SOLUTIONS TO END-OF-CHAPTER PROBLEMS

10-1 a. Here are the steps involved:

(1) Determine the variable cost per unit at present, V:

$$\begin{aligned} \text{Profit} &= P(Q) - FC - V(Q) \\ \$500{,}000 &= (\$100{,}000)(50) - \$2{,}000{,}000 - V(50) \\ 50(V) &= \$2{,}500{,}000 \\ V &= \$50{,}000. \end{aligned}$$

(2) Determine the new profit level if the change is made:

$$\begin{aligned} \text{New profit} &= P_2(Q_2) - FC_2 - V_2(Q_2) \\ &= \$95{,}000(70) - \$2{,}500{,}000 - (\$50{,}000 - \$10{,}000)(70) \\ &= \$1{,}350{,}000. \end{aligned}$$

(3) Determine the incremental profit:

$$\text{Profit} = \$1{,}350{,}000 - \$500{,}000 = \$850{,}000.$$

(4) Estimate the approximate rate of return on new investment:

$$\text{ROI} = \text{Profit/Investment} = \$850{,}000/\$4{,}000{,}000 = 21.25\%.$$

Since the ROI exceeds the 15 percent cost of capital, this analysis suggests that the firm should go ahead with the change.

b. If we measure operating leverage by the ratio of fixed costs to total costs at the expected output, then the change would increase operating leverage:

Old:

$$FC/[FC + V(Q)] = \$2{,}000{,}000/(\$2{,}000{,}000 + \$2{,}500{,}000) = 44.44\%.$$

New:

$$\frac{FC_2}{FC_2 + V_2(Q_2)} = \frac{\$2{,}500{,}000}{\$2{,}500{,}000 + \$2{,}800{,}000} = 47.17\%.$$

The change would also increase the breakeven point:

Old:

$$Q_{BE} = \frac{F}{P - V} = \frac{\$2{,}000{,}000}{\$100{,}000 - \$50{,}000} = 40 \text{ units}.$$

New:

$$\$95{,}000 - \$40{,}000$$

However, one could measure operating leverage in other ways, say by degree of operating leverage:

Old:

$$DOL = \frac{Q(P - V)}{Q(P - V) - F} = \frac{50(\$50{,}000)}{50(\$50{,}000) - \$2{,}000{,}000} = 5.0.$$

New: The new DOL, at the expected sales level of 70, is

$$\frac{70(\$95{,}000 - \$40{,}000)}{70(\$55{,}000) - \$2{,}500{,}000} = 2.85.$$

The problem here is that we have changed both output and sales price, so the DOLs are not really comparable.

c. It is impossible to state unequivocally whether the new situation would have more or less business risk than the old one. We would need information on both the sales probability distribution and the uncertainty about variable input cost in order to make this determination. However, since a higher breakeven point, other things held constant, is more risky, the change in breakeven points--and also the higher percentage of fixed costs--suggests that the new situation is more risky.

10-2 a. Expected ROE for Firm C:

ROE_C = (0.1)(-5.0%) + (0.2)(5.0%) + (0.4)(15.0%)
+ (0.2)(25.0%) + (0.1)(35.0%) = 15.0%.

Note: The distribution of ROE_C is symmetrical. Thus, the answer to this problem could have been obtained by simple inspection.

Standard deviation of ROE for Firm C:

$= \sqrt{0.1(-20)^2 + 0.2(-10)^2 + 0.4(0)^2 + 0.2(10)^2 + 0.1(20)^2} = \sqrt{40 + 20 + 0 + 20 + 40} = \sqrt{120} = 11.0\%$

b. According to the standard deviations of ROE, Firm A is the least risky, while C is the most risky. However, this analysis does not take into account portfolio effects--if C's ROE goes up when most other companies' ROEs decline (that is, its beta is negative), its apparent riskiness would be reduced.

c. Firm A's $s_{ROE} = s_{BEP} = 5.5\%$. Therefore, Firm A uses no financial leverage and has no financial risk. Firm B and Firm C have $s_{ROE} > s_{BEP}$, and hence both use leverage. Firm C uses the most leverage because it has the highest $s_{ROE} - s_{BEP} =$ measure of financial risk. However, Firm C's stockholders also have the highest expected ROE.

10-3 a. V = Value of debt + Value of equity = D + S = D + $\frac{(\text{EBIT} - \text{I})(1 - \text{T})}{k_s}$.

Calculation of EBIT:

Sales		$12,000,000
Variable costs	$6,000,000	
Fixed costs	5,000,000	
Total costs before interest and taxes		11,000,000
	EBIT =	$ 1,000,000

I = Interest cost of the original $1,000,000 debt at 8%
+ Interest cost of incremental $1,000,000 debt at 9%
= $1,000,000(0.08) + $1,000,000(0.09) = $80,000 + $90,000 = $170,000.

$$V = \$2,000,000 + \frac{(\$1,000,000 - \$170,000)(1 - 0.4)}{0.115}$$

= $2,000,000 + $4,330,435 = $6,330,435.

