = \left(\frac{1}{4}\right) \times [0.115420] = 0.02886$$

$$\sigma = 0.170 = 17.0\%$$

2. Internet exercise; answers will vary.

3. a. A long-term United States government bond is always absolutely safe in terms of the dollars received. However, the price of the bond fluctuates as interest rates change and the rate at which coupon payments can be invested also changes as interest rates change. And, of course, the payments are all in nominal dollars, so inflation risk must also be considered.

   b. It is true that stocks offer higher long-run rates of return than bonds, but it is also true that stocks have a higher standard deviation of return. So, which investment is preferable depends on the amount of risk one is willing to tolerate. This is a complicated issue and depends on numerous factors, one of which is the investment time horizon. If the investor has a short time horizon, then stocks are generally not preferred.

   c. Unfortunately, 10 years is not generally considered a sufficient amount of time for estimating average rates of return. Thus, using a 10-year average is likely to be misleading.

4. If the distribution of returns is symmetric, it makes no difference whether we look at the total spread of returns or simply the spread of unexpectedly low returns. Thus, the speaker does not have a valid point as long as the distribution of returns is symmetric.

5. The risk to Hippique shareholders depends on the market risk, or beta, of the investment in the black stallion. The information given in the problem suggests that the horse has very high unique risk, but we have no information regarding the horse's market risk. So, the best estimate is that this horse has a market risk about equal to that of other racehorses, and thus this investment is not a particularly risky one for Hippique shareholders.

6. In the context of a well-diversified portfolio, the only risk characteristic of a single security that matters is the security's contribution to the overall portfolio risk. This contribution is measured by beta. Lonesome Gulch is the safer investment for a diversified investor because its beta (+0.10) is lower than the beta of Amalgamated Copper (+0.66). For a diversified investor, the standard deviations are irrelevant.

7. a. To the extent that the investor is interested in the variation of possible future outcomes, risk is indeed variability. If returns are random, then the greater the period-by-period variability, the greater the variation of possible future outcomes. Also, the comment seems to imply that any rise to $20 or fall to $10 will inevitably be reversed; this is not true.

b. A stock's variability may be due to many uncertainties, such as unexpected changes in demand, plant manager mortality or changes in costs. However, the risks that are not measured by beta are the risks that can be diversified away by the investor so that they are not relevant for investment decisions. This is discussed more fully in later chapters of the text.

c. Given the expected return, the probability of loss increases with the standard deviation. Therefore, portfolios that minimize the standard deviation for any level of expected return also minimize the probability of loss.

d. Beta is the sensitivity of an investment's returns to market returns. In order to *estimate* beta, it is often helpful to analyze past returns. When we do this, we are indeed assuming betas do not change. If they are liable to change, we must allow for this in our estimation. But this does not affect the *idea* that some risks cannot be diversified away.

8. $x_I = 0.60$ $\sigma_I = 0.10$
$x_J = 0.40$ $\sigma_J = 0.20$

a. $\rho_{IJ} = 1$

$$\sigma_p^2 = [x_I^2\sigma_I^2 + x_J^2\sigma_J^2 + 2(x_I x_J \rho_{IJ}\sigma_I\sigma_J)]$$

$$= [(0.60)^2(0.10)^2 + (0.40)^2(0.20)^2 + 2(0.60)(0.40)(1)(0.10)(0.20)] = 0.0196$$

b. $\rho_{IJ} = 0.50$

$$\sigma_p^2 = [x_I^2\sigma_I^2 + x_J^2\sigma_J^2 + 2(x_I x_J \rho_{IJ}\sigma_I\sigma_J)]$$

$$= [(0.60)^2(0.10)^2 + (0.40)^2(0.20)^2 + 2(0.60)(0.40)(0.50)(0.10)(0.20)] = 0.0148$$

c. $\rho_{ij} = 0$

$$\sigma_p^2 = [x_I^2\sigma_I^2 + x_J^2\sigma_J^2 + 2(x_I x_J \rho_{IJ}\sigma_I\sigma_J)]$$

$$= [(0.60)^2(0.10)^2 + (0.40)^2(0.20)^2 + 2(0.60)(0.40)(0)(0.10)(0.20)] = 0.0100$$

9. a. Refer to Figure 7.10 in the text. With 100 securities, the box is 100 by 100. The variance terms are the diagonal terms, and thus there are 100 variance terms. The rest are the covariance terms. Because the box has (100 times 100) terms altogether, the number of covariance terms is:
$100^2 - 100 = 9{,}900$
Half of these terms (i.e., 4,950) are different.

b. Once again, it is easiest to think of this in terms of Figure 7.10. With 50 stocks, all with the same standard deviation (0.30), the same weight in the portfolio (0.02), and all pairs having the same correlation coefficient (0.4), the portfolio variance is:

$$\text{Variance} = 50(0.02)^2(0.30)^2 + [(50)^2 - 50](0.02)^2(0.4)(0.30)^2 = 0.0371$$
Standard deviation = 0.193 = 19.3%

c. For a completely diversified portfolio, portfolio variance equals the average covariance:

Variance = (0.30)(0.30)(0.40) = 0.036
Standard deviation = 0.190 = 19.0%

10. a. Refer to Figure 7.10 in the text. For each different portfolio, the relative weight of each share is [one divided by the number of shares (n) in the portfolio], the standard deviation of each share is 0.40, and the correlation between pairs is 0.30. Thus, for each portfolio, the diagonal terms are the same, and the off-diagonal terms are the same. There are n diagonal terms and $(n^2 – n)$ off-diagonal terms. In general, we have:

$$\text{Variance} = n(1/n)^2(0.4)^2 + (n^2 - n)(1/n)^2(0.3)(0.4)(0.4)$$

For one share: $\text{Variance} = 1(1)^2(0.4)^2 + 0 = 0.160000$

For two shares:

$$\text{Variance} = 2(0.5)^2(0.4)^2 + 2(0.5)^2(0.3)(0.4)(0.4) = 0.104000$$

The results are summarized in the second and third columns of the table on the next page.

b. (Graphs are on the next page.) The underlying market risk that can not be diversified away is the second term in the formula for variance above:

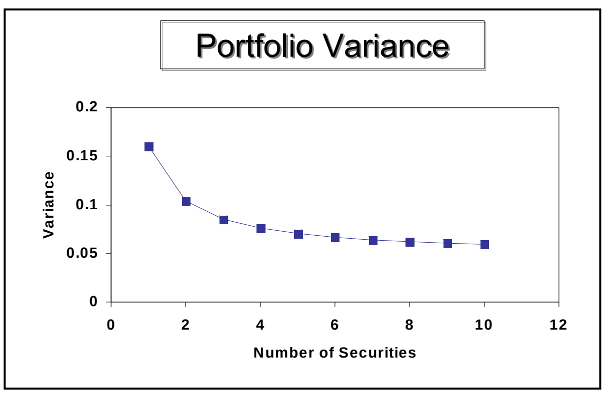
$$\text{Underlying market risk} = (n^2 - n)(1/n)^2(0.3)(0.4)(0.4)$$

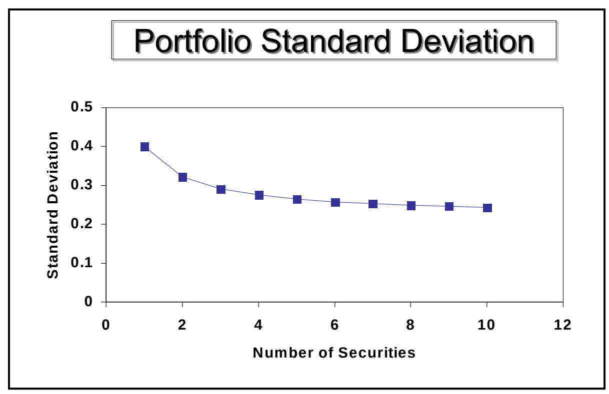
As n increases, $[(n^2 - n)(1/n)^2] = [(n-1)/n]$ becomes close to 1, so that the underlying market risk is: [(0.3)(0.4)(0.4)] = 0.048

c. This is the same as Part (a), except that all the off-diagonal terms are now equal to zero. The results are summarized in the fourth and fifth columns of the table below.

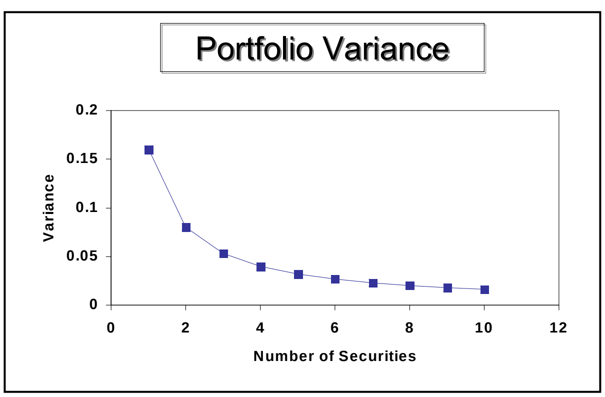
No. of Shares	(a) Variance	(a) Standard Deviation	(c) Variance	(c) Standard Deviation
1	.160000	.400	.160000	.400
2	.104000	.322	.080000	.283
3	.085333	.292	.053333	.231
4	.076000	.276	.040000	.200
5	.070400	.265	.032000	.179
6	.066667	.258	.026667	.163
7	.064000	.253	.022857	.151
8	.062000	.249	.020000	.141
9	.060444	.246	.017778	.133
10	.059200	.243	.016000	.126

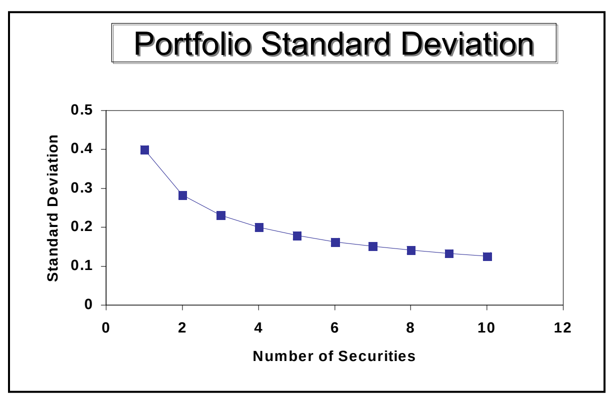
Graphs for Part (a):





Graphs for Part (c):





11. Internet exercise; answers will vary depending on time period.

12. $x_{BP} = 0.4$

$x_{KLM} = 0.4$

$x_N = 0.2$

$$\sigma_p^2 = x_{BP}^2\sigma_{BP}^2 + x_{KLM}^2\sigma_{KLM}^2 + x_N^2\sigma_N^2 +$$

$$2[(x_{BP}x_{KLM}\rho_{BP,KLM}\sigma_{BP}\sigma_{KLM} + x_{BP}x_N\rho_{BP,N}\sigma_{BP}\sigma_N + x_{KLM}x_N\rho_{KLM,N}\sigma_{KLM}\sigma_N)]$$

$$= (0.4)^2(0.248)^2 + (0.4)^2(0.396)^2 + (0.2)^2(0.197)^2 +$$

$$2[(0.4)(0.4)(0.2)(0.248)(0.396) + (0.4)(0.2)(0.23)(0.248)(0.197) +$$

$$(0.4)(0.2)(0.32)(0.396)(0.197)] = 0.048561$$

$$\sigma_p = 0.220$$

13. Internet exercise; answers will vary depending on time period.

14. "Safest" means lowest risk; in a portfolio context, this means lowest variance of return. Half of the portfolio is invested in Alcan stock, and half of the portfolio must be invested in one of the other securities listed. Thus, we calculate the portfolio variance for six different portfolios to see which is the lowest. The safest attainable portfolio is comprised of Alcan and Nestle.

Stocks	Portfolio Variance
Alcan & BP	0.057852
Alcan & Deutsche	0.082431
Alcan & KLM	0.082871
Alcan & LVMH	0.095842
Alcan & Nestle	0.041666
Alcan & Sony	0.096994

15. a. In general, we expect a stock's price to change by an amount equal to (beta × change in the market). Beta equal to -0.25 implies that, if the market rises by an extra 5 percent, the expected change is -1.25 percent. If the market declines an extra 5 percent, then the expected change is +1.25 percent.

b. “Safest” implies lowest risk. Assuming the well-diversified portfolio is invested in typical securities, the portfolio beta is approximately one. The largest reduction in beta is achieved by investing the $20,000 in a stock with a negative beta. Answer (iii) is correct.

16. a. If the standard deviation of the market portfolio’s return is 20 percent, then the variance of the market portfolio’s return is 20 squared, or 400. Further, we know that a stock’s beta is equal to: the covariance of the stock’s returns with the market divided by the variance of the market return. Thus:

$$\beta_Z = 800/400 = 2.0$$

b. For a fully diversified portfolio, the standard deviation of portfolio return is equal to the portfolio beta times the market portfolio standard deviation:

$$\text{Standard deviation} = 2 \times 20\% = 40\%$$

c. By definition, the average beta of all stocks is one.

d. The extra return we would expect is equal to (beta × the extra return on the market portfolio):

$$\text{Extra return} = 2 \times 5\% = 10\%$$

17. Diversification by corporations does not benefit shareholders because shareholders can easily diversify their portfolios by buying stock in many different companies.

Challenge Questions

1. a. In general:

$$\text{Portfolio variance} = \sigma_P^2 = x_1^2\sigma_1^2 + x_2^2\sigma_2^2 + 2x_1x_2\rho_{12}\sigma_1\sigma_2$$

Thus:

$$\sigma_P^2 = (0.5^2)(0.627^2)+(0.5^2)(0.507^2)+2(0.5)(0.5)(0.66)(0.627)(0.507)$$

$$\sigma_P^2 = 0.26745$$

$$\text{Standard deviation} = \sigma_P = 0.517 = 51.7\%$$

b. We can think of this in terms of Figure 7.10 in the text, with three securities. One of these securities, T-bills, has zero risk and, hence, zero standard deviation. Thus:

$$\sigma_P^2 = (1/3)^2(0.627^2)+(1/3)^2(0.507^2)+2(1/3)(1/3)(0.66)(0.627)(0.507)$$

$$\sigma_P^2 = 0.11887$$

$$\text{Standard deviation} = \sigma_P = 0.345 = 34.5\%$$

Another way to think of this portfolio is that it is comprised of one-third T-Bills and two-thirds a portfolio which is half Dell and half Microsoft. Because the risk of T-bills is zero, the portfolio standard deviation is two-thirds of the standard deviation computed in Part (a) above:

$$\text{Standard deviation} = (2/3)(0.517) = 0.345 = 34.5\%$$

c. With 50 percent margin, the investor invests twice as much money in the portfolio as he had to begin with. Thus, the risk is twice that found in Part (a) when the investor is investing only his own money:

$$\text{Standard deviation} = 2 \times 51.7\% = 103.4\%$$

d. With 100 stocks, the portfolio is well diversified, and hence the portfolio standard deviation depends almost entirely on the average covariance of the securities in the portfolio (measured by beta) and on the standard deviation of the market portfolio. Thus, for a portfolio made up of 100 stocks, each with beta = 2.21, the portfolio standard deviation is approximately: $(2.21 \times 15\%) = 33.15\%$. For stocks like Microsoft, it is: $(1.81 \times 15\%) = 27.15\%$.

2. For a two-security portfolio, the formula for portfolio risk is:

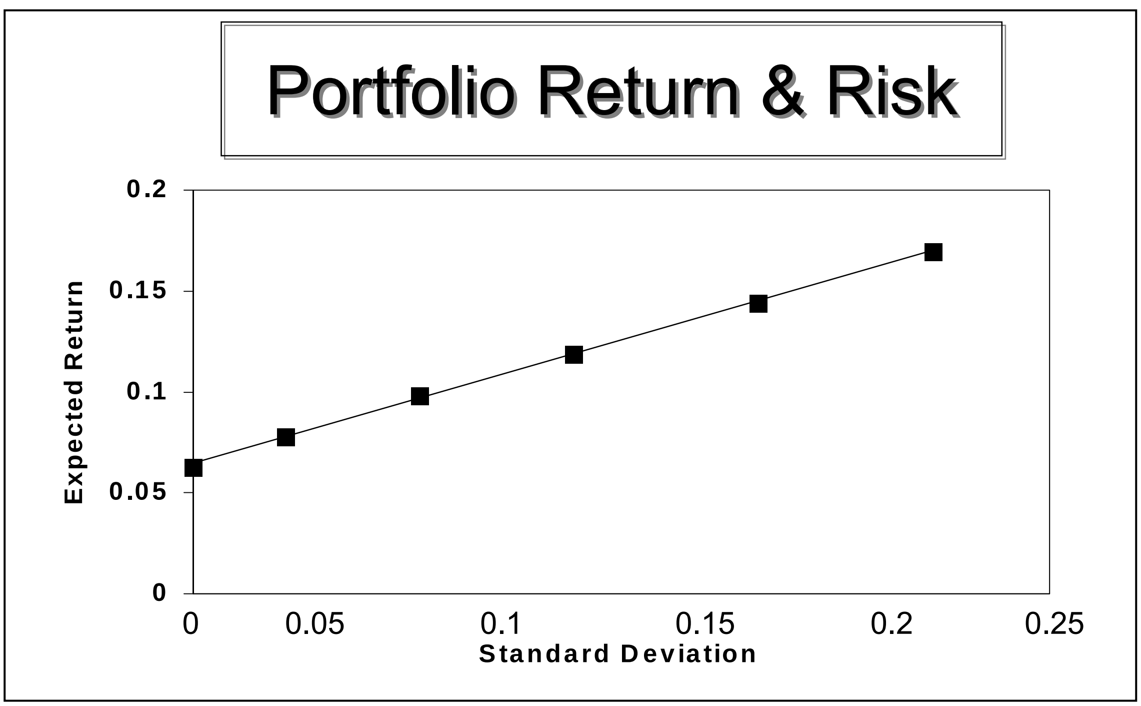
$$\text{Portfolio variance} = x_1^2\sigma_1^2 + x_2^2\sigma_2^2 + 2x_1x_{2\rho}\rho_{12}\sigma_1\sigma_2$$

If security one is Treasury bills and security two is the market portfolio, then σ_1 is zero, σ_2 is 20 percent. Therefore:

$$\text{Portfolio variance} = x_2^2\sigma_2^2 = x_2^2(0.20)^2$$
$$\text{Standard deviation} = 0.20\ x_2$$

$$\text{Portfolio expected return} = x_1\ (0.06) + x_2\ (0.06 + 0.85)$$
$$\text{Portfolio expected return} = 0.06x_1 + 0.145x_2$$

Portfolio	X_1	X_2	Exp. Return	Std. Deviation
1	1.0	0	0.060	0
2	0.8	0.2	0.077	0.040
3	0.6	0.4	0.094	0.080
4	0.4	0.6	0.111	0.120
5	0.2	0.8	0.128	0.160
6	0	1.0	0.145	0.200



3. a. From the text, we know that the standard deviation of a well-diversified portfolio of common stocks (using history as our guide) is about 20.2 percent. Hence, the variance of portfolio returns is 0.202 squared, or 0.040804 for a well-diversified portfolio.

The variance of our portfolio is given by (see Figure 7.10):

$$\begin{aligned} \text{Variance} = {} & 2[(0.2)^2(0.4)^2] + 6[(0.1)^2(0.4)^2] \\ & + 2[(0.2)(0.2)(0.3)(0.4)(0.4)] \\ & + 24[(0.1)(0.2)(0.3)(0.4)(0.4)] \\ & + 30[(0.1)(0.1)(0.3)(0.4)(0.4)] = 0.063680 \end{aligned}$$

Thus, the proportion is (0.040804/0.063680) = 0.641

b. In order to find n, the number of shares in a portfolio that has the same risk as our portfolio, with equal investments in each typical share, we must solve the following portfolio variance equation for n:

$$n(1/n)^2(0.4)^2 + (n^2 - n)(1/n)^2(0.3)(0.4)(0.4) = 0.063680$$

Solving this equation, we find that n = 7.14 shares.

The first measure provides an estimate of the amount of risk that can still be diversified away. With a fully diversified portfolio, the ratio is approximately one. Unfortunately, the use of average historical data does not necessarily reflect current or expected conditions.

The second measure indicates the potential reduction in the number of securities in a portfolio while retaining the current portfolio's risk. However, this measure does not indicate the amount of risk that can yet be diversified away.

4. Internet exercise; answers will vary.

5. Internet exercise; answers will vary.

CHAPTER 8
Risk and Return

Answers to Practice Questions

1. a. False – investors demand higher expected rates of return on stocks with more nondiversifiable risk.
   b. False – a security with a beta of zero will offer the risk-free rate of return.
   c. False – the beta will be: $(1/3)\times(0) + (2/3)\times(1) = 0.67$
   d. True.
   e. True.

2. In the following solution, security one is Coca-Cola and security two is Reebok. Then:

   $r_1 = 0.10 \qquad \sigma_1 = 0.315$

   $r_2 = 0.20 \qquad \sigma_2 = 0.585$

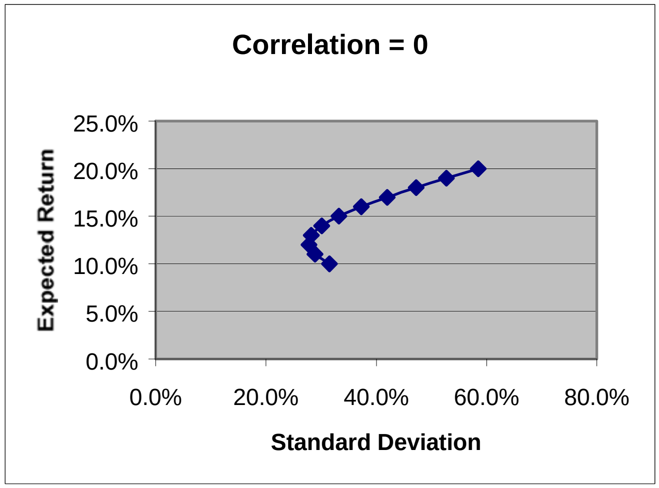
   Further, we know that for a two-security portfolio:

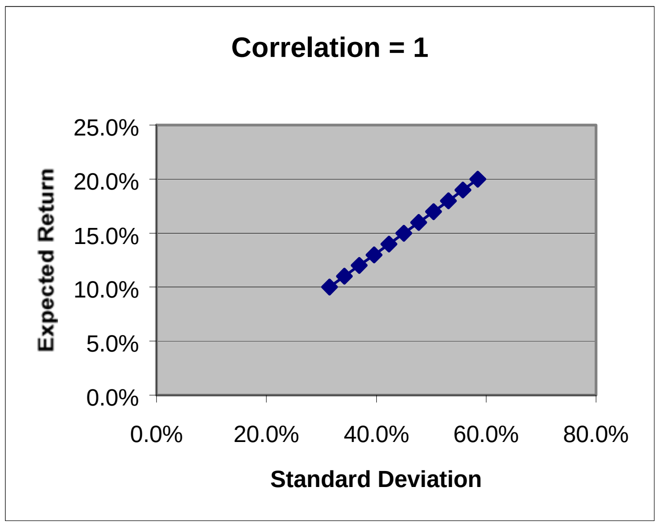
   $r_p = x_1r_1 + x_2r_2$

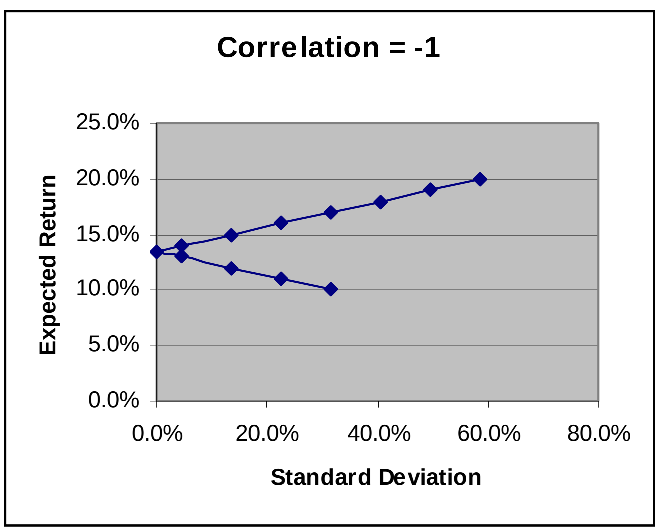
   $\sigma_p^2 = x_1^2\sigma_1^2 + 2x_1x_2\sigma_1\sigma_2\rho_{12} + x_2^2\sigma_2^2$

   Therefore, we have the following results:

x_1	x_2	r_p	σ_{p1} when $\rho = 0$	σ_{p1} when $\rho = 1$	σ_{p1} when $\rho = -1$
1.0	0.0	0.10	0.315	0.315	0.315
0.9	0.1	0.11	0.289	0.342	0.225
0.8	0.2	0.12	0.278	0.369	0.135
0.7	0.3	0.13	0.282	0.396	0.045
0.6	0.4	0.14	0.301	0.423	0.045
0.5	0.5	0.15	0.332	0.450	0.135
0.4	0.6	0.16	0.373	0.477	0.225
0.3	0.7	0.17	0.420	0.504	0.315
0.2	0.8	0.18	0.472	0.531	0.405
0.1	0.9	0.19	0.527	0.558	0.495
0.0	0.0	0.20	0.585	0.585	0.585


Correlation = 0
Expected Return
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
0.0%
20.0%
40.0%
60.0%
80.0%
Standard Deviation


Correlation = 1
Expected Return
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
0.0%
20.0%
40.0%
60.0%
80.0%
Standard Deviation

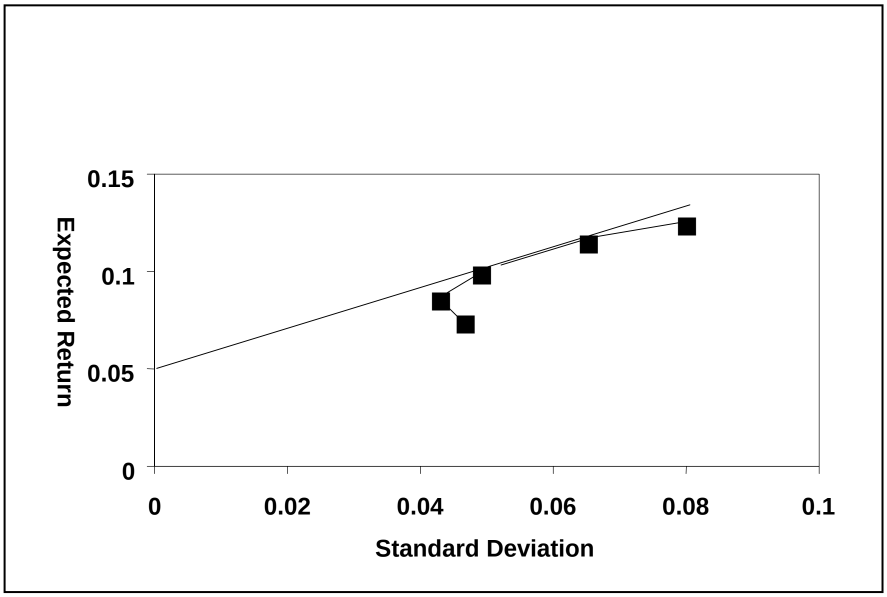

Correlation = -1
Expected Return
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
0.0%
20.0%
40.0%
60.0%
80.0%
Standard Deviation

3. a.

Portfolio	r	σ
1	10.0%	5.1%
2	9.0	4.6
3	11.0	6.4

b. See the figure below. The set of portfolios is represented by the curved line. The five points are the three portfolios from Part (a) plus the two following two portfolios: one consists of 100% invested in X and the other consists of 100% invested in Y.

c. See the figure below. The best opportunities lie along the straight line. From the diagram, the optimal portfolio of risky assets is portfolio 1, and so Mr. Harrywitz should invest 50 percent in X and 50 percent in Y.-+



4. a. Expected return = $(0.6 \times 15) + (0.4 \times 20) = 17\%$

Variance = $(0.6)^2 \times (20)^2 + (0.4)^2 \times (22)^2 + 2(0.6)(0.4)(0.5)(20)(22) = 327$

Standard deviation = $(327)^{(1/2)} = 18.1\%$

b. Correlation coefficient = 0 $\Rightarrow$ Standard deviation = 14.9%

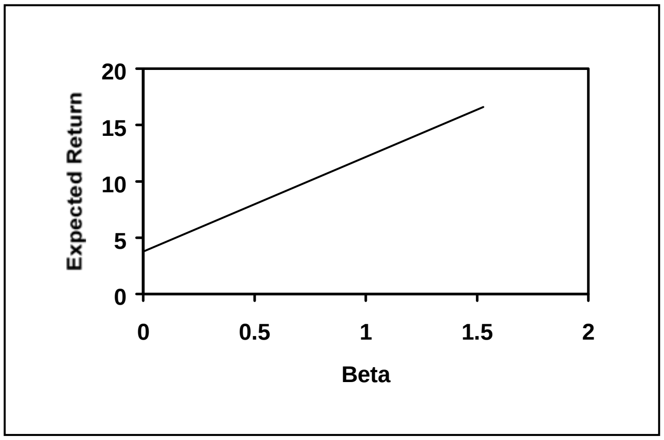
Correlation coefficient = -0.5 $\Rightarrow$ Standard deviation = 10.8%

c. His portfolio is better. The portfolio has a higher expected return *and* a lower standard deviation.

5. Internet exercise; answers will vary depending on time period.

6. Internet exercise; answers will vary depending on time period.

7. a.



b. Market risk premium = $r_m - r_f$ = 0.12 - 0.04 = 0.08 = 8.0%

c. Use the security market line:

$$r = r_f + \beta(r_m - r_f)$$

$$r = 0.04 + [1.5\times(0.12 - 0.04)] = 0.16 = 16.0\%$$

d. For any investment, we can find the opportunity cost of capital using the security market line. With β = 0.8, the opportunity cost of capital is:

$$r = r_f + \beta(r_m - r_f)$$

$$r = 0.04 + [0.8\times(0.12 - 0.04)] = 0.104 = 10.4\%$$

The opportunity cost of capital is 10.4 percent and the investment is expected to earn 9.8 percent. Therefore, the investment has a negative NPV.

e. Again, we use the security market line:

$$r = r_f + \beta(r_m - r_f)$$

$$0.112 = 0.04 + \beta(0.12 - 0.04) \Rightarrow \beta = 0.9$$

8. Internet exercise; answers will vary depending on time period.

9. Internet exercise; answers will vary.

10. a. Percival's current portfolio provides an expected return of 9 percent with an annual standard deviation of 10 percent. First we find the portfolio weights for a combination of Treasury bills (security 1: standard deviation = 0 percent) and the index fund (security 2: standard deviation = 16 percent) such that portfolio standard deviation is 10 percent. In general, for a two security portfolio:

$$\sigma_P^2 = x_1^2\sigma_1^2 + 2x_1x_2\sigma_1\sigma_2\rho_{12} + x_2^2\sigma_2^2$$

$$(0.10)^2 = 0 + 0 + x_2^2(0.16)^2$$

$$x_2 = 0.625 \Rightarrow x_1 = 0.375$$

Further:

$$r_p = x_1r_1 + x_2r_2$$

$$r_p = (0.375 \times 0.06) + (0.625 \times 0.14) = 0.11 = 11.0\%$$

Therefore, he can improve his expected rate of return without changing the risk of his portfolio.

b. With equal amounts in the corporate bond portfolio (security 1) and the index fund (security 2), the expected return is:

$$r_p = x_1r_1 + x_2r_2$$

$$r_p = (0.5 \times 0.09) + (0.5 \times 0.14) = 0.115 = 11.5\%$$

$$\sigma_P^2 = x_1^2\sigma_1^2 + 2x_1x_2\sigma_1\sigma_2\rho_{12} + x_2^2\sigma_2^2$$

$$\sigma_P^2 = (0.5)^2(0.10)^2 + 2(0.5)(0.5)(0.10)(0.16)(0.10) + (0.5)^2(0.16)^2$$

$$\sigma_P^2 = 0.0097$$

$$\sigma_P = 0.985 = 9.85\%$$

Therefore, he can do even better by investing equal amounts in the corporate bond portfolio and the index fund. His expected return increases to 11.5% and the standard deviation of his portfolio decreases to 9.85%.

11. No. Every stock has unique risk in addition to market risk. The unique risk reflects uncertain events that are unrelated to the return on the market portfolio. The Capital Asset Pricing Model does not predict these events. If the events are favorable, the stock will do better than the model predicts. If the events are unfavorable, the stock will do worse.

12. a. True
    b. True
    c. True

13. a. True. By definition, the factors represent macro-economic risks that cannot be eliminated by diversification.

b. False. The APT does not specify the factors.

c. True. Investors will not take on nondiversifiable risk unless it entails a positive risk premium.

d. True. Different researchers have proposed and empirically investigated different factors, but there is no widely accepted theory as to what these factors should be.

e. True. To be useful, we must be able to estimate the relevant parameters. If this is impossible, for whatever reason, the model itself will be of theoretical interest only.

14. For Stock P $\Rightarrow r = (1.0)\times(6.4\%) + (-2.0)\times(-0.6\%) + (-0.2)\times(5.1\%) = 6.58\%$

For Stock P^2 $\Rightarrow r = (1.2)\times(6.4\%) + (0)\times(-0.6\%) + (0.3)\times(5.1\%) = 9.21\%$

For Stock P^3 $\Rightarrow r = (0.3)\times(6.4\%) + (0.5)\times(-0.6\%) + (1.0)\times(5.1\%) = 6.72\%$

15. a. Factor risk exposures:

b_1(Market) = $(1/3)\times(1.0) + (1/3)\times(1.2) + (1/3)\times(0.3) = 0.83$

b_2(Interest rate) = $(1/3)\times(-2.0) +(1/3)\times(0) + (1/3)\times(0.5) = -0.50$

b_3(Yield spread) = $(1/3)\times(-0.2) + (1/3)\times(0.3) + (1/3)\times(1.0) = 0.37$

b. $r_P = (0.83)\times(6.4\%) + (-0.50)\times(-0.6\%) + (0.37)\times(5.1\%) = 7.5\%$

16. $r_{CC} = 3.5\% + (0.82 \times 8.8\%) + (-0.29 \times 3.1\%) + (0.24 \times 4.4\%) = 10.87\%$

$r_{XON} = 3.5\% + (0.50 \times 8.8\%) + (0.04 \times 3.1\%) + (0.27 \times 4.4\%) = 9.21\%$

$r_P = 3.5\% + (0.66 \times 8.8\%) + (-0.56 \times 3.1\%) + (-0.07 \times 4.4\%) = 7.26\%$

$r_R = 3.5\% + (1.17 \times 8.8\%) + (0.73 \times 3.1\%) + (1.14 \times 4.4\%) = 21.08\%$

Challenge Questions

1. [NOTE: In the first printing of the seventh edition of the text, footnote 4 states that, for the minimum risk portfolio, the investment in Reebok is 21.4%. This figure is incorrect. The correct figure is 16.96%, as shown below.]

   In general, for a two-security portfolio:

   $$\sigma_p^2 = x_1^2\sigma_1^2 + 2x_1x_2\sigma_1\sigma_2\rho_{12} + x_2^2\sigma_2^2$$

   and:

   $$x_1 + x_2 = 1$$

   Substituting for x_2 in terms of x_1 and rearranging:

   $$\sigma_p^2 = \sigma_1^2x_1^2 + 2\sigma_1\sigma_2\rho_{12}(x_1 - x_1^2) + \sigma_2^2(1 - x_1)^2$$

   Taking the derivative of σ_p^2 with respect to x_1, setting the derivative equal to zero and rearranging:

   $$x_1(\sigma_1^2 - 2\sigma_1\sigma_2\rho_{12} + \sigma_2^2) + (\sigma_1\sigma_2\rho_{12} - \sigma_2^2) = 0$$

   Let Coca-Cola be security one ($\sigma_1 = 0.315$) and Reebok be security two ($\sigma_2 = 0.585$). Substituting these numbers, along with $\rho_{12} = 0.2$, we have:

   $$x_1 = 0.8304$$

   Therefore:

   $$x_2 = 0.1696$$

2. a. The ratio (expected risk premium/standard deviation) for each of the four portfolios is as follows:

Portfolio A:	(34.6 – 10.0)/110.6 = 0.222
Portfolio B:	(21.6 – 10.0)/30.8 = 0.377
Portfolio C:	(19.0 – 10.0)/23.7 = 0.380
Portfolio D:	(13.4 – 10.0)/14.6 = 0.233

   Therefore, an investor should hold Portfolio C.

b. The beta for Amazon relative to Portfolio C is equal to the ratio of the risk premium of Amazon to the risk premium of the portfolio times the beta of the portfolio:

$$[(34.6\% - 10.0\%)/(19\% - 10\%)] \times 1.0 = 2.733$$

Similarly, the betas for the remainder of the holdings are as follows:

$\beta_{Amazon} = 2.733$
$\beta_{Boeing} = 0.333$
$\beta_{Dell} = 1.800$
$\beta_{EX\text{-}M} = 0.200$
$\beta_{GE} = 0.889$
$\beta_{McD} = 0.444$
$\beta_{Pfizer} = 0.533$
$\beta_{Reebok} = 1.111$

c. If the interest rate is 5%, then Portfolio C remains the optimal portfolio, as indicated by the following calculations:

Portfolio A: (34.6 – 5.0)/110.6 = 0.268

Portfolio B: (21.6 – 5.0)/30.8 = 0.539

Portfolio C: (19.0 – 5.0)/23.7 = 0.591

Portfolio D: (13.4 – 5.0)/14.6 = 0.575

The betas for the holdings in Portfolio C become:

$\beta_{Amazon} = 2.114$
$\beta_{Boeing} = 0.571$
$\beta_{Dell} = 1.514$
$\beta_{EX\text{-}M} = 0.486$
$\beta_{GE} = 0.929$
$\beta_{McD} = 0.643$
$\beta_{Pfizer} = 0.700$
$\beta_{Reebok} = 1.071$

3 Whether the APT can be used to make money is a question related to competition in the financial markets. Given sufficient competition, no widely-known model will provide an advantage (i.e., enable someone to make a return above that expected, given the level of risk undertaken). So, whether an economic model enables one to make money is not relevant to the validity of that model. To put this somewhat differently, the validity of an economic model hinges on whether the model enables us to better identify and understand relationships among key parameters, not whether the model can be used to make money.

4. Let r_x be the risk premium on investment X, let x_x be the portfolio weight of X (and similarly for Investments Y and Z, respectively).

a. $r_x = (1.75)\times(0.04) + (0.25)\times(0.08) = 0.09 = 9.0\%$

$r_y = (-1.00)\times(0.04) + (2.00)\times(0.08) = 0.12 = 12.0\%$

$r_z = (2.00)\times(0.04) + (1.00)\times(0.08) = 0.16 = 16.0\%$

b. This portfolio has the following portfolio weights:

$x_x = 200/(200 + 50 - 150) = 2.0$

$x_y = 50/(200 + 50 - 150) = 0.5$

$x_z = -150/(200 + 50 - 150) = -1.5$

The portfolio's sensitivities to the factors are:

Factor 1: $(2.0)\times(1.75) + (0.5)\times(-1.00) - (1.5)\times(2.00) = 0$

Factor 2: $(2.0)\times(0.25) + (0.5)\times(2.00) - (1.5)\times(1.00) = 0$

Because the sensitivities are both zero, the expected risk premium is zero.

c. This portfolio has the following portfolio weights:

$x_x = 80/(80 + 60 - 40) = 0.8$

$x_y = 60/(80 + 60 - 40) = 0.6$

$x_z = -40/(80 + 60 - 40) = -0.4$

The sensitivities of this portfolio to the factors are:

Factor 1: $(0.8)\times(1.75) + (0.6)\times(-1.00) - (0.4)\times(2.00) = 0$

Factor 2: $(0.8)\times(0.25) + (0.6)\times(2.00) - (0.4)\times(1.00) = 1.0$

The expected risk premium for this portfolio is equal to the expected risk premium for the second factor, or 8 percent.

d. This portfolio has the following portfolio weights:

$x_x = 160/(160 + 20 - 80) = 1.6$

$x_y = 20/(160 + 20 - 80) = 0.2$

$x_z = -80/(160 + 20 - 80) = -0.8$

The sensitivities of this portfolio to the factors are:

Factor 1: $(1.6)\times(1.75) + (0.2)\times(-1.00) - (0.8)\times(2.00) = 1.0$

Factor 2: $(1.6)\times(0.25) + (0.2)\times(2.00) – (0.8)\times(1.00) = 0$

The expected risk premium for this portfolio is equal to the expected risk premium for the first factor, or 4 percent.

e. The sensitivity requirement can be expressed as:

Factor 1: $(x_x)(1.75) + (x_y)(-1.00) + (x_z)(2.00) = 0.5$

In addition, we know that:

$$x_x + x_y + x_z = 1$$

With two linear equations in three variables, there is an infinite number of solutions. Two of these are:

1. $x_x = 0$ $x_y = 0.5$ $x_z = 0.5$

2. $x_x = (6/11)$ $x_y = (5/11)$ $x_z = 0$

The risk premiums for these two funds are:

$r_1 = 0\times[(1.75 \times 0.04) + (0.25 \times 0.08)]$

$+ (0.5)\times[(-1.00 \times 0.04) + (2.00 \times 0.08)]$

$+ (0.5)\times[(2.00 \times 0.04) + (1.00 \times 0.08)] = 0.14 = 14.0\%$

$r_2 = (6/11)\times[(1.75 \times 0.04) + (0.25 \times 0.08)]$

$+(5/11)\times[(-1.00 \times 0.04) + (2.00 \times 0.08)]$

$+0 \times [(2.00 \times 0.04) + (1.00 \times 0.08)] = 0.104 = 10.4\%$

These risk premiums differ because, while each fund has a sensitivity of 0.5 to factor 1, they differ in their sensitivities to factor 2.

f. Because the sensitivities to the two factors are the same as in Part (b), one portfolio with zero sensitivity to each factor is given by:

$x_x = 2.0$ $x_y = 0.5$ $x_z = -1.5$

The risk premium for this portfolio is:

$(2.0)\times(0.08) + (0.5)\times(0.14) – (1.5)\times(0.16) = -0.01$

Because this is an example of a portfolio with zero sensitivity to each factor and a nonzero risk premium, it is clear that the Arbitrage Pricing Theory does not hold in this case.

A portfolio with a positive risk premium is:

$x_x = -2.0$ $x_y = -0.5$ $x_z = 1.5$

CHAPTER 9
Capital Budgeting and Risk

Answers to Practice Questions

1. It is true that the cost of capital depends on the risk of the project being evaluated. However, if the risk of the project is similar to the risk of the other assets of the company, then the appropriate rate of return is the company cost of capital.

2. Internet exercise; answers will vary.

3. Internet exercise; answers will vary.

4. a. Both British Petroleum and British Airways had R^2 values of 0.25, which means that, for both stocks 25% of total risk comes from movements in the market (i.e., market risk). Therefore, 75% of total risk is unique risk.

   b. The variance of British Petroleum is: $(25)^2 = 625$
   Unique variance for British Petroleum is: $(0.75 \times 625) = 468.75$

   c. The t-statistic for β_{BA} is: $(0.90/0.17) = 5.29$
   This is significant at the 1% level, so that the confidence level is 99%.

   d. $r_{BP} = r_f + \beta_{BP} \times (r_m - r_f) = 0.05 + (1.37)\times(0.12 – 0.05) = 0.1459 = 14.59\%$

   e. $r_{BP} = r_f + \beta_{BP} \times (r_m - r_f) = 0.05 + (1.37)\times(0 – 0.05) = -0.0185 = -1.85\%$

5. Internet exercise; answers will vary.

6. If we don't know a project's β, we should use our best estimate. If β's are uncertain, the required return depends on the *expected* β. If we know *nothing* about a project's risk, our best estimate of β is 1.0, but we usually have *some* information on the project that allows us to modify this prior belief and make a better estimate.

7. a. The total market value of outstanding debt is 300,000 euros. The cost of debt capital is 8 percent. For the common stock, the outstanding market value is: (50 euros × 10,000) = 500,000 euros. The cost of equity capital is 15 percent. Thus, Lorelei's weighted-average cost of capital is:

$$r_{assets} = \left(\frac{300{,}000}{300{,}000 + 500{,}000}\right) \times (0.08) + \left(\frac{500{,}000}{300{,}000 + 500{,}000}\right) \times (0.15)$$

$r_{assets} = 0.124 = 12.4\%$

b. Because business risk is unchanged, the company's weighted-average cost of capital will not change. The financial structure, however, has changed. Common stock is now worth 250,000 euros. Assuming that the market value of debt and the cost of debt capital are unchanged, we can use the same equation as in Part (a) to calculate the new equity cost of capital, r_{equity}:

$$0.124 = \left(\frac{300{,}000}{300{,}000 + 250{,}000}\right) \times (0.08) + \left(\frac{250{,}000}{300{,}000 + 250{,}000}\right) \times (\, r_{equity}\,)$$

$r_{equity} = 0.177 = 17.7\%$

8. a. $r_{BN} = r_f + \beta_{BN} \times (r_m - r_f) = 0.035 + (0.64 \times 0.08) = 0.0862 = 8.62\%$

$r_{IND} = r_f + \beta_{IND} \times (r_m - r_f) = 0.035 + (0.50 \times 0.08) = 0.075 = 7.50\%$

b. No, we can not be confident that Burlington's true beta is not the industry average. The difference between β_{BN} and β_{IND} (0.14) is less than one standard error (0.20), so we cannot reject the hypothesis that $\beta_{BN} = \beta_{IND}$.

c. Burlington's beta might be different from the industry beta for a variety of reasons. For example, Burlington's business might be more cyclical than is the case for the typical firm in the industry. Or Burlington might have more fixed operating costs, so that operating leverage is higher. Another possibility is that Burlington has more debt than is typical for the industry so that it has higher financial leverage.

d. Company cost of capital = $(D/V)(r_{debt}) + (E/V)(r_{equity})$

Company cost of capital = $(0.4 \times 0.06) + (0.6 \times 0.075) = 0.069 = 6.9\%$

9. a. With risk-free debt: $\beta_{assets} = E/V \times \beta_{equity}$
Therefore:

$$\beta_{food} = 0.7 \times 0.8 = 0.56$$
$$\beta_{elec} = 0.8 \times 1.6 = 1.28$$
$$\beta_{chem} = 0.6 \times 1.2 = 0.72$$

b. $\beta_{assets} = (0.5 \times 0.56) + (0.3 \times 1.28) + (0.2 \times 0.72) = 0.81$

Still assuming risk-free debt:

$$\beta_{assets} = (E/V) \times (\beta_{equity})$$
$$0.81 = (0.6) \times (\beta_{equity})$$
$$\beta_{equity} = 1.35$$

c. Use the Security Market Line:

$$r_{assets} = r_f + \beta_{assets} \times (r_m - r_f)$$

We have:

$$r_{food} = 0.07 + (0.56)\times(0.15 - 0.07) = 0.115 = 11.5\%$$
$$r_{elec} = 0.07 + (1.28)\times(0.15 - 0.07) = 0.172 = 17.2\%$$
$$r_{chem} = 0.07 + (0.72)\times(0.15 - 0.07) = 0.128 = 12.8\%$$

d. With risky debt:

$$\beta_{food} = (0.3 \times 0.2) + (0.7 \times 0.8) = 0.62 \Rightarrow r_{food} = 12.0\%$$
$$\beta_{elec} = (0.2 \times 0.2) + (0.8 \times 1.6) = 1.32 \Rightarrow r_{elec} = 17.6\%$$
$$\beta_{chem} = (0.4 \times 0.2) + (0.6 \times 1.2) = 0.80 \Rightarrow r_{chem} = 13.4\%$$

10.

	Ratio of σ's	Correlation	Beta
Egypt	3.11	0.5	1.56
Poland	1.93	0.5	0.97
Thailand	2.91	0.5	1.46
Venezuela	2.58	0.5	1.29

The betas increase compared to those reported in Table 9.2 because the returns for these markets are now more highly correlated with the U.S. market. Thus, the contribution to overall market risk becomes greater.

11. Foreign capital investment projects will be evaluated on the basis of the amount of market risk the project brings to the portfolio. Further, the decrease in diversifiable country bias may result in higher overall correlations.

12. The information could be helpful to a U.S. company considering international capital investment projects. By examining the beta estimates, such companies can evaluate the contribution to risk of the potential cash flows.

A German company would not find this information useful. The relevant risk depends on the beta of the country relative to the portfolio held by investors. German investors do not invest exclusively, or even primarily, in U.S. company stocks. They invest the major portion of their portfolios in German company stocks.

13. a. The threat of a coup d'état means that the *expected* cash flow is less than \$250,000. The threat could also increase the discount rate, but only if it increases market risk.

b. The expected cash flow is: $[(0.25 \times 0) + (0.75 \times 250{,}000)] = \$187{,}500$
Assuming that the cash flow is about as risky as the rest of the company's business:

$$PV = \$187{,}500/1.12 = \$167{,}411$$

14. a. Expected daily production =

$$(0.2 \times 0) + (0.8) \times [(0.4 \text{ x } 1{,}000) + (0.6 \text{ x } 5{,}000)] = 2{,}720 \text{ barrels}$$

Expected annual cash revenues = 2,720 x 365 x \$15 = \$14,892,000

b. The possibility of a dry hole is a diversifiable risk and should not affect the discount rate. This possibility should affect forecasted cash flows, however. See Part (a).

15. The opportunity cost of capital is given by:

$$r = r_f + \beta(r_m - r_f) = 0.05 + (1.2)\times(0.06) = 0.122 = 12.2\%$$

Therefore:

$$CEQ_1 = 150(1.05/1.122) = 140.37$$
$$CEQ_2 = 150(1.05/1.122)^2 = 131.37$$
$$CEQ_3 = 150(1.05/1.122)^3 = 122.94$$
$$CEQ_4 = 150(1.05/1.122)^4 = 115.05$$
$$CEQ_5 = 150(1.05/1.122)^5 = 107.67$$

a_1 = 140.37/150 = 0.9358

a_2 = 131.37/150 = 0.8758

a_3 = 122.94/150 = 0.8196

a_4 = 115.05/150 = 0.7670

a_5 = 107.67/150 = 0.7178

From this, we can see that the a_t values decline by a constant proportion each year:

a_2/a_1 = 0.8758/0.9358 = 0.9358

a_3/a_2 = 0.8196/0.8758 = 0.9358

a_4/a_3 = 0.7670/0.8196 = 0.9358

a_5/a_4 = 0.7178/0.7670 = 0.9358

16. a. Using the Security Market Line, we find the cost of capital:

$$r = 0.07 + 1.5\times(0.16 - 0.07) = 0.205 = 20.5\%$$

Therefore:

$$PV = \frac{40}{1.205} + \frac{60}{1.205^2} + \frac{50}{1.205^3} = 103.09$$

b.

$CEQ_1 = 40\times(1.07/1.205) =$ 35.52

$CEQ_2 = 60\times(1.07/1.205)^2 =$ 47.31

$CEQ_3 = 50\times(1.07)/1.205)^3 =$35.01

c.

a_1 = 35.52/40 = 0.8880

a_2 = 47.31/60 = 0.7885

a_3 = 35.01/50 = 0.7001

d. Using a constant risk-adjusted discount rate is equivalent to assuming that a_t decreases at a constant compounded rate.

17. At t = 2, there are two possible values for the project's NPV:

$$NPV_2\,(\text{if test is not successful}) = 0$$

$$NPV_2\,(\text{if test is successful}) = -5{,}000{,}000 + \frac{700{,}000}{0.12} = \$833{,}333$$

Therefore, at t = 0:

$$NPV_0 = -500{,}000 + \frac{(0.40 \times 0) + (0.60 \times 833{,}333)}{1.40^2} = -\$244{,}898$$

Challenge Questions

1. It is correct that, for a high beta project, you should discount *all* cash flows at a high rate. Thus, the higher the risk of the cash outflows, the less you should worry about them because, the higher the discount rate, the closer the present value of these cash flows is to zero. This result does make sense. It is better to have a series of payments that are high when the market is booming and low when it is slumping (i.e., a high beta) than the reverse.

   The beta of an investment is independent of the sign of the cash flows. If an investment has a high beta for anyone paying out the cash flows, it must have a high beta for anyone receiving them. If the sign of the cash flows affected the discount rate, each asset would have one value for the buyer and one for the seller, which is clearly an impossible situation.

2. a. The real issue is the degree of risk relative to the investor's portfolio. If German investors hold a stock portfolio comprised largely of German equities, then they are likely to find that U.S. pharmaceutical stocks are less highly correlated with their portfolios than they are with U.S. stocks, and will therefore have lower betas. This suggests that German investors might require a lower return for investing in U.S. pharmaceutical companies than U.S. investors require. That does not necessarily imply that they should move their R&D and production facilities to the U.S. however. First, there might be extra costs involved in managing the business in a foreign country. Also, R&D that simply serves a German parent company may be more highly correlated with the German market.

   b. The answer here depends on the reason that German investors keep much of their money at home. If there are high costs for shareholders to invest overseas, then the German company may well provide its shareholders with a service by providing them with cheap international diversification.

   c. Not necessarily. The German company needs to be remunerated only for the risk it is taking relative to its German portfolio. If the German company holds a portfolio comprised primarily of U.S. holdings, then 13% is the appropriate rate.

3. a. Since the risk of a dry hole is unlikely to be market-related, we can use the same discount rate as for producing wells. Thus, using the Security Market Line:

$$r_{nominal} = 0.06 + (0.9)\times(.08) = 0.132 = 13.2\%$$

We know that:

$$(1 + r_{nominal}) = (1 + r_{real}) \times (1 + r_{inflation})$$

Therefore:

$$r_{real} = \frac{1.132}{1.04} - 1 = 0.0885 = 8.85\%$$

b.

$$NPV_1 = -10\,\text{million} + \sum_{t=1}^{10} \frac{3\text{million}}{1.2885^t} = -10\,\text{million} + [(3\text{million})\times(3.1914)]$$

$$NPV_1 = -\$425{,}800$$

$$NPV_2 = -10\,\text{million} + \sum_{t=1}^{15} \frac{2\text{million}}{1.2885^t} = -10\text{million} + [(2\text{million})\times(3.3888)]$$

$$NPV_2 = -\$3{,}222{,}300$$

d. Expected income from Well 1: [(0.2 × 0) + (0.8 × 3 million)] = $2.4 million

Expected income from Well 2: [(0.2 × 0) + (0.8 × 2 million)] = $1.6 million

Discounting at 8.85 percent gives.

$$NPV_1 = -10\,\text{million} + \sum_{t=1}^{10} \frac{2.4\text{million}}{1.0885^t} = -10\,\text{million} + [(2.4\text{million})\times(6.4602)]$$

$$NPV_1 = \$5{,}504{,}600$$

$$NPV_2 = -10\,\text{million} + \sum_{t=1}^{15} \frac{1.6\text{million}}{1.0885^t} = -10\text{million} + [(1.6\text{million})\times(8.1326)]$$

$$NPV_2 = \$3{,}012{,}100$$

e. For Well 1, one can certainly find a discount rate (and hence a “fudge factor”) that, when applied to cash flows of $3 million per year for 10 years, will yield the correct NPV of $5,504,600. Similarly, for Well 2, one can find the appropriate discount rate. However, these two “fudge factors” will be different. Specifically, Well 2 will have a smaller “fudge factor” because its cash flows are more distant. With more distant cash flows, a smaller addition to the discount rate has a larger impact on present value.

4. Internet exercise; answers will vary.

CHAPTER 10
A Project is Not a Black Box

Answers to Practice Questions

1.

	Year 0	Years 1-10
Investment	¥15 B	
1. Revenue		¥44.00 B
2. Variable Cost		39.60 B
3. Fixed Cost		2.00 B
4. Depreciation		1.50 B
5. Pre-tax Profit		¥0.90 B
6. Tax @ 50%		0.45 B
7. Net Operating Profit		¥0.45 B
8. Operating Cash Flow		¥1.95 B

$$NPV = -¥15B + \sum_{t=1}^{10} \frac{¥1.95B}{1.10^t} = -¥3.02B$$

2. Following the calculations in Section 10.1 of the text, we find:

	NPV		
	Pessimistic	Expected	Optimistic
Market Size	-1.2	3.4	8.0
Market Share	-10.4	3.4	17.3
Unit Price	-19.6	3.4	11.1
Unit Variable Cost	-11.9	3.4	11.1
Fixed Cost	-2.7	3.4	9.6

The principal uncertainties appear to be market share, unit price, and unit variable cost.

3. a.

	Year 0	Years 1-10
Investment	¥30 B	
1. Revenue		¥37.5 B
2. Variable Cost		26.0
3. Fixed Cost		3.0
4. Depreciation		3.0
5. Pre-tax Profit (1-2-3-4)		¥5.5
6. Tax		2.75
7. Net Operating Profit (5-6)		¥2.75
8. Operating Cash Flow (4+7)		5.75
Net cash flow	- ¥30 B	+ ¥5.33 B

b. (See chart on next page.)

Unit Sales (000's)	Inflows: Revenues Yrs 1-10	Outflows: Investment Yr 0	V. Costs Yr 1-10	F. Cost Yr 1-10	Taxes Yr 1-10	PV Inflows	PV Outflows	NPV
0	0.00	30.00	0.00	3.00	-3.00	0.0	-30.0	-30.0
100	37.50	30.00	26.00	3.00	2.75	230.4	-225.1	5.3
200	75.00	60.00	52.00	3.00	7.00	460.8	-441.0	19.8

Note that the break-even point can be found algebraically as follows:

$$\text{NPV} = \text{-Investment} + [\text{PV} \times (t \times \text{Depreciation})] + [\text{Quantity} \times (\text{Price - V.Cost}) - \text{F.Cost}] \times (1 - t) \times (\text{PVA}_{10/10\%})$$

Set NPV equal to zero and solve for Q:

$$Q = \frac{I - (PV \times D \times t)}{(PVA_{10/10\%}) \times (P - V) \times (1 - t)} + \frac{F}{P - V}$$

$$= \frac{30{,}000{,}000{,}000 - 9{,}216{,}850{,}659}{(6.144567) \times (375{,}000 - 260{,}000) \times (0.5)} + \frac{3{,}000{,}000{,}000}{375{,}000 - 260{,}000}$$

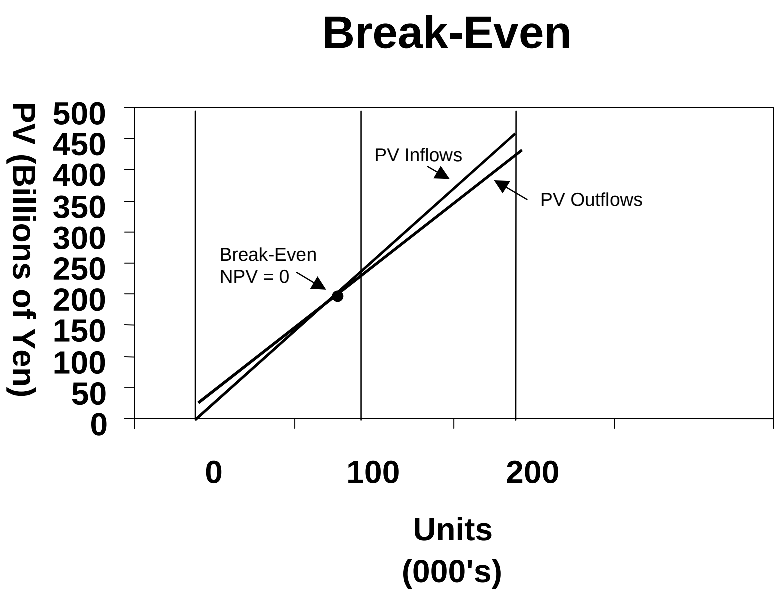
$$= \frac{20{,}783{,}149{,}342}{353{,}313} + \frac{3{,}000{,}000{,}000}{115{,}000} = 58{,}823.7 + 26{,}087.0 = 84{,}910.7$$

Proof:

1. Revenue	¥31.8 B
2. Variable Cost	22.1
3. Fixed Cost	3.0
4. Depreciation	3.0
5. Pre-tax Profit	¥3.7 B
6. Tax	1.85
7. Net Profit	¥1.85
8. Operating Cash Flow	¥4.85

$$\text{NPV} = \sum_{t=1}^{10} \frac{4.85}{(1.10)^t} - 30 = 29.8 - 30 = -0.2$$

(difference due to rounding)



c. The break-even point is the point where the present value of the cash flows, including the opportunity cost of capital, yields a zero NPV.

d. To find the level of costs at which the project would earn zero profit, write the equation for net profit, set net profit equal to zero, and solve for variable costs:

$$\text{Net Profit} = (R - VC - FC - D)\times(1 - t)$$

$$0 = (37.5 - VC - 3.0 - 1.5)\times(0.5)$$

$$VC = 33.0$$

This will yield zero profit.

Next, find the level of costs at which the project would have zero NPV. Using the data in Table 10.1, the equivalent annual cash flow yielding a zero NPV would be:

$$¥15\text{ B}/PVA_{10/10\%} = ¥2.4412\text{ B}$$

If we rewrite the cash flow equation and solve for the variable cost:

$$NCF = [(R - VC - FC - D)\times(1 - t)] + D$$

$$2.4412 = [(37.5 - VC – 3.0 – 1.5)\times(0.5)] + 1.5$$

$$VC = 31.12$$

This will yield NPV = 0, assuming the tax credits can be used elsewhere in the company.

4. If Rustic replaces now rather than in one year, several things happen:
   i. It incurs the equivalent annual cost of the $10 million capital investment.
   ii. It reduces manufacturing costs.
   iii. It earns a return for 1 year on the $1 million salvage value.

   For example, for the "Expected" case, analyzing "Sales" we have (all dollar figures in millions):

   i. The economic life of the new machine is expected to be 10 years, so the equivalent annual cost of the new machine is:

   $$10/5.6502 = 1.77$$

   ii. The reduction in manufacturing costs is:

   $$(0.5) \times (4) = 2.00$$

   iii. The return earned on the salvage value is:

   $$(0.12) \times (1) = 0.12$$

   Thus, the equivalent annual cost savings is:

   $$-1.77 + 2.0 + 0.12 = 0.35$$

   Continuing the analysis for the other cases, we find:

	Equivalent Annual Cost Savings (Millions)		
	Pessimistic	Expected	Optimistic
Sales	-0.05	0.35	1.15
Manufacturing Cost	-0.65	0.35	0.85
Economic Life	-0.07	0.35	0.56

5. From the solution to Problem 4, we know that, in terms of potential negative outcomes, manufacturing cost is the key variable. Rustic should go ahead with the study, because the cost of the study is considerably less than the possible annual loss if the pessimistic manufacturing cost estimate is realized.

6. a. ‘Optimistic’ and ‘pessimistic’ rarely show the full probability distribution of outcomes.

b. Sensitivity analysis changes variables one at a time, while in practice, all variables change, and the changes are often interrelated. Sensitivity analysis using scenarios can help in this regard.

7. a.

$$\text{Operating leverage} = \frac{\text{\% change in operating income}}{\text{\% change in sales}}$$

For a 1% increase in sales, from 100,000 units to 101,000 units:

$$\text{Operating leverage} = \frac{0.075/3}{0.375/37.5} = 2.50$$

b.

$$\text{Operating leverage} = 1 + \frac{\text{fixed cost} + \text{deprecation}}{\text{operating profit}}$$

$$= 1 + \frac{(3.0 + 1.5)}{3.0} = 2.5$$

c.

$$\text{Operating leverage} = \frac{\text{\% change in operating income}}{\text{\% change in sales}}$$

For a 1% increase in sales, from 200,000 units to 202,000 units:

$$\text{Operating leverage} = \frac{(10.65 - 10.5)/10.5}{(75.75 - 75)/75} = 1.43$$

8. This is an opened-ended question, and the answer is a matter of opinion. However, a satisfactory answer should make the following points regarding Monte Carlo simulation:

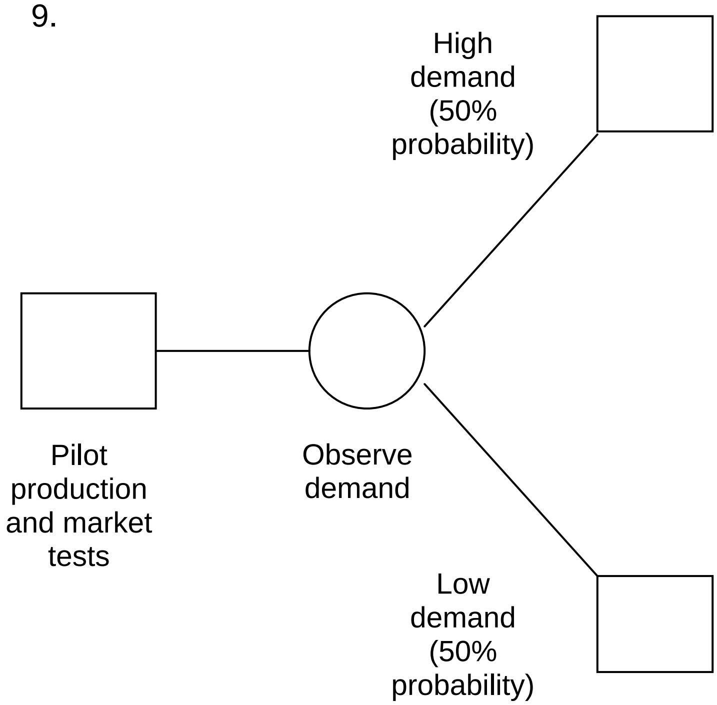
a. It is more likely to be worthwhile if a large amount of money is at stake.

b. It will be most useful for a complex project with cash flows that depend on several interacting variables; forecasting cash flows and assessing risks is likely to be particularly difficult for such projects.

c. It is most useful when it can be applied to a series of similar projects, so that the decision-maker can make the personal investment necessary to understand the technique and gain experience in interpreting the output.

d. It is most likely to be useful to large companies in industries that require major investments. For example, capital intensive industries, such as oil refining, chemicals, steel, and mining, or the pharmaceutical industry, require large investments in research and development.

9.



Invest in full-scale production:

NPV = -1000 + (250/0.10)

= +$1,500

Stop:

NPV = $0

[For full-scale production:

NPV = -1000 + (75/0.10)

= -$250]

10. a. Timing option
    b. Expansion option
    c. Abandonment option
    d. Production option
    e. Expansion option

11. a. The expected value of the NPV for the plant is:

    $(0.5 \times \$140 \text{ million}) + (0.5 \times \$50 \text{ million}) - \$100 \text{ million} = -\$5 \text{ million}$

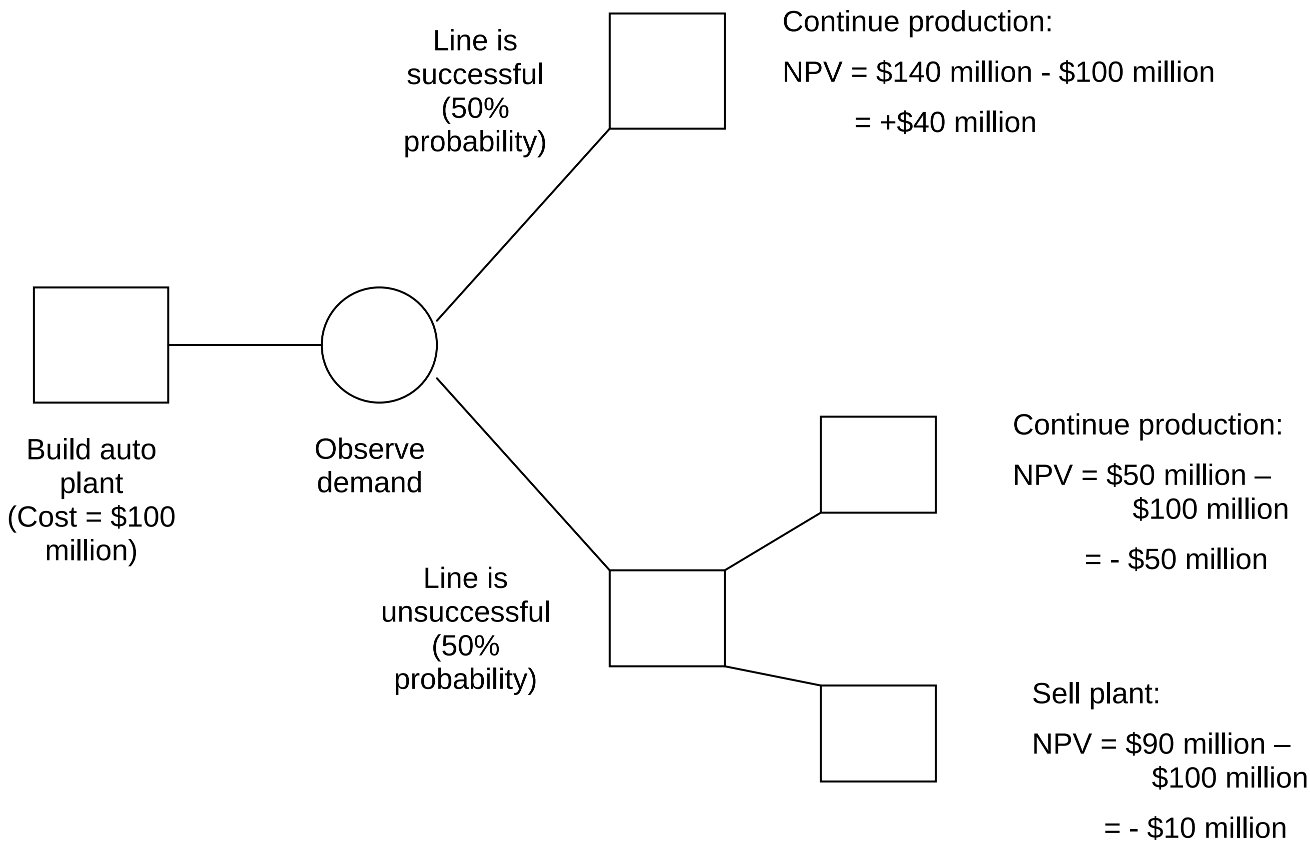
    Since the expected NPV is negative you would not build the plant.

    b. The expected NPV is now:

    $(0.5 \times \$140 \text{ million}) + (0.5 \times \$90 \text{ million}) - \$100 \text{ million} = +\$15 \text{ million}$

    Since the expected NPV is now positive, you would build the plant.

c.



12. (See Figure 10.9, which is a revision of Figure 10.8 in the text.)
Which plane should we buy?
We analyze the decision tree by working backwards. So, for example, if we purchase the piston plane and demand is high:

- The NPV at t = 1 of the 'Expanded' branch is:

$$-150+\frac{(0.8\times 800)+(0.2\times 100)}{1.08}=\$461$$

- The NPV at t = 1 of the 'Continue' branch is:

$$\frac{(0.8\times 410)+(0.2\times 180)}{1.08}=\$337$$

Thus, if we purchase the piston plane and demand is high, we should expand further at t = 1. This branch has the highest NPV.

Similarly, if we purchase the piston plane and demand is low:

- The NPV of the 'Continue' branch is:

$$\frac{(0.4\times 220)+(0.6\times 100)}{1.08}=\$137$$

- We can now use these results to calculate the NPV of the 'Piston' branch at t = 0:

$$-180 + \frac{(0.6)\times(100 + 461) + (0.4)\times(50 + 137)}{1.08} = \$201$$

- Similarly for the 'Turbo' branch, if demand is high, the expected cash flow at t = 1 is:

$$(0.8 \times 960) + (0.2 \times 220) = \$812$$

- If demand is low, the expected cash flow is:

$$(0.4 \times 930) + (0.6 \times 140) = \$456$$

- So, for the 'Turbo' branch, the combined NPV is:

$$NPV = -350 + \frac{(0.6\times150) + (0.4\times30)}{(1.08)} + \frac{(0.6\times812) + (0.4\times456)}{(1.08)^2} = \$319$$

Therefore, the company should buy the turbo plane.

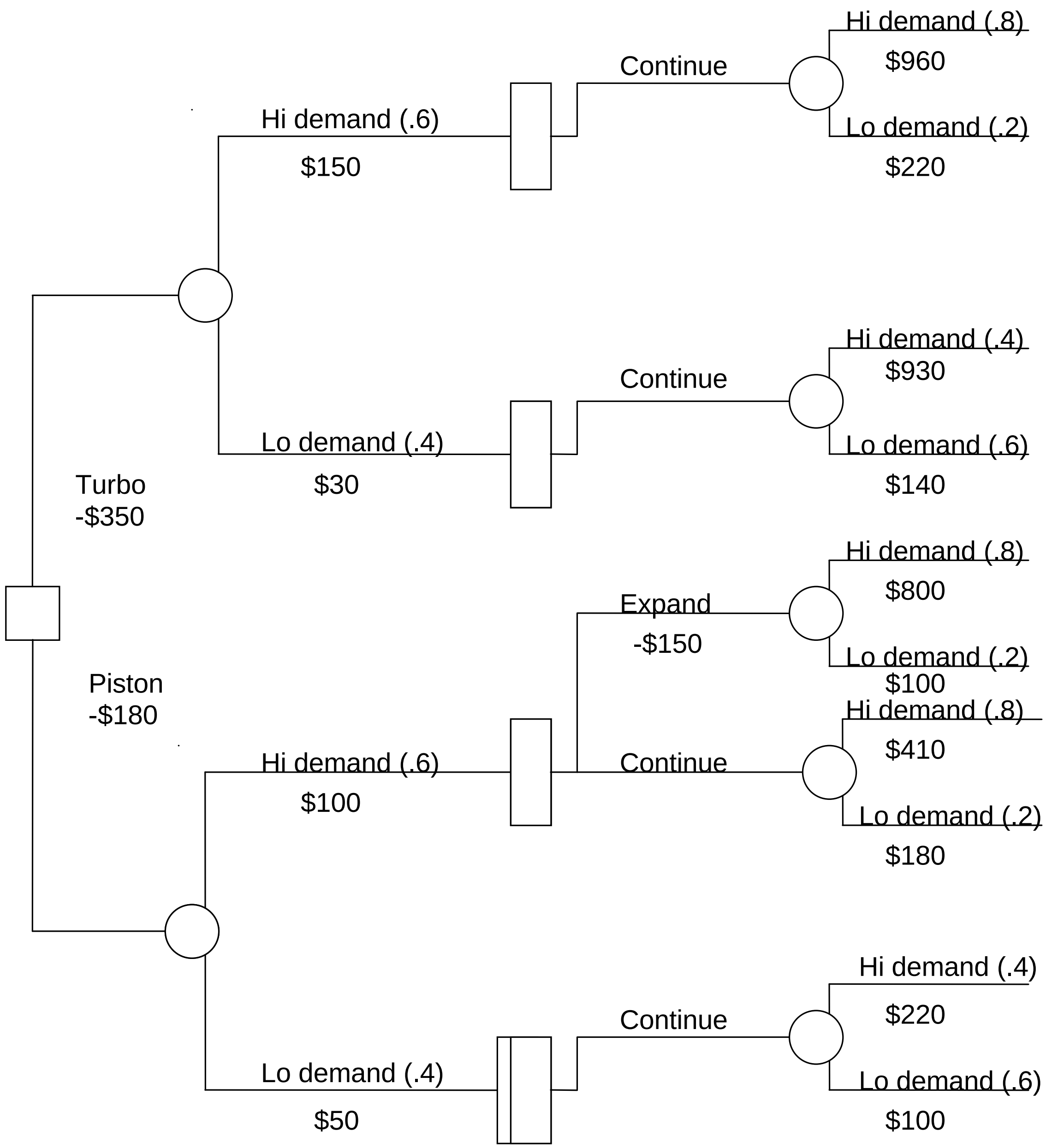
In order to determine the value of the option to expand, we first compute the NPV without the option to expand:

$$NPV = -250 + \frac{(0.6\times100) + (0.4\times50)}{(1.08)} +$$

$$\frac{(0.6)[(0.8\times410) + (0.2\times180)] + (0.4)[(0.4\times220) + (0.6\times100)]}{(1.08)^2} = \$62.07$$

Therefore, the value of the option to expand is: \$201 - \$62 = \$139

FIGURE 10.9


Hi demand (.8)
$960
Continue
Hi demand (.6)
Lo demand (.2)
$150
$220
Hi demand (.4)
$930
Continue
Lo demand (.4)
Lo demand (.6)
Turbo
-$350
$30
$140
Hi demand (.8)
$800
Expand
-$150
Lo demand (.2)
Piston
-$180
$100
Hi demand (.8)
$410
Hi demand (.6)
Continue
$100
Lo demand (.2)
$180
Hi demand (.4)
$220
Continue
Lo demand (.4)
Lo demand (.6)
$50
$100

13. a. Ms. Magna should be prepared to sell either plane at t = 1 if the present value of the expected cash flows is less than the present value of selling the plane.

b. See Figure 10.10, which is a revision of Figure 10.8 in the text.

c. We analyze the decision tree by working backwards. So, for example, if we purchase the piston plane and demand is high:

- The NPV at t = 1 of the 'Expand' branch is:

$$-150 + \frac{(0.8 \times 800) + (0.2 \times 100)}{1.08} = \$461$$

- The NPV at t = 1 of the 'Continue' branch is:

$$\frac{(0.8 \times 410) + (0.2 \times 180)}{1.08} = \$337$$

- The NPV at t = 1 of the 'Quit' branch is $150.

Thus, if we purchase the piston plane and demand is high, we should expand further at t = 1 because this branch has the highest NPV.

Similarly, if we purchase the piston plane and demand is low:

- The NPV of the 'Continue' branch is:

$$\frac{(0.4 \times 220) + (0.6 \times 100)}{1.08} = \$137$$

- The NPV of the 'Quit' branch is $150

Thus, if we purchase the piston plane and demand is low, we should sell the plane at t = 1 because this alternative has a higher NPV.

Putting these results together, we calculate the NPV of the 'Piston' branch at t = 0:

$$-180 + \frac{(0.6) \times (100 + 461) + (0.4) \times (50 + 150)}{1.08} = \$206$$

- Similarly for the 'Turbo' branch, if demand is high, the NPV at t = 1 is:

$$\frac{(0.8 \times 960) + (0.2 \times 220)}{1.08} = \$752$$

- The NPV at t = 1 of 'Quit' is $500.
- If demand is low, the NPV at t = 1 of 'Quit' is $500.

- The NPV of 'Continue' is:

$$\frac{(0.4 \times 930) + (0.6 \times 140)}{1.08} = \$422$$

In this case, 'Quit' is better than 'Continue.' Therefore, for the 'Turbo' branch at t = 0, the NPV is:

$$-350 + \frac{0.6 \times (150 + 752) + 0.4 \times (30 + 500)}{1.08} = \$347$$

With the abandonment option, the turbo has the greater NPV, \$347 compared to \$206 for the piston.

d. The value of the abandonment option is different for the two different planes. For the piston plane, without the abandonment option, NPV at t = 0 is:

$$-180 + \frac{0.6 \times (100 + 461) + 0.4 \times (50 + 137)}{1.08} = \$201$$

Thus, for the piston plane, the abandonment option has a value of:

\$206 - \$201 = \$5

For the turbo plane, without the abandonment option, NPV at t = 0 is:

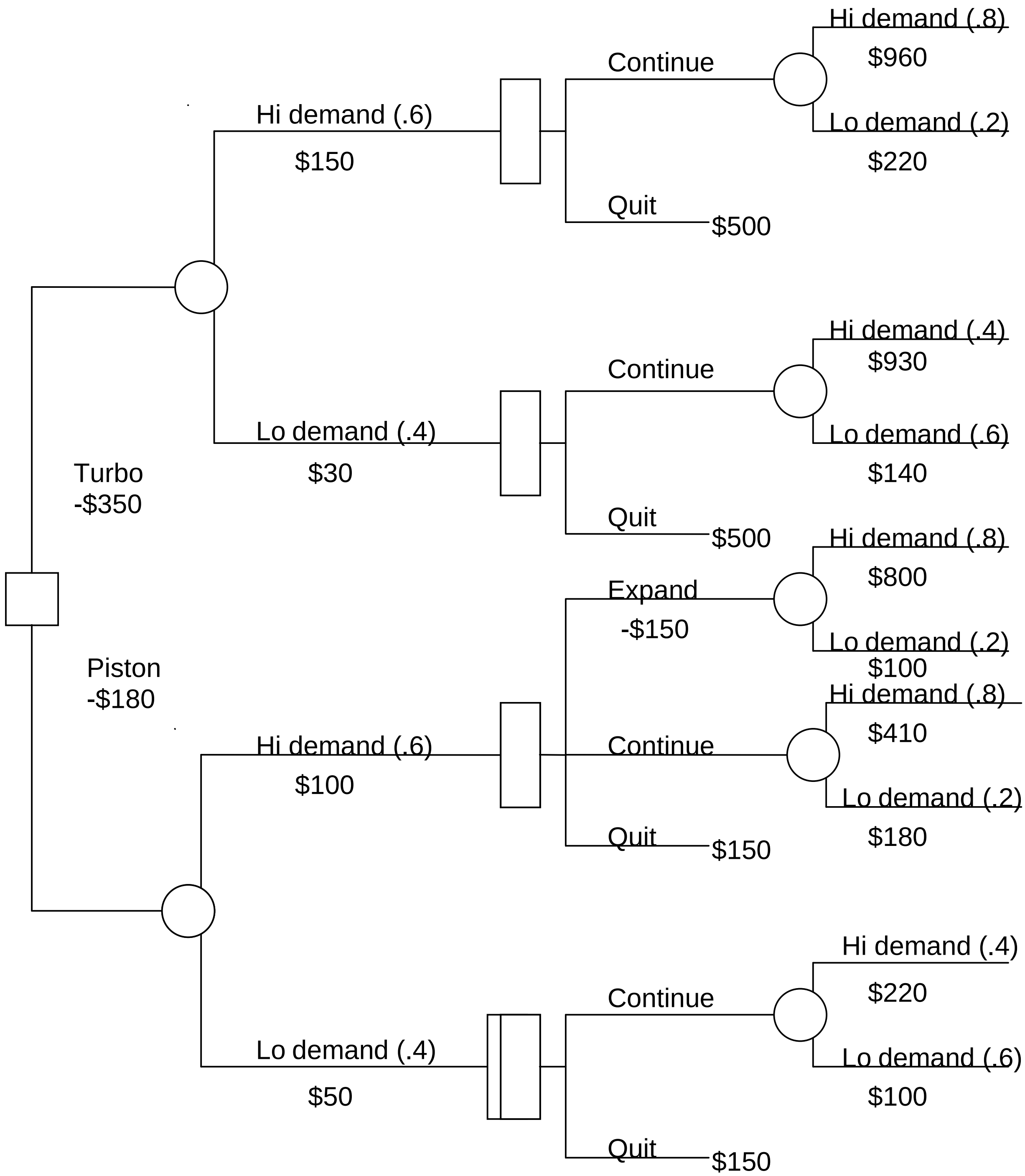
$$-350 + \frac{0.6 \times (150 + 752) + 0.4 \times (30 + 422)}{1.08} = \$319$$

For the turbo plane, the abandonment option has a value of:

\$347 - \$319 = \$28

14. Decision trees can help the financial manager to better understand a capital investment project because they illustrate how future decisions can mitigate disasters or help to capitalize on successes. However, decision trees are not complete solutions to the valuation of real options because they cannot show all possibilities and they do not inform the manager how discount rates can change as we go through the tree.

FIGURE 10.10



Hi demand (.8)
$960
Continue
Lo demand (.2)
$220
Hi demand (.6)
$150
Quit
$500
Hi demand (.4)
$930
Continue
Lo demand (.6)
$140
Lo demand (.4)
$30
Turbo
-$350
Quit
$500
Hi demand (.8)
$800
Expand
-$150
Lo demand (.2)
$100
Piston
-$180
Hi demand (.8)
$410
Hi demand (.6)
$100
Continue
Lo demand (.2)
$180
Quit
$150
Hi demand (.4)
$220
Continue
Lo demand (.4)
$50
Lo demand (.6)
$100
Quit
$150

Challenge Questions

1. a. 1. Assume we open the mine at t = 0. Taking into account the distribution of possible future prices of gold over the next 3 years, we have:

$$\text{NPV} = -100{,}000 + \frac{(1{,}000)\times[(0.5\times 550) + (0.5\times 450) - 460]}{1.10}$$

$$+\frac{(1{,}000)\times[(0.5^{2})\times(600+500+500+400) - 460]}{1.10^{2}}$$

$$+\frac{(1{,}000)\times[(0.5^{3})\times(650+550+550+550+450+450+450+350) - 460]}{1.10^{3}} = -\$526$$

Notice that the answer is the same if we simply assume that the price of gold remains at $500. This is because, at t = 0, the expected price for all future periods is $500.

Because this NPV is negative, we should not open the mine at t = 0. Further, we know that it does not make sense to plan to open the mine at any price less than or equal to $500 per ounce.

2. Assume we wait until t = 1 and then open the mine if the price is $550. At that point:

$$\text{NPV} = -100{,}000 + \sum_{t=1}^{3}\frac{(1{,}000)\times(550-460)}{1.10^{t}} = \$123{,}817$$

Since it is equally likely that the price will rise or fall by $50 from its level at the start of the year, then, at t = 1, if the price reaches $550, the expected price for all future periods is then $550. The NPV, at t = 0, of this NPV at t = 1 is:

$123,817/1.10 = $112,561

If the price rises to $550 at t = 1, we should open the mine at that time. The expected NPV of this strategy is:

$(0.50 \times 112{,}561) + (0.50 \times 0) = 56{,}280.5$

b. 1. Suppose you open at t = 0, when the price is $500. At t = 2, there is a 0.25 probability that the price will be $400. Then, since the price at t = 3 cannot rise above the extraction cost, the mine should be closed. At t = 1, there is a 0.5 probability that the price will be $450. In that case, you face the following, where each branch has a probability of 0.5:

<u>t = 1</u>		<u>t = 2</u>		<u>t = 3</u>
			⇒	550
	⇒	500		
450			⇒	450
	⇒	400	⇒	Close mine

To check whether you should close the mine at t = 1, calculate the PV with the mine open:

$$PV = (0.5)\sum_{t=1}^{2}\frac{1{,}000 \times (500 - 460)}{1.10^t} + (0.5) \times \frac{1{,}000 \times (400 - 460)}{1.10} = \$7{,}438$$

Thus, if you open the mine when the price is $500, you should not close if the price is $450 at t = 1, but you should close if the price is $400 at t = 2. There is a 0.25 probability that the price will be $400 at t = 1, and then you will save an expected loss of $60,000 at t = 3. Thus, the value of the option to close is:

$$(0.25) \times \frac{(1{,}000 \times 60)}{1.10^3} = \$11{,}270$$

Now calculate the PV, at t = 1, for the branch with price equal to $550:

$$PV = \sum_{t=0}^{2}\frac{90{,}000}{1.10^t} = \$246{,}198$$

The expected PV at t = 1, with the option to close, is:

(0.5) × [7,438 + (450 – 460) × (1,000)] + (0.5 × 246,198) = $121,818

The NPV at t = 0, with the option to close, is:

NPV = 121,818/1.10 – 100,000 = $10,744

Therefore, opening the mine at t = 0 now has a positive NPV.

We can verify this result by noting that the NPV from part (a) (without the option to abandon) is -$526, and the value of the option to abandon is $11,270 so that the NPV with the option to abandon is:

NPV = -$526 + $11,270 = 10,744

2. Now assume that we wait until t = 1 and then open the mine if the price is $550 at that time. For this strategy, the mine will be abandoned if price reaches $450 at t = 3 because the expected profit at t = 4 is: [(450 – 460) × 1,000] = -$10,000

Thus, with this strategy, the value of the option to close is:

(0.125) × (10,000/1.10^4) = $854

Therefore, the NPV for this strategy is: $56,280.5 [the NPV for this strategy from part (a)] plus the value of the option to close:

NPV = $56,280.5 + $854 = $57,134.5

The option to close the mine increases the net present value for each strategy, but the optimal choice remains the same; that is, strategy 2 is still the preferable alternative because its NPV ($57,134.5) is still greater than the NPV for strategy 1 ($10,744).

2. See Figure 10.11. The choice is between buying the computer or renting.

If we buy:

The cost is $2,000 at t = 0. If demand is high at t = 1, we will have, at that time:

($900 - $500) = $400

If demand is high at t = 1, there is an 80 percent chance that demand will continue high for the remaining time (until t = 10). The present value (at t = 1) of $400 per year for 9 years is $2,304. Because there is an 80 percent chance demand will be high for the remaining time, there is a 20 percent chance it will be low, in which case we will get ($700 - $500) = $200 per year. This has a present value of $1,152. Similar calculations are made for the case of low initial demand.

If we rent:

The cost is 40 percent of revenue per year, so if demand is high at t = 1, then we will get:

[($900 - $500) – (0.4×$900)] = $40

If demand continues high, we get $40 per year for the remaining time. This has a present value of $230. If demand is low at t = 2, we will get:

[($70 - $500) – (0.4×$700)] = -$80

In this case, it pays to stop renting after low demand in year 2 because we know this low demand will continue. Similar calculations are made for the case of low initial demand.

From the tree (Figure 10.11):

$$PV_{Buy} = -2{,}000 + \frac{(0.6 \times 400) + (0.4 \times 200)}{1.10}$$

$$+ \frac{(0.6)[(0.8 \times 2{,}304) + (0.2 \times 1{,}152)] + (0.4)[(0.4 \times 2{,}304) + (0.6 \times 1{,}152)]}{1.10}$$

PV_{Buy} = $8.44 or $8,440

$$PV_{Rent} = \frac{(0.6 \times 40) + [0.4 \times (-80)]}{1.10}$$

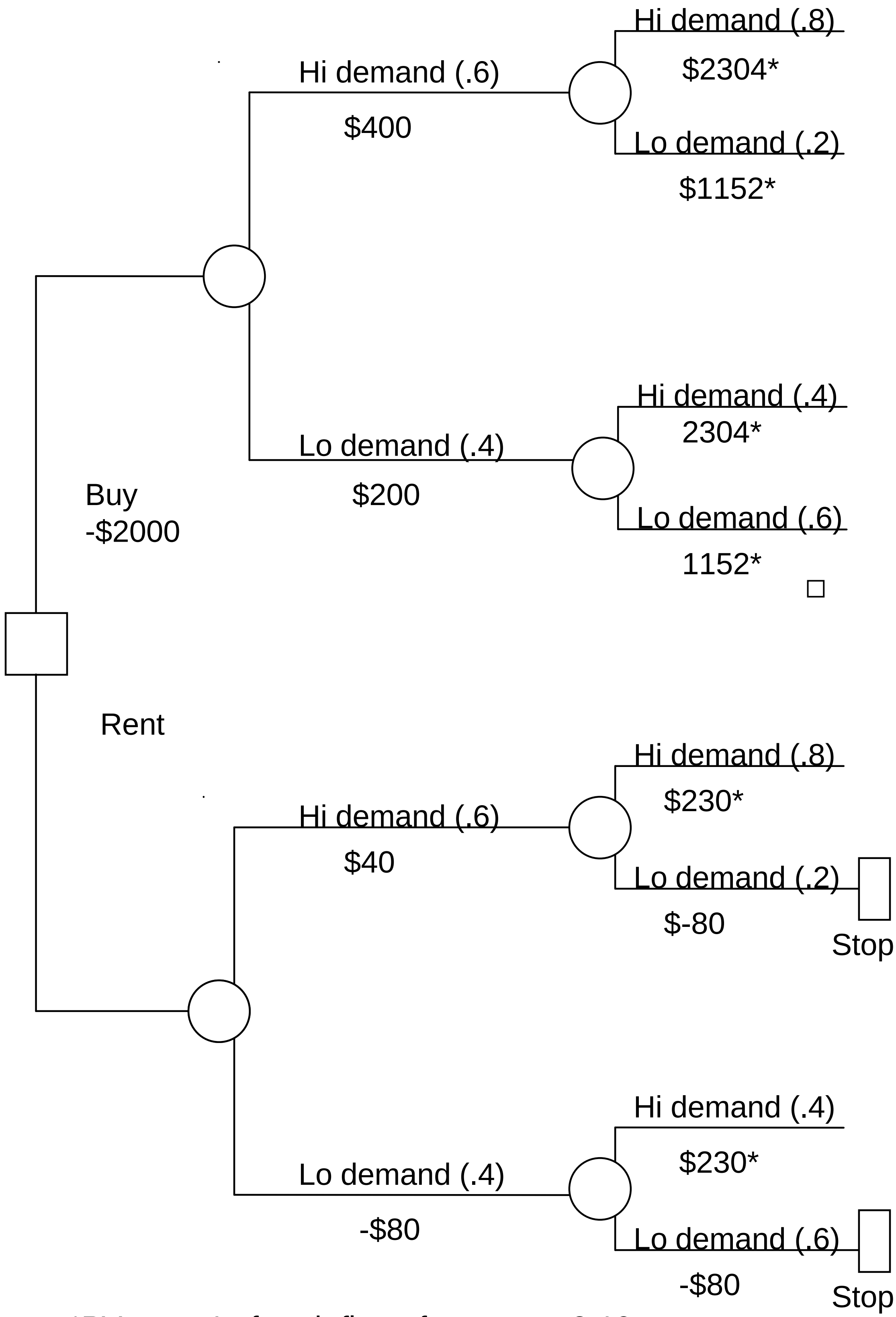
$$+ \frac{(0.6)[(0.8 \times 230) + (0.2) \times (-80)] + (0.4)[(0.4 \times 230) + (0.6) \times (-80)]}{1.10}$$

PV_{Rent} = $100.36 or $100,360

The computer should be rented, not purchased.

3. In the extreme case, if future cash flows are known with certainty, options have no value because optimal choices can be determined with certainty. Therefore, the option to choose other alternative courses of action has no value to the decision-maker. On the other hand, the option to abandon a project has value if there is a chance that demand for a product will not meet expectations, so that cash flows are below expectations. Or, the option to expand a project has value if there is a chance that demand w ill exceed expectations.

FIGURE 10.11



*PV at t = 1 of cash flows from years 2-10.

CHAPTER 11
Where Positive Net Present Value Comes From

Answers to Practice Questions

1. The 757 must be a zero-NPV investment for the marginal user. Unless Boeing can charge different prices to different users (which is precluded with a secondary market), Delta will earn economic rents if the 757 is particularly well suited to Delta's routes (and competition does not force Delta to pass the cost savings through to customers in the form of lower fares). Thus, the decision focuses on the issue of whether the plane is worth more in Delta's hands than in the hands of the marginal user.
   a. With a good secondary market and information on past changes in aircraft prices, it becomes somewhat more feasible to ignore cash flows beyond the first few years and to substitute the expected residual value of the plane.
   b. Past aircraft prices may be used to estimate systematic risk (see Chapter 9).
   c. The existence of a secondary market makes it more important to take note of the abandonment option (see Chapter 10).

2. The key question is: Will Gamma Airlines be able to earn economic rents on the Akron-Yellowknife route? The necessary steps include:
   a. Forecasting costs, including the cost of building and maintaining terminal facilities, all necessary training, advertising, equipment, etc.
   b. Forecasting revenues, which includes a detailed market demand analysis (what types of travelers are expected and what prices can be charged) as well as an analysis of the competition (if Gamma is successful, how quickly would competition spring up?).
   c. Calculating the net present value.

   The leasing market comes into play because it tells Gamma Airlines the opportunity cost of the planes, a critical component of costs.

   If the Akron-Yellowknife project is attractive and growth occurs at the Ulan Bator hub, Gamma Airlines should simply lease additional aircraft.

3. To a baby with a hammer, everything looks like a nail. The point is that financial managers should not mechanically apply DCF to every problem. Sometimes, part or all of a valuation problem can be solved by direct observation of market values. Sometimes careful thought about economic rents clarifies whether NPV is truly positive.

4. The price of $280 per ounce represents the discounted value of expected future gold prices. Hence, the present value of 1 million ounces produced 8 years from now should be: ($280 × 1 million) = $280 million

5. First, consider the sequence of events:
   - At t = 0, the investment of $25,000,000 is made.
   - At t = 1, production begins, so the first year of revenue and expenses is recorded at t = 2.
   - At t = 5, the patent expires and competition may enter. Since it takes one year to achieve full production, competition is not a factor until t = 7. (This assumes the competition does not begin construction until the patent expires.)
   - After t = 7, full competition will exist and thus any new entrant into the market for BGs will earn the 9% cost of capital.

   Next, calculate the cash flows:
   - At t = 0: -$25,000,000
   - At t = 1: $0
   - At t = 2, 3, 4, 5, 6: Sale of 200,000 units at $100 each, with costs of $65 each, yearly cash flow = $7,000,000.
   - After t = 5, the NPV of new investment must be zero. Hence, to find the selling price per unit (P) solve the following for P:

$$0 = -25{,}000{,}000 + \frac{(200{,}000)\times(P-65)}{1.09^2} + \cdots + \frac{(200{,}000)\times(P-65)}{1.09^{12}}$$

   Solving, we find P = $85.02 so that, for years t = 7 through t = 12, the yearly cash flow will be: [(200,000)×($85.02 - $65)] = $4,004,000.

   Finally, the net present value (in millions):

$$NPV = -25 + \frac{7}{1.09^2} + \frac{7}{1.09^3} + \cdots + \frac{7}{1.09^6} + \frac{4.004}{1.09^7} + \cdots + \frac{4.004}{1.09^{12}}$$

   NPV = $10.69 or $10,690,000

6. The selling price after t = 6 now changes because the required investment is:

$$[\$25,000,000 \times (1 - 0.03)^5] = \$21,468,351$$

After t = 5, the NPV of new investment must be zero, and hence the selling price per unit (P) is found by solving the following equation for P:

$$0 = -21,468,351 + \frac{(200,000) \times (P - 65)}{1.09^2} + \cdots + \frac{(200,000) \times (P - 65)}{1.09^{12}}$$

P = $82.19

Thus, for years t = 7 through t = 12, the yearly cash flow will be:

$$[200,000 \times (\$82.19 - \$65)] = \$3,438,000.$$

Finally, the net present value (in millions) is:

$$NPV = -25 + \frac{7}{1.09^2} + \frac{7}{1.09^3} + \cdots + \frac{7}{1.09^6} + \frac{3.438}{1.09^7} + \cdots + \frac{3.438}{1.09^{12}}$$

NPV = $9.18 or $9,180,000

7. a. (See the table below.) The net present value is positive at $3.76 million. However, this seems like a very small margin. Unless there is some factor unaccounted for in the analysis (e.g., strategic position such that the project creates an option for future expansion), management might not proceed with the Polyzone project.

	t = 0	t = 1	t = 2	t = 3	t = 4	t = 5	t = 6-10
Investment	100						
Production	0	0	40	80	80	80	80
Spread	1.20	1.20	1.20	1.20	1.20	1.10	0.95
Net Revenues	0	0	48	96	96	88	76
Prod. Costs	0	0	30	30	30	30	30
Transport	0	0	4	8	8	8	8
Other Costs	0	20	20	20	20	20	20
Cash Flow	-100	-20	-6	38	38	30	18
NPV (at 8%) =	$3.76						

b. (See the table below.) The net present value is $14.68 million, and so the project is acceptable.

	t = 0	t = 1	t = 2	t – 3	t = 4	t = 5-10
Investment	100					
Production	0	40	80	80	80	80
Spread	1.20	1.20	1.20	1.20	1.10	0.95
Net Revenues	0	48	96	96	88	76
Prod. Costs	0	30	60	30	30	30
Transport	0	4	8	8	8	8
Other Costs	0	20	20	20	20	20
Cash Flow	-100	-6	8	38	30	18
NPV (at 8%) =	$14.68					

c. (See the table below.) The net present value is $18.64 million, and so the project is acceptable. However, the assumption that the technological advance will elude the competition for ten years seems questionable.

	t = 0	t = 1	t = 2	t – 3	t = 4	t = 5-10
Investment	100					
Production	0	0	40	80	80	80
Spread	1.20	1.20	1.20	1.20	1.10	0.95
Net Revenues	0	0	48	96	88	76
Prod. Costs	0	0	25	25	25	25
Transport	0	0	4	8	8	8
Other Costs	0	20	20	20	20	20
Cash Flow	-100	-20	-1	43	35	23
NPV (at 8%) =	$18.64					

8. There are four components that contribute to this project's NPV:
   - The initial investment of $100,000.
   - The depreciation tax shield. Depreciation expense is $20,000 per year for five years and is valued at the nominal rate of interest because it applies to nominal cash flows, i.e., earnings.
   - The after-tax value of the increase in silver yield. Like gold, silver has low convenience yield and storage cost. (You can verify this by checking that the difference between the futures price and the spot price is approximately the interest saving from buying the futures contract.) We conclude, therefore, that the PV of silver delivered (with certainty) in the future is approximately today's spot price, and so there is no need to forecast the price of silver and then discount.
   - The cost of operating the equipment. This cost is $80,000 per year for ten years and is not valued at the real company cost of capital because we do not assume any future increase in cost due to inflation. We are concerned only with the after-tax cost.

Assume that the nominal interest rate is 11 percent. Then:

$$NPV = -100{,}000 + \sum_{t=1}^{5} \frac{(0.35)\times(20{,}000)}{1.11^t} + (1-.35)\times(10\times5{,}000\times20)$$

$$-\sum_{t=1}^{10} \frac{(1-.35)\ (80{,}000)}{1.08^t} = \$226{,}947$$

9. Assume we can ignore dividends paid on the stock market index. On June 30, 2005, each ticket must sell for $100 because this date marks the base period for the return calculation. At this price, investment in a ticket will offer the same return as investment in the index. On January 1, 2005, you know that each ticket will be worth $100 in 6 months. Therefore, on January 1, 2005, a ticket will be worth:

$$100/(1.10)^{1/2} = \$95.35$$

The price will be the same for a ticket based on the Dow Jones Industrial Average.

10. If available for immediate occupancy, the building would be worth $1 million. But because it will take the company one year to clear it out, the company will incur $200,000 in clean-up costs and will lose $80,000 net rent. Assume both rent *and* costs are spread evenly throughout the year. Thus (all dollar amounts are in millions):

PV = 1,000 - PV(200 + 80) = 1,000 - 280(0.962) = 731

Since the selling price at each date is the present value of forecasted rents, the only effect of postponing the sale to year 2 is to postpone the sales commission. The commission is currently $(0.05 \times 1000) = 50$ and grows in line with property value. To estimate the growth rate of value, we can use the constant-growth model:

PV = 1000 = 80/(0.08 - g) so that g = 0%

Thus, the commission in year 2 is: (50×1.00^2) and:

PV (commission) = $50 \times (1.00^2/1.08^2) = 43$

The value of the warehouse, net of the sales commission, is:

731 - 43 = 688 or $688,000

Challenge Questions

1. a. The NPV of such plants is likely to be zero, because the industry is competitive and, after two years, no company will enjoy any technical advantages.

   b. The PV of each of these new plants would be $100,000 because the NPV is zero and the cost is $100,000.

   c. The PV of revenue from such a plant is:

   $$[100{,}000 \text{ tons} \times (\text{Price} - 0.85)]/0.10 = 100{,}000$$

   Therefore, the price of polysyllabic acid will be $0.95 per ton.

   d. At t = 2, the PV of the existing plant will be:

   $$[100{,}000 \text{ tons} \times (0.95 - 0.90)]/0.10 = \$50{,}000$$

   Therefore, the existing plant would be scrapped at t = 2 as long as scrap value at that time exceeds $50,000.

   e. No. Book value is irrelevant. NPV of the existing plant is negative after year 2.

   f. Yes. Sunk costs are irrelevant. NPV of the existing plant is negative after year 2.

   g. Phlogiston's project causes temporary excess capacity. Therefore, the price for the next two years must be such that the existing plant's owners will be indifferent between scrapping now and scrapping at the end of year 2. This allows us to solve for price in years 1 and 2.

   Today's scrap value is $60,000. Also, today's scrap value is equal to the present value of future cash flows. Therefore:

   $$\frac{100{,}000 \times (\text{Price} - 0.90)}{1.10} + \frac{100{,}000 \times (\text{Price} - 0.90)}{1.10^2} + \frac{57{,}900}{1.10^2} = 60{,}000$$

   Solving, we find that the price is $0.97 per ton. Knowing this, we can calculate the PV of Phlogiston's new plant:

   $$\text{PV} = 100{,}000 \times \left[\frac{0.97 - 0.85}{1.10} + \frac{0.97 - 0.85}{1.10^2} + \frac{0.95 - 0.85}{0.10 \times 1.10^2}\right] = \$103{,}471$$

2. Aircraft will be deployed in a manner that will minimize costs. This means that each aircraft will be used on the route for which it has the greatest comparative advantage. Thus, for example, for Part (a) of this problem, it is clear that Route X will be served with five A's and five B's, and that Route Y will be served with five B's and five C's. The remaining C-type aircraft will be scrapped.

The maximum price that anyone would pay for an aircraft is the present value of the total additional costs that would be incurred if that aircraft were withdrawn from service. Using the annuity factor for 5 time periods at 10 percent, we find the PV of the operating costs (all numbers are in millions):

Type	X	Y
A	5.7	5.7
B	9.5	7.6
C	17.1	13.3

Again, consider Part (a). The cost of using an A-type aircraft on Route X (Cost = Price of A + 5.7) must be equal to the cost of using a B-type aircraft on Route X (Cost = Price of B + 9.5). Also, the cost of using a B-type aircraft on Route Y (Price of B + 7.6) equals the cost of using a C-type on Route Y (Price of C + 13.3). Further, because five C-type aircraft are scrapped, the price of a C-type aircraft must be $1.0, the scrap value. Therefore, solving first for the price of B and then for the price of A, we find that the price of an A-type is $10.5 and the price of a B-type is $6.7. Using this approach, we have the following solutions:

	Usage			Aircraft Value (in millions)		
	X	Y	Scrap	A	B	C
a.	5A+5B	5B+5C	5C	$10.5	$6.7	$1.0
b.	10A	10B	10C	10.5	6.7	1.0
c.	10A	5A+5B	5B+10C	2.9	1.0	1.0
d.	10A	10A	10B+10C	2.9	1.0	1.0

3. a.

$$\text{PV of 1-year-old plant} = \frac{43.33}{1.20} + \frac{58.33}{1.20^2} = \$76.62$$

$$\text{PV of 2-year-old plant} = \frac{58.33}{1.20} = \$48.61$$

b. Given that the industry is competitive, the investment in a new plant to produce bucolic acid must yield a zero NPV. First, we solve for the revenues (R) at which a new plant has zero NPV.

		0	1	2	3
1.	Initial investment	-100			
2.	Revenues net of tax		0.6R	0.6R	0.6R
3.	Operating costs net of tax		-30	-30	-30
4.	Depreciation tax shield		+40		
5.	Salvage value net of tax				+15

Therefore:

$$NPV = -100 + \frac{(0.6R - 30 + 40)}{1.20} + \frac{(0.6R - 30)}{1.20^2} + \frac{(0.6R - 30 + 15)}{1.20^3} = 0$$

$$0 = -100 + 1.264R - 21.181$$

$$R = \$95.87$$

We can now use the new revenue to re-compute the present values from Part (a) above. (Recall that existing plants must use the original tax depreciation schedule.).

$$\text{PV of 1-year-old plant} = \frac{40.93}{1.20} + \frac{55.93}{1.20^2} = \$72.95$$

$$\text{PV of 2-year-old plant} = \frac{55.93}{1.20} = \$46.61$$

c. Existing 2-year-old plants have a net-of-tax salvage value of:

$$50 - [(0.4) \times (50.0 - 33.3)] = \$43.33$$

d. Solve again for revenues at which the new plant has zero NPV:

		0	1	2	3
1.	Initial investment	-100			
2.	Revenues		+R	+R	+R
3.	Operating costs		-50	-50	-50
4.	Salvage value				+25

$$NPV = -100 + \frac{(R - 50)}{1.20} + \frac{(R - 50)}{1.20^2} + \frac{(R - 50 + 25)}{1.20^3} = 0$$

$$0 = -100 + 2.106R - 90.856$$

$$R = \$91$$

With revenues of $91:

$$\text{PV of 1-year-old plant} = \frac{41}{1.20} + \frac{66}{1.20^2} = \$80$$

$$\text{PV of 2-year-old plant} = \frac{66}{1.20} = \$55$$

CHAPTER 12
Making Sure Managers Maximize NPV

Answers to Practice Questions

1. Post-audits provide information on problems that may need to be corrected in order for newly completed projects to operate as intended. Also, the postaudit provides preliminary data on the validity of the forecasts for the project and the corrections that may be needed in this process.

   The postaudit should be performed by a disinterested party. It should not be done by someone involved in the operations of the project or someone responsible for its planning. The postaudit should be performed after resolving any minor "bugs" that occur during the start-up process. Once this stage has been reached, the postaudit should investigate all phases of the project, both financial and technical.

   The issue of which projects to audit depends on the cost of performing audits and on the value of the information obtained. Larger projects usually require audits in order to be certain that everything performs as expected. If there are unexpected problems, it is generally advisable to find out about them as soon as possible. Postaudits for smaller projects might make sense when a series of projects of a given type can be investigated. Standardized postaudit procedures can be developed and statistical analyses performed.

2. Outline of steps in capital budgeting process:
   (1) Plant manager gets idea, does some very rough estimates, and determines whether idea is worth pursuing.
   (2) Staff of plant manager develops detailed proposal, including:
       - Discussion of reason that the company should invest in this machine
       - Economic forecasts
       - Demand forecasts
       - Cash flow forecasts, both revenue and expenses
       - Estimate of cost of capital (unless specified at a higher level)
       - Net present value or internal rate of return calculation
   (3) Proposal is evaluated by division level staff. If approved, proposal is evaluated at company level.
   (4) Project authorization is requested, which may require a final check/revision of the numbers in the original proposal.
   (5) Purchase and installation proceed. If there are significant cost overruns, these must be re-approved by the division and company staff.
   (6) When the machine is up and running, say after one year, a postaudit might be conducted to evaluate the entire process.

3. The typical compensation and incentive plans for top management include salary plus profit sharing and stock options. This is usually done to align as closely as possible the interests of the manager with the interests of the shareholders. These managers are usually responsible for corporate strategy and policies that can directly affect the future of the entire firm.

   Plant and divisional managers are usually paid a fixed salary plus a bonus based on accounting measures of performance. This is done because they are directly responsible for day-to-day performance and this valuation method provides an absolute standard of performance, as opposed to a standard that is relative to shareholder expectations. Further, it allows for the evaluation of junior managers who are only responsible for a small segment of the total corporate operation.

4. a. When paid a fixed salary without incentives to act in shareholders' best interest, managers often act sub-optimally.
      1. They may reduce their efforts to find and implement projects that add value.
      2. They may extract benefits-in-kind from the corporation in the form of a more lavish office, tickets to social events, overspending on expense accounts, etc.
      3. They may expand the size of the operation just for the prestige of running a larger company
      4. They may choose second-best investments to reward existing employees rather than the alternative that requires outside personnel but has a higher NPV.
      5. In order to maintain their comfortable jobs, managers may invest in safer rather than riskier projects.

   b. Tying the manager's compensation to EVA attempts to ensure that assets are deployed efficiently and that earned returns exceed the cost of capital. Hence, actions taken by the manager to shirk the duty of maximizing shareholder wealth generally result in a return that does not exceed the minimum required rate of return (cost of capital). The more the manager works in the interests of the shareholder, the greater the EVA.

5. a. EVA = Income earned – (Cost of capital x Investment)

      = \$8.03m – (0.09 x \$55.4m) = \$8.03m - \$4.99m = \$3.04m

   b. EVA = \$8.03m – (0.09 x \$95m) = \$8.03m - \$8.55m = -\$0.52m

      The market value of the assets should be used to capture the true opportunity cost of capital.

6. a. If a firm announces the hiring of a new manager who is expected to increase the firm's value, this information should be immediately reflected in the stock price. If the manager then performs as expected, there should not be much change in the share price since this performance has already been incorporated in the stock value.

b. This could potentially be a very serious problem since the manager could lose money for reasons out of her control. One solution might be to index the price changes and then compare the actual raw material price paid with the indexed value. Another alternative would be to compare the performance with the performance of competitive firms.

c. It is not necessarily an advantage to have a compensation scheme tied to stock returns. For example, in addition to the problem of expectations discussed in Part (a), there are numerous factors outside the manager's control, such as federal monetary policy or new environmental regulations. However, the stock price does tend to increase or decrease depending on whether the firm does or does not exceed the required cost of capital. To this extent, it is a measure of performance.

7. EVA = Income earned – (Cost of capital x Investment)

= \$1.2m – [0.15 x (\$4m + \$2m + \$8m)] = \$1.2m - \$2.1m = -\$0.9m

8. Agency problems likely to be encountered in capital investment decisions:

- *Reduced effort:* Shirking the responsibility of finding and implementing value-added projects.
- *Perks:* Exploiting the benefits of the managerial position in order to get benefits from the corporation for personal use.
- *Empire building:* Obtaining and running larger operations merely for personal prestige.
- *Entrenching investment:* Favoring projects to reward existing managers instead of pursuing higher value-added projects requiring new expertise.
- *Avoiding risk:* Choosing safer projects over more risky, higher value-added projects.

9. Security analysts generate business for their own firms based upon the accuracy of their recommendations. Thus, in looking-out for their own shareholders' or customers' interests, they are also working in the best interests of the shareholders of the firms they analyze. This is particularly true for firms with large numbers of shareholders. A motivated monitoring agent reduces the free-rider problem by assuming the delegated monitoring duties. Also, because they are industry experts and are paid by potential investors, the analysts examine the performance of the firm's capital investment program. Firms are eager to have more investors since it makes raising capital easier for future projects.

10. Delegated monitoring refers to a group of individuals, usually the Board of Directors and independent outside auditors, who are elected and/or paid to meet with top management in order to determine whether the firm is being operated in a fashion consistent with the best interests of the shareholders.

11. a. False. The biases rarely wash out. For example, steady state income may not be much affected by investments in R & D but book asset value is understated. Thus, book profitability is too high, even in the steady state.

    b. True. All biases in book profitability can be traced to accounting rules governing which assets are put on the balance sheet and the choice of book depreciation schedules.

12. The year-by-year book and economic profitability and rates of return are calculated in the table below. (We assume straight-line depreciation, $10 per year for years one through ten).

    Because a plant lasts for 10 years, ‘steady state’ for a mature company implies that we are operating ten plants, and every year we close one and begin construction on another. The total book income is $76, which is the same as the sum of the Book Income figures from the table (i.e., the sum of -$30, -$22, $16, etc.). Similarly, the total book investment is $550. Thus, the steady state book rate of return for a mature company producing Polyzone is: (76/550) = 13.8%. Note that this is considerably different from the economic rate of return, which is 8 percent.

	t=0	t=1	t=2	t=3	t=4	t=5	t=6	t=7	t=8	t=9	t=10
Investment	100										
Depreciation		10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Book Value End of Year		90.0	80.0	70.0	60.0	50.0	40.0	30.0	20.0	10.0	0.0
Net Revenue	0	0.0	38.0	76.0	76.0	76.0	76.0	76.0	76.0	76.0	76.0
Production Costs	0	0.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0
Transport & Other	0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
Book Income	0	-30.0	-22.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0
Book Rate of Return		-30.0%	-24.4%	20.0%	22.9%	26.7%	32.0%	40.0%	53.3%	80.0%	160.0%
Cash Flow	-100	-20.0	-12.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0
PV at Start of Year		99.3	127.2	149.4	135.4	120.2	103.8	86.1	67.0	46.4	24.1
PV at End of Year		127.2	149.4	135.4	120.2	103.8	86.1	67.0	46.4	24.1	0.0
Change in PV		27.9	22.2	-14.0	-15.2	-16.4	-17.7	-19.1	-20.6	-22.3	-24.1
Economic Depreciation		-27.9	-22.2	14.0	15.2	16.4	17.7	19.1	20.6	22.3	24.1
Economic Income		7.9	10.2	12.0	10.8	9.6	8.3	6.9	5.4	3.7	1.9
Economic Rate of Return		8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%

13. a. See table below. Straight-line depreciation would be $166.67 per year. Hence, economic depreciation in this case is accelerated, relative to straight-line depreciation.

b. The true rate of return is found by dividing economic income by the start-of-period present value. As stated in the text, this will always be 10 percent. The book ROI is calculated in Panel B (using straight-line depreciation).

A. Forecasted Economic Income and Rate of Return

	Year					
	1	2	3	4	5	6
Cash Flow	298.0	298.0	298.0	138.0	138.0	138.0
PV at start of year	998.9	800.8	582.9	343.2	239.5	125.5
PV at end of year	800.8	582.9	343.2	239.5	125.5	0.0
Change in PV	-198.1	-217.9	-239.7	-103.7	-114.0	-125.5
Economic depreciation	198.1	217.9	239.7	103.7	114.0	125.5
Economic return	99.9	80.1	58.3	34.3	24.0	12.5
Rate of return	0.1000	0.1000	0.1000	0.0999	0.1002	0.0996

B. Forecasted Book Income and ROI

	Year					
	1	2	3	4	5	6
Cash Flow	298.00	298.00	298.00	138.00	138.00	138.00
BV at start of year	1000.00	833.33	666.66	500.00	333.33	166.66
BV at end of year	833.33	666.66	500.00	333.33	166.66	0.00
Change in BV	-166.67	-166.67	-166.66	-166.67	-166.67	-166.66
Book depreciation	166.67	166.67	166.66	166.67	166.67	166.66
Book income	131.33	131.33	131.34	-28.67	-28.67	-28.66
Book ROI	0.1313	0.1576	0.1970	-0.0573	-0.0860	-0.1720

14. Internet exercise; answers will vary.

Challenge Questions.

1. The optimal level of agency costs is the point at which the marginal return derived from monitoring top management and ensuring they are working in the best interests of the shareholders equals the marginal cost of any shirking and other acts that do not maximize value.

2. No, there would be no need for EVA. The problem in managing performance is the difficulty in obtaining economic values for some activities (e.g., the ability to expand production in the future). As a result, we are left with accounting figures derived from arbitrary rules governing the assets or expenditures that should be put on the balance sheet, and how these assets are treated for deprecation purposes.

3. For a 10 percent expansion in book investment, ROI for Nodhead is given in the table below. When the steady-state growth rate is exactly equal to the economic rate of return (i.e., 10 percent), the economic rate of return and book ROI are the same.

Book Income for Assets Put in Place During Year	1	2	3	4	5	6
1	-67	33	83	131	131	131
2		-74	36	91	144	144
3			-81	40	100	159
4				-89	44	110
5					-98	48
6						-108
Total Book Income:	-67	-41	38	173	321	484

Book Value for Assets Put in Place During Year	1	2	3	4	5	6
1	1000	833	667	500	333	167
2		1100	916	734	550	366
3			1210	1008	807	605
4				1331	1109	888
5					1464	1220
6						1610
Total Book Income:	1000	1933	2793	3573	4263	4856
Book ROI:	-0.067	-0.021	0.014	0.048	0.075	0.100*

*This is the steady state rate of return.