Since the value of the firm increases from its current value of $6,257,143 to $6,330,435 by increasing the debt from $1,000,000 to $2,000,000, the firm should increase its use of debt.

b. Value of the firm with debt = $3,000,000:

I = Interest cost of original $1,000,000 debt at 8%
+ Interest cost of incremental $2,000,000 at 12%
= $1,000,000(0.08) + $2,000,000(0.12) = $320,000.

$$V = \$3,000,000 + \frac{(\$1,000,000 - \$320,000)(1 - 0.4)}{0.15} = \$5,720,000.$$

Since increasing the debt from $2 million to $3 million would cause the value of the firm to decline, it should limit its use of debt to $2 million.

c. The original market price of the firm's stock was $20. We can use this information to determine the number of shares outstanding:

Shares outstanding = Price P P

$$n = \frac{\$6{,}257{,}143 - \$1{,}000{,}000}{\$20} = 262{,}857 \text{ shares.}$$

The firm increases its leverage by selling debt and repurchasing its shares of stock. The repurchase price is the equilibrium price that would prevail after the repurchase transaction. The original shareholders would sell their stock only at a price that incorporated the increased value of the firm resulting from the repurchase:

$$P_1 = \frac{V_1 - D_0}{n_0}.$$

At D = \$2 million: $P_1 = \frac{(\$6{,}330{,}435 - \$1{,}000{,}000)}{262{,}857} = \$20.28.$

At D = \$3 million: $P_1 = \frac{(\$5{,}720{,}000 - \$1{,}000{,}000)}{262{,}857} = \$17.96.$

d. Since the firm pays out all its earnings as dividends, DPS = EPS.

$$P = \frac{DPS}{k_s} = \frac{EPS}{k_s}, \text{and } EPS = (P)(k_s).$$

EPS(D = \$1 million) = (\$20.00)(0.105) = \$2.10.
EPS(D = \$2 million) = (\$20.28)(0.115) = \$2.33.
EPS(D = \$3 million) = (\$17.96)(0.150) = \$2.69.

Although the firm's EPS is higher at D = \$3 million, the firm should not increase its debt from \$2 to \$3 million because the stock price is higher at a debt level of \$2 million. The optimum capital structure is the one that maximizes stock price rather than EPS.

e. The value of the old bonds would decline. They have a fixed coupon rate, so k_d rises because of added financial risk, and the value of the bonds must fall. This value is transferred to the stockholders. For exactly this reason, bond indentures do place limits on the amount of additional debt firms can issue.

10-4 a. Original value of the firm (D = \$0):

$$V = D + \frac{(EBIT - I)(1 - T)}{k_s}$$

$$= 0 + \frac{(\$500{,}000 - \$0)(1 - 0.4)}{0.10} = \$0 + \$3{,}000{,}000 = \$3{,}000{,}000.$$

With financial leverage (D = \$900,000):

$$V = D + \frac{(EBIT - I)(1 - T)}{k_s}.$$

I = Interest cost = k_dD = (0.07)($900,000) = $63,000.

$$V = \$900,000 + \frac{(\$500,000 - \$63,000)(1 - 0.4)}{0.11}$$

= $900,000 + $2,383,636 = $3,283,636.

Increasing the financial leverage by adding $900,000 of debt results in an increase in the firm's value from $3,000,000 to $3,283,636.

b. Shares are repurchased at the equilibrium market price that prevails after the announcement of the transaction. This is because existing shareholders would only sell at a price that incorporated the increased value of the firm resulting from the repurchase. We know that

$$P_1 = \frac{V_1 - D_0}{n_0}$$

$$\text{thus } P_1 = \frac{\$3,283,636}{200,000} = \$16.42,$$

up from $15 with zero debt financing.

c. Since the firm pays out all earnings as dividends, DPS = EPS, and

$$P = \frac{DPS}{k_s} = \frac{EPS}{k_s}.$$

Therefore, EPS = (P)(k_s).

Initial position: EPS = ($15.00)(0.10) = $1.50.
With financial leverage: EPS = ($16.42)(0.11) = $1.81.

Thus, by adding $900,000 of debt, the firm increased its EPS by $0.31.