4.

	Year 1	Year 2	Year 3
Cash Flow	5.20	4.80	4.40
PV at start of year	12	8	4
PV at end of year	8	4	0
Change in PV	-4	-4	-4
Economic depreciation	4	4	4
Economic income	1.20	0.80	0.40
Economic rate of return	0.10	0.10	0.10
Book depreciation	4	4	4
Book income	1.20	0.80	0.40
Book rate of return	0.10	0.10	0.10

5. First calculate present value and economic income of one parlor (figures in thousands):

	Year 1	Year 2	Year 3	Year 4	Year 5
Cash flow	0	40	80	120	170
PV start of year	200	240	248	218	142
Change in PV	+40	+8	-30	-76	-142
Economic income	+40	+48	+50	+44	+28
Economic return	0.20	0.20	0.20	0.20	0.20

Given that the cost of capital is 20 percent, these parlors are break-even investments; i.e., the rate of return equals the cost of capital (or investing $200,000 buys an asset worth $200,000). In that case, the rate of expansion is immaterial. The value of Kipper's stock should not be affected by the announcement that it intends to make more zero-NPV investments. If Kipper's sole asset in 2001 was one parlor, the market value of the common stock should be $200,000.

Now consider what happens to Kipper's book income and return. For the first expansion plan:

	Year 1	Year 2	Year 3	Year 4	Year 5
Number of parlors	1	2	3	4	5
Cash flow	0	40	120	240	410
BV start of year	200	360	480	560	600
Book depreciation	40	80	120	160	200
Book income	-40	-40	0	80	210
Book ROI	-0.20	-0.11	0	0.14	0.35

The steady-state book return of 35 percent is reached in year 5.

For the second expansion plan:

	Year 1	Year 2	Year 3	Year 4	Year 5
Number of parlors	1	3	6	10	15
Cash flow	0	40	160	400	810
BV start of year	200	560	1040	1600	2200
Book depreciation	40	120	240	400	600
Book income	-40	-80	-80	0	210
Book ROI	-0.20	-0.14	-0.08	0	0.10

By year 5, Kipper's book profitability has crept up to only 10 percent. Perhaps this explains the market letter's change of heart. Of course, Kipper's rate of expansion under the second plan must slow down eventually. The point is that, because economic depreciation is decelerated, more rapid growth in zero-NPV investments hurts book profitability. It would also reduce earnings per share. Of course, the rate at which you add zero-NPV investments does not affect economic return or economic earnings per share. Thus, the market letter has responded to book prospects, not to true value.

6. a. See table on next page. Note that economic depreciation is simply the change in market value, while book depreciation (per year) is:

$$[19.69 - (0.2 \times 19.69)]/15 = 1.05$$

Thus, economic depreciation is accelerated in this case, relative to book depreciation.

b. See table on next page. Note that the book rate of return exceeds the true rate in only the first year.

c. Because the economic return from investing in one airplane is 10 percent each year, the economic return from investing in a fixed number per year is also 10 percent each year. In order to calculate the book return, assume that we invest in one new airplane each year (the number of airplanes does not matter, just so long as it is the same each year). Then, book income will be (3.67 – 1.05) = 2.62 from the airplane in its first year, (3.00 – 1.95) = 1.95 from the airplane in its second year, etc., for a total book income of 15.21. Book value is calculated similarly: 19.69 for the airplane just purchased, 18.64 for the airplane that is one year old, etc., for a total book value of 185.10. Thus, the steady-state book rate of return is 8.22 percent, which understates the true (economic) rate of return (10 percent).

	Year							
	1	2	3	4	5	6	7	8
Market value	19.69	17.99	16.79	15.78	14.89	14.09	13.36	12.68
Economic depreciation		1.70	1.20	1.01	0.89	0.80	0.73	0.68
Cash flow		3.67	3.00	2.69	2.47	2.29	2.14	2.02
Economic income		1.97	1.80	1.68	1.58	1.49	1.41	1.34
Economic return		10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%
Book value	19.69	18.64	17.59	16.54	15.49	14.44	13.39	12.34
Book depreciation		1.05	1.05	1.05	1.05	1.05	1.05	1.05
Book income		2.62	1.95	1.64	1.42	1.24	1.09	0.97
Book return		13.3%	10.5%	9.3%	8.6%	8.0%	7.5%	7.2%

	Year							
	9	10	11	12	13	14	15	16
Market value	12.05	11.46	10.91	10.39	9.91	9.44	9.01	8.59
Economic depreciation	0.63	0.59	0.55	0.52	0.48	0.47	0.43	0.42
Cash flow	1.90	1.80	1.70	1.61	1.52	1.46	1.37	1.32
Economic income	1.27	1.21	1.15	1.09	1.04	0.99	0.94	0.90
Economic return	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%
Book value	11.29	10.24	9.19	8.14	7.09	6.04	4.99	3.94
Book depreciation	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05
Book income	0.85	0.75	0.65	0.56	0.47	0.41	0.32	0.27
Book return	6.9%	6.6%	6.3%	6.1%	5.8%	5.8%	5.3%	5.4%

CHAPTER 13
Corporate Financing and the Six Lessons of Market Efficiency

Answers to Practice Questions

1. a. An individual *can* do crazy things, but still not affect the efficiency of markets. The price of the asset in an efficient market is a consensus price as well as a marginal price. A nutty person can give assets away for free or offer to pay twice the market value. However, when the person's supply of assets or money runs out, the price will adjust back to its prior level (assuming there is no new, relevant information released by his action). If you are lucky enough to know such a person, you *will* receive a positive gain at the nutty investor's expense. You had better not count on this happening very often, though. Fortunately, an efficient market protects crazy investors in cases less extreme than the above. Even if they trade in the market in an "irrational" manner, they can be assured of getting a fair price since the price reflects all information.

   b. Yes, and how many people have dropped a bundle? Or more to the point, how many people have made a bundle only to lose it later? People can be lucky and some people can be very lucky; efficient markets do not preclude this possibility.

   c. Investor psychology is a slippery concept, more often than not used to explain price movements that the individual invoking it cannot personally explain. Even if it exists, is there any way to make money from it? If investor psychology drives up the price one day, will it do so the next day also? Or will the price drop to a 'true' level? Almost no one can tell you beforehand what 'investor psychology' will do. Theories based on it have no content.

   d. What good is a stable value when you can't buy or sell at that value because new conditions or information have developed which make the stable price obsolete? It is the market price, the price at which you can buy or sell today, which determines value.

2. a. There is risk in almost everything you do in daily life. You could lose your job or your spouse, or suffer damage to your house from a storm. That doesn't necessarily mean you should quit your job, get a divorce, or sell your house. If we accept that our world is risky, then we must accept that asset values fluctuate as new information emerges. Moreover, if capital markets are functioning properly, then stock price changes will follow a random walk. The random walk of values is the *result* of rational investors coping with an uncertain world.

b. To make the example clearer, assume that everyone believes in the same chart. What happens when the chart shows a downward movement? Are investors going to be willing to hold the stock when it has an expected loss? Of course not. They start selling, and the price will decline until the stock is expected to give a positive return. The trend will ‘self-destruct.’

c. Random-walk theory as applied to efficient markets means that fluctuations from the *expected* outcome are random. Suppose there is an 80 percent chance of rain tomorrow (because it rained today). Then the local umbrella store’s stock price will respond *today* to the prospect of high sales tomorrow. The store’s *sales* will not follow a random walk, but its stock price will, because each day the stock price reflects all that investors know about future weather and future sales.

3. One of the ways to think about market inefficiency is that it implies there is easy money to be made. The following appear to suggest market inefficiency:
   (b) strong form
   (d) weak form
   (e) semi-strong form

4. a. Companies tend to split after their stock has performed well, but that does not mean that the stock of each individual company in the figure performed well in *each* month before the split. Some may have performed well in month 12 and others in month 11, and so on. There is a smooth progression in the averages, but you could not have taken advantage of this unless you knew ahead of time which stocks would split and when they would split.

b. The price fell to levels prevailing before the announcement of the split.

5. Dividends. A company that pays high dividends is putting its money where its mouth is, i.e., showing that it has (and expects to continue to have) cash to distribute.

Capital Structure. If the manager suffers a penalty when the firm goes bankrupt, high leverage may be a signal of management confidence.

Manager’s Shareownership. An entrepreneur who puts her own money into the business is telling you something about that business’s prospects.

6. The estimates are first substituted in the market model. Then the result from this expected return equation is subtracted from the actual return for the month to obtain the abnormal return.

   Abnormal return (Intel) = Actual return - [0.07 + (1.61 $\times$ Market return)]

   Abnormal return (Conagra) = Actual return - [0.17 + (0.47 $\times$ Market return)]

7. One possible procedure is to first form groups of stocks with similar P/E ratios, adjusting for market risk (using either historical estimates of alpha or estimates based on the Capital Asset Pricing Model). Then determine whether the alpha of each group is significantly different from zero. Here are some things to look out for:
   a. Don't select samples of stock at the end of the period. You will have omitted the companies that went bankrupt.
   b. Include dividends in the actual rate of return. Low P/E stocks have high yields.
   c. Check that earnings are known on the date that you calculate P/E. Stocks whose earnings *subsequently* turned out high relative to price naturally perform better.
   d. Adjust for risk. Low P/E stocks tend to be more risky.
   e. You may need to disentangle the P/E effect from other effects, e.g., size or dividend yield.

8. This is not necessarily true. The company should consider its particular circumstances. There may be tax advantages to issuing debt or some other security, for example. The transaction costs of issuing some securities may be more than the costs of issuing others. (These and related issues are examined in subsequent chapters.)

9. The efficient market hypothesis does not imply that portfolio selection should be done with a pin. The manager still has three important jobs to do. First, she must make sure that the portfolio is well diversified. It should be noted that a large number of stocks is not enough to ensure diversification. Second, she must make sure that the risk of the diversified portfolio is appropriate for the manager's clients. Third, she might want to tailor the portfolio to take advantage of special tax laws for pension funds. These laws may make it possible to increase the expected return of the portfolio without increasing risk.

10. They are both under the illusion that markets are predictable and they are wasting their time trying to guess the market's direction. Remember the first lesson of market efficiency: Markets have no memory. The decision as to when to issue stock should be made without reference to 'market cycles.'

11. The efficient-market hypothesis says that there is no easy way to make money. Thus, when such an opportunity seems to present itself, we should be very skeptical. For example:
    - In the case of short- versus long-term rates, and borrowing short-term versus long-term, there are different risks involved. For example, suppose that we need the money long-term but we borrow short-term. When the short-term note is due, we must somehow refinance. However; this may not be possible, or may only possible at a very high interest rate.
    - In the case of Japanese versus United States interest rates, there is the risk that the Japanese yen - U.S. dollar exchange rate will change during the period of time for which we have invested.

12. Some key points are as follows:
    a. Unidentified Risk Factor: From an economic standpoint, given the information available and the number of participants, it is hard to believe that any securities market in the U.S is not very efficient. Thus, the most likely explanation for the small-firm effect is that the model used to estimate expected returns is incorrect, and that there is some as-yet-unidentified risk factor.
    b. Coincidence: In statistical inference, we never prove an affirmative fact. The best we can do is to accept or reject a specified hypothesis with a given degree of confidence. Thus, no matter what the outcome of a statistical test, there is always a possibility, however slight, that the small-firm effect is simply the result of statistical chance or, in other words, a coincidence.
    c. Market Inefficiency: One key to market efficiency is the high level of competition among participants in the market. For small stocks, the level of competition is relatively low because major market participants (e.g., mutual funds and pension funds) are biased toward holding the securities of larger, well-known companies. Thus, it is likely that the market for small stocks is fundamentally different from the market for larger stocks and hence, it is quite plausible that the small-firm effect is simply a reflection of market inefficiency.

13. Not true. If everyone believes that patterns exist, all will look for these patterns and all will trade based on such patterns. But such trading itself will destroy the patterns. Remember that we cannot all get rich simultaneously.

14. There are several ways to approach this problem, but all (when done correctly!) should give approximately the same answer. We have chosen to use the regression analysis function of an electronic spreadsheet program to calculate the alpha and beta for each security. The regressions are in the following form:

Security return = alpha + (beta × market return) + error term

The results are:

	Alpha	Beta
Executive Cheese	-0.89	0.50
Paddington Beer	-0.51	2.01

(As a point of interest, the R^2 for the Executive Cheese regression is 0.082, which is relatively low for a regression of this type. For Paddington Beer, it is 0.74, a relatively high value.)

The abnormal return for Executive Cheese in September 2000 was:

$$5.6 – [-0.89 + 0.50 \times (-5.7)] = 9.34\%$$

For Paddington Beer in January 2000 the abnormal return was:

$$-11.1 – [-0.51 + 2.01 \times (-9.5)] = 8.51\%$$

Thus, the average abnormal return of the two stocks during the month of the dividend announcement was 8.93 percent.

15. The market is most likely efficient. The government of Kuwait is not likely to have non-public information about the BP shares. Goldman Sachs is providing an intermediary service for which they should be remunerated. Stocks are bought at (higher) ask prices and sold at (lower) bid prices. The spread between the two ($0.11) is revenue for the broker. In the U.S., at that time, a bid-ask spread of 1/8 ($0.125) was not uncommon. The ‘profit’ of $15 million reflects the size of the order more than any mispricing.

Challenge Questions

1. Used car dealers do not have all relevant information about a car that they plan to purchase. The current owner, who wants to sell the car, is better informed about its condition. In order for the used car dealer to make up for the 'lemons' he unwittingly buys, he has to have a large spread between buying and selling prices.

   The bond dealer does not usually have to worry about buying a bond for too high a price from a seller with inside information. (If strong-form efficiency holds, the dealer doesn't have to worry at all.) Whether the dealer knows everything about the particular bond makes no difference. The market has the information and that information is reflected in the price. Therefore, the cost of 'lemons' is a relatively small part of the dealer's spread.

2. No, this does not follow. The decline in prices merely reflects the consensus market opinion about the seriousness of the country's difficulties. The stability after the announcement reflects the market's opinion of the nature of the assistance and its likelihood of success.

3. Internet exercise; answers will vary.

CHAPTER 14
An Overview of Corporate Financing

Answers to Practice Questions

1. Internet exercise; answers will vary.

2. In general, using market values of equity results in lower debt-to-total capital ratios. This occurs because the book value of equity reflects historical values at the time of the original stock issues. Market values reflect not only the firm's current operations but also the market's expectations of future operations.

3. Besides the function of providing funds to industry, capital markets also provide managers with information. Without this information, it would be very difficult to determine the firm's opportunity cost of capital or to assess the firm's financial performance.

   Capital markets provide liquidity for investors. Because individual stockholders can always recover retained earnings by selling shares, they are willing to invest in companies that retain earnings rather than paying out earnings as dividends. Well-functioning capital markets allow the firm to serve all its stockholders simply by maximizing value.

4. a. It appears that par value is approximately $0.05 per share, which is computed as follows:

   $213 million/4,260 million shares

   b. The shares were sold at an average price of:

   [$213 million + $5,416 million]/4,260 million shares = $1.32

   c. The company has repurchased:

   4,260 million - 3,847 million = 413 million shares.

   d. Average repurchase price:

   $6,851 million/413 million shares = $16.59 per share.

   e. The value of the net common equity is:

   $213 million + $5,416 million + $10,109 million - $6,851 million = $8,887 million

5. a. The day after the founding of Inbox:

Common shares ($0.10 par value)	$ 50,000
Additional paid-in capital	1,950,000
Retained earnings	0
Treasury shares at cost	0
Net common equity	$2,000,000

b. After 2 years of operation:

Common shares ($0.10 par value)	$ 50,000
Additional paid-in capital	1,950,000
Retained earnings	120,000
Treasury shares at cost	0
Net common equity	$2,120,000

c. After 3 years of operation:

Common shares ($0.10 par value)	$ 50,000
Additional paid-in capital	6,850,000
Retained earnings	370,000
Treasury shares at cost	0
Net common equity	$7,370,000

6. a.

Common shares ($0.25 par value)	$ 120.5
Additional paid-in capital	1,791.5
Retained earnings	4,757.0
Treasury shares	(2,920.0)
Other adjustments	(652.0)
Net common equity	$3,097.0

b.

Common shares ($0.25 par value)	$ 120.5
Additional paid-in capital	1,791.5
Retained earnings	4,757.0
Treasury shares	(3,620.0)
Other adjustments	(652.0)
Net common equity	$2,397.0

7. One would expect that the voting shares have a higher price because they have an added benefit/responsibility that has value.

8. a.

Gross profits	$	760,000
Interest		100,000
EBT	$	660,000
Tax (at 35%)		231,000
Funds available to common shareholders	$	429,000

b.

Gross profits	$	760,000
Interest		100,000
EBT	$	660,000
Tax (at 35%)		231,000
Net income	$	429,000
Preferred dividend		80,000
Funds available to common shareholders	$	349,000

9. Internet exercise; answers will vary.

10. a. Less valuable
b. More valuable
c. More valuable
d. Less valuable

Challenge Questions

1. a. For majority voting, you must own or otherwise control the votes of a simple majority of the shares outstanding, i.e., one-half plus one. Here, with 200,000 shares outstanding, you must control the votes of 100,001 shares.

   b. With cumulative voting, the directors are elected in order of the total number of votes each receives. With 200,000 shares outstanding and five directors to be elected, there will be a total of 1,000,000 votes cast. To ensure you can elect at least one director, you must ensure that someone else can elect at most four directors. That is, you must have enough votes so that, even if the others split their votes evenly among five other candidates, the number of votes your candidate gets would be higher by one.

   Let x be the number of votes controlled by you, so that others control (1,000,000 - x) votes. To elect one director:

$$x = \frac{1{,}000{,}000 - x}{5} + 1$$

   Solving, we find x = 166,667.8 votes, or 33,333.4 shares. Because there are no fractional shares, we need 33,334 shares.

2. A corporation could issue a bond whose interest payments are linked to economic variables, such as the level of unemployment or housing prices. Such a security might not be issued due to problems in measurement of the relevant economic variables, or the cash flows might have a low correlation with the firm's ability to pay.

   Other possibilities include:
   - Securities that act as a hedge for the issuer, such as bonds indexed to copper prices for a copper producer, or to real estate prices for a real estate firm.
   - Securities that may help to avoid undesirable outcomes, such as a bond that converts automatically to equity as the firm approaches bankruptcy.

CHAPTER 15
How Corporations Issue Securities

Answers to Practice Questions

1. a. Zero-stage financing represents the savings and personal loans the company's principals raise to start a firm. First-stage and second-stage financing comes from funds provided by others (often venture capitalists) to supplement the founders' investment.

   b. An after-the-money valuation represents the estimated value of the firm after the first-stage financing has been received.

   c. Mezzanine financing comes from other investors, after the financing provided by venture capitalists.

   d. A road show is a presentation about the firm given to potential investors in order to gauge their reactions to a stock issue and to estimate the demand for the new shares.

   e. A best efforts offer is an underwriter's promise to sell as much as possible of a security issue.

   f. A qualified institutional buyer is a large financial institution which, under SEC Rule 144A, is allowed to trade unregistered securities with other qualified institutional buyers.

   g. Blue-sky laws are state laws governing the sale of securities within the state.

2. a. Management's willingness to invest in Marvin's equity was a credible signal because the management team stood to lose everything if the new venture failed, and thus they signaled their seriousness. By accepting only part of the venture capital that would be needed, management was increasing its own risk and reducing that of First Meriam. This decision would be costly and foolish if Marvin's management team lacked confidence that the project would get past the first stage.

   b. Marvin's management agreed not to accept lavish salaries. The cost of management perks comes out of the shareholders' pockets. In Marvin's case, the managers *are* the shareholders.

3. Alternative procedures for initial public offerings of common stock include:
   a. Firm commitment underwriting in which the investment bankers buy the entire issue before reselling it to the public. The issuing company receives the money immediately, but at a price below the offering price.
   b. Best efforts offers in which the investment banker tries to sell as much of the issue as possible. The share price is higher but the entire issue may not be sold.
   c. In some countries, the issue may be auctioned off. In these cases, the firm may place a reserve (i.e., lowest acceptable) price, but both price and the number of shares sold are not known in advance.
   d. In a fixed price offer, the price of the shares is fixed and the number of shares sold is in question. If the price is too high, not enough shares will be sold; if the price is too low, the issue is oversubscribed and investors receive only a portion of their desired shares.

4. If he is bidding on under-priced stocks, he will receive only a portion of the shares he applies for. If he bids on under-subscribed stocks, he will receive his full allotment of shares, which no one else is willing to buy. Hence, on average, the stocks may be under-priced but once the weighting of all stocks is considered, it may not be profitable.

5. Some possible reasons for cost differences:
   a. Large issues have lower proportionate costs.
   b. Debt issues have lower costs than equity issues.
   c. Initial public offerings involve more risk for underwriters than issues of seasoned stock. Underwriters demand higher spreads in compensation.

6. There are several possible reasons why the issue costs for debt are lower than those of equity, among them:
   - The cost of complying with government regulations may be lower for debt.
   - The risk of the security is less for debt and hence the price is less volatile. This increases the probability that the issue will be mis-priced and therefore increases the underwriter's.

7. This is a one-time cost, not an annual cost, so it is not correct that flotation costs increase the cost of external equity capital by ten percentage points. However, flotation costs do increase the cost of external equity capital.

8. a. Inelastic demand implies that a large price reduction is needed in order to sell additional shares. This would be the case only if investors believe that a stock has no close substitutes (i.e., they value the stock for its unique properties).

b. Price pressure may be inconsistent with market efficiency. It implies that the stock price falls when new stock is issued and subsequently recovers.

c. If a company's stock is undervalued, managers will be reluctant to sell new stock, even if it means foregoing a good investment opportunity. The converse is true if the stock is overvalued. Investors know this and, therefore, mark down the price when companies issue stock. (Of course, managers of a company with undervalued stock become even more reluctant to issue stock because their actions can be misinterpreted.)

If (b) is the reason for the price fall, there should be a subsequent price recovery. If (a) is the reason, we would not expect a price recovery, but the fall should be greater for large issues. If (c) is the reason, the price fall will depend only on issue size (assuming the information is correlated with issue size).

9. A private placement is preferable to a public issue for firms that face high public issue costs, and for firms that may later require a re-negotiation of the terms of the debt contract.

10. a. Example: Before issue, there are 100 shares outstanding at \$10 per share. The company sells 20 shares for cash at \$5 per share. Company value increases by: (20 x \$5) = \$100. Thus, after issue, each share is worth:

$$\frac{(100 \times \$10) + \$100}{(100 + 20)} = \frac{\$1{,}100}{120} = \$9.17$$

Note that new shareholders gain: (20 × \$4.17) = \$83, while old shareholders lose: (100 × \$0.83) = \$83.

b. Example: Before issue, there are 100 shares outstanding at \$10 per share. The company makes a rights issue of 20 shares at \$5 per share. Each right is worth:

$$\text{Value of right} = \frac{(\text{rights on price}) - (\text{issue price})}{N + 1} = \frac{10 - 5}{6} = \$0.83$$

The new share price is \$9.17. If a shareholder sells his right, he receives \$0.83 cash and the value of each share declines by \$10 - \$9.17 = \$0.83. The shareholder's total wealth is unaffected.

11. [Note: The parts of this problem were labeled incorrectly in the first printing of the seventh edition.]

a. $5 \times (10{,}000{,}000/4) = \$12.5$ million

b. $$\text{Value of right} = \frac{(\text{rights on price}) - (\text{issue price})}{N + 1} = \frac{6 - 5}{4 + 1} = \$0.20$$

c. $$\text{Stock price} = \frac{(10{,}000{,}000 \times \$6) + \$12{,}500{,}000}{(10{,}000{,}000 + 2{,}500{,}000)} = \$5.80$$

A stockholder who previously owned four shares had stocks with a value of: (4 × \$6) = \$24. This stockholder has now paid \$5 for a fifth share so that the total value is: (\$24 + \$5) = \$29. This stockholder now owns five shares with a value of: (5 × \$5.80) = \$29, so that she is no better or worse off than she was before.

d. The share price would have to fall to the issue price per share, or \$5 per share. Firm value would then be: (10 million × \$5) = \$50 million

12. (\$12,500,000/\$4) = 3,125,000 shares

(\$10,000,000/3,125,000) = 3.20 rights per share

$$\text{Value of right} = \frac{(\text{rights on price}) - (\text{issue price})}{N + 1} = \frac{6 - 4}{3.2 + 1} = \$0.48$$

$$\text{Stock price} = \frac{(10{,}000{,}000 \times \$6) + \$12{,}500{,}000}{(10{,}000{,}000 + 3{,}125{,}000)} = \$5.52$$

A stockholder who previously owned 3.2 shares had stocks with a value of: (3.2 × \$6) = \$19.20. This stockholder has now paid \$4 for an additional share, so that the total value is: (\$19.20 + \$4) = \$23.20. This stockholder now owns 4.2 shares with a value of: (4.2 × \$5.52) = \$23.18 (difference due to rounding).

Challenge Questions

1. a. Venture capital companies prefer to advance money in stages because this approach provides an incentive for management to reach the next stage, and it allows First Meriam to check at each stage whether the project continues to have a positive NPV. Marvin is happy because it signals their confidence. With hindsight, First Meriam loses because it has to pay more for the shares at each stage.

   b. The problem with this arrangement would be that, while Marvin would have an incentive to ensure that the option was exercised, it would not have the incentive to maximize the price at which it sells the new shares.

   c. The right of first refusal could make sense if First Meriam was making a large up-front investment that it needed to be able to recapture in its subsequent investments. In practice, Marvin is likely to get the best deal from First Meriam.

2. In a uniform-price auction, all successful bidders pay the same price. In a discriminatory auction, each successful bidder pays a price equal to his own bid. A uniform-price auction provides for the pooling of information from bidders and reduces the winner's curse.

3. Pisa Construction's return on investment is 8%, whereas investors require a 10% rate of return. Pisa proposes a scenario in which 2,000 shares of common stock are issued at \$40 per share, and the proceeds (\$80,000) are then invested at 8%. Assuming that the 8% return is received in the form of a perpetuity, then the NPV for this scenario is computed as follows:

$$-\$80{,}000 + (0.08 \times \$80{,}000)/0.10 = -\$16{,}000$$

   Share price would decline as a result of this project, not because the company sells shares for less than book value, but rather due to the fact that the NPV is negative.

Note that, if investors know price will decline as a consequence of Pisa's undertaking a negative NPV investment, Pisa will not be able to sell shares at $40 per share. Rather, after the announcement of the project, the share price will decline to:

($400,000 - $16,000)/10,000 = $38.40

Therefore, Pisa will have to issue ($80,000/$38.40) = 2,083 new shares. One can show that, if the proceeds of the stock issue are invested at 10%, then share price remains unchanged.

4. This question is a matter of opinion. Students might discuss whether there are likely to be shortages of venture capital; for example, in some countries there might not be an active market for small firm IPOs. Another issue to be discussed is whether there are side benefits to the rest of the economy from an active venture capital industry.

CHAPTER 16
The Dividend Controversy

Answers to Practice Questions

1. Newspaper exercise; answers will vary depending on the stocks chosen.

2. The available evidence is consistent with the observation that managers believe shareholders prefer a steady progression of dividends. For managers of risky companies whose earnings have high variability, it is easy to show, using the Lintner model, that a lower target payout (e.g., zero) and a lower adjustment rate (e.g., zero) reduce the variance of dividend changes.

3. a. Distributes a relatively low proportion of current earnings to offset fluctuations in operational cash flow; lower P/E ratio.

   b. Distributes a relatively high proportion of current earnings since the decline is unexpected; higher P/E ratio.

   c. Distributes a relatively low proportion of current earnings in order to offset anticipated declines in earnings; lower P/E ratio.

   d. Distributes a relatively low proportion of current earnings in order to fund expected growth; higher P/E ratio.

4. a. A t = 0 each share is worth \$20. This value is based on the expected stream of dividends: \$1 at t = 1, and increasing by 5% in each subsequent year. Thus, we can find the appropriate discount rate for this company as follows:

$$P_0 = \frac{DIV_1}{r - g}$$

$$20 = \frac{1}{r - g} \quad \Rightarrow \quad r = 0.10 = 10.0\%$$

Beginning at t = 2, each share in the company will enjoy a perpetual stream of growing dividends: \$1.05 at t = 2, and increasing by 5% in each subsequent year. Thus, the total value of the shares at t = 1 (after the t = 1 dividend is paid and after N new shares have been issued) is given by:

$$V_1 = \frac{1.05 \text{ million}}{0.10 - 0.05} = \$21 \text{ million}$$

If P_1 is the price per share at t = 1, then:

$$V_1 = P_1 \times (1{,}000{,}000 + N) = \$21{,}000{,}000$$

and:

$$P_1 \times N = \$1{,}000{,}000$$

From the first equation:

$$(1{,}000{,}000 \times P_1) + (N \times P_1) = 21{,}000{,}000$$

Substituting from the second equation:

$$(1{,}000{,}000 \times P_1) + 1{,}000{,}000 = 21{,}000{,}000$$

so that P_1 = \$20.00

b. With P_1 equal to \$20, and \$1,000,000 to raise, the firm will sell 50,000 new shares.

c. The expected dividends paid at t = 2 are \$1,050,000, increasing by 5% in each subsequent year. With 1,050,000 shares outstanding, dividends per share are: \$1 at t = 2, increasing by 5% in each subsequent year. Thus, total dividends paid to old shareholders are: \$1,000,000 at t = 2, increasing by 5% in each subsequent year.

d. For the current shareholders:

$$PV(t=0) = \frac{\$2{,}000{,}000}{1.10} + \frac{\$1{,}000{,}000}{(0.10-0.05)\times(1.10)} = \$20{,}000{,}000$$

5. From Question 4, the fair issue price is \$20 per share. If these shares are instead issued at \$10 per share, then the new shareholders are getting a bargain, i.e., the new shareholders win and the old shareholders lose.

   As pointed out in the text, any increase in cash dividend must be offset by a stock issue if the firm's investment and borrowing policies are to be held constant. If this stock issue cannot be made at a fair price, then shareholders are clearly not indifferent to dividend policy.

6. The risk stems from the decision to not invest, and it is not a result of the form of financing. If an investor consumes the dividend instead of re-investing the dividend in the company's stock, she is also 'selling' a part of her stake in the company. In this scenario, she will suffer an equal opportunity loss if the stock price subsequently rises sharply.

7. No, this does *not* make sense. Restricting dividends does not restrict the investor's 'wages.' For the policy to be effective, it would also have to restrict capital gains.

8. If the company does not pay a dividend:

Cash	0	0	Debt
Existing fixed assets	4,500	5,500 + NPV	Equity
New project	1,000 + NPV		
	$5,500 + NPV	$5,500 + NPV	

If the company pays a $1,000 dividend:

Cash	0	0	Debt
Existing fixed assets	4,500	1,000	Value of new stock
New project	1,000 + NPV	4,500 + NPV	Value of original stock
	$5,500 + NPV	$5,500 + NPV	

Because the new stockholders receive stock worth $1,000, the value of the original stock declines by $1,000, which exactly offsets the dividends.

9. One problem with this analysis is that it assumes the company's net profit remains constant even though the asset base of the company shrinks by 20%. That is, in order to raise the cash necessary to repurchase the shares, the company must sell assets. If the assets sold are representative of the company as a whole, we would expect net profit to decrease by 20% so that earnings per share and the P/E ratio remain the same. After the repurchase, the company will look like this next year:

Net profit:	$8	million
Number of shares:	0.8	million
Earnings per share:	$10	
Price-earnings ratio:	20	
Share price:	$200	

10. a. If we ignore taxes and there is no information conveyed by the repurchase when the repurchase program is announced, then share price will remain at $80.

b. The regular dividend has been $4 per share, and so the company has $400,000 cash on hand. Since the share price is $80, the company will repurchase 5,000 shares.

c. Total asset value (before each dividend payment or stock repurchase) remains at $8,000,000. These assets earn $400,000 per year, under either policy.

Old Policy: The annual dividend is $4, which never changes, so the stock price (immediately prior to the dividend payment) will be $80 in all years.

New Policy: Every year, $400,000 is available for share repurchase. As noted above, 5,000 shares will be repurchased at t = 0. At t = 1, immediately prior to the repurchase, there will be 95,000 shares outstanding. These shares will be worth $8,000,000, or $84.21 per share. With $400,000 available to repurchase shares, the total number of shares repurchased will be 4,750. Using this reasoning, we can generate the following table:

Time	Shares Outstanding	Share Price	Shares Repurchased
t = 0	100,000	$80.00	5,000
t = 1	95,000	$84.21	4,750
t = 2	90,250	$88.64	4,513
t = 3	85,737	$93.31	4,287

Note that the stock price is increasing by 5.26% each year. This is consistent with the rate of return to the shareholders under the old policy, whereby every year assets worth $7,600,000 (the asset value immediately after the dividend) earn $400,000, or a return of 5.26%.

11. If markets are efficient, then a share repurchase is a zero-NPV investment. Suppose that the trade-off is between an investment in real assets or a share repurchase. Obviously, the shareholders would prefer a share repurchase to a negative-NPV project. The quoted statement seems to imply that firms have only negative-NPV projects available.

    Another possible interpretation is that managers have inside information indicating that the firm’s stock price is too low. In this case, share repurchase is detrimental to those stockholders who sell and beneficial to those who do not. It is difficult to see how this could be beneficial to the firm, however.

12. Because companies are reluctant to reduce their dividends, they will normally increase dividends only when management is fairly certain that the increases can be sustained. Thus, an increase in dividends signals management’s confidence about the company’s future earnings potential, and it is this signal that causes the stock price to rise.

13. a. This statement implicitly equates the cost of equity capital with the stock's dividend yield. If this were true, companies that pay no dividend would have a zero cost of equity capital, which is clearly not correct.

b. One way to think of retained earnings is that, from an economic standpoint, the company earns money on behalf of the shareholders, who then immediately re-invest the earnings in the company. Thus, retained earnings do not represent free capital. Retained earnings carry the full cost of equity capital (although issue costs associated with raising new equity capital are avoided).

c. If the tax on capital gains is less than that on dividends, the conclusion of this statement is correct; i.e., a stock repurchase is always preferred over dividends. This conclusion, however, is strictly because of taxes. Earnings per share is irrelevant.

14. a. If we assume that the constraint on dividends is binding, that is, if we assume that dividends would have risen in the absence of the constraint, then the restriction on dividends would increase capital gains. In other words, the total return to shareholders would not change. Dividends would be lower than otherwise, but capital gains would increase to offset the reduction in dividends. Thus, stock prices would increase.

b. The total return to equity capital is unchanged, and the firm's overall cost of capital is also unchanged. Thus, there will be no effect on capital investment.

15. a. Because this is a regular dividend, the announcement is not news to the stock market. Hence, the stock price will adjust only when the stock begins to trade without the dividend and, thus, the stock price will fall on the ex-dividend date.

b. With no taxes, the stock price will fall by the amount of the dividend, here $1.

c. With taxes on dividends but no taxes on capital gains, investors will require the same after-tax return from two comparable companies, one of which pays a dividend, the other, a capital gain of the same magnitude. The stock price will thus fall by the amount of the after-tax dividend, here $\$1 \times (1 - 0.30) = \$0.70$.

d. If dealers are taxed equally on capital gains and dividends, then they should not demand any extra return for holding stocks that pay dividends. Thus, if shareholders are able to freely trade securities around the time of the dividend payment, there should be no tax effects associated with dividends.

16. a. If you own 100 shares at $100 per share, then your wealth is $10,000. After the dividend payment, each share will be worth $99 and your total wealth will be the same: 100 shares at $99 per share plus $100 in dividends, or $10,000.

b. With no taxes, it does not matter how the company transfers wealth to the shareholders; that is, you are indifferent between a dividend and a share repurchase program. In either case, your total wealth will remain at $10,000.

17. *After-tax Return on Share A*: At t = 1, a shareholder in company A will receive a dividend of $10, which is subject to taxes of 30%. Therefore, the after-tax gain is $7. Since the initial investment is $100, the after-tax rate of return is 7%.

After-tax Return on Share B: If an investor sells share B after 2 years, the price will be: $(100 \times 1.10^2) = \$121$. The capital gain of $21 is taxed at the 30% rate, and so the after-tax gain is $14.70. On an initial investment of $100, over a 2-year time period, this is an after-tax annual rate of return of 7.10%.

If an investor sells share B after 10 years, the price will be:
$(100 \times 1.10^{10}) = \$259.37$. The capital gain of $159.37 is taxed at the 30% rate, and so the after-tax gain is $111.56. On an initial investment of $100, over a 10-year time period, this is an after-tax annual rate of return of 7.78%.

18. a. (i) The tax-free investor should buy on the with-dividend date because the dividend is worth $1 and the price decrease is only $0.90.
(ii) The dividend is worth only $0.60 to the taxable investor who is subject to a 40% marginal tax rate. Therefore, this investor should buy on the ex-dividend date. [Actually, the taxable investor's problem is a little more complicated. By buying at the ex-dividend price, this investor increases the capital gain that is eventually reported upon the sale of the asset. At most, however, this will cost:
$(0.16 \times 0.90) = \$0.14$
This is not enough to offset the tax on the dividend.]

b. The marginal investor, by definition, must be indifferent between buying with-dividend or ex-dividend. If we let T represent the marginal tax rate on dividends, then the marginal tax rate on capital gains is (0.4T). In order for the net extra return from buying with-dividend (instead of ex-dividend) to be zero:

- Extra investment + After-tax dividend + Reduction in capital gains tax = 0

Therefore, per dollar of dividend:

$$-0.85 + [(1 - T) \times (1.00)] + [(0.4T) \times (0.85)] = 0$$

$$T = 0.227 = 22.7\%$$

c. We would expect the high-payout stocks to show the largest decline per dollar of dividends paid because these stocks should be held by investors in low, or perhaps even zero, marginal tax brackets.

d. Some investors (e.g., pension funds and security dealers) are indifferent between $1 of dividends and $1 of capital gains. These investors should be prepared to buy any amount of stock with-dividend as long as the fall-off in price is fractionally less than the dividend. Elton and Gruber's result suggests that there must be some impediment to such tax arbitrage (e.g., transactions costs or IRS restrictions). But, in that case, it is difficult to interpret their result as indicative of marginal tax rates.

e. Since the passage of the Tax Reform Act, the tax advantage to capital gains has been reduced. If investors are now indifferent between dividends and capital gains, we would expect that the payment of a $1 dividend would result in a $1 decrease in price.

19. Under the tax system in the United States, the only investors who are indifferent to the dividend payout ratio are those who pay the same tax rate on dividends as on capital gains. This is true regardless of the corporate tax rate.

Under Australia's imputation tax system, shareholders pay income tax on dividends received, but they can deduct from their tax bill their share of the corporate tax on pre-tax earnings paid by the company. The only investors who would be indifferent with regard to the payout ratio are those whose marginal tax rate is 100%, because they do not receive anything after tax, regardless of whether the income is a capital gain or a dividend. Therefore, all Australian investors prefer dividends because the corporation, in effect, pays part of the personal tax on dividends but pays no part of the personal tax on capital gains.

20. Even if the middle-of-the-road party is correct about the supply of dividends, we still do not know why investors wanted the dividends they got. So, it is difficult to be sure about the effect of the tax change. If there is some non-tax advantage to dividends that offsets the apparent tax disadvantage, then we would expect investors to demand more dividends after the Tax Reform Act. If the apparent tax disadvantage were irrelevant because there were too many loopholes in the tax system, then the Tax Reform Act would not affect the demand for dividends. In any case, the middle-of-the-roaders would argue that once companies adjusted the supply of dividends to the new equilibrium, dividend policy would again become irrelevant.

Challenge Questions

1. We make use of Lintner's model, suitably rearranged:

   DIV_t = Adjustment Rate x Target Ratio x EPS_t + (1 – Adjustment Rate) x DIV_{t-1}

   Thus, if we regress dividends at time t against earnings per share (also at time t) and dividends (at time t – 1), the adjustment rate and the target rate can be found as follows:

   Adjustment Rate = 1 – (coefficient of DIV_{t-1})

   Target Ratio = (coefficient of EPS_t)/Adjustment Rate

   These two regressions were performed using Excel® (forcing the constant to be zero). The results are:

	Merck	International Paper
Adjustment Rate	0.043	0.009
Target Ratio	1.574	2.309

   For Merck, if EPS in 2001 is $5, then the predicted dividend in 2001 is:

   DIV_{2001} = (0.043)×(1.574)×(5.00) + (1 - 0.043)×(1.21) = $1.50

   For International Paper, if EPS in 2001 is $3, then the predicted dividend in 2001 is:

   DIV_{2001} = (0.009)×(2.309)×(3.00) + (1 - 0.009)×(1.00) = $1

2. Reducing the amount of earnings retained each year will, of course, reduce the growth rate of dividends. Also, the firm will have to issue new shares each year in order to finance company growth. Under the original dividend policy, we expect next year's stock price to be: ($50 × 1.08) = $54. If N is the number of shares previously outstanding, the value of the company at t = 1 is (54N).

   Under the new policy, n new shares will be issued at t = 1 to make up for the reduction in retained earnings resulting from the new policy. This decrease is: ($4 - $2) = $2 per original share, or an aggregate reduction of 2N. If P_1 is the price of the common stock at t = 1 under the new policy, then:

   $2N = nP_1$

   Also, because the total value of the company is unchanged:

   $54N = (N + n)P_1$

   Solving, we find that P_1 = $52.

If g is the expected growth rate under the new policy and P_0 the price at t = 0, we have:

$$52 = (1 + g)P_0$$

and:

$$P_0 = \frac{4}{0.12 - g}$$

Substituting the second equation above for P_0 in the first equation and then solving, we find that g = 4% and P_0 = $50, so that the current stock price is unchanged.

3. Generally, a share repurchase is viewed as a signal that::
   a. Management desires to avoid excess cash, and/or;
   b. Management desires to Increase the debt:equity ratio, and/or;
   c. The stock is a good value even at 20% above the current market share price.

   Under any or all of these conditions, the share price would likely increase. Conversely, if the repurchase made the firm substantially more risky, or if managers were having their own shares repurchased, or if the action was interpreted as an inability to find positive NPV projects for the future, then the share price might either remain unchanged or decrease.

4. It is true that researchers have been consistent in finding a positive association between price-earnings multiples and payout ratios. But simple tests like this one do not isolate the effects of dividend policy, so the evidence is not convincing.

   Suppose that King Coal Company, which customarily distributes half its earnings, suffers a strike that cuts earnings in half. The setback is regarded as temporary, however, so management maintains the normal dividend. The payout ratio for that year turns out to be 100 percent, not 50 percent.

   The temporary earnings drop also affects King Coal's price-earnings ratio. The stock price may drop because of this year's disappointing earnings, but it does not drop to one-half its pre-strike value. Investors recognize the strike as temporary, and the ratio of price to this year's earnings increases. Thus, King Coal's labor troubles create both a high payout ratio and a high price-earnings ratio. In other words, they create a spurious association between dividend policy and market value. The same thing happens whenever a firm encounters temporary good fortune, or whenever reported earnings underestimate or overestimate the true long-run earnings on which both dividends and stock prices are based.

A second source of error is omission of other factors affecting both the firm's dividend policy and its market valuation. For example, we know that firms seek to maintain stable dividend rates. Companies whose prospects are uncertain therefore tend to be conservative in their dividend policies. Investors are also likely to be concerned about such uncertainty, so that the stocks of such companies are likely to sell at low multiples. Again, the result is an association between the price of the stock and the payout ratio, but it stems from the common association with risk and not from a market preference for dividends.

Another reason that earnings multiples may be different for high-payout and low-payout stocks is that the two groups may have different growth prospects. Suppose, as has sometimes been suggested, that management is careless in the use of retained earnings but exercises appropriately stringent criteria when spending external funds. Under such circumstances, investors would be correct to value stocks of high-payout firms more highly. But the reason would be that the companies have different investment policies. It would not reflect a preference for high dividends as such, and no company could achieve a lasting improvement in its market value simply by increasing its payout ratio.

CHAPTER 17
Does Debt Policy Matter?

Answers to Practice Questions

1. a. The two firms have equal value; let V represent the total value of the firm. Rosencrantz could buy one percent of Company B's equity and borrow an amount equal to:

$$0.01 \times (D_A - D_B) = 0.002V$$

This investment requires a net cash outlay of (0.007V) and provides a net cash return of:

$$(0.01 \times \text{Profits}) – (0.003 \times r_f \times V)$$

where r_f is the risk-free rate of interest on debt. Thus, the two investments are identical.

b. Guildenstern could buy two percent of Company A's equity and lend an amount equal to:

$$0.02 \times (D_A - D_B) = 0.004V$$

This investment requires a net cash outlay of (0.018V) and provides a net cash return of:

$$(0.02 \times \text{Profits}) – (0.002 \times r_f \times V)$$

Thus the two investments are identical.

c. The expected dollar return to Rosencrantz' original investment in A is:

$$(0.01 \times C) – (0.003 \times r_f \times V_A)$$

where C is the expected profit (cash flow) generated by the firm's assets. Since the firms are the same except for capital structure, C must also be the expected cash flow for Firm B. The dollar return to Rosencrantz' alternative strategy is:

$$(0.01 \times C) – (0.003 \times r_f \times V_B)$$

Also, the cost of the original strategy is ($0.007V_A$) while the cost of the alternative strategy is ($0.007V_B$).

If V_A is less than V_B, then the original strategy of investing in Company A would provide a larger dollar return at the same time that it would cost less than the alternative. Thus, no rational investor would invest in Company B if the value of Company A were less than that of Company B.

2. When a firm issues debt, it shifts its cash flow into two streams. MM's Proposition I states that this does not affect firm value if the investor can reconstitute a firm's cash flow stream by creating personal leverage or by undoing the effect of the firm's leverage by investing in both debt and equity.

   It is similar with Carruther's cows. If the cream and skim milk go into the same pail, the cows have no special value. (If an investor holds both the debt and equity, the firm does not add value by splitting the cash flows into the two streams.) In the same vein, the cows have no special value if a dairy can costlessly split up whole milk into cream and skim milk. (Firm borrowing does not add value if investors can borrow on their own account.) Carruther's cows will have extra value if consumers want cream and skim milk and if the dairy cannot split up whole milk, or if it is costly to do so.

3. The company cost of capital is:

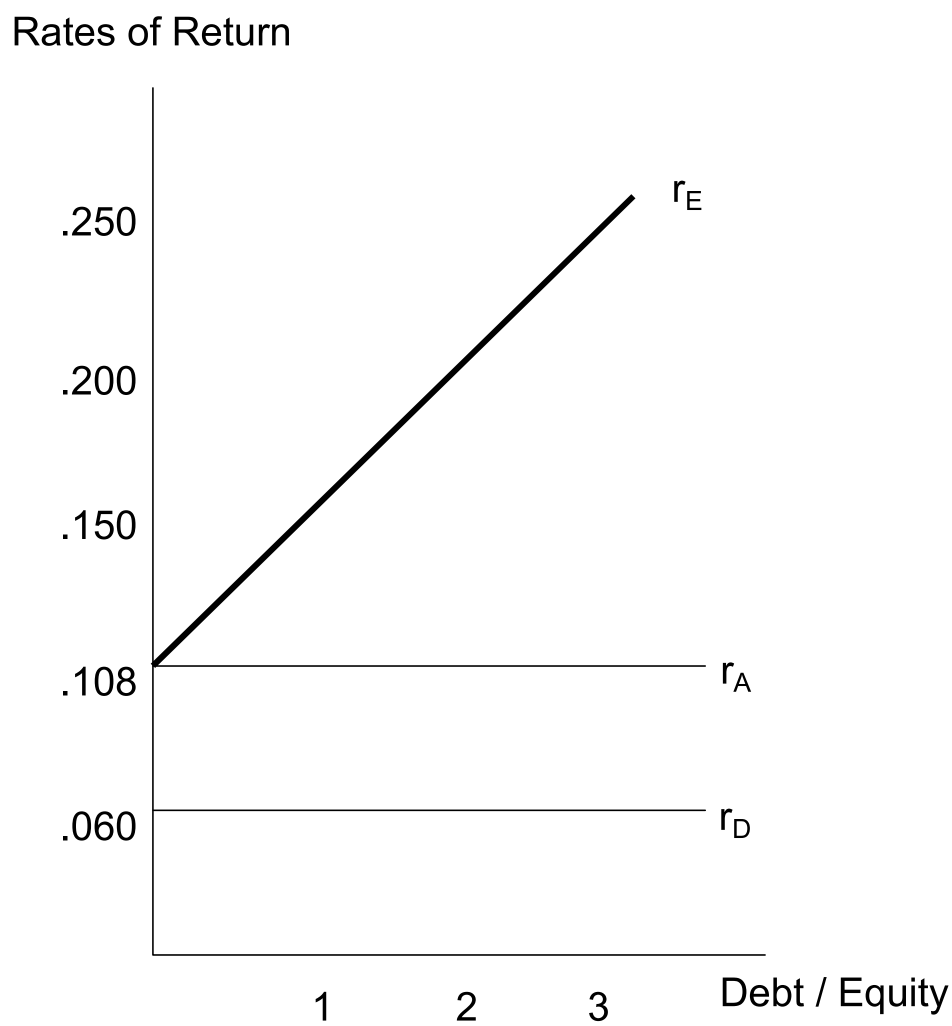
   $$r_A = (0.8 \times 0.12) + (0.2 \times 0.06) = 0.108 = 10.8\%$$

   Under Proposition I, this is unaffected by capital structure changes. With the bonds remaining at the 6 percent default-risk free rate, we have:

Debt-Equity Ratio	r_E	r_A
0.00	0.108	0.108
0.10	0.113	0.108
0.50	0.132	0.108
1.00	0.156	0.108
2.00	0.204	0.108
3.00	0.252	0.108

   See figure on next page.

4. This is not a valid objection. MM's Proposition II explicitly allows for the rates of return for both debt and equity to increase as the proportion of debt in the capital structure increases. The rate for debt increases because the debt-holders are taking on more of the risk of the firm; the rate for common stock increases because of increasing financial leverage. See Figure 17.2 and the accompanying discussion.


Rates of Return
.250
.200
.150
.108
.060
r_E
r_A
r_D
1
2
3
Debt / Equity

5. a. Under Proposition I, the firm's cost of capital (r_A) is not affected by the choice of capital structure. The reason the quoted statement seems to be true is that it does not account for the changing proportions of the firm financed by debt and equity. As the debt-equity ratio increases, it is true that both the cost of equity and the cost of debt increase, but a smaller proportion of the firm is financed by equity. The overall effect is to leave the firm's cost of capital unchanged.

   b. Moderate borrowing does not significantly affect the probability of financial distress, but it does increase the variability (and market risk) borne by stockholders. This additional risk must be offset by a higher average return to stockholders.

6. a. If the opportunity were the firm's only asset, this would be a good deal. Stockholders would put up no money and, therefore, would have nothing to lose. However, rational lenders will not advance 100 percent of the asset's value for an 8 percent promised return unless other assets are put up as collateral.

   Sometimes firms find it convenient to borrow all the cash required for a particular investment. Such investments do not support all of the additional debt; lenders are protected by the firm's other assets too.

   In any case, if firm value is independent of leverage, then any asset's contribution to firm value must be independent of how it is financed. Note also that the statement ignores the effect on the stockholders of an increase in financial leverage.

   b. This is not an important reason for conservative debt levels. So long as MM's Proposition I holds, the company's overall cost of capital is unchanged despite increasing interest rates paid as the firm borrows more. (However, the increasing interest rates may signal an increasing probability of financial distress—and that can be important.

7. Examples of such securities are given in the text and include unbundled stock units, preferred equity redemption cumulative stock and floating-rate notes. Note that, in order to succeed, such securities must both meet regulatory requirements and appeal to an unsatisfied clientele.

8. Why does share price drop during a recession? Because forecasted cash flows to stockholders decline. (Stockholders may also perceive higher risks and demand a higher expected rate of return.) The stock price will decline to the point where the expected return to the stock, given the amount of debt, is a 'fair' return.

Suppose that a recession hits and stock price declines. Would the cost of capital for new investment be less if the firm had used more debt in the past? No, the firm's past financing decisions are bygones. Moreover, MM's Proposition I holds in recessions as well as booms. The firm's overall cost of capital is independent of its debt ratio.

Incidentally, the more debt a firm has, the greater the percentage decline in the value of its shares as a result of a recession or any other unfortunate event.

9. a. As the debt/equity ratio increases, both the cost of debt capital and the cost of equity capital increase. The cost of debt capital increases because increasing the debt/equity ratio increases the risk of default so that bondholders require a higher rate of return to compensate for the increase in risk. The cost of equity capital increases because increasing the debt/equity ratio increases the financial risk borne by the stockholders; a higher rate of return is required to compensate for this increase in risk.

   b. For higher levels of the debt/equity ratio, we have the cost of debt capital increasing and approaching (but never being equal to, or greater than) the cost of capital for the firm. Similarly, the cost of equity capital will also continue to rise; in particular, it can not decrease beyond a certain point.

10. a. As leverage is increased, the cost of equity capital rises. This is the same as saying that, as leverage is increased, the ratio of the income after interest (which is the cash flow stockholders are entitled to) to the value of equity increases. Thus, as leverage increases, the ratio of the market value of the equity to income after interest decreases.

    b. (i) Assume MM are correct. The market value of the firm is determined by the income of the firm, not how it is divided among the firm's security holders. Also, the firm's income before interest is independent of the firm's financing. Thus, both the value of the firm and the value of the firm's income before interest remain constant as leverage is increased. Hence, the ratio is a constant.

    (ii) Assume the traditionalists are correct. The firm's income before interest is independent of leverage. As leverage increases, the firm's cost of capital first decreases and then increases; as a result, the market value of the firm first increases and then decreases. Thus, the ratio of the market value of the firm to firm income before interest first increases and then decreases, as leverage increases.

11. We begin with r_E and the capital asset pricing model:

$$r_E = r_f + \beta_E (r_m - r_f)$$

$$r_E = 0.10 + 1.5 (0.18 - 0.10) = 0.22 = 22.0\%$$

Similarly for debt:

$$r_D = r_f + \beta_D (r_m - r_f)$$

$$0.12 = 0.10 + \beta_D (0.18 – 0.10)$$

$$\beta_D = 0.25$$

Also, we know that:

$$r_A = \left(\frac{D}{D+E} \times r_D\right) + \left(\frac{E}{D+E} \times r_E\right) = (0.5 \times 0.12) + (0.5 \times 0.22) = 0.17 = 17.0\%$$

To solve for β_A, use the following:

$$\beta_A = \left(\frac{D}{D+E} \times \beta_D\right) + \left(\frac{E}{D+E} \times \beta_E\right) = (0.5 \times 0.25) + (0.5 \times 1.5) = 0.875$$

12. We know from Proposition I that the value of the firm will not change. Also, because the expected operating income is unaffected by changes in leverage, the firm's overall cost of capital will not change. In other words, r_A remains equal to 17% and β_A remains equal to 0.875. However, risk and, hence, the expected return for equity and for debt, will change. We know that r_D is 11%, so that, for debt:

$$r_D = r_f + \beta_D (r_m - r_f)$$

$$0.11 = 0.10 + \beta_D (0.18 - 0.10)$$

$$\beta_D = 0.125$$

For equity:

$$r_A = \left(\frac{D}{D+E} \times r_D\right) + \left(\frac{E}{D+E} \times r_E\right)$$

$$0.17 = (0.3 \times 0.11) + (0.7 \times r_E)$$

$$r_E = 0.196 = 19.6\%$$

Also:

$$r_E = r_f + \beta_E (r_m - r_f)$$

$$0.196 = 0.10 + \beta_E (0.18 - 0.10)$$

$$\beta_E = 1.20$$

13. Before the refinancing, Schuldenfrei is all equity financed. The equity beta is 0.8 and the expected return on equity is 8%. Thus, the firm's asset beta is 0.8 and the firm's cost of capital is 8%. We know that these overall firm values will not change after the refinancing and that the debt is risk-free.

a. $$\beta_A = \left(\frac{D}{D+E} \times \beta_D\right) + \left(\frac{E}{D+E} \times \beta_E\right)$$

$0.8 = (0.5 \times 0) + (0.5 \times \beta_E)$

$\beta_E = 1.60$

b. Before the refinancing, the stock's required return is 8% and the risk-free rate is 5%; thus, the risk premium for the stock is 3%.

c. After the refinancing:

$$r_A = \left(\frac{D}{D+E} \times r_D\right) + \left(\frac{E}{D+E} \times r_E\right)$$

$0.08 = (0.5 \times 0.05) + (0.5 \times r_E)$

$r_E = 0.11 = 11.0\%$

After the refinancing, the risk premium for the stock is 6%.

d. The required return for the debt is 5%, the risk-free rate.

e. The required return for the company remains at 8%.

f. Let E be the operating profit of the company and N the number of shares outstanding before the refinancing. Also, we know that E is (0.08V). Thus, the earnings per share before the refinancing is:

$EPS_B = 0.08V/N$

After the refinancing the operating profit is still E and the number of shares is $(0.5 \times N)$. Interest on the debt is 5% of the value of the debt, which is $(0.5 \times V)$. Thus, the earnings per share after the refinancing is:

$EPS_A = [0.08V - (0.05 \times 0.5 \times V)]/(0.5 \times N) = 0.11V/N$

It follows that earnings per share has increased by 37.5%.

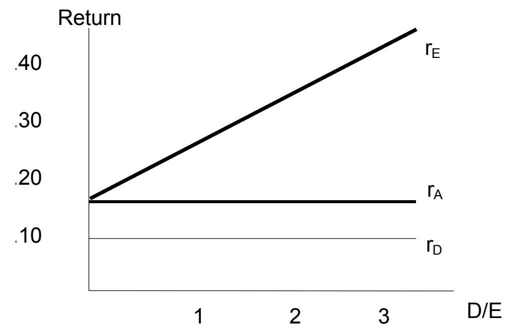
g. Before the refinancing, the P/E ratio is 12.5. The price of the common stock is the same before and after the refinancing, but the earnings per share has increased from (0.08V/N) to (0.11V/N). (See Part (f) above.) Thus, the new P/E ratio is 9.09.

14. We make use of the basic relationship:

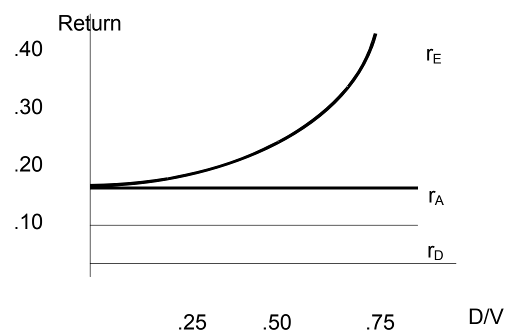
$$r_A = \left(\frac{D}{D+E} \times r_D\right) + \left(\frac{E}{D+E} \times r_E\right)$$

If the company is all-equity-financed and the cost of equity capital (r_E) is 18%, then the company cost of capital (r_A) is 18%, which will not change as the capital structure changes. In addition, we know that the risk-free rate (r_f) is 10% and that Gamma's debt is risk-free. Thus:

D/E	r_A	r_D	r_E
0	0.18	0.10	0.18
1	0.18	0.10	0.26
2	0.18	0.10	0.34
3	0.18	0.10	0.42



D/V	r_A	r_D	r_E
0	0.18	0.10	0.180
0.25	0.18	0.10	0.207
0.50	0.18	0.10	0.260
0.75	0.18	0.10	0.420



15. a. Because the firms are identical except for capital structure, and there are no taxes or other market imperfections, the total values of these companies must be the same. Thus, L's stock is worth: (\$500 - \$400) = \$100.

b. If you own \$20 of U's common stock, you own 4% of the outstanding shares and, thus, are entitled to (0.04 × \$150) = \$6 if there is a boom and (0.04 × \$50) = \$2 if there is a slump.

The equivalent investment is to purchase 4% of L's outstanding stock, which will cost (0.04 × \$100) = \$4, and to invest \$16 at the risk-free rate. The total amount invested is the same (\$20). In a boom, you are entitled to: [(0.10 × \$16) + (0.04) × (\$150 - \$40)] = \$6, and in a slump you are entitled to: [(0.10 × \$16) + (0.04) × (\$50 - \$40)] = \$2.

c. If you own $20 of L's common stock, you own 20% of the outstanding shares and, thus, are entitled to [0.20 × ($150 - $40)] = $22 if there is a boom, and [0.20 × ($50 - $40) = $2 if there is a slump.

The equivalent investment is to purchase 20% of U's outstanding stock, which costs: (0.20 × $500) = $100 and to borrow $80 at the risk-free rate. The total invested is the same ($20). In a boom you are entitled to: [(-0.10) × ($80) + (0.20 × $150)] = $22 and in a slump you are entitled to: [(-0.10) × ($80) + (0.20 × $50)] = $2.

d. Proposition II can be stated as follows:

$$r_E = r_A + \frac{D}{E}(r_A - r_D)$$

For U, the expected return on assets is:

$$\frac{(0.5 \times \$50) + (0.5 \times \$150)}{\$500} = \frac{\$100}{\$500} = 0.20 = 20.0\%$$

Thus, for both companies, r_A is 20%. For L, the expected return on equity is:

$$\frac{[0.5 \times (\$50 - \$40)] + [0.5 \times (\$150 - \$40)]}{\$100} = \frac{\$60}{\$100} = 0.60 = 60.0\%$$

This is the same result we derive from the Proposition II formula:

r_E = 0.20 + [4 × (0.20 - 0.10) = 0.60 = 60%

Challenge Questions

1. Assume the election is near so that we can safely ignore the time value of money.

   Because one, and only one, of three events will occur, the guaranteed payoff from holding all three tickets is $10. Thus, the three tickets, taken together, could never sell for less than $10. This is true whether they are bundled into one composite security or unbundled into three separate securities.

   However, unbundled they may sell for more than $10. This will occur if the separate tickets fill a need for some currently unsatisfied clientele. If this is indeed the case, Proposition I fails. The sum of the parts is worth more than the whole.

2. Some shoppers may want only the chicken drumstick. They could buy a whole chicken, cut it up, and sell off the other parts in the supermarket parking lot. This is costly. It is far more efficient for the store to cut up the chicken and sell the pieces separately. But this also has some cost, hence the observation that supermarkets charge more for chickens after they have been cut.

   The same considerations affect financial products, but:

   a. The proportionate costs to companies of repackaging the cash flow stream are generally small.
   b. Investors can also repackage cash flows cheaply for themselves. In fact, specialist financial institutions can often do so more cheaply than the companies can do it themselves.

CHAPTER 18
How Much Should a Firm Borrow?

Answers to Practice Questions

1. For $1 of debt income:

Corporate tax = $0
Personal tax = $0.44\times\$1 = \$0.440$
Total = $0.440

For $1 of equity income, with all capital gains realized immediately:

Corporate tax = $0.35\times\$1 = \$0.350$
Personal tax = $0.44\times0.5\times[\$1 - (0.35\times\$1)] + 0.20\times0.5\times[\$1 - (0.35\times\$1)] =$ $0.208
Total = $0.558

For $1 of equity income, with all capital gains deferred forever:

Corporate tax = $0.35\times\$1 = \$0.350$
Personal tax = $0.44\times0.5\times[\$1 - (0.35\times\$1)] = \$0.143$
Total = $0.493

2. Consider a firm that is levered, has perpetual expected cash flow X, and has an interest rate for debt of r_D. The personal and corporate tax rates are T_p and T_c, respectively. The cash flow to stockholders each year is:

$$(X - r_D D)(1 - T_c)(1 - T_p)$$

Therefore, the value of the stockholders' position is:

$$V_L = \frac{(X)(1-T_c)(1-T_p)}{(r)(1-T_p)} - \frac{(r_D)(D)(1-T_c)(1-T_p)}{(r_D)(1-T_p)}$$

$$V_L = \frac{(X)(1-T_c)(1-T_p)}{(r)(1-T_p)} - [(D)(1-T_c)]$$

where r is the opportunity cost of capital for an all-equity-financed firm. If the stockholders borrow D at the same rate r_D, and invest in the unlevered firm, their cash flow each year is:

$$[(X)(1-T_c)(1-T_p)] - [(r_D)(D)(1-T_p)]$$

The value of the stockholders' position is then:

$$V_U = \frac{(X)(1-T_c)(1-T_p)}{(r)(1-T_p)} - \frac{(r_D)(D)\ (1-T_p)}{(r_D)(1-T_p)}$$

$$V_U = \frac{(X)(1-T_c)(1-T_p)}{(r)(1-T_p)} - D$$

The difference in stockholder wealth, for investment in the same assets, is:

$$V_L - V_U = DT_c$$

This is the change in stockholder wealth predicted by MM. If individuals could not deduct interest for personal tax purposes, then:

$$V_U = \frac{(X)(1-T_c)(1-T_p)}{(r)(1-T_p)} - \frac{(r_D)(D)}{(r_D)(1-T_p)}$$

Then:

$$V_L - V_U = \frac{(r_D)(D) - [(r_D)(D)(1-T_c)(1-T_p)]}{(r_D)(1-T_p)}$$

$$V_L - V_U = (D\ T_c) + \left(D\ \frac{T_p}{(1-T_p)} \right)$$

So the value of the shareholders' position in the levered firm is relatively greater when no personal interest deduction is allowed.

3. The book value of Pfizer's assets is \$21,529 million. With a 40 percent book debt ratio:

Long-term debt + Other long-term liabilities = 0.40 × \$21,529 = \$8,612

This is [\$8,612 – (\$2,123 + \$4,330)] = \$2,159 more than shown in Table 18.3(a). The corporate tax rate is 35 percent, so firm value increases by:

0.35 × \$2,159 = \$756 million

The market value of the firm is now: (\$296,247 + \$756) = \$297,003 million.

The market value balance sheet is:

Net working capital	\$5,206	\$4,282	Long-term debt
Market value of long-term assets	291,797	4,330	Other long-term liabilities
		288,391	Equity
Total Assets	\$297,003	\$297,003	Firm market value

4. Answers here will vary depending on the company chosen.

5. The value of interest tax shields is determined by:
   - The on-going degree of profitability.
   - The ability to carry-forward and carry-back excess credits
   - The ability to maintain debt levels on an on-going basis.
   - The rates of personal and corporate taxes.
   - The amount of non-interest tax shields

6. When a firm defaults, the cause (absent fraud) is usually an operating problem. Although both shareholders and debtholders are worse off, their respective expected rates of return are determined in a manner that compensates for this risk. The combined positions of stockholders and bondholders in limited liability and unlimited liability firms are the same. The ability to assign the assets to the creditors, and not have to repay, has value to the shareholders since it is a more efficient transfer of wealth.

7. Assume the following facts for Circular File:

	Book Values		
Net working capital	$20	$50	Bonds outstanding
Fixed assets	80	50	Common stock
Total assets	$100	$100	Total liabilities

	Market Values		
Net working capital	$20	$25	Bonds outstanding
Fixed assets	10	5	Common stock
Total assets	$30	$30	Total liabilities

a. <u>Playing for Time</u>
Suppose Circular File foregoes replacement of $10 of capital equipment, so that the new balance sheet may appear as follows:

	Market Values		
Net working capital	$30	$29	Bonds outstanding
Fixed assets	8	9	Common stock
Total assets	$38	$38	Total liabilities

Here the shareholder is better off but has obviously diminished the firm's competitive ability.

b. <u>Cash In and Run</u>
Suppose the firm pays a $5 dividend:

	Market Values		
Net working capital	$15	$23	Bonds outstanding
Fixed assets	10	2	Common stock
Total assets	$25	$25	Total liabilities

Here the value of common stock should have fallen to zero, but the bondholders bear part of the burden.

c. Bait and Switch

	Market Values		
Net working capital	$30	$20	New Bonds outstanding
		20	Old Bonds outstanding
Fixed assets	20	10	Common stock
Total assets	$50	$50	Total liabilities

8. Static trade-off theory reduces the debt-equity decision to a trade-off between interest tax shields and the costs of financial distress. In the real world, matters are not so simple because there are costs to adjusting the firm's capital structure, and individual managers have different attitudes toward debt. High-tech growth firms with risky assets tend to be equity financed while low risk mature businesses tend to have more debt. Similarly, firms often issue equity to pay off excess debt. However, many profitable firms have very little debt and changes in tax rates have little effect on debt-equity ratios.

9. Answers here will vary according to the companies chosen; however, the important considerations are given in the text, Section 18.3.

10. a. SOS stockholders could lose if they invest in the positive NPV project and then SOS becomes bankrupt. Under these conditions, the benefits of the project accrue to the bondholders.

b. If the new project is sufficiently risky, then, even though it has a negative NPV, it might increase stockholder wealth by more than the money invested. This is a result of the fact that, for a very risky investment, undertaken by a firm with a significant risk of default, stockholders benefit if a more favorable outcome is actually realized, while the cost of unfavorable outcomes is borne by bondholders.

c. Again, think of the extreme case: Suppose SOS pays out all of its assets as one lump-sum dividend. Stockholders get all of the assets, and the bondholders are left with nothing.

These conflicts of interest are severe only when the company is in financial distress. Adherence to a moderate target debt ratio limits the conflicts.

11. a. The bondholders benefit. The fine print limits actions that transfer wealth from the bondholders to the stockholders.

b. The stockholders benefit. In the absence of fine print, bondholders charge a higher rate of interest to ensure that they receive a fair deal. The firm would probably issue the bond with standard restrictions. It is likely that the restrictions would be less costly than the higher interest rate.

12. Certainly part of this drop must be attributed to bankruptcy costs, which come out of the shareholders' pockets. It is likely, however, that the actual bankruptcy filing conveyed some negative information to the market about Caldor's future prospects and that part of the drop must, therefore, be attributed to this negative information.

13. Other things equal, the announcement of a new stock issue to fund an investment project with an NPV of $40 million should increase equity value by $40 million (less issue costs). But, based on past evidence, management expects equity value to fall by $30 million. There may be several reasons for the discrepancy:

(i) Investors may have already discounted the proposed investment. (However, this alone would not explain a fall in equity value.)

(ii) Investors may not be aware of the project at all, but they may believe instead that cash is required because of, say, low levels of operating cash flow.

(iii) Investors may believe that the firm's decision to issue equity rather than debt signals management's belief that the stock is overvalued.

If the stock is indeed overvalued, the stock issue merely brings forward a stock price decline that will occur eventually anyway. Therefore, the fall in value is not an issue cost in the same sense as the underwriter's spread. If the stock is not overvalued, management needs to consider whether it could release some information to convince investors that its stock is correctly valued, or whether it could finance the project by an issue of debt.

14. a. Masulis' results are consistent with the view that debt is always preferable because of its tax advantage, but are not consistent with the 'tradeoff' theory, which holds that management strikes a balance between the tax advantage of debt and the costs of possible financial distress. In the tradeoff theory, exchange offers would be undertaken to move the firm's debt level toward the optimum. That ought to be good news, if anything, regardless of whether leverage is increased or decreased.

b. The results are consistent with the evidence regarding the announcement effects on security issues and repurchases.

c. One explanation is that the exchange offers signal management's assessment of the firm's prospects. Management would only be willing to take on more debt if they were quite confident about future cash flow, for example, and would want to decrease debt if they were concerned about the firm's ability to meet debt payments in the future.

15. Let us assume that, as companies are started, grow, and mature, they stick to the same line of business and are consistently profitable. Then, if the tradeoff theory is correct, because the types of assets the company has do not change over time, the firm's debt ratio will likewise not be expected to change over time. If the pecking-order theory is correct, the company's debt ratio will tend to decrease over time because the company will fund projects from retained earnings, i.e., internally generated cash.

16. In general, the pecking order theory explains intra-industry debt levels since less profitable firms end up borrowing more because they have lower internal cash flow. However, the argument seems to fail on an inter-industry basis. High-tech, high growth firms have low debt levels even though they need cash, and stable, mature industries (e.g., utilities) often do not pay down debt but pay the cash out as dividends.

17. Bondholders require a higher interest rate than they would otherwise in order to compensate for the fact that interest attracts more tax than equity returns.

18. a.

	Expected Payoff to Bank	Expected Payoff to Ms. Ketchup
Project 1	+10.0	+5
Project 2	$(0.4\times10) + (0.6\times0) = +4.0$	$(0.4\times14)+(0.6\times0)=+5.6$

Ms. Ketchup would undertake Project 2.

b. Break even will occur when Ms. Ketchup's expected payoff from Project 2 is equal to her expected payoff from Project 1. If X is Ms. Ketchup's payment on the loan, then her payoff from Project 2 is:

$$0.4\ (24 – X)$$

Setting this expression equal to 5 (Ms. Ketchup's payoff from Project 1), and solving, we find that: $X = 11.5$
Therefore, Ms. Ketchup will borrow less than the present value of this payment.

19. Internet exercise; answers will vary.

Challenge Questions

1. a. Internet exercise; answers will vary.

CHAPTER 19
Financing and Valuation

Answers to Practice Questions

1. If the bank debt is treated as permanent financing, the capital structure proportions are:

Bank debt (r_D = 10 percent)	$280	9.4%
Long-term debt (r_D = 9 percent)	1800	60.4
Equity (r_E = 18 percent, 90 x 10 million shares)	900	30.2
	$2980	100.0%

WACC* = $[0.10\times(1 - 0.35)\times0.094] + [0.09\times(1 - 0.35)\times0.604] + [0.18\times0.302]$
$= 0.096 = 9.6\%$

2. Forecast after-tax incremental cash flows as explained in Section 6.1. Interest is not included; the forecasts assume an all-equity financed firm.

3. Calculate APV by subtracting $4 million from base-case NPV.

4. We make three adjustments to the balance sheet:
- Ignore deferred taxes; this is an accounting entry and represents neither a liability nor a source of funds
- 'Net out' accounts payable against current assets
- Use the market value of equity (7.46 million x $46)

Now the right-hand side of the balance sheet (in thousands) looks like:

Short-term debt	$75,600
Long-term debt	208,600
Share holder equity	343,160
Total	$627,360

The after-tax weighted-average cost of capital formula, with one element for each source of funding, is:

$$WACC = [r_{D\text{-}ST}\times(1 - T_c)\times(D\text{-}ST/V)]+[r_{D\text{-}LT}\times(1 - T_c)\times(D\text{-}LT/V)]+[r_E \times(E/V)]$$

$$WACC = [0.06\times(1 - 0.35)\times(75{,}600/627{,}360)] + [0.08\times(1 - 0.35)\times(208{,}600/627{,}360)]$$

$$+ [0.15\times(343{,}160/627{,}360)]$$

$$= 0.004700 + 0.017290 + 0.082049 = 0.1040 = 10.40\%$$

5. Assume that short-term debt is temporary. From Practice Question 4:

Long-term debt	$208,600
Share holder equity	343,160
Total	$551,760

Therefore:

$(D/V) = (\$208,600/\$551,760) = 0.378$

$(E/V) = (\$343,160/\$551,760) = 0.622$

Step 1:

$r = r_D\,(D/V) + r_E\,(E/V) = (0.08 \times 0.378) + (0.15 \times 0.622) = 0.1235$

Step 2:

$r_E = r + (r - r_D)\,(D/E) = 0.1235 + (0.1235 - .08) \times (0.4) = 0.1409$

Step 3:

$WACC = [r_D \times (1 - T_C) \times (D/V)] + [r_E \times (E/V)]$

$= (0.08 \times 0.65 \times 0.286) + (0.1409 \times 0.714) = 0.1155 = 11.55\%$

6.

Pre-tax operating income	$100.5
Short-term interest	4.5
Long-term interest	16.7
Earnings before tax	$79.3
Tax	27.8
Net income	$51.5

Value of equity = $51.5/0.15 = $343.3

Value of firm = $343.3 + $75.6 + $208.6 = $627.5

7. The problem here is that issue costs are a one-time expenditure, while adjusting the WACC implies a correction every year. The only way to account for issue costs in project evaluation is to use the APV formulation and adjust directly by subtracting the issue costs from the base case NPV.

8. a. Base case NPV = $-1,000 + (600/1.12) + (700/1.12^2)$ = $93.75 or $93,750

Year	Debt Outstanding at Start Of Year	Interest	Interest Tax Shield	PV (Tax Shield)
1	300	24	7.20	6.67
2	150	12	3.60	3.09

APV = 93.75 + 6.67 + 3.09 = 103.5 or $103,500

9. [$100,000 × (1 - 0.35)] + [$100,000 × (1 - 0.35) × (Annuity Factor$_{5/9\ (1 - 0.35)\%}$)]
= $65,000 + $274,925 = $339,925

10. a. Base-case NPV = -$1,000,000 + ($85,000/0.10) = -$150,000

PV(tax shields) = 0.35 × $400,000 = $140,000

APV = -$150,000 + $140,000 = -$10,000

b. PV(tax shields, approximate) = (0.35 × 0.07 × $400,000)/0.10 = $98,000

APV = -$150,000 + $98,000 = -$52,000

PV(tax shields, exact) = $98,000 × (1.10/1.07) = $100,748

APV = -$150,000 + $100,748 = -$49,252

The present value of the tax shield is higher when the debt is fixed and therefore the tax shield is certain. When borrowing a constant proportion of the market value of the project, the interest tax shields are as uncertain as the value of the project, and therefore must be discounted at the project's opportunity cost of capital.

11. The immediate source of funds (i.e., both the proportion borrowed and the expected return on the stocks sold) is irrelevant. The project would not be any more valuable if the university sold stocks offering a lower return. If borrowing is a zero-NPV activity for a tax-exempt university, then base-case NPV equals APV, and the adjusted cost of capital r* equals the opportunity cost of capital with all-equity financing. Here, base-case NPV is negative; the university should not invest.

12. r* is the after-tax adjusted weighted average cost of capital. An adjusted discount rate does not equal the WACC when it takes into account major changes in expected capital structure or costs.

13. Note the following:

- The costs of debt and equity are not 8.5% and 19%, respectively. These figures assume the issue costs are paid every year, not just at issue.
- The fact that Bunsen can finance the entire cost of the project with debt is irrelevant. The cost of capital does not depend on the immediate source of funds; what matters is the project's contribution to the firm's overall borrowing power.
- The project is expected to support debt in perpetuity. The fact that the first debt issue is for only 20 years is irrelevant.

Assume the project has the same business risk as the firm's other assets. Because it is a perpetuity, we can use the firm's weighted-average cost of capital. If we ignore issue costs:

$$WACC = [r_D \times (1 - T_C) \times (D/V)] + [r_E \times (E/V)]$$

$$WACC = [0.07 \times (1 - .35) \times (0.4)] + [0.14 \times 0.6] = 0.1022 = 10.22\%$$

Using this discount rate:

$$NPV = -\$1{,}000{,}000 + \frac{\$130{,}000}{0.1022} = \$272{,}016$$

The issue costs are:

Stock issue:	(0.050 × \$1,000,000) = \$50,000
Bond issue:	(0.015 × \$1,000,000) = \$15,000

Debt is clearly less expensive. Project NPV net of issue costs is reduced to: (\$272,016 - \$15,000) = \$257,016. However, if debt is used, the firm's debt ratio will be above the target ratio, and more equity will have to be raised later. If debt financing can be obtained using retaining earnings, then there are no other issue costs to consider. If stock will be issued to regain the target debt ratio, an additional issue cost is incurred.

A careful estimate of the issue costs attributable to this project would require a comparison of Bunsen's financial plan 'with' as compared to 'without' this project.

14. From the text, Section 19.6, footnote 29, solving for β_A, we find that:

$$\beta_A = (1 - T_C)(\beta_D)\left(\frac{D}{V - (T_C\,D)}\right) + (\beta_E)\left(\frac{E}{V - (T_C\,D)}\right)$$

$$\beta_A = (1 - T_C)(\beta_D)\left(\frac{D/V}{1 - (T_C\,D/V)}\right) + (\beta_E)\left(\frac{E/V}{1 - (T_C\,D/V)}\right)$$

$$\beta_A = (1 - 0.35)(0.15)\left(\frac{0.55}{1 - (0.35 \times 0.55)}\right) + (1.09)\left(\frac{0.45}{1 - (0.35 \times 0.55)}\right) = 0.6738$$

Using the Security Market Line, we calculate the opportunity cost of capital for Sphagnum's assets:

$$r_A = r_f + \beta_A\,(r_m - r_f) = 0.09 + (0.6738 \times 0.085) = 0.147 = 14.7\%$$

Following MM's original analysis and considering only corporate taxes, we have:

$$r^* = r\,(1 - T_C\,L)$$

$$r^* = 0.147 \times [1 - (0.35 \times 0.55)] = 0.1187 \text{ or approximately } 12\%$$

This matches the consultant's estimate for the weighted-average cost of capital.

15. Disagree. The Banker's Tryst calculations are based on the assumption that the cost of debt will remain constant, and that the cost of equity capital will not change even though the firm's financial structure has changed. The former assumption is appropriate while the latter is not.

16. Tax or financing side effects in international projects:
    - Project financing issues, such as early cash flows going to debt service resulting in a non-constant debt ratio.
    - Subsidized financing rates.
    - Guaranteed contracts for output.
    - Government restrictions on the flow of funds.

17. a.

Year	Principal at Start of Year	Principal Repayment	Interest	Interest Less Tax	Net Cash Flow On Loan
1	5000.0	397.5	250.0	162.5	560.0
2	4602.5	417.4	230.1	149.6	567.0
3	4185.1	438.2	209.3	136.0	574.2
4	3746.9	460.2	187.3	121.7	581.9
5	3286.7	483.2	164.3	106.8	590.0
6	2803.5	507.3	140.2	91.1	598.4
7	2296.2	532.7	114.8	74.6	607.3
8	1763.5	559.3	88.2	57.3	616.6
9	1204.2	587.3	60.2	39.1	626.4
10	616.9	616.9	30.8	20.0	636.9

Therefore:

$$\text{PV of loan} = \frac{560.0}{1 + (1-.35)\,(.08)^1} + \cdots + \frac{636.9}{1 + (1-.35)\,(.08)^{10}} = \$4{,}530{,}000$$

Value of subsidy = \$5,000,000 - \$4,530,000 = \$470,000

b. Yes. The value of the subsidy measures the additional value to the firm from a government loan at 5 percent, compared to an unsubsidized loan at 10 percent. Therefore, the company should calculate APV, including PV (tax shields) on the unsubsidized loan, and then add in the value of subsidy.

18. a. Assume that the expected future Treasury-bill rate is equal to the 20-year Treasury bond rate (5.8%) less the average historical premium of Treasury bonds over Treasury bills (1.8%), so that the risk-free rate (r_f) is 4%. Also assume that the market risk premium ($r_m - r_f$) is 8%. Then, using the CAPM, we find r_E as follows:

$$r_E = r_f + \beta_A \times [r_m - r_f] = 4\% + (0.66 \times 8\%) = 9.28\%$$

Market value of equity (E) is equal to: 256.2 × \$59 = \$15,115.8 so that:

V = \$6,268 + \$15,115.8 = \$21,383.8

D/V = \$6,268/\$21,383.8 = 0.293

E/V = \$15,115.8/\$21,383.8 = 0.707

WACC = (0.707 × 9.28%) + (0.293 × 0.65 × 7.4%) = 7.97%

b. Step 1. Calculate the opportunity cost of capital.

Opportunity cost of capital = $r = r_D \times (D/V) + r_E \times (E/V)$

$$= 7.4\% \times 0.293 + 9.28\% \times 0.707 = 8.73\%$$

Step 2. Estimate the cost of debt and calculate the new cost of equity.

Assume that the interest rate on the debt falls to 7.2% so that:

$r_E = r + (r - r_D) \times (D/E) = 8.73\% + (8.73\% - 7.2\%) \times (0.25/0.75) = 9.25\%$

Step 3. Recalculate WACC.

WACC = (0.75 × 9.25%) + (0.25 × 0.65 × 7.2%) = 8.11%

19. The company weighted-average cost of capital is appropriate for evaluating capital budgeting projects that are exact replicas of the firm as it currently exists. If the project in question is more like the industry as a whole than it is like the company, then the industry weighted-average cost of capital would be a better choice.

Challenge Questions

1. a. For a one-period project to have zero APV:

$$APV = C_0 + \frac{C_1}{1+r} + \frac{(T^* \times r_D \times D)}{1+r_D} = 0$$

Rearranging gives:

$$\frac{C_1}{-C_0} - 1 = r - (T^* \times r_D)\left(\frac{D}{-C_0}\right)\left(\frac{1+r}{1+r_D}\right)$$

For a one-period project, the left-hand side of this equation is the project IRR. Also, $(D/ -C_0)$ is the project's debt capacity. Therefore, the minimum acceptable return is:

$$r^* = r - (T^* \times r_D \times L)\left(\frac{1+r}{1+r_D}\right)$$

b. For a company that follows Financing Rule 2, all of the variables in the Miles-Ezzell formula are constant. For example, we know that debt is assumed to be a constant proportion of market value, so that the adjusted cost of capital (r^*) is also constant over time. In other words, when we are at period 1, the Miles-Ezzell formula gives the same value for r^* as at period 0. We know from part (a) that the formula is correct for a one-period cash flow. So the value, in period 1, of the period 2 cash flow is:

$$PV_1 = C_2/(1 + r^*)$$

The value today is:

$$PV_0 = PV_1/(1 + r^*) = C_2/(1 + r^*)^2$$

By analogy, we would discount the period 3 cash flow, at r^*, in period 2 to give:

$$PV_2 = C_3/(1 + r^*)$$

Therefore, the value today is:

$$PV_0 = C_3/(1 + r^*)^3$$

2.

D/V	E/V	D/E	r	r_d	r_E	WACC	ME
0.20	0.80	0.250	12.00%	8.00%	13.00%	11.44%	11.42%
0.40	0.60	0.667	12.00%	8.00%	14.67%	10.88%	10.84%
0.60	0.40	1.500	12.00%	10.00%	15.00%	9.90%	9.86%

$T^* = T_C = 0.35$

Different values result because the Miles-Ezzell formula assumes debt is rebalanced at the end of every period (Financing Rule 2).

3. The expected cash flow from the firm is: ($V_u r + T_c r_D D$) where r is the return on assets and r_D is the rate on debt (the interest tax shield has the same level of risk). The cash flow to the stockholders and bondholders is:

$$Er^* + Dr_D$$

Because the firm generates a perpetual cash flow stream:

$$Er^* + Dr_D = V_u r + T_c r_D D$$

Divide by E and subtract Dr_D:

$$r^* = \left(\frac{V_u}{E} r\right) - (1 - T_c)\left(\frac{D}{E} r_D\right)$$

Substitute L = D/E

$$r^* = \left(\frac{V_u}{E} r\right) - (1 - T_c)(r_D L)$$

We know that: $V_u = E + (1 - T_c)D$:

$$r^* = \left(\frac{E + (1 - T_c)D}{E}(r)\right) - [(1 - T_c)r_D L]$$

$$r^* = r + [(r - r_D)(1 - T_c)L]$$

a. Whenever $r > r_D$, r* increases with leverage.

b. The formulas for levering and relevering the cost of equity implicitly assume on-going corporate profitability so that the interest tax shields can be exploited.

4. This is not necessarily true. Note that, when the debt is rebalanced, next year’s interest tax shields are fixed and, thus, discounted at a lower rate. The following year’s interest is not known with certainty for one year and, hence, is discounted for one year at the higher risky rate and for one year at the lower rate. This is much more realistic since it recognizes the uncertainty of future events.

CHAPTER 20
Understanding Options

Answers to Practice Questions

1. Statement (a) incorporates a put option.
   Statement (b) uses ‘option’ in the sense of choice.
   Statement (c) uses ‘option’ in the sense of choice.
   Statement (d) incorporates a call option.

2. a. The put places a floor on value of investment, i.e., less risky than buying stock. The risk reduction comes at the cost of the option premium.

   b. Benefit from upside, but also lose on the downside.

   c. A naked option position is riskier than the underlying asset. Investor gains from increase in stock price, but loses entire investment if stock price is less than exercise price at expiration.

   d. Investor exchanges uncertain upside changes in stock price for the known up-front income from the option premium.

   e. Safe investment if the debt is risk free.

   f. From put-call parity, this is equivalent (for European options) to ‘buy bond.’ Therefore, this is a safe investment.

   g. Another naked, high-risk position with known up-front income but exposure to down movements in stock price.

3. While it is true that both the buyer of a call and the seller of a put hope the price will rise, the two positions are not identical. The buyer of a call will find her profit changing from zero and increasing as the stock price rises (see text Figure 20.2), while the seller of a put will find his loss decreasing and then remaining at zero as the stock price rises (see text Figure 20.3).

4. You would buy the American call for $75, exercise the call immediately in order to purchase a share of Pintail stock for $50, and then sell the share of Pintail stock for $200. The net gain is: [$200 – ($75 + $50)] = $75.

   If the call is a European call, you should buy the call, deposit in the bank an amount equal to the present value of the exercise price, and sell the stock short. This produces a current cash flow equal to: [$200 – $75 – ($50/1 + r))]. At the maturity of the call, the action depends on whether the stock price is greater than or less than the exercise price. If the stock price is greater than $50, then you would exercise the call (using the cash from the bank deposit) and buy back the stock. If the stock price is less than $50, then you would let the call expire and buy back the stock. The cash flow at maturity is the greater of zero (if the stock price is greater than $50) or [$50 – stock price] (if the stock price is less than $50). Therefore, the cash flows are positive now and zero or positive one year from now.

5. Let P_3 = the value of the three month put, C_3 = the value of the three month call, S = the market value of a share of stock, and EX = the exercise price of the options. Then, from put-call parity:

   $$C_3 + [EX/(1 + r)^{0.25}] = P_3 + S$$

   Since both options have an exercise price of $60 and both are worth $10, then:

   $$EX/(1 + r)^{0.25} = S$$

   From put-call parity for the six-month options, we have:

   $$C_6 + [EX/(1 + r)^{0.50}] = P_6 + S$$

   Since $S = EX/(1 + r)^{0.25}$, and $EX/(1 + r)^{0.50}$ is less than $EX/(1 + r)^{0.25}$, then the value of the six-month call is greater than the value of the six-month put.

6. [Note: In the first printing of the seventh edition, the call option price is shown incorrectly as $2.30. The price should be $12.30.]

   From put-call parity:

   $$C + [EX/(1 + r)^{0.50}] = P + S$$

   $$P = -S + C + [EX/(1 + r)^{0.50}] = -27.27 + 12.30 + [22.50/(1.039^{0.50})] = \$7.10$$

7. Internet exercise; answers will vary.

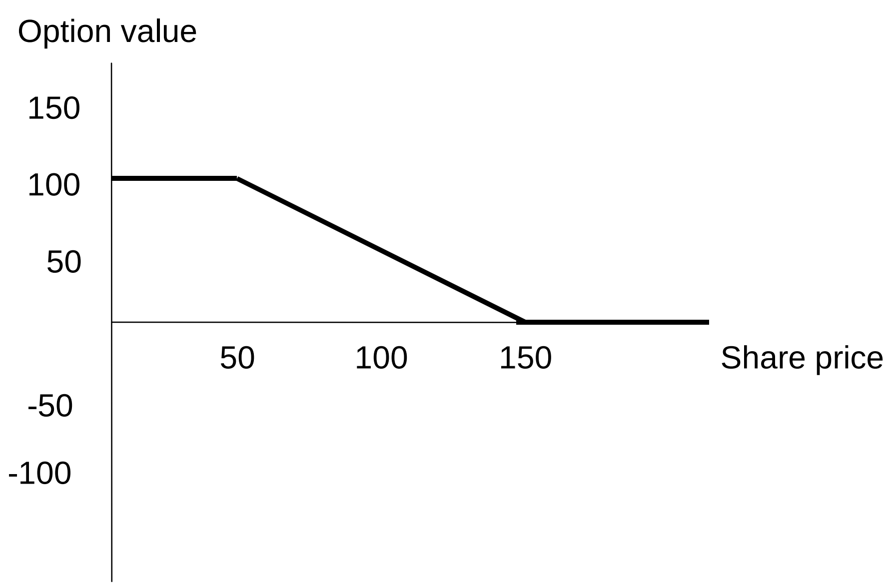
8. a. Rank and File has an option to put the stock to the underwriter.

b. 1. EX = exercise price of the rights
2. t = time from rights agreement to final exercise date for right
3. σ^2 = variance of stock returns
4. r_f = interest rate

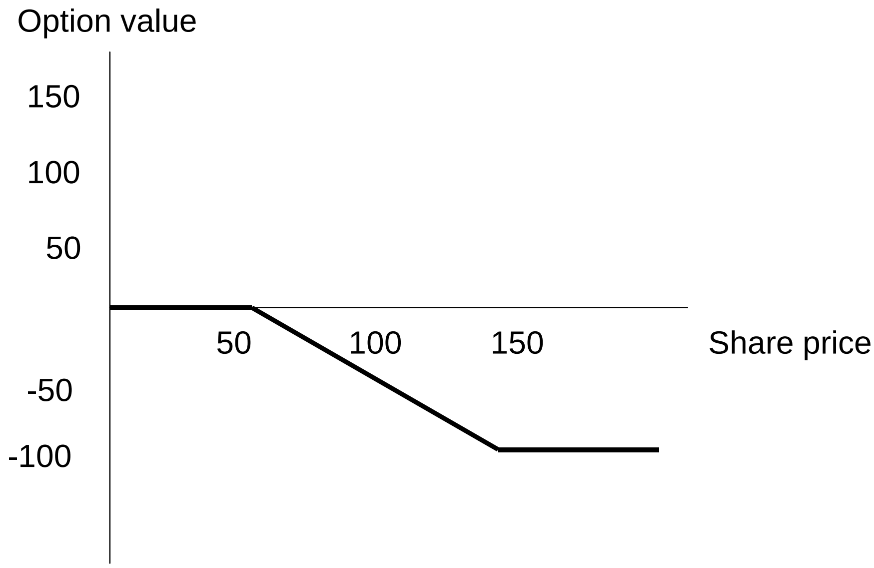
[Note: The answer to (b) ignores dilution. Chapter 23 discusses how dilution affects the valuation of warrants and convertibles. Dilution has a similar effect on the valuation of standby underwriting. This is because, if the option is exercised, the underwriter pays the issue price, but also obtains an equity stake in this new money. After reading Chapter 23, students might return to the issue of the effect of dilution on the value of standby agreements.]

9. The $100 million threshold can be viewed as an exercise price. Since she gains 20% of all profits in excess of this level, it is comparable to a call option. Whether this provides an adequate incentive depends on how achievable the $100 million threshold is and how Ms. Cable evaluates her prospects of generating income greater than this amount.

10. a. The payoffs at expiration for the two options are shown in the following position diagram:



Taking into account the $100 that must be repaid at expiration, the net payoffs are:



b. Here we can use the put-call parity relationship:

Value of call + Present value of exercise price = Value of put + Share price

The value of Mr. Colleoni’s position is:

Value of put (EX = 150) - Value of put (EX = 50) - PV (150 - 50)

Using the put-call parity relationship, we find that this is equal to:

Value of call (EX = 150) - Value of call (EX = 50)

Thus, one combination that gives Mr. Colleoni the same payoffs is:

- Buy a call with an exercise price of $150
- Sell a call with an exercise price of $50

Similarly, another combination with the same set of payoffs is:

- Buy a put with an exercise price of $150
- Buy a share of stock
- Borrow the present value of $150
- Sell a call with an exercise price of $50

11. Statement (b) is correct. The appropriate diagrams are in Figure 20.5 in the text. The second row of diagrams in Figure 20.5 shows the payoffs for the strategy:

Buy a share of stock and buy a put.

The third row of Figure 20.5 shows the payoffs for the strategy:

Buy a call and lend an amount equal to the exercise price.

12. Answers here will vary depending on the options chosen, but the formulas will work very well; discrepancies should be on the order of 5 percent or so, at most.

13. We make use of the put-call parity relationship:

Value of call + Present value of exercise price = Value of put + Share price

a. Rearranging the put-call parity relationship to show a short sale of a share of stock, we have:

(- Share price) = Value of put - Value of call - PV(EX)

This implies that, in order to replicate a short sale of a share of stock, you would purchase a put, sell a call, and borrow the present value of the exercise price.

b. Again we rearrange the put-call parity relationship:

PV(EX) = Value of put - Value of call + Share price

This implies that, in order to replicate the payoffs of a bond, you buy a put, sell a call, and buy the stock.

14. a. Use the put-call parity relationship for European options:

Value of call + Present value of exercise price = Value of put + Share price

Solve for the value of the put:

Value of put = Value of call + PV(EX) - Share price

Thus, to replicate the payoffs for the put, you would buy a 26-week call with an exercise price of $100, invest the present value of the exercise price in a 26-week risk-free security, and sell the stock short.

b. Using the put-call parity relationship, the European put will sell for:

8 + (100/1.05) - 90 = $13.24

15. a. From the put-call parity relationship:

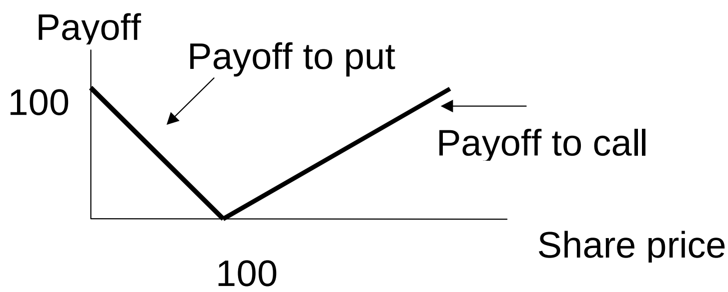
Value of call + Present value of exercise price = Value of put + Share price

Equity + PV(Debt, at risk-free rate) = Default option + Assets

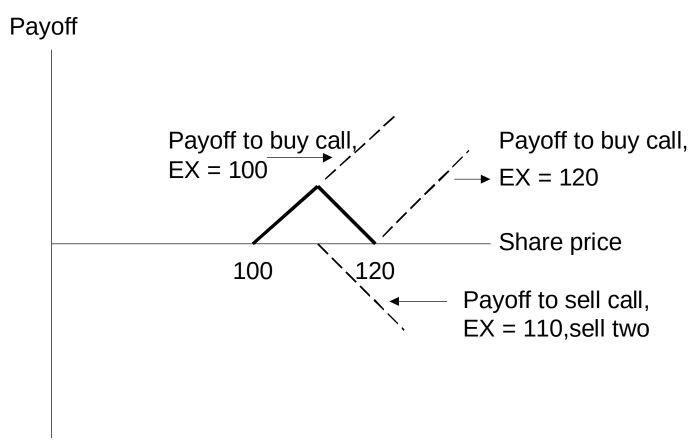
$250 + $350 = $70 + $530

b. Value of default put = $350 - $280 = $70

16. Straddle



Butterfly



The buyer of the straddle profits if the stock price moves substantially in either direction; hence, the straddle is a bet on high variability. The buyer of the butterfly profits if the stock price doesn't move very much, and hence, this is a bet on low variability.

17. a. The bond value increases to the present value of the guaranteed payoff, valued at the risk-free rate:

Bond value = ($50 + $5)/1.08 = $50.93

b. The payoffs to stockholders are unaffected. If the firm defaults, its bondholders are paid off, but shareholders get nothing, just as before. If the firm does not default, payments to shareholders do not change.

c. The firm effectively acquires a new asset, the government guarantee worth $25.93 (the difference between the previous and new bond values). The firm's balance sheet could be expressed this way:

Asset value	$30.00	$50.93	Bonds
Government's guarantee	25.93	5.00	Stock
	$55.93	$55.93	Firm value

d. By issuing 10-percent bonds with $50 face value, Rectangular raises $50.93 cash (the present value, at 8 percent, of $55), which is used to repurchase stock. After the transaction, the market value balance sheet is the same as Circular's. Shareholders have pocketed the $25.93 value of the government guarantee.

18. Answers here will vary according to the stock and the specific options selected, but all should exhibit properties very close to those predicted by the theory described in the chapter.

19. Imagine two stocks, each with a market price of $100. For each stock, you have an at-the-money call option with an exercise price of $100. Stock A's price now falls to $50 and Stock B's rises to $150. The value of your portfolio of call options is now:

	Value
Call on A	0
Call on B	50
Total	$50

Now compare this with the value of an at-the-money call to buy a portfolio with equal holdings of A and B. Since the average change in the prices of the two stocks is zero, the call expires worthless.

This is an example of a general rule: An option on a portfolio is less valuable than a portfolio of options on the individual stocks because, in the latter case, you can choose which options to exercise.

20. Consider each company in turn, making use of the put-call parity relationship:

Value of call + Present value of exercise price = Value of put + Share price

Drongo Corp. Here, the left-hand side [52 + (50/1.05) = 99.62] is less than the right-hand side [20 + 80 = 100]. Therefore, there is a slight mispricing. To take advantage of this situation, one should buy the call, invest $47.62 at the risk-free rate, sell the put, and sell the stock short.

Ragwort, Inc. Here, the left-hand side [15 + (100/1.05) = 110.24) is greater than the right-hand side [10 + 80 = 90]. Therefore, there is a significant mispricing. To take advantage of this situation, one should sell the call, borrow $95.24 at the risk-free rate, buy the put, and buy the stock.

Wombat Corp. For the three-month option, the left-hand side [18 + (40/1.025) = 57.02] and the right-hand side [7 + 50 = 57] are essentially equal, so there is no mispricing.

For the first six-month option, the left-hand side [17 + (40/1.05) = 55.10] is slightly greater than the right-hand side [5 + 50 = 55], so there is a slight mispricing.

For the second six-month option, the left-hand side [10 + (50/1.05) = 57.62] is slightly less than the right-hand side [8 + 50 = 58], and so there is a slight mispricing.

21. The value of the options increases if the variance of the cash flows increases. Therefore, you will prefer the riskier proposal.

22. One strategy might be to buy straddle, that is, buy a call and a put with exercise price equal to the asset's current price. If the asset price does not change, both options become worthless. However, if the price falls, the put will be valuable and, if price rises, the call will be valuable. The larger the price movement in either direction, the greater the profit.

    If investor's have underestimated volatility, the option prices will be too low. Thus, an alternative strategy is to buy a call (or a put) and hedge against changes in the asset price by simultaneously selling (or, in the case of the put, buying) delta shares of stock.

Challenge Questions

1. Letter the diagrams in Figure 20.13 (a) through (d), beginning in the upper-left corner and proceeding clockwise. Then we have the following diagram interpretations:

   a. Purchase a call with a given exercise price and sell a call with a higher exercise price; borrow the difference necessary. (This is known as a 'Bull Spread.')

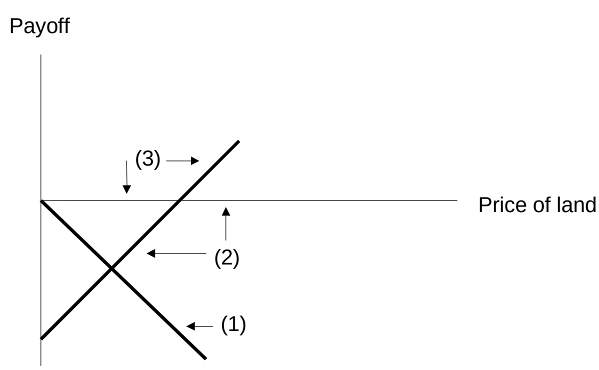
   b. Sell a put and sell a call with the same exercise price. (This is known as a 'Short Straddle.')

   c. Buy one call with a given exercise price, sell two calls with a higher exercise price, and buy one call with a still higher exercise price. (This is known as a 'Butterfly Spread.')

   d. Borrow money and use this money to buy a put and buy the stock.

2. a. If the land is worth more than $110 million, Bond will exercise its call option. If the land is worth less than $110 million, the buyer will exercise its put option.

   b. Bond has: (1) sold a share; (2) sold a put; and (3) purchased a call. Therefore:



This is equivalent to:

c. The interest rate can be deduced using the put-call parity relationship. We know that the call is worth \$20, the exercise price is \$110, and the combination [sell share and sell put option] is worth \$110. Therefore:

Value of call + Present value of exercise price = Value of put + Share price

Value of call + PV(EX) = Value of put + Share price

$20 + [110/(1 + r)] = 110$

$r = 0.222 = 22.2\%$

d. From the answer to Part (a), we know that Bond will end up owning the land after the expiration of the options. Thus, in an economic sense, the land has not really been sold, and it seems misleading to declare a profit on a sale that did not really take place. In effect, Bond has borrowed money, not sold an asset.

3. One way to profit from Hogswill options is to purchase the call options with exercise prices of \$90 and \$110, respectively, and sell two call options with an exercise price of \$100. The immediate benefit is a cash inflow of:

$[(2 \times 11) - (5 + 15)] = \$2$

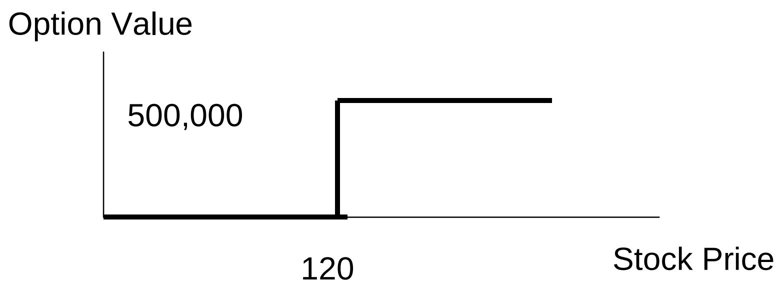
Immediately prior to maturity, the value of this position and the net profit (at various possible stock prices) is:

Stock Price	Position Value	Net Profit
85	0	0 + 2 = 2
90	0	0 + 2 = 2
95	5	5 + 2 = 7
100	10	10 + 2 = 12
105	5	5 + 2 = 7
110	0	0 + 2 = 2
115	0	0 + 2 = 2

Thus, no matter what the final stock price, we can make a profit trading in these Hogswill options.

It is possible, but very unlikely, that you can identify such opportunities from data published in the newspaper. Someone else has most likely already noticed (even before the paper was printed, much less distributed to you) and traded on the information; such trading tends to eliminate these profit opportunities.

4. a.



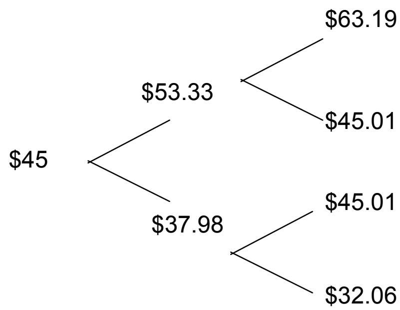
b. This incentive scheme is a combination of the following options:

- Buy 4,000,000 call options with an exercise price of $119.875.
- Sell 4,000,000 call options with an exercise price of $120.

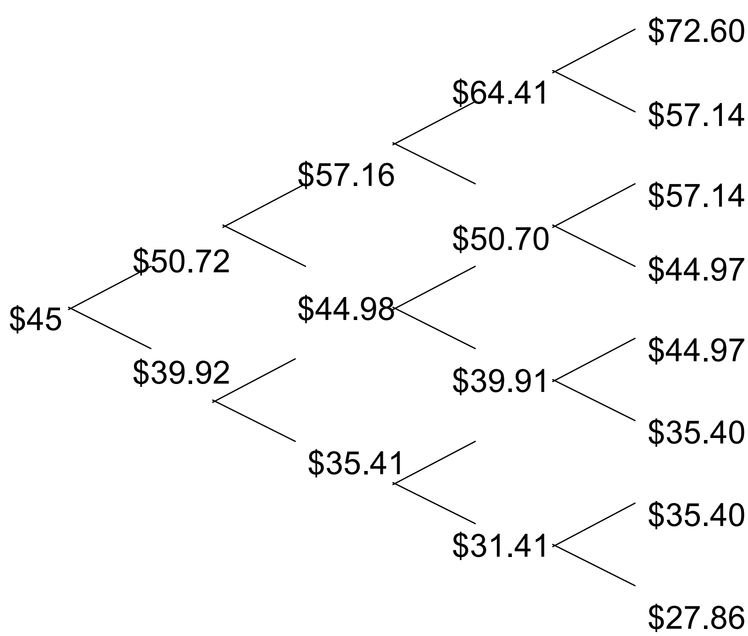
CHAPTER 21
Valuing Options

Answers to Practice Questions

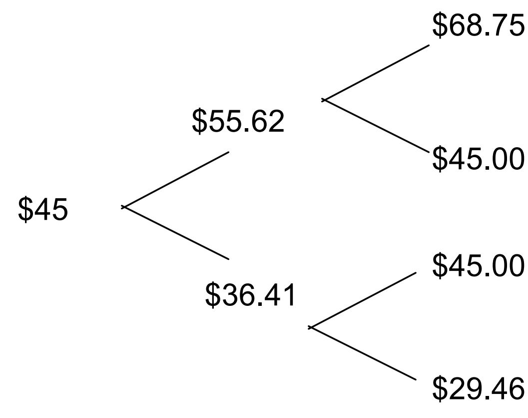
1. a. $u = e^{0.24\sqrt{0.5}} = 1.185$; $d = 1/u = 0.844$



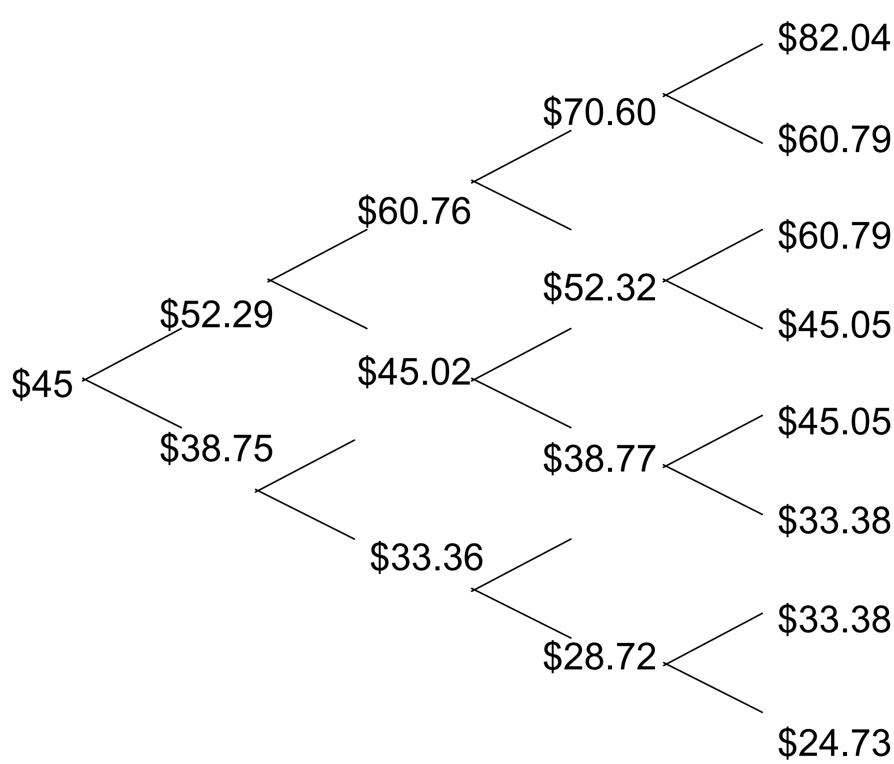
$u = e^{0.24\sqrt{0.25}} = 1.127$; $d = 1/u = 0.887$



b. $u = e^{0.3\sqrt{0.5}} = 1.236$, $d = 1/u = 0.809$



$u = e^{0.3\sqrt{0.25}} = 1.162$; $d = 1/u = 0.861$



2. a. Let p equal the probability of a rise in the stock price. Then, if investors are risk-neutral:

$$(p \times 0.15) + (1 - p)\times(-0.13) = 0.10$$

$$p = 0.821$$

The possible stock prices next period are:

$$\$60 \times 1.15 = \$69.00$$

$$\$60 \times 0.87 = \$52.20$$

Let X equal the break-even exercise price. Then the following must be true:

$$X – 60 = (p)(\$0) + [(1 – p)(X – 52.20)]/1.10$$

That is, the value of the put if exercised immediately equals the value of the put if it is held to next period. Solving for X, we find that the break-even exercise price is $61.52.

b. If the interest rate is increased, the value of the put option decreases.

3.

If there is an increase in:	The change in the put option price is:
Stock price (P)	Negative
Exercise price (EX)	Positive
Interest rate (r_f)	Negative
Time to expiration (t)	Positive
Volatility of stock price (σ)	Positive

Consider the following base case assumptions:

$P = 100$, $EX = 100$, $r_f = 5\%$, $t = 1$, $\sigma = 50\%$

Then, using the Black-Scholes model, the value of the put is $16.98

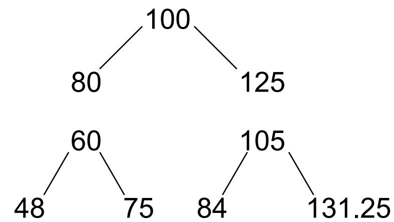
The base case value along with values computed for various changes in the assumed values of the variables are shown in the table below:

	Black-Scholes put value:
Base case	16.98
P = 120	11.04
EX = 120	29.03
r_f = 10%	14.63
t = 2	21.94
σ = 100%	35.04

4. a. The future stock prices of Matterhorn Mining are:

With dividend

Ex-dividend

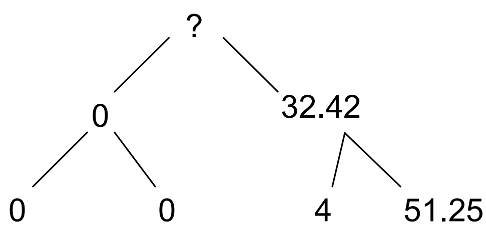


Let p equal the probability of a rise in the stock price. Then, if investors are risk-neutral:

$$(p \times 0.25) + (1 - p)\times(-0.20) = 0.10$$

$$p = 0.67$$

Now, calculate the expected value of the call in month 6.



If stock price decreases to SFr80 in month 6, then the call is worthless. If stock price increases to SFr125, then, if it is exercised at that time, it has a value of (125 – 80) = SFr45. If the call is not exercised, then its value is:

$$\frac{(0.67 \times 51.25) + (0.33 \times 4)}{1.10} = \text{SFr}32.42$$

Therefore, it is preferable to exercise the call.

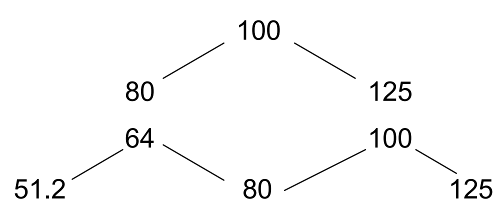
The value of the call in month 0 is:

$$\frac{(0.67 \times 45) + (0.33 \times 0)}{1.10} = \text{SFr}27.41$$

b. The future stock prices of Matterhorn Mining are:

With dividend

Ex-dividend

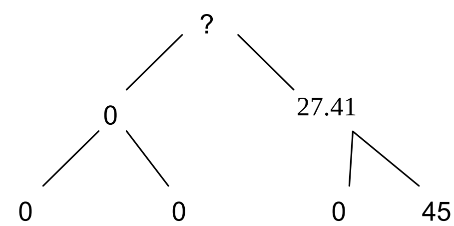


Let p equal the probability of a rise in the price of the stock. Then, if investors are risk-neutral:

$(p \times 0.25) + (1 - p)\times(-0.20) = 0.10$

$p = 0.67$

Now, calculate the expected value of the call in month 6.



If stock price decreases to SFr80 in month 6, then the call is worthless. If stock price increases to SFr125, then, if it is exercised at that time, it has a value of (125 – 80) = SFr45. If the call is not exercised, then its value is:

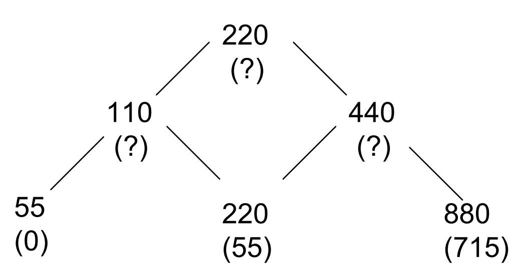
$$\frac{(0.67 \times 45) + (0.33 \times 0)}{1.10} = \text{SFr}27.41$$

Therefore, it is preferable to exercise the call.

The value of the call in month 0 is:

$$\frac{(0.67 \times 45) + (0.33 \times 0)}{1.10} = \text{SFr}27.41$$

5. a. The possible prices of Buffelhead stock and the associated call option values (shown in parentheses) are:



Let p equal the probability of a rise in the stock price. Then, if investors are risk-neutral:

$p\,(1.00) + (1 - p)(-0.50) = 0.10$

$p = 0.4$

If the stock price in month 6 is $110, then the option will not be exercised so that it will be worth:

$$[(0.4 \times 55) + (0.6 \times 0)]/1.10 = \$20$$

Similarly, if the stock price is $440 in month 6, then, if it is exercised, it will be worth ($440 - $165) = $275. If the option is not exercised, it will be worth:

$$[(0.4 \times 715) + (0.6 \times 55)]/1.10 = \$290$$

Therefore, the call option will not be exercised, so that its value today is:

$$[(0.4 \times 290) + (0.6 \times 20)]/1.10 = \$116.36$$

b. (i) If the price rises to $440:

$$\text{Delta} = \frac{715 - 55}{880 - 220} = 1.0$$

(ii) If the price falls to $110:

$$\text{Delta} = \frac{55 - 0}{220 - 55} = 0.33$$

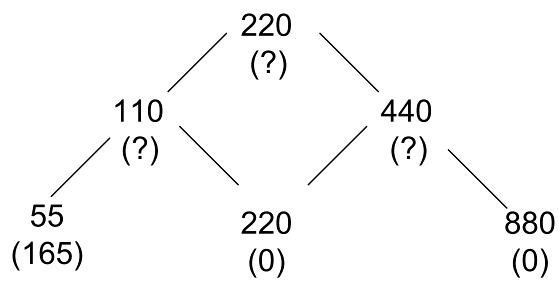
c. The option delta is 1.0 when the call is certain to be exercised and is zero when it is certain not to be exercised. If the call is certain to be exercised, it is equivalent to buying the stock with a partly deferred payment. So a one-dollar change in the stock price must be matched by a one-dollar change in the option price. At the other extreme, when the call is certain not to be exercised, it is valueless, regardless of the change in the stock price.

d. If the stock price is $110 at 6 months, the option delta is 0.33. Therefore, in order to replicate the stock, we buy three calls and lend, as follows:

	Initial Outlay	Stock Price = 55	Stock Price = 220
Buy 3 calls	-60	0	165
Lend PV(55)	-50	+55	+55
	-110	+55	+220
This strategy Is equivalent to:			
Buy stock	-110	+55	+220

6. a. Yes, it is rational to consider the early exercise of an American put option.

b. The possible prices of Buffelhead stock and the associated American put option values (shown in parentheses) are:



Let p equal the probability of a rise in the stock price. Then, if investors are risk-neutral:

$$p\,(1.00) + (1 - p)(-0.50) = 0.10$$

$$p = 0.4$$

If the stock price in month 6 is \$110, and if the American put option is not exercised, it will be worth:

$$[(0.4 \times 0) + (0.6 \times 165)]/1.10 = \$90$$

On the other hand, if it is exercised after 6 months, it is worth \$110. Thus, the investor should exercise the put early.