Confirm this as follows:

$$EPS = \frac{\text{Net income}}{\text{Shares outstanding}} = \frac{(\$500,000 - \$63,000)(0.6)}{200,000 - (\$900,000/\$16.42)} = \frac{\$262,200}{145,189} = \$1.81.$$

d. Zero debt:

$$EPS = \frac{EBIT(1 - T)}{n} = \frac{EBIT(0.6)}{200,000}.$$

Probability	EPS

0.10	($0.30)
0.20	0.60
0.40	1.50
0.20	2.40
0.10	3.30

$900,000 debt:

$$EPS = \frac{(EBIT - I)(1 - T)}{n} = \frac{(EBIT - \$63{,}000)(0.6)}{145{,}189}.$$

Probability	EPS
0.10	($0.67)
0.20	0.57
0.40	1.81
0.20	3.05
0.10	4.29

By inspection, the EPS distribution at $900,000 debt is more variable, and hence riskier in the total risk sense.

e. Zero debt:

$$TIE = \frac{EBIT}{I} = \frac{EBIT}{\$0} = \text{Undefined}.$$

$900,000 debt:

$$TIE = \frac{EBIT}{I} = \frac{EBIT}{\$63{,}000}.$$

Probability	TIE
0.10	(1.59)
0.20	3.17
0.40	7.94
0.20	12.70
0.10	17.46

The interest payment is not covered when TIE < 1.0. The probability of this occurring is 0.10, or 10 percent.

10-5 a. Present situation (in millions):

EBIT	$13.24
Interest	5.00
EBT	$ 8.24
Taxes (15%)	1.24
Net income	$ 7.00

$$DPS = EPS = \frac{\text{Net income}}{\text{Shares}} = \frac{\$7 \text{ million}}{1 \text{ million}} = \$7.00.$$

$$k_s = \frac{DPS}{P_0} = \frac{\$7.00}{\$50} = 14.0\% \text{ at present}.$$

b. Original leverage (D = $50 million):

$$V = D + \frac{[EBIT - D(k_d)](1 - T)}{k_s}$$

$$= \$50 + \frac{[\$13.24 - \$5)(1 - 0.15)}{0.14} = \$50 + \$50 = \$100 \text{ million}.$$

Decrease leverage (D = $30 million):

$$V = \$30 + \frac{[\$13.24 - \$2.4)(0.85)}{0.13} = \$30 + \$70.88 = \$100.88 \text{ million}.$$

Increase leverage (D = $70 million):

$$V = \$70 + \frac{[\$13.24 - \$8.4)(0.85)}{0.16} = \$70 + \$25.71 = \$95.71 \text{ million}.$$

Since the value of the company increases with a decrease in leverage to $30 million, the company should decrease its capital structure from $50 million debt to $30 million debt. This can be verified by looking at what the new stock price would be if $30 million debt were used in the capital structure:

$$P_1 = \frac{\text{New value of company - Old value of debt}}{\text{Old shares outstanding}}.$$

For D = $30 million:

$$P_1 = \frac{\$100{,}880{,}000 - \$50{,}000{,}000}{\$1{,}000{,}000} = \$50.88 \text{ versus } \$50.00 = P_0.$$

c. $$V = \$50 + \frac{(\$13.24 - \$5)(0.66)}{0.14} = \$50 + \$38.85 = \$88.85 \text{ million}.$$

The stock price falls to ($88.85 million - $50 million)/(1 million shares) = $38.85.

d. If the firm uses $30 million of 8 percent debt, the value will be:

$$V = \$30 + \frac{(13.24 - \$2.4)(0.66)}{0.13} = \$85.03 \text{ million}.$$

$$P_1 = \frac{\$85{,}030{,}000 - \$50{,}000{,}000}{1{,}000{,}000} = \$35.03.$$

If the firm uses $70 million of 12 percent debt, the value will be:

$$V = \$70 + \frac{(\$13.24 - \$8.4)(0.66)}{0.16} = \$89.97 \text{ million} .$$

$$P_1 = \frac{V_1 - D_0}{n_0} = \frac{\$89{,}970{,}000 - \$50{,}000{,}000}{1{,}000{,}000} = \$39.97 .$$

Thus, with the higher tax rates, the value of the firm is maximized with *more* financial leverage. The final stock price, if more leverage is used, will be $39.97, up from $38.85 with only $50 million of debt. (The equilibrium value, after refinancing, of the firm will be $89.97 million. Investors would recognize that this value will exist shortly, so the *current* stock price would reflect this value. The current value of the debt is $50 million, so the current value of equity is $89.97 - $50 = $39.97 million. Since there are 1 million shares now outstanding, each share will sell for $39.97.)

This problem illustrates a very important principle: The major advantage of debt financing is the fact that interest is a tax-deductible expense. The value of a tax deduction depends on the tax rate. Thus, when the tax rate is high, like 34 percent, leverage has a more favorable impact than when it is low (15 percent). Companies in high tax brackets get more benefits from the use of financial leverage. $k_d(1 - T)$ is smaller if T is larger.

e. If the firm's 10 percent debt could not be called, then it would be difficult to reduce leverage. The bonds might be bought on the open market, but if the company lowered its leverage, k_d would decline, causing the 10 percent bonds' prices to rise. This would mean that the firm would have to pay a premium to retire its old bonds, and this would reduce the benefits of the refunding.