Similarly, if the stock price in month 6 is \$440, and if the American put option is not exercised, it will be worth:

$$[(0.4 \times 0) + (0.6 \times 0)]/1.10 = \$0$$

On the other hand, if it is exercised after 6 months, it will cost the investor \$220. The investor should not exercise early.

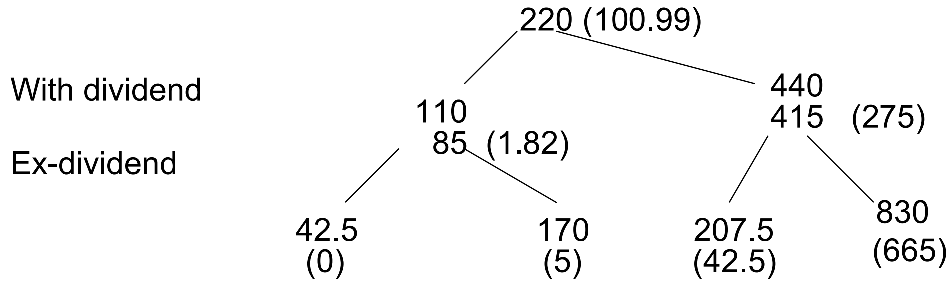
Finally, the value today of the American put option is:

$$[(0.4 \times 0) + (0.6 \times 110)]/1.10 = \$60$$

c. Unlike the American put in part (b), the European put can not be exercised prior to expiration. We noted in part (b) that, If the stock price in month 6 is \$110, the American put would be exercised because its value if exercised (i.e., \$110) is greater than its value if not exercised (i.e., \$90). For the European put, however, the value at that point is \$90 because the European put can not be exercised early. Therefore, the value of the European put is:

$$[(0.4 \times 0) + (0.6 \times 90)]/1.10 = \$49.09$$

7. The following tree shows stock prices, with option values in parentheses:



We calculate the option value as follows:

1. The option values in month 6, if the option is not exercised, are computed as follows:

$$\frac{(0.4 \times 5) + (0.6 \times 0)}{1.10} = 1.82$$

$$\frac{(0.4 \times 665) + (0.6 \times 42.5)}{1.10} = 265$$

If the stock price in month 6 is \$110, then it would not pay to exercise the option. If the stock price in month 6 is \$440, then the call is worth: (440 - 165) = 275. Therefore, the option would be exercised at that time.

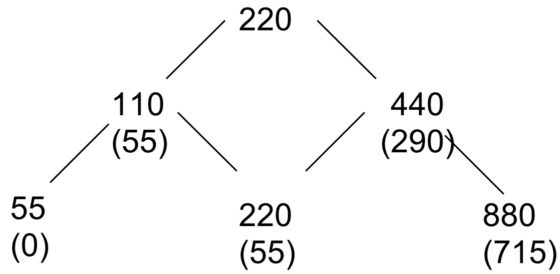
2. Working back to month 0, we find the option value as follows:

$$\text{Option value} = \frac{(0.4 \times 275) + (0.6 \times 1.82)}{1.10} = 100.99$$

b. If the option were European, it would not be possible to exercise early. Therefore, if the price rises to \$440 at month 6, the value of the option is \$265, not \$275 as is the case for the American option. Therefore, in this case, the value of the European option is less than the value of the American option. The value of the European option is computed as follows:

$$\text{Option value} = \frac{(0.4 \times 265) + (0.6 \times 1.82)}{1.10} = 97.36$$

8. The following tree (see Practice Question 5) shows stock prices, with the values for the one-year option values in parentheses:



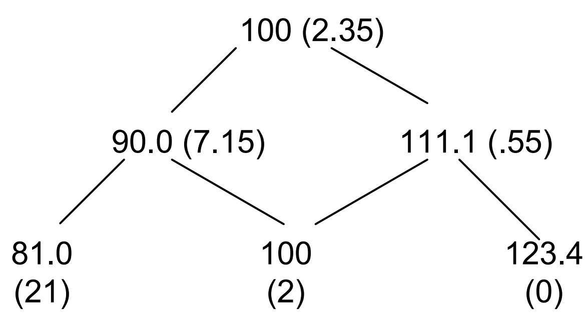
The put option is worth \$55 in month 6 if the stock price falls and \$0 if the stock price rises. Thus, with a 6-month stock price of \$110, it pays to exercise the put (value = \$55). With a price in month 6 of \$440, the investor would not exercise the put since it would cost \$275 to exercise. The value of the option in month 6, if it is not exercised, is determined as follows:

$$\frac{(0.4 \times 715) + (0.6 \times 55)}{1.10} = 290$$

Therefore, the month 0 value of the option is:

$$\text{Option value} = \frac{(0.4 \times 290) + (0.6 \times 55)}{1.10} = \$135.45$$

9. a. The following tree shows stock prices (with put option values in parentheses):



Let p equal the probability that the stock price will rise. Then, for a risk-neutral investor:

$$(p \times 0.111) + (1 - p)\times(-0.10) = 0.05$$

$$p = 0.71$$

If the stock price in month 6 is C$111.1, then the value of the European put is:

$$\frac{(0.71 \times 0) + (0.29 \times 2)}{1.05} = \text{C\$}0.55$$

If the stock price in month 6 is C$90.0, then the value of the put is:

$$\frac{(0.71 \times 2) + (0.29 \times 21)}{1.05} = \text{C\$}7.15$$

Since this is a European put, it can not be exercised at month 6.

The value of the put at month 0 is:

$$\frac{(0.71 \times 0.55) + (0.29 \times 7.15)}{1.05} = \text{C\$}2.35$$

b. Since the American put can be exercised at month 6, then, if the stock price is C$90.0, the put is worth (102 – 90) = $12 if exercised, compared to $7.15 if not exercised. Thus, the value of the American put in month 0 is:

$$\frac{(0.71 \times 0.55) + (0.29 \times 12)}{1.05} = \text{C\$}3.69$$

10. a. P = 200 EX = 180 σ = 0.223 t = 1.0 r_f = 0.21

$$d_1 = \log[P/PV(EX)]/\sigma\sqrt{t} + \sigma\sqrt{t}/2$$

$$= \log[200/(180/1.21)]/(0.223 \times \sqrt{1.0}) + (0.223 \times \sqrt{1.0})/2 = 1.4388$$

$$d_2 = d_1 - \sigma\sqrt{t} = 1.4388 - (0.223 \times \sqrt{1.0}) = 1.2158$$

$N(d_1)$ = N(1.4388) = 0.9249

$N(d_2)$ = N(1.2158) = 0.8880

Call value = [$N(d_1) \times$ P] – [$N(d_2) \times$ PV(EX)]

= [0.9249 × 200] – [0.8880 × (180/1.21)] = $52.88

b.

$$1 + \text{upside change} = u = e^{\sigma\sqrt{h}} = e^{0.223\sqrt{1.0}} = 1.2498$$

$$1 + \text{downside change} = d = 1/u = 1/1.2498 = 0.8001$$

Let p equal the probability that the stock price will rise. Then, for a risk-neutral investor:

$(p \times 0.25) + (1 - p)\times(-0.20) = 0.21$

p = 0.91

In one year, the stock price will be either \$250 or \$160, and the option values will be \$70 or \$0, respectively. Therefore, the value of the option is:

$$\frac{(0.91 \times 70) + (0.09 \times 0)}{1.21} = \$52.64$$

c.

$$1 + \text{upside change} = u = e^{\sigma\sqrt{h}} = e^{0.223\sqrt{0.5}} = 1.1708$$

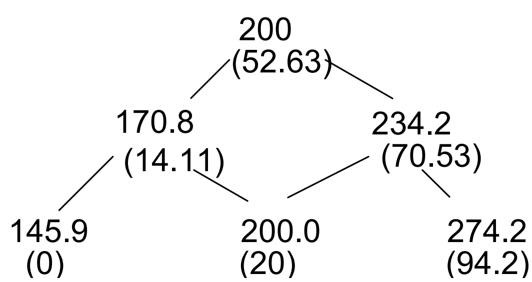
$$1 + \text{downside change} = d = 1/u = 1/1.1708 = 0.8541$$

Let p equal the probability that the stock price will rise. Then, for a risk-neutral investor:

$$(p \times 0.171) + (1 - p) \times (-0.146) = 0.10$$

$$p = 0.776$$

The following tree gives stock prices, with option values in parentheses:



Option values are calculated as follows:

1. $$\frac{(0.776 \times 20) + (0.224 \times 0)}{1.10} = \$14.11$$

2. $$\frac{(0.224 \times 20) + (0.776 \times 94.2)}{1.10} = \$70.53$$

3. $$\frac{(0.224 \times 14.11) + (0.776 \times 70.53)}{1.10} = \$52.63$$

d. (i) $$\text{Option delta} = \frac{\text{spread of possible option prices}}{\text{spread of possible stock prices}}$$

$$\text{Option delta} = \frac{70.53 - 14.11}{234.2 - 170.8} = 0.89$$

To replicate a call, buy 0.89 shares and borrow:
[(0.89 × 200) - 52.63] = $125.37

(ii) $$\text{Option delta} = \frac{94.2 - 20}{274.2 - 200} = 1.00$$

To replicate a call, buy one share and borrow:
[(1.0 × 200) - 70.53] = $129.47

(iii) $$\text{Option delta} = \frac{20 - 0}{200 - 145.9} = 0.37$$

To replicate a call, buy 0.37 shares and borrow:
[(0.37 × 200) - 14.11] = $59.89

11. To hold time to expiration constant, we will look at a simple one-period binomial problem with different starting stock prices. Here are the possible stock prices:

Now consider the effect on option delta:

Option Deltas		Current Stock Price 100	Current Stock Price 110
In-the-money	(EX = 60)	140/150 = 0.93	160/165 = 0.97
At-the-money	(EX = 100)	100/150 = 0.67	120/165 = 0.73
Out-of-the-money	(EX = 140)	60/150 = 0.40	80/165 = 0.48

Note that, for a given difference in stock price, out-of-the-money options result in a larger change in the option delta. If you want to minimize the number of times you rebalance an option hedge, use in-the-money options.

12. a. The call option. (You would delay the exercise of the put until after the dividend has been paid and the stock price has dropped.)

b. The put option. (You never exercise a call if the stock price is below exercise price.)

c. The put when the interest rate is high. (You can invest the exercise price.)

13. a. When you exercise a call, you purchase the stock for the exercise price. Naturally, you want to maximize what you receive for this price, and so you would exercise on the with-dividend date in order to capture the dividend.

b. When you exercise a put, your gain is the difference between the price of the stock and the amount you receive upon exercise, i.e., the exercise price. Therefore, in order to maximize your profit, you want to minimize the price of the stock and so you would exercise on the ex-dividend date.

14. [Note: the answer to this question is based on the assumption that the stock price is known.]

We can value the call by using the put-call parity relationship:

Value of put = value of call – share price + present value of exercise price

Then we must purchase two items of information [value of European put and PV(Exercise price)] and, hence, will spend $20.

If we use the Black-Scholes model, we must also purchase two items [standard deviation times square root of time to maturity and PV(exercise price)] and, hence, will spend $20.

15. Internet exercise; answers will vary.

Challenge Questions

1. For the one-period binomial model, assume that the exercise price of the options (EX) is between u and d. Then, the spread of possible option prices is:

   For the call: [(u – EX) – 0]

   For the put: [(d – EX) – 0]

   The option deltas are:

   Option delta(call) = [(u – EX) – 0]/(u – d) = (u – EX)/(u – d)

   Option delta(put) = [(d – EX) – 0]/(u – d) = (d – EX)/(u – d)

   Therefore:

   [Option delta(call) – 1] = [(u – EX)/(u – d)] – 1

   = [(u – EX)]/(u – d)] – [(u – d)/(u – d)]

   = [(u – EX) – (u – d)]/(u – d)

   = [d – EX]/(u – d) = Option delta(put)

2. If the exercise price of a call is zero, then the option is equivalent to the stock, so that, in order to replicate the stock, you would buy one call option. Therefore, if the exercise price is zero, the option delta is one. If the exercise price of a call is indefinitely large, then the option value remains low even if there is a large percentage change in the price of the stock. Therefore, the dollar change in the value of the option will be much smaller than the dollar change in the price of the stock, so that the option delta is close to zero. Between these two extreme cases, the option delta varies between zero and one.

3. Spreadsheet exercise.

4. Both of these announcements may convey information about company prospects, and thereby affect the price of the stock. But, when the dividend is paid, stock price decreases by an amount approximately equal to the amount of the dividend. This price decrease reduces the value of the option. On the other hand, a stock repurchase at the market price does not affect the price of the stock. Therefore, you should hope that the board will decide to announce a stock repurchase program.

5. a. Assume the following:

1. The annual market standard deviation is 21 percent.
2. The risk-free interest rate is 3 percent.
3. Dividends equal 2 percent of the index value, and grow by 9 percent per year to give a total return of 11 percent.
4. The yield on a 4-year bond is 5.5 percent.

Then:

$$\sigma\sqrt{\text{time}} = 0.21\sqrt{4} = 0.42$$

$$\frac{\text{Asset value} - \text{PV(dividends)}}{\text{PV(Exercise price)}}$$

$$= \frac{1000 - \frac{20.00}{1.11} - \frac{21.80}{1.11^2} - \frac{23.76}{1.11^3} - \frac{25.90}{1.11^4}}{1000 / 1.03^4} = \frac{929.85}{888.49} = 1.047$$

Therefore, the value of the call option = 172.78

$$\text{Value of SPINS} = \frac{1{,}000}{1.055^4} + 172.78 = \$980.00$$

b. Salomon Brothers has sold a four-year call option on the market. To hedge this position, Salomon needs to replicate the purchase of an equivalent option. It could do this by a series of levered investments in a diversified stock portfolio. (A more practical alternative would be to use index futures, rather than the underlying stocks; these are discussed in Chapter 27.)

6. a. As the life of the call option increases, the present value of the exercise price becomes infinitesimal. Thus the only difference between the call option and the stock is that the option holder misses out on any dividends. If dividends are negligible, the value of the option approaches its upper bound, i.e., the stock price.

b. While it is true that the value of an option approaches the upper bound as maturity increases and dividend payments on the stock decrease, a stock that never pays dividends is valueless.

CHAPTER 22
Real Options

Answers to Practice Questions

1. a. A five-year American call option on oil. The initial exercise price is $32 a barrel, but the exercise price rises by 5 percent per year.

   b. An American put option to abandon the restaurant at an exercise price of $5 million. The restaurant's current value is ($700,000/r). The annual standard deviation of the changes in the value of the restaurant as a going concern is 15 percent.

   c. A put option, as in (b), except that the exercise price should be interpreted as $5 million in real estate value plus the present value of the future fixed costs avoided by closing down the restaurant. Thus, the exercise price is: $5,000,000 + ($300,000/0.10) = $8,000,000. Note: The underlying asset is now PV(revenue – variable cost), with annual standard deviation of 10.5 percent.

   d. A complex option that allows the company to abandon temporarily (an American put) and (if the put is exercised) to subsequently restart (an American call).

   e. An in-the-money American option to choose between two assets; that is, the developer can defer exercise and then determine whether it is more profitable to build a hotel or an apartment building. By waiting, however, the developer loses the cash flows from immediate development.

   f. A call option that allows Air France to fix the delivery date and price.

2. A *commitment* to invest in the Mark II would have a negative NPV. The *option* to invest has a positive NPV. The value of the option more than offsets the negative NPV of the Mark I.

3. a. P = 467 EX = 800 σ = 0.35 t = 3.0 r_f = 0.10

$$d_1 = \log[P/PV(EX)]/\sigma\sqrt{t} + \sigma\sqrt{t}/2$$

$$= \log[467/(800/1.10^3)]/(0.35\times\sqrt{3.0}) + (0.35\times\sqrt{3.0})/2 = -0.1132$$

$$d_2 = d_1 - \sigma\sqrt{t} = -0.1132 - (0.35\times\sqrt{3.0}) = -0.7194$$

$N(d_1)$ = N(-0.1132) = 0.4549

$N(d_2)$ = N(-0.7194) = 0.2359

Call value = $[N(d_1) \times P] - [N(d_2) \times PV(EX)]$

$= [0.4549 \times 467] - [0.2359 \times (800/1.10^3)] = \$70.65$

b. P = 500 EX = 900 σ = 0.35 t = 3.0 r_f = 0.10

$d_1 = \log[P/PV(EX)]/\sigma\sqrt{t} + \sigma\sqrt{t}/2$

$= \log[500/(900/1.10^3)]/(0.35\times\sqrt{3.0}) + (0.35\times\sqrt{3.0})/2 = -0.1948$

$d_2 = d_1 - \sigma\sqrt{t} = -0.1948 - (0.35\times\sqrt{3.0}) = -0.8010$

$N(d_1)$ = N(-0.1948) = 0.4228

$N(d_2)$ = N(-0.8010) = 0.2116

Call value = $[N(d_1) \times P] - [N(d_2) \times PV(EX)]$

$= [0.4228 \times 500] - [0.2116 \times (900/1.10^3)]$ = \$68.32

c. P = 467 EX = 900 σ = 0.20 t = 3.0 r_f = 0.10

$d_1 = \log[P/PV(EX)]/\sigma\sqrt{t} + \sigma\sqrt{t}/2$

$= \log[467/(900/1.10^3)]/(0.20\times\sqrt{3.0}) + (0.20\times\sqrt{3.0})/2 = -0.8953$

$d_2 = d_1 - \sigma\sqrt{t} = -0.8953 - (0.20\times\sqrt{3.0}) = -1.2417$

$N(d_1)$ = N(-0.8953) = 0.1853

$N(d_2)$ = N(-1.2417) = 0.1072

Call value = $[N(d_1) \times P] - [N(d_2) \times PV(EX)]$

$= [0.1853 \times 467] - [0.1072 \times (900/1.10^3)]$ = \$14.05

4. P = 1.7 EX = 2 σ = 0.15 t = 1.0 r_f = 0.12

$d_1 = \log[P/PV(EX)]/\sigma\sqrt{t} + \sigma\sqrt{t}/2$

$= \log[1.7/(2/1.12^1)]/(0.15\times\sqrt{1.0}) + (0.15\times\sqrt{1.0})/2 = -0.2529$

$d_2 = d_1 - \sigma\sqrt{t} = -0.2529 - (0.15\times\sqrt{1.0}) = -0.4029$

$N(d_1)$ = N(-0.2529) = 0.4002

$N(d_2)$ = N(-0.4029) = 0.3435

Call value = $[N(d_1) \times P] - [N(d_2) \times PV(EX)]$

$= [0.4002 \times 1.7] - [0.3435 \times (2/1.12^1)]$ = \$0.0669 million or \$66,900

5. The asset value from Practice Question 4 is now reduced by the present value of the rents:

PV(rents) = 0.15/1.12 = 0.134

Therefore, the asset value is now (1.7 – 0.134) = 1.566

P = 1.566 EX = 2 σ = 0.15 t = 1.0 r_f = 0.12

$$d_1 = \log[P/PV(EX)]/\sigma\sqrt{t} + \sigma\sqrt{t}/2$$

$$= \log[1.566/(2/1.12^1)]/(0.15 \times \sqrt{1.0}) + (0.15 \times \sqrt{1.0})/2 = -0.8003$$

$$d_2 = d_1 - \sigma\sqrt{t} = -0.8003 - (0.15 \times \sqrt{1.0}) = -0.9503$$

$N(d_1)$ = N(-0.8003) = 0.2118

$N(d_2)$ = N(-0.9503) = 0.1710

Call value = [$N(d_1) \times$ P] – [$N(d_2) \times$ PV(EX)]

= [0.2118 × 1.566] – [0.1710 × $(2/1.12^1)$] = $0.0263 million or $26,300

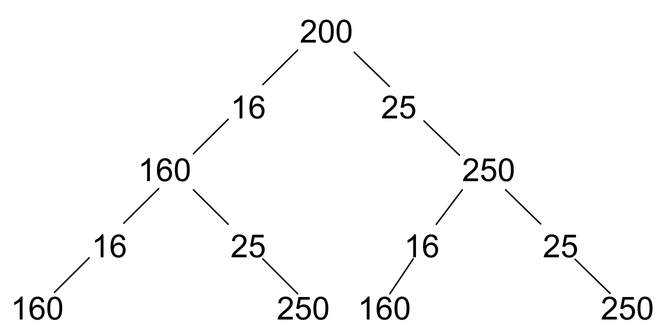
6. a. In general, an increase in variability increases the value of an option. Hence, if the prices of both oil and gas were very variable, the option to burn either oil or gas would be more valuable.

b. If the prices of coal and gas were highly correlated, then there would be minimal advantage to shifting from one to the other, and hence, the option would be less valuable.

7. If the cash flows are delayed one year, the value of the option is:

$$\frac{(0.343 \times 70) + (0.657 \times 0)}{1.05^2} = \$21.8 \text{ million}$$

8. For the case where the investment can be postponed for two years, the end-of-period values and intermediate cash flows are:

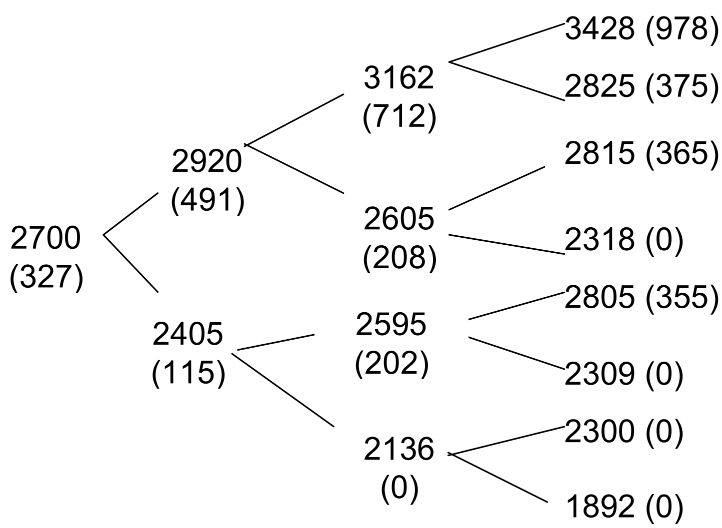


a. At the end of the first year, the decision about whether or not to invest should be postponed if demand at that time is low.

b. Because the option to delay has value, overall project Net Present Value will be higher.

c. If you could undertake the project only in years 0 and 2, overall project Net Present Value would change because choices would be constrained. If, for example, demand is high at t = 1, but the project cannot be undertaken until t = 2, the intermediate cash flow of $25 will be lost.

9. a. The values in the binomial tree below are the ex-dividend values, with the option values shown in parentheses.



b. The option values in the binomial tree above are computed using the risk neutral method. Let p equal the probability of a rise in asset value. Then, if investors are risk-neutral:

$$p\,(0.10) + (1 - p)(-0.0909) = 0.02$$

$$p = 0.581$$

If, for example, asset value at month 6 is $3,162 (this is the value after the $50 cash flow is paid to the current owners), then the option value will be:

$$[(0.419 \times 375) + (0.581 \times 978)]/1.02 = \$711$$

If the option is exercised at month 6 when asset value is $3,212 then the option value is: ($3,212 - $2,500) = $712. Therefore, the option value is $712.

At each asset value in month 3 and in month 6, the option value if the option if not exercised is greater than or equal to the option value if the option is exercised. (The one minor exception here is the calculation above where we show that the value is $712 if the option is exercised and $711 if it is not exercised. Due to rounding, this difference does not affect any of our results and conclusions.) Therefore, under the condition specified in part (b), you should not exercise the option now because its value if not exercised ($327) is greater than its value if exercised ($200).

c. If you exercise the option early, it is worth the with-dividend value less $2,500. For example, if you exercise in month 3 when the with-dividend value is $2,970, the option would be worth: ($2,970 - $2,500) = $470. Since the option is worth $490 if not exercised, you are better off keeping the option open. At each point before month 9, the option is worth more unexercised than exercised. (As noted above in part (b) there is one minor exception to this conclusion.) Therefore, you should wait rather than exercise today. The value of the option today is $327, as shown in the binomial tree above.

10. a. Technology B is equivalent to Technology A less a certain payment of $0.5 million. Since PV(A) = $11.5 million then, ignoring abandonment value:

PV(B) = PV(A) – PV(certain $0.5 million)

= $11.5 million – ($0.5 million/1.07) = $11.03 million

b. Assume that, if you abandon Technology B, you receive the $10 million salvage value but no operating cash flows. Then, if demand is sluggish, you should exercise the put option and receive $10 million. If demand is buoyant, you should continue with the project and receive $18 million. So, in year 1, the put would be worth: ($10 million - $8 million) = $2 million if demand is sluggish and $0 if demand is buoyant

We can value the put using the risk-neutral method. If demand is buoyant, then the gain in value is: (\$18 million/\$10 million) –1 = 63.2%
If demand is sluggish, the loss is: (\$8 million/\$11.03 million) = -27.5%
Let p equal the probability of a rise in asset value. Then, if investors are risk-neutral:

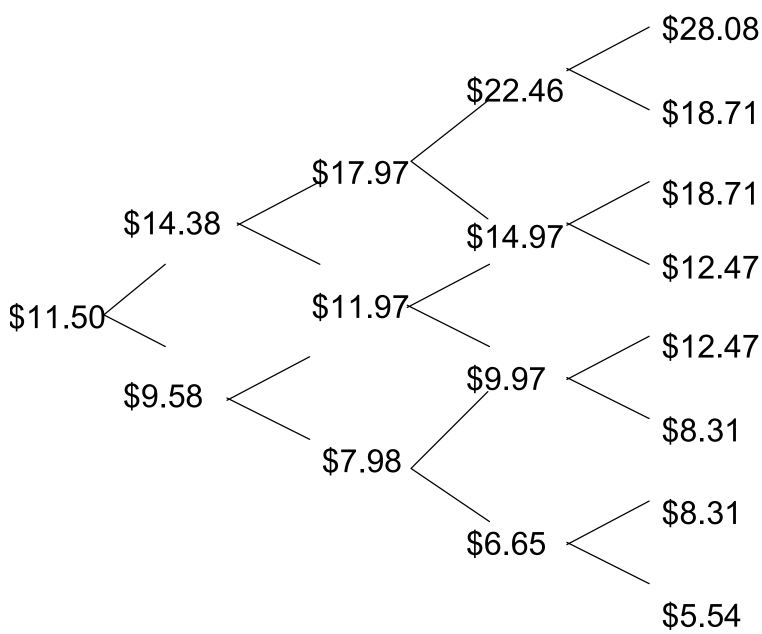
$$p\,(0.632) + (1 - p)(-0.275) = 0.07$$

$$p = 0.38$$

Therefore, the value of the option to abandon is:

$$[(0.62 \times 0) + (0.38 \times 2)]/1.07 = \$0.71 \text{ million}$$

11. a.



b. The only case in which one would want to abandon at the end of the year is if project value is \$5.54 (i.e., if value declines in each of the four quarters). In this case, the value of the abandonment option would be: (7 – 5.54) = 1.46

Let p equal the probability of a rise in asset value. Then, using the quarterly risk-free rate, we find that, if investors are risk-neutral:

$$p\,(0.25) + (1 - p)(-0.167) = 0.017$$

$$p = 0.441$$

The risk-neutral probability of a fall in value in each of the four quarters is:

$(1 - 0.441)^4 = 0.0976$

The expected risk-neutral value of the abandonment option is:

$0.0976 \times 1.06 = 0.1035$

The present value of the abandonment option is:

$(0.0976 \times 1.06)/1.07 = 0.0967$ or $96,700

12. Decision trees are potentially more complex that the simple binomial trees. For example, decision trees might recognize three or more outcomes at each stage. Furthermore, decision trees are used to help decision-makers to understand the alternative courses of action available, while the binomial trees in Chapter 22 are used for valuation purposes.

13. The valuation approach proposed by Josh Kidding will not give the right answer because it ignores the fact that the discount rate within the tree changes as time passes and the value of the project changes.

14. We can no longer rely on arbitrage arguments for assets that are not traded in financial markets, but we can use the risk-neutral method, which is an application of the certainty-equivalent concept. (See the end of Section 22.6.)

Challenge Questions

1. a. You don't take delivery of the new plant until month 36. Think of the situation one month before completion. You have a call option to get the plant by paying the final month's construction costs to the contractors. One month before that, you have an option on the option to buy the plant. The exercise price of this second call option is the construction cost in the next to last month. And so on.

   b. Alternatively, you can think of the firm as agreeing to construction and putting the present value of the construction cost in an escrow account. Each month, the firm has the option to abandon the project and receive the unspent balance in the escrow account. Thus, in month 1, you have a put option on the project with an exercise price equal to the amount in the escrow account. If you do not exercise the put in month 1, you get another option to abandon it in month 2. The exercise price of this option is the amount in the escrow account in month 2. And so on.

2. The present value of the investment is:

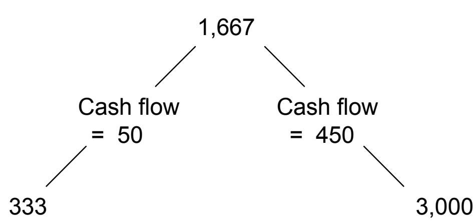
   PV = 250/0.15 = $1,667

   The net present value is:

   NPV = -1,000 + 1,667 = $667

   Considered by itself, the project has a positive Net Present Value.

   Now consider the option to wait one year. This is a call option with an exercise price of $1,000. The possible cash flows and end-of-period values for the first year are:



If fuel savings are $450 per year, then the project has a cash flow of $450 the first year and an end-of-year value equal to: ($450/0.15) = $3,000. The total return is: [(450 + 3,000)/1,667] – 1.0 = 1.07 = 107%. On the other hand, if fuel savings are $50 per year, then the project has a cash flow of $50 the first year and an end-of-year value equal to: ($50/0.15) = $333. The total return is: [(50 + 333)/1,677] – 1.0 = -0.77 = -77%. In a risk-neutral world, the expected return would be equal to the risk-free interest rate. Let p be the probability that fuel prices are high, under the assumption of risk-neutrality:

$$(p \times 1.07) + [(1 - p) \times (-0.77)] = 0.10$$

$$p = 0.473 = 47.3\%$$

To value the call option, consider its possible values. If fuel prices rise to $450, the option will be worth: ($3,000 - $1,000) = $2,000. If fuel prices fall to $50, the option is worthless. Thus, today the option to invest in energy-saving equipment is worth:

$$\frac{(0.473 \times 2{,}000) + [(1 - 0.473) \times 0]}{1.10} = \$860$$

If the energy-efficient investment is undertaken today, its value is $667. However, the value of the option to wait is $860. Hence, it makes sense for consumers to wait.

3. a. An increase in PVGO increases the stock’s risk. Since PVGO is a portfolio of expansion options, it has higher risk than the risk of the assets currently in place.

   b. The cost of capital derived from the CAPM is not the correct hurdle rate for investments to expand the firm’s plant and equipment, or to introduce new products. The expected return will reflect the expected return on the real options as well as the assets in place. Consequently, the rate will be too high.

CHAPTER 23
Warrants and Convertibles

Answers to Practice Questions

1. a. Exercise later. By exercising now, you gain a dividend of $3. However, you forgo the interest you could have earned on the exercise price: $(0.10 \times \$40) = \$4$. Also, by exercising now, you give up the option to own the bond and not own the stock.

   b. If the dividend is $5, you pick up $1 of extra income by exercising, but you still give up the option. If the stock has low variability, it is unlikely that the share price will change very much. In that case, the income gain may outweigh the loss from shortening the option life. If the stock has high variability, it may be better to keep the option alive because of the higher option value.

2. a. The Moose Stores warrant issue is large relative to the value of the firm, so the dilution adjustment is correspondingly important. Total equity value after the warrant issue (V) is ($40 million + $5 million) = $45 million. Thus, (V/N) = ($45 million/1 million shares) = 45.

   P = (V/N) = 45 EX = 30 $\sigma = 0.20$ t = 5.0 $r_f = 0.08$

$$d_1 = \log[P/PV(EX)]/\sigma\sqrt{t} + \sigma\sqrt{t}/2$$

$$= \log[45/(30/1.08^5)]/(0.20 \times \sqrt{5.0}) + (0.20 \times \sqrt{5.0})/2 = 1.9907$$

$$d_2 = d_1 - \sigma\sqrt{t} = 1.9907 - (0.20 \times \sqrt{5.0}) = 1.5435$$

$N(d_1) = N(1.9907) = 0.9767$

$N(d_2) = N(1.5435) = 0.9386$

Call value = $[N(d_1) \times P] - [N(d_2) \times PV(EX)]$

$= [0.9767 \times 45] - [0.9386 \times (30/1.08^5)] = \$24.79$

$$\text{Warrant value} = \left(\frac{1}{1+q}\right) \times (\text{Call value}) = \frac{\$24.79}{2} = \$12.395$$

   b. The market value of each share of common stock is:

   ($45 - $12.395) = $32.605

3. a. An approximate solution can be derived here by assuming that the warrant holder pre-commits to exercising at a specified future date. For example, suppose the warrants are not exercised before year five. Warrant holders would then lose the first four dividends. We recalculate the warrant value as follows:

P = (V/N) – PV(dividends) = 45 – 11.27 = 33.73

EX = 30 $\sigma = 0.20$ t = 5.0 $r_f = 0.08$

$$d_1 = \log[P/PV(EX)]/\sigma\sqrt{t} + \sigma\sqrt{t}/2$$

$$= \log[33.73/(30/1.08^5)]/(0.20\times\sqrt{5.0}) + (0.20\times\sqrt{5.0})/2 = 1.3461$$

$$d_2 = d_1 - \sigma\sqrt{t} = 1.3461 - (0.20\times\sqrt{5.0}) = 0.8989$$

$N(d_1) = N(1.3461) = 0.9109$

$N(d_2) = N(0.8989) = 0.8156$

Call value = $[N(d_1) \times P] - [N(d_2) \times PV(EX)]$

$= [0.9109 \times 33.73] - [0.8156 \times (30/1.08^5)] = \$14.07$

$$\text{Warrant value} = \left(\frac{1}{1+q}\right) \times (\text{Call value}) = \frac{\$14.07}{2} = \$7.035$$

b. The market value of each share of common stock is:

(\$45 - \$7.035) = \$37.965

4. The cost of extending the warrant life is the same as issuing a new warrant with maturity equal to the time of extension. In essence, the new warrants are given to the old warrant holders at no charge.

5. a. With a \$1,000 face value for the bonds, a bondholder can convert one bond into: (1,000/25) = 40 shares. The conversion value is: (40 × \$30) = \$1,200

b. A convertible sells at the conversion value only if the convertible is certain to be exercised. You can think of owning the convertible as equivalent to owning forty shares plus an option to put the shares back to the company in exchange for the value of the bond. The price of the convertible bond exceeds the conversion value by the value of this put. Also, if the interest on the convertible exceeds the dividends on forty shares of common stock, the convertible's value reflects this additional income.

c. Yes. When Surplus calls, the price of the convertibles will fall to the conversion value. That is, bondholders will be forced to convert in order to escape the call. By not calling, Surplus is handing bondholders a 'free gift' worth 25 percent of the bond's face value (i.e., 130 - 105), at the expense of the shareholders.

6. a. If the fair rate of return on a 10-year zero-coupon non-convertible bond is 8%, then the price would be:

$$\$1{,}000/1.08^{10} = \$463.19$$

The conversion value is: $(10 \times \$50) = \$500$. By converting, you would gain: ($500 - $463.19) = $36.81. That is, you could convert, sell the ten shares for $500, and then buy a comparable straight bond for $463.19. Otherwise, if you do not convert, and the bond is no longer convertible in the future, you will own a non-convertible Piglet bond worth $463.19

b. Investors are paying ($550.00 - $463.19) = $86.81 for the option to buy ten shares.

c. In one year, bond value = ($\$1{,}000/1.08^9$) = $500.25 (i.e., the value of a comparable non-convertible bond). Then the value of the convertible bond is: ($500.25 + $86.81) = $587.06

7. a. Assume a face value of $1,000. The conversion price is:

($1,000/27) = $37.04

b. The conversion value is: $(27 \times \$47) = \$1{,}269$.

c. Yes, you should convert because the value of the shares ($1,269) is greater than the maturity value of the bond.

8. a. Stock

b. Straight bond

c. Straight bond

d. Stock

9. a. The yield to maturity on the bond is computed as follows:

$$1{,}000 = 532.15 \times (1 + r)^{15}$$

$$1{,}000/532.15 = 1.8792 = (1 + r)^{15}$$

$$1.8792^{(1/15)} = 1.0430 = (1 + r)$$

$$r = 0.0430 = 4.30\%$$

b. The value of the non-convertible bond would be:

$$1{,}000/(1.10)^{15} = \$239.39$$

The conversion option was worth:

$$\$532.15 - \$239.39 = \$292.76$$

c. Conversion value of the bonds at time of issue was:

$8.76 \times \$50.50 = \$442.38$

d. The initial conversion price was:

$\$532.15/8.76 = \$60.75$

e. Call price in 2005 is:

$603.71 \times (1.0430^6) = \$777.20$

Therefore, the conversion price is:

$\$777.20/8.76 = \$88.72$

The increase in the conversion price reflects the accreted value of the bond since it has a zero coupon.

f. If investors act rationally, they should put the bond back to Marriott as soon as the market price falls to the put exercise price.

g. Marriott can call the bonds at $810.36. Marriott should call the bonds if the price is greater than $810.36.

10. Disagree. The expected return affects the price of the stock, but it does not affect the relative values of the stock and the option. Remember that the investor can construct a package of debt and warrants that gives exactly the same return as the stock. The value of this package does not depend on the stock return.

11. A convertible feature in a bond is analogous to a call option. When the riskiness of the stock increases, the value of the conversion feature also increases.

12. These companies have a need for cash but the current share price often does not allow for large issuances of equity. Issuing a convertible effectively lets the firm 'sell' shares at a higher price.

13. The option holder misses out on the bond's interest payments. The present value of these missed payments is subtracted from the present value of the bond (which is $1,000, or par, because the coupon rate is equal to the interest rate). In other words, the option buyer saves interest by not having to buy the bond immediately but loses out by not receiving the next two years' interest payments on the bond. Thus:

$$\text{Asset value} = 1{,}000 - \frac{120}{1.12} - \frac{120}{1.12^2} = 797.19$$

P = 797.19 EX = 1,200 σ = 0.20 t = 3.0 r_f = 0.12

$$d_1 = \log[P/PV(EX)]/\sigma\sqrt{t} + \sigma\sqrt{t}/2$$

$$= \log[797.19/(1200/1.12^3)]/(0.20 \times \sqrt{3.0}) + (0.20 \times \sqrt{3.0})/2 = -0.0260$$

$$d_2 = d_1 - \sigma\sqrt{t} = -0.0260 - (0.20 \times \sqrt{3.0}) = -0.3724$$

$N(d_1)$ = N(-0.0260) = 0.4896

$N(d_2)$ = N(-0.3724) = 0.3548

Call value = $[N(d_1) \times P] - [N(d_2) \times PV(EX)]$

$= [0.4896 \times 797.19] - [0.3548 \times (1200/1.12^3)] = \$87.26$

Challenge Questions

1. a. The warrant is like a 5-year call option with an exercise price of $30 on a stock with a value of $19. Given an estimate of the appropriate standard deviation and risk-free rate of return, the warrant can be valued using the Black-Scholes formula. However, you would need to adjust for dividends.

   b. To take dilution into account, we note that the warrant value is equal to the value of [1/(1 + q)] call options written on a stock with price (V/N).

   The standard deviation for the Black-Scholes formula is the standard deviation of (V/N) rather than the standard deviation of the firm's common stock.

2. a. The value of the alternative share = (V/N) where V is the total value of equity (common stock plus warrants) and N is the number of shares outstanding. For Electric Bassoon:

$$\frac{V}{N} = \frac{20{,}000 + 5{,}000}{2{,}000} = \$12.50$$

   When valuing the warrant, we use the standard deviation of this alternative 'share.' This can be obtained from the following relationship (see chapter footnote 6):

   The proportion of the firm financed by equity (calculated before the issue of the warrant) *times* the standard deviation of stock returns (calculated before the issue of the warrant)

   is equal to

   the proportion of the firm financed by equity (calculated after the issue of the warrant) *times* the standard deviation of the alternative share.

   b. The value of the warrant is equal to the value of [1/(1 + q)] call options on the alternative share, where q is the number of warrants issued per share outstanding. For Electric Bassoon:

   q = 1,000/2,000 = 0.5

   Therefore:

   1/(1 + q) = 1/1.5 = 0.67

   The value of the warrant is [0.67 × 6] = $4. At the current price of $5 the warrants are overvalued.

3. a. In the case of the safe project, the payoff always exceeds \$7 million, so that the lender will always receive the promised payment. Ms. Blavatsky has a 40% chance of receiving (\$12.5 million - \$7 million) = \$5.5 million and a 60% chance of receiving (\$8 million - \$7 million) = \$1 million. Thus, for the lender, the expected payoff is:

$$(0.4 \times 7) + (0.4 \times 7) = \$7 \text{ million}$$

For Ms. Blavatsky, the expected payoff is:

$$(0.4 \times 5.5) + (0.6 \times 1) = \$2.8 \text{ million}$$

b. In the case of the risky project, there is a 40% chance of a \$20 million payoff, in which case the lender will receive \$7 million and Ms. Blavatsky \$13 million. There is also a 60% chance of a \$5 million payoff, in which case the lender will receive \$5 million and Ms. Blavatsky nothing.

For the lender, the expected payoff is:

$$(0.4 \times 7) + (0.6 \times 5) = \$5.8 \text{ million}$$

For Ms. Blavatsky, the expected payoff is:

$$(0.4 \times 13) + (0.6 \times 0) = \$5.2 \text{ million}$$

Thus, the lender will want Ms. Blavatsky to choose the safe project while Ms. Blavatsky will prefer the risky project.

Suppose now that the debt is convertible into 50% of the value of the firm. For the safe project, there is a 40% chance the lender will be faced with a choice of \$7 million or 50% of the \$12.5 million, which is \$6.25 million; the lender will choose the former. There is also a 60% chance the lender will face a choice of \$7 million or 50% of \$8 million, which is \$4 million; the lender will choose \$7 million. Thus, the expected payoff to the lender from the safe project is:

$$(0.4 \times 7) + (0.6 \times 7) = \$7 \text{ million}$$

For the risky project, there is a 40% chance the lender will be faced with a choice of \$7 million or 50% of \$20 million, which is \$10 million; the lender will choose the latter. There is also a 60% chance the lender will face a choice of \$5 million or 50% of \$5 million, which is \$2.5 million; the lender will choose \$5 million. Thus, the expected payoff to the lender from the risky project is:

$$(0.4 \times 10) + (0.6 \times 5) = \$7 \text{ million}$$

Therefore, the lender receives the same expected payoff (i.e., \$7 million) from each of the two projects.

4. The existing shareholders will be harmed by the issue of convertible bonds. The conversion provision will be worth more than the convertible holders pay for it. The new convertible holders will gain less than new shareholders would gain, however. This can be seen by considering the convertible as the stock plus a put option. In general, if the stock is truly underpriced, the existing shareholders are better off issuing the safest possible asset; this prevents the new holders of the asset from sharing the rewards of an increase in stock value when an increase in new information becomes known.

   The one exception to this result may occur when common stock is undervalued because investors overestimate the firm's risk. Remember that options written on risky assets are more valuable than options written on safe ones. Thus, in this case, investors may overvalue the conversion option, which may make the convertible issue more attractive than a stock issue.

CHAPTER 24
Valuing Debt

Answers to Practice Questions

1. Some reasons Fisher's theory might not be true are:
   a. Taxes are levied on nominal interest. Therefore, if expected inflation is high, part of the tax is actually on the real principal.
   b. Inflation may be associated with the level of real economic activity, which, in turn, may affect real interest rates.
   c. It ignores uncertainty about inflation.

2. If expected real interest rates are negative, then individuals will be tempted to save by buying and storing real goods. This forces the prices of goods up and the prices of securities down until real rates are no longer negative.

   However, goods are costly to store and expensive to resell if you do not want them. Some goods are impossible to store, e.g., haircuts and appendectomies. Prices of these goods may be expected to rise faster than the interest rate. Note also that it is difficult for a country on its own to maintain a very low real rate without imposing exchange controls on its citizens.

3. The key here is to find a combination of these two bonds (i.e., a portfolio of bonds) that has a cash flow only at t = 6. Then, knowing the price of the portfolio and the cash flow at t = 6, we can calculate the 6-year spot rate.

   We begin by specifying the cash flows of each bond and using these and their yields to calculate their current prices:

Investment	Yield	C_1	. . .	C_5	C_6	Price
6% bond	12%	60	. . .	60	1,060	$753.32
10% bond	8%	100	. . .	100	1,100	$1,092.46

   From the cash flows in years one through five, it is clear that the required portfolio consists of one 6% bond minus 60% of one 10% bond, i.e., we should buy the equivalent of one 6% bond and sell the equivalent of 60% of one 10% bond. This portfolio costs:

   $\$753.32 - (0.6 \times \$1{,}092.46) = \$97.84$

   The cash flow for this portfolio is equal to zero for years one through five and, for year 6, is equal to:

   $\$1{,}060 - (0.6 \times 1{,}100) = \$400$

   Thus:

   $\$97.84 \times (1 + r_6)^6 = 400$

   $r_6 = 0.265 = 26.5\%$

4. Downward sloping. This is because high coupon bonds provide a greater proportion of their cash flows in the early years. In essence, a high coupon bond is a 'shorter' bond than a low coupon bond of the same maturity.

5. Using the general relationship between spot and forward rates, we have:

$(1 + r_2)^2 = (1 + r_1) \times (1 + f_2) = (1.060) \times (1.064) \quad \Rightarrow r_2 = 0.062 = 6.2\%$
$(1 + r_3)^3 = (1 + r_2)^2 \times (1 + f_3) = (1.062)^2 \times (1.071) \quad \Rightarrow r_3 = 0.065 = 6.5\%$
$(1 + r_4)^4 = (1 + r_3)^3 \times (1 + f_4) = (1.065)^3 \times (1.073) \quad \Rightarrow r_4 = 0.067 = 6.7\%$
$(1 + r_5)^5 = (1 + r_4)^4 \times (1 + f_5) = (1.067)^4 \times (1.082) \quad \Rightarrow r_5 = 0.070 = 7.0\%$

If the expectations hypothesis holds, we can infer—from the fact that the forward rates are increasing—that spot interest rates are expected to increase in the future.

6. In order to lock in the currently existing forward rate for year five (f_5), the firm should:

- Borrow the present value of $100 million. Because this money will be received in four years, this borrowing is at the four-year spot rate: $r_4 = 6.7\%$
- Invest this amount for five years, at the five-year spot rate: $r_5 = 7.0\%$

Thus, the cash flows are:

Today: Borrow $(100/1.067)^4$ = $77.151 million
Invest $77.151 million for 5 years at 7.0%
Net cash flow: Zero

In four years: Repay loan: ($77.151 $\times$ 1.067^4) = $100 million dollars
Net cash flow: -$100 million

In five years: Receive amount of investment:
($77.151 $\times$ 1.070^5) = $108.2 million
Net cash flow: +$108.2 million

Note that the cash flows from this strategy are exactly what one would expect from signing a contract today to invest $100 million in four years, for a time period of one year, at today's forward rate for year 5 (8.2%). With $108.2 million available, the firm can cover the payment of $107 million at t = 5.

7. We make use of the usual definition of the internal rate of return to calculate the yield to maturity for each bond.

5% Coupon Bond:

$$NPV = -920.70 + \frac{50}{(1+r)} + \frac{50}{(1+r)^2} + \frac{50}{(1+r)^3} + \frac{50}{(1+r)^4} + \frac{1050}{(1+r)^5} = 0$$

r = 0.06930 = 6.930%

7% Coupon Bond:

$$NPV = -1003.10 + \frac{70}{(1+r)} + \frac{70}{(1+r)^2} + \frac{70}{(1+r)^3} + \frac{70}{(1+r)^4} + \frac{1070}{(1+r)^5} = 0$$

r = 0.06925 = 6.925%

12% Coupon Bond:

$$NPV = -1209.20 + \frac{120}{(1+r)} + \frac{120}{(1+r)^2} + \frac{120}{(1+r)^3} + \frac{120}{(1+r)^4} + \frac{1120}{(1+r)^5} = 0$$

r = 0.06910 = 6.910%

Assuming that the default risk is the same for each bond, one might be tempted to conclude that the bond with the highest yield is the best investment. However, we know that the yield curve is rising (the spot rates are those found in Question 5) and that, because the bonds have different coupon rates, their durations are different.

5% Coupon Bond:

$$DUR = \frac{\frac{1(50)}{1.060} + \frac{2(50)}{1.062^2} + \frac{3(50)}{1.065^3} + \frac{4(50)}{1.067^4} + \frac{5(1050)}{1.070^5}}{920.70}$$

$$DUR = 4157.5/920.70 = 4.52 \text{ years}$$

7% Coupon Bond:

$$DUR = \frac{\frac{1(70)}{1.060} + \frac{2(70)}{1.062^2} + \frac{3(70)}{1.065^3} + \frac{4(70)}{1.067^4} + \frac{5(1070)}{1.070^5}}{1003.10}$$

$$DUR = 4394.5/1003.10 = 4.38 \text{ years}$$

12% Coupon Bond:

$$DUR = \frac{\frac{1(120)}{1.060} + \frac{2(120)}{1.062^2} + \frac{3(120)}{1.065^3} + \frac{4(120)}{1.067^4} + \frac{5(1120)}{1.070^5}}{1209.20}$$

$$DUR = 4987.1/1209.20 = 4.12 \text{ years}$$

Thus, the bond with the longest duration is also the bond with the highest yield to maturity. This is precisely what is expected, given that the yield curve is rising. We conclude that the bonds are equally attractive.

8. a. & b.

Year	Discount Factor	Forward Rate
1	1/1.05 = 0.952	
2	$1/(1.054)^2$ = 0.900	$(1.054^2/1.05) - 1$ = 0.058 = 5.8%
3	$1/(1.057)^3$ = 0.847	$(1.057^3/1.054^2) - 1$ = 0.063 = 6.3%
4	$1/(1.059)^4$ = 0.795	$(1.059^4/1.057^3) - 1$ = 0.065 = 6.5%
5	$1/(1.060)^5$ = 0.747	$(1.060^5/1.059^4) - 1$ = 0.064 = 6.4%

c. 1. 5%, two-year note:

$$PV = \frac{50}{1.05} + \frac{1050}{(1.054)^2} = \$992.79$$

2. 5%, five-year note:

$$PV = \frac{50}{1.05} + \frac{50}{(1.054)^2} + \frac{50}{(1.057)^3} + \frac{50}{(1.059)^4} + \frac{1050}{(1.060)^5} = \$959.34$$

3. 10%, five-year note:

$$PV = \frac{100}{1.05} + \frac{100}{(1.054)^2} + \frac{100}{(1.057)^3} + \frac{100}{(1.059)^4} + \frac{1100}{(1.060)^5} = \$1{,}171.43$$

d. First, we calculate the yield for each of the two bonds. For the 5% bond, this means solving for r in the following equation:

$$959.34 = \frac{50}{1+r} + \frac{50}{(1+r)^2} + \frac{50}{(1+r)^3} + \frac{50}{(1+r)^4} + \frac{1050}{(1+r)^5}$$

r = 0.05964 = 5.964%

For the 10% bond:

$$1171.43 = \frac{100}{1+r} + \frac{100}{(1+r)^2} + \frac{100}{(1+r)^3} + \frac{100}{(1+r)^4} + \frac{1100}{(1+r)^5}$$

r = 0.05937 = 5.937%

The yield depends upon both the coupon payment and the spot rate at the time of the coupon payment. The 10% bond has a slightly greater proportion of its total payments coming earlier, when interest rates are low, than does the 5% bond. Thus, the yield of the 10% bond is slightly lower.

e. The yield to maturity on a five-year zero coupon bond is the five-year spot rate, here 6.00%.

f. First, we find the price of the five-year annuity, assuming that the annual payment is $1:

$$PV = \frac{1}{1.05} + \frac{1}{(1.054)^2} + \frac{1}{(1.057)^3} + \frac{1}{(1.059)^4} + \frac{1}{(1.060)^5} = \$4.2417$$

Now we find the yield to maturity for this annuity:

$$4.2417 = \frac{1}{1+r} + \frac{1}{(1+r)^2} + \frac{1}{(1+r)^3} + \frac{1}{(1+r)^4} + \frac{1}{(1+r)^5}$$

$r = 0.0575 = 5.75\%$

g. The yield on the five-year Treasury note lies between the yield on a five-year zero-coupon bond and the yield on a 5-year annuity because the cash flows of the Treasury bond lie between the cash flows of these other two financial instruments. That is, the annuity has fixed, equal payments, the zero-coupon bond has one payment at the end, and the bond's payments are a combination of these.

9. A 6-year spot rate of 4.8 percent implies a negative forward rate:

$(1.048^6/1.06^5) - 1 = -0.01 = -1.0\%$

To make money, you could borrow $1,000 for 6 years at 4.8 percent and lend $990 for 5 years at 6 percent. The future value of the amount borrowed is:

$FV_6 = \$1,000 \times (1.048)^6 = \$1,324.85$

The future value of the amount loaned is:

$FV_5 = \$990 \times (1.06)^5 = \$1,324.84$

This ensures enough money to repay the loan by holding cash over from year 5 to year 6, and provides an immediate $10 inflow.

The minimum sensible rate satisfies the condition that the forward rate is 0%:

$(1 + r_6)^6/(1.06)^5 = 1.00$

This implies that r_6 = 4.976 percent.

10. a. Under the expectations theory, the expected spot rate equals the forward rate, which is equal to:

$$(1.06^5/1.059^4) - 1 = 0.064 = 6.4 \text{ percent}$$

b. If the liquidity-preference theory is correct, the expected spot rate is less than 6.4 percent.

c. If the term structure contains an inflation uncertainty premium, the expected spot is less than 6.4 percent.

11. In general, yield changes have the greatest impact on long-maturity, low-coupon bonds.

12. It may be upward sloping because short-term rates are expected to rise or because long-term bonds are more risky. A sensible starting position is to assume that all debt is fairly priced.

13. [Note: The duration stated in Section 24.3 is 4.574 years. The table below provides a result that differs from this figure due to rounding.]

Year	C_t	PV @4.90%	Proportion of Value	Proportion of Value x Time
1	46.25	44.09	0.045	0.045
2	46.25	42.03	0.043	0.086
3	46.25	40.07	0.041	0.123
4	46.25	38.20	0.039	0.156
5	1046.25	823.68	0.834	4.170
	Totals	988.07		4.580

14. The duration of a perpetual bond is: [(1 + yield)/yield]

The duration of a perpetual bond with a yield of 5% is:

$D_5 = 1.05/0.05 = 21$ years

The duration of a perpetual bond yielding 10% is:

$D_{10} = 1.10/0.10 = 11$ years

Because the duration of a zero-coupon bond is equal to its maturity, the 15-year zero-coupon bond has a duration of 15 years.

Thus, comparing the 5% bond and the zero-coupon bond, the 5% bond has the longer duration. Comparing the 10% bond and the zero, the zero has a longer duration.

15. The formula for the duration of a level annuity is:

$$\frac{1+y}{y}-\frac{T}{(1+y)^{T}-1}=\frac{1.09}{0.09}-\frac{5}{(1.09)^{5}-1}=12.11-9.28=2.83 \text{ years}$$

Also, we know that:

$$\text{Volatility (percent)}=\frac{\text{duration}}{1+\text{yield}}=\frac{2.83}{1.09}=2.60\%$$

This tells us that a 1% variation in the interest rate will cause the contract's value to change by 2.60%. On average, then, a 0.5% increase in yield will cause the contract's value to fall by 1.30%. The present value of the annuity is \$583,448 so the value of the contract decreases by: (0.0130 × \$583,448) = \$7,585

16. If interest rates rise and the medium-term bond price decreases to \$90.75 instead of \$95, then it will be underpriced relative to the short-term and long-term bonds. Investors would buy the medium-term bond at the low price in order to gain from the difference between its value and its price. This will increase the price and decrease the yield. If the bond price increased to \$115.50 instead of \$111.50, investors would sell the medium-term bond because it is overpriced relative to the short-term and long-term bonds.

17. The value of a corporate bond can be thought of as the value of a risk-free bond minus the value of a put option on the firm's assets. The value of the safe bond depends on risk-free spot rates. The value of the put decreases as the value of the assets increases relative to the exercise price. The value of the put also decreases with increases in the interest rate, and increases with increases in the volatility of the stock. Other factors that determine the yield on corporate bonds are: differences in features (e.g., call or put provisions), differences in tax treatment and differences among countries.

18. If the floating rate debt is risk free, then the price should vary only if the interest rate on the bond is not reset continuously. However, the value of risky debt will also vary as the value of the default option varies.

19. The value of Company A's zero-coupon bond depends only on the ten-year spot rate. In order to value Company B's ten-year coupon bond, each coupon interest payment must be discounted at the appropriate spot rate. This is not complicated if the term structure is flat so that all spot rates are the same. However, it can cause difficulties when long-term rates are very different from short-term rates.

20. If Company X has successfully matched the terms of its assets and liabilities, the payment of $150 may be reasonably assured while the $50 is considerably smaller and not due until the distant future. Company Y has a relatively large amount due in an intermediate time frame. Thus, the risk exposure of Company Y to future events may be greater than that for Company X.

Challenge Questions

1. The statement that the nominal interest rate equals the real rate plus the expected inflation rate *is* a tautology. Fisher's hypothesis is that changes in the inflation rate do not change the expected real rate; in other words, the two variables fluctuate independently.

2. Arbitrage opportunities can be identified by finding situations where the implied forward rates or spot rates are different.

   We begin with the shortest-term bond, Bond G, which has a two-year maturity. Since G is a zero-coupon bond, we determine the two-year spot rate directly by finding the yield for Bond G. The yield is 9.5 percent, so the implied two-year spot rate (r_2) is 9.5 percent. Using the same approach for Bond A, we find that the three-year spot rate (r_3) is 10.0 percent.

   Next we use Bonds B and D to find the four-year spot rate. The following position in these bonds provides a cash payoff only in year four:
   a long position in two of Bond B and a short position in Bond D.
   Cash flows for this position are:

   [(-2 × \$842.30) + (\$980.57)] = -\$704.03 today;
   [(2 × \$50) – (\$100)] = \$0 in years 1, 2 and 3; and,
   [(2 × \$1050) – (\$1100)] = \$1000 in year 4.

   We determine the four-year spot rate from this position as follows:

$$704.03 = \frac{1000}{(1+r_4)^4}$$

$$r_4 = 0.0917 = 9.17\%$$

   Next, we use r_2, r_3 and r_4 with the one of the four-year coupon bonds to determine r_1. For Bond C:

$$1{,}065.28 = \frac{120}{1+r_1} + \frac{120}{(1.095)^2} + \frac{120}{(1.100)^3} + \frac{1120}{(1.0917)^4} = \frac{120}{1+r_1} + 978.74$$

$$r_1 = 0.3867 = 38.67\%$$

   Now, in order to determine whether arbitrage opportunities exist, we use these spot rates to value the remaining two four-year bonds. This produces the following results: for Bond B, the present value is \$854.55, and for Bond D, the present value is \$1,005.07. Since neither of these values equals the current market price of the respective bonds, arbitrage opportunities exist. Similarly, the spot rates derived above produce the following values for the three-year bonds: \$1,074.22 for Bond E and \$912.77 for Bond F.

3. We begin with the definition of duration as applied to a bond with yield r and an annual payment of C in perpetuity

$$DUR = \frac{\frac{1C}{1+r} + \frac{2C}{(1+r)^2} + \frac{3C}{(1+r)^3} + \cdots + \frac{tC}{(1+r)^t} + \cdots}{\frac{C}{1+r} + \frac{C}{(1+r)^2} + \frac{C}{(1+r)^3} + \cdots + \frac{C}{(1+r)^t} + \cdots}$$

We first simplify by dividing each term by C:

$$DUR = \frac{\frac{1}{(1+r)} + \frac{2}{(1+r)^2} + \frac{3}{(1+r)^3} + \cdots + \frac{t}{(1+r)^t} + \cdots}{\frac{1}{1+r} + \frac{1}{(1+r)^2} + \frac{1}{(1+r)^3} + \cdots + \frac{1}{(1+r)^t} + \cdots}$$

The denominator is the present value of a perpetuity of $1 per year, which is equal to (1/r). To simplify the numerator, we first denote the numerator S and then divide S by (1 + r):

$$\frac{S}{(1+r)} = \frac{1}{(1+r)^2} + \frac{2}{(1+r)^3} + \frac{3}{(1+r)^4} + \cdots + \frac{t}{(1+r)^{t+1}} + \cdots$$

Note that this new quantity [S/(1 + r)] is equal to the square of denominator in the duration formula above, that is:

$$\frac{S}{(1+r)} = \left(\frac{1}{1+r} + \frac{1}{(1+r)^2} + \frac{1}{(1+r)^3} + \cdots + \frac{1}{(1+r)^t} + \cdots\right)^2$$

Therefore:

$$\frac{S}{(1+r)} = \left(\frac{1}{r}\right)^2 \Rightarrow S = \frac{1+r}{r^2}$$

Thus, for a perpetual bond paying C dollars per year:

$$DUR = \frac{1+r}{r^2} \times \frac{1}{(1/r)} = \frac{1+r}{r}$$

4. We begin with the definition of duration as applied to a common stock with yield r and dividends that grow at a constant rate g in perpetuity:

$$DUR = \frac{\frac{1C(1+g)}{1+r} + \frac{2C(1+g)^2}{(1+r)^2} + \frac{3C(1+g)^3}{(1+r)^3} + \cdots + \frac{tC(1+g)^t}{(1+r)^t} + \cdots}{\frac{C(1+g)}{1+r} + \frac{C(1+g)^2}{(1+r)^2} + \frac{C(1+g)^3}{(1+r)^3} + \cdots + \frac{C(1+g)^t}{(1+r)^t} + \cdots}$$

We first simplify by dividing each term by [C(1 + g)]:

$$\text{DUR} = \frac{\dfrac{1}{1+r} + \dfrac{2(1+g)}{(1+r)^2} + \dfrac{3(1+g)^2}{(1+r)^3} + \cdots + \dfrac{t(1+g)^{t-1}}{(1+r)^t} + \cdots}{\dfrac{1}{1+r} + \dfrac{1+g}{(1+r)^2} + \dfrac{(1+g)^2}{(1+r)^3} + \cdots + \dfrac{(1+g)^{t-1}}{(1+r)^t} + \cdots}$$

The denominator is the present value of a growing perpetuity of $1 per year, which is equal to [1/(r - g)]. To simplify the numerator, we first denote the numerator S and then divide S by (1 + r):

$$\frac{S}{(1+r)} = \frac{1}{(1+r)^2} + \frac{2(1+g)}{(1+r)^3} + \frac{3(1+g)^2}{(1+r)^4} + \cdots + \frac{t(1+g)^{t-2}}{(1+r)^{t+1}} + \cdots$$

Note that this new quantity [S/(1 + r)] is equal to the square of denominator in the duration formula above, that is:

$$\frac{S}{(1+r)} = \left(\frac{1}{1+r} + \frac{1+g}{(1+r)^2} + \frac{(1+g)^2}{(1+r)^3} + \cdots + \frac{(1+g)^{t-1}}{(1+r)^t} + \cdots\right)^2$$

Therefore:

$$\frac{S}{(1+r)} = \left(\frac{1}{r-g}\right)^2 \Rightarrow S = \frac{1+r}{(r-g)^2}$$

Thus, for a perpetual bond paying C dollars per year:

$$\text{DUR} = \frac{1+r}{(r-g)^2} \times \frac{1}{[1/(r-g)]} = \frac{1+r}{r-g}$$

5. a. We make use of the one-year Treasury bill information in order to determine the one-year spot rate as follows:

$$93.46 = \frac{100}{1+r_1}$$

r_1 = 0.0700 = 7.00%

The following position provides a cash payoff only in year two:

a long position in twenty-five two-year bonds and a short position in one one-year Treasury bill. Cash flows for this position are:

[(-25 × $94.92) + (1 × $93.46)] = -$2,279.54 today;
[(25 × $4) – (1 × $100)] = $0 in year 1; and,
(25 × $104) = $2,600 in year 2.

We determine the two-year spot rate from this position as follows:

$$2279.54 = \frac{2600}{(1+r_2)^2}$$

r_2 = 0.0680 = 6.80%

The forward rate f_2 is computed as follows:

$f_2 = [(1 + 0.0680)^2/1.0700] = 0.0660 = 6.60\%$

The following position provides a cash payoff only in year three:

a long position in the three-year bond and a short position equal to (8/104) times a package consisting of a one-year Treasury bill and a two-year bond. Cash flows for this position are:

[(-1 × \$103.64) + (8/104) × (\$93.46 + \$94.92)] = -\$89.15 today;
[(1 × \$8) – (8/104) × (\$100 + \$4)] = \$0 in year 1;
[(1 × \$8) – (8/104) × \$104] = \$0 in year 2; and,
(1 × \$108) = \$108 in year 3.

We determine the three-year spot rate from this position as follows:

$$89.15 = \frac{108}{(1+r_3)^3}$$

r_3 = 0.0660 = 6.60%

The forward rate f_3 is computed as follows:

$f_3 = [(1 + 0.0660)^3/(1.0680)^2] = 0.0620 = 6.20\%$

b. We make use of the spot and forward rates to calculate the price of the 4 percent coupon bond:

$$P = \frac{40}{(1.07)} + \frac{40}{(1.07)\,(1.066)} + \frac{1040}{(1.07)\,(1.066)\,(1.062)} = \$931.01$$

The actual price of the bond (\$950) is significantly greater than the price deduced using the spot and forward rates embedded in the prices of the other bonds (\$931.01). Hence, a profit opportunity exists. In order to take advantage of this opportunity, one should sell the 4 percent coupon bond short and purchase the 8 percent coupon bond.

6. a. Let B_S, B_M and B_L be the prices of the short-, medium- and long-term bonds, respectively. Then, buying two medium-term bonds and short-selling one short-term bond gives the same payoffs as buying the long-term bond. Therefore, $B_L = 2B_M - B_S = (2 \times 83) - 98 = \$68$

b. Whether rates rise or fall, the short-term bond will be worth 100. The price of the medium-term bond will decrease to \$76.5 if rates rise and will increase to \$93 if rates fall. The price of the long-term bond will decrease to \$53 if rates rise and will increase to \$86 if rates fall.

c. The risk-neutral expectation is 2% per quarter, or, more precisely:

$$2/98 = 2.04\% \text{ per quarter}$$

d. Let p equal the probability of a rate decrease. Then, if investors are risk-neutral:

$$83 + (10 \times p) + (1 - p) \times -6.5 = 83 \times 1.02$$

Solving, we find that: $p = 0.4945$ and $(1 - p) = 0.5055$

e. The expected return for the Treasury bill is 2%. The expected return for the medium term bond is:

$$0.4945 \times (10/83) + 0.5055 \times (-6.5/83) = 0.02 = 2\%$$

The expected return for the long-term bond is:

$$0.4945 \times (18/68) + 0.5055 \times (-15/68) = 0.02 = 2\%$$

7. Newspaper exercise. The price of the bonds should be higher if the government had guaranteed them.

8. a. It is difficult to charge for information because; you cannot stop one person from transmitting it to another for free. The bond-rating services thus find it much easier to charge the companies, rather than the investors.

b. Start with a scenario in which no bonds are rated. Companies with the highest quality bonds want to demonstrate that fact. Once the highest quality bonds have been rated, companies with the highest quality bonds of those remaining have an incentive to demonstrate that their bonds are the best of the remainder. And so on, until only the lowest quality bonds are left. In essence, companies are willing to pay to have their bonds rated in order to alleviate investors' fears that the bonds might be of even lower quality.

c. It follows from the answer to (b) that only companies with extremely poor quality bonds will not pay to have them rated.

9. We can consider the value of equity to be the value of a call on the firm's assets, with an exercise price equal to the payment due to the bondholders. For Backwoods, the exercise price is $1,090. Also:

$P = 1200 \qquad \sigma = 0.45 \qquad t = 1.0 \qquad r_f = 0.09$

$$d_1 = \log[P/PV(EX)]/\sigma\sqrt{t} + \sigma\sqrt{t}/2$$

$$= \log[1200/(1090/1.09^1)]/(0.45 \times \sqrt{1.0}) + (0.45 \times \sqrt{1.0})/2 = 0.6302$$

$$d_2 = d_1 - \sigma\sqrt{t} = 0.6302 - (0.45 \times \sqrt{1.0}) = 0.1802$$

$N(d_1) = N(0.6302) = 0.7357$

$N(d_2) = N(0.1802) = 0.5714$

Call value = $[N(d_1) \times P] - [N(d_2) \times PV(EX)]$

$= [0.7357 \times 1200] - [0.5714 \times 1000)] = \$311.44$

Thus, the value of equity is $311. With an asset market value of $1,200, the market value of debt is: ($1,200 - $311) = $889.

10. Backwoods will default if the market value of the assets one year from now is less than $1,090. From Challenge Question 9, we know that the current value of the debt is $889. Assuming that the debt earns the same return as the assets, then in one year the expected payoff is: ($889 × e^{rt}) = ($889 × $e^{0.10}$) = $982.50

Let x = the probability of default. Then:

$982.50 = $1090 (1 – x) + $0 (x)

0.9014 = (1 – x)

x = 0.0986 = 9.86% probability of default

CHAPTER 25
The Many Different Kinds of Debt

Answers to Practice Questions

1. If the bond is issued at face value and investors demand a yield of 9.5%, then, immediately after the issue, the price will be $1,000. As time passes, the price will gradually rise to reflect accrued interest. For example, just before the first (semi-annual) coupon payment, the price will be $1,047.50, and then, upon payment of the coupon ($47.50), the price will drop to $1,000. This pattern will be repeated throughout the life of the bond as long as investors continue to demand a return of 9.5%.

2. Answers here will vary, depending on the company chosen. Some key areas that should be examined are: coupon rate, maturity, security, sinking fund provision, and call provision.

3. Floating-rate bonds provide bondholders with protection against inflation and rising interest rates, but this protection is not complete. In practice, the extent of the protection depends on the frequency of the rate adjustments and the benchmark rate. (Not only can the yield curve shift, but yield spreads can shift as well.)

   Similarly, puttable bonds provide the bondholders with protection against an increase in default risk, but this protection is not absolute. If the company's problems suddenly become public knowledge, the value of the company may fall so quickly that bondholders might still suffer losses even if they put their bonds immediately.

4. First mortgage bondholders will receive the $200 million proceeds from the sale of the fixed assets. The remaining $50 million of mortgage bonds then rank alongside the unsecured senior debentures. The remaining $100 million in assets will be divided between the mortgage bondholders and the senior debenture holders. Thus, the mortgage bondholders are paid in full, the senior debenture holders receive $50 million and the subordinated debenture holders receive nothing.

5. If the assets are sold and distributed according to strict precedence, the following distribution will result. In Subsidiary A, the $320 million of debentures will be paid off and ($500 million - $320 million) = $180 million will be remitted to the parent. In Subsidiary B, the $180 million of senior debentures will be paid off and ($220 million - $180 million) = $40 million of the $60 million subordinated debentures will be paid. In the holding company, the real estate will be sold and ($180 million + $80 million) = $260 million will be paid in partial satisfaction of the $400 million senior collateral trust bonds.

6. a. Typically, a variable-rate mortgage has a lower interest rate than a comparable fixed-rate mortgage. Thus, you can buy a bigger house for the same mortgage payment if you use a variable-rate mortgage. The second consideration is risk. With a variable-rate mortgage, the borrower assumes the interest rate risk (although in practice this is mitigated somewhat by the use of caps), whereas, with a fixed-rate mortgage, the lending institution assumes the risk.

   b. If borrowers have an option to prepay on a fixed-rate mortgage, they are likely to do so when interest rates are low. Of course, this is not the time that lenders want to be repaid because they do not want to reinvest at the lower rates. On the other hand, the option to prepay has little value if rates are floating, so floating rate mortgages reduce the reinvestment risk for holders of mortgage pass-through certificates.

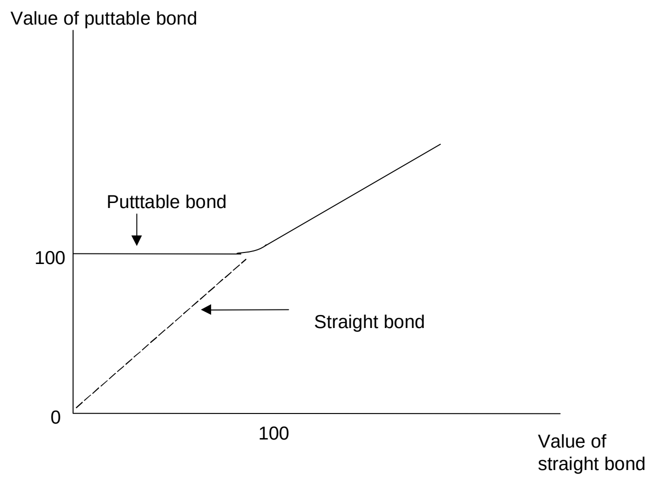
7. A sharp increase in interest rates reduces the price of an outstanding bond relative to the price of a newly issued bond. For a given call price, this implies that the value to the firm of the call provision is greater for the newly issued bond. Other things equal, the yield of the more recently issued bonds should be greater, reflecting the higher probability of call. Notice, however, that the outstanding bond will probably have a lower call price and perhaps a shorter period of call protection; these may be offsetting factors.

8. If the company acts rationally, it will call a bond as soon as the bond price reaches the call price. For a zero-coupon bond, this will never happen because the price will always be below the face value. For the coupon bond, there is some probability that the bond will be called. To put this somewhat differently, the company’s option to call is meaningless for the zero-coupon bond, but has some value for the coupon bond. Therefore, the price of the coupon bond (all else equal) will be less than the price of the zero, and, hence, the yield on the coupon bond will be higher.

9. a. Using Figure 25.2 in the text, we can see that, if interest rates rise, the change in the price of the noncallable bond will be greater than the change in price of the callable bond.

b. On that date, it will be in one party's interest to exercise its option, and the bonds will be repaid.

10. See figure below.



11. Most bonds contain covenants that restrict the firm's ability to issue new debt of equal or greater seniority unless the firm's tangible assets exceed some multiple of the existing debt. This restriction is intended to preclude the firm from increasing the default risk borne by existing bondholders.

A similar restriction is the negative pledge clause, which prevents the firm from issuing more secured debt. Even if this did not increase the ratio of debt to tangible assets, it would decrease the value of unsecured debt because unsecured debt is junior to secured debt in the event of default.

12. The issue of additional junior debt does not harm the senior bondholders. As far as senior bondholders are concerned, the junior debt is similar to equity. The senior bondholders would prefer that the junior debt not have a shorter maturity, but it is still in their interest to have a claim on the money put up by the junior bondholders for the duration of the junior debt.

13. Alpha Corp.'s net tangible asset limit is 200 percent of senior debt. Therefore, with net tangible assets of $250 million, Alpha's total debt cannot exceed $125 million. Alpha can issue an additional $25 million in senior debt.

14. a. There are two primary reasons for limitations on the sale of company assets. First, coupon and sinking fund payments provide a regular check on the company's solvency. If the firm does not have the cash, the bondholders would like the shareholders to put up new money or default. But this check has little value if the firm can sell assets to pay the coupon or sinking fund contribution. Second, the sale of assets in order to reinvest in more risky ventures harms the bondholders.

b. The payment of dividends to shareholders reduces assets that can be used to pay off debt. In the extreme case, a dividend that is equal to the value of the assets leaves bondholders with nothing.

c. If the existing debt is junior, then the original debtholders lose by having the new debt rank ahead of theirs. If the existing debt is senior, then debt the issuance of additional senior debt means that the same amount of equity supports a greater amount of debt; i.e., the firm's leverage has increased, and the firm faces a greater probability of default. This harms the original debtholders.

15. Answers will vary depending on instrument chosen.

16. For purposes of illustration, assume the Christiania Bank issue is a one-year reverse floater. Suppose also that the current interest rate on fixed-rate one-year loans is 7.8 percent. Then, for three different possible future interest rates, the payoffs on the reverse floater, a fixed-rate loan, and a normal floating-rate loan are as follows:

Possible Future Interest Rates	Payoffs at End of Year		
	Reverse Floater	Fixed-Rate	Normal Floater
9.8%	1,030	1,078	1,098
7.8%	1,050	1,078	1,078
5.8%	1,070	1,078	1,058

Now consider the payoffs if you borrowed $1,000 at a floating rate and loaned $1,974 at a fixed rate of 7.8%:

Possible Future Interest Rates	Payoffs at End of Year		
	Floating Rate Borrowing	Fixed-Rate Lending	Total
9.8%	-1,098	2,128	1,030
7.8%	-1,078	2,128	1,050
5.8%	-1,058	2,128	1,070

Thus, buying a reverse floater is equivalent to issuing floating-rate debt and buying fixed-rate debt. This is equivalent to borrowing at short-term rates in order to lend long-term, which is a risky strategy. The reverse floater is a very volatile bet on future interest rates.

17. Project finance makes sense if the project is physically isolated from the parent, offers the lender tangible security and involves risks that are better shared between the parent and others. The best example is in the financing of major foreign projects, where political risk can often be minimized by involving international lenders.

18. A prepackaged bankruptcy avoids the expenses of a bankruptcy court, and can usually be negotiated more quickly. A prepackaged bankruptcy also avoids the problems that can arise, as in Eastern's case, from continuing to operate assets at a loss. Unlike informal workouts, prepackaged bankruptcies reduce the likelihood of subsequent litigation and get the tax advantages of Chapter 11. The problems of conflicts of interest are the same, and each party can threaten to hold out for a court solution unless the respective parties each believe that the prepackaged bankruptcy provides at least as good a deal.

Challenge Questions

1. The existing bonds provide $30,000 per year for 10 years and a payment of $1,000,000 in the tenth year. Assuming that all bondholders are exempt from income taxes, the market value of the bonds is:

$$PV = \frac{30{,}000}{1.10} + \frac{30{,}000}{1.10^2} + \cdots + \frac{30{,}000}{1.10^{10}} + \frac{1{,}000{,}000}{1.10^{10}} = \$569{,}880$$

Thus, the debt could be repurchased with a payment of $569,880 today.

From the standpoint of the company, the cash outflows associated with the bonds are $1,000,000 in the tenth year, and $30,000 per year, less annual tax savings of (0.35 × $30,000) = $10,500. Therefore, the net cash outflow is ($30,000 - $10,500) = $19,500 per year. To calculate the amount of new 10 percent debt supported by these cash flows, discount the after-tax cash flows at the after-tax interest rate (6.5 percent):

$$PV = \frac{19{,}500}{1.065} + \frac{19{,}500}{1.065^2} + \cdots + \frac{19{,}500}{1.065^{10}} + \frac{1{,}000{,}000}{1.065^{10}} = \$672{,}908$$

In other words, the value of these bonds to the firm is $672,908 and the market value of the bonds is $569,880. The firm could repurchase the bonds for $569,880 and then issue $672,908 of new 10 percent debt that would require cash outflows with a present value equal to that of the original debt. The firm could also, of course, immediately pocket the difference ($103,028).

Now suppose that bondholders are subject to personal income taxes. High-income investors (i.e., those in high income tax brackets) will favor low-coupon bonds and will bid up the prices of those bonds. If the low coupon bonds are worth more to the high-income investor than they are to Dorlcote, then Dorlcote should not repurchase the bonds. (Note that, if Dorlcote issued the 3 percent bonds at face value and then repurchases the bonds for $569,880, then the company will be liable for taxes on the gain.)

2. The advantages of setting up a separately financed company for Hubco stem primarily from the attempt to align the interests of various parties with the successful operation of the plant. For example, the construction firm was also a shareholder in order to ensure that the plant would run according to specifications. By making it a separate entity, Hubco could also enter into contraction agreements without the need to gain approval from a parent company. Similarly, if Hubco failed, then no assets beyond the projects' could be attached. Independence also allowed Hubco to design contracts with suppliers, customers, and funding sources to meet specific needs and/or concerns.

CHAPTER 26
Leasing

Answers to Practice Questions

1. "100 percent financing" is not an advantage unique to the lessee because precisely the same cash flows can be arranged by borrowing as an alternate source of financing for the acquisition of an asset.

2. a. For comparison purposes, the solution to Quiz Question 5 is shown below:

	t = 0	t = 1	t = 2	t = 3	t = 4	t = 5	t = 6
Initial Cost	-3000.00						
Depreciation		600.00	960.00	576.00	345.60	345.60	172.80
Depreciation tax shield		210.00	336.00	201.60	120.96	120.96	60.48
After-tax admin. costs	-260.00	-260.00	-260.00	-260.00	-260.00	-260.00	
Total	-3260.00	-50.00	76.00	-58.40	-139.40	-139.40	60.48
PV(at 9%) = -$3,439.80							
Break-even rent	1082.30	1082.30	1082.30	1082.30	1082.30	1082.30	
Tax	-378.81	-378.81	-378.81	-378.81	-378.81	-378.81	
Break-even rent after tax	703.49	703.49	703.49	703.49	703.49	703.49	
PV(at 9%) = -$3,439.82							
Cash Flow	-2556.51	653.50	779.50	645.10	564.46	564.46	60.48

In the above table, we solve for the break-even lease payments by first solving for the after-tax payment that provides a present value, discounted at 9%, equal to the present value of the costs, keeping in mind that the annuity begins immediately. Then solve for the break-even rent as follows:

Break-even rent = $703.49/(1 – 0.35) = $1,082.30

If the expected rate of inflation is 5 percent per year, then administrative costs increase by 5 percent per year. We further assume that the lease payments grow at the rate of inflation (i.e., the payments are indexed to inflation). However, the depreciation tax shield amounts do not change because depreciation is based on the initial cost of the desk. The appropriate nominal discount rate is now:

$(1.05 \times 1.09) – 1 = 0.1445 = 14.45\%$

These changes yield the following, indicating that the initial lease payment has increased from $1,082 to about $1,113:

	t = 0	t = 1	t = 2	t = 3	t = 4	t = 5	t = 6
Initial Cost	-3000.00						
Depreciation		600.00	960.00	576.00	345.60	345.60	172.80
Depreciation. tax shield		210.00	336.00	201.60	120.96	120.96	60.48
After-tax admin. costs	-260.00	-273.00	-286.65	-300.98	-316.03	-331.83	
Total	-3260.00	-63.00	49.35	-99.38	-195.07	-210.87	60.48
PV(at 14.45%) = -$3,537.83							
Break-even rent	1113.13	1168.79	1227.23	1288.59	1353.02	1420.67	
Tax	-389.60	-409.08	-429.53	-451.01	-473.56	-497.23	
Break-even rent after tax	723.53	759.71	797.70	837.58	879.46	923.43	
PV(at 14.45%) = -$3,537.83							
Cash Flow	-2536.47	696.71	847.05	738.20	684.39	712.56	60.48

Here, we solve for the break-even lease payments by first solving for the after-tax payment that provides a present value, discounted at 9%, equal to the present value of the costs, keeping in mind that the annuity begins immediately. We use the 9% discount rate in order to find the real value of the payments (i.e., $723.53). Then each of the subsequent payments reflects the 5% inflation rate. Solve for the break-even rent as follows:

Break-even rent = $723.53/(1 – 0.35) = $1,113.13

b. With a reduction in real lease rates of 10 percent each year, the nominal lease amount will decrease by 5.5 percent each year. That is, the nominal lease rate is multiplied by a factor of $(1.05 \times 0.9) = 0.945$ each year. Thus, we have:

	t = 0	t = 1	t = 2	t = 3	t = 4	t = 5	t = 6
Initial Cost	-3000.00						
Depreciation		600.00	960.00	576.00	345.60	345.60	172.80
Depreciation. tax shield		210.00	336.00	201.60	120.96	120.96	60.48
After-tax admin. costs	-260.00	-273.00	-286.65	-300.98	-316.03	-331.83	
Total	-3260.00	-63.00	49.35	-99.38	-195.07	-210.87	60.48
PV(at 14.45%) = -3537.83							
Break-even rent	1388.85	1312.46	1240.28	1172.06	1107.60	1046.68	
Tax	-486.10	-459.36	-434.10	-410.22	-387.66	-366.34	
Break-even rent after tax	902.75	853.10	806.18	761.84	719.94	680.34	
PV(at 14.45%) = -3537.84							
Cash Flow	-2357.25	790.10	855.53	662.46	524.87	469.47	60.48

Here, when we solve for the first after-tax payment, use a discount rate of:

[(0.9/1.09) – 1 = 0.2111 = 21.11%

3. If the cost of new limos decreases by 5 percent per year, then the lease payments also decrease by 5 percent per year. In terms of Table 26.1, the only change is in the break-even rent.

	t = 0	t = 1	t = 2	t = 3	t = 4	t = 5	t = 6
Total	-82.80	-2.55	0.60	-2.76	-4.78	-4.78	-6.29
Break-even rent	29.97	28.47	27.05	25.70	24.41	23.19	22.03
Tax	-10.49	-9.97	-9.47	-8.99	-8.54	-8.12	-7.71
Cash flow	-63.32	15.96	18.18	13.94	11.09	10.29	8.03

NPV (at 7%) = 0.00

4. The leasing of trucks, airplanes, or computers is big business because each such asset requires a significant outlay of cash and each is used by many companies that are marginally profitable. Also, in each case standardization of the asset leased leads naturally to standardization of the contracts; this, in turn, provides low administrative and transactions costs.

5. Yes, but because operating leases are generally much shorter term than financial leases, the value of this advantage is not nearly as great as it is for operating leases.

6. a.

	t = 0	t = 1	t = 2	t = 3	t = 4	t = 5	t = 6	t = 7
Cost of new bus	100.00							
Lost depreciation tax shield		-4.00	-6.40	-3.84	-2.30	-2.30	-1.15	0.00
Lease payment	-16.90	-16.90	-16.90	-16.90	-16.90	-16.90	-16.90	-16.90
Tax shield of lease payment	3.38	3.38	3.38	3.38	3.38	3.38	3.38	3.38
Cash flow of lease	86.48	-17.52	-19.92	-17.36	-15.82	-15.82	-14.67	-13.52

NPV (at 6.5%) = -$4,510

b. Assume the straight-line depreciation is figured on the same basis as the ACRS depreciation, namely 5 years, beginning halfway through the first year.

	t = 0	t = 1	t = 2	t = 3	t = 4	t = 5	t = 6	t = 7
Cost of new bus	100.00							
Lost depreciation tax shield		-3.50	-7.00	-7.00	-7.00	-7.00	-3.50	0.00
Lease payment	-16.90	-16.90	-16.90	-16.90	-16.90	-16.90	-16.90	-16.90
Tax shield of lease payment	5.92	5.92	5.92	5.92	5.92	5.92	5.92	5.92
Cash flow of lease	89.02	-14.49	-17.99	-17.99	-17.99	-17.99	-14.49	-10.99

NPV (at 6.5%) = $566

7. The net present value of the lessor's cash flows consists of the cost of the bus ($100), the present value of the depreciation tax shield ($29.469) and the present value of the after-tax lease payments:

$$-100 + 29.469 + (1 - 0.35) \times P \times \left(1 + \frac{1}{1.065} + \frac{1}{1.065^2} + \cdots + \frac{1}{1.065^7} \right)$$

To find the minimum rental, set NPV = 0 and solve for P:

4.21494P = 70.53

P = 16.73 or $16,730

Greymare should take the lease as long as the NPV of the lease is greater than or equal to zero. The net present value of the cash flows is the cost of the bus saved ($100) less the present value of the lease payments:

$$100 - P \times \left(1 + \frac{1}{1.10} + \frac{1}{1.10^2} + \cdots + \frac{1}{1.10^7} \right)$$

(Note that, because Greymare pays no taxes, the appropriate discount rate is 10 percent.)
Setting this expression equal to zero and solving for P, we find:

P = 17.04 or $17,040

This is the maximum amount that Greymare could pay. Thus, the lease payment will be between $16,730 and $17,040.

8. The original cash flows are as given in the text. In general, the net present value of the lessor's cash flows consists of the cost of the bus, the present value of the depreciation tax shield, and the present value of the after-tax lease payments. To find the minimum rental P, we set the net present value to zero and solve for P. We can then use this value for P to calculate the value of the lease to the lessee.

a. A lessor tax rate of 50%. Cash flows for the lessor are:

$$-100 + (0.50 \times 100) \times \left(\frac{0.2000}{1.05} + \frac{0.3200}{1.05^2} + \frac{0.1920}{1.05^3} + \frac{0.1152}{1.05^4} + \frac{0.1152}{1.05^5} + \frac{0.0576}{1.05^6} \right)$$

$$+ (1 - 0.50) \times P \times \left(1 + \frac{1}{1.05} + \frac{1}{1.05^2} + \cdots + \frac{1}{1.05^7} \right) = -100 + 43.730 + P(3.3932) = 0$$

P = 16.58 or $16,580

For Greymare, the net present value of the cash flows is the cost of the bus saved (100) less the present value of the lease payments:

$$100 - P \times \left(1 + \frac{1}{1.10} + \frac{1}{1.10^2} + \cdots + \frac{1}{1.10^7} \right) = 100 - (16.58 \times 5.8684) = 2.70 \text{ or } \$2,700$$

b. Immediate 100% depreciation. Cash flows for the lessor are:

$$-100+(0.35\times 100)+(1-0.35)\times P\times\left(1+\frac{1}{1.065}+\frac{1}{1.065^2}+\cdots+\frac{1}{1.065^7}\right)=$$

$$-100+35+(P\times 4.2149)=0$$

P = 15.42 or $15,240

For Greymare, the net present value of the cash flows is:

$$100\ -\ P\times\left(1+\frac{1}{1.10}+\frac{1}{1.10^2}+\cdots+\frac{1}{1.10^7}\right)=100-(15.42\times 5.8684)=9.51\text{ or }\$9{,}510$$

c. 3-year lease with 4 annual rentals. Cash flows for the lessor are:

$$-100+(0.35\times 100)\times\left(\frac{0.2000}{1.065}+\frac{0.3200}{1.065^2}+\frac{0.1920}{1.065^3}+\frac{0.1152}{1.065^4}+\frac{0.1152}{1.065^5}+\frac{0.0576}{1.065^6}\right)$$

$$+(1-0.35)\times P\times\left(1+\frac{1}{1.065}+\frac{1}{1.065^2}+\frac{1}{1.065^3}\right)=-100+29.469+P(2.3715)=0$$

P = 29.74 or $29,740

For Greymare, the net present value of the cash flows is

$$100\ -\ P\times\left(1+\frac{1}{1.10}+\frac{1}{1.10^2}+\frac{1}{1.10^3}\right)=100-(29.74\times 3.4869)=-3.70\text{ or }-\$3{,}700$$

d. An interest rate of 20%. Cash flows for the lessor are:

$$-100+(0.35\times 100)\times\left(\frac{0.2000}{1.13}+\frac{0.3200}{1.13^2}+\frac{0.1920}{1.13^3}+\frac{0.1152}{1.13^4}+\frac{0.1152}{1.13^5}+\frac{0.0576}{1.13^6}\right)$$

$$+(1-0.35)\times P\times\left(1+\frac{1}{1.13}+\frac{1}{1.13^2}+\cdots+\frac{1}{1.13^7}\right)=-100+25.253+P(3.5247)=0$$

P = 21.21 or $21,210

For Greymare, the net present value of the cash flows is:

$$100\ -\ P\times\left(1+\frac{1}{1.20}+\frac{1}{1.20^2}+\cdots+\frac{1}{1.10^7}\right)=100-(21.21\times 4.6046)=2.34\text{ or }\$2{,}340$$

9. If Greymare pays no taxes, its lease cash flows consist of an inflow of $100 at t = 0 and yearly outflows of $16.9 at t = 0 through t = 7. If the interest rate is zero, the NPV of the lease is the sum of these cash flows, or -$35.2 (-$35,200).

10. Under the conditions outlined in the text, the value to the lessor is $700 and the value to the lessee is $820. The key to structuring the lease is to realize that the lessee and the lessor are discounting at different interest rates: 10% for the lessee and 6.5% for the lessor. Thus, if we decrease the early lease payments and increase the later lease payments in such a way as to leave the lessor's NPV unchanged, the lessee, by virtue of the higher discount rate, will be better off. One such set of lease payments is shown in the following table:

	t = 0	t = 1	t = 2	t = 3	t = 4	t = 5	t = 6	t = 7
Cost of new bus	-100.00							
Depreciation tax shield		7.00	11.20	6.72	4.03	4.03	2.02	0.00
Lease payment	13.00	14.00	17.00	17.00	17.00	20.00	20.00	20.00
Tax on lease payment	-4.55	-4.90	-5.95	-5.95	-5.95	-7.00	-7.00	-7.00
Cash flow of lease	-91.55	16.10	22.25	17.77	15.08	17.03	15.02	13.00

Lessor NPV (at 6.5%) = 0.707 ($707)
Lessee NPV (at 10%) = 1.868 ($1,868)

The value to the lessor is $707 and the value to the lessee (still assuming it pays no tax) is $1,868.

11. a. Because Nodhead pays no taxes:

$$\text{NPV} = +250 - \sum_{t=0}^{5} \frac{62}{1.08^t} = -59.5 \text{ or } -\$59{,}500$$

b. The cash flows to Compulease are as follows (assume 5-year ACRS beginning at t = 0):

	t = 0	t = 1	t = 2	t = 3	t = 4	t = 5	t = 6
Cost of computer	-250.0						
Depreciation		50.0	80.0	48.0	28.8	28.8	14.4
Depreciation tax shield		17.5	28.0	16.8	10.1	10.1	5.0
Lease payment	62.0	62.0	62.0	62.0	62.0	62.0	
Tax on lease payment	-21.7	-21.7	-21.7	-21.7	-21.7	-21.7	
Net Cash Flow	-209.7	57.8	68.3	57.1	50.4	50.4	5.0

The after-tax interest rate is: $[(1 - 0.35) \times 0.08] = 0.052 = 5.2\%$. The NPV of the cash flows for Compulease is: 40.0 or $40,000.

c. The overall gain from leasing is: ($40,000 - $59,600) = -$19,600.

12. a. The Safety Razor Company should take the lease as long as the NPV of the financing is greater than or equal to zero. If P is the annual lease payment, then the net present value of the lease to the company is:

$$NPV = 100 - P \times \left(1 + \frac{1}{1.10} + \cdots + \frac{1}{1.10^7}\right)$$

Setting NPV equal to zero and solving for P, we find the company's maximum lease payment is 17.04 or $17,040.

The NPV to the lessor has three components:

- Cost of machinery = -100

- PV of after-tax lease payments, discounted at the after-tax interest rate of: [(1 - 0.35) × 0.10] = .065 = 6.5%:

$$P \times (1 - 0.35) \times \left(1 + \frac{1}{1.065} + \cdots + \frac{1}{1.065^7}\right) = P \times 4.2149$$

- PV of the depreciation tax shield, discounted at the after-tax rate of 6.50% (we assume depreciation expense begins at t = 1):

$$(0.35 \times 100)\left(\frac{.1429}{1.065} + \frac{.2449}{1.065^2} + \frac{.1749}{1.065^3} + \frac{.1249}{1.065^4} + \frac{.0893}{1.065^5} + \frac{.0893}{1.065^6} + \frac{.0893}{1.065^7} + \frac{.0445}{1.065^8}\right) = 28.095$$

To find the minimum rental the lessor would accept, we sum these three components, set this total NPV equal to zero, then solve for P:

$$-100 + (P \times 4.2149) + 28.095 = 0$$

Thus, P is equal to 17.06 or $17,060, which is the minimum lease payment the lessor will accept.

b. If the lessor is obliged to use straight-line depreciation, this has no effect on the company's maximum lease payment. The lessor's PV of the depreciation tax shield becomes:

$$PV = (0.35) \times (100/8) \times \left(\frac{1}{1.065} + \cdots + \frac{1}{1.065^8}\right) = 26.638$$

Thus, the lessor's minimum acceptable lease payment becomes $17,410.

13. In general, if INV is the value of the leased asset, P the lease payment, T_c the corporate tax rate, D_t the depreciation at time t, n the appropriate time horizon and r* the after-tax discount rate [i.e., $r^* = r_d \times (1 - T_c)$], then:

$$\text{Value to lessee} = \text{INV} - \sum_{t=0}^{n} \frac{[P \times (1 - T_c)] + (D_t T_c)}{(1 + r^*)^t}$$

$$\text{Value to lessor} = -\text{INV} + \sum_{t=0}^{n} \frac{[P \times (1 - T_c)] + (D_t T_c)}{(1 + r^*)^t}$$

The overall gain from leasing is the sum of these values. The overall gain is zero if the firms have the same discount rate, the same depreciation schedule for tax purposes, and the same corporate tax rates.

In order to illustrate how the gains to the lessee and lessor are affected by changes in these parameters, we can use the Greymare bus example from the text.

a. Consider the rate of interest. If, for example, the appropriate rate of interest is 20%, instead of 10%, for both the lessor and the lessee, then the cash flows given in the text remain the same but the NPV changes for both parties. The NPV of the lease to the lessor is still precisely the negative of the NPV to the lessee and the overall gain is still zero.

   If the discount rate is different for the lessor and the lessee, then the overall gain is not be zero. For example, if the lessor's discount rate is less than the lessee's discount rate, then the overall gain from leasing is positive.

b. Consider the choice of depreciation schedule. If, for example, the lessor uses 5-year ACRS but the lessee uses straight-line depreciation, then the lessee's cash flows and NPV do not change. The cash flows and NPV for the lessee change, and the overall gain is now positive.

c. Consider the difference between the tax rates of the lessor and the lessee. If the lessor's tax rate remains at 35% and the lessee's tax rate is zero, then the NPV to the lessor does not change. For the lessee, however, both the cash flows and the after-tax discount rate change; the effect is to increase the overall gain, which is now positive.

d. Consider the length of the lease. If the length of the lease changes, the NPV to each of the parties changes, but they are still equal in absolute value. The overall gain to the lease is still zero.

14. The problems resulting from the use of IRR for analyzing financial leases are the same problems discussed in Chapter 5. However, four of these problems are particularly troublesome here:

  a. Multiple roots occur rarely in capital budgeting because the expected cash flows generally change signs only once. For financial leases, however, this is often not the case. A lessee has an immediate cash inflow, a series of outflows for a number of years, and then an inflow in the last year. With two changes of sign, there may be, and in practice frequently are, two different values for the IRR.
  b. Another problem arises from the fact that risk is not constant. For the lessee, the lease payments are fairly riskless and the interest rate should reflect this. However, the salvage value of the asset is probably much riskier. This requires two different discount rates. Each cash flow is not implicitly discounted to reflect its risk when the IRR is used.
  c. If the lessor and lessee do not pay taxes or if both pay at the same rate, then the IRR should be calculated for the lease cash flows and then compared to the after-tax rate of interest. However, if the company is temporarily in a non-taxpaying position, the cost of capital changes over time. There is no simple standard of comparison.
  d. The IRR method cannot be used to choose between alternative lease bids with different lives or payment patterns.

15. a. Proponents of this view note that a firm paying no taxes already has an advantage over tax-paying companies in the development of new projects, even without leasing. In addition, leasing for a company in this position allows for a shifting of tax shields from lessee to lessor. The government loses and the lessee and/or lessor gain. Many believe that the combination of these two advantages is more than is necessary to encourage non-taxpaying companies to invest.

  b. The argument for this view is as follows: If the government feels more investment is needed, then allowing non-taxpaying companies to take advantage of depreciation tax shields, through leasing, is likely to provide an incentive. Why make investment incentives like accelerated depreciation credit available only to currently profitable companies? If such companies end up with an excessive tax break, then the solution should be to restrict tax loss carry-forwards rather than to change the tax rules for leasing.

Challenge Questions

1. Consider first the choice between buying and a five-year financial lease. Ignoring salvage value, the incremental cash flows from leasing are shown in the following table:

	t = 0	t = 1	t = 2	t = 3	t = 4	t = 5
Buy: 0.80 probability that contract will be renewed for 5 years						
Initial cost of plane	500.00					
Depreciation tax shield		-35.00	-35.00	-35.00	-35.00	-35.00
Lease payment	-75.00	-75.00	-75.00	-75.00	-75.00	
Lease payment tax shield	26.25	26.25	26.25	26.25	26.25	
Total cash flow	451.25	-83.75	-83.75	-83.75	-83.75	-35.00
Buy: 0.20 probability that contract will not be renewed						
Initial cost of plane	500.00					
Depreciation tax shield		-35.00				
Lease payment	-75.00					
Lease payment tax shield	26.25					
Total cash flow	451.25	-35.00				
Expected cash flow	451.25	-74.00	-67.00	-67.00	-67.00	-28.00
PV(at 5.85%)	451.25	-69.91	-59.80	-56.49	-53.37	-21.07
Total PV(at 5.85%) = $190.61						

We have discounted these cash flows at the firm's after-tax borrowing rate:

$$0.65 \times 0.09 = 0.0585 = 5.85\%$$

The table above shows an apparent net advantage to leasing of $190.61. However, if Magna buys the plane, it receives the salvage value. There is an 80% probability that the plane will be kept for five years and then sold for $300 (less taxes) and there is a 20% probability that the plane will be sold for $400 in one year. Discounting the expected cash flows at the company cost of capital (these are risky flows) gives:

$$0.80 \times \left(\frac{300 \times (1 - 0.35)}{(1.14)^5} \right) + 0.20 \times \left(\frac{400}{(1.14)^1} \right) = \$151.20$$

The net gain to a financial lease is: ($190.61 - $151.20) = $39.41

(Note that the above calculations assume that, if the contract is not renewed, Magna can, with certainty, charge the same rent on the plane that it is paying, and thereby zero-out all subsequent lease payments. This is an optimistic assumption.)

The after-tax cost of the operating lease for the first year is:

$0.65 \times \$118 = \$76.70$

Assume that a five-year old plane is as productive as a new plane, and that plane prices increase at the inflation rate (i.e., 4% per year). Then the expected payment on an operating lease will also increase by 4% per year. Since there is an 80% probability that the plane will be leased for five years, and a 20% probability that it will be leased for only one year, the expected cash flows for the operating lease are as shown in the table below:

	t = 0	t = 1	t = 2	t = 3	t = 4	t = 5
Lease: 0.80 probability that contract will be renewed for 5 years						
After-tax lease payment	-76.70	-79.77	-82.96	-86.28	-89.73	0.00
Lease: 0.20 probability that contract will not be renewed						
After-tax lease payment	-76.70					
Expected cash flow	-76.70	-63.81	-66.37	-69.02	-71.78	0.00
PV(at 14%)	-76.70	-55.97	-51.07	-46.59	-42.50	0.00
Total PV(at 14%) = $-272.83						

These cash flows are risky and depend on the demand for light aircraft. Therefore, we discount these cash flows at the company cost of capital (i.e., 14%). The present value of these payments is greater than the present value of the safe lease payments from the financial lease (-$184.36), so it appears that the financial lease is the lower cost alternative. Notice, however, our assumption about future operating lease costs. If old planes are less productive than new ones, the lessor would not be able to increase lease charges by 4% per year.

2. The net payments for the cancelable lease are:

$0.65 \times (-\$125) = -\$81.25$

Ignoring the cancellation option, the first payment is -$81.25, and the expected value for the subsequent payments is:

$0.80 \times (-\$81.25) = -\$65$

The present value of these payments, discounted at the after-tax borrowing rate (5.85%) is -$307.26, compared to -$184.36 for the financial lease. Therefore, Magna would be paying $122.90 for the cancellation option. Suppose that, for example, Magna were able to cancel its lease after one year and take out a four-year financial lease with rental payments of $57 per year. The present value of the cash flows would then be the same as for the financial lease. Therefore, it would require a 24% reduction in the lease payments, from $75 to $57, to make the cancellation option worthwhile

3.

	t = 0	t = 1	t = 2	t = 3	t = 4	t = 5	t = 6	t = 7
Cost of new bus	100.00							
Lost depreciation tax shield		0.00	0.00	-6.72	-4.03	-4.03	-2.02	0.00
Lease payment	-16.90	-16.90	-16.90	-16.90	-16.90	-16.90	-16.90	-16.90
Tax shield of lease payment	0.00	0.00	0.00	5.92	5.92	5.92	5.92	5.92
Cash Flow of Lease	83.10	-16.90	-16.90	-17.70	-15.02	-15.02	-13.00	-10.98

NPV = 0.503 ($503)

CHAPTER 27
Managing Risk

Answers to Practice Questions

1. Insurance companies have the experience to assess routine risks and to advise companies on how to reduce the frequency of losses. Insurance company experience and the very competitive nature of the insurance industry result in correct pricing of routine risks. However, BP Amoco has concluded that insurance industry pricing of coverage for large potential losses is not efficient because of the industry's lack of experience with such losses. Consequently, BP has chosen to self insure against these large potential losses. Effectively, this means that BP uses the stock market, rather than insurance companies, as its vehicle for insuring against large losses. In other words, large losses result in reductions in the value of BP's stock. The stock market can be an efficient risk-absorber for these large but diversifiable risks.

2. As we have noted in the answer to Practice Question 1, insurance company expertise can be beneficial to large businesses because the insurance company's experience allows the insurance company to correctly price insurance coverage for routine risks and to provide advice on how to minimize the risk of loss. In addition, the insurance company is able to pool risks and thereby minimize the cost of insurance.

   Rarely does it pay for a company to insure against all risks, however. Typically, large companies self-insure against small potential losses. In addition, at least one very large company, BP Amoco, has also chosen to self-insure against very large losses, as described in the answer to Practice Question 1.

3. *Moral hazard*: Having an insurance policy can make the policyholder less careful with regard to the insured risk and can therefore increase the odds of loss.

   Adverse selection: When an insurance company offers insurance coverage at a set price, without discriminating between high-risk and low-risk customers, it will attract more high-risk customers.

   Moral hazard and adverse selection both increase the insurance company's losses. Consequently, the insurance company must increase the premium it charges.

4. If payments are reduced when claims against one issuer exceed a specified amount, the issuer is co-insured above some level, and some degree of on-going viability is ensured in the event of a catastrophe. The disadvantage is that, knowing this, the insurance company may over-commit in this area in order to gain additional premiums. If the payments are reduced based on claims against the entire industry, an on-going and viable insurance market may be assured but some firms may under-commit and yet still enjoy the benefits of lower payments. Basis risk will be highest in the first case due to the larger firm specific risk.

5. This is not a fair comment. By selling wheat futures, the farmer has indeed eliminated risk. She knows exactly what the price will be. 'Eliminating risk' means that there is no possibility of a loss, but it also means that there is no possibility of a gain.

6. a. Futures contracts are available only in standardized units, for standardized contract dates, and for a limited number of assets. Forward contracts are not standardized with respect to unit, date or asset.

   b. Futures contracts are traded on organized exchanges. You can buy a six-month futures contract today and sell it tomorrow. Your contract is with the futures exchange clearing house, not with a particular investor. A forward contract is not traded on an exchange, and a forward contract is a contract with a particular investor.

   c. Futures contracts are marked-to-market. In effect, you close your position each day, settle any profits or losses, and open up a new position. Forward contracts are not marked-to-market.

7. The list of commodity futures contracts is long, and includes.
   - Gold — Buyers include jewelers.
     Sellers include gold-mining companies.
   - Sugar — Buyers include bakers.
     Sellers include sugar-cane farmers.
   - Aluminum — Buyers include aircraft manufacturers.
     Sellers include bauxite miners.

8. (i) A currency swap is a promise to make a series of payments in one currency in exchange for receiving a series of payments in another currency.

(ii) An interest rate swap is a promise to make a series of fixed-rate payments in exchange for receiving a series of floating-rate payments (or vice versa). Also, the exchange of floating-rate payments is linked to different reference rates (e.g., LIBOR and the commercial paper rate).

(iii) A default swap is a promise to pay a series of fixed rate payments in exchange for receiving a single large payment in the event that a particular issuer defaults on a loan.

Swaps may be used because a company believes it has an advantage borrowing in a particular market or because a company wishes to change the structure of its existing liabilities.

9. $$\frac{\text{Futures price}}{(1+r_f)^t} = \text{spot price} - \text{PV(dividends)}$$

$$\frac{\text{Futures price}}{(1+r_f)^t} = \frac{15{,}330}{(1.19)^{1/2}} = 14{,}052.99$$

Spot price – PV(dividends) = 13,743 – [(13,743 $\times$ 0.04 $\times$ 0.5)/$1.19^{(1/2)}$] = 13,491.04

The futures are not fairly priced.

10. If we purchase a 9-month Treasury bill futures contract today, we are agreeing to spend a certain amount of money nine months from now for a 3-month Treasury bill. So, the valuation of this futures contract involves three steps:

- First, find the expected yield of a 3-month Treasury bill 9 months from now (y_f).
- Second, find the corresponding price of the 3-month Treasury bill 9 months from now (P_f). (Note: P_f is the answer to this Practice Question, so step 3 is not a required step for this solution.)
- Third, find the corresponding spot price today.

(Note that the yields given in the problem statement are annualized.)

The yield of a 3-month Treasury bill nine months from today is found as follows (where r denotes a spot rate and the subscripts refer to the time to maturity, in months):

$$(1 + r_9)^{3/4} \times (1 + y_f)^{1/4} = (1 + r_{12})^1$$

$$(1 + 0.07)^{3/4} \times (1 + y_f)^{1/4} = (1 + 0.08)^1$$

Solving, we find that: y_f = 0.1106 = 11.06% (annualized rate).

It follows that the price (per dollar) of a 3-month Treasury bill nine months from now will be:

$$P_f = \frac{1}{(1+0.1106)^{1/4}} = \$0.9741$$

The corresponding spot price today is:

$$P = \frac{0.9741}{(1+0.07)^{3/4}} = \$0.9259$$

11. To check whether futures are correctly priced, we use the basic relationship:

$$\frac{\text{Value of Future}}{(1+r_f)^t} = \text{spot price} + \text{PV(storage costs)} - \text{PV(convenience yield)}$$

This gives the following:

		Actual Futures Price	Value of Future
a.	Magnoosium	$2728.50	$2728.50
b.	Quiche	0.514	0.589
c.	Nevada Hydro	78.39	78.39
d.	Pulgas	6,900.00	7,126.18
e.	Establishment Industries stock	97.54	97.58
f.	Wine	14,200.00	13,107.50*

* Assumes surplus storage cannot be rented out. Otherwise, futures are overpriced as long as the opportunity cost of storage is less than: ($14,200 - $13,107.50) = $1,092.50

Note that for the currency futures in part (d), the futures and spot currency quotes are indirect quotes (i.e., pulgas per dollar) rather than direct quotes (i.e., dollars per pulga). If I buy pulgas today, I pay ($1/9300) per pulga in the spot market and earn interest of $[(1.95^{0.5}) - 1] = 0.3964 = 39.64\%$ for six months. If I buy pulgas in the futures market, I pay ($1/6900) per pulga and I earn 7% interest on my dollars. Thus, the futures price of one pulga should be:

$$1.3964/(9300 \times 1.07) = 0.00014033 = 1/7126.18$$

Therefore, a futures buyer should demand 7126.18 pulgas for $1.

Where the futures are overpriced [i.e., (f) above], it pays to borrow, buy the goods on the spot market, and sell the future. Where they are underpriced [i.e., (b) and (d)], it pays to buy the future, sell the commodity on the spot market, and invest the receipts in a six-month account.

12. We make use of the basic relationship between the value of futures and the spot price:

$$\frac{\text{Futures price}}{(1+r_f)^t} = \text{spot price}$$

This gives the following values:

	Contract Length (Months)				
	1	3	9	15	21
$(1 + r_f)^t$	1.00437	1.01663	1.05799	1.10288	1.15058
r_f	5.37%	6.82%	7.81%	8.15%	8.34%

13. a. The NPV of a swap at initiation is zero, assuming the swap is fairly priced.

b. If the long-term rate rises, the value of a five-year note with a coupon rate of 4.5% would decline to 957.30:

$$\frac{45}{(1.055)^t} + \frac{45}{(1.055)^2} + \frac{45}{(1.055)^3} + \frac{45}{(1.055)^4} + \frac{1045}{(1.055)^5} = 957.30$$

With hindsight, it is clear that *A* would have been better off keeping the fixed-rate debt. *A* loses as a result of the increase in rates and the dealer gains.

c. *A* now has a liability equal to (1,000 – 957.30) = 42.70 and the dealer has a corresponding asset.

14. Once it is clear that a swap is profitable, then it must be determined how this profit is to be divided between the principals. For purposes of illustration, let us first assume that A will break even and then calculate the profit to B. (Having shown that there is a profit, we could then rearrange the calculations to find the swap which gives all the gains to A, or to find a swap for which the gains are shared.)

To begin, we assume that A demands a 10% dollar cost of borrowing:

Step 1: B borrows $1,000 at its 8 percent borrowing rate.

Step 2: B changes $1,000 into 2,000 Swiss Francs (SF).

Step 3: A promises to pay B $80 per year in years 1 through 4, and $1,080 in year 5. (This covers B's cost of servicing its dollar debt.)

Step 4: A discounts these promised dollar payments at its 10 percent dollar cost of borrowing:

$$\sum_{t=1}^{4} \frac{80}{1.1^t} + \frac{1080}{1.1^5} = \$924.18 = 1.848.36 \text{ SF}$$

This is the amount that A needs to borrow.

Step 5: A borrows 1848.36 SF at its 7 percent borrowing rate.
Step 6: A changes 1848.36 SF into $924.18.
Step 7: B promises to pay A 129.39 SF per year in years 1 through 4, and 1977.75 SF in year 5. This covers A's cost of servicing its SF debt.

The net effect of B's dollar loan, A's Swiss franc loan, and the currency swap is:

1. A borrows $924.18 at 10 percent, i.e., A receives $924.18 and is obligated to pay $80 per year in years 1 through 4, and $1,080 in year 5. A's SF obligations are paid by B.
2. B borrows 2000 SF and is obligated to pay 129.39 SF per year in years 1 through 4, and 1,977.75 SF in year 5. B's dollar obligations are paid by A. The cost, or yield, of this loan to B may be calculated from the following:

$$\sum_{t=1}^{4} \frac{129.39}{(1+x)^t} + \frac{1977.75}{(1+x)^5} = 2000 \Rightarrow x = 0.051 = 5.1\%$$

Thus, as a result of the swap, A can borrow dollars on a break-even basis, and B can borrow Swiss francs more cheaply (5.1 percent versus 6 percent). As noted above, we could rearrange this so that the profit is shared, which is the usual case.

15. Suppose you own an asset A and wish to hedge against changes in the value of this asset by selling another asset B. In order to minimize your risk, you should sell delta units of B; delta measures the sensitivity of A's value to changes in the value of B.

In practice, delta can be measured by using regression analysis, where the value of A is the dependent variable and the value of B is the independent variable. Delta is the regression coefficient of B. Sometimes considerable judgement must be used. For example, it may be that hedge you wish to establish has no historical data that can be used in a regression analysis.

16.

Gold Price Per Ounce	(a) Unhedged Revenue	(b) Futures-Hedged Revenue	(c) Options-Hedged Revenue
$280	$280,000	$301,000	$298,000
$300	$300,000	$301,000	$298,000
$320	$320,000	$301,000	$318,000

17. Standard & Poor's index futures are contracts to buy or sell a mythical share, which is worth $500 times the value of the index. For example, if the index is currently at 400, each 'share' is worth: ($500 × 400) = $200,000. Legs' portfolio is equivalent to five such 'shares.'

If Legs sells five index futures contracts, then, in six months, he will receive:

$$5 \times \$500 \times \text{price of futures}$$

If the relationship between the futures price and the spot price is used, this is equivalent to receiving:

$$5 \times 500 \times (\text{spot price of index}) \times (1 + r_f)^{1/2} = \$1{,}000{,}000 \times (1 + r_f)^{1/2}$$

This is exactly what he would receive in six months if he sold his portfolio now and put the money in a six-month deposit. Of course, when he sells the futures, Legs also agrees to hand over the value of a portfolio of five index 'shares.' So, at the end of six months, he can sell his portfolio and use the proceeds to settle his futures obligation. Thus, by hedging his portfolio, Legs can 'cash in' without selling his portfolio today.

18. Legs can equally well hedge his portfolio by selling seven-month index futures now and liquidating his futures position six months from today. If r_p is the return on the portfolio and r_f is the risk-free rate, then his cash flows are:

Sell portfolio:	$+1{,}000{,}000 \times (1 + r_p)$
Sell 7-month future:	$+1{,}000{,}000 \times (1 + r_f)^{½}$ (using the relationship between the spot and futures prices)
Buy 7-month future:	$-1{,}000{,}000 \times (1 + r_p)$ (because the spot price of the future will increase as the index increases)

Thus, the net cash flow six months from today will be $[1{,}000{,}000 \times (1 + r_f)^{1/2}]$, exactly what Legs would receive if he sold the $1,000,000 portfolio now and put the money in a six-month deposit.

19. We find the appropriate delta by using regression analysis, with the change in the value of Swiss Roll as the dependent variable and the change in the value of Frankfurter Sausage as the independent variable. The result is that the regression coefficient, which is the delta, is 0.5. In other words, the short position in Frankfurter Sausage should be half as large as that in Swiss Roll, or $50 million.

20. a. $0.75 \times 100{,}000 = \$75{,}000$

b. $\delta = 0.75$

c. You could sell $(1.2 \times 100{,}000) = \$120{,}000$ of gold (or gold futures) to hedge your position. However, since the R^2 is less (0.5 versus 0.6 for Stock B), you would be less well hedged.