If the firm increased its leverage to $70 million, its old debt would decline in value as k_d rose, because of the added risk of additional debt. Thus, the value of the firm would be:

$$V = D_1 + D_2 + S,$$

where D_1 is the (below par) value of the old bonds and D_2 is the (par) value of the new bonds.

The value of the stock, S, would be higher than in the case where the old bonds must be refunded because the interest payments are now lower as a result of continuing to use 10 percent debt even after k_d rises to 12 percent. At T = 15%, and D = $70 million:

$$S = \frac{[\text{EBIT} - (\text{Old } k_d)(\text{Old debt}) - (\text{New } k_d)(\text{New debt})](1 - T)}{k_s}$$

$$= \frac{[\$13.24 - \$5 - 0.12(\$20)](0.85)}{0.16} = \$31.03 \text{ million},$$

up from $25.7 million in Part b of the solution. This assumes the old debt is a perpetuity and remains outstanding forever. If this were not the case, and the old debt had to eventually be retired, then the value of the equity would eventually fall to $25.7 million.

Note that the value of the old bonds would decline from $50 million to:

$$V_{B_0} = \frac{k_{d_0}(\$50\,M)}{k_d} = \frac{\$5\,M}{0.12} = \$41{,}666{,}667 \approx \$41.67 \text{ million}.$$

or by $8,333,333. The value of the equity would rise by $31,030,000 - $25,700,000 = $5,330,000.

The new total value of the firm would be:

V_1 = Value of old debt + Value of new debt + Value of stock
= $41.67 + $20.00 + $31.03 = $92.7 million.

Thus, the value of the firm would fall by $7.3 million as a result of the increased leverage, but the value of the equity would rise by $5.33 million. Obviously, stockholders would be benefiting at the expense of the old bondholders.

The price of the stock would be $51.03:

$$P_1 = \frac{V - D_{Old}}{n_{Old}} = \frac{\$92{,}700{,}000 - \$41{,}670{,}000}{1{,}000{,}000} = \$51.03.$$

This is up from $50.

f. Under these assumptions, here are the income statements:

Probability	0.2	0.6	0.2
EBIT	$5,000,000	$15,000,000	$25,000,000
Debt = $70 million:			
Interest:			
Old	$5,000,000	$5,000,000	$ 5,000,000
New	2,400,000	2,400,000	2,400,000
EBT	($2,400,000)	$7,600,000	$17,600,000
Taxes (at 15%)	(360,000)	1,140,000	2,640,000
Net income	($2,040,000)	$6,460,000	$14,960,000
EPS*	($3.35)	$10.62	$24.60
Expected EPS		$10.62	
$σ_{EPS}$**		$ 8.84	
CV_{EPS}		0.83	
TIE = EBIT/I	0.68×	2.03×	3.38×
E(TIE)		2.03×	
$σ_{TIE}$		0.85×	
CV_{TIE}		0.42	

*n_1 = 1,000,000 - ($20,000,000/$51.03) = 608,074.

**$σ_{EPS} = \sqrt{(x_i - \bar{x})^2 P_1}$.

10-6 Here is a list of some of the factors which influence the capital structure decision and how they apply to Firms A and Z. Each factor is analyzed assuming that the other factors are irrelevant.

Business risk. A's business risk is probably higher than Z's since it faces far more uncertainty in sales demand and margins, and hence revenues. Thus, Z should be able to use higher leverage before it faces significant financial distress costs.

Reserve borrowing capacity. Firm A would probably have a greater requirement for reserve borrowing capacity. It is in a highly volatile, fast-growth business and is more likely to face uncertain equity markets. Thus, Firm A should favor lower leverage.

Asset structure. Firm Z has a higher percentage of assets suitable as collateral. Thus, Firm Z can probably carry more debt.

Ownership structure. Firm Z's majority stockholders (the founder's family) may have much of their personal wealth tied up in the company. If this is the case, their lack of diversification may indicate less leverage, and hence less risk of financial distress, for Firm Z.

Profitability. Firm A is more profitable. Thus, it can retain more funds and this lessens the debt requirement. Conversely, highly profitable firms can carry more debt.

Taxes. Firm Z's accelerated depreciation expenses tend to lower its effective tax rate, which decreases the benefits of debt financing.

Here is a matrix summarizing the analysis. A plus (+) indicates that the factor favors higher leverage, while a minus (-) indicates lower leverage. A zero (0) indicates uncertain effects.

Factor	Firm A	Firm Z
Business risk	-	+
Reserve borrowing capacity	-	0
Asset structure	-	+
Ownership structure	0	-
Profitability	0	0
Taxes	+	-

All in all, it is tough to balance out the contradictory effects. However, working managers have a better feel for which factors are most relevant to their firms.