21. a. For the lease:

Year	C_t	$PV(C_t)$ at 12%	Proportion of Total Value	Proportion of Total Value Times Year
1	2	1.786	0.180	0.180
2	2	1.594	0.160	0.320
3	2	1.424	0.143	0.429
4	2	1.271	0.128	0.512
5	2	1.135	0.114	0.570
6	2	1.013	0.102	0.612
7	2	0.905	0.091	0.637
8	2	0.808	0.081	0.648
	V =	9.935	Duration =	3.908

For the 6-year debt (value $8.03 million):

Year	C_t	$PV(C_t)$ at 12%	Proportion of Total Value	Proportion of Total Value Times Year
1	120	107.1	0.107	0.107
2	120	95.7	0.096	0.191
3	120	85.4	0.085	0.256
4	120	76.3	0.076	0.305
5	120	68.1	0.068	0.340
6	1120	567.4	0.567	3.402
	V =	1000.0	Duration =	4.601

The duration of the one-year debt (value $1.91 million) is one year. Therefore, the average duration of the debt portfolio is:

$$\left(\frac{1.91}{1.91+8.03}\times 1\right)+\left(\frac{8.03}{1.91+8.03}\times 4.6\right)=3.91 \text{ years}$$

This is equal to the duration of the lease.

b. See the table below. Potterton is no longer fully hedged. The value of the liabilities ($14.02 million) is now less than the value of the asset ($14.04 million). A one percent change in interest rates affects the value of the asset more than the value of the liabilities. To maintain the hedge, the financial manager would adjust the debt package to have the same duration as the lease. Note, however, that the mismatch is negligible and should not give the manager sleepless nights.

	Lease		6-Year Debt		1-Year Debt		Debt Package	
Yield	Value	Change	Price	Value	Price	Value	Value	Change
2.5%	14.340	+2.144%	152.33	12.232[a]	109.27	2.087[b]	14.319	+2.118%
3.0%	14.039		148.75	11.945	108.74	2.077	14.022	
3.5%	13.748	-2.073%	145.29	11.667	108.21	2.067	13.734	-2.054%

(a) $8.03 million face value
(b) $1.91 million face value

22. a. PV = $[-20/(1.10)^3] – [20/(1.10)^4]$ = -$28.69

b. Duration of the liability:

Year	C_t	$PV(C_t)$ at 12%	Proportion of Total Value	Proportion of Total Value Times Year
3	20	15.03	0.524	1.572
4	20	13.66	0.476	1.904
	V =	28.69	Duration =	3.476

Duration of the note:

Year	C_t	$PV(C_t)$ at 12%	Proportion of Total Value	Proportion of Total Value Times Year
1	12	10.91	0.103	0.103
2	12	9.92	0.093	0.187
3	12	9.02	0.085	0.254
4	112	76.50	0.719	2.877
	V =	106.35	Duration =	3.421

c. Let x = the proportion invested in the note so that (1 – x) is the proportion invested in the bank deposit. Then:

$3.421x + 0\,(1 – x) = 3.476$

$x = 3.476/3.421 = 1.016$

$1 – x = -0.016$

Therefore, invest (1.016 × $28.69 million) = $29.149 million in the note and borrow ($29.149 million - $28.69 million) = $0.459 million.

d. No, not perfectly. However, the imbalance would generally be relatively small.

e. In order to perfectly hedge this liability, we must invest so that the cash flows from the investment exactly match the cash flows of the liability. One way to do this is with zero-coupon notes, as follows:

- Invest $15.03 million in a 3-year zero-coupon note paying 10%
- Invest $13.66 million in a 4-year zero-coupon note paying 10%

When the 3-year zero-coupon note matures, it will pay $20 million, and when the 4-year zero-coupon note matures, it will pay $20 million.

23. Assume the current price of oil is $14 per barrel, the futures price is $16, and the option exercise price is $16.

Oil Price Per Barrel	Futures-Hedged Expense	Options-Hedged Expense
$14	$16	$14
$16	$16	$16
$18	$16	$16

The advantages of using futures are that risk is eliminated and that the hedge, once in place, can be safely ignored. The disadvantage, compared to hedging with options, is that options allow for the possibility of a gain. Hedging with options has a cost (i.e., the cost of the option).

24. Insurance eliminates downside risk by providing a put option. Hedging removes all uncertainty. Option hedging therefore requires a dynamic strategy. An example is the delta hedge set up by the miller, as described in the chapter.

25. Think of Legs Diamond's problem (see Practice Question 17). If futures are underpriced, he will still be hedged by selling futures and borrowing, but he will make a known loss (the amount of the underpricing). If he hedges by selling seven-month futures (see Practice Question 18), he not only needs to know that they are fairly priced now but also that they will be fairly priced when he buys them back in six months. If there is uncertainty about the fairness of the repurchase price, he will not be fully hedged.

Speculators like mispriced futures. For example, if six-month futures are overpriced, speculators can make arbitrage profits by selling futures, borrowing and buying the spot asset. This arbitrage is known as 'cash-and-carry.'

Challenge Questions

1. a. Phillips is not necessarily stupid. The company simply wants to eliminate interest rate risk.

   b. The initial terms of the swap (ignoring transactions costs and dealer profit) will be such that the net present value of the transaction is zero. Phillips will borrow $20 million for five years at a fixed rate of 9% and simultaneously lend $20 million at a floating rate two percentage points above the three-month Treasury bill rate which is currently a rate of 7%.

   c. Under the terms of the swap agreement, Phillips is obligated to pay $0.45 million per quarter ($20 million at 2.25% per quarter) and, in turn, receives $0.40 million per quarter ($20 million at 2% per quarter). That is, Phillips has a net swap payment of $0.05 million per quarter.

   d. Long-term rates have decreased, so the present value of Phillips' long-term borrowing has increased. Thus, in order to cancel the swap, Phillips will have to pay the dealer. The amount paid is the difference between the present values of the two positions:
   - The present value of the borrowed money is the present value of $0.45 million per quarter for 16 quarters, plus $20 million at quarter 16, evaluated at 2% per quarter (8% annual rate, or two percentage points over the long-term Treasury rate). This present value is $20.68 million.
   - The present value of the lent money is the present value of $0.40 million per quarter for 16 quarters, plus $20 million at quarter 16, evaluated at 2% per quarter. This present value is $20 million, as we would expect. Because the rate floats, the present value does not change.

   Thus, the amount that must be paid to cancel the swap is $0.68 million.

2. a. Cash flows (in thousands) for the two alternatives are as follows:

Hoopoe's International Issue

Year	Cash Flow	
0	C$99,800	100,000 – (100,000 × 0.002)
1	-10,625	-(100,000 × 0.10625)
2	-10,625	
3	-10,625	
4	-10,625	
5	-110,625	(-10,625 - 100,000)

The 'all-in cost' (yield to maturity) implicit in these cash flows is 10.68%.

Hoopoe's Swiss Franc (SF) Issue:

Year	Cash Flow	
0	SF 199,600	200,000 – (200,000 × 0.002)
1	-10,750	-(200,000 × 0.05375)
2	-10,750	
3	-10,750	
4	-10,750	
5	-210,750	(-10,750 - 200,000)

For the swap to be successful the counterparty must pay Hoopoe's Swiss franc costs (10,750 in years 1 through 4 and 210,750 in year 5). Further, the counterparty requires an all-in cost in Swiss francs of 6.45%. Using 6.45% as the discount rate, we can calculate the net proceeds required from the counterparty's dollar issue:

$$\sum_{t=1}^{4} \frac{10{,}750}{(1.0645)^t} + \frac{210{,}750}{(1.0645)^5} = 191{,}053 \text{ SF or } \$95{,}527$$

With these net proceeds, we can calculate the required dollar face value (x) of the counterparty's debt issue:

$$x\,(1 - 0.002) = 95{,}527 \Rightarrow x = \$95{,}718$$

We can now calculate the cash flows related to the counterparty's issue of dollar debt.

Year	Cash Flow	
0	$95,527	95,718 – (95,718 × 0.002)
1	-10,170	(95,718 × 0.10625)
2	-10,170	
3	-10,170	
4	-10,170	
5	-105,888	(-10,170 - 95,178)

Thus, Hoopoe can issue Swiss franc debt and raise 199,600 SF, which is equivalent to $99,800, and have its SF obligation paid by the counterparty; in turn, it is obligated to pay its counterparty's dollar obligations. The all-in cost (x) implied by these cash flows is calculated as follows:

$$\sum_{t=1}^{4} \frac{10{,}170}{(1+x)^t} + \frac{105{,}888}{(1+x)^5} = 99{,}800 \;\Rightarrow\; x = 0.0951 = 9.51\%$$

(Note that, by construction, the counterparty's all-in cost is 6.45 percent for its SF borrowing.)

The swap is better than the international bond issue, since the effective interest rate is less: 9.51% versus 10.66%

b. Hoopoe must clearly worry that the counterparty may default on the swap agreement. The cost of a replacement swap with a new counterparty could be considerably higher than the first one, for example, if the dollar has fallen sharply relative to the franc. Often, however, the counterparty is a major international bank; in that case, the default risk is probably small.

3. a. For each, we make use of the general relationship:

$$\frac{\text{Futures price}}{(1+r_f)^t} = \text{Spot price} - \text{PV(convenience yield)}$$

or

$$\text{Futures price} = (1 + r_f)^t \times [\text{Spot price} - \text{PV(convenience yield)}]$$

Thus, the six-month futures prices are:

Magnoosium:	$1.03 \times [2800 - (0.04 \times 2800)/1.03] =$	\$2,722 per ton
Oat Bran:	$1.03 \times [0.44 - (0.005 \times 0.44)/1.03] =$	\$0.451 per bushel
Biotech:	$1.03 \times [140.2 - 0] =$	\$144.4
Allen Wrench:	$1.03 \times [58.00 - (1.2/1.03)] =$	\$58.54
5-Year T-Note:	$1.03 \times [108.93 - (4/1.03)] =$	\$108.20
Ruple:	*	3.017 ruples/\$

*Note that, for the currency futures (i.e., the Westonian ruple), the spot currency quote is an indirect quote (i.e., ruples per dollar) rather than a direct quote (i.e., dollars per ruple). If I buy ruples today in the spot market, I pay (\$1/3.1) per ruple in the spot market and earn interest of $[(1.12^{0.5}) - 1] = 0.0583 = 5.83\%$ for six months. If I buy ruples in the futures market, I pay (\$1/X) per ruple (where X is the indirect futures quote) and I earn 6% interest on my dollars. Thus, the futures price of one ruple should be:

$$1.0583/(3.1 \times 1.03) = 0.33144 = 3.017$$

Therefore, a futures buyer should demand 3.017 ruples for \$1.

b. The magnoosium producer would sell 1,000 tons of six-month magnoosium futures.

c. Because magnoosium prices have fallen, the magnoosium producer will receive payment from the exchange. It is not necessary for the producer to undertake additional futures market trades to restore its hedge position.

d. No, the futures price depends on the spot price, the risk-free rate of interest, and the convenience yield.

e. The futures price will fall to \$48.24 (same calculation as above, with a spot price of \$48).

f. First, we recalculate the current spot price of the 5-year Treasury note. The spot price given (\$108.93) is based on semi-annual interest payments of \$40 each (annual coupon rate is 8%) and a flat term structure of 6% per year. Assuming that 6% is the compounded rate, the six-month rate is:

$$(1 + 0.06)^{1/2} - 1 = 0.02956 = 2.956\%$$

Incorporating similar assumptions with the new term structure specified in the problem, the new spot price of the 5-year Treasury note will be \$113.46. Thus, the futures price of the 5-year T-note will be:

$$1.02 \times [113.46 - (4/1.02)] = \$111.73$$

The dealer who shorted 100 notes at the (previous) futures price has lost money.

g. The importer could buy a three-month option to exchange dollars for ruples, or the importer could buy a futures contract, agreeing to exchange dollars for ruples in three months' time.

CHAPTER 28
Managing International Risks

Answers to Practice Questions

1. Answers here will vary, depending on when the problem is assigned.

2. a. The dollar is selling at a forward premium on the baht.

   b. $$4\times\left(\frac{44.555}{44.345}-1\right)=0.0189=1.89\%$$

   c. Using the expectations theory of exchange rates, the forecast is:

      $1 = 44.555 baht

   d. 100,000 baht = $(100,000/44.555) = $2,244.42

3. We can utilize the interest rate parity theory:

$$\frac{1+r_{rand}}{1+r_{\$}}=\frac{f_{rand/\$}}{s_{rand/\$}}$$

$$\frac{1+r_{rand}}{1.035}=\frac{8.4963}{8.3693}\Rightarrow r_{rand}=0.0507=5.07\%$$

If the three-month rand interest rate were substantially higher than 5.07%, then you could make an immediate arbitrage profit by buying rands, investing in a three-month rand deposit, and selling the proceeds forward.

4. Answers will vary depending on when the problem is assigned. However, we can say that if a bank has quoted a rate substantially different from the market rate, an arbitrage opportunity exists.

5. Our four basic relationships imply that the difference in interest rates equals the expected change in the spot rate:

$$\frac{1+r_{L}}{1+r_{\$}}=\frac{f_{L/\$}}{s_{L/\$}}=\frac{E(s_{L/\$})}{s_{L/\$}}$$

We would expect these to be related because each has a clear relationship with the difference between forward and spot rates.

6. If international capital markets are competitive, the real cost of funds in Japan must be the same as the real cost of funds elsewhere. That is, the low Japanese yen interest rate is likely to reflect the relatively low expected rate of inflation in Japan and the expected appreciation of the Japanese yen. Note that the parity relationships imply that the difference in interest rates is equal to the expected change in the spot exchange rate. If the funds are to be used outside Japan, then Ms. Stone should consider whether to hedge against changes in the exchange rate, and how much this hedging will cost.

7.
   a. *Exchange exposure*. Compare the effect of local financing with the export of capital from the U.S.
   b. *Capital market imperfections*. Some countries use exchange controls to force the domestic real interest rate down; others offer subsidized loans to foreign investors.
   c. *Taxation*. If the subsidiary is in a country with high taxes, the parent may prefer to provide funds in the form of a loan rather than equity.
   d. *Government attitudes to remittance.* Interest payments, royalties, etc., may be less subject to control than dividend payments
   e. *Expropriation risk.* Although the host government might be ready to expropriate a venture that was wholly financed by the parent company, the government may be reluctant to expropriate a project financed directly by a group of leading international banks.
   f. *Availability of funds, issue costs, etc.* It is not possible to raise large sums outside the principal financial centers. In other cases, the choice may be affected by issue costs and regulatory requirements. For example, Eurodollar issues avoid SEC registration requirements.

8. Suppose, for example, that the real value of the deutschemark (DM) declines relative to the dollar. Competition may not allow Lufthansa to raise trans-Atlantic fares in dollar terms. Thus, if dollar revenues are fixed, Lufthansa will earn fewer DM. This will be offset by the fact that Lufthansa’s costs may be partly set in dollars, such as the cost of fuel and new aircraft. However, wages are fixed in DM. So the net effect will be a fall in DM profits from its trans-Atlantic business.

   However, this is not the whole story. For example, revenues may not be wholly in dollars. Also, if trans-Atlantic fares are unchanged in dollars, there may be extra traffic from German passengers who now find that the DM cost of travel has fallen.

   In addition, Lufthansa may be exposed to changes in the nominal exchange rate. For example, it may have bills for fuel that are awaiting payment. In this case, it would lose from a rise in the dollar.

Note that Lufthansa is partly exposed to a commodity price risk (the price of fuel may rise in dollars) and partly to an exchange rate risk (the rise in fuel prices may not be offset by a fall in the value of the dollar). In some cases, the company can, to a great extent, fix the dollar cash flows, such as by buying oil futures. However, it still needs at least a rough-and-ready estimate of the hedge ratios, i.e., the percentage change in company value for each 1% change in the exchange rate. (Hedge ratios are discussed in Chapter 27.) Lufthansa can then hedge in either the exchange markets (forwards, futures, or options) or the loan markets.

9. Suppose a firm has a known foreign currency income (e.g., a foreign currency receivable). Even if the law of one price holds, the firm is at risk if the overseas inflation rate is unexpectedly high and the value of the currency declines correspondingly. The firm can hedge this risk by selling the foreign currency forward or borrowing foreign currency and selling it spot. Note, however, that this is a relative inflation risk, rather than a currency risk; e.g., if you were less certain about your domestic inflation rate, you might prefer to keep the funds in the foreign currency.

   If the firm owns a foreign real asset (like Outland Steel's inventory), your worry is that changes in the exchange rate may not affect relative price changes. In other words, you are exposed to changes in the real exchange rate. You cannot so easily hedge against these changes unless, say, you can sell commodity futures to fix income in the foreign currency and then sell the currency forward.

10. The dealer estimates the following relationship in order to calculate the hedge ratio (delta):

$$\text{Expected change in company value} = a + (\delta \times \text{Change in value of yen})$$

   For the Ford dealer:

$$\text{Expected change in company value} = a + (5 \times \text{Change in value of yen})$$

   Thus, to fully hedge exchange rate risk, the dealer should sell yen forward in an amount equal to one-fifth of the current company value.

11. The future cash flows from the two strategies are as follows:

Sell Euro Forward	Euro Appreciates to $0.92/euro	Euro Depreciates to $0.89/euro
i. Do not receive order (must buy euros at future spot rate to settle contract)	1,000,000 (0.9070) - 1,000,000 (0.92) = -$13,000	1,000,000 (0.9070) - 1,000,000 (0.89) = $17,000
ii. Receive order (deliver) (inflow of 1,000,000 euros to settle contract)	1,000,000 (0.9070) = $907,000	1,000,000 (0.9070) = $907,000

Buy 6-Month Put Option	Euro Appreciates to $0.92/euro	Euro Depreciates to $0.89/euro
i. Do not receive order (if euro depreciates, buy euros at future spot rate and exercise put)	$0	1,000,000 (0.9070) - 1,000,000 (0.89) = $17,000
ii. Receive order (sell euros received at the higher of the spot or put exercise price)	1,000,000 (0.92) = $920,000	1,000,000 (0.9070) = $907,000

Note that, if the firm is uncertain about receiving the order, it cannot completely remove the uncertainty about the exchange rate. However, the put option does place a downside limit on the cash flow although the company must pay the option premium to obtain this protection.

12. a. Pesos invested = 1,000 × 500 pesos = 500,000 pesos

Dollars invested = 500,000/9.1390 = 54,710.58

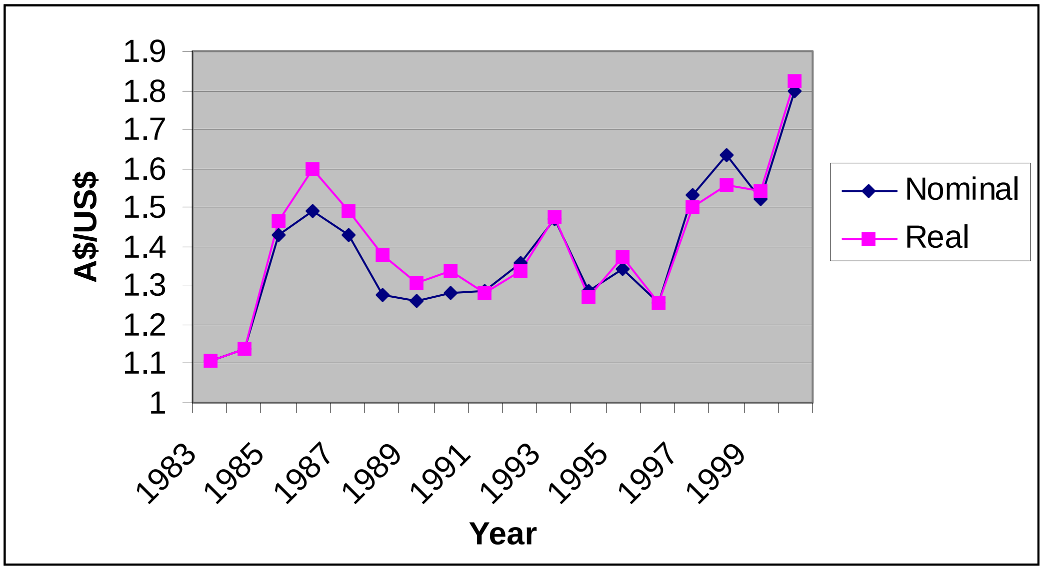
b. $$\text{Total return in pesos} = \frac{(550 - 500)\times(1000)}{500\times1000} = 0.10 = 10.0\%$$

Dollars received = (550 × 1000)/9.5 = 57,894.74

$$\text{Total return in dollars} = \frac{57,894.74 - 54,710.58}{54,710.58} = 0.0582 = 5.82\%$$

c. There has been a return on the investment of 10% but a loss on the exchange rate.

13. The nominal exchange rate is given in the table in the statement of the problem. The real exchange rate is equal to the nominal exchange rate multiplied by the inflation differential. (See footnote 15, p. 795 of the text.)



14. George lives in the U.S. and receives $100,000 per year. Since 1983, inflation in the U.S. has reduced his real earnings. From 1983 to 2000, inflation in the U.S. was 63%. So, his real income (measured in 1983 US dollars) has decreased from $100,000 in 1983 to: ($100,000/1.63) = $61,349 in 2000, a decrease of 38.7%.

Bruce, who lives in Australia, received US $100,000 in 1983, which was worth A$110,800. In 2000, he also received US$100,000, which was worth A$179,900 (in 2000 Australian dollars). Because of Australian inflation (202% since 1983), his real income in 2000 (measured in 1983 Australian dollars) was:

A$179,900/2.02 = A$89,059

Therefore, Bruce's real income, measured in Australian dollars, has decreased by 19.6%.

15. a. If the law of one price holds, then the bottle of Scotch will cost the same anywhere, which implies that:

US$22.84 = S$69 $\Rightarrow$ US$1 = S$3.02
US$22.84 = 3240 roubles $\Rightarrow$ US$1 = 141.9 roubles

b. Using the actual exchange rates, the Scotch costs:

$22.84 in the U.S.
$42.33 in Singapore
$12.96 in Moscow

We would prefer to buy our Scotch in Moscow.

16. To determine whether arbitrage opportunities exist, we use the interest rate theory. For example, we check to see whether the following relationship between the U.S. and Costaguana holds:

$$\frac{1 + r_{pulgas}}{1 + r_{\$}} = \frac{f_{pulgas/\$}}{s_{pulgas/\$}}$$

For the different currencies, we have:

	Difference in Interest Rates	Difference between Spot and Forward Rates
Costaguana	1.194175	1.194200
Westonia	1.019417	1.019231
Gloccamorra	1.048544	1.064327
Anglosaxophonia	1.010680	0.991304

For Anglosaxophonia and Gloccamorra, there are arbitrage opportunities because interest rate parity does not hold. For example, one could borrow $1,019 at 3% today, convert $1,000 to 2,300 wasps, and invest at 4.1%. This yields 2,394 wasps in one year. With a forward contract to sell these for dollars, one receives (2,394/2.28) = $1,050 dollars in one year. This is just sufficient to repay the $1,019 loan. The $19 difference between the amount borrowed ($1,019) and the amount converted to wasps ($1,000) is risk-free profit today.

17. A major point in finance is that risk is undesirable particularly when it can be reduced or eliminated. This is the purpose of hedging. At the time the hedge was initiated, the hedger's opinion was that sterling was priced correctly (otherwise the hedge would not have been placed) and that any deviations from the expected value were unacceptable.

18. Future spot prices are rarely equal to forward prices and ex post rationalization regarding which strategy would have been more successful is irrelevant since the decision must be made before the future spot price is known. Recall that forward contract gains or losses are exactly offset by losses or gains in the underlying transaction and the forward contract is costless at inception. However, if the transaction exposure is uncertain because the volume and/or foreign currency prices of the items bought or sold are unknown, a forward contract will not match the transaction exposure. In these cases, a currency option is more appropriate, but the option does have a cost. Nonetheless, currency options allow the manager to lock in a rate that will be no greater than the exercise price and allows the firm to benefit from favorable currency movements.

19. $$NPV_G = -78 + \frac{12.877}{1.10} + \frac{19.134}{(1.10)^2} + \frac{18.953}{(1.10)^3} + \frac{25.033}{(1.10)^4} + \frac{24.797}{(1.10)^5} + \frac{24.563}{(1.10)^6} = \$10.12$$

$$NPV_S = -80 + \frac{13.462}{1.10} + \frac{20.386}{(1.10)^2} + \frac{20.582}{(1.10)^3} + \frac{24.244}{(1.10)^4} + \frac{24.477}{(1.10)^5} + \frac{24.712}{(1.10)^6} = \$10.26$$

Sample calculations:

$$(1.3 \times 10) \times \left(\frac{1.05}{1.06}\right) = 12.877$$

$$\left(\frac{20}{1.5}\right) \times \left(\frac{1.05}{1.04}\right) = 13.462$$

Since both projects have a positive NPV, both should be accepted. If the firm must choose, then the Swiss plant is the better choice. Note that the NPV calculation is in dollars and implicitly assumes currency hedging.

Challenge Questions

1. a. Revenues are dollars, expenses are Swiss francs: SwissAir stock price will decline.

   b. Both revenues and expenses are in a wide range of currencies, none of which is tied directly to the Swiss franc: Nestle stock price will be unaffected.

   c. All monetary positions are hedged, expenses are Swiss francs: Union Bank stock price will be unaffected or may increase, depending on the nature of the hedge.

2. Alpha has revenues in euros and expenses in dollars. If the value of the euro falls, its profit will decrease. In the short run, Alpha could hedge this exchange risk by entering into a forward contract to sell euros for dollars.

   Omega has revenues in dollars and expenses in euros. If the value of the euro falls, its profit will increase. In the short run, Omega could hedge this exchange risk by entering into a forward contract to sell dollars for euros.

CHAPTER 29
Financial Analysis and Planning

Answers to Practice Questions

1. Internet exercise; answers will vary.

2. Internet exercise; answers will vary.

3. Internet exercise; answers will vary.

4. a. The following are examples of items that may not be shown on the company's books: intangible assets, off-balance sheet debt, pension assets and liabilities (if the pension plan has a surplus), derivatives positions.

   b. The value of intangible assets generally does not show up on the company's balance sheet. This affects accounting rates of return because book assets are too low. It can also make debt ratios seem high, again because assets are undervalued. Research and development expenditures are generally recorded as expenses rather than assets, thereby understating income and understating assets. Patents and trademarks, which can be extremely valuable assets, are not recorded as assets unless they are acquired from another company.

   c. Inventory profits can increase. Depreciation is understated, as are asset values. Equity income is depressed because the inflation premium in interest payments is not offset by a reduction in the real value of debt.

5. Individual exercise; answers will vary.

6. The answer, as in all questions pertaining to financial ratios, is, "It depends on what you want to use the measure for." For most purposes, a financial manager is concerned with the market value of the assets supporting the debt, but, since intangible assets may be worthless in the event of financial distress, the use of book values may be an acceptable proxy. You may need to look at the market value of debt, e.g., when calculating the weighted average cost of capital. However, if you are concerned with, say, probability of default, you are interested in what a firm has promised to pay, not necessarily in what investors think that promise is worth.

Looking at the face value of debt may be misleading when comparing firms with debt having different maturities. After all, a certain payment of $1,000 ten years from now is worth less than a certain payment of $1,000 next year. Therefore, if the information is available, it may be helpful to discount face value at the risk-free rate, i.e., calculate the present value of the exercise price on the option to default. (Merton refers to this measure as the quasi-debt ratio.)

You should not exclude items just because they are off-balance-sheet, but you need to recognize that there may be other offsetting off-balance-sheet items, e.g., the pension fund.

How you treat preferred stock depends upon what you are trying to measure. Preferred stock is largely a fixed charge that accentuates the risk of the common stock. On the other hand, as far as lenders are concerned, preferred stock is a junior claim on firm assets.

Deferred tax reserves arise because companies typically use accelerated depreciation for tax calculations while they use straight-line depreciation for financial reporting. In the event that the company's investment slows down or ceases, this tax would become payable, but, for most companies, deferred tax reserves are a permanent feature.

Minority interests arise because the company consolidates all the assets of its subsidiaries even though some subsidiaries may be less than 100% owned. Minority interests reflect the portion of the equity of these subsidiaries that is not owned by the company's shareholders. For most purposes, it makes sense to exclude deferred tax and minority interests from measures of leverage.

7. a. Liquidity ratios:

1. Net working capital to total assets =

$$\frac{(900 + 300) - (460 + 300)}{1450 + 300} = 0.251 \text{ (decrease)}$$

2. Current ratio $= \dfrac{900 + 300}{460 + 300} = 1.58$ (decrease)

3. Quick ratio $= \dfrac{110 + 300 + 440}{460 + 300} = 1.12$ (decrease)

4. Cash ratio $= \dfrac{110 + 300}{460 + 300} = 0.539$ (increase)

5. Interval measure $= \dfrac{110 + 300 + 440}{1980 \div 365} = 156.7$ days (increase)

b. Leverage ratios:

1. The Debt Ratio and the Debt-Equity Ratio would be unchanged at 0.45 and 0.83, respectively. These calculations involve only long-term debt, leases and equity, none of which is affected by a short-term loan that increases cash. However, the Debt Ratio (including short-term debt) changes from 0.50 to 0.61, as shown below:

$$\frac{100+450}{100+450+540}=0.50$$

$$\frac{100+450+300}{100+450+540+300}=0.61$$

2. Times interest earned would decrease because approximately the same amount would be added to the numerator (interest earned on the marketable securities) and the denominator (interest expense associated with the short-term loan).

8. The effect on the current ratio of the following transactions:
   a. Inventory is sold ⇒ no effect
   b. The firm takes out a bank loan to pay its suppliers ⇒ no effect
   c. A customer pays its overdue bills ⇒ no effect
   d. The firm uses cash to purchase additional inventories ⇒ no effect

9. After the merger, sales will be $100, assets will be $70, and profit will be $14. The financial ratios for the firms are:

	Federal Stores	Sara Togas	Merged Firm
Sales-to-Assets	2.00	1.00	1.43
Profit Margin	0.10	0.20	0.14
ROA	0.20	0.20	0.20

Note that the calculation of profit is straightforward in one sense, but in another it is somewhat complicated. Before the merger, Federal's cost of goods includes the $20 it purchases from Sara, and Sara's cost of goods sold is: ($20 - $4) = $16. After the merger, therefore, the cost of goods sold will be: ($90 - $20 + $16) = $86. With sales of $100, profit will be $14.

10. The dividend per share is $2 and the dividend yield is 4%, so the stock price per share is $50. A market-to-book ratio of 1.5 indicates that the book value per share is 2/3 of the market price, or $33.33. The number of outstanding shares is 10 million, so that the book value of equity is $333.3 million.

11. [Note: In the first printing of the seventh edition, Times Interest Earned is incorrectly stated in this practice question; Times Interest Earned should be 11.2 rather than 8.]

Total liabilities + Equity = 115 ⇒ Total assets = 115
Total current liabilities = 30 + 25 = 55
Current ratio = 1.4 ⇒ Total current assets = 1.4 × 55 = 77
Cash ratio = 0.2 ⇒ Cash = 0.2 × 55 = 11
Quick ratio = 1.0 ⇒ Cash + Accounts receivable = current liabilities = 55 ⇒
Accounts receivable = 44
Total current assets = 77 = Cash + Accounts receivable + Inventory ⇒
Inventory = 22
Total assets = Total current assets + Fixed assets = 115 ⇒ Fixed assets = 38
Long-term debt + Equity = 115 – 55 = 60
Financial leverage = 0.4 = Long-term debt/(Long-term debt + Equity) ⇒
Long-term debt = 24
Equity = 60 – 24 = 36
Average inventory = (22 + 26)/2 = 24
Inventory turnover = 5.0 = (Cost of goods sold/Average inventory) ⇒
Cost of goods sold = 120
Average receivables = (34 + 44)/2 = 39
Receivables' collection period = 71.2 = Average receivables/(Sales/365) ⇒
Sales = 200
EBIT = 200 – 120 – 10 – 20 = 50
Times-interest-earned = 11.2 = (EBIT + Depreciation)/Interest ⇒ Interest = 6.27
Earnings before tax = 50 – 6.27 = 43.73
Average total assets = (105 + 115)/2 = 110
Return on total assets = 0.18 = (EBIT – Tax)/Average total assets ⇒ Tax = 30.2
Average equity = (30 + 36)/2 = 33
Return on equity = 0.41 = Earnings available for common stock/average equity ⇒
Earnings available for common stockholders = 13.53

The result is:

Fixed assets	$38	Sales	200.0
Cash	11	Cost of goods sold	120.0
Accounts receivable	44	Selling, general, and	
Inventory	22	Administrative	10.0
Total current assets	77	Depreciation	20.0
TOTAL	$115	EBIT	50.0
Equity	$36	Interest	6.27
Long-term debt	24	Earnings before tax	43.73
Notes payable	30	Tax	30.20
Accounts payable	25	Available for common	13.53
Total current liabilities	55		
TOTAL	$115		

12. Two obvious choices are:

a. Total industry income over total industry market value:

Company	A	B	C	D	E	Total
Net income	10	0.5	6.67	-1.0	6.67	22.84
Market value	300	30	120	50.0	120	620

Price/earnings = 620/22.84 = 27.1

b. Average of the individual companies' P/Es:

Company	A	B	C	D	E
EPS	3.33	.125	3.35	-.20	.67
Share price	100	5	50	8	10
P/E	30	40	15	-40	15

Average P/E = 12.0

Clearly, the method of calculation has a substantial impact on the result. The first method is generally preferable. Here, the second method gives too much weight to Company D, which is a small company and has a negative P/E that is large in absolute value.

13. Any of the following can temporarily depress or inflate accounting earnings:

a. Capitalizing or expensing investment in intangibles, e.g., Research and Development.
b. Straight-line versus accelerated depreciation.
c. LIFO versus FIFO for pricing inventory.
d. Standards for capitalizing leases.
e. Profits on work-in-process.
f. Bad debt provisions.
g. Profits and losses on foreign exchange.
h. Compensation in options rather than cash.

14. Rapid inflation distorts virtually every item on a firm's balance sheet and income statement. For example, inflation affects the value of inventory (and, hence, cost of goods sold), the value of plant and equipment, the value of debt (both long-term and short-term); and so on. Given these distortions, the relevance of the numbers recorded is greatly diminished.

The presence of debt introduces more distortions. As mentioned above, the value of debt is affected, but so is the rate demanded by bondholders, who include the effects of inflation in their lending decisions.

15. In 1986, the book value of each airplane was $0.2 million, while the market value was $20 million. In other words, the depreciation charges used were too high, relative to economic depreciation. Thus, the book value of assets has understated actual asset value, and reported earnings have understated actual earnings. This has the following effects on the firm's financial ratios:

- *Leverage ratios:* Because assets were understated, equity has been understated, and leverage ratios have been overstated (i.e., a more realistic depreciation schedule would result in a lower debt ratio).
- *Liquidity ratios:* Some would be unaffected (e.g., the cash ratio) while others were overstated. For example, a more realistic depreciation schedule would result in a lower ratio of net working capital to total assets.
- *Profitability ratios:* Some would be unaffected (e.g., sales to net working capital), some would decrease (e.g., sales to average total assets), and for some the effect is ambiguous. More information is needed to determine the impact on return on total assets, for example. Both the numerator and denominator would increase with a more realistic depreciation schedule.
- *Market value ratios:* Some would be unaffected, as long as we make the assumption (common in finance) that capital markets can see through the obscurity imposed on the firm's financial condition by accounting conventions (e.g., dividend yield). Others would decrease by using a more realistic depreciation schedule (e.g., the P/E ratio).

16. In general, more information facilitates comparisons between firms, so the short answer is yes. However, one could also argue that the market certainly has already taken the value of these brand names into consideration, and any financial analysis that does not do so is poor indeed. Then too, if one expects to use these numbers for meaningful comparisons, one must assume that the managers of RHM have correctly estimated their brand names' value.

17. All of the financial ratios are likely to be helpful, although to varying degrees. Presumably those ratios that relate directly to the variability of earnings and the behavior of the stock price have the strongest associations with market risk; likely candidates include the debt-equity ratio and the P/E ratio. Other accounting measures of risk might be devised by taking five-year averages of these ratios.

18. Answers will vary depending on companies and industries chosen.

19. Pro forma financial statements (balance sheets, income statements, and sources and uses of cash), a description of planned capital expenditures, and a summary of planned financing.

20. Most financial models are designed to forecast accounting statements. They do not focus on the factors that directly determine firm value, such as incremental cash flow or risk.

21. Any discussion of this topic should include the following points:
    a. Most models are accounting-based and do not recognize firm value maximization as the objective of the firm. In other words, key concepts like incremental cash flow, net present value and market risk are ignored.
    b. Often the “rules” embodied in the model are arbitrarily chosen, and the decisions they imply are not considered explicitly once the model has been constructed.
    c. Models are expensive to build and maintain.
    d. Models are often so complicated that it is difficult to use or to efficiently make changes to them.

22. Ideally, the financial plan should provide unbiased forecasts. Many times, however, the financial plan represents the goals of the firm, which exceed the true expectations.

23. Bottom-up models may be excessively detailed and can prevent managers from seeing the forest for the trees. However, if the firm has diverse operations or large, discrete investments, it may be essential to forecast separately for individual divisions or projects. Thus, we would expect conglomerates or companies with individually large projects (e.g., Boeing) to use a bottom-up approach.

    It is easier to express and implement corporate strategy with a top-down model. We expect to find such models used for homogeneous businesses, especially where growth is rapid, markets are changing, and intangible assets are important. Of course, the danger is that such models lose contact with plant-by-plant, product-by-product developments that are the activities that actually generate profits and growth.

    It is generally easier to evaluate performance if the detail of a bottom-up model is available.

24. The ability to meet or beat the targets embodied in a financial plan is obviously a reassuring signal of management talent and motivation. Moreover, the financial plan focuses attention on the specific targets that top management deems most important. There are, however, several dangers.

    a. Financial plans are usually accounting-based, and thus, are subject to the biases inherent in book profitability measures.
    b. Managers may sacrifice the firm's best long-term interests in order to meet the plan's short- or medium-run targets.
    c. Manager A may make all the right decisions, but fail to meet the plan because of events beyond his control. Manager B may make the wrong decisions, but be rescued by good luck. In other words, it may be difficult to separate performance and ability from results.

25. Obviously, problems multiply as the plan attempts to track more and more detail. But keeping it up-to-date is not just a matter of mechanical updating. Remember that a plan is the end result of a discussion and bargaining process involving virtually all top and middle management, at least to some degree. A completed plan sets performance targets and governs operating and investment strategies. Completed plans are, therefore, not scrapped in mid-stream unless a major new problem or opportunity emerges. Similarly, it is a very time-consuming (and, hence, expensive) task to update financial plans.

26. A financial model describes a series of relationships among financial variables. Given these required relationships, it might not be possible to find a solution unless one variable is unconstrained. This allows all stated relationships to be met by setting the unconstrained variable, called the "balancing item," at the level required so that the Balance Sheet and the Sources and Uses Statement are reconciled.

    If dividends were made the balancing item, then an equation relating borrowing to some other variable would be required.

27. From Table 29.6, we see that, in 2000, total uses of funds equals 312. Since total sources of funds equals 153.4, the firm requires 158.6 of external capital (assuming dividends of 59.0). If no dividends are paid, the firm's external financing required is: ($158.6 - $59.0) = $99.6

28. In the following table, long-term debt is the balancing item:

Pro Forma Income Statement	1999	2000 (+50%)	2000 (+10%)
Revenues	2200.0	3300.0	2420.0
Costs (90% of revenues)	1980.0	2970.0	2178.0
Depreciation (10% of fixed assets at start of year)	53.3	55.0	55.0
EBIT	166.7	275.0	187.0
Interest (10% of long-term debt at start of year)	42.5	45.0	45.0
Tax (40% of pretax profit)	49.7	92.0	56.8
Net Income	74.5	138.0	85.2
Operating cash flow	127.8	193.0	140.2

Pro Forma Sources & Uses of Funds	1999	2000 (+50%)	2000 (+10%)
Sources			
Net Income	74.5	138.0	85.2
Depreciation	53.3	55.0	55.0
Operating cash flow	127.8	193.0	140.2
Issues of long-term debt	25.0	439.8	64.9
Issues of equity	0.0	0.0	0.0
Total sources	152.8	632.8	205.1
Uses			
Investment in net working capital	38.5	220.0	44.0
Increase in fixed assets	71.0	330.0	110.0
Dividends	43.8	82.8	51.1
Total uses	152.8	632.8	205.1
External capital required	25.0	439.8	64.9

Pro Forma Balance Sheet	1999	2000 (+50%)	2000 (+10%)
Net working capital (20% of revenues)	440.0	660.0	484.0
Net fixed assets (25% of revenues)	550.0	825.0	605.0
Total net assets	990.0	1485.0	1089.0
Long-term debt	450.0	889.8	514.9
Equity	540.0	595.2	574.1
Total long-term liabilities and equity	990.0	1485.0	1089.0

The borrowing requirement is much greater if revenues increase by 50% ($439.8) than it is if revenues increase by 10% ($64.9).

29. a.

Pro Forma Income Statement	1999	2000	2001
Revenues	2200.0	2860.0	3718.0
Costs (90% of revenues)	1980.0	2574.0	3346.2
Depreciation (10% of fixed assets at start of year)	53.3	55.0	71.5
EBIT	166.7	231.0	300.3
Interest (10% of long-term debt at start of year)	42.5	45.0	70.2
Tax (40% of pretax profit)	49.7	74.4	92.0
Net Income	74.5	111.6	138.1
Operating cash flow	127.8	166.6	209.6

Pro Forma Sources & Uses of Funds	1999	2000	2001
Sources			
Net Income	74.5	111.6	138.1
Depreciation	53.3	55.0	71.5
Operating cash flow	127.8	166.6	209.6
Issues of long-term debt	25.0	252.4	330.9
Issues of equity	0.0	0.0	0.00
Total sources	152.8	419.0	540.5
Uses			
Investment in net working capital	38.5	132.0	171.6
Increase in fixed assets	71.0	220.0	286.0
Dividends	43.8	67.0	82.9
Total uses	152.8	419.0	540.5
External capital required	25.0	252.4	330.9

Pro Forma Balance Sheet	1999	2000	2001
Net working capital (20% of revenues)	440.0	572.0	743.6
Net fixed assets (25% of revenues)	550.0	715.0	929.5
Total net assets	990.0	1287.0	1673.1
Long-term debt	450.0	702.4	1033.3
Equity	540.0	584.6	639.8
Total long-term liabilities and equity	990.0	1287.0	1673.1

b. For the year 2000, the firm's debt ratio is: ($702.4/$1287.0) = 0.546 and the interest coverage ratio is: ($231 + $55)/$45 = 6.356
For the year 2001, the firm's debt ratio is: ($1033.3/$1673.1) = 0.618 and the interest coverage ratio is: ($300.3 + $71.5)/$70.2 = 5.296

c. It would be difficult to financing continuing growth at this rate by borrowing alone. The debt ratio is already very high. If the firm continued to expand at a 30% rate, then by 2009 the debt ratio would reach 84%.

30. a. & b. [Note: the following solution is based on the assumption that working capital remains a constant proportion of fixed assets. This assumption is not stated in the first printing of the seventh edition.]

Pro Forma Income Statement	2001	2002
Revenue	1785.0	2100.0
Fixed costs	53.0	53.0
Variable costs (80% of revenue)	1428.0	1680.0
Depreciation	80.0	100.0
EBIT	224.0	267.0
Interest (at 11.8%)	24.0	28.3
Taxes (at 40%)	80.0	95.5
Net Income	120.0	143.2
Operating cash flow	200.0	243.2

Pro Forma Sources & Uses of Funds	2001	2002
Sources		
Net Income	120.0	143.2
Depreciation	80.0	100.0
Operating cash flow	200.0	243.2
Issues of long-term debt	36.0	30.0
Issues of equity	104.0	72.3
Total sources	340.0	345.5
Uses		
Investment in net working capital	60.0	50.0
Increase in fixed assets	200.0	200.0
Dividends	80.0	95.5
Total uses	340.0	345.5
External capital required	140.0	102.3

Pro Forma Balance Sheet	2001	2002
Net working capital	400.0	450.0
Net fixed assets	800.0	900.0
Total net assets	1200.0	1350.0
Long-term debt	240.0	270.0
Equity	960.0	1080.0
Total long-term liabilities and equity	1200.0	1350.0

31. [Note: The references to the year 2007 that appear in the first printing of the seventh edition are incorrect; the relevant year is 2003. Also in the first printing, Table 29.14 incorrectly states that Dividends are $80 and Retained earnings are $40. These figures should be Dividends: $120 and Retained earnings: $0.]

a.

Pro Forma Income Statement	2002	2003
Revenue	1800.0	2250.0
Fixed costs	56.0	56.0
Variable costs (80% of revenue)	1440.0	1800.0
Depreciation	80.0	80.0
EBIT	224.0	314.0
Interest (8% of beginning-of-year debt)	24.0	24.0
Taxes (at 40%)	80.0	116.0
Net Income	120.0	174.0
Operating cash flow	200.0	254.0

Pro Forma Sources & Uses of Funds	2002	2003
Sources		
Net Income	120.0	174.0
Depreciation	80.0	80.0
Operating cash flow	200.0	254.0
Issues of long-term debt	0.0	75.0
Issues of equity	0.0	167.0
Total sources	200.0	496.0
Uses		
Investment in net working capital	0.0	100.0
Increase in fixed assets	80.0	280.0
Dividends	120.0	116.0
Total uses	200.0	496.0
External capital required	0.0	242.0

Pro Forma Balance Sheet	2002	2003
Net working capital	400.0	500.0
Net fixed assets	800.0	1000.0
Total net assets	1200.0	1500.0
Long-term debt	300.0	375.0
Equity	900.0	1125.0
Total long-term liabilities and equity	1200.0	1500.0

b.

Pro Forma Income Statement	2002	2003
Revenue	1800.0	2250.0
Fixed costs	56.0	56.0
Variable costs (80% of revenue)	1440.0	1800.0
Depreciation	80.0	80.0
EBIT	224.0	314.0
Interest (8% of beginning-of-year debt)	24.0	24.0
Taxes (at 40%)	80.0	116.0
Net Income	120.0	174.0
Operating cash flow	200.0	254.0

Pro Forma Sources & Uses of Funds	2002	2003
Sources		
Net Income	120.0	174.0
Depreciation	80.0	80.0
Operating cash flow	200.0	254.0
Issues of long-term debt	0.0	242.0
Issues of equity	0.0	0.0
Total sources	200.0	496.0
Uses		
Investment in net working capital	0.0	100.0
Increase in fixed assets	80.0	280.0
Dividends	120.0	116.0
Total uses	200.0	496.0
External capital required	0.0	242.0

Pro Forma Balance Sheet	2002	2003
Net working capital	400.0	500.0
Net fixed assets	800.0	1000.0
Total net assets	1200.0	1500.0
Long-term debt	300.0	542.0
Equity	900.0	958.0
Total long-term liabilities and equity	1200.0	1500.0

The debt ratios are:

For 2002: $300/$1200 = 0.250

For 2003: $542/$1500 = 0.361

32. a. With a growth rate of 15%, total assets will increase to $3,450, implying required funding of $450. With a growth rate of 15% and using a tax rate of (200/700) = 28.6%, Eagle's Income Statement for 2003 will be:

Sales	$1,092.5
Costs	287.5
EBIT	805.0
Taxes	230.0
Net Income	$575.0

Dividends will be: (0.6 × $575) = $345
Retained earnings will be: (0.4 × $575) = $230
Thus, the needed external funds will be: ($450 - $230) = $220

b. Debt must be the balancing item, and will increase by $220 to a total value of $1,220.

c. With no new shares of stock, and debt increased by $100, the only other source of the additional $120 is retained earnings, which must increase to $350. Dividends will, thus, be reduced to $225.

33. a. Internal growth rate = retained earnings/net assets

Internal growth rate = $230/$3000 = 0.077 = 7.7%

b. $$\text{Sustainable growth rate} = \text{Plowback ratio} \times \text{Return on equity} = \frac{RE}{NI} \times \frac{NI}{\text{Equity}}$$

$$\text{Sustainable growth rate} = 0.4 \times \frac{575}{2000} = 0.115 = 11.5\%$$

34. a.

$$\text{Internal growth rate} = \frac{\text{retained earnings}}{\text{net assets}} = \text{Plowback ratio} \times \text{ROE} \times \frac{\text{Equity}}{\text{Net assets}}$$

$$\text{Internal growth rate} = \frac{0.20 \times 1{,}000{,}000 \times 0.40}{1{,}000{,}000} = 0.40 \times 0.20 \times 1.0 = 0.08 = 8.0\%$$

b. The need for external financing is equal to the increase in assets less the retained earnings:

(0.30 × 1,000,000) – (0.20 × 1,000,000 × 0.40 = $220,000

c. With no dividends, the plowback ratio becomes 1.0 and:

$$\text{Internal growth rate} = \frac{0.20 \times 1{,}000{,}000 \times 1.0}{1{,}000{,}000} = 0.20 = 20.0\%$$

d. Retained earnings will now be $200,000 and the need for external funds is reduced to $100,000. Clearly, the more generous the dividend policy (i.e., the higher the payout ratio), the greater the need for external financing.

Challenge Questions

1. Because both current assets and current liabilities are, by definition, short-term accounts, 'netting' them out against each other and then calculating the ratio in terms of total capitalization is preferable when evaluating the safety of long-term debt. Having done this, the bank loan would not be included in debt.

   Whether or not the other accounts (i.e., deferred taxes, R&R reserve, and the unfunded pension liability) are included in the calculation would depend on the time horizon of interest. All of these accounts represent long-term obligations of the firm. If the goal is to evaluate the safety of Geomorph's debt, the key question is: What is the maturity of this debt relative to the obligations represented by these accounts? If the debt has a shorter maturity, then they should not be included because the debt is, in effect, a senior obligation. If the debt has a longer maturity, then they should be included. [It may be of interest to note here that some companies (e.g., Disney) have recently issued debt with a maturity of 100 years.)

2. Internet exercise; answers will vary.

CHAPTER 30
Short-term Financial Planning

Answers to Practice Questions

1. Unless otherwise stated in the problem, assume all expenses are for cash.

	February	March	April
Sources of cash			
Collections on cash sales	$100	$110	$90
Collections on A/R	90	100	110
Total sources of cash	190	210	200
Uses of cash			
Payments on A/P	30	40	30
Cash purchases of materials	70	80	60
Other expenses	30	30	30
Capital expenditures	100	0	0
Taxes, interest, dividends	10	10	10
Total uses of cash	240	160	130
Net cash inflow	-50	50	70
Cash at start of period	100	50	100
+ Net cash inflow	-50	50	70
= Cash at end of period	50	100	170
+ Minimum operating cash balance	100	100	100
= Cumulative short-term financing required	$50	$0	$0

2. *30-Day Delay*: This quarter it will pay 1/3 of last quarter's purchases and 2/3 of this quarter's.

   60-Day Delay: This quarter it will pay 2/3 of last quarter's purchases and 1/3 of this quarter's.

3. a. *Rise in interest rates:* Interest payments on bank loan and interest on marketable securities

b. *Interest on late payments:* Stretching payables; net new borrowing.

c. *Underpayment of taxes:* Cash required for operations.

(Bear in mind, however, that if any of these events were unforeseen, they would not appear in the financial plan, which is constructed well in advance of the beginning of the first quarter.)

4. Sources and Uses of Cash:

Sources	
Sold marketable securities	2
Increased bank loans	1
Increased accounts payable	5
Cash from operations:	
Net income	6
Depreciation	2
Total sources	16
Uses	
Increased inventories	6
Increased accounts receivable	3
Invested in fixed assets	6
Dividend	1
Total uses	16
Increase in cash balance	0

Sources and Uses of Funds:

Sources	
Cash from operations	
Net income	6
Depreciation	2
Total sources	8
Uses	
Invested in fixed assets	6
Dividend	1
Total uses	7
Increase in net working capital	1

5. The new plan is shown below:

	First Quarter	Second Quarter	Third Quarter	Fourth Quarter
New borrowing:				
1. Bank loan	41.50	8.50	0.00	0.00
2. Stretching payables	0.00	7.64	0.00	0.00
3. Total	41.50	16.14	0.00	0.00
Repayments:				
4. Bank loan	0.00	0.00	16.59	33.41
5. Stretching payables	0.00	0.00	7.64	0.00
6. Total	0.00	0.00	24.23	33.41
7. Net new borrowing	41.50	16.14	-24.23	-33.41
8. Plus securities sold	5.00	0.00	0.00	0.00
9. Less securities bought	0.00	0.00	0.00	0.65
10. Total cash raised	46.50	16.14	-24.23	-34.06
Interest payments:				
11. Bank loan	0.00	1.04	1.25	0.84
12. Stretching payables	0.00	0.00	0.43	0.00
13. Interest on securities sold	0.00	0.10	0.10	0.10
14. Net interest paid	0.00	1.14	1.78	0.94
15. Cash required for operations	46.50	15.00	-26.00	-35.00
16. Total cash required	46.50	16.14	-24.23	-34.06

6.

	First Quarter	Second Quarter	Third Quarter	Fourth Quarter
Sources of cash:				
Collections on A/R	85.0	80.3	108.5	128.0
Other	0.0	0.0	12.5	0.0
Total sources	85.0	80.3	121.0	128.0
Uses of cash:				
Payments on A/P	65.0	60.0	55.0	50.0
Labor, administrative, other	30.0	30.0	30.0	30.0
Capital expenditures	2.5	1.3	5.5	8.0
Lease	1.5	1.5	1.5	1.5
Taxes, interest, dividends	4.0	4.0	4.5	5.0
Total uses	103.0	96.8	96.5	94.5
Sources - uses	-18.0	-16.5	24.5	33.5
Calculation of short-term financing requirement				
1. Cash at start of period	5.0	-13.0	-29.5	-5.0
2. Change in cash balance	-18.0	-16.5	24.5	33.5
3. Cash at end of period	-13.0	-29.5	-5.0	28.5
4. Min. operating cash bal.	5.0	5.0	5.0	5.0
5. Cumulative short-term financing required.	18.0	34.5	10.0	-23.5

	First Quarter	Second Quarter	Third Quarter	Fourth Quarter
New borrowing:				
1. Bank loan	13.00	16.93	0.00	0.00
2. Stretching payables	0.00	0.00	0.00	0.00
3. Total	13.00	16.93	0.00	0.00
Repayments:				
4. Bank loan	0.00	0.00	22.81	7.12
5. Stretching payables	0.00	0.00	0.00	0.00
6. Total	0.00	0.00	22.81	7.12
7. Net new borrowing	13.00	16.93	-22.81	-7.12
8. Plus securities sold	5.00	0.00	0.00	0.00
9. Less securities bought	0.00	0.00	0.00	26.10
10. Total cash raised	18.00	16.93	-22.81	-33.22
Interest payments:				
11. Bank loan	0.00	0.33	0.75	0.18
12. Stretching payables	0.00	0.00	0.85	0.00
14. Interest on securities sold	0.00	0.10	0.10	0.10
14. Net interest paid	0.00	0.43	1.69	0.28
16. Cash required for operations	18.00	16.50	-24.50	-33.50
16. Total cash required	18.00	16.93	-22.81	-33.22

7. Newspaper exercise; answers will vary depending on time period.

8. The following assets are most likely to be good collateral:

a ⇒ a tanker load of fuel in transit from the Middle East
c ⇒ an account receivable for office supplies sold to the City of New York
g ⇒ 100 ounces of gold
h ⇒ a portfolio of Treasury bills

The following assets are likely to be bad collateral:

b ⇒ 1,000 cases of Beaujolais Nouveau, because it might depreciate quickly and be difficult to value.
d ⇒ an inventory of 15,000 used books, because these are difficult to value.
e ⇒ a boxcar full of bananas, because it will depreciate quickly.
f ⇒ electric typewriters, because they are obsolete.
i ⇒ a half-completed luxury yacht, because it has little value unless completed.

9. a ⇒ a tanker load of fuel in transit from the Middle East – The lender would require a bill of lading.
b ⇒ 1,000 cases of Beaujolais Nouveau – Might be good collateral for a short-term loan.
c ⇒ an account receivable for office supplies sold to the City of New York – The lender might require the borrower to obtain credit insurance.
d ⇒ an inventory of 15,000 used books – The lender would have to be able to validate the condition and the value of the books.
e ⇒ a boxcar full of bananas – Might be collateral for a very short-term loan.
f ⇒ electric typewriters – A floor-planning arrangement might be arranged.
g ⇒ 100 ounces of gold – The bank would require that the gold be held by another financial institution, and would lend only a fraction of the current market value. The shorter the term of the loan, the higher the fraction would be.
h ⇒ a portfolio of Treasury bills – The lender would want to hold the Treasury bills.
i ⇒ a half-completed luxury yacht – The lender might require the builder to find a committed buyer for the yacht.

10. It pays to eliminate the middleman (i.e., the bank) when the borrower is a larger, well-known firm, so that the lender does not require collateral and does not incur costs of credit appraisal. Note that the cost of commercial paper includes the dealer’s commission plus the cost of a stand-by line of credit. Note also that companies may wish to maintain a relationship with the bank in order to be able to obtain other services from the bank, and to ensure a source of funds if commercial paper is no longer a feasible alternative source of financing.

11. There are several factors to be considered. First, the scenario described in the question is what finance companies do, and so you would have to compete with finance companies. Second, banks have come under increasing pressure in recent years from the commercial paper market, and have shown a willingness to lower their rates in order to remain competitive. Therefore, the competition would be intense, which is another way of saying that the profit margins will be very thin and, perhaps, negative for a new firm.

12. Internet exercise; answers will vary.

13. Internet exercise; answers will vary.

14. Internet exercise; answers will vary.

Challenge Questions

1. One of the disadvantages of this sort of short-term borrowing is the uncertainty it creates about future interest payments. Most firms prefer a known stream of payments. However, the real interest rate may actually be more certain with successive short-term loans. Also, long-term lending may carry a higher expected real interest rate if lenders are concerned about uncertain future inflation.

   Another problem is the cost, in time and money, of having to renegotiate the loan every period. This is necessary only once with the longer-term loan. There is one advantage to frequent renegotiations, however. Just as with privately placed debt, it is possible to have non-standard terms in the loan contract. Lenders are more likely to accept such terms if they are not locked into them for a long time.

2. Axle Chemical's expected requirement for short-term financing is:

   $(0.5 \times \$1{,}000{,}000) + (0.2 \times \$0) + (0.3 \times \$2{,}000{,}000) = \$1{,}100{,}000$

   If Axle Chemical takes out a 90-day unsecured loan for $2 million, then the interest paid at the end of the 90 days is:

   $\$2{,}000{,}000 \times [(1.01^3) – 1] = \$60{,}602$

   Under this arrangement, the expected cash surplus is:

   $\$2{,}000{,}000 - \$1{,}100{,}000 = \$900{,}000$

   This surplus will earn interest for an average period of 1.5 months at a 9% annual rate, for total interest of:

   $\$900{,}000 \times [(1.0075^{1.5}) – 1] = \$10{,}144$

   Therefore, the expected net cost of borrowing is:

   $\$60{,}602 - \$10{,}144 = \$50{,}458$

   If Axle Chemical uses the credit line, then the future value of the $20,000 commitment fee is:

   $\$20{,}000 \times 1.01^3 = \$20{,}606$

   Assuming that the cash requirement accumulates steadily during the quarter, the average maturity of the loan is 1.5 months and the expected interest cost is:

   $\$1{,}100{,}000 \times [(1.01^{1.5}) – 1] = \$16{,}541$

   The total cost of the credit line is therefore: $20,606 + $16,541 = $37,147. The credit line has the lower expected cost.

3. The main points to be considered are:

- The commercial paper is cheaper than the bank loan (9% compared to 10%). Large firms with good credit ratings can usually reduce the cost of credit by not borrowing from a bank.
- On the other hand, the firm will need to roll over the commercial paper ten times. That is acceptable as long as the firm's credit rating remains good, but commercial paper can be very expensive for companies with poor credit ratings, and may even dry up entirely. Also, liquidity in the commercial paper market varies over time. For example, during the Russian crisis in 1998, commercial paper became very expensive. The advantage of the bank loan is that the company is sure of the availability of the money for five years and is also certain regarding the margin above the prime rate. It is also important to note that the commercial paper will need to be backed by a line of credit, which will increase its cost.
- The floating rate loan from the bank appears to be cheaper than the 11% fixed rate loan from the insurance company, but it is important to remember that the difference between fixed and floating rates may indicate an expectation of a rate rise.
- The choice between the fixed-rate and the floating-rate loans may also depend on whether one or the other better hedges the firm's exposure to interest rates. For example, if the firm's income is positively related to interest rate levels, it might make sense to borrow at a floating rate; that is, when the firm's income is low, its cost of debt service is also low.

CHAPTER 31
Cash Management

Answers to Practice Questions

1. a. Payment float = 5 × \$100,000 = \$500,000

   Availability float = 3 × \$150,000 = \$450,000

   Net float = \$500,000 – \$450,000 = \$50,000

   b. Reducing the availability float to one day means a gain of:

   2 × \$150,000 = \$300,000

   At an annual rate of 6%, the annual savings will be:

   0.06 × \$300,000 = \$18,000

   The present value of these savings is the initial gain of \$300,000. (Or, if you prefer, it is the present value of a perpetuity of \$18,000 per year at an interest rate of 6% per year, which is \$300,000.)

2. a. Ledger balance = starting balance – payments + deposits

   Ledger balance = \$250,000 – \$20,000 – \$60,000 + \$45,000 = \$215,000

   b. The payment float is the outstanding total of (uncashed) checks written by the firm, which equals \$60,000.

   c. The net float is: \$60,000 - \$45,000 = \$15,000

3. a. Knob collects \$180 million per year, or (assuming 360 days per year) \$0.5 million per day. If the float is reduced by three days, then Knob gains by increasing average balances by \$1.5 million.

   b. The line of credit can be reduced by \$1.5 million, for savings per year of:

   1,500,000 × 0.12 = \$180,000

   c. The cost of the old system is \$40,000 plus the opportunity cost of the extra float required (\$180,000), or \$220,000 per year. The cost of the new system is \$100,000. Therefore, Knob will save \$120,000 per year by switching to the new system.

4. Because the bank can forecast early in the day how much money will be paid out, the company does not need to keep extra cash in the account to cover contingencies. Also, since zero-balance accounts are not held in a major banking center, the company gains several days of additional float.

5. The cost of a wire transfer is $10, and the cash is available the same day. The cost of a check is $0.80 plus the loss of interest for three days, or:

$$0.80 + [0.12 \times (3/365) \times (\text{amount transferred})]$$

Setting this equal to $10 and solving, we find the minimum amount transferred is $9,328.

6. a. The lock-box will collect an average of ($300,000/30) = $10,000 per day. The money will be available three days earlier so this will increase the cash available to JAC by $30,000. Thus, JAC will be better off accepting the compensating balance offer. The cost is $20,000, but the benefit is $30,000.

   b. Let x equal the average check size for break-even. Then, the number of checks written per month is (300,000/x) and the monthly cost of the lock-box is:

   $$(300{,}000/x)\ (0.10)$$

   The alternative is the compensating balance of $20,000. The monthly cost is the lost interest, which is equal to:

   $$(20{,}000)\ (0.06/12)$$

   These costs are equal if x = $300. Thus, if the average check size is greater than $300, paying per check is less costly; if the average check size is less than $300, the compensating balance arrangement is less costly.

   c. In part (a), we compare available dollar balances: the amount made available to JAC compared to the amount required for the compensating balance. In part (b), one cost is compared to another. The interest foregone by holding the compensating balance is compared to the cost of processing checks, and so here we need to know the interest rate.

7. a. In the 28-month period encompassing September 1976 through December 1978, there are 852 days (365 + 365 + 30 + 31 +30 + 31). Thus, per day, Merrill Lynch disbursed:

   $$\$1{,}250{,}000{,}000/852 = \$1{,}467{,}000$$

b. Remote disbursement delayed the payment of:

$$1.5 \times \$1{,}467{,}000 = \$2{,}200{,}500$$

That is, remote disbursement shifted the stream of payments back by 1½ days. At an annual interest rate of 8%, the present value of the gain to Merrill Lynch was:

$$PV = [2{,}200{,}500 \times (1.08^{(28/12)} - 1)]/[1.08^{(28/12)}] = \$361{,}708$$

c. If the benefits are permanent, the net benefit is the immediate cash flow of $2,200,500

d. The gain per day to Merrill Lynch was:

$$1{,}467{,}000 \times [1.08^{(1.5/365)} - 1] = \$464$$

Merrill Lynch writes (365,000/852] = 428.4 checks per day Therefore, Merrill Lynch would have been justified in incurring extra costs of no more than (464/428.4) = $1.083 per check.

8. Firms may choose to pay by check because of the float available. Wire transfers do not generate float. Also, the payee may not be a part of the Automated Clearinghouse system.

9. a. An increase in interest rates should decrease cash balances, because an increased interest rate implies a higher opportunity cost of holding cash.

b. A decrease in volatility of daily cash flow should decrease cash balances.

c. An increase in transaction costs should increase cash balances and decrease the number of transactions.

10. The problem here is a straightforward application of the Baumol model. The optimal amount to transfer is:

$$Q = [(2 \times 100{,}000 \times 10)/(0.01)]^{1/2} = \$14{,}142$$

This implies that the average number of transfers per month is:

$$100{,}000/14{,}142 = 7.07$$

This represents approximately one transfer every four days.

11. With an increase in inflation, the rate of interest also increases, which increases the opportunity cost of holding cash. This by itself will decrease cash balances. However, sales (measured in nominal dollars) also increase. This will increase cash balances. Overall, the firm's cash balances relative to sales might be expected to remain essentially unchanged.

12. a. The average cash balance is Q/2 where Q is given by the square root of:

$(2 \times \text{annual cash disbursements} \times \text{cost per sale of T-bills})/(\text{annual interest rate})$

Thus, if interest rates double, then Q and, hence, the average cash balance, will be reduced to $(1/\sqrt{2}) = 0.707$ times the previous cash balance. In other words, the average cash balance decreases by approximately 30 percent.

b. If the interest rate is doubled, but all other factors remain the same, the gain from operating the lock-box also doubles. In this case, the gain increases from \$72 to \$144.

13. Price of three-month Treasury bill = \$100 – (3/12 × 10) = \$97.50

$\text{Yield} = (100/97.50)^4 - 1 = 0.1066 = 10.66\%$

Price of six-month Treasury bill = \$100 – (6/12 × 10) = \$95.00

$\text{Yield} = (100/95.00)^2 - 1 = 0.1080 = 10.80\%$

Therefore, the six-month Treasury bill offers the higher yield.

14. The annually compounded yield of 5.19% is equivalent to a five-month yield of:

$1.0519^{(5/12)} - 1 = 0.021306 = 2.1306\%$

The price (P) must satisfy the following:

$(100/P) - 1 = 0.021306$

Therefore: P = \$97.9138

The return for the month is:

$(\$97.9138/\$97.50) - 1 = 0.004244$

The annually compounded yield is:

$1.004244^{12} - 1 = 0.0521 = 5.21\%$ (or approximately 5.19%)

15. [Note: In the first printing of the seventh edition, the second sentence of this Practice Question is incorrect; it should read: "Suppose another month has passed, so the bill has only *four months* left to run."]

Price of the four-month bill is: $100 – (4/12) × $5 = $98.33

Return over four months is: ($100/$98.33) – 1 = 0.01698 = 1.698%

Yield (on a simple interest basis) is: 0.01698 × 3 = 0.05094 = 5.094%

Realized return over two months is: ($98.33/$97.50) – 1 = 0.0085 = 0.85%

16. Answers here will vary depending on when the problem is assigned.

17. Let X = the investor's marginal tax rate. Then, the investor's after-tax return is the same for taxable and tax-exempt securities, so that:

$$0.0589\ (1 - X) = 0.0399$$

Solving, we find that X = 0.3226 = 32.26%, so that the investor's marginal tax rate is 32.26%.

Numerous other factors might affect an investor's choice between the two types of securities, including the securities' respective maturities, default risk, coupon rates, and options (such as call options, put options, convertibility).

18. If the IRS did not prohibit such activity, then corporate borrowers would borrow at an effective after-tax rate equal to [(1 – tax rate) × (rate on corporate debt)], in order to invest in tax-exempt securities if this after-tax borrowing rate is less than the yield on tax-exempts. This would provide an opportunity for risk-free profits.

19. For the individual paying 39.1 percent tax on income, the expected after-tax yields are:

a. On municipal note: 6.5%
b. On Treasury bill: 0.10 × (1 – 0.391) = 0.0609 = 6.09%
c. On floating-rate preferred: 0.075 × (1 – 0.391) = 0.0457 = 4.57%

For a corporation paying 35 percent tax on income, the expected after-tax yields are:

a. On municipal note: 6.5%
b. On Treasury bill: 0.10 × (1 – 0.35) = 0.065 = 6.50%
c. On floating-rate preferred (a corporate investor excludes from taxable income 70% of dividends paid by another corporation):
Tax = 0.075 × (1 - 0.70) × 0.35 = 0.007875
After-tax return = 0.075 – 0.007875 = 0.067125 = 6.7125%

Two important factors to consider, other than the after tax yields, are the credit risk of the issuer and the effect of interest rate changes on long-term securities.

20. The limits on the dividend rate increase the price variability of the floating-rate preferreds. When market rates move past the limits, so that further adjustments in rates are not possible, market prices of the securities must adjust so that the dividend rates can adjust to market rates. Companies include the limits in order to reduce variability in corporate cash flows.

Challenge Questions

1. Corporations exclude from taxable income 70% of dividends paid by another corporation. Therefore, for a corporation paying a 35% income tax rate, the effective tax rate for a corporate investor in preferred stock is 10.5%, as shown in Section 31.5 of the text. Therefore, if risk were not an issue, the yield on preferreds should be equal to [(1 – 0.35)/0.895] = 0.726 = 72.6% of the yield on Treasury bills. Of course this is a lower limit because preferreds are both riskier and less liquid than Treasury bills.

CHAPTER 32
Credit Management

Answers to Practice Questions

1. a. There is a 2% discount if the bill is paid within 30 days of the invoice date; otherwise, the full amount is due within 60 days.

   b. The full amount is due within 10 days of invoice.

   c. There is a 2% discount if payment is made within 5 days of the end of the month; otherwise, the full amount is due within 30 days of the invoice date.

2. a. Paying in 60 days (as opposed to 30) is like paying interest of $2 on a $98 loan for 30 days. Therefore, the equivalent annual rate of interest, with compounding, is:

$$\left(\frac{100}{98}\right)^{(365\,/\,30)} - 1 = 0.2786 = 27.86\%$$

   b. No discount.

   c. For a purchase made at the end of the month, these terms allow the buyer to take the discount for payments made within five days, or to pay the full amount within thirty days. For these purchases, the interest rate is computed as follows:

$$\left(\frac{100}{98}\right)^{(365\,/\,25)} - 1 = 0.3431 = 34.31\%$$

   For a purchase made at the beginning of the month, these terms allow the buyer to take the discount for payments made within thirty-five days, or to pay the full amount within thirty days of the purchase. Clearly, under these circumstances, the buyer will take the discount and pay within thirty-five days. The interest rate is negative.

3. When the company sells its goods cash on delivery, for each $100 of sales, costs are $95 and profit is $5. Assume now that customers take the cash discount offered under the new terms. Sales will increase to $104, but after rebating the cash discount, the firm receives: (0.98 × $104) = $101.92
Since customers pay with a ten-day delay, the present value of these sales is:

$$\frac{\$101.92}{1.06^{(10/365)}} = \$101.757$$

Since costs remain unchanged at $95, profit becomes:

$101.757 - $95 = $6.757

If customers pay on day 30 and sales increase to $104, then the present value of these sales is:

$$\frac{\$104}{1.06^{(30/365)}} = \$103.503$$

Profit becomes: ($103.503 - $ 95) = $8.503

In either case, granting credit increases profits.

4. The more stringent policy should be adopted because profit will increase. For every $100 of current sales:

	Current Policy	More Stringent Policy
Sales	$100.0	$95.0
Less: Bad Debts*	6.0	3.8
Less: Cost of Goods**	80.0	76.0
Profit	$14.0	$15.2

* 6% of sales under current policy; 4% under proposed policy
** 80% of sales

5. Consider the NPV (per $100 of sales) for selling to each of the four groups:

Classification	NPV per $100 Sales
1	$-85 + \frac{100 \times (1-0)}{1.15^{45/365}} = \$13.29$
2	$-85 + \frac{100 \times (1-0.02)}{1.15^{42/365}} = \$11.44$
3	$-85 + \frac{100 \times (1-0.10)}{1.15^{40/365}} = \$3.63$
4	$-85 + \frac{100 \times (1-0.20)}{1.15^{80/365}} = -\$7.41$

If customers can be classified without cost, then Velcro should sell only to Groups 1, 2 and 3. The exception would be if non-defaulting Group 4 accounts subsequently became regular and reliable customers (i.e., members of Group 1, 2 or 3). In that case, extending credit to new Group 4 customers might be profitable, depending on the probability of repeat business.

6. By making a credit check, Velcro Saddles avoids a $7.41 loss per $100 sale 25 percent of the time. Thus, the expected benefit (loss avoided) from a credit check is:

$$0.25 \times 7.41 = \$1.85 \text{ per } \$100 \text{ of sales, or } 1.85\%$$

A credit check is not justified if the value of the sale is less than x, where:

$$0.0185\,x = 95$$

$$x = \$5{,}135$$

7. Original terms:

$$\text{NPV per \$100 sales} = -80 + \frac{100}{1.12^{75/365}} = \$17.70$$

Changed terms: Assume the average purchase is at mid-month and that the months have 30 days.

$$\text{NPV per \$100 sales} = -80 + \frac{(0.60 \times 98)}{1.12^{30/365}} + \frac{(0.40 \times 100)}{1.12^{80/365}} = \$17.27$$

8. For every $100 of prior sales, the firm now has sales of $102. Thus, the cost of goods sold increases by 2%, as do sales, both cash discount and net:

$$\text{NPV per \$100 of initial sales} = 1.02 \times 17.27 = \$17.62$$

9. Some of the most important ratios to consider are:
   (1) Measures of leverage: debt ratio, times-interest-earned
   (2) Measures of liquidity: cash ratio, quick ratio
   (3) Measures of profitability: return on assets
   (4) Measures of efficiency: especially important is the average collection period.
   (5) Market-value ratios: such as the market-to-book ratio

   Identifying the least informative ratios depends on the circumstances. However, some points to note in this regard are:
   (1) Efficiency ratios are often difficult to interpret.
   (2) Liquidity ratios may be misleading in some circumstances, for example, if a company has an unused line of credit.
   (3) A high price-earning ratio might be the result of temporarily low earnings.

10. Some common problems are:
   a. Dishonest responses (usually not a significant problem).
   b. The company never learns what would have happened to rejected applicants, nor can it revise the coefficients to allow for changing customer behavior.
   c. The credit scoring system can only be used to separate (fairly obvious) sheep from goats.
   d. Mechanical application may lead to social and legal problems (e.g., red-lining)
   e. The coefficient estimation data are, of necessity, from a sample of actual loans; in other words, the estimation process ignores data from loan applications that have been rejected. This can lead to biases in the credit scoring system.
   f. If a company overestimates the accuracy of the credit scoring system, it will reject too many applicants. It might do better to ignore credit scores altogether and offer credit to everyone.

11. In real life:
   a. Repeat orders are not certain, even if the customer pays for the first one.
   b. Customers might make partial or delayed payments.
   c. There are more than two periods.
   d. Order size is not constant.
   e. The probabilities of payment are unknown.

   The complexity of these factors means that experience and judgement are necessary in the management of credit; scientific models, while helpful, cannot do the entire job.

12. a. Other things equal, it makes more sense to grant credit when the profit margin is high. The expected profit from offering credit (where p is the probability of payment) is:

$$[p \times PV(REV - COST)] - [(1 - p) \times PV(COST)]$$

Rearranging, expected profit is:

$$PV(REV - COST) - [(1 - p) \times PV(REV)]$$

If the difference between revenue and cost is small, then extending credit is more likely to result in a loss. Suppose that, for example, the profit margin is 10% so that PV(REV) = \$100 and PV(COST) = \$90, and the probability of payment is p = 90% (so that the probability of default is 10%). Then the firm breaks even: [\$100 - \$90 – (0.10 × \$100)] = \$0
If the profit margin is only 5% and the probability of default remains at 10%, the result is a loss: [\$100 - \$95 – (0.10 × \$100)] = -\$5

b. Other things equal, it is more costly to grant credit when interest rates are high. Since the effect of granting credit is to postpone receipt of revenues, the present value of revenues is reduced by high interest rates. Suppose that, for example, the only effect of granting credit is to postpone payment by 30 days. If the interest rate is 10%, this reduces PV(REV) by:

$$1.10^{(30/365)} - 1 = 0.0079 = 0.79\%$$

If the rate is 5%, then PV(REV) is reduced by:

$$1.05^{(30/365)} - 1 = 0.0040 = 0.40\%$$

c. If the probability of repeat orders is high, you should be more willing to grant credit because, if the customer pays promptly, you may then have a regular customer who is less likely to default in the future. (Page 917 of the text provides a numerical example.)

13. Internet exercise; answers will vary.

14. Internet exercise; answers will vary.

Challenge Questions

1. If the alternative is to literally pay cash on delivery, it is clearly not practical for most business transactions:
   - Deliveries of materials take place on a recurring basis, and it is simpler for customers to pay on statement rather than invoice.
   - Large items of equipment may take considerable time to install and check out, and customers will want to delay payment until they are sure everything is working.

   A more reasonable question is why firms do not charge interest, e.g., from date of invoice. The answer is partly the cost of calculation and enforcement. Also, credit is often used as a tool for price discrimination; powerful customers obtain an effective price cut by delaying payment.

2. Captive finance companies may offer organizational and marketing benefits, in addition to financial gains. Because the assets of captive finance companies are homogenous and relatively low risk, these finance companies can offer large amounts of high-quality, easily analyzed commercial paper, thus utilizing a relatively cheap source of funds. It would be more difficult for the market to monitor debt quality if the parent borrowed directly against both the receivables and fixed assets.

3. [Note: in the following solution, we have assumed an interest rate of 10%.]
   At a purchase price of $10, the sales of 30,000 umbrellas will generate $300,000 in sales and $47,000 in profit. It follows that the cost of goods sold is:

   ($300,000 - $47,000)/30,000 = $8.43 per umbrella

   Assume that, if Plumpton pays, it does so on the due date. Then, at a 10 percent interest rate, the net present value of profit per umbrella is:

   NPV per umbrella = PV(Sales price) - Cost of goods

   NPV per umbrella = $[10/(1.10)^{(60/365)}] - 8.43 = \$1.41$

   (If Plumpton pays 30 days slow, i.e., in 90 days, then the NPV falls to $1.34)

   Thus, the sales have a positive NPV if the probability of collection exceeds 86 percent. However, if Reliant thinks this sale may lead to more profitable sales in Nevada, then it may go ahead even if the probability of collection is less than 86 percent.

Relevant credit information includes a fair Dun and Bradstreet rating, but some indication of current trouble (i.e., other suppliers report Plumpton paying 30 days slow) and indications of future trouble (a pending re-negotiation of a term loan). Financial ratios can be calculated and compared with those for the industry.

Debt ratio	=	0.15
Net working capital / total assets	=	0.39
Current ratio	=	2.2
Quick ratio	=	0.40
Sales / total assets	=	3.0
Net profit margin	=	0.020 = 2.0%
Inventory turnover	=	2.9
Return on total assets	=	0.059 = 5.9%
Return on equity	=	0.054 = 5.4%

Some things the credit manager should consider are:

i. What does the stock market seem to be saying about Plumpton?

ii. How critical is the term loan renewal? Can we get more information about this from the bank or delay the credit decision until after renewal?

iii. Is there any way to make the debt more secure, e.g., use a promissory note, time draft, or conditional sale?

iv. Should Reliant seek to reduce risk, e.g., by a lower initial order or credit insurance? How painful would default be to Reliant?

v. What alternatives are available? Are there better ways to enter the Nevada market? What is the competition?

4. a. For every $100 in current sales, Galenic has $5.0 profit, ignoring bad debts. This implies the cost of goods sold is $95.0. If the bad debt ratio is 1%, then per $100 sales the bad debts will be $1 and actual profit will be $4.0, a net profit margin of 4%.

b. Sales will fall to 91.6% of their previous level (9,160/10,000), or to $91.6 per $100 of original sales. With a cost of goods sold ratio of 95%, CGS will be $87.0. Bad debts will be: (0.007 × 91.6) = $0.64
Therefore, the profit under the new scoring system, per $100 of original sales, will be $4.0. Profit will be unaffected.

c. There are many reasons why the predicted and actual default rates may differ. For example, the credit scoring system is based on historical data and does not allow for changing customer behavior. Also, the estimation process ignores data from loan applications that have been rejected, which may lead to biases in the credit scoring system. If a company overestimates the accuracy of the credit scoring system, it will reject too many applications.

d. If one of the variables is whether the customer has an account with Galenic, the credit scoring system is likely to be biased because it will ignore the potential profit from new customers who might generate repeat orders.

CHAPTER 33
Mergers

Answers to Practice Questions

1. Answers here will vary, depending on student choice.

2. Answers here will vary, depending on student choice.

3. a. This is a version of the diversification argument. The high interest rates reflect the risk inherent in the volatile industry. However, if the merger allows increased borrowing and provides increased value from tax shields, there will be a net gain.

   b. The P/E ratio does not determine earnings. The efficient markets hypothesis suggests that investors will be able to see beyond the ratio to the economics of the merger.

   c. There will still be a wealth transfer from the acquiring shareholders to the target shareholders.

4. Start with the market value of the combined firm and subtract the market value of the acquiring firm pre-merger. This is the gain from the merger. The cost of the merger can be determined in the following way. First, determine what percentage of the combined firm the target shareholders now own as a result of receiving shares. Now multiply this percentage by the market value of the combined firm. This is the cost of the merger using post-merger pricing.

5. Suppose the market value of the acquiring firm is $150 million and the value of the firm with a merger is $200 million. If the probability of a merger is 70%, then the market value of the firm pre-merger could be:

   $$(\$150 \times 0.3) + (\$200 \times 0.7) = \$185 \text{ million}$$

   If the acquiring managers used this value, they would underestimate the value of the acquisition.

6. This is an interesting question that centers on the source of the information. If you obtain the information from someone at Backwoods Chemical whom you know has access to this valuable information, then you are guilty of insider trading if you act upon it. However, if you come across the information as a result of analysis you have done or research you have performed (which anyone could have done, but did not do), then you are free to act upon the information.

7. a. Use the perpetual growth model of stock valuation to find the appropriate discount rate (r) for the common stock of Plastitoys (Company B):

$$\frac{0.80}{r - 0.06} = 20 \;\Rightarrow\; r = 0.10 = 10.0\%$$

Under new management, the value of the combination (AB) would be the value of Leisure Products (Company A) before the merger (because Company A's value is unchanged by the merger) plus the value of Plastitoys after the merger, or:

$$PV_{AB} = (1{,}000{,}000 \times 90) + 600{,}000 \times \left(\frac{0.80}{0.10 - 0.08}\right) = \$114{,}000{,}000$$

We now calculate the gain from the acquisition:

$$Gain = PV_{AB} - (PV_A + PV_B)$$

$$Gain = \$114{,}000{,}000 - (\$90{,}000{,}000 + \$12{,}000{,}000) = \$12{,}000{,}000$$

b. Because this is a cash acquisition:

Cost = Cash Paid – PV_B = (25 × 600,000) – 12,000,000 = \$3,000,000

c. Because this acquisition is financed with stock, we have to take into consideration the effect of the merger on the stock price of Leisure Products. After the merger, there will be 1,200,000 shares outstanding. Hence, the share price will be:

\$114,000,000/1,200,000 = \$95.00

Therefore:

Cost = (95 × 200,000) - (20 × 600,000) = \$7,000,000

d. If the acquisition is for cash, the cost is the same as in Part (b), above: Cost = \$3,000,000

If the acquisition is for stock, the cost is different from that calculated in Part (c). This is because the new growth rate affects the value of the merged company. This, in turn, affects the stock price of the merged company and, hence, the cost of the merger. It follows that:

PV_{AB} = (90 × 1,000,000) + (20 × 600,000) = \$102,000,000

The new share price will be:

\$102,000,000/1,200,000 = \$85.00

Therefore:

Cost = (85 × 200,000) - (20 × 600,000) = \$5,000,000

8. a. We complete the table, beginning with:

Total market value = \$4,000,000 + \$5,000,000 = \$9,000,000
Total earnings = \$200,000 + \$500,000 = \$700,000

Earnings per share equal to \$2.67 implies that the number of shares outstanding is: (700,000/2.67) = 262,172. The price per share is: (\$9,000,000/262,172) = \$34.33
The price-earnings ratio is: (34.33/2.67) = 12.9

b. World Enterprises issued (262,172 - 100,000) = 162,272 new shares in order to take over Wheelrim and Axle, which had 200,000 shares outstanding. Thus, (162,172/200,00) = 0.81 shares of World Enterprises were exchanged for each share of Wheelrim and Axle.

c. World Enterprises paid a total of (162,172 × \$34.33) = \$5,567,365 for a firm worth \$5,000,000. Thus, the cost is:

\$5,567,365 - \$5,000,000 = \$567,365

d. The change in market value will be a decrease of \$567,365.

9. In a tax-free acquisition, the selling shareholders are viewed as exchanging their shares for shares in the new company. In a taxable acquisition, the selling shareholders are viewed as selling their shares. Whether the acquisition is tax-free or taxable also affects the resulting firm's tax position. If the acquisition is tax-free, the firms are taxed as though they had always been together. If the acquisition is taxable, the assets of the selling firm are revalued, which may produce a taxable gain or loss and which affects future depreciation, and, hence, depreciation tax shields.

It follows that buyers and sellers will only agree to a taxable merger when the tax benefits to one group outweigh the tax losses to the other and some middle ground is agreed upon.

10. Table 33.3 becomes:

NWC	2.1	3.0	D
FA	9.2	8.8	E
Goodwill	0.5		
	11.8	11.8	

If the acquisition is tax-free, then the value of AB Corporation does not change. If the acquisition is taxable, the revaluation of fixed assets increases the allowable depreciation, but the write-up in asset value is a taxable gain. This reduces the value of AB.

11. The common theme in Pickens's attempts was to force management to operate the businesses in a way that maximized shareholders' wealth. Through take-over attempts, Pickens forced management to re-examine operations and to find ways to cut operating costs, eliminate negative NPV projects and return cash to the shareholders. This usually involved share repurchases which increased the market value of the firm. On the whole, this is an example of the market disciplining a firm to become more efficient.

12. a. The available evidence indicates that shareholders are generally better off as sellers. The reason seems to be competition. Once a company is "in play," the potential suitors are attracted and a bidding war ensues. By the time a winner is declared, whatever gains there are to the merger accrue mostly to the seller.

    b. An active acquisition strategy makes sense for any company and its shareholders whenever other companies can be purchased such that the benefits to the merger outweigh the cost. This is, of course, much easier said than done.

13. Adherents of the free-cash-flow hypothesis would argue that NatWest was expending resources in unproductive ways, in other words, that NatWest was unable to profitably operate its U.S. retail banking operations, for whatever reason. Thus, when these operations were sold, even though at less than full value, the action was viewed positively because it meant an end to further losses. Also, NatWest's serious consideration of the possibility of putting this money into the hands of the stockholders would be viewed as another sign that management would not waste shareholder resources on unprofitable ventures.

Challenge Questions

1. Answers here will vary, depending on student choice.

2. Answers here will vary, depending on one's views of the proper role of government, as well as one's views of the role of financial markets.

3. There are many possible reasons for this rule, which gives the first firm a significant advantage in the bidding process. One reason is that the first firm did the initial work to identify the potential of the target firm and so deserves to have the best chance to reap the benefits.

   Whether it should be introduced into the United States is debatable and depends on one's views on the proper role of government, as well as one's views of the role of financial markets.

4. If you do, please contact the authors of the text; they, and most of the rest of the finance profession, would dearly love to better understand merger activity.

CHAPTER 34
Control, Governance, and Financial Architecture

Answers to Practice Questions

1. a. In the U.S., the largest shareholders of corporations are financial institutions. However, since ownership is usually widely dispersed, effective control often rests with management. In many countries outside the U.S., families and governments often have large equity stakes.

   b. False. Top managers in Germany are more likely to balance the interests of all stakeholders (rather than just those of shareholders), but poor performance can still result in management turnover.

   c. True. Carve-out or spin-off of a division improves incentives for the division's managers. If the businesses are independent, it is easier to measure the performance of the division's managers.

   d. False. The limited life of a private-equity partnership reassures the limited partners that the cash flow will not be reinvested in a wasteful manner. It also tends to ensure that partnerships focus on opportunities to reorganize poorly performing businesses and to provide them with new management before selling them off.

   e. True. The remuneration package for the general partners typically includes a 20% carried interest. This is equivalent to a call option on the partnership's value and, as is the case for all options, this option is more valuable when the value of the assets is highly variable.

2. In general, firms with narrow margins in highly competitive environments are not good candidates for LBO's or MBO's. These firms are often highly efficient and do not have excess assets or unnecessary capital expenditures. Further, the thinness of the margins limits the amount of debt capacity.

3. The common theme is that investors do not want companies to waste resources. Investors would much prefer that companies pay out their free cash flow, instead of wasting it on poor capital investments or using it to subsidize an inefficient operation. Financial leverage was a necessary part of both deals because it increased the companies' cash obligations and, thus, reduced managers' flexibility.

4. RJR issued a lot of debt and repurchased shares to reduce the equity base. Sealed Air issued a lot of debt and paid a special dividend to all shareholders to reduce the equity base. RJR was seen as a company that needed to streamline operations and reexamine its capital expenditures and asset holdings. The firm was in a highly competitive environment, but had the advantage of brand name recognition for its products. Sealed Air needed to streamline its operations because it had grown inefficient due to the patent protection it had for its products. Sealed Air remained public in order to increase the pressure to perform by remaining exposed to buying and selling pressure in the market.

5. Answers will vary depending upon the examples chosen.

6. The story told in *Barbarians at the Gate* is a very complicated one. Those who favor mergers can find much evidence in this story to support their position, as can those who oppose mergers. In a similar fashion, those who espouse one particular theory or another as to why companies merge can find evidence here to support their position (and evidence to refute the positions of others). Thus, the answer will vary, depending on one's views.

7. Private equity partnerships are usually run by professional equity managers representing larger institutional investors. The institutional investors act as the limited partners while the professional managers act as general partners in the limited partnership. The general partners are companies that focus on funding and managing equity investments in closely-held firms. The incentive for general partners is a management fee plus a share in the company profits that they can increase if they successfully "fix" the firm. The limited partners get paid first but are not entitled to all the profits. Further, the limited life of the partnership precludes wasteful reinvestment. These partnerships are designed to make investments in various types of firms from venture capital start-ups to mature firms that need to re-invigorate management.

8. There are, in general, four reasons for conglomerates to exist outside of the United States. First, you can be limited by the size of the local economy. To be a larger firm is to be a diversified firm. Second, increased size often means increased political power when dealing with centrally managed economies or operating in countries with unstable economic policies. Third, companies may need to be of a certain size to attract professional management. Finally, size is important if the external capital market is poorly developed and internal capital is an important source of funds.

9. The internal capital market refers to free cash flow, generated by companies in mature industries, that can be funneled to other divisions with profitable growth opportunities. The allocation will be efficient if managers correctly allocate funds to the most potentially profitable projects and avoid incurring transactions costs associated with issuing public securities. Unfortunately, funds are not allocated by an actual market mechanism. Rather, conglomerates are centrally run and internal corporate politics can play as important a role as economies.

Challenge Question

1. The major problem with financial management of a conglomerate is that the division is not forced to face the scrutiny and judgement of an external capital market. Thus, there may easily be serious misallocations of capital within the firm. Many of the problems might be resolved by basing performance measurement and compensation on residual income or EVA but this may be fraught with problems of implementation. For example, in order to measure performance, divisional costs of capital have to be developed, as well as other arbitrary allocations, such as determining the amount and cost of debt to be borne by any division. Recall also that one of the important roles of an external capital market is to assess future expectations. Measures of residual income and EVA tend often to be single period measures. As a consequence, they can introduce short-term incentives to avoid long-term benefits, such as declining to purchase land at a bargain price to sit idle for five years in preparation for a major expansion.

CHAPTER 3
How to Calculate Present Values

Answers to Practice Questions

1.

a. PV = $100 × 0.905 = $90.50

b. PV = $100 × 0.295 = $29.50

c. PV = $100 × 0.035 = $ 3.50

d. PV = $100 × 0.893 = $89.30

PV = $100 × 0.797 = $79.70

PV = $100 × 0.712 = $71.20

PV = $89.30 + $79.70 + $71.20 = $240.20

2.

a. PV = $100 × 4.279 = $427.90

b. PV = $100 × 4.580 = $458.00

c. We can think of cash flows in this problem as being the difference between two separate streams of cash flows. The first stream is $100 per year received in years 1 through 12; the second is $100 per year paid in years 1 through 2.

The PV of $100 received in years 1 to 12 is:

PV = $100 × [Annuity factor, 12 time periods, 9%]

PV = $100 × [7.161] = $716.10

The PV of $100 paid in years 1 to 2 is:

PV = $100 × [Annuity factor, 2 time periods, 9%]

PV = $100 × [1.759] = $175.90

Therefore, the present value of $100 per year received in each of years 3 through 12 is: ($716.10 - $175.90) = $540.20. (Alternatively, we can think of this as a 10-year annuity starting in year 3.)

3. a. $DF_1 = \frac{1}{1+r_1} = 0.88 \Rightarrow$ so that r_1 = 0.136 = 13.6%

b. $DF_2 = \frac{1}{(1+r_2)^2} = \frac{1}{(1.105)^2} = 0.82$

c. $AF_2 = DF_1 + DF_2 = 0.88 + 0.82 = 1.70$

d. PV of an annuity = C × [Annuity factor at r% for t years]

Here:

$24.49 = $10 × [$AF_3$]

$AF_3 = 2.45$

e. $AF_3 = DF_1 + DF_2 + DF_3 = AF_2 + DF_3$

$2.45 = 1.70 + DF_3$

$DF_3 = 0.75$

4. The present value of the 10-year stream of cash inflows is (using Appendix Table 3): ($170,000 × 5.216) = $886,720
Thus:

NPV = -$800,000 + $886,720 = +$86,720

At the end of five years, the factory's value will be the present value of the five remaining $170,000 cash flows. Again using Appendix Table 3:

PV = 170,000 × 3.433 = $583,610

5. a. Let S_t = salary in year *t*

$$PV = \sum_{t=1}^{30} \frac{S_t}{(1.08)^t} = \sum_{t-1}^{30} \frac{20{,}000\ (1.05)^{t-1}}{(1.08)^t} = \sum_{t=1}^{30} \frac{(20{,}000/1.05)}{(1.08/1.05)^t} = \sum_{t-1}^{30} \frac{19{,}048}{(1.029)^t}$$

$$= 19{,}048 \times \left[\frac{1}{0.029} - \frac{1}{(0.029) \times (1.029)^{30}} \right] = \$378{,}222$$

b. PV(salary) x 0.05 = $18,911.

Future value = $18,911 x $(1.08)^{30}$ = $190,295

c. Annual payment = initial value ÷ annuity factor

20-year annuity factor at 8 percent = 9.818

Annual payment = $190,295/9.818 = $19,382

6.

Period	Discount Factor	Cash Flow	Present Value
0	1.000	-400,000	-400,000
1	0.893	+100,000	+ 89,300
2	0.797	+200,000	+159,400
3	0.712	+300,000	+213,600
			Total = NPV = $62,300

7. We can break this down into several different cash flows, such that the sum of these separate cash flows is the total cash flow. Then, the sum of the present values of the separate cash flows is the present value of the entire project. All dollar figures are in millions.

- Cost of the ship is $8 million
  PV = -$8 million

- Revenue is $5 million per year, operating expenses are $4 million. Thus, operating cash flow is $1 million per year for 15 years.
  PV = $1 million × [Annuity factor at 8%, t = 15] = $1 million × 8.559
  PV = $8.559 million

- Major refits cost $2 million each, and will occur at times t = 5 and t = 10.
  PV = -$2 million × [Discount factor at 8%, t = 5]
  PV = -$2 million × [Discount factor at 8%, t = 10]
  PV = -$2 million × [0.681 + 0.463] = -$2.288 million

- Sale for scrap brings in revenue of $1.5 million at t = 15.
  PV = $1.5 million × [Discount factor at 8%, t = 15]
  PV = $1.5 million × [0.315] = $0.473

Adding these present values gives the present value of the entire project:

PV = -$8 million + $8.559 million - $2.288 million + $0.473 million

PV = -$1.256 million

8. a. PV = $100,000

b. PV = $180,000/1.12^5 = $102,137

c. PV = $11,400/0.12 = $95,000

d. PV = $19,000 × [Annuity factor, 12%, t = 10]

PV = $19,000 × 5.650 = $107,350

e. PV = $6,500/(0.12 - 0.05) = $92,857

Prize (d) is the most valuable because it has the highest present value.

9. a. Present value per play is:

$PV = 1{,}250/(1.07)^2 = \$1{,}091.80$

This is a gain of 9.18 percent per trial. If x is the number of trials needed to become a millionaire, then:

$(1{,}000)(1.0918)^x = 1{,}000{,}000$

Simplifying and then using logarithms, we find:

$(1.0918)^x = 1{,}000$

$x (\ln 1.0918) = \ln 1000$

$x = 78.65$

Thus the number of trials required is 79.

b. $(1 + r_1)$ must be less than $(1 + r_2)^2$. Thus:

$DF_1 = 1/(1 + r_1)$

must be larger (closer to 1.0) than:

$DF_2 = 1/(1 + r_2)^2$

10. Mr. Basset is buying a security worth $20,000 now. That is its present value. The unknown is the annual payment. Using the present value of an annuity formula, we have:

$PV = C \times [\text{Annuity factor, } 8\%, t = 12]$

$20{,}000 = C \times 7.536$

$C = \$2{,}654$

11. Assume the Turnips will put aside the same amount each year. One approach to solving this problem is to find the present value of the cost of the boat and equate that to the present value of the money saved. From this equation, we can solve for the amount to be put aside each year.

$PV(\text{boat}) = 20{,}000/(1.10)^5 = \$12{,}418$

$PV(\text{savings}) = \text{Annual savings} \times [\text{Annuity factor, } 10\%, t = 5]$

$PV(\text{savings}) = \text{Annual savings} \times 3.791$

Because PV(savings) must equal PV(boat):

Annual savings × 3.791 = $12,418

Annual savings = $3,276

Another approach is to find the value of the savings at the time the boat is purchased. Because the amount in the savings account at the end of five years must be the price of the boat, or $20,000, we can solve for the amount to be put aside each year. If x is the amount to be put aside each year, then:

$$x(1.10)^4 + x(1.10)^3 + x(1.10)^2 + x(1.10)^1 + x = \$20,000$$

$$x(1.464 + 1.331 + 1.210 + 1.10 + 1) = \$20,000$$

$$x(6.105) = \$20,000$$

$$x = \$\ 3,276$$

12. The fact that Kangaroo Autos is offering "free credit" tells us what the cash payments are; it does not change the fact that money has time value. A 10 percent annual rate of interest is equivalent to a monthly rate of 0.83 percent:

$$r_{monthly} = r_{annual} /12 = 0.10/12 = 0.0083 = 0.83\%$$

The present value of the payments to Kangaroo Autos is:

$$\$1000 + \$300 \times [\text{Annuity factor, } 0.83\%, t = 30]$$

Because this interest rate is not in our tables, we use the formula in the text to find the annuity factor:

$$\$1,000 + \$300 \times \left[\frac{1}{0.0083} - \frac{1}{(0.0083) \times (1.0083)^{30}}\right] = \$8,938$$

A car from Turtle Motors costs $9,000 cash. Therefore, Kangaroo Autos offers the better deal, i.e., the lower present value of cost.

13. The NPVs are:

at 5 percent $\Rightarrow \text{NPV} = -\$150{,}000 - \dfrac{\$100{,}000}{1.05} + \dfrac{\$300{,}000}{(1.05)^2} = \$26{,}871$

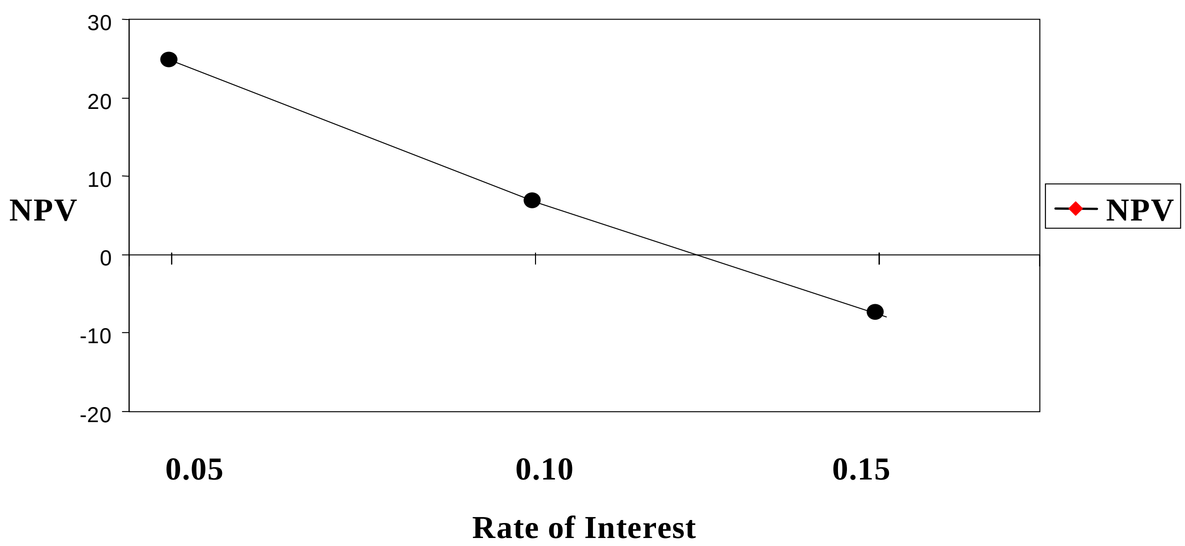
at 10 percent $\Rightarrow \text{NPV} = -\$150{,}000 - \dfrac{\$100{,}000}{1.10} + \dfrac{300{,}000}{(1.10)^2} = \$7{,}025$

at 15 percent $\Rightarrow \text{NPV} = -\$150{,}000 - \dfrac{\$100{,}000}{1.15} + \dfrac{300{,}000}{(1.15)^2} = -\$10{,}113$

The figure below shows that the project has zero NPV at about 12 percent.

As a check, NPV at 12 percent is:

$$\text{NPV} = -\$150{,}000 - \frac{\$100{,}000}{1.12} + \frac{300{,}000}{(1.12)^2} = -\$128$$



14. a. Future value = \$100 + (15 × \$10) = \$250

b. FV = \$100 × $(1.15)^{10}$ = \$404.60

c. Let x equal the number of years required for the investment to double at 15 percent. Then:

$$(\$100)(1.15)^x = \$200$$

Simplifying and then using logarithms, we find:

$$x\,(\ln 1.15) = \ln 2$$

$$x = 4.96$$

Therefore, it takes five years for money to double at 15% compound interest. (We can also solve by using Appendix Table 2, and searching for the factor in the 15 percent column that is closest to 2. This is 2.011, for five years.)

15. a. This calls for the growing perpetuity formula with a negative growth rate (g = -0.04):

$$PV = \frac{\$2\text{ million}}{0.10 - (-0.04)} = \frac{\$2\text{ million}}{0.14} = \$14.29\text{ million}$$

b. The pipeline's value at year 20 (i.e., at t = 20), assuming its cash flows last forever, is:

$$PV_{20} = \frac{C_{21}}{r - g} = \frac{C_1(1+g)^{20}}{r - g}$$

With C_1 = \$2 million, g = -0.04, and r = 0.10:

$$PV_{20} = \frac{(\$2\text{ million}) \times (1 - 0.04)^{20}}{0.14} = \frac{\$0.884\text{ million}}{0.14} = \$6.314\text{ million}$$

Next, we convert this amount to PV today, and subtract it from the answer to Part (a):

$$PV = \$14.29\text{ million} - \frac{\$6.314\text{ million}}{(1.10)^{20}} = \$13.35\text{ million}$$

16. a. This is the usual perpetuity, and hence:

$$PV = \frac{C}{r} = \frac{\$100}{0.07} = \$1,428.57$$

b. This is worth the PV of stream (a) *plus* the immediate payment of $100:

PV = $100 + $1,428.57 = $1,528.57

c. The continuously compounded equivalent to a 7 percent annually compounded rate is approximately 6.77 percent, because:

$e^{0.0677} = 1.0700$

Thus:

$$PV = \frac{C}{r} = \frac{\$100}{0.0677} = \$1,477.10$$

Note that the pattern of payments in part (b) is more valuable than the pattern of payments in part (c). It is preferable to receive cash flows at the start of every year than to spread the receipt of cash evenly over the year; with the former pattern of payment, you receive the cash more quickly.

17. a. PV = $100,000/0.08 = $1,250,000

b. PV = $100,000/(0.08 - 0.04) = $2,500,000

c. $$PV = \$100,000 \times \left[\frac{1}{0.08} - \frac{1}{(0.08) \times (1.08)^{20}}\right] = \$981,800$$

d. The continuously compounded equivalent to an 8 percent annually compounded rate is approximately 7.7 percent , because:

$e^{0.0770} = 1.0800$

Thus:

$$PV = \$100,000 \times \left[\frac{1}{0.077} - \frac{1}{(0.077) \times e^{(0.077)(20)}}\right] = \$1,020,284$$

(Alternatively, we could use Appendix Table 5 here.) This result is greater than the answer in Part (c) because the endowment is now earning interest during the entire year.

18. To find the annual rate (r), we solve the following future value equation:

$$1{,}000\ (1 + r)^8 = 1{,}600$$

Solving algebraically, we find:

$$(1 + r)^8 = 1.6$$

$$(1 + r) = (1.6)^{(1/8)} = 1.0605$$

$$r = 0.0605 = 6.05\%$$

The continuously compounded equivalent to a 6.05 percent annually compounded rate is approximately 5.87 percent, because:

$$e^{0.0587} = 1.0605$$

19. With annual compounding: $FV = \$100 \times (1.15)^{20} = \$1{,}637$

With continuous compounding: $FV = \$100 \times e^{(0.15)(20)} = \$2{,}009$

20. One way to approach this problem is to solve for the present value of:
(1) $100 per year for 10 years, and
(2) $100 per year in perpetuity, with the first cash flow at year 11
If this is a fair deal, these present values must be equal, and thus we can solve for the interest rate, r.

The present value of $100 per year for 10 years is:

$$PV = \$100 \times \left[\frac{1}{r} - \frac{1}{(r) \times (1+r)^{10}}\right]$$

The present value, as of year 10, of $100 per year forever, with the first payment in year 11, is: $PV_{10} = \$100/r$

At t = 0, the present value of PV_{10} is:

$$PV = \left[\frac{1}{(1+r)^{10}}\right] \times \left[\frac{\$100}{r}\right]$$

Equating these two expressions for present value, we have:

$$\$100 \times \left[\frac{1}{r} - \frac{1}{(r) \times (1+r)^{10}}\right] = \left[\frac{1}{(1+r)^{10}}\right] \times \left[\frac{\$100}{r}\right]$$

Using trial and error or algebraic solution, we find that r = 7.18%.

21. Assume the amount invested is one dollar.
Let A represent the investment at 12 percent, compounded annually.
Let B represent the investment at 11.7 percent, compounded semiannually.
Let C represent the investment at 11.5 percent, compounded continuously.
After one year:

$FV_A = \$1 \times (1 + 0.12)^1 = \$1.120$

$FV_B = \$1 \times (1 + 0.0585)^2 = \$1.120$

$FV_C = \$1 \times (e^{0.115\times1}) = \$1.122$

After five years:

$FV_A = \$1 \times (1 + 0.12)^5 = \$1.762$

$FV_B = \$1 \times (1 + 0.0585)^{10} = \$1.766$

$FV_C = \$1 \times (e^{0.115\times5}) = \$1.777$

After twenty years:

$FV_A = \$1 \times (1 + 0.12)^{20} = \$9.646$

$FV_B = \$1 \times (1 + 0.0585)^{40} = \$9.719$

$FV_C = \$1 \times (e^{0.115\times 20}) = \$9.974$

The preferred investment is C.

22. $1 + r_{nominal} = (1 + r_{real}) \times (1 + \text{inflation rate})$

Nominal Rate	Inflation Rate	Real Rate
6.00%	1.00%	4.95%
23.20%	10.00%	12.00%
9.00%	5.83%	3.00%

23. $1 + r_{nominal} = (1 + r_{real}) \times (1 + \text{inflation rate})$

Approximate Real Rate	Actual Real Rate	Difference
4.00%	3.92%	0.08%
4.00%	3.81%	0.19%
11.00%	10.00%	1.00%
20.00%	13.33%	6.67%

24. The total elapsed time is 113 years.

At 5%: $FV = \$100 \times (1 + 0.05)^{113} = \$24,797$

At 10%: $FV = \$100 \times (1 + 0.10)^{113} = \$4,757,441$

25. Because the cash flows occur every six months, we use a six-month discount rate, here 8%/2, or 4%. Thus:

PV = $100,000 + $100,000 × [Annuity Factor, 4%, t = 9]
PV = $100,000 + $100,000 × 7.435 = $843,500

26. PV_{QB} = $3 million × [Annuity Factor, 10%, t = 5]

PV_{QB} = $3 million × 3.791 = $11.373 million

$PV_{RECEIVER}$ = $4 million + $2 million × [Annuity Factor, 10%, t = 5]

$PV_{RECEIVER}$ = $4 million + $2 million × 3.791 = $11.582 million

Thus, the less famous receiver is better paid, despite press reports that the quarterback received a "$15 million contract," while the receiver got a "$14 million contract."

27. a. Each installment is: $9,420,713/19 = $495,827

PV = $495,827 × [Annuity Factor, 8%, t = 19]

PV = $495,827 × 9.604 = $4,761,923

b. If ERC is willing to pay $4.2 million, then:

$4,200,000 = $495,827 × [Annuity Factor, x%, t = 19]

This implies that the annuity factor is 8.471, so that, using the annuity table for 19 times periods, we find that the interest rate is about 10 percent.

28. This is an annuity problem with the present value of the annuity equal to $2 million (as of your retirement date), and the interest rate equal to 8 percent, with 15 time periods. Thus, your annual level of expenditure (C) is determined as follows:

$2,000,000 = C × [Annuity Factor, 8%, t = 15]

$2,000,000 = C × 8.559

C = $233,672

With an inflation rate of 4 percent per year, we will still accumulate $2 million as of our retirement date. However, because we want to spend a constant amount per year in real terms (R, constant for all t), the nominal amount (C_t) must increase each year. For each year t:

$$R = C_t /(1 + \text{inflation rate})^t$$

Therefore:

$$PV\ [\text{all } C_t] = PV\ [\text{all } R \times (1 + \text{inflation rate})^t] = \$2{,}000{,}000$$

$$R \times \left[\frac{(1+0.04)^1}{(1+0.08)^1} + \frac{(1+0.04)^2}{(1+0.08)^2} + \ldots + \frac{(1+0.04)^{15}}{(1+0.08)^{15}}\right] = \$2{,}000{,}000$$

$$R \times [0.9630 + 0.9273 + \ \ldots \ + 0.5677] = \$2{,}000{,}000$$

$$R \times 11.2390 = \$2{,}000{,}000$$

$$R = \$177{,}952$$

Thus C_1 = ($177,952 × 1.04) = $185,070, C_2 = $192,473, etc.

29. First, with nominal cash flows:

a. The nominal cash flows form a growing perpetuity at the rate of inflation, 4%. Thus, the cash flow in 1 year will be $416,000 and:

$$PV = \$416{,}000/(0.10 - 0.04) = \$6{,}933{,}333$$

b. The nominal cash flows form a growing annuity for 20 years, with an additional payment of $5 million at year 20:

$$PV = \left[\frac{416{,}000}{(1.10)^1} + \frac{432{,}640}{(1.10)^2} + \ldots + \frac{876{,}449}{(1.10)^{20}} + \frac{5{,}000{,}000}{(1.10)^{20}}\right] = \$5{,}418{,}389$$

Second, with real cash flows:

a. Here, the real cash flows are $400,000 per year in perpetuity, and we can find the real rate (r) by solving the following equation:

$$(1 + 0.10) = (1 + r) \times (1.04) \Rightarrow r = 0.0577 = 5.77\%$$

$$PV = \$400{,}000/(0.0577) = \$6{,}932{,}409$$

b. Now, the real cash flows are \$400,000 per year for 20 years and \$5 million (nominal) in 20 years. In real terms, the \$5 million dollar payment is:

$\$5,000,000/(1.04)^{20} = \$2,281,935$

Thus, the present value of the project is:

$$PV = \$400,000 \times \left[\frac{1}{(0.0577)} - \frac{1}{(0.0577)(1.0577)^{20}} \right] + \frac{\$2,281,935}{(1.0577)^{20}} = \$5,417,986$$

[As noted in the statement of the problem, the answers agree, to within rounding errors.]

30. Let x be the fraction of Ms. Pool's salary to be set aside each year. At any point in the future, t, her real income will be:

$(\$40,000)(1 + 0.02)^{t}$

The real amount saved each year will be:

$(x)(\$40,000)(1 + 0.02)^{t}$

The present value of this amount is:

$$\frac{(x)(\$40,000)(1+0.02)^{t}}{(1+0.05)^{t}}$$

Ms. Pool wants to have \$500,000, in real terms, 30 years from now. The present value of this amount (at a real rate of 5 percent) is:

$\$500,000/(1 + 0.05)^{30}$

Thus:

$$\frac{\$500,000}{(1.05)^{30}} = \sum_{t=1}^{30} \frac{(x)(\$40,000)(1.02)^{t}}{(1.05)^{t}}$$

$$\frac{\$500,000}{(1.05)^{30}} = (x)\sum_{t=1}^{30} \frac{(\$40,000)(1.02)^{t}}{(1.05)^{t}}$$

$\$115,688.72 = (x)(\$790,012.82)$

$x = 0.146$

31. $$PV = \sum_{t=1}^{5} \frac{\$600}{(1.048)^t} + \frac{\$10,000}{(1.048)^5} = \$10,522.42$$

$$PV = \sum_{t=1}^{10} \frac{\$300}{(1.024)^t} + \frac{\$10,000}{(1.024)^{10}} = \$10,527.85$$

32. $$PV = \sum_{t=1}^{5} \frac{\$600}{(1.035)^t} + \frac{\$10,000}{(1.035)^5} = \$11,128.76$$

$$PV = \sum_{t=1}^{10} \frac{\$300}{(1.0175)^t} + \frac{\$10,000}{(1.0175)^{10}} = \$11,137.65$$

33. Using trial and error:

At r = 12.0% $\Rightarrow PV = \sum_{t=1}^{2} \frac{\$100}{(1.12)^t} + \frac{\$1,000}{(1.12)^2} = \$966.20$

At r = 13.0% $\Rightarrow PV = \sum_{t=1}^{2} \frac{\$100}{(1.13)^t} + \frac{\$1,000}{(1.13)^2} = \$949.96$

At r = 12.5% $\Rightarrow PV = \sum_{t=1}^{2} \frac{\$100}{(1.125)^t} + \frac{\$1,000}{(1.125)^2} = \$958.02$

At r = 12.4% $\Rightarrow PV = \sum_{t=1}^{2} \frac{\$100}{(1.124)^t} + \frac{\$1,000}{(1.124)^2} = \$959.65$

Therefore, the yield to maturity is approximately 12.4%.

Challenge Questions

1. a. Using the Rule of 72, the time for money to double at 12 percent is 72/12, or 6 years. More precisely, if x is the number of years for money to double, then:

$$(1.12)^x = 2$$

Using logarithms, we find:

$$x\ (\ln 1.12) = \ln 2$$

$$x = 6.12 \text{ years}$$

b. With continuous compounding for interest rate r and time period x:

$$e^{r\,x} = 2$$

Taking the natural logarithm of each side:

$$r\,x = \ln(2) = 0.693$$

Thus, if r is expressed as a percent, then x (the time for money to double) is: x = 69.3/(interest rate, in percent).

2. Spreadsheet exercise

3. Let P be the price per barrel. Then, at any point in time t, the price is:

$$P\ (1 + 0.02)^t$$

The quantity produced is: $100{,}000\ (1 - 0.04)^t$

Thus revenue is:

$$100{,}000P \times [(1 + 0.02) \times (1 - 0.04)]^t = 100{,}000P \times (1 - 0.021)^t$$

Hence, we can consider the revenue stream to be a perpetuity that grows at a negative rate of 2.1 percent per year. At a discount rate of 8 percent:

$$PV = \frac{100{,}000P}{0.08 - (-0.021)} = 990{,}099P$$

With P equal to \$14, the present value is \$13,861,386.

4. Let c = the cash flow at time 0
g = the growth rate in cash flows
r = the risk adjusted discount rate

$$PV = c(1 + g)(1 + r)^{-1} + c(1 + g)^2(1 + r)^{-2} + \ldots + c(1 + g)^n(1 + r)^{-n}$$

The expression on the right-hand side is the sum of a geometric progression (see Footnote 7) with first term: $a = c(1 + g)(1 + r)^{-1}$
and common ratio: $x = (1 + g)(1 + r)^{-1}$
Applying the formula for the sum of n terms of a geometric series, the PV is:

$$PV = (a)\left[\frac{1 - x^N}{1 - x}\right] = c(1+g)(1+r)^{-1}\left[\frac{1-(1+g)^n(1+r)^{-n}}{1-(1+g)(1+r)^{-1}}\right]$$

5. The 7 percent U.S. Treasury bond (see text Section 3.5) matures in five years and provides a nominal cash flow of $70.00 per year. Therefore, with an inflation rate of 2 percent:

Year	Nominal Cash Flow	Real Cash Flow
2002	70.00	$70.00/(1.02)^1$ = 68.63
2003	70.00	$70.00/(1.02)^2$ = 67.28
2004	70.00	$70.00/(1.02)^3$ = 65.96
2005	70.00	$70.00/(1.02)^4$ = 64.67
2006	1,070.00	$1070.00/(1.02)^5$ = 969.13

With a nominal rate of 7 percent and an inflation rate of 2 percent, the real rate (r) is:

$$r = [(1.07/1.02) - 1] = 0.0490 = 4.90\%$$

The present value of the bond, with nominal cash flows and a nominal rate, is:

$$PV = \frac{70}{(1.07)^1} + \frac{70}{(1.07)^2} + \frac{70}{(1.07)^3} + \frac{70}{(1.07)^4} + \frac{1070}{(1.07)^5} = \$1,000.00$$

The present value of the bond, with real cash flows and a real rate, is:

$$PV = \frac{68.63}{(1.0490)^1} + \frac{67.28}{(1.0490)^2} + \frac{65.96}{(1.0490)^3} + \frac{64.67}{(1.0490)^4} + \frac{969.13}{(1.0490)^5} = \$1,000.00$$

6. Spreadsheet exercise.